SUSTAINABLE URBAN ENERGY

A Sourcebook for Asia

UN HABITAT
FOR A BETTER URBAN FUTURE

IUTC

Sustainable Urban Energy: A Sourcebook for Asia

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FOREWORD by *Prof. Kwi-Gon Kim*

Confronting the challenges of fossil fuels depletion looming large and rapid climate change, it is inevitable for cities to develop and implement urban energy management solutions for their sustainable future. This publication has been created as collaboration between International Urban Training Centre (IUTC) and UN-HABIATAT in order to provide basic principles, knowledge and diverse case studies on sustainable urban energy planning and management. The publication reflects knowledge and experience gained from the last five years of training programmes operation at IUTC, and I am certain that it will provide far more than basic information but also practical and hands-on guideline for actual implementation in the cities of the Asia and Pacific Region. I hope this Sourcebook will serve to enhance the capacity and creativity for future urban energy in the Region and beyond. On behalf of IUTC, I appreciate the valuable contributions of Dr. Brahmanand Mohanty and the staff at the IUTC and UN-Habitat.

Prof. Kwi-Gon Kim
Emeritus Professor at Seoul National University
Director, International Urban Training Center

FOREWORD by *Dr. Gulelat Kebede*

This publication forms part of a series of documents on urban issues, for use as background and training materials for local government training. The publication is the result of the collaboration between UN-Habitat and the International Urban Training Centre (IUTC), Republic of Korea. Two earlier drafts of this document were tested in "Sustainable Urban Energy Courses" at the centre and it is hoped that the tool will be useful for similar trainings in the future, at the IUTC as well as for local government training in the countries of the Asia and Pacific Region. The Sourcebook's wealth of information and tools will serve training participants and urban energy practitioners alike to help them to move their cities to sustainable energy management and to improve access to affordable energy to all. The Sourcebook looks at energy from a holistic approach exploring a multitude of urban sectors that influence energy supply and demand.

Dr. Gulelat Kebede
Chief, Training and Capacity Building Branch
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Introduction

"One point is certain. The centre of gravity of global energy demand growth now lies in the developing world, especially in China and India. But uncertainties abound."

- Nobuo Tanaka, Executive Director, International Energy Agency

Cities are engines of economic growth. On an average they are responsible for more than 75 per cent of a country's Gross Domestic Product (GDP). The world's total population is close to 7 billion today, with half living in urban centres, and expected to increase to 68 per cent by 2050 (Doman 2009). Asian cities will double in size over the next 20 years, adding more than 40 million each year. Hence the 21st century will undoubtedly be the century of urban development for Asia. The challenge for Asia will be to provide the basic amenities such as food, water and shelter, transportation, education and sanitation for its urban and rural population, without disturbing the ecological balance. Cities are voracious resource consumers, and as cities grow, their consumption also follows suit, absorbing more resources and increasing the ecological footprint. Cities need an uninterrupted supply of energy to fuel their activities, and this is currently being met predominantly by fossil fuels. However, fossils fuels are finite; their availability is under question, with harmful effects on the environment.

The way forward is likely to be an alternative development model that is not carbon intensive, one that is economically and socially inclusive, and focuses on the well-being of the population. A systematic understanding of today's energy consumption and production systems will provide us with some insights on how to achieve this. Various initiatives in Asia and around the world can be replicated, adapted and scaled up by municipal authorities.

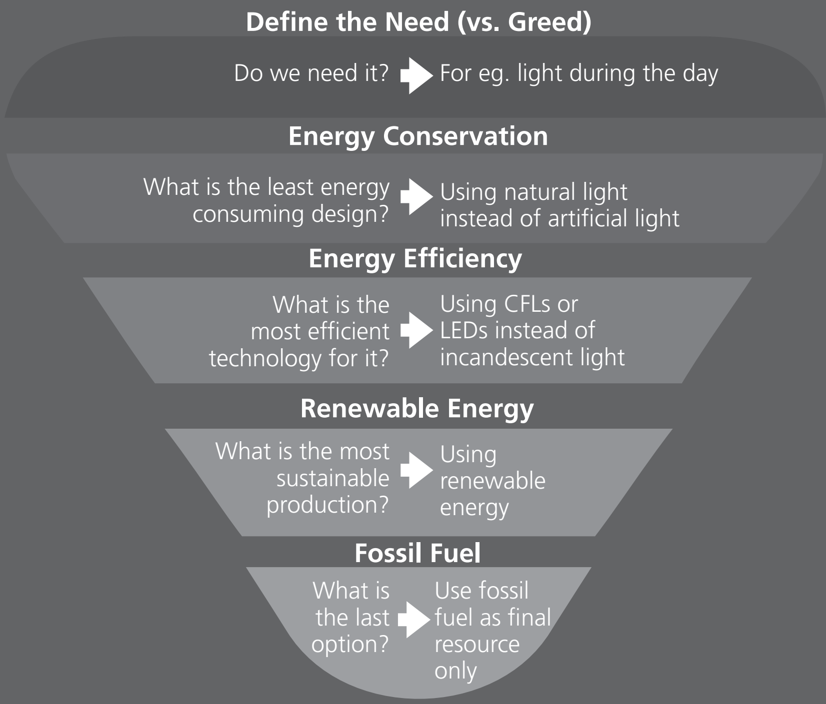
This Sourcebook addresses sustainable energy solutions from a system's perspective, as a three-step process - energy conservation, energy efficiency and renewable energy. Energy conservation asks the question, "do we need to consume a given good/service?" Energy efficiency asks, "what would be the best possible way to consume the same good/service", while renewable energy asks, "could there be sustainable renewable energy alternatives for fossil fuels".

Figure 0.1 illustrates the potential for a more sustainable future by taking an example of a light bulb during the day. We first ask the question, whether additional light is needed during the day, as opposed to whether we want it. If needed, then we could perhaps move into a better-lit room or even open the curtains to let in more light? If a light bulb is required, then could we use Compact Fluorescent

Lamps (CFLs) or Light Emitting Diodes (LEDs) that are more energy efficient? And can the energy for this come from a renewable source?

In order to exert less pressure on energy production, cities need to cut down on consumption and make behavioural changes. An intervention that reduces energy use even by a small amount at the individual level, can translate into large reductions in the amount of energy that needs to be produced.

Figure 0.1 Energy Pyramid
This diagram illustrates how energy usage can be lowered using a three-step process



There are many low hanging fruits such as these that local authorities can use to conserve energy independently, without having to refer to national authorities. If they take advantage of this, the primary goal of having well-planned, well-managed and well-governed cities using sustainable urban energy will become a more tangible reality.

What are the Objectives of this Sourcebook?

This Sourcebook focuses primarily on Asian cities, and hopes to
- Illustrate the challenges of meeting the required energy demand and providing access to affordable energy to all.
- Present a concept of more sustainable energy management in the Asian urban context.

- Analyse the linkages between various sectors and subsectors in a systematic way and address the need for a more holistic approach in energy issues.
- Present existing and future solutions for a more sustainably integrated development of urban areas and to learn from initiatives from around the world
- Provide a tool kit for policy makers, planners and local authorities who aim at making their cities carbon-frugal or carbon-neutral.

In light of global warming and other environmental threats, local Governments around the world have taken up initiatives in mitigation and adaptation to climate change. This sourcebook serves as an informative document that can help local leaders such as mayors, councillors and even task managers to take stock of the situation, analyse wastage, and look for innovative solutions to reduce energy demand and to implement more sustainable energy systems. The book may also serve as a guidebook for National Governments as well as Non-Governmental Organisations (NGOs).

Contents of the Sourcebook

The sourcebook is divided into 4 chapters. Chapter 1 focuses on current trends of urban development in Asia and around the world. Chapter 2 explores options for cities to become more energy sustainable through the use of existing technologies and energy conservation methods. Chapter 3 presents best practices for developing more sustainable cities, while Chapter 4 shares basic policy instruments for local authorities in attaining a carbon neutral city. Key considerations that have enabled the creation of this sourcebook are as follows:

Holistic Approach

This sourcebook focuses on energy issues in urban areas; however, since this has implications on many non-energy sectors such as water, waste, governance, management and planning, these issues are addressed as well. Energy is closely linked with all basic services that urban dwellers need. Hence, an integrated approach is the key to energy management.

Focus on Small to Medium Sized Cities

Large cities dominate discussions on growth, but they are strangled by problems relating to urbanization, with little or no room for mitigation. Growth patterns suggest that most future development will take place in Asia's small- and middle-size cities. Unlike Megacities, these cities often have a limited stock of infrastructure in place. Whilst these cities face significant challenges, not being locked into past investment and planning decisions provides opportunities for sustainable development. The Sourcebook defines small cities as those having a population of less than one million; and medium-sized cities as those with a population of one to two million. Most of the growth in population and GDP will occur in so-called middle-weight cities, many of which are in Asia (McKinsey Global Institute 2011). These cities presently lack the necessary knowledge, institutional, financial and political capital for such transformation to take place in a sustainable way.

Context and Heterogeneity of the Continent

The "one-size-fits-all" approach may not work for a continent as diverse as Asia. Geographically and politically as well, the situation of one Asian country differs drastically from its neighbour. Solutions that will work for a particular geographic location, under a specific style of governance are not applicable to other locations. While examples are cited from around Asia and the world, the idea is to make them as relevant to leaders of Asian countries as possible.

Focus on Immediate Action

The sourcebook emphasizes that the time to act is now in order to avert catastrophic global climate change.

Emphasis on Local Solutions

Finding solutions at the local level in small and medium-sized cities is the main focus, with mayors, councillors and task managers at the centre of the sourcebook. All discussions keep local leaders in mind. Although it is understandable that certain policies trickle down from central policies, and very often local authorities follow national or regional action plans, the emphasis is on proactive and independent decision-making by local leaders. Whether it is mobilizing communities at the micro level or making policies and regulations, local leadership plays a crucial role in bringing about this change.

01. Energy is all Pervasive

" If everyone consumed as much energy as the average Singaporean and U.S. resident, the world's oil reserves would be depleted in 9 years."

- WWF Energy Report 2050

For nearly everything we produce or consume we require energy. Energy is all pervasive, human life is build upon resources that have embodied energy. Energy is not only required to produce electricity of to fuel a vehicle all essentials of our life depend on energy input, water needs energy for pumping and supply, waste has embodied energy and needs energy for it's disposal, housing and infrastructure take up vast amount of energy resources. Cities exert a particularly high demand of energy. A big percentage of this increasing energy demand is covered by fossil fuels, a resource that is getting more and more scare, increasing in price and that is a large contributor to global warming. The fossil fuel depended urbanization is still expanding all over the world even though the resource of fossil fuel is being fast depleted. Facing this facts energy security presents itself as one of the keys for the development of Asia's cities.

1.1 General Trend of Urbanization

"Urbanization and economic growth typically happen in tandem; however, equitable distribution of benefits and opportunities remains a challenge."

- (UN Habitat 2011)

Cities occupy less than 3 per cent of the land surface, and yet house half of the world's population. They use 75 per cent of the available resources, and account for about 67 per cent of all greenhouse gas emissions (World Energy Outlook, 2008). The energy and materials that are consumed by cities must be disposed in some form, and they do so in vast quantities of solid, liquid and gaseous waste. In other words, cities are dissipative structures of intense energy and material consumption as well as waste production.

Goods and services needed within a city are generally produced outside the city, and often in other countries. Urban centres thus rely on the supply of natural resources from around the planet, with the associated environmental impact. Tokyo for example, has an eco-footprint, which is 344 times larger than its region, and 4.3 times the area of Japan (Figure 1.1).

In a world where all inhabitants share their resources equally, the per capita sustainable footprint would be 1.8 Hectares. The average footprint of the Asian giant China is 1.6, while that of Shanghai is already at 7.0. (ADB, 2008)

Figure 1.1 Tokyo's Eco-Footprint

Adapted from: Rees, 2010

Box 1.1 Ecological Footprint

"The Ecological Footprint has emerged as the world's premier measure of humanity's demand on nature. It measures how much land and water area a human population requires to produce the resource it consumes and to absorb its carbon dioxide emissions, using prevailing technology. It now takes the Earth one year and six months to regenerate what we use in a year. We maintain this overshoot by liquidating the Earth's resources."

Source: www.footprintnetwork.org

The future of the planet depends on how cities deal with the demand for energy, as well as their demand for ecological resources. This chapter addresses current growth trends, the importance of energy in urban centres and the challenges that developing countries in Asia face to provide (continuous) energy to millions of people, keeping the local/global environment in mind, as well as the need to draw millions out of poverty.

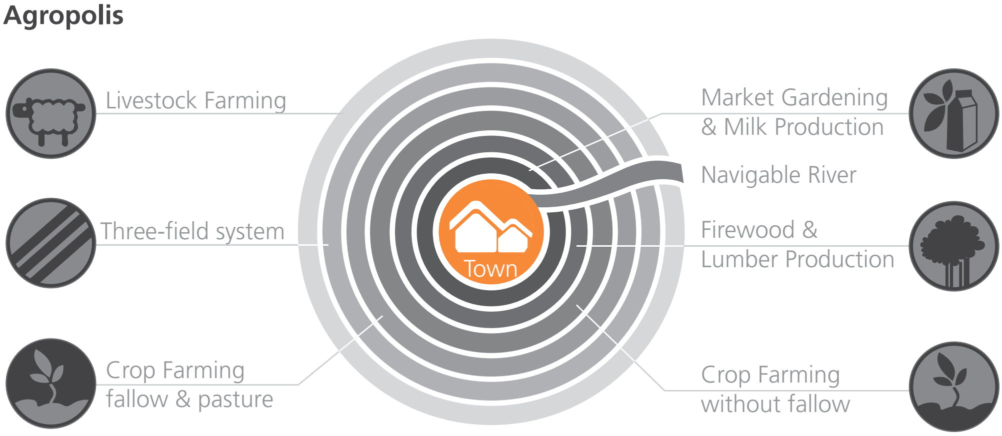
20th Century Agropolis to Petropolis

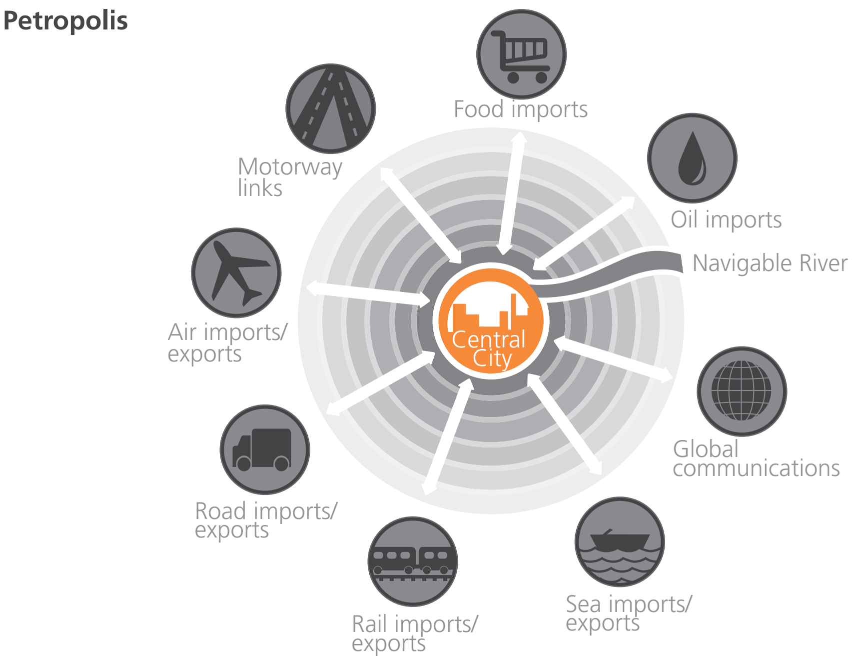
In the past, cities based their operations on an elaborate economic and ecological system to meet their sustenance. In the absence of major transport systems, the hinterland supplied the city with its needs of food and other goods, and the city assured the continuous productivity of the hinterland by returning appropriate amounts of organic waste that could be used for fertilizing the cropland. "This type of traditional settlement system is called Agropolis. Until very recently, many Asian cities were still largely self-sufficient in food as well as fertilizer, using human and animal wastes to sustain the fertility of local farms" (World Future Council, 2010).

With the industrial revolution, this symbiotic relation between a city and its hinterland was replaced. Faster modes of transport made the supply of food and raw materials easier to handle. Cities became economic trade centres with access to global resources. Such a system has been described as 'Petropolis' since all key functions – production, consumption and transport – are powered by massive injections of petroleum and other fossil fuels. But there is ever growing evidence that the resulting dependencies are ecologically, economically and geopolitically untenable, particularly because the fossil fuel supplies on which modern cities depend are finite (World Future Council, 2010).

The paradigm for a city's sustained economic growth should focus on developing competitive industrial clusters, on fostering rural-urban linkages, on improving productivity and conditions in the informal sector, and on infrastructure development. (ADB, 2008)

Figure 1.2 Metabolism of Agropolis Compared to Petropolis





Adapted from: World Future Council, 2010

Cost of Climate Change

The large usage of fossil fuels and greenhouse gas emissions has contributed to Climate Change. The costs of adapting to this will be colossal: a recent report suggests that by 2030, the world may need to spend more than €USD 200 billion a year on measures such as building flood defences, transporting water for agriculture and rebuilding infrastructure affected by climate change (IIED, 2009). Costal cities and island states will be particularly affected, with those in the Least Developed Countries being particularly vulnerable. Only 2 per cent of the world's land is in the Low Elevation Coastal Zone (LECZ) – the area adjacent to the coast that is less than ten metres above mean sea level – but this zone is home to 10 per cent of the world's population, 60 per cent of whom live in urban areas (IIED, 2009). Large areas of cities may become uninhabitable as a result of flooding or water-logging, or may be agriculturally unusable due to salt erosion. As well as damage to infrastructure, many areas could be rendered completely uninhabitable as a result of inundation (IIED, 2009).

The future battle against climate change is likely to be largely won or lost in Asian cities, which are expected to contribute over half the increment in GHGs over the next 20 years. (ADB 2008)

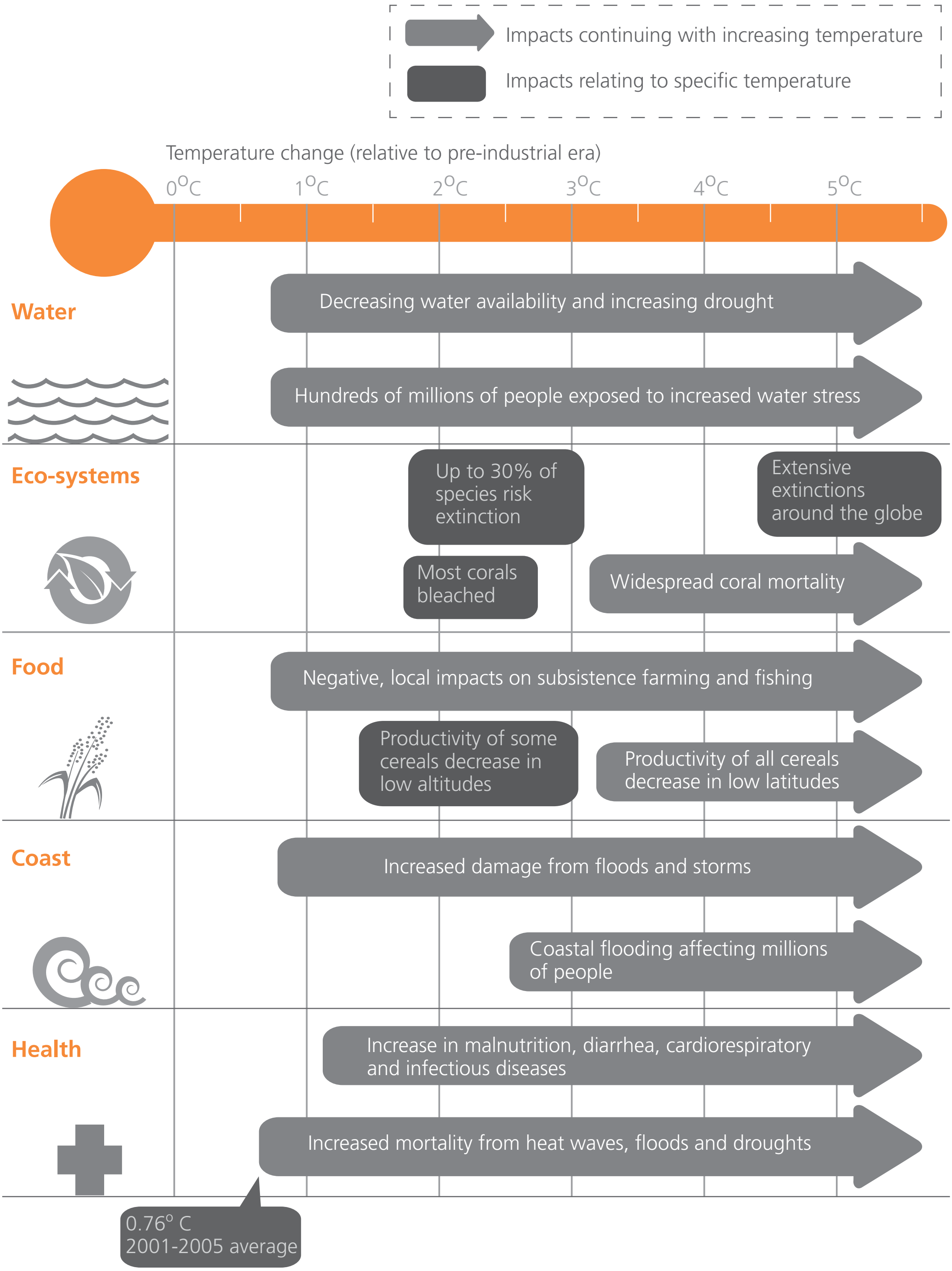
In cities where rainfall is low, drought is the issue that is most likely to be accentuated by climate change. The effects of drought are widespread but are focused in particular on drinking water shortages and increased food prices (IIED, 2009). The global consensus is that 1.2 billion people could experience freshwater scarcity by 2020; crop yields in Central and South Asia could drop by 50 per cent between now and 2050; and coastal community ecosystems, and even entire island nations could vanish (ADB, 2007). To effectively address mitigation, all three areas—energy, fugitive emissions, and land use—must be addressed (ADB, 2007).

Box 1.2 The Stern Review in Brief

- Climate change will have a serious impact on the environment, human life and world output. All the countries will be affected.
- To stabilise greenhouse gas levels in the atmosphere, annual emissions need to be cut by more than 80 per cent.
- Climate change could cost the equivalent of 5 per cent of global GDP per year. The worst case scenario could be 20 per cent.
- The cost of action could be limited to about 1 per cent of global GDP per year.
- Action on climate change will create new business opportunities in low-carbon energy technologies and low-carbon goods and services.
- Tackling climate change can be done in a way that will not stop growth in rich and poor nations.
- Developing countries must also take significant action – but should not have to bear the costs alone.
- Emissions can be cut through increased energy efficiency, reduced demand, and by adopting clean fuel technologies. Government policies must encourage these.
- The response must be coordinated, long term and international, and include measures such as emissions trading, technology cooperation and reduced deforestation.

Source: Stern, 2006

Figure 1.3 Impacts of Climate Change

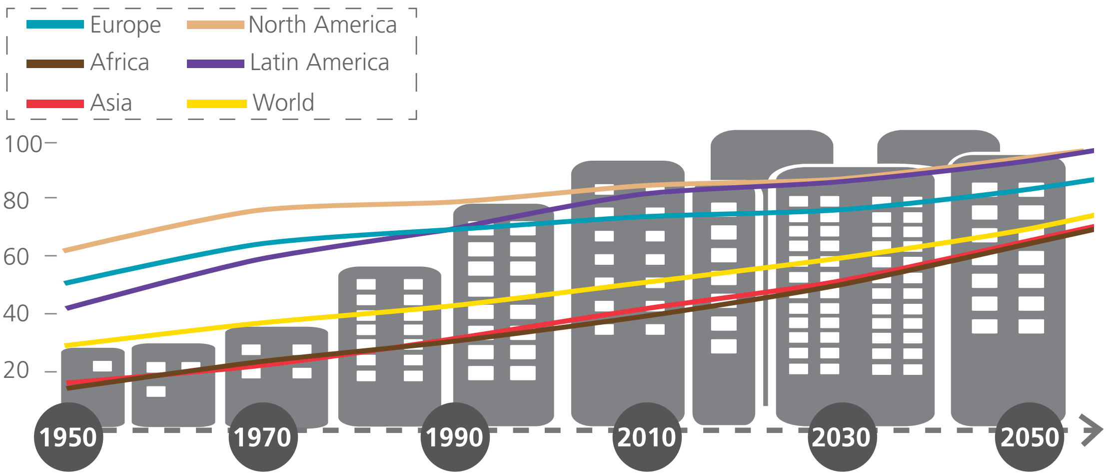


Adapted from: IPCC, 2007

Population Growth and Urbanization

Today, more than half of the planet's population lives in cities. It is expected that by 2050 another 3 billion people will be living in urban areas, or about 68 per cent of the global population. Most Asian countries still have a relatively low level of urbanization: 30 per cent in India, 44 per cent in China and 47 per cent in Indonesia. The average rate of urbanization in Europe is 73 per cent and even higher: 80 per cent for the United Kingdom, 85 per cent for France and in the United States, it is 82 per cent.

Figure 1.4 Proportion of Urban Population 1950-2060 (in per cent)



Adapted from: United Nations, Department of Economic and Social Affairs Database, accessed July 2011

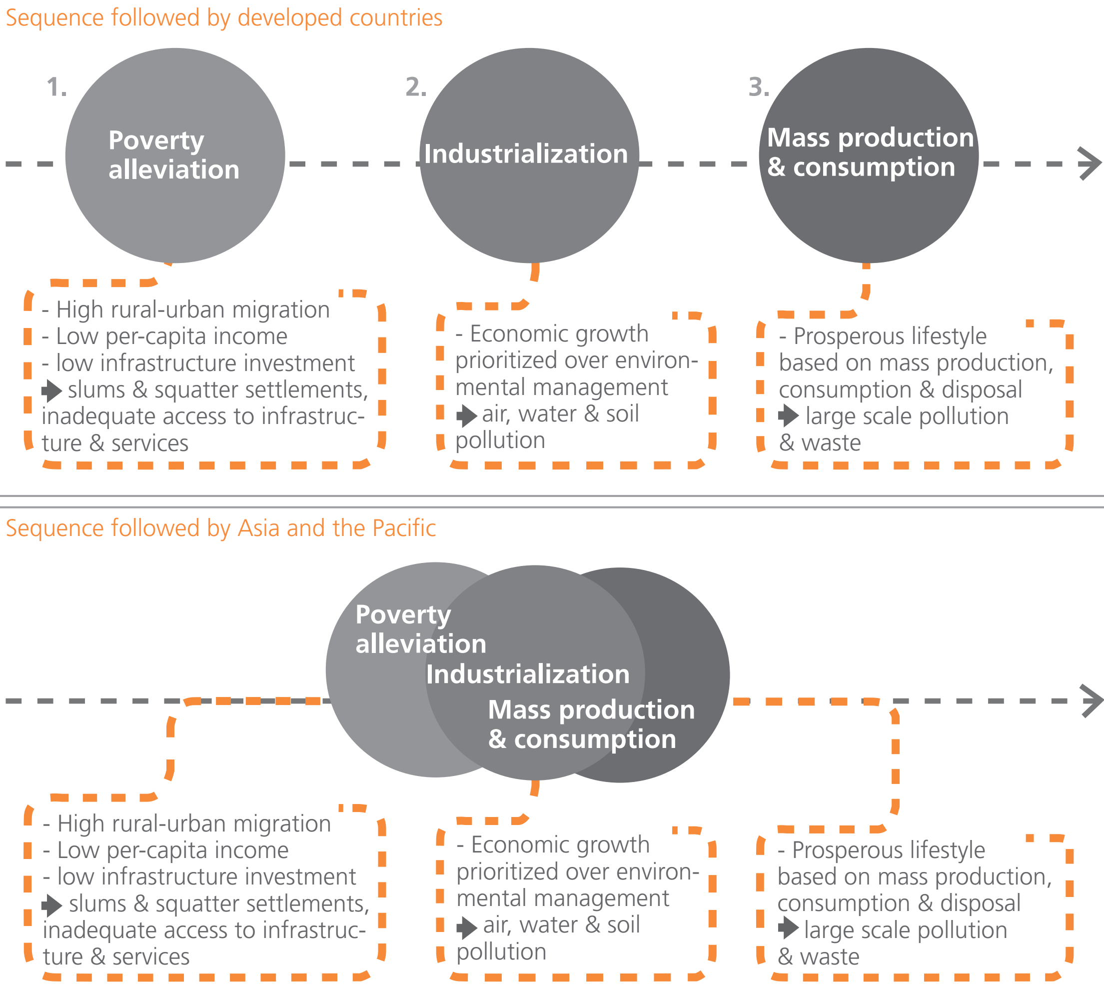
Urban Evolution: Developed vs. Developing Countries

According to the World Bank (1992) we can identify three levels of environmental problems in urban areas, each of which corresponds to different levels of economic development:

- Poverty related issues such as slums, inadequate infrastructure etc.;
- Industrial pollution related issues such as air, water and soil pollution;
- Mass production and consumption related issues such as large-scale pollution, solid waste, etc.

Bai and Imura (2001) developed a hypothesis that cities develop through these three stages (viz. poverty stage, industrial pollution stage, consumption and mass production stage) before approaching the sustainable city stage. However this model explains how industrialized cities have evolved. For developing countries the picture presented is quite different. In fact, we are witnessing a synchronicity of all phases - while poverty is rampant and the per capita energy consumption is low, there is a massive growth in production, which mostly caters the industrialized world (Figure 1.5). The urban rich are adopting lifestyles that are comparable to those of the developed countries. Even though Asia's ecological footprint is still relatively low, there is need for serious retrospection on whether it is wise to continue with development and lifestyles that are unsustainable.

Figure 1.5 Urban Environmental Evolution: Developed vs. Developing Countries



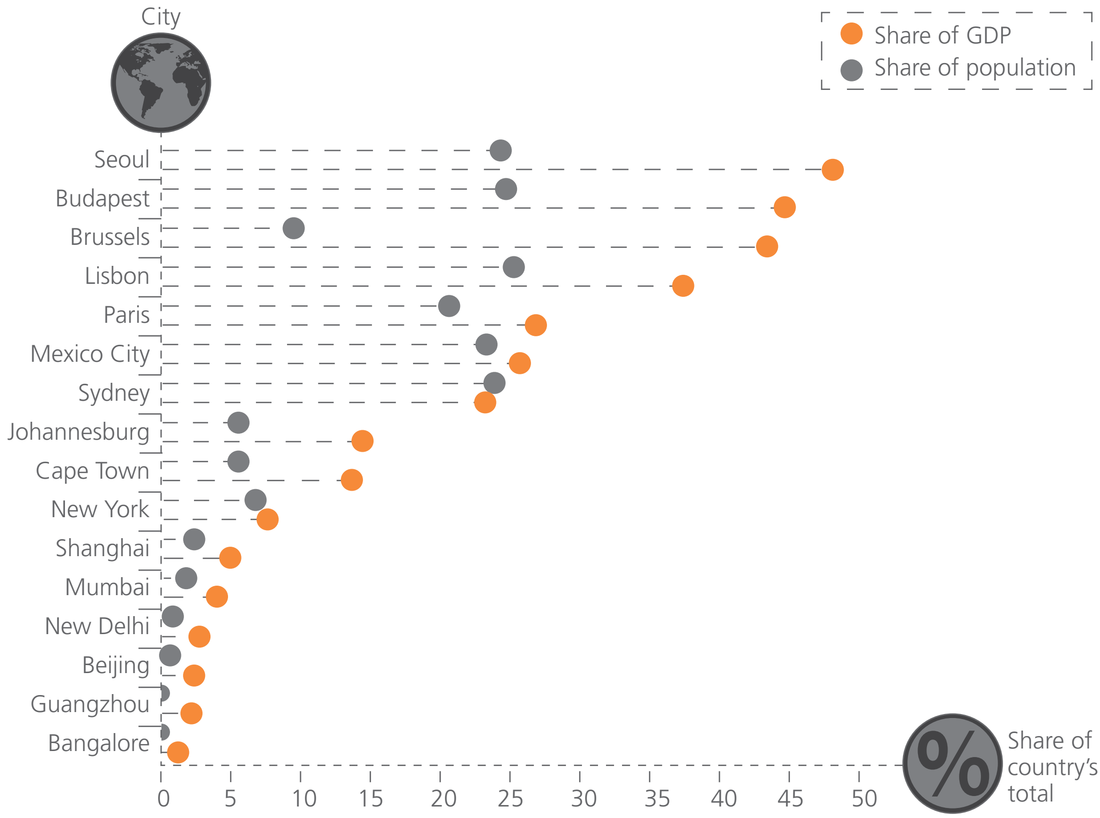
Adapted from: Bai and Imura, 2000

Economic Growth and Urbanization

Cities are centres of cultural, human and economic capital. This is an important pull factor for people to migrate to cities. The correlation between economic growth and urbanization has been long known.

"No country has ever achieved sustained economic growth and rapid social development without urbanizing" (UN Habitat, 2011). According to the McKinsey Global Institute (2011), today there are 600 urban centres that generate about 60 per cent of the global Gross Domestic Product (GDP). To take an extreme example, the city of Seoul contributes close to 50 per cent of Republic of Korea's GDP while having a population of about 24 per cent of the country's total. Figure 1.6 illustrates this. Globally cities consume 67 per cent of all energy and account for 71 per cent of all greenhouse gas emissions.

Figure 1.6 Share of National Gross Domestic Product (GDP) and Population for Selected Cities



Adapted from: UN Habitat, 2008

They need vast amounts of water and energy for transportation, infrastructure, housing, food supply, etc. Obviously there is a nexus between urbanization, economic growth and increase of carbon emissions.

GDP and urban development are intrinsically linked to each other. Nations with a high GDP per capita also rank high regarding the proportion of their urban population. Table 1.1 shows that high income level countries have a much higher percentage urban population than middle or low income countries.

In both India and China, the five largest cities contributed approximately 15 per cent of national GDP in 2004 – roughly three times what could have been expected based solely on their relative shares of the population. (UN Habitat, 2011a)

Table 1.1 Growth of Urbanization and Gross Domestic Product (GDP)

By Level of Income	GDP per capita (Constant 2000 USD)	Urban Population (% of total)
High income	28,755	78
Middle income	2,011	48
Low income	415	32

Adapted from: UN Habitat, 2011a

1.2 How are Asian Cities Growing?

"Evidence shows that the transition from low-income to middle-income country status is almost always accompanied by a transition from a rural to an urban economy."

- Commission on Growth and Development, 2009

The scale of urbanization in Asia is striking and difficult to visualize – on average, around 120,000 people are added to city populations every day. This implies that "… each day, the construction of more than 20,000 new dwellings, 250 kilometres of new roads and additional infrastructure to supply more than 6 million litres of potable water is required" (ADB, 2006). It is not surprising that nearly a third of all urban dwellers live in slums today.

Like elsewhere, the expansion of cities in Asia has often been characterized by unplanned and informal settlements. Poverty and slums have been closely associated with urban growth. A large proportion of Asia's urban population suffers from food deprivation, low income, premature mortality, lack of access to services and poor quality of housing (UN Habitat, 2011). In 2010 about 30 per cent of Asia's population lived in slums. Even though significant progress has been made and the percentage of people living in slums is falling, the total number of slum dwellers is still on the rise (Table 1.2).

The population of slum dwellers around the world continues to grow by around 10 per cent every year, intensifying the problem worldwide. (UN Habitat, 2011a)

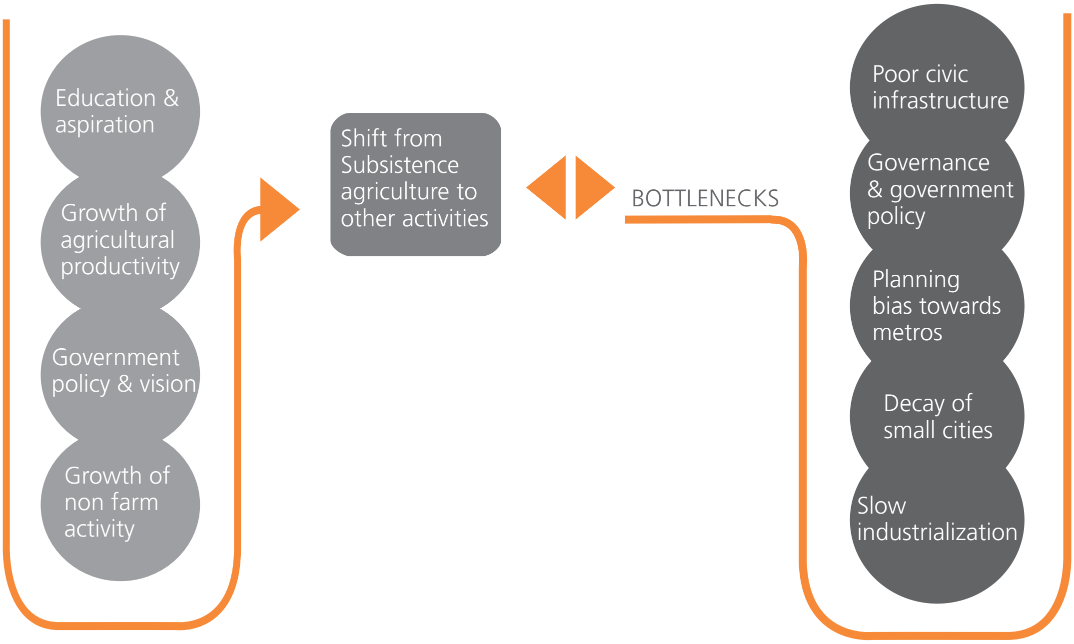
Table 1.2 Proportion of Urban Population Living in Slums (per cent)

Regions	1990	2000	2010
Eastern Asia	43.7	37.4	28.2
Southern Asia	57.2	45.8	35
South Eastern Asia	49.5	39.6	31
Western Asia	22.5	20.6	24.6

Adapted from: UN Habitat, 2011

Urbanization is driven by migration from rural areas as well as by population increase. Immigration from rural areas triggered by the surge for employment and a better life will account for a big part of this. Most of this growth will be concentrated in informal settlements and slum areas.

Figure 1.7 Drivers and Bottlenecks of Urbanization



Adapted from: WWF, 2010

Box 1.3 UN Millennium Goal for Slum Reduction

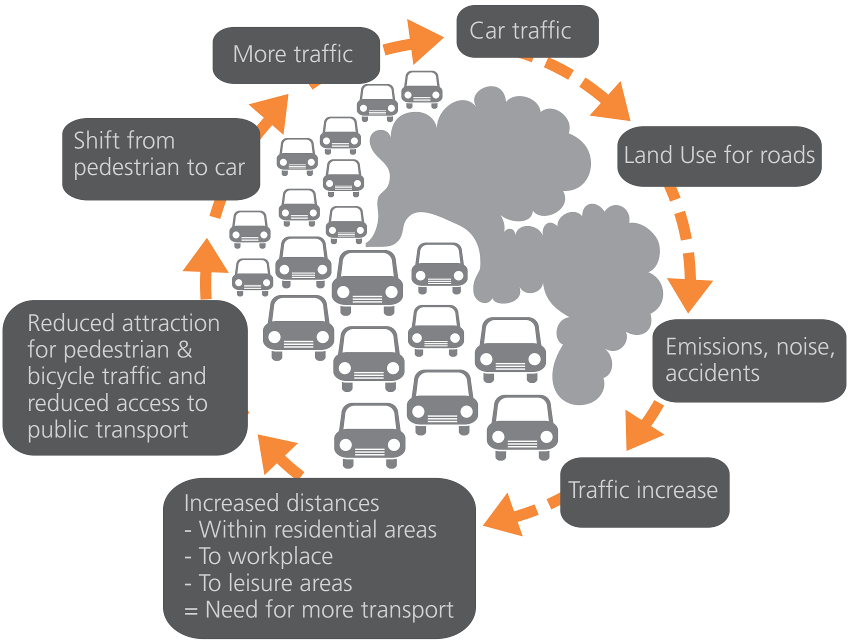
The United Nations system assigned UN-Habitat the responsibility of assisting Member States to monitor and gradually attain the "Cities Without Slums" target, also known as Target 11, which is one of the three targets of Goal 7, "Ensure Environmental Sustainability". Target 11 aims: "by 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers".

Source: ww2.unhabitat.org/mdg/

Urban Planning and Sprawl

With urbanization, as land prices increase in the heart of the city due to economic development, the city starts to expand horizontally. Urban sprawl is very energy inefficient, as it leads to "more travel, more fuel consumption, more air pollution, and also to inefficiencies in infrastructure and service provision" (Sierra Club, 2009). Also, as a result of sprawl, modern cities are planned according to the dimensions of cars with broad highways and flyovers. This creates a vicious circle - it boosts traffic, increases distances people drive and reduces the attraction of walking and bicycle transport (Figure 1.8).

Figure 1.8 The Vicious Circle of Private Motorized Transport



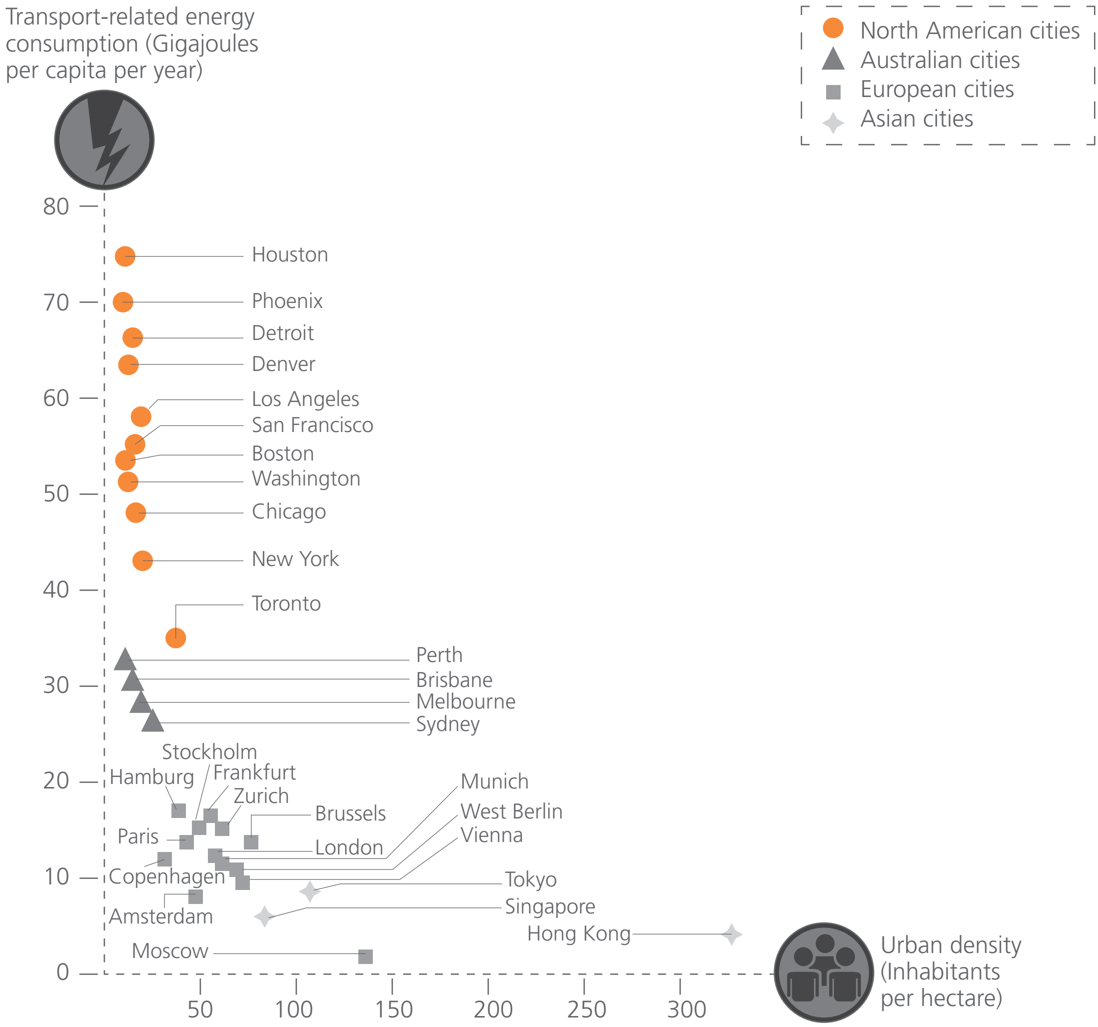
Adapted from: GTZ, 2004

Cities with sprawl development end up consuming more energy than cities that have allowed denser growth around city centres (Figure 1.9). It is estimated that sprawl development uses five times more pipe and wire, five times more energy for heating and cooling, twice as many building materials, three times more automobiles, and causes four times more driving. It also consumes 35 times as much land, and requires 15 times as much pavement as compact urban living (Sierra Club, 2009).

As an example, the daily residential energy need for Hong Kong, one of the densest cities in the world, is just 20 Mega Joules (MJ) per capita as compared to the average consumption of 70 MJ/capita in OECD countries. The energy needed for Hong Kong's transport is just 8 MJ/capita compared to Houston's 75 MJ/capita (UN HABITAT, 2006). Hong Kong achieved this because authorities allowed high-rises for both residential and commercial use.

Suburbanization and urban sprawl are happening in different places throughout the world, spreading low-density urban patterns and negative environmental, economic and social externalities. (UN Habitat, 2011a)

Figure 1.9 Urban Density and Transport Related Energy Consumption



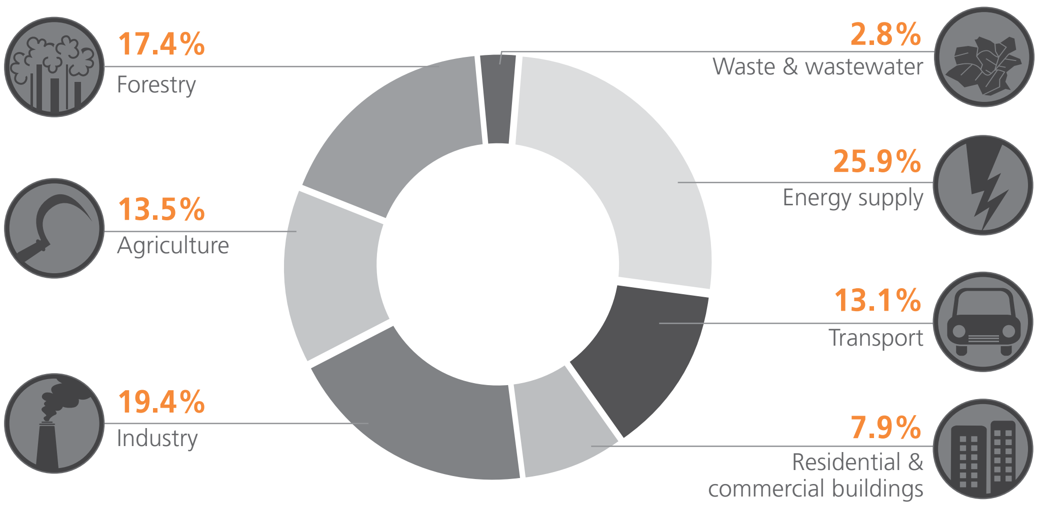
Adapted from: Kirby, 2008

Environmental Implications of Urban Growth

Agriculture and Forestry have been found to be responsible for around 30 per cent of greenhouse gas emissions. Urban areas shape this in two major ways. First, urbanization can involve direct changes in land-use, as formerly agricultural land becomes built-up areas. Indeed, global urban trends towards suburbanization mean that cities are continuing to sprawl and encroach on land that was previously used for agriculture, thereby reducing its potential to absorb CO_2. For instance, carbon dioxide released from land use change in Indonesia accounts for more than three quarters than three quarters of the country's total greenhouse gas (GHG) emissions.

Second, to meet the consumption needs of wealthy urbanites, city-based enterprises, households and institutions place significant demands on forests, farmlands and watersheds outside urban boundaries (UN Habitat, 2011).

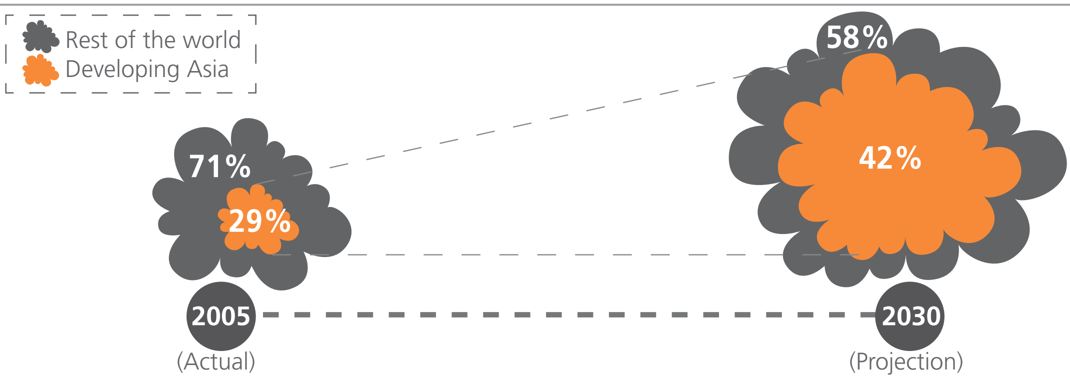
Figure 1.10 Sources of Greenhouse Gas Emissions 2004



Adapted from: Vattenfall, 2009

If current trends continue, the greenhouse gas emissions in the Asia-Pacific region will soon be comparable to those of Europe and North America. Emissions from energy use alone are projected to be 127 per cent higher in 2030 than they are today, with the region being responsible for 42 per cent of all global energy-related emissions (ADB, 2007).

Figure 1.11 Developing Asia's Share in Global CO_2 Emissions from Energy Consumption



Adapted from: IEA,2007

Table 1.3 Evolution of National Greenhouse Gas (GHG) Emissions and those of Selected Cities

City	City GHG emissions per capita (Tonnes of CO_2 eq) (Year of study in brackets)	National emissions per capita (Tonnes of CO_2 eq) (Year of study in brackets)
Washington, DC (US)	19.7 (2005)	23.9 (2004)
Glasgow (UK)	8.4 (2004)	11.2 (2004)
Toronto (Canada)	8.2 (2001)	23.7 (2004)
Shanghai (China)	8.1 (1998)	3.4 (1994)
New York City (US)	7.1 (2005)	23.9 (2004)
Beijing (China)	6.9 (1998)	3.4 (1994)
London (UK)	6.2 (2006)	11.2 (2004)
Tokyo (Japan)	4.8 (1998)	10.6 (2004)
Seoul (Republic of Korea)	3.8 (1998)	6.7 (1990)
Barcelona (Spain)	3.4 (1996)	10.0 (2004)
Rio de Janeiro (Brazil)	2.3 (1998)	8.2 (1994)
Sao Paulo (Brazil)	1.5 (2003)	8.2 (1994)

Adapted from: Dohan, 2009

Box 1.4 Environmental Impact on a City's Economy

According to a 2006 survey by the American Chamber of Commerce in Hong Kong, almost four out of five professionals based in Hong Kong were thinking of leaving, or knew others who had already left, because of the quality of the environment. Ninety five per cent of respondents were worried about the air quality in Hong Kong and the potential long-term effects on the health of themselves and their children. In addition, 55 per cent of respondents knew of professionals who had declined to move to Hong Kong because of the quality of its natural environment. The same survey showed that "quality of the natural environment" topped a list of seven factors in terms of importance when selecting a place to live: 94 per cent ranked it as either the most important or the second most important factor. The Hong Kong example shows that if the environment were cleaner and the air quality better, companies would invest more money in the city. A healthy environment is vital to attract and keep capital investment.

Source: American Chamber of Commerce, 2006

The costs of adapting to climate change will be colossal: a recent report suggests that by 2030, the world may need to spend more than €200 billion a year on measures such as building flood defences, transporting water for agriculture and rebuilding infrastructure affected by climate change (IIED, 2009). Coastal cities and island states will be particularly affected, with those in the Least Developed Countries being particularly vulnerable. Large areas of cities may become uninhabitable as a result of flooding or waterlogging, or may be agriculturally unusable due to salt erosion (IIED, 2009).

1.3 The Energy Needs of Cities

"Cities all over the world are getting bigger as more and more people move from rural to urban sites, but that has created enormous problems with respect to environmental pollution and the general quality of life."

–Alan Dundes, Former Professor of Anthropology, University of California (2002)

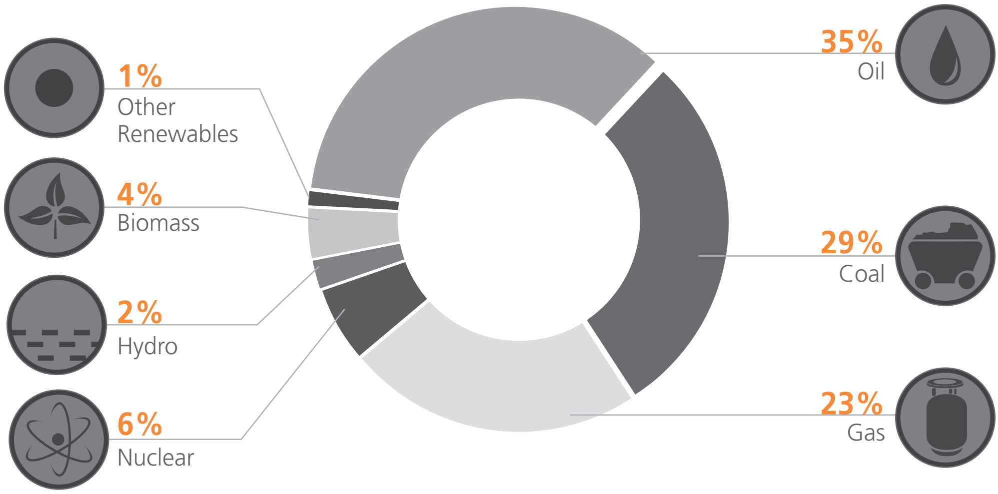
Some of the key environmental and social challenges associated with urban development are un-proportionally high energy consumption, a high level of greenhouse gas emissions, a vast ecological footprint, high resource consumption (water, food) and large infrastructure costs aggravated by urban sprawl, the growth of slums and the lack of livelihood opportunities. Asia especially is witnessing a rapid urbanization and a fast rise in the above mentioned consequences. This is a tremendous challenge for Asia's governments, which are often not equipped with tools to respond to this fast-paced development.

High Dependency on Fossil Fuels

According to the forecast of the International Energy Agency (2006), the world will need almost 60 per cent more energy in 2030 than in 2002 to meet its demand. Most of this demand increase will come from non-OECD countries. Under the current business as-usual scenario, energy use in Asia will increase 112 per cent by 2030. China's energy consumption is one of the fastest growing with an annual increase of 11.2 per cent, and it has surpassed the US as the world's largest energy consumer (BP, 2011). Today, fossil fuels supply over 80 per cent of primary energy globally. But as we know they are finite resources that will be depleted in the near future. Asian cities are on the path of economic growth as well as a fast population growth, both of which will increase the demand for energy and resources. Most of Asia's growth today is fuelled by fossil energies such as coal, oil and gas. Import dependency and soaring prices of fossil fuels are threatening the emergent growth of Asia's cities.

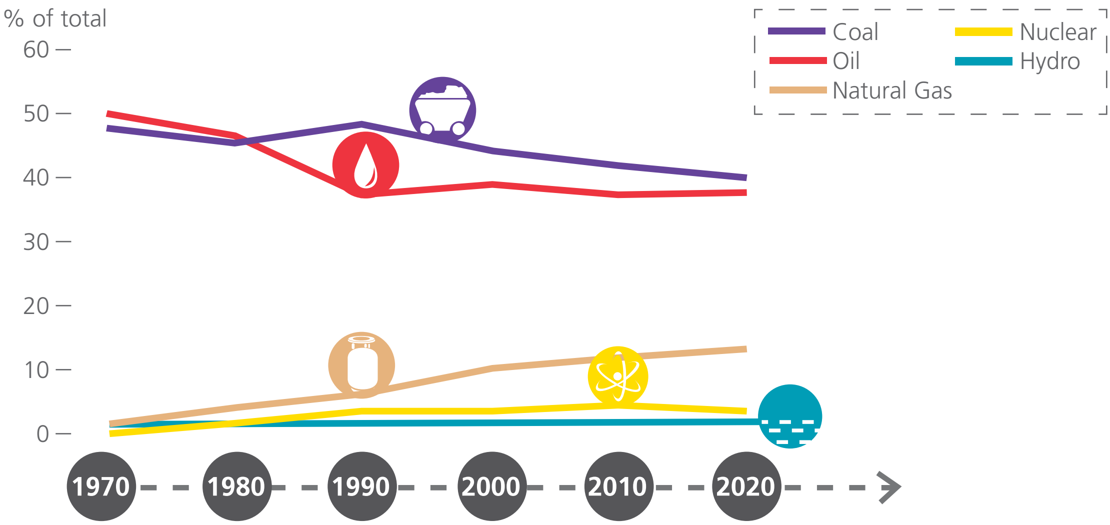
Fossil fuels in China, India, Indonesia, the Philippines, Thailand and Vietnam provide more than 75 per cent of total final energy consumption. (UNESCAP, 2008)

Figure 1.12 World Primary Energy Supply 2010



Adapted from: OECD, 2010

Figure 1.13 Primary Energy Supply by Source for Asia (1971 – 2020)



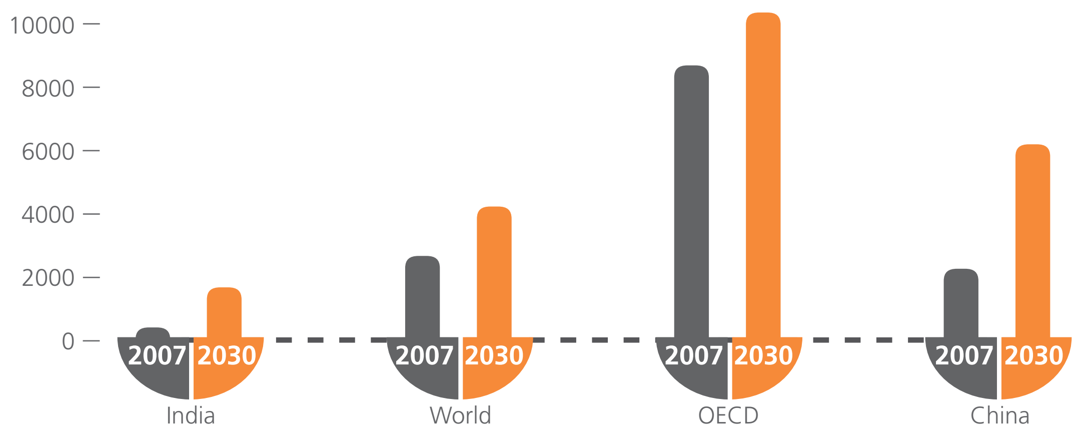
Adapted from: Institute for Energy Economics, 2006

Intrinsic Link between Urban Life and Electricity

Electricity is pivotal for modern lifestyles. It runs our industries and fuels our homes. With demographic expansion and economic growth the demand for electricity has been growing as well. According to IEA estimates, the world's average annual electricity consumption per capita for 2007 was 2,752 kWh, and for 2030 it will be about 4,128 kWh. In 2007, the per capita electricity consumption in OECD countries was about three times higher than the world average and it is expected to continue this way till 2030. In order to supply this growing demand for electricity, developing countries are expected to increase capacity by installing new power plants. However one-fifth of the world's population does not have access to reliable electricity. In developing Asia the number of people lacking access to electricity was 799 million in 2009. In India alone 100,000 villages are yet to have access to electricity, and over 44 million households do not have access to energy (GWEC, 2010).

While the average worldwide losses in transmission and distribution are in the range of 10 per cent, in some developing countries non-technical losses could reach up to 50 per cent of the total electricity transmitted over the network. (WEC, 2001)

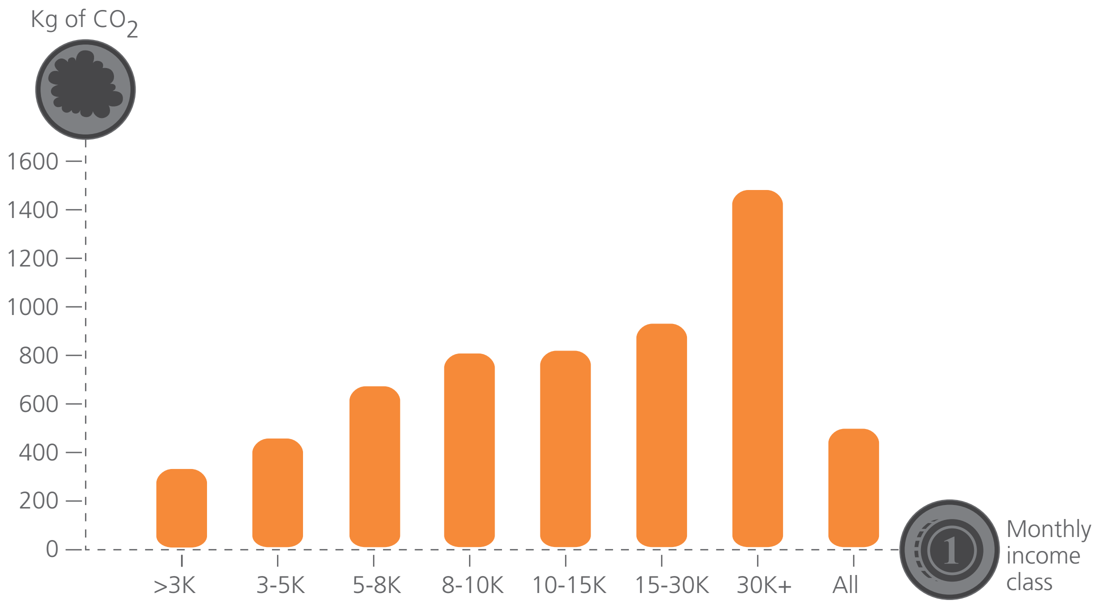
Figure 1.14 Annual Per Capita Electricity Consumption



Adapted from: IEA, 2009

Cities are the biggest consumers of the supplied electricity. In India for example, the one-third of the population that live in cities consume 87 per cent of the nation's electricity (Starke, 2007). Also, there are stark variations in the consumption rates between different income groups. In India, the higher income groups have around 4 times the per capita CO_2 emissions from household energy consumption and transport than the lowest income group (Figure 1.15).

Figure 1.15 Per Capita Annual CO_2 Emissions from Household Energy Consumption and Transport of Different Income Groups



Adapted from: Greenpeace, 2007

Box 1.5 Market Distortions through Fossil Fuel Subsidies

Fossil-fuel subsidies result in an economically inefficient allocation of resources and market distortions, while often failing to meet their intended objectives. Subsidies that artificially lower energy prices encourage wasteful consumption, exacerbate energy-price volatility by blurring market signals, incentivize fuel adulteration and smuggling, and undermine the competitiveness of renewables and more efficient energy technologies. For importing countries, subsidies often impose a significant fiscal burden on state budgets, while for producers they quicken the depletion of resources and can thereby reduce export earnings over the long term.

Source: OECD, 2010

Regular power cuts, resulting from load shedding when the demand is higher than supply, are common in many Asian countries. This problem is likely to get worse since economic growth leads to increased demand for electricity. In Asia adding new capacity is the most widely used answer, but this takes time and is costly as well. There are other options that are often less capital intensive and could be considered. These include behavioural and lifestyle changes, smart appliances, co-generation and reducing the losses in the distribution network (technical and non-technical ones).

Distribution losses are especially high in Asia. The World Bank reports that for Pakistan, "reducing electricity transmission and distribution losses are more cost-effective measures for reducing the demand-supply imbalances than adding generation capacity". The same will apply to many other Asian countries (World Bank, 2006).

Table 1.4 Transmission and Distribution (T&D) Losses in Selected Countries

Country	T&D losses%	Country	T&D losses%
Japan	4.0	Switzerland	6.0
Denmark	4.0	Sweden	6.4
Germany	4.0	United States	7.0
Ghana	4.0	United Kingdom	7.0
Singapore	4.0	Taiwan	7.0
Guam	4.50	Italy	7.4
Macau	4.81	London	8.3
ROK*	5.4	Malaysia	10.0
France	5.9	Thailand	10.3
Australia	6.0	Fiji	10.52
Canada	6.0	Indonesia	12.0
China	6.0	Mexico	14.0
South Africa	6.0	Hong Kong	15.0

*Republic of Korea

Adapted from: World Bank, 1997

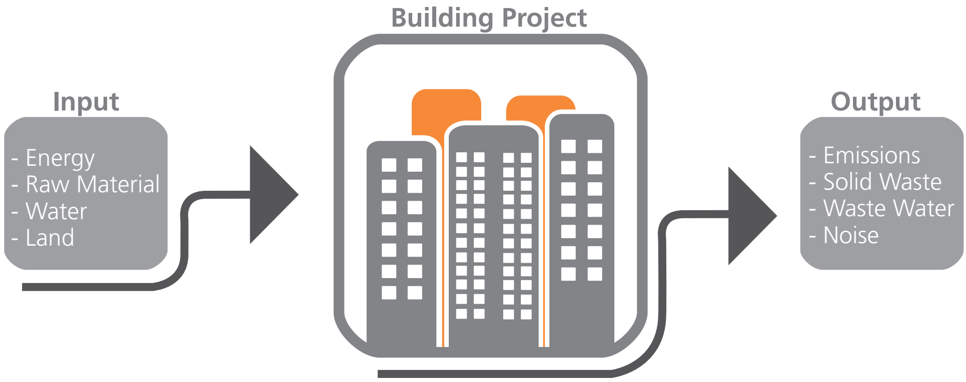
Energy for the Built Environment

Buildings consume large amounts of raw materials, energy and water and at the same time produce immense quantities of waste and pollution. The way we build is shaped by geography, cultural values and by the availability of raw material. Buildings usually have a long life span, hence their effect on people and the environment is long and continuing. This makes the building sector a particular issue in terms of sustainability.

In countries like India and China, where expansion of the middle class and urbanization is occurring rapidly, the emissions and energy use of buildings are projected to increase dramatically. (UNEP, 2008)

Energy is used through out the lifecycle of a building. First, the construction material that is used has embodied energy, since energy is needed for the extraction and manufacture of raw materials. Second, energy is used in the construction phase of the project as. all the drilling machines, pumps, tractors, etc, need energy for their operation. Thirdly, energy is needed for the usage and maintenance of the building (viz. lighting, air conditioning, cleaning) and lastly energy is needed for demolishing the building and for removing the debris.

Figure 1.16: Input and Output of a Building



According to the IPCC (2007) report, buildings have the largest potential of any sector for reducing greenhouse gas emissions, estimated at 29 per cent by 2030. Hence, it is vital that building design and construction methods are re-evaluated.

Figure 1.17 Life Cycle Energy Use of Buildings

Adapted from: World Business Council for Sustainable Development, 2010

Embodied Energy

The building sector has been one of the booming industries in Asian cities. More than 50 per cent of all new buildings constructed are in Asia. Developed countries spend most of their energy in maintaining existing buildings, but the developing countries spend more energy in construction and development.

The modern building and construction sector is very steel, cement and glass based. All of these materials embody a high amount of energy equal to the sum of all the energy inputs during all stages of their life cycles. Table 1.5 shows embodied energy of commonly-used building materials, highlighting the fact that steel can have 24 times the embodied energy of wood, and aluminium a whopping 124 times.

The rapid pace of construction taking place in Asia is unsustainable, and unless traditional building and construction methods are altered, they will account for immense amounts of energy, material, and water waste and contribute significantly to global climate change. (UNEP, 2008)

Table 1.5 Embodied Energy of Commonly used Construction Materials (expressed in terms of kWh of energy used per kg weight)

Materials	kWh/ton
Wood	640
Brick	4x
Concrete	5x
Plastic	6x
Glass	14x
Steel	24x
Aluminium	124x

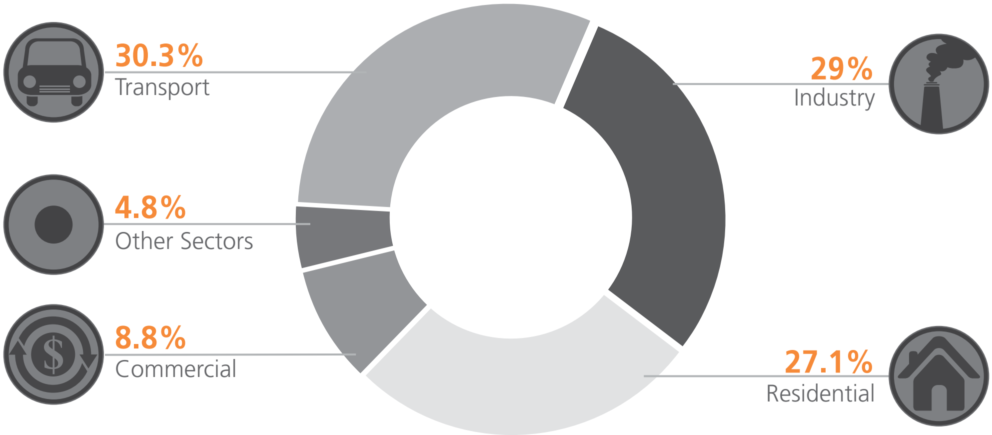
X = 640kWh/ton

Adapted from: TSG, 2009

Energy in use

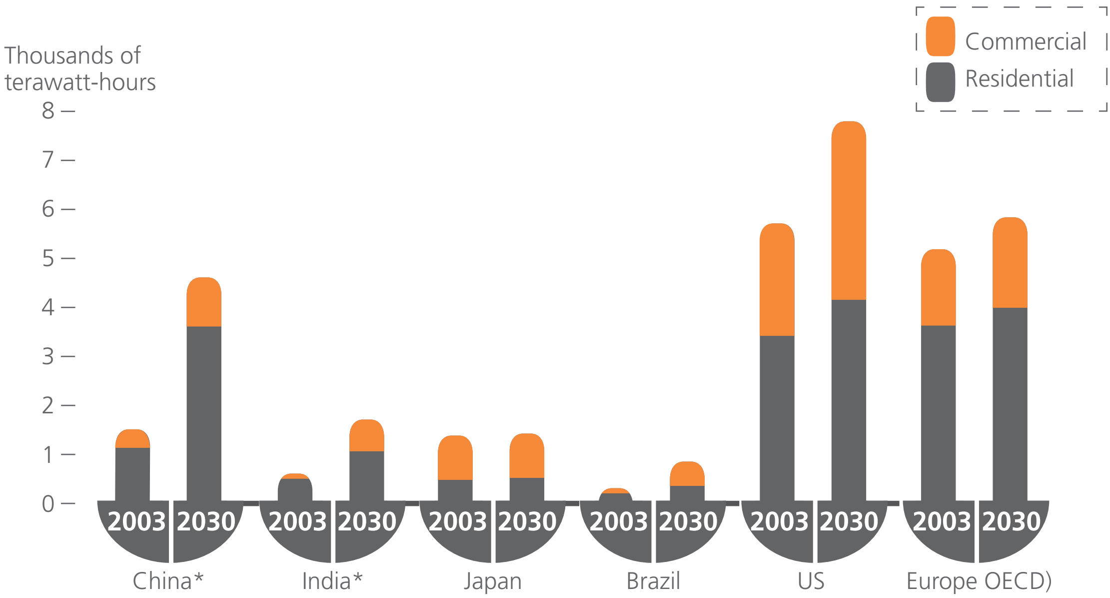
The residential and commercial sectors account for about 40 per cent of the total energy use. The International Energy Agency (IEA, 2006) estimates that current trends in energy demand for buildings will stimulate about half of energy supply investments up to 2030 in the developed countries.

Figure 1.18 Energy Consumption in Different Sectors



Adapted from: IES, 2007

Figure 1.19 Projection of Energy for Buildings by Region - 2003-2030

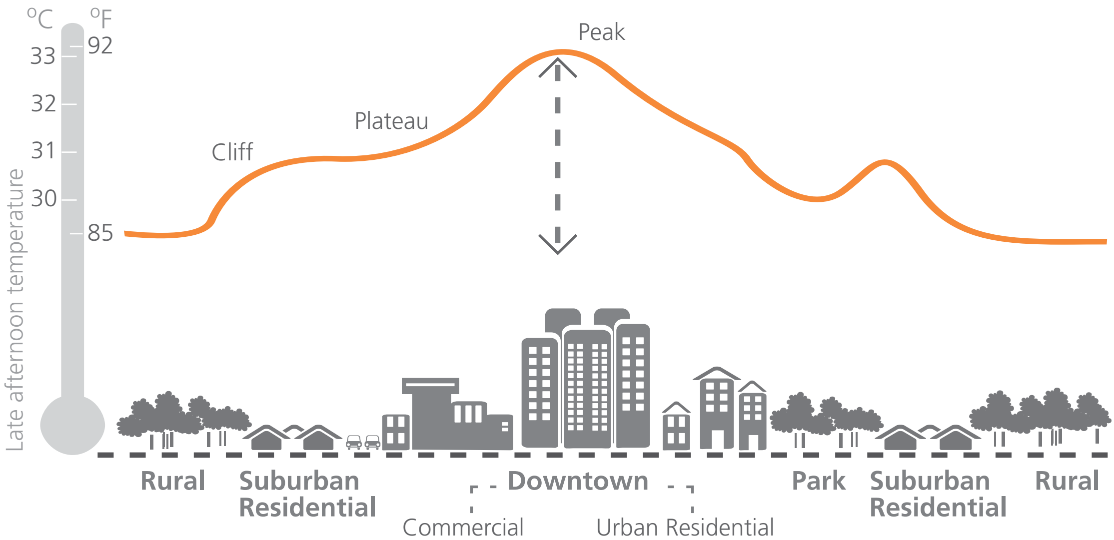


Adapted from: World Business Council for Sustainable Development, 2010

The single largest use of energy in buildings has been attributed to either heating or cooling. Climatic conditions along with rising income levels have increased the demand for maintaining an optimum temperature in buildings. In 2005, 67 per cent of the domestic energy consumption in the EU was for heating purposes while it was 40 per cent in China's urban areas.

Built environments designed with little concern for bioclimatic parameters create heat islands[1] (Figure 1.20) that necessitate the use of air-conditioning, causing energy wastages. In some of the Asian cities such as Tokyo and Shanghai, the rise in temperature is found to be about five degrees higher than the surroundings. This contributes to the vicious cycle of more and more air-conditioning (UN HABITAT, 2006), which is responsible for more than half of the peak power demand in many Asian cities (UN HABITAT, 2006). Japan heads the list with one hundred per cent air conditioning in the service sector (APERC, 2006).

Figure 1.20 Urban Heat Islands



Adapted from: Roth, 2002

Box 1.6 Reducing Energy Consumption in Buildings

Construct "greener" built environments that use water and energy efficiently. Building more efficiently and re-skinning existing edifices can halve (or more) their use of energy and water. Given that approximately 75 per cent of the building stock that will be standing in developing countries in 2050 will be built over the next 40 years, building 'green' therefore is not so much a luxury as a necessity from an economic development perspective. Furthermore, green buildings not only use less energy and leave a smaller carbon footprint – they also result in health-related economic benefits such as higher classroom attendance rates and fewer sick days. At the same time many technologies for improving the energy and water efficiency of buildings are mature and financially viable: the long-term savings outweigh the upfront costs. In the worldwide effort to reduce greenhouse gas emissions, improving the building sector thus represents a win-win opportunity. Governments can modernize building regulations so that they require more green features, such as solar water heaters that are winning acceptance even in low-cost housing developments in developing countries (e.g. via a Clean Development Mechanism project in South Africa).

Source: UN-Habitat, 2011b

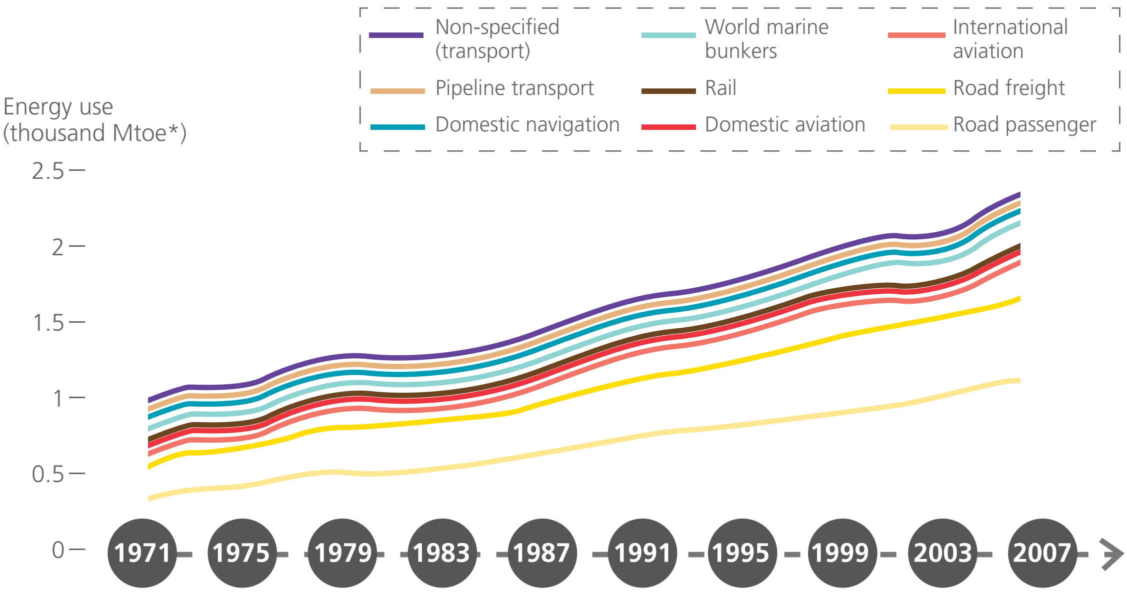
1 Heat Island: The buildings, concrete, asphalt, and human and industrial activities of urban areas have caused cities and spaces within cities to maintain higher temperatures than their surrounding areas. This phenomenon is known as "urban heat island". The air in an urban heat island can be as much as 5-10°C higher than surrounding areas (Geography, 2009)

Energy and Transport

Transport of people as well as of goods is a key component of today's economic activities and its volume and intensity is increasing around the world. The problems and challenges associated with transport, such as air and noise pollution, greenhouse gas emissions, petroleum dependency, traffic congestions, traffic fatalities and infrastructure costs, are growing equally fast. These challenges are especially pronounced in Asia's developing cities.

In 2008 passenger and freight transport accounted for about 22 per cent of the global CO_2 emissions (IEA, 2010a). Mitigating climate change will require drastic improvements in the sustainability of the transport sector.

Figure 1.21 World Transport Energy Use by Mode 1971 – 2006



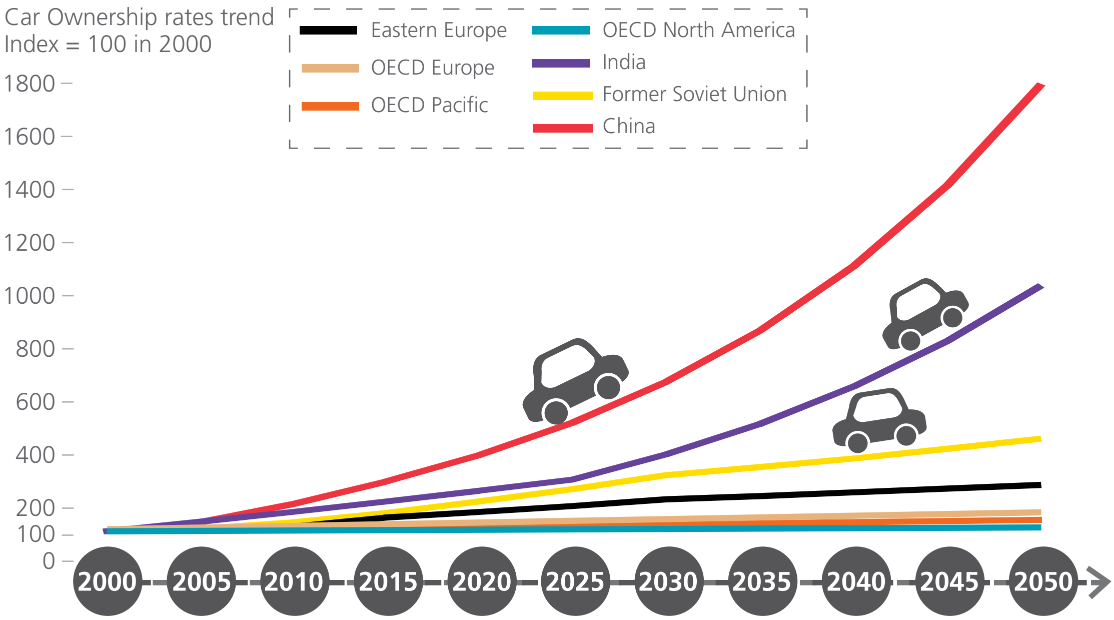
* Million Tonnes of Oil Equivalent

Adapted from: IEA, 2009

Transport of people

Asia is experiencing a vehicle boom. Between 1977 and 2008, China's vehicle ownership increased by a factor of 51, from 1 million to 51 million (Bloomberg News, 2010). Taken together, the Chinese and Indian consumers bought about 20 million new passenger vehicles in 2010, around 70 per cent more than consumers did in the United States of America in the same year. China is now the largest auto market in the world. The fast pace of car ownership increase in developing countries is apparent, as shown in Figure 1.22.

Figure 1.22 Car Ownership Rates Projected; Index = 100 in 2000



Adapted from: WBCSD, 2004

Comparing China's car ownership per 1000 people (22.3)[2] in 2007 with the figures from the United Kingdom (463.5) or the United States of America (719.8), it is evident that the growth in car ownership will be sustained for years to come.[3] But there is also a sharp contrast in terms of car ownership between urban rich and rural poor. For example, Beijing's vehicle ownership per 1,000 people rapidly increased from 9 in 1980 to 171 in 2009, which is much higher than the country's average level (Naoko Doi, 2011). The increase in global vehicle ownership paired with an increase of the overall distance people travel increases the demand for oil which, according to Asian Development Bank (2007) estimates, will be three times more in 2030 than it was in 2007. Given the current dependence on oil, the global transport sector will face a challenging future if matters continue as they are today.

Growing numbers of vehicles on urban roadways will put huge stress on the urban transportation infrastructure and on the environment. (ABC 2010)

2 In 2008 China's car ownership per 1000 inhabitant was 29
3 BBC News "Cracking China's car market" May 17, 2007

Table 1.6 Passenger Vehicle Ownership per 1,000 Persons (1980, 2002 and 2020)

	1980	2002	2020	1980 - 2002 (%)#	2002 - 2020 (%)#
PRC*	2	19	65	10.8	7.1
Beijing	9	80	177	10.4	4.5
Shanghai	5	47	100	10.7	4.3
Hong Kong, China	41	59	70	1.7	1.0
Indonesia	5	16	26	5.4	2.7
Jakarta	34	143	161	6.7	0.7
Japan	203	428	522	3.4	1.1
Tokyo	159	266	271	2.4	0.1
ROK*	7	204	284	16.6	1.9
Seoul	15	205	288	12.6	1.9
Thailand	-	100	158	-	2.6
Bangkok	-	324	389	-	1.0

*PRC: People's Republic of China, (-): No data available, #: Annually projected growth rate
*ROK: Republic of Korea

Adapted from: APERC, 2006

Public Transport as well as cycling and walking are workable solutions for reducing energy consumption and CO_2 emissions in the transport sector. For these to become valid options, infrastructure and soft policies (such as awareness campaigns, incentives to change lifestyles) coupled with hard policies (such as higher taxes on roads or on private vehicle ownership) need to be implemented.

Box 1.7 Greenhouse Gas (GHG) Savings from Non-Motorized Transport

Cycling is best adapted to city centres and densely populated areas. 1.5 billion people are expected to live in cities with 1 million or more inhabitants by 2050. If a 5 per cent increase in mode share for cycling could be achieved in these cities, and if an equal increase were achieved in towns and villages containing another 1.5 billion people, car travel would be cut by around 600 billion km a year world-wide, saving 100 million tonnes of CO_2 emissions. If it cost an investment of USD 5 per person per year to achieve this 5 per cent mode shift the total investment required would be of the order of USD 15 billion a year. But this would be more than offset by the direct cost savings from fuel alone which, at USD 60/barrel, would be around USD 25 billion per year. With other benefits including a healthier population, reductions in traffic congestion and emissions and time savings, the total cost of the cycling infrastructure would probably be very small compared to the net benefits, and the CO_2 savings would come at negative cost.

Source: APERC, 2006

Transport of Goods

The twin phenomenon of urbanization and globalisation has increased the need for transportation of goods, within and in between cities, and between rural and urban areas. The logistic and supply chain sector contributes more than 5.5 per cent of total greenhouse gas emissions (World Economic Forum, 2009). In terms of emission intensity per tonne-km, air freight is the most carbon intensive, followed by road freight. Rail and ocean freight are the most carbon efficient modes. There is a large potential to reduce emissions just by changing the mode of transport for freights. The often cited example of Maersk Star Flower elaborates the carbon mitigation potential by shifting from air freight to ocean freight. For instance, transporting cut-flowers by sea rather than by air would cut the relevant CO_2 emissions by 98 per cent. Using road transportation and opting for less carbon intensive ways (rails and waterways) must be encouraged by policy makers.

In the period 2005-2030, more than half of the world's increase in fuel consumption will come from transportation. (ABC 2010)

Box 1.8 The Story of a Toothpick

David Morris, an environmentalist tracks the journey of a toothpick which, he says, he picked up after finishing his lunch in a restaurant in Minnesota. He learnt from the plastic packing of the individual toothpick that the toothpick had landed at his table from Japan. Morris deduces that a country that probably thought that it was cheaper to ship toothpicks to Minnesota from Japan probably sent its wood and oil across to the island, thus a toothpick travels 50,000 embodied miles. He further reveals that Minnesota had set up a factory to make chopsticks for exporting to Japan. This is the import-export paradigm in which our global economy runs. It is also the way our waste economy runs.

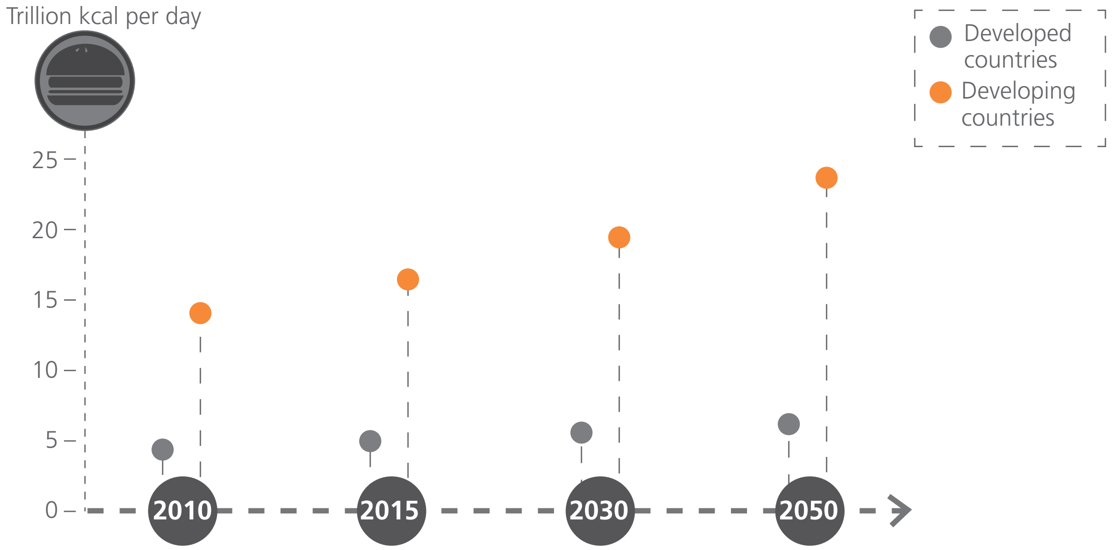
Source: Morris, 1988

Energy in Food

Cities rarely produce food, and their supply of agricultural products normally comes from the rural hinterland and from the international market. This implies much energy use for transportation, as well as for cooling and storing of food. In the United States, one farmer, with his complex array of fossil fuelled equipment, typically feeds 100 city dwellers. Ten times more fossil fuel energy goes into this type of food production than the resulting calories that are contained in the food produced (World Future Council, 2010).

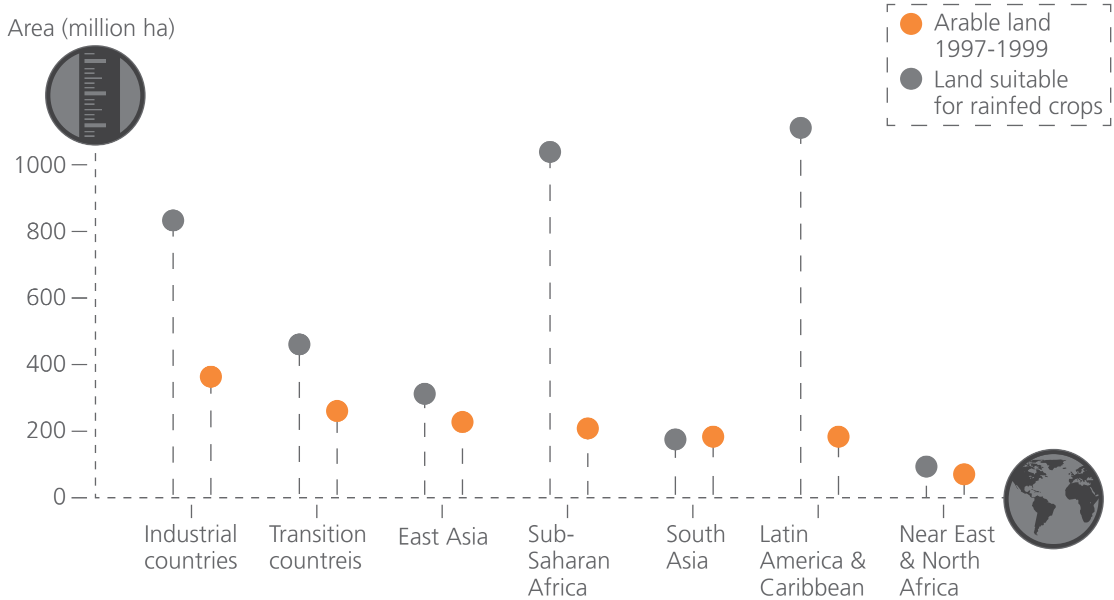
With the increase in urban population, more food will need to be produced and supplied from the hinterland. It will need a sevenfold increase of food production to feed the projected population of 9 billion in 2050 (OECD and FAO). This will demand a higher usage of energy and land resources in an era where the existing usage already has adverse impacts on the environment and agricultural land is continuously lost through urban sprawl.

Figure 1.23 Projected Food Demand



Adapted from: Vattenfall, 2009

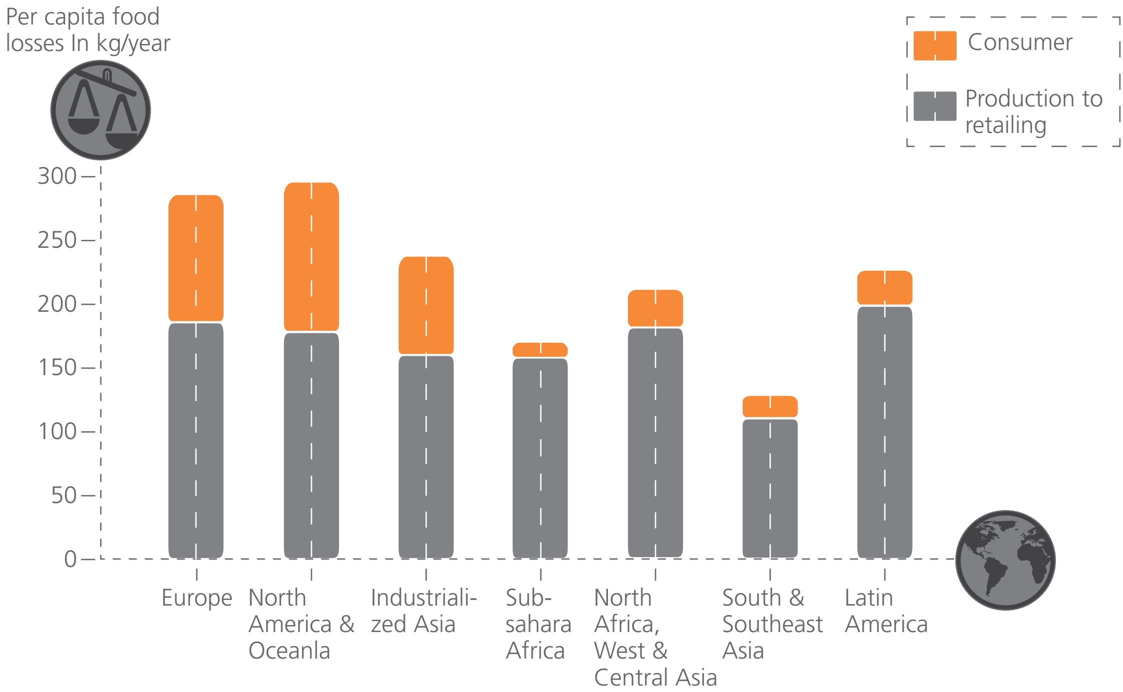
Figure 1.24 Theoretical Potential for Cropland Expansion



Adapted from: FAQ, 2003

The need to increase agricultural productivity could be significantly addressed if we were able to reduce production losses (e.g. from pests, diseases, storage, processing, etc.) and food waste arising from transportation and consumption. Urban authorities can actively pursue the reduction of food waste at the consumer and retailer end with soft and hard policy measures such as awareness campaigns and charges for food waste. Promoting urban agriculture has proven to be another successful tool in addressing food shortage.

Figure 1.25 Per Capita Food Losses and Waste, at Consumption and Pre-consumption Stages



Adapted from: FAO, 2011

Box 1.9 Urban Agriculture, a Quiet Revolution

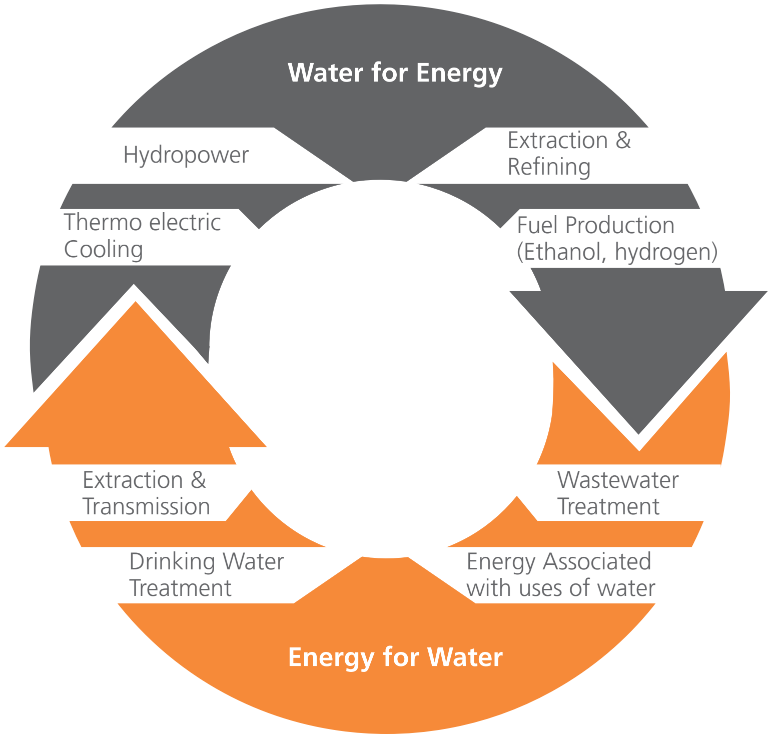
"There is a quiet revolution stirring in our food system. It is not happening so much on the distant farms that still provide us with the majority of our food; it is happening in cities, neighborhoods and towns. It has evolved out of the basic need that every person has to know their food, and to have some sense of control over its safety and security. It is a revolution that is providing poor people with an important safety net where they can grow some nourishment and income for themselves and their families. And it is providing an oasis for the human spirit where urban people can gather, preserve something of their culture through native seeds and foods, and teach their children about food and the earth. The revolution is taking place in small gardens, under railroad tracks and power lines, on rooftops, at farmers' markets, and in the most unlikely of places. It is a movement that has the potential to address a multitude of issues: economic, environmental, personal health, etc."

Source: Michael Ableman, 2000

Energy in Water

Water is used in the production of energy and its supply, while energy is used to pump, treat and distribute water. With a growing population, the demand for water has been rising simultaneously, requiring more and more energy for making it available for human and industrial usage.

Figure 1.26 Water for Energy, Energy for Water



Adapted from: World Energy Council, 2010

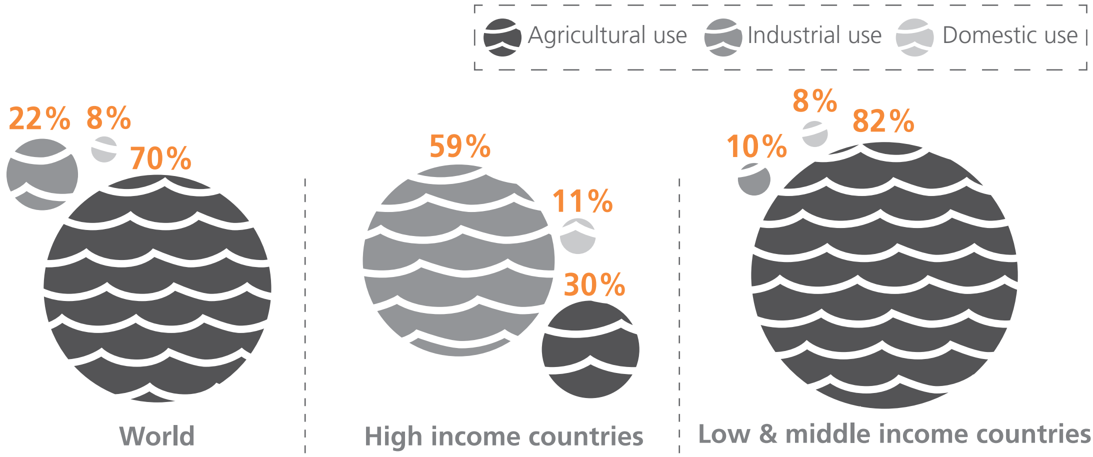
Freshwater withdrawals have tripled over the last 50 years. It is estimated that the demand for freshwater will continue to increase by 64 billion cubic metres a year till 2050 due to rapid population growth, extensive deployment of irrigation methods and globally rising living standards[4] (UN, 2009a). The reliability and regularity of water supply in low-income countries is a big problem, with poor quality water and the high price when bought from street vendors. On the sanitation front, shared toilets and pit latrines are inadequate and poorly maintained in urban areas.

One of the largest uses of water is electricity production. To produce one kilowatt-hour of electricity requires 140 litres of water for fossil fuels and 205 litres for nuclear power plants. (Natural Resources Canada. 2004)

4 Hinrichsen, Robey and Upadhyay, 1997

Globally the agriculture sector accounts for around 70 per cent of water used depending on the income level of the nation (Figure 1.27). Developing countries use a higher proportion of water on agriculture than the industrialized nations. Also, in North America and Europe, agriculture is predominantly rain fed and does not require much irrigation unlike in Asia.

Figure 1.27 Water Uses for Main Income Groups of Countries



Industrial use of water increases with country income, going from 10% for low and middle income countries to 59% for high income countries

Adapted from: UNESCO, 2003

Non-Revenue Water

Water loss, also referred to as non-revenue water, refers to the total amount of water lost through leakage in distribution networks. A conservative estimate for this has been placed at around 35 per cent of the total water supplied (IBNET, 2011). For some low-income countries this loss may be as high as 80 per cent. Indian cities like Delhi and Indore lose about 50 per cent of their water production compared with Berlin (3 per cent losses) or Singapore (2.5 per cent losses) that have managed to attain very successful water distribution systems (WWF, 2010). Cutting these losses is important. However, passive leakage control, or repairing only the visible leaks, will not be sufficient. Reducing the total water losses by half would cost around USD 20 billion, and the amount of water saved could be used to serve almost 150 million people. In addition, the total revenue of Asia's urban water facilities will increase by USD 4.3 billion annually (GIZ, 2010).

Asia has one of the world's lowest per capita availabilities of fresh water. (ABC, 2010)

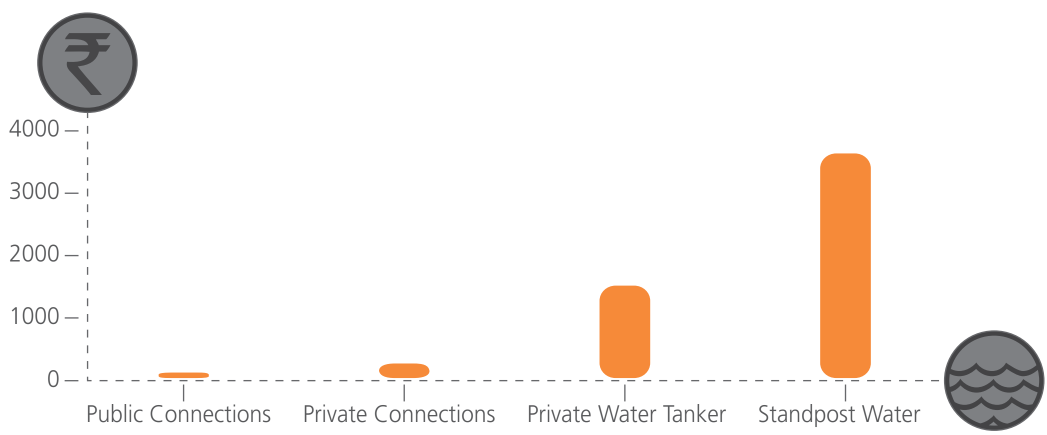
Table 1.7 Non-Revenue Water (NRW) Estimates and Values in Asia

Region	Urban population	l/c/d	System input volume	NRW per day		NRW per year			Value
	(Service connections in millions)	(litres per capita/day)	m^3/day	%/day	m^3/day	(Physical losses billion m^3/ year)	(Commercial Losses billion m^3/ year)	Total	(billion USD/ year)
Central and West Asia	29	450	13,050,000	**40**	**5,220,000**	1.4	0.5	**1.9**	**0.6**
East Asia	605	230	139,150,000	**25**	**34,787,500**	9.5	3.2	**12.7**	**3.8**
Middle East	167	250	41,750,000	**30**	**12,525,000**	3.4	1.1	**4.5**	**1.4**
South Asia	202	180	36,360,000	**35**	**12,726,000**	3.5	1.2	**4.7**	**1.4**
Southeast Asia	133	280	37,240,000	**35**	**13,034,000**	3.6	1.3	**4.9**	**1.5**
Total Asia	1,136		267,550,000		**78,292,500**	21.4	7.3	**28.7**	**8.6**

Adapted from: WHO/UNICEF, 2006

Most investments in water infrastructure are spent on increasing production instead of maintaining or improving the existing facilities. By reducing water losses, water utilities have additional supply to expand services to previously unserved areas. Water scarcity is certainly not only an issue of availability of water, but very much also a lack of appropriate management and governance of water systems.

Figure 1.28 Water Costs in India (Monthly Costs for 500 Litres of Water per Day in INR)



Adapted from: HPEC, 2011

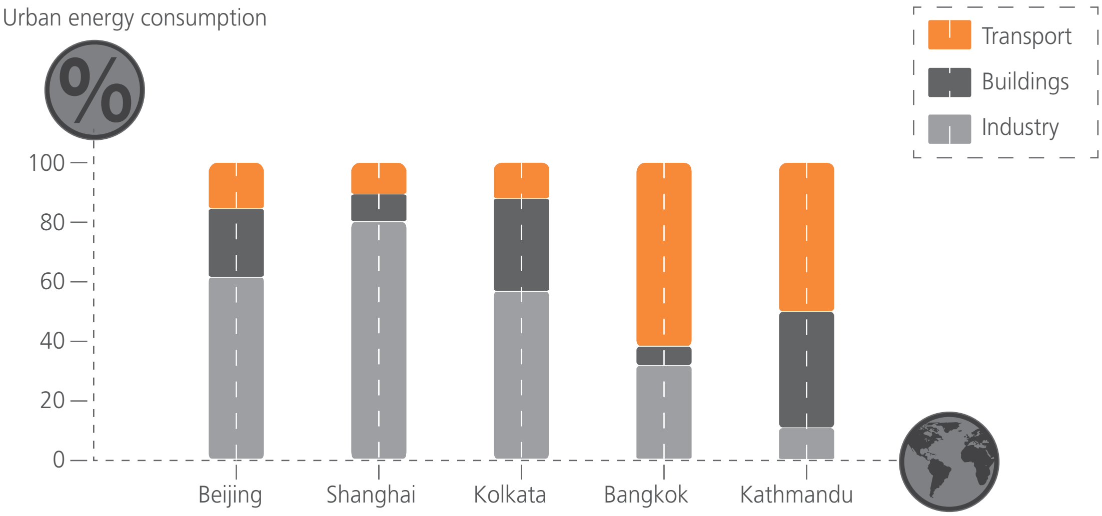
Another challenge for many Asian cities is the intermittent water supply, as only 30 per cent of Asian cities have 24-hour water supply. An intermittent water supply forces the poor to forgo work on days when water arrives in order to collect it. Alternatively, they may have to pay a much higher cost for supply from illegal or informal networks.

Industries and Commerce

Industrial growth drives economic development but also raises the demand for energy. Urban industry is usually fossil-fuel driven and directly contributes to increased air pollution and greenhouse gas emissions. The industrial sector in Shanghai uses 80 per cent of the total energy. In Thane city, near Mumbai, industry that has only 2 per cent of the users, consumes 44 per cent of all energy supplied (ICLEI, 2009a). Similarly, the commercial sectors such as hotels, restaurants, shopping malls and entertainment places that define the new urban life, are vast consumers of energy. In some cities the energy use in the industrial or commercial sector is so huge that it can draw in all energy that is supplied, impacting severely on those living in the peripheries.

Air pollution, mostly industrial, prematurely kills two million people a year, the majority in the developing world. (ABC, 2010)

Figure 1.29 Energy Consumption per Sector in Selected Asian Cities



Adapted from: UN-Habitat, 2008

Box 1.10 Promote Clusters of Green Industries and Green Jobs

A final, complementary approach to promoting environmentally-friendly economic development involves focusing on 'green' industries and trying to create more green jobs. While the impact of this approach on urban patterns may be less direct, as it focuses more on the economics of industrial location and growth and less on urban agglomeration this strategy still directly addresses green economic growth within the city-region.

Adapted from: UN-Habitat, 2011b

Waste

In the past, waste resources were regarded as rare and precious. Each resource, including what we would today define as waste was used and reused, transmuted into a new resource. This attitude of careful resource management still exists today in some cultures and especially in villages in developing countries where everything has a value, and nearly nothing is wasted. However, with development and improved resource extraction and production, the increase in wealth and a change in lifestyle, the amount of worldwide waste produced has started to explode. The problem faced now is how to avoid, minimize, reuse and recycle the generated waste. Today, cities consume approximately 80 per cent of the world's resources and they are also responsible for the discharge of waste in similar proportions (World Future Council, 2010).

The amount of waste generated is often linked directly to income level and lifestyle. (EWAB, 2008)

We can roughly distinguish between two kinds of waste: municipal waste and industrial waste. Municipal waste refers to household waste and other waste related to economic activities (including restaurants, shops, malls, etc.) and public or private activities (such as schools, etc.).

Industrial waste on the other hand is linked to extraction, production and disposal of products. Debris from the construction and demolition sector, waste from mining activities, waste generated by agricultural activities as well as hazardous waste can be grouped under the industrial waste category. It is estimated that the total amount of municipal and industrial waste produced worldwide is about 4 billion metric tons annually, and this does not include waste from construction, mining, agriculture and forestry.

Table 1.8 Estimated World Waste Production and Collection for 2006

Waste	Quantities produced (Tonnes)	Quantities collected (Tonnes)
World total municipal waste	1.7 - 1.9 billion	1.24 billion
Manufacturing industry non-hazardous waste	1.2 - 1.67 billion	1.2 billion
Manufacturing industry hazardous waste for a selection of countries	490 million	300 million
Total	3.4 - 4 billion	2.74 billion

Adapted from: Veolia, 2009

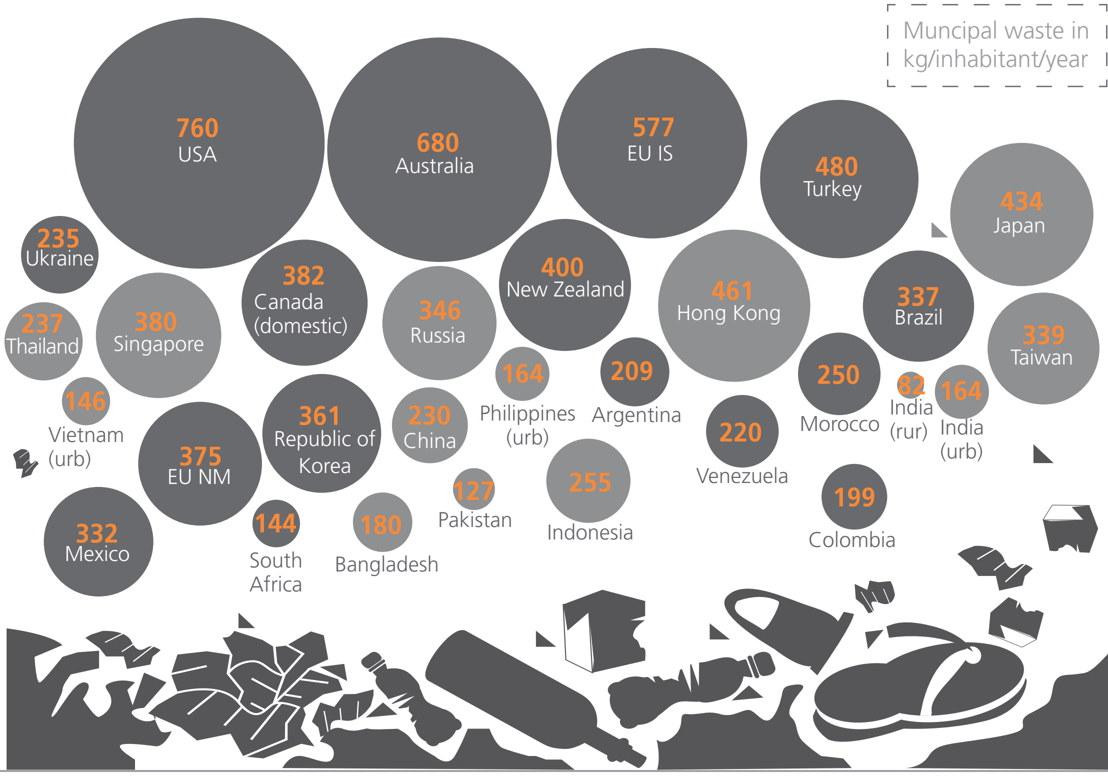
The total municipal waste collected worldwide for the year 2006 is estimated at 1.24 billion metric tonnes. Organic waste and paper contribute substantially to the total amount of municipal waste, while plastic, glass and metal are other contributors. But again income level, lifestyle as well as the longevity of products consumed influence the composition of municipal waste. Low-income households have a higher percentage of organic waste than higher income households, while richer households discard more plastic, glass and metal due to their consumption pattern.

Table 1.9 Recycling in Some Developing Countries

City	Quantities recycled by year (Tonnes)	Number of persons involved in the informal sector
Cairo, Egypt	2,162,500	40,000
Cluj, Romania	14,700	3,200
Lima, Peru	529,400	11,200
Lusaka, Zambia	5,400	390
Pune, India	117,900	9,500
Quezon City, Philippines	141,800	10,100

Adapted from: Veolia, 2009

Figure 1.30 Municipal Waste in kg/Inhabitant/Year



Adapted from: Veolia, 2009

Recycling is now globally accepted as the most efficient way of managing waste. Producing paper, glass, plastics and extracting metals from ores is much more energy intensive than recycling and reusing. According to a study by the Waste & Resources Action Programme (WRAP 2010), up to a 95 per cent energy reduction can be achieved from recycling waste materials. Recycling also reduces emissions of pollutants that can cause smog, acid rain and the contamination of waterways (Sanjeev, 2009).

Recycling makes an important contribution to reducing energy consumption and associated pollution of air and water. (UNEP, 2008b)

The informal sector of waste recycling and collecting is highly developed in many developing countries, such as India. Often the waste is sorted for recycling at the landfill sites themselves. According to some estimates about 15 million persons worldwide are involved in material recycling in developing countries alone. With an informal economy of several hundred million dollars such activities have the potential of being formalized by creating micro-businesses and cooperatives. In Dhaka's slums for example, organic matter, which accounts for about 80 per cent of the total waste generated is being composted and sold as a fertilizer (EWAG, 2008).

02. Cities hold the Keys to Energy Sustainability

"Every city can improve its quality of life in less than three years. No matter the scale of the city, no matter the financial conditions."
- Jaime Lerner, Architect and former Mayor of Curitiba, Brazil

In the previous chapter we saw that today's cities are following an unsustainable path of development by consuming most of the world's available energy resources that are mainly based on fossil fuels. But this makes cities potentially the most effective agent of change. Cities thus hold the keys to energy sustainability. Increasing concern of climate change has resulted in falling costs for renewable energy technologies, and at the same time resource intensive technologies are becoming more expensive. For change to happen we do not have to wait for future technologies to emerge, a lot can be achieved using existing technologies, smart urban planning, energy conservation and improvements in efficiency.

The challenges for achieving sustainable urban energy systems are: energy sufficiency, energy conservation, energy efficiency and the deployment of renewable energy systems and appropriate technologies. Developing green cities and green economies will need supportive policies, capacity building, knowledge transfer, financial support mechanisms, market stimulation and sensitizing the population, both at the national and the local level.

This chapter introduces some concepts that have the potential to transform the current urban energy related practices. It explores answers to the following questions:

- How do we provide urban energy without adversely impacting the local or the global environment and in an equitable and economically sustainable manner?
- How can we build Smart Cities that are energy sustainable?
- How do we close the loop to achieve more energy efficiency?
- How can cities reduce their carbon footprint?
- What is integrated urban planning?

Box 2.1 What is Sustainable Development?

The 1972 UN Stockholm Conference focused international attention on environmental issues, especially those relating to environmental degradation and "trans boundary pollution." Over the decades following Stockholm, this concept was broadened to encompass environmental issues that are truly transnational in scope, requiring concerted action by all countries and all regions of the world in a universal manner in order to deal with them effectively.

Such important global environmental problems include all kinds of pollution, climate change, the depletion of the ozone layer, the use and management of oceans and fresh water resources, excessive deforestation, desertification and land degradation, hazardous waste and depleting biological diversity. In the years that followed, it also came to be recognized that regional or local environmental problems, such as extensive urbanization, deforestation, desertification, and general natural resource scarcity, can pose serious repercussions for broader international security. Environmental degradation in diverse parts of the developing as well as the developed world can affect the political, economic and social interests of the world as a whole.

International recognition of the fact that environmental protection and natural resources management must be integrated with socio-economic issues of poverty and underdevelopment culminated in the 1992 Rio Earth Summit. This idea was captured in the definition of "sustainable development," as defined by the World Commission on Environment and Development, also known as the Brundtland Commission, in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The concept was designed to meet the requirements of both the supporters of economic development as well as of those concerned primarily with environmental conservation. Today, it is recognized that social, economic and environmental considerations are completely interconnected. In the city context, this means that sustainable urban development is not a choice but a necessity if cities are to meet the needs of their citizens. Urban centres must be socially equitable, economically successful and environmentally sustainable if cities are indeed to be the home of humanity's future.

Source: www.un.org

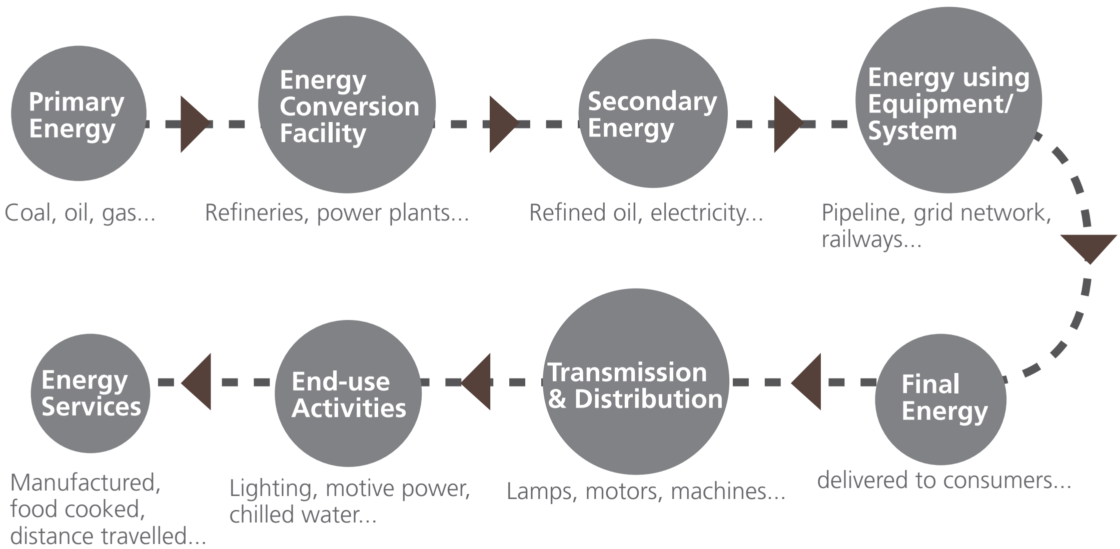
2.1 From Energy Supply to End-use: Huge losses in the Conversion Chain

"It's so much cheaper to save fuel than to buy it."
- Amory Lovins, Chairman of Rocky Mountain Institute in Colorado

By analysing current energy systems we can trace losses, and hidden and compounding cost, which will help us in understanding which interventions will be more (in terms of cost and ecology) effective in achieving more sustainable energy systems. Typically, centralized energy systems waste more than two thirds of their energy in the process of generation, transmission and consumption. These are huge losses. It also means that every kWh saved at the consumer side equates to at least 3 kWh worth of energy that does not need to be produced in the first place. A similar analysis can be applied to other systems such as food, water or transport services (Figure 2.1). The point is that energy conserving interventions at the end-user level translate into substantial savings at the production, transmission and distribution side, no matter which resource system we are looking at.

Every US dollar invested on demand-side management of electricity can save more than 2 US dollars of investment in the power sector—or almost 3 US dollars in developing countries. (ESCAP, 2008)

Figure 2.1 The Energy Conversion Chain from Supply to End-use



Can we imagine reducing energy consumption by 75 per cent (also known as Factor 4) or more, through energy conservation and energy efficient technologies? What would be the equivalent power plant capacity that can be avoided, and the resulting savings?

Box 2.2 From Megawatts to Negawatts

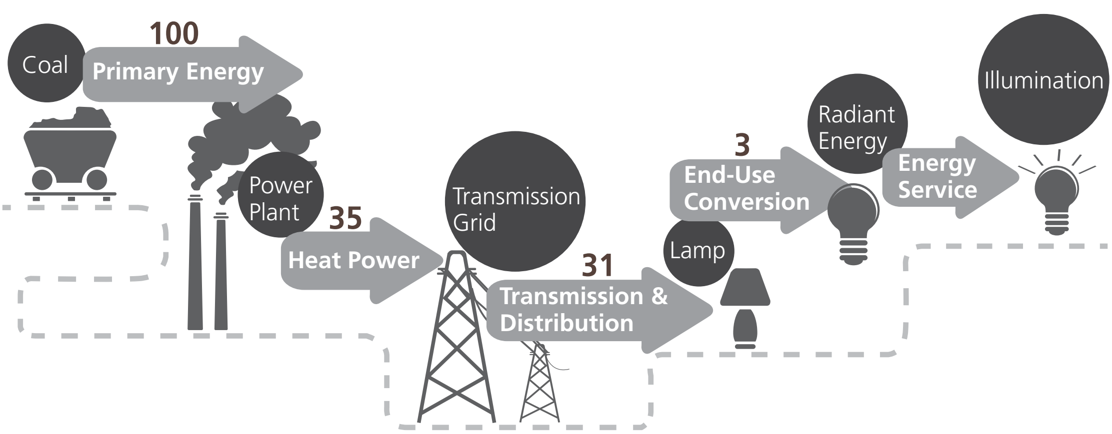
Amory Lovins introduced the concept of a "Negawatt". Much like the classic concept of using machines to generate electricity or a Megawatt, reducing demand side energy consumption increases the available supply side generation capacity. This reduces the need for additional generation capacity while lowering the emissions from fossil fuels used in most electricity generating technologies. This means that every organization can be a "virtual power generator" by generating Negawatts – the absence of consuming Megawatts.

Source: Frieden, 2010

Achieving Factor 4 with Compact Fluorescent Lamps (CFLs)

Let us consider a fossil fuel based energy plant with an initial energy input of 100 units, 65 units get wasted at the source due to generation inefficiency and heat wastage. Another 5 units get wasted in the transmission and distribution process via the high voltage power grid. Hence, from the initial 100 energy units, only 30 units are available for the end-use; however, 27 units (or 90 per cent) go to waste because of an inefficient end use and conversion process (incandescent lamp). As a result, an input of 100 units of primary energy on the supply side will result in an equivalent of only 3 units of energy service rendered at end-use; the remaining 97 units go to waste (Figure 2.2).

Figure 2.2 Example of Losses in the Energy Conversion Process

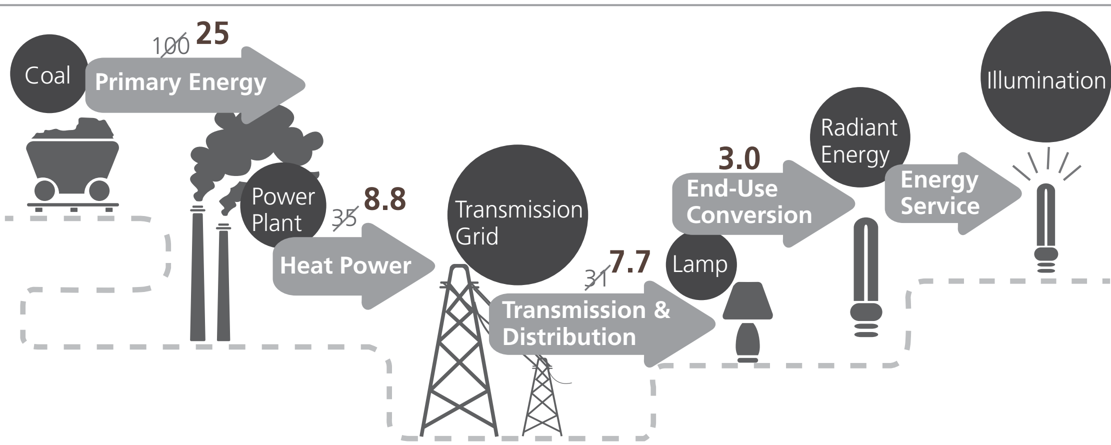


The conventional reaction to this would be to first scale up the energy production by adding new power plants and then improve the efficiency of the production and transmission process, though this may not be the most efficient and cost effective interventions at hand. By looking at the end-use level first, where according to the example given above 90 per cent or 27 energy units get wasted in the conversion process, we can further trace the losses back in the energy supply chain. Out of the 100 energy units, only 3 units finally give us the desired level of lighting. And this is the point where there are low hanging fruits and where energy efficiency initiatives should start.

Lighting is one of the lowest hanging fruits for energy-efficiency measures because the transition can occur at relatively low costs with already existing technology and provides immediate results. (UNEP, 2008)

Let us assume that these 3 units of useful lighting service are obtained by using an incandescent lamp of 100 Watts. On the other hand, compact fluorescent lamps (CFLs) are 4 to 5 times more efficient than incandescent lights, delivering the same lighting service while using about 25 Watts of electricity. By switching from an incandescent light to the CFL, we can divide the energy consumption by a factor of 4 (Figure 2.3). That will not only result in financial savings for the end-user, but by replacing an incandescent lamp with a CFL, the 100 units of primary energy needed to supply the 3 end-units will be reduced to only 25 primary units for the same service output. This represents a saving of 75 units of primary energy by simply adopting a more efficient appliance.

Figure 2.3 Achieving Factor 4 with Compact Fluorescent Lamps (CFLs)



CFLs or any other energy efficient appliance has one obstacle in becoming popular, which is the high initial cost. But in the long run this initial higher investment will pay off in both consumer and production investment through energy savings. Another decisive advantage of CFLs is their long life span, typically 5-10 times longer than the conventional incandescent lamps.

Box 2.3 Environmental Problems Associated with Compact Fluorescent Lamps (CFLs)

The only drawback to using compact fluorescent lamps is that each bulb contains about 5 milligrams of mercury, a toxic heavy metal that is harmful for humans and the environment. Proper recycling of CFLs is important. The future alternative to CFLs may be LEDs (light-emitting diodes), they contain no mercury or other toxic substances and are even more energy efficient than CFLs.

Promoting energy efficient appliances instead of scaling-up the production capacity is one of the most cost effective interventions, resulting in both financial savings and the lowering of CO_2 emissions. Reducing losses in the transmission phase through smart grids and a more decentralized power-supply system are more capital-intensive interventions but they will further improve energy efficiency. After energy improvements have been made, the next step would be to revert to renewables for energy production; the use of fossil fuel should be considered as the last resort.

Let us pick up our example of lighting again. Energy conservation in this context could mean asking the simple question: Do I need to switch on the light? If it is daytime I may just open the curtains to let in more natural light or go into another room where there is enough light. By not using artificial lighting at all, we will save all 100 units of primary energy. Looking at the energy pyramid again (Figure 2.4) we see that the low hanging fruits for reducing losses in the energy system and hence reducing carbon emissions are energy conservation and energy efficiency.

Energy efficiency improvement is the most preferable alternative, since each kilowatt-hour of conventional coal generated electricity saved results in a roughly 1kg (1000g) reduction in emissions. (APERC 2010)

Figure 2.4 Energy Pyramid - Example of CFLs

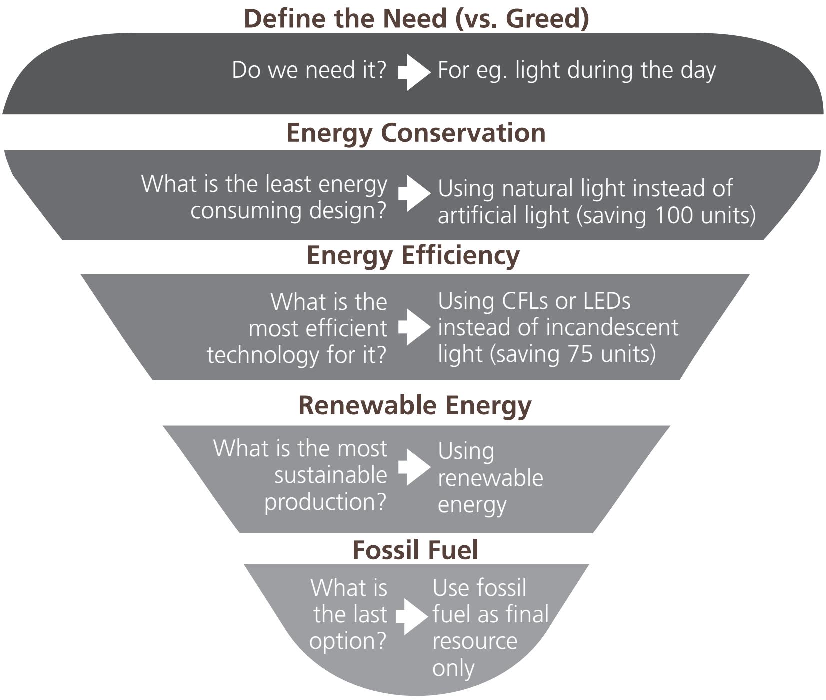


Table 2.1 Savings by Switching from Incandescent Bulbs to CFLs

	kWh per year	Costs in USD
100 Watt incandescent lamp	146.0	8.76
25 Watt CFL	36.5	2.19
Savings per year	109.5	6.57

Note: assumptions for the calculations: price per kWh is US$ 0.06; 4 hours use per day;

Table 2.2 Payback Rate for CFLs

	in USD
Cost of CFL lamp	4
Cost of incandescent lamp	0.5
Savings per year with CFL	6.57
Payback rate in years	0.53

Table 2.3 Savings through CFLs

End user (demand-side)		Power utility (supply side)	
Investment to avoid the Demand for a kW:	USD 40	Investment to increase generation capacity by a kW	USD 1,000

Virtual power plant (energy savings by CFLs)		Fossil-fuel based thermal power plant	
Production	3 million CFLs per year	Production	1,350 MW
Avoided demand	1,350 MW (during 10 years production)		
Investment	USD 20 - 25 million	Investment	USD 1.35 billion
Operating Cost	???	Operating Cost	??? (mainly fuel cost)
Savings over ten years	USD 1.08 billion		

Box 2.4 Gains of Phasing out Incandescent Bulbs

Electric lighting consumes 19 per cent of global electricity grid production and is responsible for more than 1,500 million tonnes of carbon dioxide (CO_2) per year, the equivalent of emissions from more than half of the world's light passenger vehicles. By phasing out incandescent lamps (ILs), peak power demand and black-outs in a large number of developing countries could be substantially reduced, making electricity available for other uses and helping to ensure energy security. When considering both aspects of the cost benefits – energy savings and saved investments – the transition to energy efficient lighting technologies is financially one of the most attractive projects worldwide, and the "lowest hanging fruit" when it comes to energy efficiency initiatives.

Shifting to efficient lighting technologies would cut the world share of electricity used for lighting from 19 to 7 per cent. This would save enough electricity to close 705 of the world's 2 670 coal-fired plants. In addition, it could save countries and users a considerable amount of money in avoided electricity bills, making these resources available for other human needs. Few actions can cut carbon emissions more easily than the phasing-out of inefficient lighting, making it one of the most effective and economically advantageous means to combat climate change.

Source: www.enlighten-initiative.org

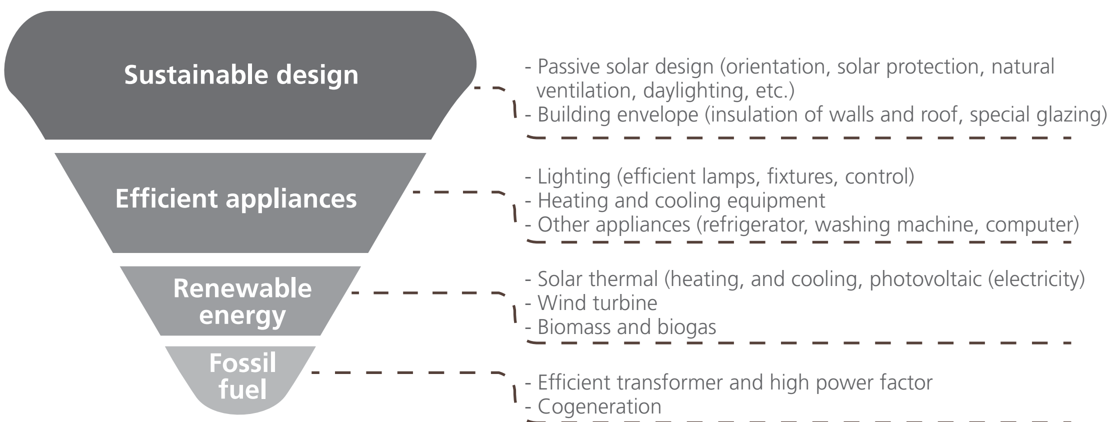
Factor 4 for the Building Sector

According to the IPCC (2007) report, buildings have the largest potential of any sector for reducing GHG emissions, estimated at 30 per cent by 2030. There are many ways to improve energy efficiency of existing and new buildings. For existing buildings, adding insulation and replacing windows and doors with high efficiency models can significantly reduce energy costs. New buildings can be designed to make them more energy efficient in the first place. Smart and energy efficient appliances, waste-heat recovery systems, solar thermal installations, natural ventilation, improved lighting technologies and greater use of daylight are some of the recommended measures to reduce energy consumption. Green roofs are another way to insulate buildings, and even planting trees that provide shade in summer and allow light into the building during winter can make a significant difference (Metz, Davidson, Bosch, Dave & Meyer 2007).

Retrofitting and replacing equipment in buildings has the largest potential within the building sector for reducing greenhouse gases by 2030. (UNEP, 2008b)

The cost of implementing Green Building Standards is estimated to be 3-5 per cent higher than conventional building, but they can significantly reduce energy consumption and carbon emissions and result in financial savings in the long run. Buildings may even be designed to become centres of prosumption (see chapter 2.2), producing energy that can be fed back into the grid, they can also be used to harvest rainwater, convert bio-degradable waste into biogas or organic compost and produce a certain percentage of their own food demand.

Figure 2.5 Energy Pyramid for Buildings



A widely used measure in Green Buildings is the zoning of buildings (dividing the building into separate zones, each with a different indoor climate and hence a different energy requirement). This enables one to make the most use of natural sources for heating, cooling and lighting and can achieve up to 30 per cent energy saving (Hyde. R. A. 1998).

Green Buildings reduce their energy load by integrating efficient systems (heating, cooling, lighting, water); use alternative energy sources (passive solar, alternative energy sources); retain energy (efficient insulation and windows, thermal mass); and use recycled, reused, or low-energy building materials. (UNEP, 2008b)

Looking at the energy pyramid again (Figure 2.5), we see that the most effective changes in terms of reducing energy consumption can be made by adopting sustainable design approaches; this is the least cost intensive option resulting in major energy savings. If one conceives a building based on bioclimatic design principles, then the use of air conditioners or indoor lighting will become redundant during a good part of the year and no energy will be needed to run such appliances. The second step is to reduce energy consumption by using energy efficient appliances such as energy-star rated fridges. These two measures can result in an overall saving of 75 per cent energy (also known as Factor 4) per household. Resorting to renewable energy systems such as solar or wind, will further reduce the carbon footprint.

If we assume an average household consumes 10 kWh per day, saving 75 per cent at the end use level (factor 4) will result in savings of 7.5 kWh per household per day. For a medium sized city of 1 million households this savings would be equivalent to a virtual power plant producing 7,500 MWh of electricity per day. This translates into financial savings of USD 312 million that would have been needed for the initial investment on a power plant of this capacity. These financial savings through energy efficient buildings could in return be invested into further energy conserving and efficient technologies and into renewable energy systems.

Table 2.4 Annual Savings of a Green Home (Factor 4)

	kWh per year	Spendings in USD a year
Conventional Building	3650	146
Green Home 75% more efficient	912	37
Annual Savings	2738	109

Assumptions: average consumption per household per day is 10 kWh; price per kWh is US$ 0.05

But one does not have to stop short at factor 4. A transition in energy efficiency from factor 4 to factor 8 or even factor 10 is possible by using cogeneration (cooling or heating, refer to Figure 2.16) or trigeneration (cooling or heating and steam generation). Other viable concepts are Bioclimatic architecture, Low energy/Zero Energy building and Green buildings, as briefly described below.

Box 2.5 Green Roofs and Energy Efficiency

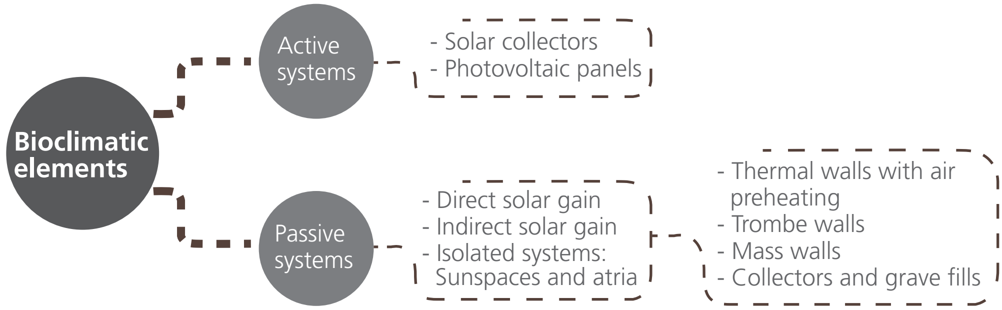
Green or vegetated roofs are becoming increasingly common. These roofs reduce the impact that sprawling development has on storm water problems, especially in urban areas. With a green roof, a portion of the rain is absorbed by the plants and soil, and over time is returned to the atmosphere through evaporation and transpiration similar to an open lawn or field. Using plants or vegetation that need low maintenance and are drought resistant decreases the upkeep of the roof. Green roofs also reduce heating and cooling costs, filter pollutants, and block sound

Source: Yudelson, 2007

Bioclimatic Architecture

Bioclimatic design means that the building is adapted to the particular weather conditions of its geographical region. It minimizes additional energy input while achieving the comfort level of a conventional building at the same time. It uses two main design principles - active and passive solar design. The active solar design is directed towards solar energy captured by mechanical or electrical systems such as solar collectors and photovoltaic panels. Passive solar design, on the other hand, uses little or no mechanical assistance at all, but rather a number of design techniques to reduce the energy demand for heating, cooling and lightning of a building. Traditional architecture followed bioclimatic design principles since artificial heat and cold sources were either not available or expensive.

Figure 2.6 Bioclimatic Architecture



Adapted from: IUSES, 2010

Low-energy and Zero-energy Building

A low-energy building demands only a small fraction of the energy consumed by a traditional building. On the other hand, a zero-energy building produces as much energy as it consumes and draws its energy needs from renewables. These buildings try to reduce the amount of external energy required through the application of intelligent design like solar passive techniques and the use of efficient lighting technologies and appliances (see chapter 3).

Green Building: Going Beyond Energy

Green Buildings do not limit their efforts to only reducing their carbon footprint through energy efficient design and renewable resources. They also look for using key resources like water, building materials, energy, waste and land in a more efficient and environment-friendly manner. Green buildings often incorporate the following features:

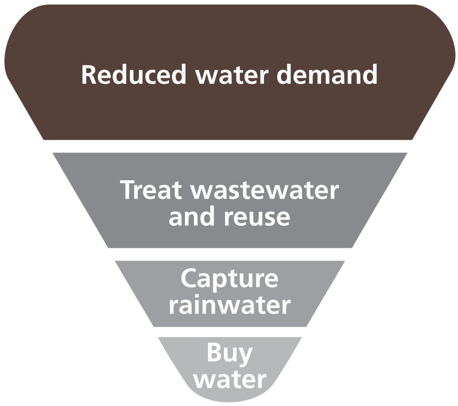
- Careful site selection to minimize impacts on the surrounding environment and increase alternative transportation options.
- Energy conservation to ensure efficient use of natural resources and reduced utility bills.
- Water conservation resulting in reduced utility bills.
- Responsible storm water management to limit disruption of natural watershed and reduce the environmental impacts of storm water runoff.
- Waste reduction, recycling, and use of "green" building materials.
- Improved indoor air quality through the use of low volatile organic compound products and careful ventilation practices during construction and renovation.
- Reduced urban heat island effect to avoid altering the surrounding air temperatures relative to nearby rural and natural areas. (EPA, 2010)

Energy-efficient buildings with green architectural design features and technologies are another high-potential opportunity that can yield as much as a 50 per cent reduction in energy consumption for buildings in Asia; savings could be even higher in cities with tropical climates. (ABC, 2010)

Factor 4 for the Water Sector

Achieving factor 4 savings in the water sector will again have to start at the demand side rather than on the supply side. If demand can be reduced, then the energy required to pump and treat water will decrease. This will also decrease the amount of waste water that flows to treatment plants which results in less energy input for treatment.

Figure 2.7. Water Pyramid for Buildings

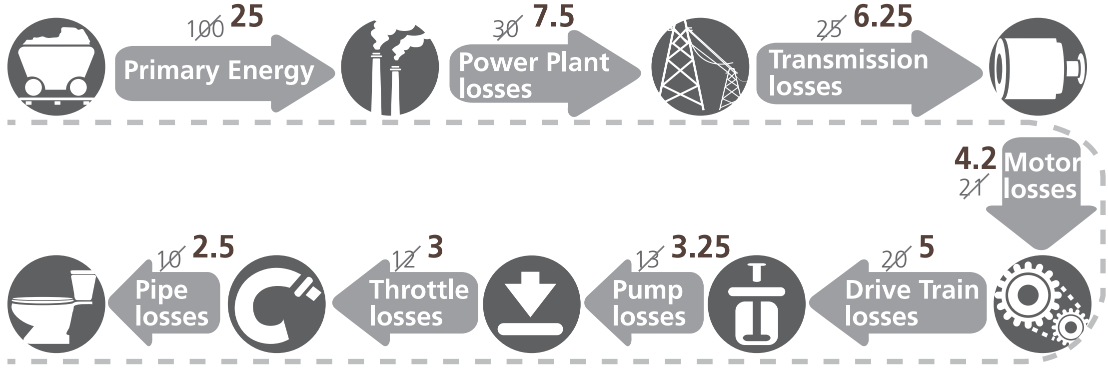


To help decrease water demand, some or all of the following can be used:

- campaigns that make people aware of wasteful habits
- water pricing and metering
- low-cost water saving technologies such as low flush toilets, low-flow shower heads and faucet aerators
- water efficient appliances that help to reduce water use and ultimately energy use. The largest daily user of water in the home is the toilet. By replacing an old water intensive model with more water efficient one, the total water usage and the energy input for water can be greatly reduced. Old model toilets use up to 12-13 litres per flush, while new models use only 4-6 litres and composting toilets do not require flushing at all. Dual flush toilet systems, due to their ability to save up to 67 per cent of water usage water would help us to achieve factor 4 in regards to water and energy consumption for toilet flushing (The ABC of Toilets, 2011).

Energy efficiency retrofit for existing housing stock should incorporate water efficiency measures, since these have the potential to save water, CO_2 and money.
(Energy Saving Trust, 2009)

Figure 2.8 Achieving Factor 4 with Low Flush Toilets



In most developing countries, electricity costs account for 40-60 per cent of the total operating costs of the water supply system. The quantity that is lost during the supply and distribution, also known as non-revenue water, is estimated to be as high as 33-50 per cent. Non-revenue water is normally from leakages in the pipes, throttle losses and pump losses, and translates into substantial energy losses (ASE, year unknown). Hence reducing water losses will help reduce the total load on the utility.

One action to reduce energy consumption in the water sector is to propagate the use of more efficient and properly sized water pumps. Pumping systems are often improperly sized, poorly maintained and highly inefficient. This increases the amount of energy needed to deliver water. The total cost of a water pump over its lifetime, can be broken up into 3 per cent for its purchase 23 per cent for its maintenance and 74 per cent for the energy needed to run the device (ASE, year unknown). These figures highlight the potential for financial and energy savings that can be achieved by replacing energy inefficient pumps with energy efficient ones. Many pumps are efficient only when they run at full capacity, but this happens only during peak demand periods. During off-peak times these pumps are simply too big and energy intensive. Having a different pump size according to the load will reduce energy costs. Other measures for energy savings in the pumping system are listed in Table 2.5.

Water metering results in lower CO_2 emissions as well as lower water use.
(Energy Saving Trust, 2009)

Table 2.5 Achieving Energy Savings in Municipal Water Supply

Energy saving measure	Energy savings (in per cent)
Size: Proper matching of pump size to load	10% – 30%
Speed: variable speed drives adjust as needed	5% – 50%
System Requirements: do not pump more and at higher pressure than needed:	5% – 20%

Source: ASE, year unknown

Box 2.6 Municipal Level Programmes to Reduce Water Demand

Some utilities often enforce and promote water restrictions through rates, municipal ordinances, federal laws, regulations and financial incentives. Typical examples include:

- Financial incentives to install water-efficient toilets
- Municipal ordinances allowing watering the garden only on certain days of the week or when designated
- Banning fountains unless they run on re-circulated water
- Requiring homes to have low-flow shower heads and faucet aerators

Source: http://www.toiletabcs.com

2.2 From Consumption to Prosumption

"The world will not evolve past its current state of crisis by using the same thinking that created the situation."

- Albert Einstein

Besides the importance of supply and end-use efficiency there is another area that has a significant potential in making cities more sustainable and self-sufficient.

"Prosumption" is the ability to produce a part of what one consumes as a product or service in a sustainable manner. It refers to the informal production of goods and service at the home or community level, but it can also be widened and applied at the city level. This can be applied to any sector such as energy, food, water and waste. Examples of prosumption include fuel cells, rooftop solar shingles, wastewater treatment, water harvesting, rooftop gardens, etc., all of which convert homes, communities and cities into places of production. Green cities generally have targets of achieving a certain level of prosumption, and try to reach these on a regular basis.

Renewable Energy

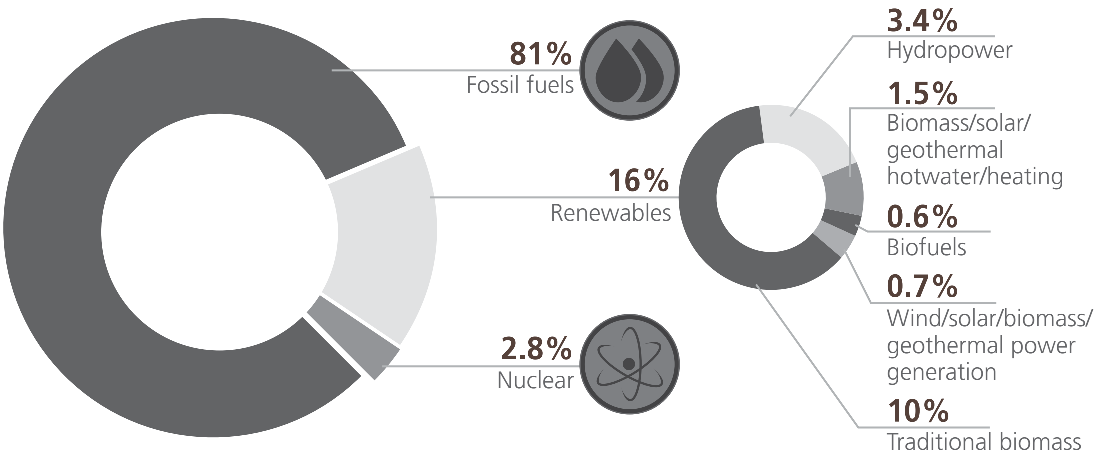
While energy efficiency initiatives reduce the amount of energy consumed, renewables offer alternative sources of energy, which are less carbon intensive. The global market for renewable energy is growing rapidly. Many pioneers around the world have made their communities (and cities as well) self-sufficient through renewable energy technologies. A combination of targets, policies, stimulus funds and a growing concern for energy security is at the bottom of the transformation from conventional energy to more renewable energy production.

Renewable energy together with other emerging technologies are now ready for use on a large scale and have the potential to meet world energy demand in a sustainable way. (UNESCAP, 2008)

While renewables currently account for 16 per cent of the world's primary energy supply, their share is as high as 32 per cent for Asia (IEA, 2007b). The UN Environment Program (July 2011) reported a 32 per cent rise in green energy investments worldwide in 2009 and 2010, accounting for about 50 per cent of newly added capacity. Investment in renewables amounted to a record USD 211 billion in 2010, which is five times more than in 2004. Developing countries overtook developed ones in terms of financial investment in renewables. China emerged as the world leader in the renewable energy market with USD 48.9 billion of new investments. India increased its investment in renewables by 25 per cent to USD 3.8 billion. The other developing countries in Asia witnessed an increase of 31 per cent to USD 4 billion (REN21, 2011a).

Renewable sources of energy are likely to increase in importance as technology improves and costs continue to fall. (UNESCAP, 2008)

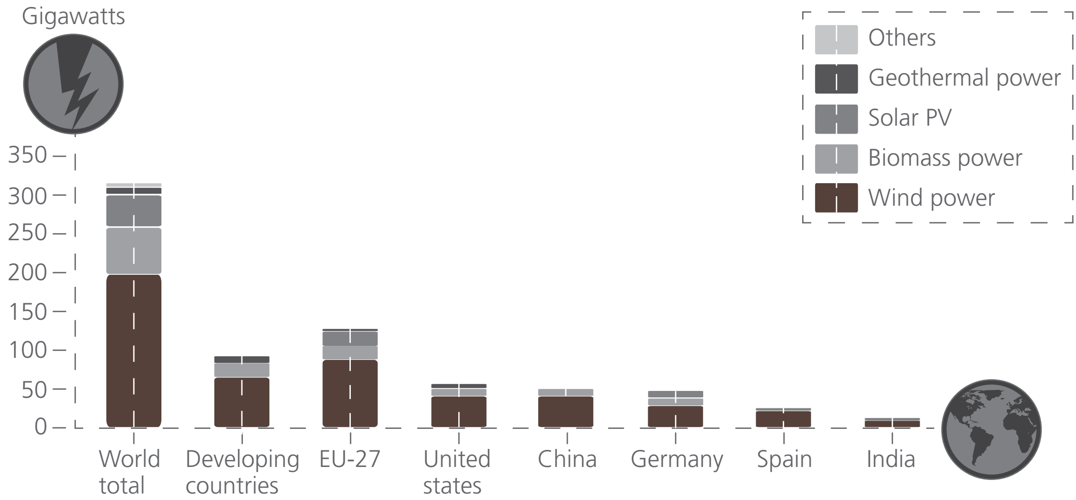
Figure 2.9 Renewable Energy Share of Global Final Energy Consumption



Adapted from: REN21, 2011a

The strongest growth in renewable energy systems has been in grid-connected power facilities such as small hydro, wind farms, solar PV and biomass cogeneration systems. Figure 2.9 shows that globally, energy from wind and biomass installations make up the major share of renewable energy. A World Bank study concluded that for off-grid or mini-grid systems, most renewable energy systems are indeed cheaper than gasoline or diesel generators (WB, 2006).

Figure 2.10 Use of Renewable Energy Systems around the World. Solar and Wind take the Major Share (excluding hydropower) and Total Energy Resources



Adapted from: REN21, 2011a and World Energy Council, 2004

Succeeding with Renewables

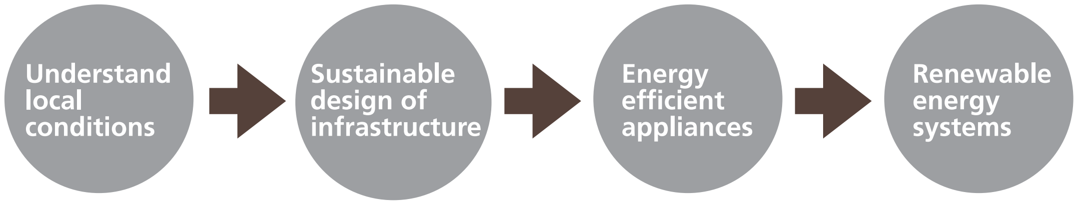
Intermittence of supply[5] and the high upfront cost are the main deterrents of renewable energy technologies. Continuity of energy supply is what most urban areas need. However, one of the intrinsic strengths of renewable energy systems is the variety of sources that can be tapped to overcome intermittency. Solutions could come from many sources but not all solutions will fit every location. A careful analysis of the energy sources available locally needs to be done. Solutions may even be hidden as in the case of energy from waste and heat recovery.

Using only renewable energy technologies (RETs) to cater to the existing demand for energy can become very capital intensive. One needs to first look at ways of reducing the city's demand for energy, by designing urban infrastructure appropriately to suit the local conditions, followed by judicious choice of energy-efficient appliances, which are chosen on the basis of value engineered demand. Once the demand is reduced and well managed, then renewables can be looked at. Renewables may not make much sense if the demand is not analysed and controlled through efficiency measures.

Renewables represent half of newly installed electric capacity worldwide in 2010, and they are becoming increasingly important in the heating and transport sectors (REN, 2011)

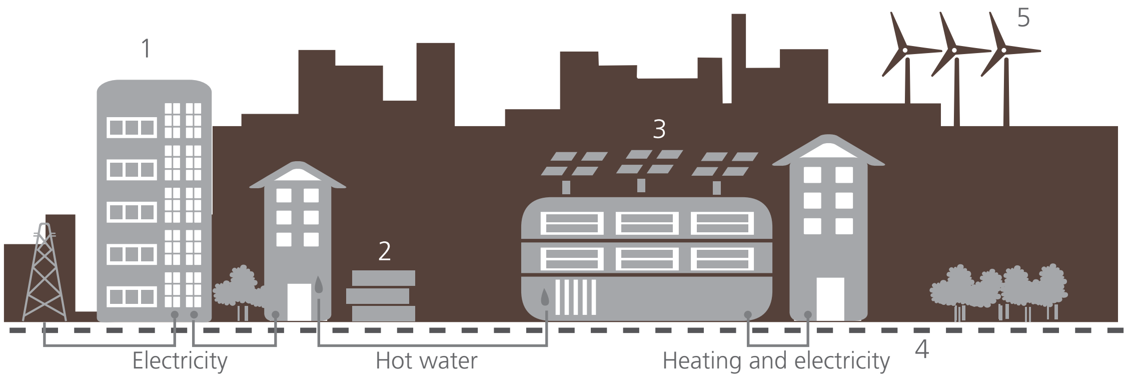
5 Intermittence is a term that is mostly used for power supply that is erratic and not continuous.

Figure 2.11 Planning for RETs



The increasing use of renewables will result in a more decentralized energy system. Existing technologies applied in a decentralized way and combined with efficiency measures and zero emission developments, can deliver low carbon communities. Power can be generated using efficient cogeneration technologies producing heat (and sometimes cooling) plus electricity, distributed via local networks. This supplements the energy from building integrated generation. Energy solutions come from local opportunities at a small and community scale. The town in Figure 2.12 makes use of – among others- wind, biomass and hydro resources; natural gas, where needed, can be deployed in a highly efficient manner.

Figure 2.12 A Decentralized Energy Future for Cities



1. Photovoltaic, solar facades will be a decorative element on office and apartment buildings. Photovoltaic systems will become more competitive and improved design will enable architects to use them more widely.
2. Renovation can cut energy consumption of old buildings by as much as 80 per cent - with improved heat insulation, insulated windows and mordern ventilation systems.
3. Solar thermal collectors produce hot water for both their own and neighbouring buildings.
4. Efficient thermal power (chp) stations will come in a variety of sizes- fitting the cellar of a detached house or supplying whole building complexes or apartment blocks with power and warmth without losses in transmission.
5. Clean electricity for the cities will also come from farther afield. Offshore wind parks and solar power stations in deserts have enormous potential.

Adapted from: Greenpeace, 2009

Box 2.7 Feed-in Tariffs

Feed-in tariffs are very common around the world at the national level and in a few cases at state/provincial levels, but not at the local level (see REN21 Renewables Global Status Report for 2007 and 2009 for more details). However, a new trend starting in 2008 was for cities and local governments to consider electric utility feed-in policies and explore how to implement these policies. The first city to adopt a local feed-in tariff in the United States was Gainesville, Florida, in 2008; Sacramento, California, was to start a feed-in tariff in 2010.

Source: (REN21, 2011b)

Urban authorities or individuals who do not find it feasible, technically or economically, to install renewable energy systems in their localities could invest in the development of renewables in the bio-region. This would also help spur economic development outside cities and improve the quality of life for non-urbanites, acting as a strong disincentive for migrating to the cities.

Large-scale implementation of RETs can be ensured through appropriate policy measures. Energy policies are often not made by city governments but are in the hands of the national government and this varies from country to country. One of the most successful policy tools for promoting renewable energy systems is the feed-in tariff. This encourages prosumption, helps overcome intermittent supply and at the same time reduces carbon emissions from the power plants. Having a feed-in tariff system will help in the uptake of renewable energy ventures, which are currently not common in Asian countries. In fact fixed feed-in tariffs have proven to be one of the most effective policy actions for the promotion of renewable energy. A mandatory electricity utility quota for industries and public institutions, net metering and financial incentives like production tax credits and capital subsidies are other interesting options for policy makers. Without political support, however, renewable energy remains at a disadvantage, marginalized by energy price distortions.

Box 2.8 Voluntary Actions of Cities

Cities all over the world undertake voluntary actions to promote renewable energy. Financial incentives like subsidies, loans and grants to end-users are common. Local governments are also investing in public or private renewable energy projects; providing municipal land or building rooftops is another possibility for local authorities in promoting renewables. Table 2.7 gives an overview of some of the actions taken by local governments in Asia to support renewable energy systems. These are discussed further in the last chapter.

Table 2.6 Selected Local Renewable Energy Policies

	Target setting	Regulation based on legal responsibility & jurisdiction				Operation of municipal infrastructure			Voluntary actions & government as role model				Info/ promo-tion
		Urban	Building	Taxes	Other	Pur-chase	Invest	Utility	Demo	Grants	Land	Other	
China													
Baoding									●			●	●
Beijing	●	●					●		●	●			
Dezhou		●					●		●				
Kunming	●	●		●			●			●		●	●
Lianyungang			●										
Rizhao		●	●				●						●
Shanghai	●	●							●		●	●	
Shenzhen			●										
Taipai City	●	●								●			
Tianjin				●					●	●		●	
Wuhan			●										
India													
Bhubaneswar	●	●							●				●
Delhi		●	●							●		●	●
Coimbatore													●
Nagpur	●	●	●	●					●				●
Rajkot	●	●	●						●			●	●
Rep. of Korea													
Busan	●												
Daegu	●	●							●			●	●
Gwangju	●	●											●
Jeju prov.	●												
Seoul	●												
Other Asia													
Hong Kong									●				
Iloilo City				●									
Kuala Lumpur										●			
Quezon City							●				●		
Singapore				●	●								●

Source: REN21, 2011b

Sustainable Urban Agriculture

Globally, two issues concerning local governments are the need to create a livelihood for the urban poor and the need for food security. Urban agriculture addresses both of these in a proactive manner. It promotes energy-saving through local food production and is also sustainable.

Prosumption in the food sector can be achieved by incorporating urban agriculture into the city's landscape. This can include green belts around the city, food production in city parks or specially allocated land, community gardens, vegetable patches at schoolyards or green roofs with edible plants. Rooftops for example comprise at least 30 per cent of a city's total land area and provide a large surface area for food production.[6] Local water bodies like rivers and lakes can be turned into fish farms and municipal parks can accommodate beehives. Urban agriculture promotes energy-saving through local food production and is generally seen as sustainable. Urban agriculture is not a new concept: in the past most cities produced food within urban areas and on the urban periphery. In fact, at present, 15 per cent of the world's food needs are met through urban production (Katz 2006), although over the last fifty years in most of the industrial world the practice has been largely abandoned. Restarting urban food production can have a series of benefits and we find plenty of model projects all over the world demonstrating this.

With the steep rise in the price of food on global markets already leading to riots and starvation, the need for fundamental change is tragically underscored.
(UNEP, 2008b)

Urban agriculture in Jinghong, China © UN-Habitat Bernhard Barth

Sustainable urban agriculture is a useful tool that will help in addressing cities' problems in an innovative way. Cities will get greener, air quality will improve, and energy requirements will be reduced as food does not need to be transported over long distances, refrigerated and packed. Solid waste can be turned into valuable compost, and grey water can be reused for agricultural purposes. Restaurants, schools or public institutions may then be encouraged to buy food from local urban producers.

Cuban cities are good examples of what can be achieved if local authorities actively support urban farming. By 2003, urban agriculture provided 60 per cent of the vegetables consumed by Cuban city dwellers. Planting of several million trees (including fruit and nut trees) in and around Havana increased groundwater recharge, improved water security and quality of water as well (Wolfe, 2005). Studies have shown that a city like London could produce about 30 per cent of all fruit and vegetable requirements within the city boundary, and do so by using only the currently abandoned and leftover space (Viljoen, 2011).

Figure 2.13 Impacts and Interrelations of Sustainable Urban Food Systems

Adapted from: Bohn & Viljoen Architects, 2002

In order to be successfully implemented, Sustainable urban agriculture needs to be incorporated in a city's land use plan. A legal framework that allocates urban areas (such as idle land, under-used land, etc.) for food production will support the development of urban agriculture. Building codes need to be adapted to reflect the actual structural contingencies for rooftop gardening. Institutions to conduct research on urban agricultural techniques, food processing and centres for training, dissemination and soil testing need to be established. Creating a support infrastructure for urban farming that includes tool banks and input materials such as compost, seeds, organic fertilizers and pesticides will have to be supported. The unemployed can be trained in food related businesses. Financial mechanisms like start-up capital or special loan schemes need to be established. Public institutions can be encouraged to buy local produce by urban farmers and community supported agriculture initiatives need to be sustained. A cooperative relationship can be forged with the municipal waste collection system for collecting and composting organic waste to effectively close the material loop.

Urban Agriculture helps sustain local economies while returning a larger share of the proceeds to the producers—reducing emissions from "food miles" at the same time. (UNEP, 2008b)

Box 2.9 Community Supported Agriculture (CSA)

Community supported agriculture (CSA) projects allow consumers to collectively support local farmers by committing to purchase their farm's food products. This type of system provides many benefits to consumers and farmers alike:

- Support local economy: Farmers receive a consistent, guaranteed income that is normally arranged before the hard work of growing season begins
- Make community connections: Farmers and consumers get to know one another which fosters a sense of community on a local scale
- Eat fresh produce: Rather than eating foods shipped from thousands of miles away, consumers are able to buy fresh, local food products
- Learn about seasonal menus: Consumers become more aware of the types of foods grown and cultivated in their region which encourages a seasonal approach to preparing meals

Source: www.ecolife.com, accessed September 2011

2.3 Circular Economy - Closing the Loop

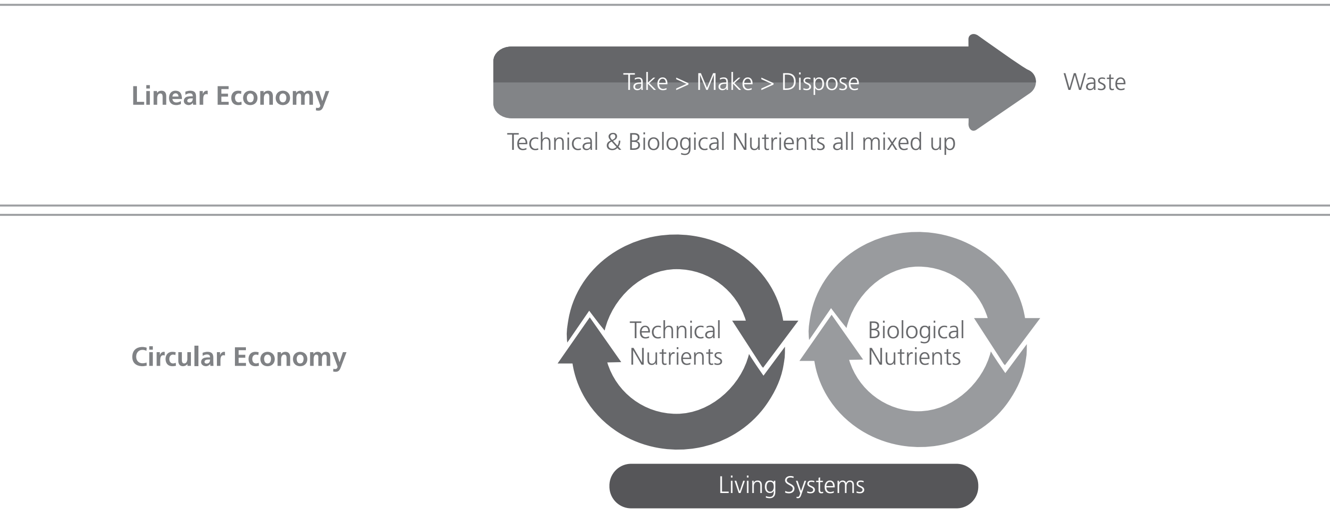
"We are making great progress, but we are going in the wrong direction."

- Ogden Nash, American Poet

A circular economy mimics nature's ecosystem in attempting to transform waste products into a resource. It tries to find strategies and methods to minimize the negative impacts of the industrial systems on the environment. Therefore it is the exact opposite of the currently predominant linear economy in which materials are sourced, goods and services are produced and waste is discarded (Figure 2.14). The practices of circular economy can be applied to all sectors, be it the energy sector with co-generative systems, or the waste sector where material is recycled and reused, or the sanitation and water sector where waste water is reused and solid waste is composted.

A circular system can be manifested in various ways, chief among which are the Eco-Industrial parks and Co-generation.

Figure 2.14 Linear versus Circular Economy



Adapted from: www.ellenmacarthurfoundation.org

Box 2.10 Principles of Circular Economy

Core principles of a circular economy are:

1. Reduce: to reduce the resource consumption and waste production as much as possible in the course of production and service so as to improve the efficiency of resource use.
2. Re-use: to use products more than once through repairing and renovating, to extend the circle of life as long as possible and to prevent products from becoming garbage prematurely.
3. Recycle: to change waste into resources to the fullest extent.

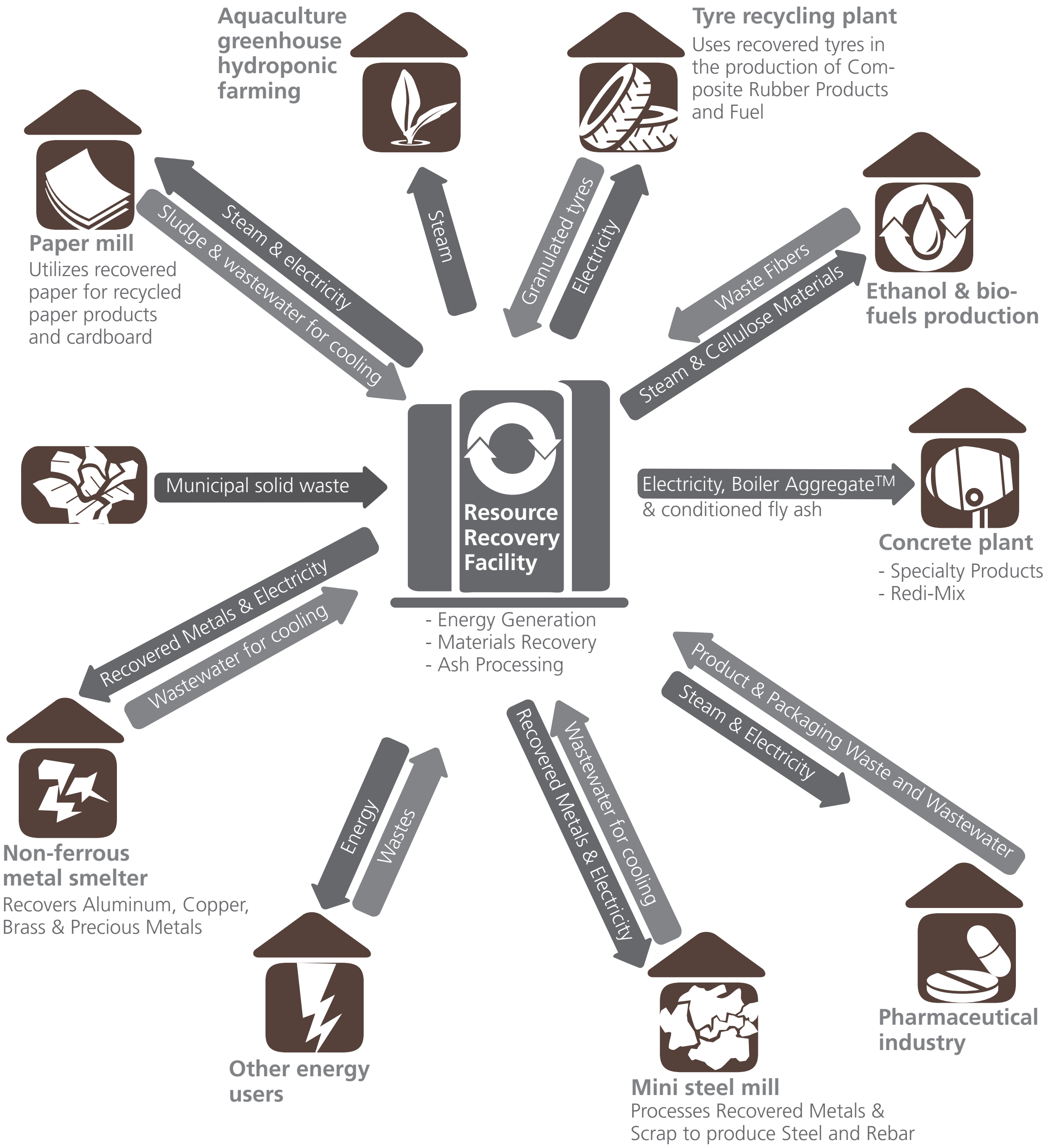
Eco-Industrial Park

The aim of an eco-industrial park is to make the waste of one industry into a valuable resource for another one, thereby improving material and energy efficiency and decreasing environmental emissions. This would also make companies more competitive as better waste management results in cost savings and a higher environmental and business performance. Virgin raw materials and energy used are reduced and replaced by wastes and by-products generated in the area. An Eco-Industrial Park can be defined as "a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water and materials. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize if it optimized its individual performance only" (Lowe, 1998).

Many governments in Europe have promoted these parks, which include chemical industry parks in Germany, and other parks in Europe such as Kalundborg (Denmark), INES (Rotterdam), National Industrial Symbiosis Program (UK) and the Landskrona Industrial Symbiosis Project (Saikku, 2006). Republic of Korea has also launched an ambitious eco-industrial park initiative. This initiative links cleaner production and industrial ecology, seeking a comprehensive approach to improving environmental, social, and business performance. This is an important initiative for the fast growing Asian economies. Careful planning and setting up designated areas for industries to sprout will be crucial for a more sustainable urban industry. Since Eco-Industrial Parks lay emphasis on local and regional economic development they offer an active role for local authorities in facilitation and land allocation.

Eco-Industrial Parks represent a promising strategy to promote sustainable industrial development and implement industrial ecology concepts. (GTZ, 2000)

Figure 2.15 Resource Recovery in an Eco-Industrial Park



Adapted from: www.energyanswers.com

Box 2.11 Eco-Effectiveness

Eco-effectiveness moves beyond zero emission approaches by focusing on the development of products and industrial systems that maintain or enhance the quality and productivity of materials through subsequent life cycles. The concept of eco-effectiveness also addresses the major shortcomings of eco-efficiency approaches: their inability to address the necessity for fundamental redesign of material flows, their inherent antagonism towards long-term economic growth and innovation, and their insufficiency in addressing toxicity issues.

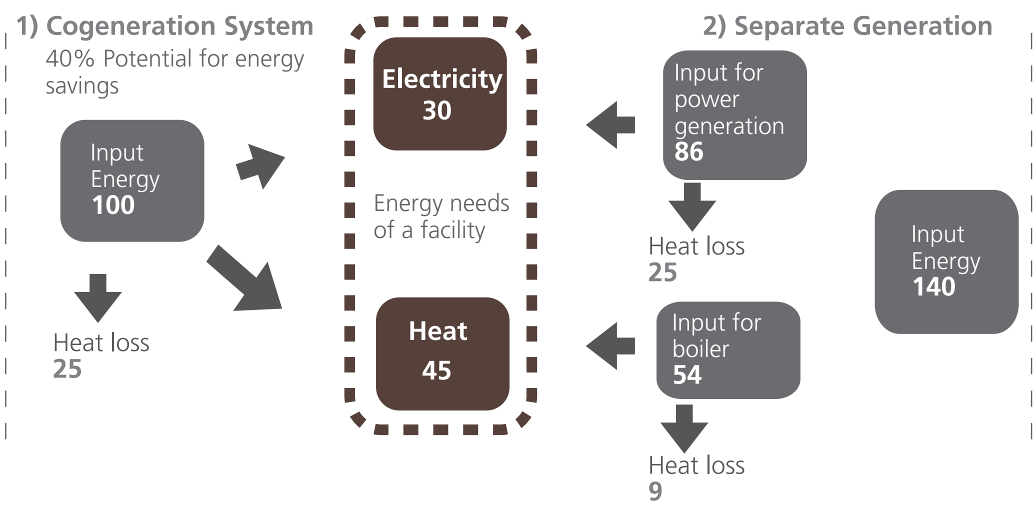
A central component of the eco-effectiveness concept (cradle-to-cradle) provides a practical design framework for creating products and industrial systems in a positive relationship with ecological health and abundance, and long-term economic growth. Against this background, the transition to eco-effective industrial systems is a five-step process beginning with an elimination of undesirable substances and ultimately calling for a reinvention of products by reconsidering how they may optimally fulfill the need or needs for which they are actually intended while simultaneously being supportive of ecological and social systems.

Source: Michael Braungart, 2006

Co-generation

Co-generation is defined as the sequential generation of two forms of useful energy from a single primary energy source. Typically, the two forms of energy are mechanical and thermal energy. Co-generation, also known as combined heat and power (CHP for short), captures heat, a by-product of electricity generation in a power plant, which can then be used for industrial purposes. When compared with a separate generator, it has the potential to save 40 per cent of energy (Figure 2.16).

Figure 2.16 Cogeneration vs. Separate Generation

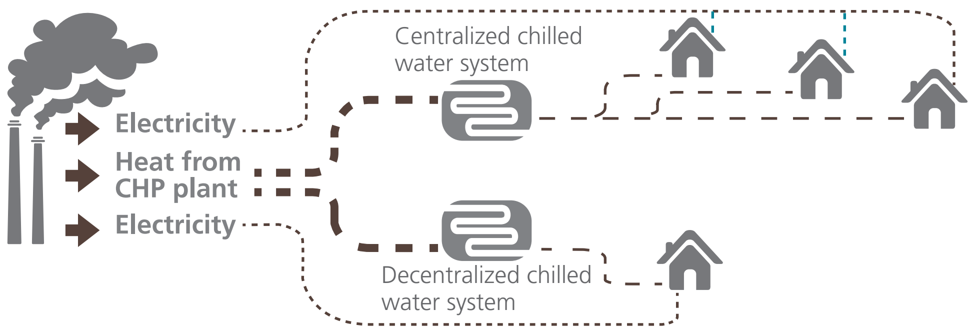


Thermal power plants are major sources of electricity for Asia's cities. The efficiency of conventional power plants is only about 35 per cent, while the remaining energy is lost. This loss in the conversion process is mainly heat (Figure 2.16). By utilizing this heat, the overall efficiency of a power plant can reach up to 90 per cent (Mohanty & Oo, 1996). Cogeneration offers energy efficiency, reduction of costs and the ability to reduce CO_2 emissions. Small, natural gas powered electricity generators in industrial or residential areas can supply heat to factories, office buildings, and household clusters. This energy can be used for various purposes like heating or cooling a building, heating or cooling water and running absorption chillers for refrigeration and air-conditioning.

This extremely efficient use of fossil fuels demands a co-ordination of energy supply with local physical planning by city governments. In Scandinavian countries, cogeneration is used to heat buildings using the hot water that is produced during electricity production. In Finland's cities over 80 per cent of the heat demand in buildings is met from community electricity production (University of Rochester, unknown).

For places where cooling is required, the steam or hot water produced by the co-generation plant can be used to generate cold water by using a vapour absorption chiller. In the case of a District Cooling system, the cooling produced in the absorption cooling units, either located in individual buildings or a centralized cooling unit, will be distributed through a chilled water piping network. District Cooling systems have been used for more than 40 years. In Japan, hundreds of such plants have been installed that act as high efficiency heat/cooling supply systems for central business districts.

Figure 2.17 Integrated Cogeneration and District Energy Network



Adapted from: Mohanty, 2011

Box 2.12 Cogeneration and District Cooling Network for Bangkok Airport

During the designing stage of the new international airport for Bangkok, a decision was taken to set up a Cogeneration and District Energy facility to reduce the overall energy consumption and improve the reliability of energy services. On the basis of the load calculations and optimization of the energy performance of the airport during the designing stage, it was estimated that 66 MW of electricity would be required to meet the overall energy demand of the airport, including 12,500 RT for cooling with a demand for 16 MW of electricity. The final configuration retained after the completion of the feasibility study consisted of 2 units of 22 MW gas turbine generators, two units of 42.5 T/h of heat recovery steam generators, and one unit of 12.5 MW back-pressure steam turbine operating with the steam generated from the waste heat of the gas turbines. The low-pressure steam exiting the steam turbines is piped to three different areas of the airport complex to be used for cooling in double-effect vapour absorption cooling units or for direct heating applications in the hotel and the catering building.

Source: Mohanty, 2011

2.4 Sustainable Transport Solutions

"A city is more civilised not when it has highways, but when a child on a tricycle is able to move about everywhere with ease and safety."

- Enrique Peñalosa, Former Mayor of Bogota

Transport systems form the lifeline of economic and social development of cities - they enable economic, social and cultural exchange and connect urban centres to the bioregion and the rest of the country. Transport is the fastest growing sector in greenhouse gas emissions at a forecasted rate of 2.5 per cent yearly until 2020. Mitigating climate change will require drastic improvements in the sustainability of the transport sector (UNEP, 2010). However, our existing transport systems are a huge cost in terms of energy demand, air pollution, greenhouse gas emissions, congestions and traffic fatalities.

This calls for a new paradigm that shifts towards implementing sustainable transport solutions. Systems that are low-energy and low-carbon intensive, emphasise quality of life and yet can cater to the needs of a modern society, need to be explored. With adequate investments into sustainable transport infrastructures, which include motorised and non-motorised modes, urban authorities can make a decisive change towards a higher quality of life and a lower carbon footprint. The paradigm shift calls for cities that are built for people rather than for cars and for cities that actively promote public transport systems instead of city highways and flyovers. Table 2.7 highlights possible interventions by city authorities to improve urban transport systems.

Some Asian cities have clearly shown that cities can be game changers and have thereby inspired new thinking on sustainable transport. (ADB, 2009)

Table 2.7 Benefits of Different Transport Objectives

Objectives	Benefits: Reduced Traffic Speeds	Shift Trip Time	Shorter Trips	Shift Mode	Reduced Veh.Trips	Reduced Veh. Ownership
Congestion Reduction		●	●	●	●	●
Road Savings			●	●	●	●
Parking Savings				●	●	●
Consumer Savings				●	●	●
Transport Choice				●	●	●
Road Safety	●		●	●	●	●
Environment Protection				●	●	●
Efficient Land Use			●		●	●
Livability	●				●	●

Adapted from: GTZ, 2003

Shanghai flyover © Flickr_ming1967

Non-Motorized Transport

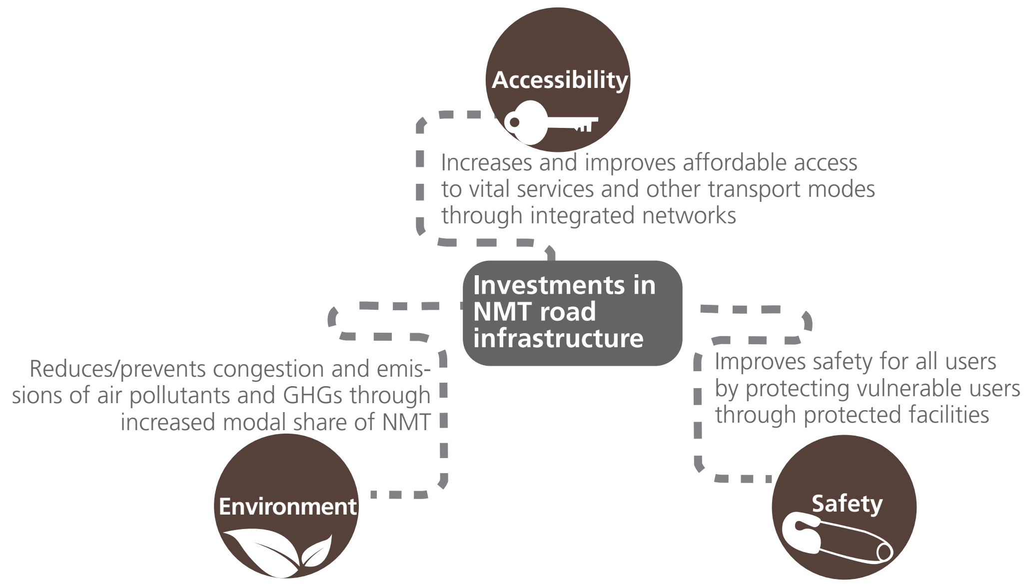
Traditional urban and transport planning often neglects non-motorized transport. The emphasis is usually on improving and expanding infrastructure facilities for motorized transport, trying to improve connection, travel time and speed. But mobility planning must include all modes of transport and should especially emphasise the non- or less polluting solutions.

Non-motorized transport mainly refers to walking and cycling. It is the most sustainable and healthy way for individuals to travel. Scaling up non-motorized transport in urban areas results in a lower per capita energy use, less dependency on fossil fuel, less air and noise pollution, a reduced carbon footprint and less traffic congestion and fatalities (Figure 2.18). Investing in infrastructure for non-motorized transport (cycle and walking lanes) is increasingly becoming popular in cities all over the world. But in many Asian cities pedestrians and cyclists are not provided with the appropriate infrastructure and facilities. And if facilities do exist, they are often poorly maintained or used for other purposes such as parking space for cars. This makes the use of non-motorized transport in many Asian cities not only challenging but very often life threatening.

Non-motorized transport modes have the unfortunate distinction of being overlooked by most traffic planners and economists. But they fulfill an important function in all societies.
(UNEP, 2008b)

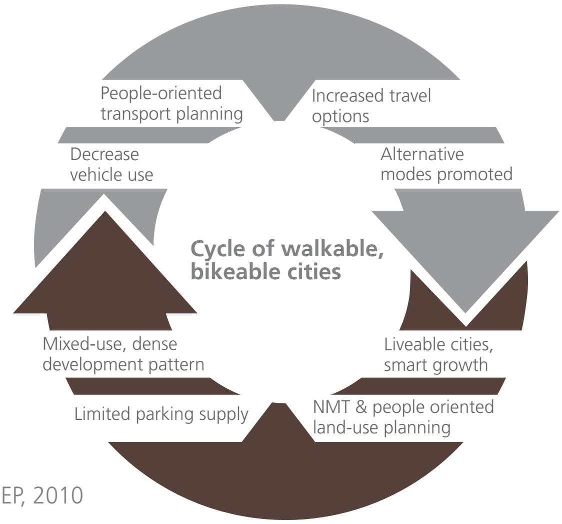
City governments that make a commitment towards more sustainable development are taking up the low-carbon mobility path. Besides the creation of the necessary infrastructure for cycling and walking, advocating non-motorized transports requires compact and smart town planning. Compact cities, where distances are kept short are more inviting to non-motorized transport solutions than urban centres in which distances are long. Specifically assigned cycling and walking paths may need to be shaded with trees, which can also act as small carbon sinks (GTZ, 2009). Bike parking, specific traffic signals, decongestion of existing roads, improved accessibility for cycling and walking along with the development of a safer road culture are mechanisms that will help in the uptake.

Figure 2.18 Triple Win from Investments in Non-Motorized Transport Road Infrastructure



Adapted from: UNEP, 2010

Figure 2.19 Smart Mobility Planning

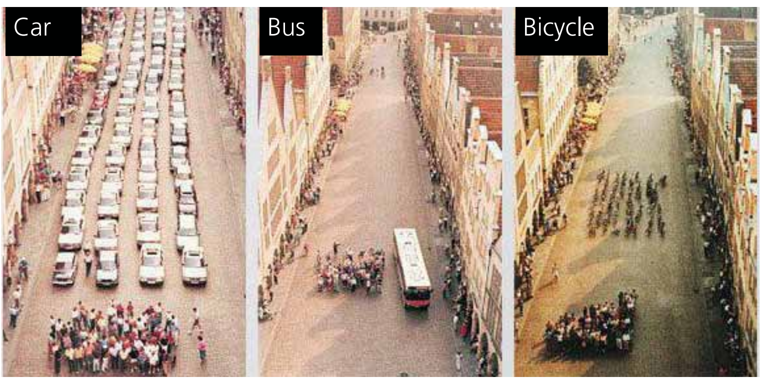


Adapted from: UNEP, 2010

Public Transport Systems

Public transport is a wide category that includes different means of transport such as buses, mini-buses, vans, metro and trams, taxis, rickshaws and three wheelers. In many Asian cities buses, mini buses and rail account for a big share of the public transport. In order to make these modes attractive for use, they have to be integrated with urban planning and with the wider region. Interconnectivity between different modes of public transport has also to be addressed. In addition the use of private motorized vehicles could be discouraged by means of higher road taxes, fees for parking, or higher registration fees for the vehicle (see chapter 4). Promoting public transport or non-motorized transport solutions will also result in the reduced need of wide and extensive road networks (Picture 2.3).

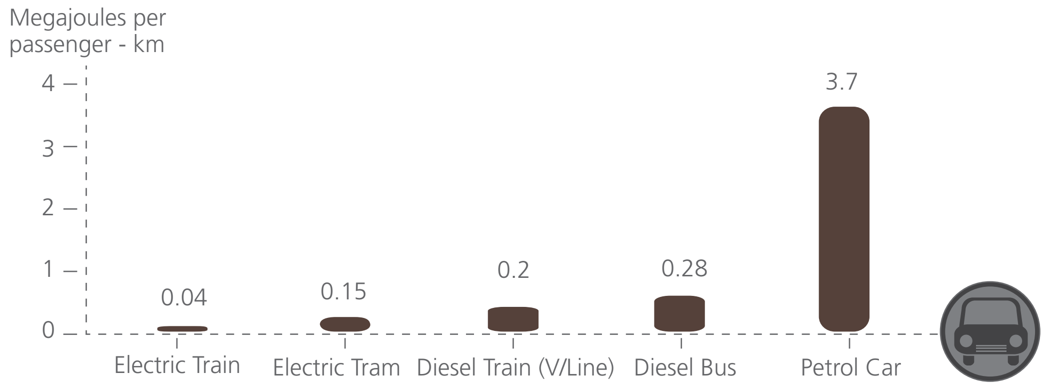
Public transit is less energy- and carbon-intensive than automobiles. (UNEP, 2008b)



Space required to transport 60 people © Press Office City of Munster, Germany

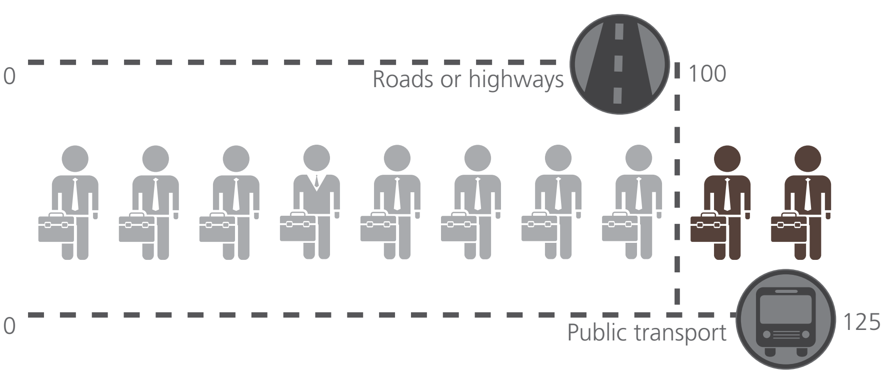
Public transport reduces fossil fuel dependency. Buses, trains and trams are more efficient per passenger, than cars (Figure 2.20. In addition, lower traffic volumes will result in reduced road maintenance costs for cities and provinces. In cities with a high share of public transport, walking and cycling, the cost of transport for the community - expressed as a proportion of the urban GDP - is half that of cities where this share is low. For example, the cost of transport represents more than 12 per cent of the local GDP in Houston or Sydney, but only 6 per cent in Tokyo or Hong Kong (UITP, unknown). Developing public transport instead of investing in road infrastructure for cars will also help in the creation of more jobs (Figure 2.21). Public transport may also help in creating more cohesive communities as it encourages social contact.

Figure 2.20 Fuel Efficiency per Vehicle Type



Adapted from: AGO, 2006.

Figure 2.21 Public transport creates 25 per cent more jobs than the same investment in building roads or highways



Adapted from: UITP, unknown

Box 2.13 Urban Water Ways as Sustainable Transport Modes

Urban waterways provide important transport infrastructure for freight transport, but also for public and private transport in some cities. Their importance and characteristics are very case-specific. In general, waterways are mainly affected by either a lack of water availability or by flooding. Where impacts are severe, certain waterways may have to be abandoned entirely or the construction of new waterways may become necessary.

Source: GTZ, 2009

2.5 Integrated Urban Planning

"Our biggest challenge in the new century is to take an idea that seems abstract 'sustainable development' and turn it into a daily reality for all this worlds' people".

- Kofi Annan, Former UN Secretary General

Urban planning decisions taken now can shape the well-being of citizens and direct urban growth for centuries. Planning has a decisive role to play in climate change resilience because it influences activities that lead to GHG emissions and guides patterns of land-use as well as energy use. The built environment also shapes and directs the location and concentration of socioeconomic activities (Jia, 2009).

Integrated urban planning rests on three pillars of sustainable development - economy, society and environment. It recognises that any urban development has to take these three parameters into account. This makes planning a highly complex activity. Environmental concerns such as land use, air pollution and the protection of water bodies have to be integrated with economic development concerns, such as the creation of jobs, the support of industry and commerce and the travel of people, goods and services while at the same time considering the needs and the well-being of the population.

To meet these goals a paradigm shift in infrastructure development is required. Instead of expensive centralized systems, a more network based or decentralized approach is emerging. This may include clusters of towns within a city that have a high compactness and that have infrastructure services such as power generation, water facilities, food production and workplaces in their vicinity. There is an increasing effort to become sustainable by increasing density, taking up mixed land use patterns, increasing energy efficiency, providing better infrastructure services and also by encouraging more sustainable lifestyles for citizens. The challenges lay not so much in finding technical solutions but more in the financial, institutional, cultural and political factors involved. There have been a number of answers to meet these challenges including the New Urbanism movement, Smart Growth, the concept of Eco Cities and Regenerative Cities.

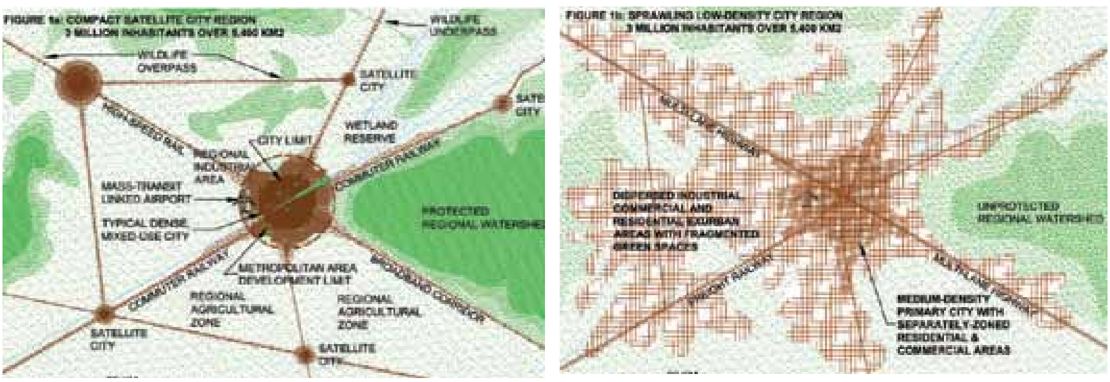
Reorienting the transportation sector toward greater sustainability requires not only a different mix of transportation modes, but also far-reaching changes in land use and land-use planning. (UNEP, 2008b)

Smart Growth

Many environmental problems can be traced back to inefficient land-use practices and policies that encourage urban sprawl, which increases the need for transport, demand for energy (for heating and cooling purposes), and has higher infrastructure costs. Smart Growth is a response to these problems and can be summarized below. It refers to a city's land-use practices that promote land-use patterns to reduce the amount of travel needed in order to reach goods or services. Smart Growth encourages high density development and compactness around commercial centres and urban transit nodes. Here are some tips for achieving Smart Growth:

- Plan strategically. Establish a community "vision" which individual land use and transportation decisions should support.
- Create more self-contained communities. Reduce average trip distances, and encourage walking, cycling and transit travel, by locating schools, shops and recreation facilities in or adjacent to residential areas.
- Foster distinctive, attractive communities with a strong sense of place. Encourage physical environments that crate a sense of civic pride and community cohesion, including attractive public spaces, high-quality architectural and natural elements that reflect unique features of the community, preservation of special cultural and environmental resources, and high standards of maintenance and repair (GTZ, 2003)

Denser cities and shorter distances reduce the overall need for motorized transportation. They also make alternatives like public transit, biking, and walking more feasible. (UNEP, 2008b)



Comparison of compact city and urban sprawl © UN-Habitat, 2011b

Table 2.8 Smart Growth Compared with Urban Sprawl

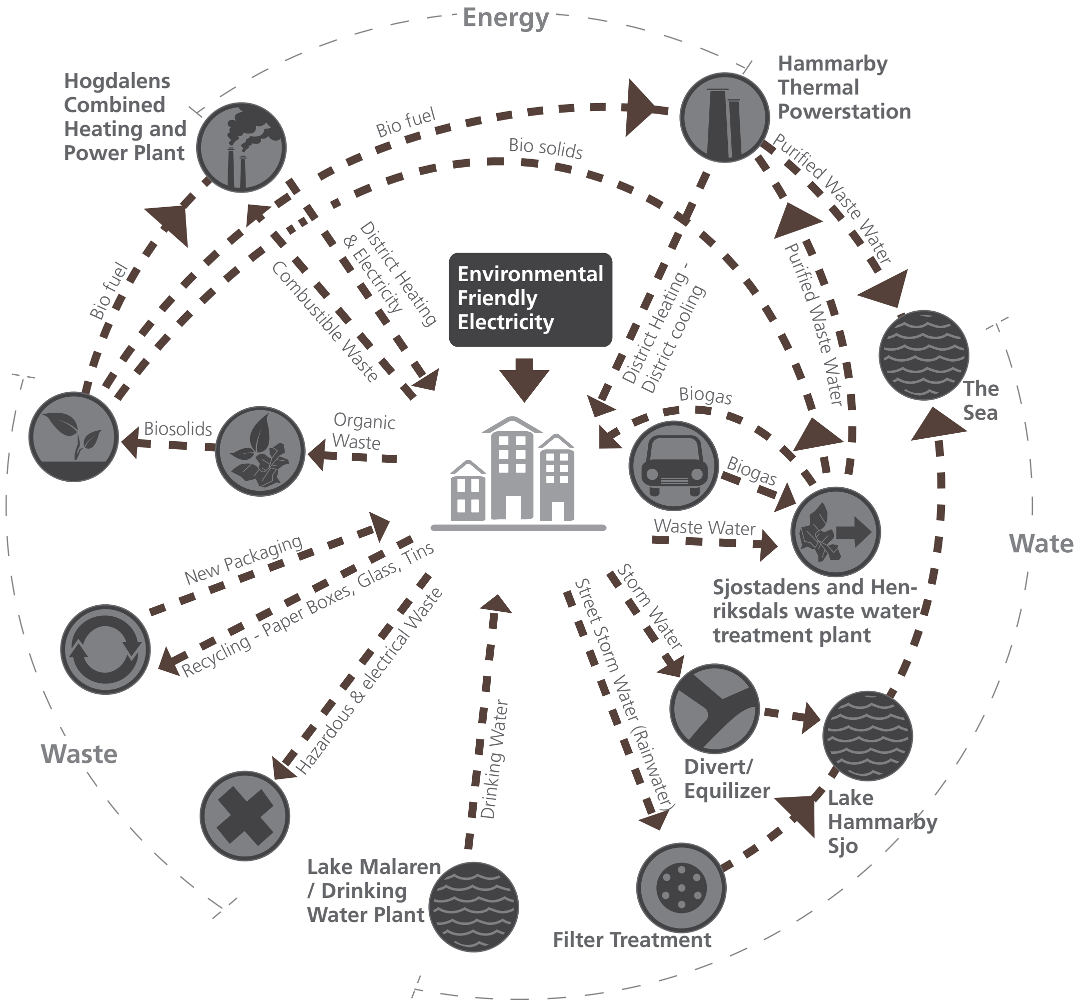
	Smart Growth	Urban Sprawl
Emphasis	Accessibility – to goods services, and activities	Mobile-physical movement, particularly by car
Density	Higher Density, clustered activities	Lower density, dispersed activities
Growth pattern	Infill development	Lower density, dispersed activities
Land Use Mix	Mixed	Single use, segregated
Public Service	Local, distributed, smaller, walking access	Regional, consolidated, larger, requiring car access
Transport	Multimodal transportation and land-use patterns that support walking, cycling, and public transportation	Car oriented, poorly suited to walking, cycling and public transportation
Connectivity	Highly connected roads, pavements and paths allowing more direct travel by motorized and non- motorized transport modes	Hierarchical road network with many unconnected roads and walkways, and barriers to non- motorized transport
Street Design	To accommodate a range of activities with street calming	Designed to maximize vehicular movement throughout
Planning Process	Planned and coordinated between jurisdictions and stakeholders	Either unplanned/little coordination, or inappropriately planned to local conditions (e.g. US)
Public Space	Emphasis on streetscape, pedestrian areas, public parks, and public facilities	Emphasis on the private realm of shopping malls, gated communities, private clubs

Eco-Cities

Eco-cities are urban centres that orient themselves on certain sustainability goals by implementing sustainable urban technologies. They follow an ecological approach to urban design where cities are conceptualized as an eco-system with circular physical processes for resources like energy, water and food. They are dedicated to minimizing material inputs and at the same time to reducing material outputs in the form of waste, heat, air pollution and polluted water. An eco-city aims at not consuming more resources than it can produce, not producing more waste than it can assimilate, and not polluting the environment. Its inhabitants' ecological impact reflects planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice and reasonable equity (Eco-City Builders, 2010). Eco-cities are an implementation of smart growth by promoting high density instead of urban sprawl development; strong incentives are given to use public transport or

A sustainable city or an eco-city is an entity developed to minimise its resource requirements and the waste output created by its inhabitants. (Woods Bagot, 2008) non-motorized transport while at the same time the use of private vehicles is discouraged. Renewable energy systems and urban and peri-urban agriculture are integrated elements of eco-cities. In eco-cities people can live healthy and economically productive lives without affecting the environment negatively.

Figure 2.22 The Hammarby Model, Stockholm: An Example of Integrated Planning and Management

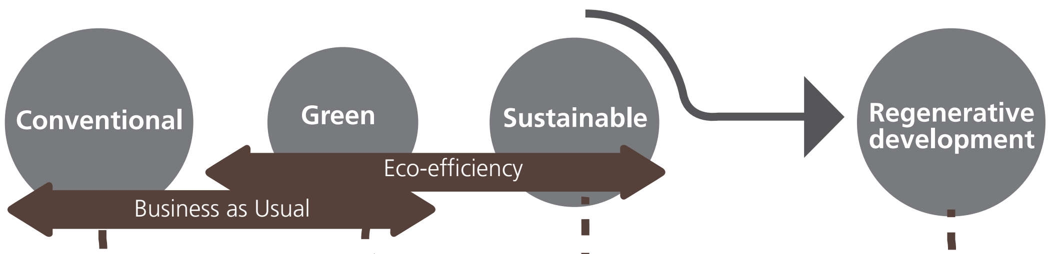


Adapted from: www.hammarbysjostad.se

Regenerative Cities

While eco-cities aim at minimizing their negative impact on the environment, the concept of regenerative cities takes on a whole new perspective in trying to restore environmental systems and to contribute to eco-system services in a positive way. This addresses the relationship between cities and their hinterland and even with the distant territories that supply them with goods and services. This can include the support of reforestation in the hinterland to increase its capacity for carbon sequestration or the support and promotion of organic agriculture through economic ties. Closing the material loop in providing the hinterland with valuable input material for agriculture like grey water or compost from solid waste is another characteristic of a regenerative city. Regenerative cities are envisioned as zero waste cities, high energy conserving and effective and as centres of prosumption, taking care of a good percentage of their energy and food needs. 'Creating regenerative cities thus primarily means one thing: Initiating comprehensive political, financial and technological strategies for an environmentally enhancing, restorative relationship between cities and the ecosystems from which they draw resources for their sustenance' (World Future Council, 2010).

Figure 2.23 From Conventional to Regenerative Cities



Conventional

Little or no consideration is given to the environmental impact of the design.

Designs generally aim to meet minimum legal requirements for the lowest first-cost price.

A rapidly expanding segment of business-as-usual is 'green' and moving towards sustainable.

Eco-efficency

Green design:
Does not challenge current production methods or consumption patterns that have negative environmental impact.

Minimizes energy use, pollution and waste (termed 'less bad' design.

Sustainable design:
Acheives neutral environmental impact and maximum efficiency.

Regenerative development

Sees humans, human developments, social structures and cultural concerns as an inherent part of ecosystems.

Questions how humans can participate in ecosystems using development to create optimum health.

Seeks to create or restore capacity of ecosystems and bio-geological cycles to function without human management.

Understands the diversity and uniqueness of each place (socially, culturally and environmentally) as crucial to the design.

Sees the design process as ongoing, indefinite and participatory

Adapted from: World Future Council, 2010

Box 2.14 The 2000-Watt Society

Today 2000-Watt is the average per capita consumption world-wide, but there are enormous disparities between developed and developing countries. The Vision of a 2000-Watt society was formulated in Switzerland by the Federal Institute of Technology in Zurich. It means the reduction of energy consumption by two thirds for Switzerland. It calls for a reduction of energy consumption and simultaneously for a rise in energy efficiency, substituting fossil fuels with renewable forms of energy, adopting a more sustainable way of life and rethinking current business practices. Changes in the construction sector through the implementation of solar passive design, zero emission buildings and fundamental changes in the road, transport and freight sector are envisioned. This should be achieved by adopting already existing technologies and without compromising present quality of life. The most significant change according to the 2000-Watt society initiatives will have to occur in human behaviour.

Source: Stulz & Lütolf, 2006

2.6 Emerging Technologies for Sustainable Urban Energy

"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait till oil and coal run out before we tackle that."

- Thomas Edison (1847–1931)

We have explored how existing technologies can be used to make cities more sustainable. At the same time new technologies are emerging that promise a decisive shift towards a more sustainable future. However, technologies alone are not the answer; they are the hard solutions for the soft issues.
The hard issues however, as seen in the example of the energy pyramid (Figure 2.4), need soft solutions such as behavioural change and effective policies based on an integrated vision towards sustainability. New technologies can bring a sustainable future only if the right policy environment supports them. One could even name awareness and lifestyle change as the single-most promising technology for a sustainable urban future.
New technology innovations can help in bringing about changes for the better in certain ways:

1. Efficiency in existing systems as in buildings, electric appliances, vehicles, and production processes.
2. Emerging technologies offer technological alternatives to processes that consume fossil fuels.

Governments in developing countries have traditionally been seen as "bottlenecks" to emerging technologies. If the gap between technology and effective policy making could be bridged by mutual effort, cities would much benefit. This gap could be bridged by more than one way:
- Rewarding and recognising innovators
- encouraging experimenting at low cost
- enabling research and development

Necessity has always been the mother of invention. Scarcity drives technology. (Vattenfall, 2009)

Governments should also motivate collaboration between local players and international partners who will enable local companies to strengthen their knowledge, expertise and market reach.

Smart Grid – Smart Appliances – Smart Home

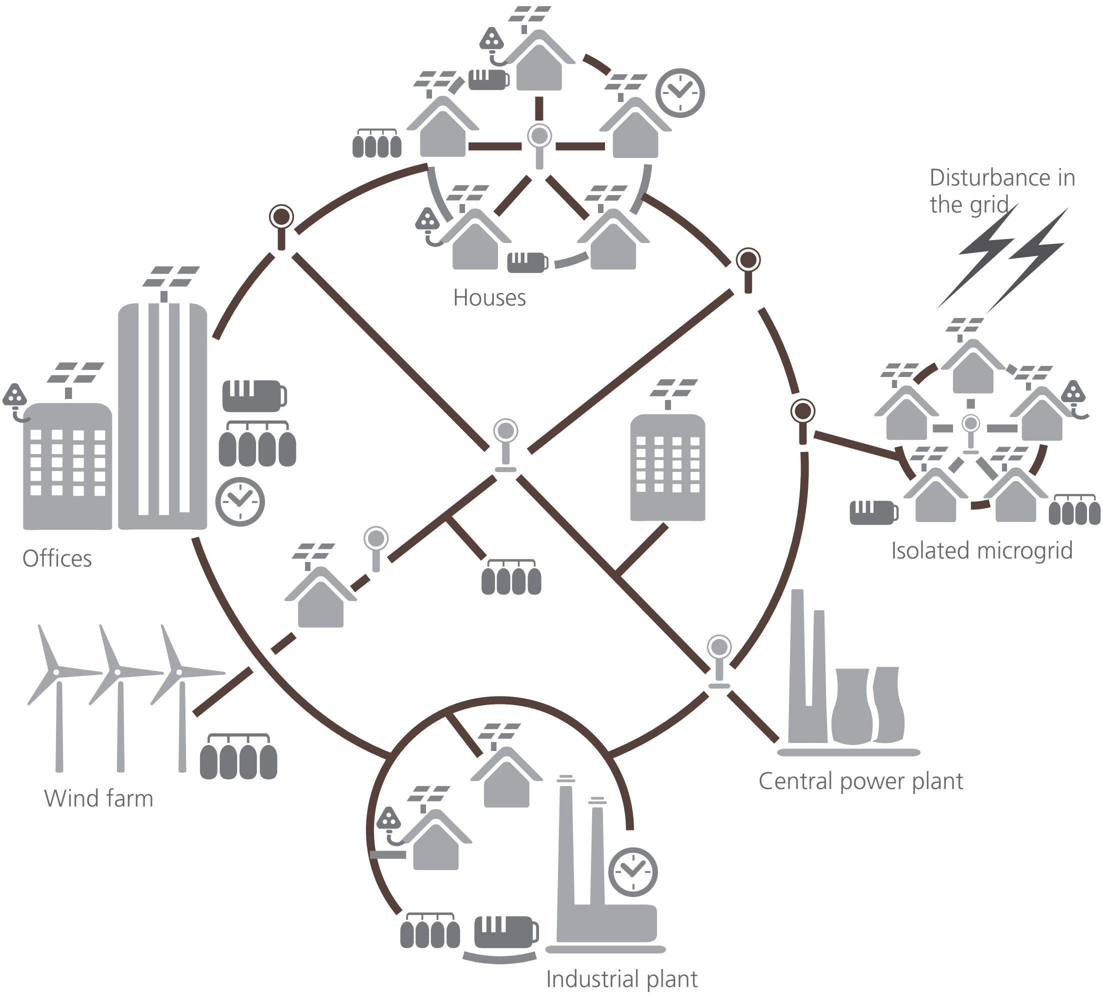
A sustainable urban energy system will need low carbon technologies on the supply side, and an efficient infrastructure and more efficient appliances at the end-user side. The next wave of technological innovation will be created around smart applications such as smart appliances, smart homes and smart cities. These are technologies that employ digital monitoring systems to improve the efficiency of power transmission and consumption and give the user detailed information on their consumption.

Smart grids may provide compelling solutions for the intermittent power supply by helping to balance variable power generation and demand. They can also help by being more efficient in transmission and distribution than the current systems and thereby provide solutions for thermal storage technologies. How does this work?

Smart Grids may be paired with smart appliances or even a smart home, which respond to varying electricity supply and prices. That means a washing machine can be programmed in such a way that it will only start operating when there is plenty of power in the grid or when the price is under a certain threshold. Households, offices or factories would program smart meters to operate certain appliances when power supplies are plentiful. Utility companies would – for example, be tweaking thermostat temperatures – to cope with spikes in demand (WWF, 2011). Smart Grids reduce peak demand by allowing customers, manually and/or automatically, to reduce and/or shift the time of their consumption with little impact on operation and lifestyle. This permits minimization of additional investment in power plants and consequently lowers prices to end-users (IEA, 2010).

The smart grid uses digital technology to communicate with facilities and appliances to understand usage patterns and deliver electricity more efficiently, thus helping to save energy, increase reliability, and reduce costs. (ABC, 2010)

Figure 2.24 Smart Grid



Solar panels

Processors:
Execute special protection schemes in microseconds

Generators:
Energy from small generators & solar panels can reduce overall demand on the grid

Demand management:
Use can be shifted to off-peak times to save money

Storage:
Energy generated at off-peak times could be stored in batteries for later use

Smart appliances:
Can shut off in response to frequency fluctuations

Sensors:
Detect fluctuations & disturbances & can signal for areas to be isolated

Adapted from: WWF, 2011

Vehicle to Grid

One of the main challenges of renewable energy systems such as solar and wind is the intermittent supply from these systems. Solar systems do not produce electricity at night and wind turbines produce more energy during high wind regimes. These systems require innovative mechanisms for capacity regulation and grid connected storage capacity.

Vehicle to grid © Rocky Mountain Institute, 2008

One possible solution to this intermittent power supply problem is through electric vehicles. These have a battery system and a charger, which can be made bi-directional allowing the vehicles to feed into the grid while not in use. Battery recharge takes only a couple of hours and electric vehicles are generally used for a small portion of the day. This provides some flexibility about when electric vehicles are charged or discharged. They have the capacity to store energy and feed it back into the grid at peak times when additional energy is required and can thus help in stabilizing the grid. This is also a potential source of income for vehicle owners, since the power fed back can be metered and result in payments. Crucial for the advance of vehicle-to-grid technologies are improved battery systems, an appropriate infrastructure such as smart grids, public plug-in stations as well as a critical mass of vehicles that join the initiative.

Success is achievable through existing proven technologies and appropriate new technologies. (World Bank, 2010)

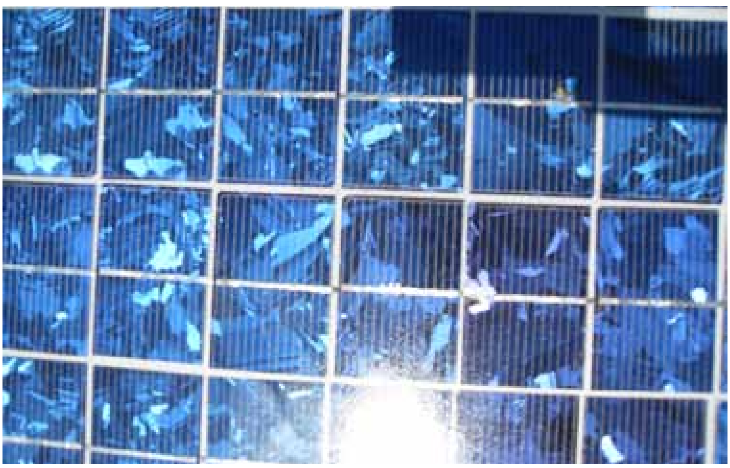
Solar Thermal Storage

Solar thermal power plants gather heat from the sun and store energy gained for hours and sometimes for even days. They have enough power to boil water into steam to run a turbine and generate electricity. This has the advantage that energy can be stored till it is required during peak demand period. For example, Gemasolar in Spain has a reflective surface of 110 square feet that follows the Sun. Its thermal storage system is able to retain up to 99 per cent of the heat for a period of 24 hours. It supplies clean and safe energy to 25,000 households and reduces carbon emissions of over 30,000 tonnes per year.

Solar thermal storage © www.gotpowered.com

Solar Shingles

Solar Shingles are based on photovoltaic (PV) technology. These look like roof shingles but have the capacity to produce power. They are said to be more effective than solar panels, absorb more light and are at the same time durable enough to be used as roofing material. They provide the same production and weather shedding effects as regular roof shingles.



Solar shingles © UN-Habitat/ Sebastian Lange

Rooftop Wind Turbines

Rooftop wind turbines or small-scale wind turbines may turn out to be a promising solution for sustainable energy production in the near future.

The benefits of a home wind system are an independence from the grid and a relative short payback period (about 5 years). The optimum amount of power that can be generated from rooftop turbines can typically provide up to a third of an average household's energy requirements.

Rooftop wind turbines © www.energy-green.net

Ambiator

It is based on thermodynamic principles to produce cooling without mechanical compression and uses only minimum electricity. The ambiator works on the principle of evaporative cooling and is particularly effective in locations with low ambient humidity. It can produce cool air at a fraction of the energy input compared to conventional refrigeration cooling.

Ambiator © www.thomex.com

Solar Window Blinds

Solar window blinds have a dual function. They can keep the sunlight out in order to keep interiors cool and at the same time they can convert light into electricity. The blinds have a solar PV film on top that enables them to produce electricity, which can be used to power small appliances and gadgets.

Solar window blinds © www.yankodesign.com

03. Good Practices

Good or best practices refer to "practices that result in change or improvements to production, resource usage, governance and use of new technology". They are used to demonstrate what works and what does not, and to accumulate and apply knowledge about how and why they work in different situations and contexts (Roberts, year unknown).

Good practices cannot be applied to all cities without considering the country, level of development, culture and lifestyle of its people, climate and other sensitivities.

If good practice approaches for urban development are to become more widely applied in Asian cities, local governments must educate citizens, including their own employees and the business community about the need for change, as well as the improved approaches to urban management involving the adoption of good practices. This most certainly will imply a change in institutional culture (Roberts, year unknown).

The following pages illustrate some good practices that authorities at the city and country level have used to make the best possible use of their areas, and many a time to transform them.

3.1 Urban Planning

Eco-District Kronsberg, Germany

Kronsberg is an eco-district situated in the city of Hannover, Germany, which is built on 1,200 hectares on the city outskirts and planned for 15,000 inhabitants. Emphasis was laid on low land occupancy, by means of high-density construction. A direct light rail links the district to the city centre; streets are designated for cycling throughout the district and a dense layout of footpaths offer an attractive alternative to private motorized transport. Almost 300 new jobs have been created in the neighbourhood with the objective of keeping commuting at a minimum. Ecological standards for developers were defined for energy, construction waste, soil management, and water and nature conservation. For the energy sector, the goal was to reduce the carbon footprint by 60 per cent compared to the national level through measures for electricity saving, innovative building and renewable energy using solar PV and wind (Rumming, 2007).

Public transport in Hannover © Region Hannover

3.2 Energy Efficiency

The Energy Efficient City, Helsinki, Finland

Heat generated from the production of electricity can be captured and used for day-to-day needs. In Finland, an important method of heating buildings is by hot water produced during electricity production and piped around whole districts, providing both heat and hot water. This extremely efficient use of fossil fuels demands a coordination of energy supply with local physical planning, which few countries are institutionally equipped to handle. Heat obtained in generating electricity is now used for heating the city instead of discarding it into the sea. The system currently serves more than 91 per cent of all Helsinki's buildings. The efficiency of energy supply has been raised from 40 per cent up to 80 per cent in Helsinki. In an average power station, for example, only around 35 per cent of the fuel burnt (coal, oil, etc.) is converted into electricity, the remainder being lost to the atmosphere, rivers or the sea, as waste heat. Combined heat and power plant stations (CHPs) on the other hand capture most of this waste heat, raising the overall efficiency to between 75 and 90 per cent (Pierce, 2004). The heat obtained can also be diverted to industries for their manufacturing needs.

Pipes © www.dreamstime.com

Energy-Plus-House, Denmark

The European Commission, along with the Danish Energy Agency has funded the development of an energy-positive house of 600 sq. metres in Denmark. As the name implies, it intends to produce more energy than it consumes. It is made up of different individual components, each having proven its efficiency. The house functions both as a solar collector and a greenhouse. Micro generation technology and low-energy building techniques such as passive solar building design, insulation and careful site selection and placement also help achieve positive energy.

Energy plus house © www.folkecenter.net

The house faces south, helping to reduce the energy needed for heating the building. The building has a glass façade with 20 cm gap between two layers of glass. This is filled with small polystyrene beads, which insulate the house at night and in winter. During summer these work as shading in the daytime, making it possible to control the indoor climate. Heat pumps inside the building condense moist air that is subsequently used for watering the plants.

Energy plus house © www.folkecenter.net

3.3 Renewables (City Initiatives)

Solar Cities Programme, India

The solar cities programme is an initiative of the Government of India to develop around 60 solar cities during the 11th Plan period (2007-2012). The objective of the programme is to empower urban local governments to address energy challenges at the city level. Cities willing to develop a master plan that aims at reducing at least 10 per cent of demand for fossil energy sources (5 per cent from energy efficiency and conservation measures and 5 per cent from renewable energy sources) are recognized as solar cities. Cities demonstrating high level of political commitment and administrative leadership will be provided financial assistance:

- To prepare a Master Plan that includes assessment of the current energy situation, future demand and action plans;
- To build capacity in the Urban Local Bodies and create awareness among all sections of civil society;
- To involve various stakeholders in the planning process; and
- To oversee the implementation of sustainable energy options through public - private partnerships.

Solar panels © UN-Habitat/ Sebastian Lange

Solar cities will focus on popularizing renewable energy projects/ systems/devices such as solar PV systems including building integrated photovoltaic systems, kitchen waste based plants, solar water heating systems, solar cooking systems, solar steam generating/ drying/air heating systems, solar concentrators for process heat applications, solar air-conditioning, power projects on methane recovery from Sewage Treatment Plants (STPs), biomass gasification based systems, biogas, wind, etc.

Ride the Wind Project, Calgary, Canada

The City of Calgary's Ride the Wind Project was launched in 2001. It is the first wind-powered public transit system in North America. All 100 cars are 100 per cent emissions free and run on wind energy. In addition, thanks to the use of massive awareness programmes, the city has managed to increase ridership in its transit system - ridership has soared by 33 per cent over the past five years while at the same time the city's population rose by 15 per cent. C-Train ridership alone shot up by 73 per cent during the same time period.[7] This initiative of Calgary is recognized as the first wind powered public transit system in North America and it has contributed to the reduction of greenhouse gas emissions by 26,000 tonnes of CO_2 annually (Archdeacon, 2008)

Calgary transit © Flickr_Hobolens

Lease and Hire of Solar Panels, Australia

Government intervention can prove helpful in the uptake of expensive renewable energy investments by low-income neighbourhoods. It can help with installations of wind energy for communities, including offshore wind parks to reduce CO_2 emission, new solar panels for existing buildings and houses, and solar water

7 www.bestpractices.org/bpbriefs

heaters for households in regions having good sunlight. Even though these options have high up-front costs, they offer significant potential for carbon abatement. There can be innovative ways of financing such investments. In Australia, for instance, households have the option of renting their rooftops to a company, which installs the solar system and then feeds the excess electricity generated into the grid (Energy Matters, 2011). Having a feed-in tariff system will help in the uptake of renewable energy ventures, which are currently not common in Asian countries. In fact fixed feed-in tariffs have proven to be one of the most effective policy actions for the promotion of renewable energy. A mandatory electricity utility quota for industries and public institutions, net metering and financial incentives like production tax credits, capital subsidies are other interesting options for policy makers.

Solar panel © UN-Habitat/ Bernhard Barth

Wind Energy for Auroville, India

Auroville, a small international community of about 2000 inhabitants in South India was meeting its electricity requirements by purchasing fossil fuel based electricity, supplied by the State power utility. But for a township that aspires to base its energy requirements on renewable energy, this solution was unsustainable – particularly as lignite, the fuel used for power generation, has a large polluting potential. A few Aurovilians set up a private company to serve the future energy and water requirements of Auroville. Two wind turbines that feed electricity into the grid were installed. Another wind turbine is envisioned to run a desalination plant to produce 1000 cubic meters of drinking water per day, which would serve the water needs of 3,300 people. Revenue received from selling the electricity to the grid is donated to the Auroville Township and will be invested in installing more renewable energy systems (Carel, 2009).

Windmill © IUTC

Offshore Wind Turbines for Shanghai, China

Shanghai city built its first wind power station in 2003 and by 2008, it had added wind turbines to a total of 39 megawatts in capacity, producing enough electricity to power an estimated 39,000 households.

By 2020 Shanghai plans to have a total of 13 wind farms with an installed capacity of a 2.1 gigawatts providing electricity to more than 4 million households. Among the wind farms to be added is a major offshore wind project, Dongahi Bridge Wind Farm, with 102 megawatt of installed capacity. Dongahi Bridge Wind Farm is the first offshore wind farm in China, and the world's first major offshore wind farm located outside of Europe. It is capable of providing about 1 per cent of the city's total power production; and is expected to cut coal use by 100,000 tonnes per year and thereby reduce carbon emissions by 246,000 tonnes annually.

Solar Power Osaka, Japan

A "megasolar" large-scale solar power plant with an output of 10 MW has been installed in the Osaka Bay waterfront. The plant's total area expands to approximately 21 hectares with some 74,000 thin-film silicon solar PV panels installed. A total power generation of 11 million kilowatt-hours a year will result in annual carbon dioxide emissions of about 4,000 tonnes.

Solar power Osaka © www.osakacity.org

Solar Water Heater, Barbados Island

Barbados, an island state in the Caribbean has come up with a National Strategic Plan for 2006-2025 to decrease its reliance on imported fossil fuel by increasing the country's renewable energy supply. The focus is particularly on raising the number of installed solar water heaters by 50 per cent by 2025. Solar water heaters are now a widely used renewable energy technology in Barbados, with installations in nearly half of the island's dwelling units. Barbados has around 91,400 dwellings and by 2008, approximately 40,000 solar water heaters were in operation - 75 per cent of which represent domestic installations. Their growing presence in this island nation illustrates how a resourceful initiative can both promote renewable energy systems and stimulate economic growth.

Source: www.unep.org

Solar power © www.solarinthecity.net

The First Cap and Trade System in Asia, Tokyo, Japan

Tokyo performs reasonably well regarding carbon emissions and energy efficiency. The city's authorities initiated their own mandatory CO_2 cap and trading system as part of the city's climate strategy. In order to reduce urban CO_2 emissions, the Tokyo Metropolitan Government introduced a cap-and-trade programme in April 2010 that covers large office buildings, commercial establishments, and industrial facilities. All organisations that use the energy equivalent of 1,500 litres of oil annually for fuel, heat and electricity are required to participate. The immediate target for each organization is a 6 per cent reduction in emissions (from their average level of emissions between 2007 and 2010) by 2015. In the following five years an additional 17 per cent reduction is targeted. Organizations that achieve higher emissions reductions than targeted are allowed to sell carbon credits. The city says that the system is unique because it is the first to cover all major buildings, including offices, hospitals, universities and government buildings. Tokyo is also trying to encourage the adaption of such schemes at the national and international level.

Tokyo, Japan © Flickr_One Finger Snap

3.4 Buildings

Auroville Earth Institute, India

The Auroville Earth Institute in Auroville (India) has been extensively researching and promoting earthen blocks as building material. This technology has been found to be both cost-effective and energy efficient. The main goal is finding ways to minimize the use of steel, cement and reinforced cement concrete (RCC) by introducing composite blocks (earth, fibres and stabilizer). The Institute is also researching "homeopathic" milk of lime and alum as an alternative to cement, and alternative water proofing with stabilized earth.

Auroville, India © www.earth-auroville.com

Sustainable Building and Construction, Harare, Zimbabwe

Using energy in more sustainable and efficient ways can have a major impact on mitigating climate change. One of the ways to use energy more efficiently is through sustainable building and construction. Harare, Zimbabwe, came up with an innovative ventilation system, based on the self-cooling mounds of African termites. The Eastgate Centre, a shopping complex and office block in downtown Harare, has been designed to be ventilated and cooled entirely by natural means. It stores heat in the day and during the evening and night the warm internal air rises and is vented, drawing in denser cool air at the bottom of the building. This 'passive' cooling system replaces artificial air-conditioning entirely. Compared to conventional buildings, the Centre decreased its energy use by 10 per cent, saving 3.5 million dollars because no air-conditioning system had to be adopted (Doan, 2010).

Contrasts © www.inhabitat.com

Zero Carbon Homes, England

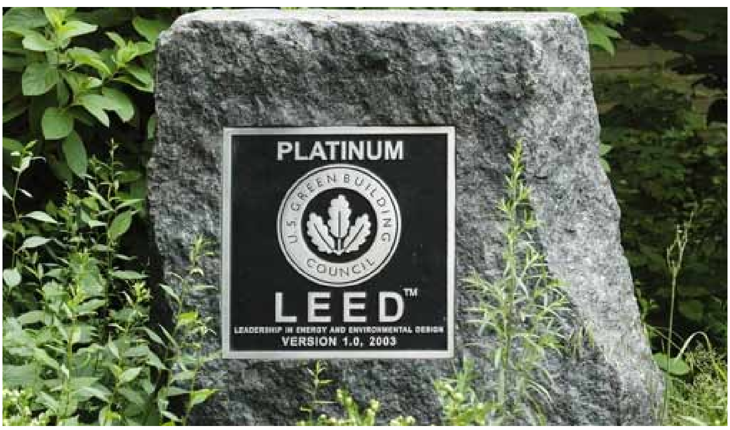
From 2016, new homes in England will have to be built to level 6 of the Code of Sustainable Homes, as 'zero carbon homes'. The exact definition of 'zero carbon' is yet to be decided but it is likely to require high energy efficiency standards (with energy demand for space heating expected to be around 40 kWh/m^2, compared to an average of around 200 kWh/m^2 in the existing stock), as well as on-site or off-site renewable energy generation for all building-related energy demand (e.g. lighting, ventilation). The involved administrations are also introducing zero carbon building standards. By 2030, one can thus expect a stock of around 2-3 million new homes built to zero carbon standards, primarily driven by the demand for extra dwellings (Morikawa, 2000).

The BRE site in Southwest England is reportedly the first house to achieve Level 6 benchmark under the Code for Sustainable Homes. BRE's zero-carbon home includes solar photovoltaic panels, biomass boiler and a 'wind catcher' (E-Architect, 2011).

Zero carbon homes © www.inhabitat.com

Credit for Green, USA

A new credit in the U.S. Green Building Council's LEED rating system could boost the use of third-party verified products in green building projects. The Certified Products credit, which was released in June 2011, gives points to projects in which at least 10 per cent of non-structural products are environment-friendly as certified by the relevant associations. The credit benefits manufacturers of environment-friendly products and encourages more product-makers to seek out third-party certification and verification services. It would also give architects a reference to find recognized products (Stroud, 2011).



© www.thinkgreenliveclean.com

3.5 Transport

Telecentres: Changing the Way People Work, Chula Vista, USA

Cities around the world are trying to address the problems of the impact of automobiles on the urban environment. Energy consumption, climate change, air pollution and the rising cost of fuel are forcing local authorities to focus on reducing emissions and slowing down global warming. Chula Vista, a small city with a population of 150,000, has responded to this through the concept of "Tele-Commuting" as part of its Carbon-dioxide Reduction Plan. Instead of commuting to work, residents can use their "Neighbourhood Telecentres" which are equipped with computers, modems, telephones and other office support services to complete normal work tasks. Doing so reduces automobile trips, traffic congestion, energy consumption and air pollution, promotes a better quality of life by providing a workplace closer to home and could also improve productivity (UN Habitat, 2008).

Work from Home Policy in Corporate Houses, India

Today many companies in the IT sectors are offering the option to work from home, thereby reducing commutes and adding more flexibility to the location of work. When undertaken by a large number of workplaces, this results in huge reductions in number of miles travelled, and the corresponding carbon emissions. A study by Nairn (2007) analyzed the environmental benefits of a 5 per cent reduction in daily commuting travel. If 5 per cent of people were to work from home using broadband, this would result in an average of 567 km less travel per vehicle and a carbon emissions reduction of 159 kg CO_2-e. Using the Internet to work from home does indeed result in significant carbon emission reductions (Baliga, Hinton, Ayre, & Tucker, 2009).

Improving Walking and Cycling Infrastructure in New York City, USA

More than 50 acres of road space in New York City (NYC) have been reclaimed from traffic lanes and car parking lots to meet the goals of long-term sustainability. After decades of car-oriented policies, the NYC Department of Transportation has succeeded in installing over 322 km of new bicycle lanes, and more than 6,000 bicycle racks, and more than two dozen bicycle parking shelters resulting in a 45 per cent increase in bicycle commuting (NYC Department of Transportation 2009).

Walking and cycling infrastructure in New York © www.ecovelo.info

In Times Square, after a century of accommodating car traffic, the city adopted a strategy of taking small nibbles of street space away from cars until reaching a point of noticeable change. The initial street reclamations were done by using coloured paint on asphalt, followed by permanent reconstruction. The city also launched a Select Bus Service with advanced fare collection, dedicated lanes and signal prioritization (Replogle & Kodransky, 2010).

Paris Vélib, France

The Paris Vélib, which combines the French words for bicycle (vélo) and freedom (liberté), and has revolutionized bicycle sharing and showcases a new kind of individualized mass transit system. The design is already being copied in cities like Hangzhou, China (any many other Asian cities). Vélib solves the problems of bicycle storage, maintenance and parking. City authorities saw an opportunity to offer advertising space to JC Decaux in exchange for management of the system. Approximately 4,000 car parking spaces were replaced with 1,451 Vélib stations that can hold 20,600 public bicycles for hire. Users pay a small fee to rent a bicycle and can return it to any station around the city. The company shuttles bicycles between stations to maintain a balance in the system and assures there are enough available bicycles at every station. A survey of users found that 15 per cent of Vélib trips had shifted from car travel. Vélib users can hire a bicycle at any time of the day or night, which is a good complement to the metro that closes around midnight. To support an increase in cycling, Paris built nearly 400 km of new bicycle lanes and also increased general bicycle parking facilities (Replogle & Kodransky, 2010).

Public bicycles in Paris © UN-Habitat/Bernhard Barth

Bicycle Sharing in Hangzhou, China

Hangzhou, on China's east coast, borrowed the model used by cities worldwide to build a biking culture: bicycle sharing. Fifty thousand bikes are available to rent at 2,000 service stations; the stations are positioned to link bikes with public transit. The stations are convenient, located every 300 metres, and the bikes are cheap. Trips under an hour are free, while those of one to two hours cost 1 Yuan (US$0.15). The bikes are rented 250,000 times each day, avoiding some 62,000 trips by car.

Bicyclists Hangzhou © Flickr_Gwydion

Integrated Transport and Public Space Planning, Seoul, Republic of Korea

Under the leadership of Mayor Lee Myung Bak, a 6.4 km elevated highway that once covered the Cheonggyecheon River in the centre of Seoul was replaced in 2005 with a riverfront park, high quality walkways and public squares. Removing the road cut traffic congestion in the area. The public responded so positively that 84 additional elevated roadways have been short listed for demolition. The city government also retrofitted 58 km with exclusive bus lanes, and added more than 100 additional bus lanes as part of a broader initiative to improve all aspects of Seoul's transportation system.

Seoul, Republic of Korea © UN-Habitat/ Bernhard Barth

Rail Centric City Development, Tokyo, Japan

Compared with the American cities the level of personal gasoline use in Tokyo is fairly moderate. This is due to the intensive use of public transport such as rail and subway transport. In 2001, 56 per cent of the total trips in Tokyo were made by trains and subway, 7 per cent by bus and 3 per cent by taxi. The extensive development of a complimentary rail/subway network within the Tokyo metropolitan area supports city dwellers' mobility. The route length of total rail/subway network in Tokyo metropolitan area reached 1,003 km in 2004 – by far the largest in the world. Tokyo's rail network also extends to the suburbs and satellite cities, making it easy for commuters to take public transport instead of private vehicles. Suburban trains in Tokyo are carrying more than 3 million passengers a day to the central business areas. For Tokyo dwellers, accessibility to rail means accessibility to their work as well as their leisure. In fact, a Tokyoites' decision on where to live largely depends on accessibility to rail.

Source: Siemens AG, 2011

Commuting Tokyo © Flickr_Arjan Richter

3.6 Industry and Commerce

Eco Industrial Park

The aim of an eco industrial park is to decrease the amount of waste, thereby decreasing environmental emissions and improving material efficiency. This would also make companies more competitive, as better waste management results in cost savings and a higher environmental and business performance. Virgin raw materials and energy use are reduced and replaced by waste and by-products generated in the area. Emissions are also reduced. And the biodiversity of the area is cherished. The social benefits in the area include creation of more jobs and improvement in working conditions. Attention is paid to the total well-being of the community. Many governments in Europe have promoted these parks, these include Chemical industry parks in Germany and other parks in Europe such as Kalundborg (Denmark), INES (Rotterdam), National Industrial Symbiosis Program, NISP (UK) and the Landskrona Industrial Symbiosis Project (Sweden) (Saikku, 2006). This would be an important initiative in the fast growing Asian economies. Careful planning and setting up designated areas for industries to sprout will be crucial in helping the nations achieve their carbon targets. At a lifestyle level, eco villages are another example well worth mentioning.

Ulsan Eco-Industrial Park © Ulsan Eco-Industrial Park

Industrial Symbiosis, Kalundborg, Denmark

"Industrial symbiosis" is a related concept in which companies in a region collaborate to utilize each other's by-products and also share resources. In Kalundborg, Denmark, a symbiosis network links a 1500 MW coal fired power plant with the community as well as with other companies. Surplus heat generated from the power plant is used to heat local homes and a nearby fish farm, whose sludge is then sold as fertilizer. Steam from the power plant is sold to Novo Nordisk, a pharmaceutical and enzyme manufacturer, and to a Statoil plant. This reuse of heat reduces the amount of thermal pollution discharged to a nearby fjord. Additionally, gypsum, a by-product from the power plant is sold to a wallboard manufacturer. Almost all of the manufacturer's gypsum needs are met this way, which reduces the amount of open-pit mining needed. Furthermore, fly ash and clinker from the power plant are utilized for road building and cement production. Such a setup reduced the ecological footprint of the industry (Gertler & Ehrenfeld, 1997). This symbiosis at Kalundborg was not created as a top-down initiative, but instead evolved gradually. But it is a good example of an industry structure that should be replicated more in Asia's emerging economies.

Power plant Kalundborg © Wikimedia Commons_Lci

Industry Based on Reuse and Recycling, Biogas from Household Waste, Czech Republic

Kromeríz Town Hall administrative officials had previously turned a large pit into a dumpsite for household waste. The layers of deposited material reached up to 12 m. Total volume of deposited waste amounted to 180,000 $m^{3.}$ The deposited subsoil consisted of clay, with substantial layers of eroded sandstone and sand-clay. As a consequence, the eco-system of a nearby pond was destroyed. Leachate from the deposit polluted the subsoil water and the deposit's biogas escaped to the ambient environment.

Utilization of biogas from household waste began in 1993. Through the initiative, the pond was cleaned and the eco-system balance restored. Biogas was tapped and re-vegetation of the entire area led to the creation of a green park. Also, this provided a cheap source of household heating energy. Since the beginning of the project, 337,177 m^3 of biogas have been tapped and pumped from the deposit. The lesson learnt from this project is that there is potential to generate biogas from household waste when proper technology is employed (UN Habitat, 2008).

3.7 Water

Water Utilities Save Money and Energy with Watergy Practices, Vizianagaram, India

In 2003 Vizianagaram Municipal Council introduced the concept of Watergy (Energy and Water efficiency). Water and energy audits of the municipal bulk water supply systems were coordinated and efficiency measures proposed and implemented. The program includes improvements in water supply, sanitation, solid waste management and street lighting equipment emphasizing no/low cost energy savings measures. Advantage was taken of untapped energy and water efficiency opportunities in their water system. The city now saves more than 100 megawatt-hours of energy and USD 63,700 annually — slashing its energy costs by 18 per cent and eliminating 600 metric tonnes of carbon dioxide emissions. The measures have also reduced water waste through more effective supply and distribution. The energy cost savings free up money for other needed urban services.

Water spire © Flickr_likeablerodent

Mandatory Rain Water Harvesting, Bangalore, India

Water for the city of Bangalore in India, has to be pumped from the river Cauvery 90 kilometres away and at 400 MSL i.e. 500 meters below the MSL of Bangalore. Huge expenditure is incurred on 50 MW of power required for pumping the water to the city. Additionally over 100 MW of power is required to pump the water from sumps to overhead tanks by households. In a year of average rainfall, a 100 square meter roof area would theoretically generate 97,000 litres of water of which about 77,600 litres could be harvested assuming 80 per cent capture efficiency (Vishwanath, April 2001).

Rain water harvesting provides a good supplement to other water sources and utility systems, thus relieving pressure on other water sources. It also provides a water supply buffer for use in times of emergency or breakdown of the public water supply systems, particularly during natural disasters, and reduces storm drainage load and flooding in city streets (The Hindu, 2009). Rainwater harvesting has now been made mandatory in the Bangalore Water Supply and Sewerage (Amendment) Bill 2009. Owners of existing buildings who fail to install a rainwater harvesting structure will be penalized.

3.8 Waste

Hot Water Heat Recycling

Water heat recycling (also known as drain water heat recovery, grey water heat recovery, or sometimes shower water heat recovery) is the use of a heat exchanger to recover energy and reuse heat from drain water from various activities such as dishwashing, clothes washing and especially showers. The technology is used to reduce primary energy consumption for water heating. Standard units save up to 60 per cent of the heat energy that is otherwise lost down the drain when using the shower. The technology is fully recognized in Canada and the USA by LEED for homes and Energy Star for New Homes Canada. Typical retail price for a domestic drain water heat recovery unit ranges from around USD 400 to USD 1,000. For a regular household, water heating is usually the second highest source of energy demand. The energy savings results in an average payback time for the initial investment of 2–10 years according to Natural Resources Canada, Canadian Centre for Housing Technology and US DOE (Wikipedia: The Free Encyclopaedia, 2010).

Hot water heat recycling © www.silverhawk.co.th

Energy Recovery through Landfills, Tianjin, China

The Municipal Government of Tianjin, the fifth largest city in China, has implemented a project to recover landfill gas (LFG) for electricity generation. The project is located at the Shuangkuo Landfill, one of five municipal waste landfills in Tianjin. The planned capacity of the project is 4.3 MW. The first generator of 1.03 MW started operation in May 2008, currently utilizing 500-600 cubic meters of landfill gas. The electricity produced is being sold to the North China Power Grid under a long-term contract. Through the project, the city was able to use waste to generate revenues and gain local environmental benefits. The project is managed by a specially created entity, the Tianjin Clean Energy and Environmental Engineering Co. Ltd. (TCEE). The initial investment was CNY 46.7 million (USD 6.9 million). Projected revenue from the sale of electricity over the project's life is estimated at CNY 245.2 million (USD 36.2 million). The successful implementation of the project provides an excellent demonstration of the technology and the institutional mechanisms for LFG recovery and electricity generation, which can be applied in many other cities.

Source: http://www.esmap.org,

Methane recovery at landfill © Arcadis

Solid Waste Management, Surabaya, Indonesia

Solid waste management is a primary concern for many developing countries. Surabaya, in Indonesia successfully reduced the amount of waste generated from 1,500 tonnes a day in 2005 to 1,300 tonnes in 2005 to 1,150 tonnes in 2008. To achieve this, an efficient solid waste management approach was first developed in one community, with an efficient composting method (a composting basket). A centre was set up that collected organic waste and households started dumping their waste here rather than on the streets and creeks. As a next step waste separation into organic and non-organic was promoted. Then, the project was scaled up, by adopting the same method in a larger number of communities. Leaders were trained to teach the residents how to produce compost from organic waste. The compost produced by households could be sold to supplement their income.

Source: IGES, 2009.

Central Surabaya © City of Surabaya

Recovering Waste Materials and Reducing Greenhouse Gas Emissions, Naga City, Philippines

To reduce the amount of garbage brought to the landfill or dumped into the river stream, Naga City developed the concept of establishing materials recovery centres in 1999. The city started off with community-based and small-scale materials recovery facilities, which evolved into a city-wide materials recovery facility (MRF) launched in February 2004. The facility serves as a waste processing and recycling plant that converts biodegradable waste to organic fertilizer, which is sold at market prices. Non-biodegradables recovered by the facility are either sold or recycled. Around 85 per cent of household garbage is collected by the city's garbage trucks and 15 per cent is disposed of by composting and or by burning.

Source: www.iclei.org

Recovering waste materials, Philippines © UN-Habitat/ Sebastian Lange

3.9 Awareness Campaigns and Consumer Information

Eco-clubs: Educating Future Environmentalists, Delhi, India

Delhi's environmental department has been using school "eco-clubs" to shape students' views. The clubs have broad aims, and engage students in a wide variety of projects, including planting trees, conserving water, creating nature trails and minimizing waste. They also provide a convenient way of spreading information and raising awareness on various issues. The clubs are given a framework to work with, along with a small subsidy, but it seems to be the enthusiasm of students and teachers that drives the idea. There are clubs in about 1,000 schools, many of which have teachers who are trained to teach others. Some schools also coordinate activities for up to 30 other schools. Students can engage in a vast range of activities, including air monitoring, water harvesting, recycling paper, awareness-raising campaigns, eco-tours, and even adventure sports. For a very small investment, Delhi has been able to harness interest in the environment in a way that encourages sustainability now and will shape attitudes of residents for years to come (Economist Intelligence Unit, year unknown).

Eco-club © www.saintmarksschool.com

Awareness on Environmental Performance

The Asian Green City Index measures and rates the environmental performance of 22 Asian cities. They are capital cities as well as certain leading business centres selected for their size and importance. The cities were picked independently rather than relying on requests from city governments to be included. The index is intended to provide stakeholders with a unique tool to help Asian cities learn from each other and to better address the common environmental challenges they face.

Table 3.1: Asian Green City Index Overall Results

Well Below Average	Below Average	Average	Above Average	Well Above Average
Karachi	Benagaluru	Bangkok	Hong Kong	Singapore
	Hanoi	Beijing	Osaka	
	Kolkata	Delhi	Seoul	
	Manila	Guangzhou	Taipei	
	Mumbai	Jakarta	Tokyo	
		Kuala Lumpur	Yokohama	
		Nanjing		
		Shanghai		
		Wuhan		

Adapted from: Siemens AG, 2011

3.10 Good Governance

Urban Management, Selman District Indonesia

Selman Regency (district) in Yogyakarta has a total population of around 850,000. The district has adopted several measures which can be classified as best practice and considered for replication elsewhere. These include a focus on the development of an education cluster, which has 35 universities, making the region the centre for education. It has also introduced performance based budgeting and asset management, valuation and appraisal. Transparency is achieved through publishing the annual accounts in the local newspaper. Municipal authorities are also coordinating with the neighbouring towns of Yogyakarta and Banjul for planning and solid waste management. The district has also developed and integrated Geographical Information System (GIS) for planning, monitoring and evaluation (Roberts, Good Practice Cases of Sustainable Urban Development in Selected Asian Countries, year unknown).

Greenhouse Gas Emissions Monitoring in Negombo, Sri Lanka

Negombo in Sri Lanka, a city of less than 100,000 inhabitants, has developed a baseline study of its emissions. It offers guidelines for measuring cities' GHG and will help cities to better understand the sources of their emissions, and policy-makers to better target their strategies. This study shows that even small cities can produce useful and detailed emissions inventories based on this simplified reporting template. In addition, it raised the issue of how the Reporting Framework should reflect emissions related to air travel to and from an airport located outside of the urban boundary. Another aspect of the assessment in Negombo is the role of fisheries and agriculture in Greenhouse Gas emissions, given the relatively high number of people employed in these two sectors. Again, where to draw the boundaries of a city needs further exploration. UN Habitat has therefore embarked to broaden the study to more comprehensively measure "out-of-boundary" GHG emissions in order to get a sense of their importance (UN Habitat, UNEP, 2011).

© www.panduphoto.wordpress.com

National Urban Renewal Mission India

Jawaharlal Nehru National Urban Renewal Mission is a massive city modernization scheme launched by the Government of India under the Ministry of Urban Development. It envisages a total investment of over $20 billion over seven years. The scheme is meant to improve the quality of life and infrastructure in cities and aims at creating 'economically productive, efficient, equitable and responsive cities' through a strategy of upgrading the social and economic infrastructure in cities and provision of Basic Services to Urban Poor (BSUP). Key Initiatives include encouragement for states/cities:

- To undertake fiscal, financial, and institutional changes required for creating efficient and equitable urban centres
- To make fuller use of energy and the initiative of the private sector in implementing its reform agenda.
- To free land and housing markets from the constraints of age-old statutes,
- To adjust infrastructure tariffs and prices to the cost of service provision in conjunction with local tax reform in order to meet the cost of joint services (Roberts, year unknown).

04. Leading for Energy Sustainability—Implementing Successful Policies

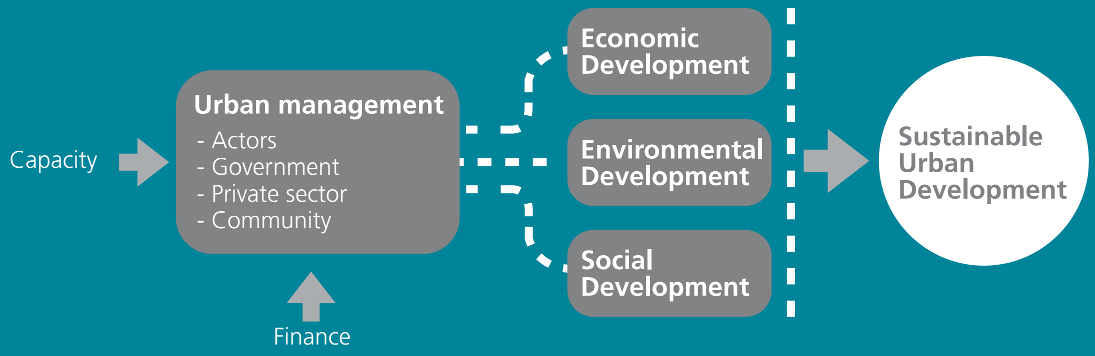
"National Governments have their national (sustainability) policies, but after all it is the local governments who have to implement these policies."
- Ban Ki-Moon, UN Secretary General, 2009

National governments establish policies pertaining to environmental sustainability, and help in developing road maps for cities. There are investment and financing implications of sustainable resource planning for water, energy, planning for the basic urban services, and achieving the Millennium Development Goals (MDGs). National governments also set standards for water and air quality, CO^2 emissions, the use of renewable energy sources, wastewater treatment, and solid waste management (ADB, 2008).

But translating the goals of these policies into action is often in the hands of local and city authorities. For a city to be sustainable, an integrated approach is needed, along with the necessary planning tools. Sustainable urban development calls for a high level of commitment from the local authorities, a transparent, participatory and inclusive urban management, along with capacity building and the appropriate financial tools (Figure 4.1).

This chapter explores tools that can be used by local authorities for planning and implementation of policies, to lead their cities towards a more sustainable future. Local governments need to be empowered to follow a city-based approach in tackling these problems. Governance that puts sustainability on the top of its agenda will make a decisive difference and can make cities more competitive, efficient and attractive to outside investors (City Alliances, 2007).

Figure 4.1 Requirements for Sustainable Urban Development



Adapted from: ADB, 2007

Creating institutions that promote sustainable development, those that cooperate with all stakeholders and promote sustainable lifestyles among citizens is the foundation for a sustainable energy future. Incentives (financial or social) are a powerful tool in the hands of urban policy makers. But these incentives need to be monitored and evaluated at regular intervals.

Authorities can influence the use of renewable energy by their citizens, by local businesses and their own consumption by

- Encouraging the use of "green electricity" for transport that is produced outside the city and imported
- Investing in local renewable energy projects
- Encouraging the uptake of "small scale, building integrated, renewable energy systems" such as solar heaters, ground source heat pumps, etc.
- Encouraging the development of the renewable energy manufacturing industry. (IEA, 2009)

4.1 Strategic Planning

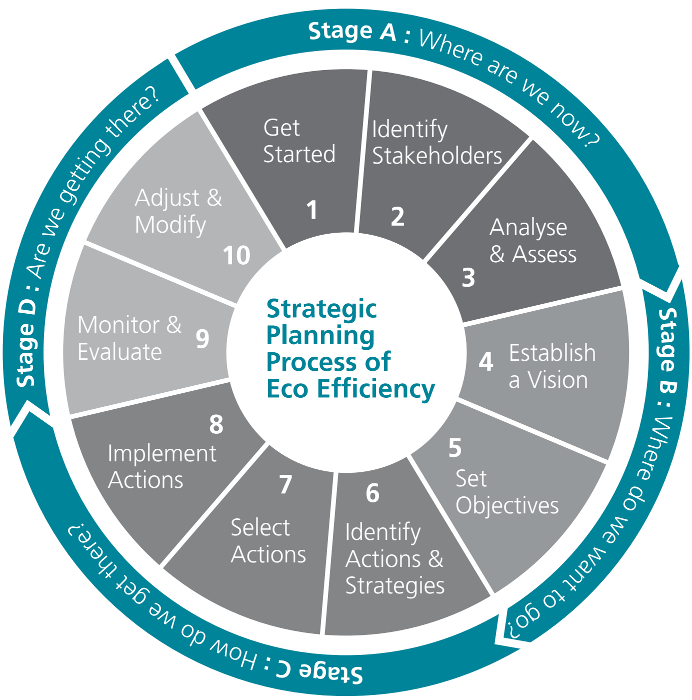
"I walk to work every day, rather than take the presidential limousine. It's better for the environment and I can stop and chat to people on the way."

- Mohamed Nasheed, President of the Maldives

Various actors such as businesses, government agencies, local governments and NGOs use strategic planning as a tool. It has proven effective to tackle challenges of a diverse nature. The guidelines below are the outcome of the experience of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP 2011) and UN-Habitat in applying a strategic planning approach for challenging projects in diverse areas such as energy resource management, disaster risk management, local economic development and climate change. Each challenge or planning process is unique in terms of its scope, objectives, capacities, leadership and pace of growth. Any strategic planning framework will have to respond to this uniqueness by providing flexible tools that can be applied by any city regardless of its size, level of development and nature of challenges faced.

When a city takes leadership in setting priorities and implementing solutions, two factors appear to be critical: its level of commitment and its capacity to act. (Worldbank, 2010)

Figure 4.2 Long-Term Planning Framework



Adapted from: UN-Habitat and Ecoplan International, 2003

Table 4.1 Steps of a Long-Term Planning Framework

Stage A	Where are we now?	Step 1 Get started Step 2 Identify stakeholders Step 3 Analyse and assess
Stage B	Where do we want to go?	Step 4 Establish a vision Step 5 Set objectives
Stage C	How do we get there?	Step 6 Identify actions and strategies Step 7 Select actions Step 8 Implement actions
Stage D	Are we getting there?	Step 9 Monitor and evaluate Step 10 Adjust and modify

Adapted from: UNESCAP, 2011

STAGE A: Where are we now?

1. Get Started

It is crucial to first secure commitment from key actors such as the mayor, council members, department heads and senior planning officials. An executive committee that will oversee the planning process needs to be formed. For strategic planning to be effective it requires a champion. Experience reveals that the best results are achieved when this champion is the mayor. Other actors, however, can also act as champions and drive the process. To carry out the actual planning process a more technical core planning team has to be created.

2. Identify Stakeholders

Involving a wide range of parties in the planning and development of infrastructure can improve the quality of the planning process and will receive support among all stakeholders. A participatory urban decision-making process begins with a stakeholder analysis and profiling to prepare and mobilise stakeholders, prioritises the issues and ensures local leaders get commitment and support from stakeholders. Smooth communication between all the stakeholders has to be ensured. Ideally participation of stakeholders in a planning process happens at all stages. It is important that all stakeholders are engaged and that various policy tools and instruments

Collaboration is also a new form of governance. By engaging stakeholders at all scales, the city creates a planning forum that is more appropriate to mixed economies in which private sector groups often control a majority of the infrastructure systems. (World Bank, 2010) are considered. Creating a matrix as illustrated in Table 4.2 can accomplish this.

Table 4.2 Stakeholder Matrix

Stake-holders	Investment & Planning Initiatives	Research & Demonstration & Leadership	Education & Inspiration	Legislation & Regulation	Market Instru-ments
National Agencies					
State Agencies					
Regional Agencies					
Municipal Agencies					
Private Sector					
NGOs					

Adapted from: World Bank, 2010

3. Analyze and Assess

For any successful strategic planning an assessment of the current situation is a must. This includes creating a profile of the city including general data and economic, social, environmental and institutional aspects. Legal frameworks and drivers/barriers of eco-efficient infrastructure development should be identified. An eco-efficiency assessment of the city's infrastructure needs to be conducted (see Annexe 1).

STAGE B: Where do we want to go?

4. Establish a Vision

The vision is the starting point to set objectives and plan actions. The vision should be inspiring and far-reaching. It can be a simple statement, a charter or even an artistic drawing (World Bank, 2010). If, for example, the scope has been defined as improving the energy efficiency in the electricity sector then the vision should focus on this sector only. It could simply state that the vision is to reduce energy demand by 50 per cent by a certain year.

The vision statement can be elated with a set of stand-alone goals such as reducing transmission losses and distribution losses by 40 per cent; reduce energy demand from the household sector by 60 per cent through energy efficient appliances; and reduce energy losses by the industrial sector by 40 per cent through the use of cogeneration or tri-generation technology.

Though such goals describe long-term conditions, they provide a reference point for all planning process. It is important that these are formulated in a collaborative process that includes all stakeholders. Since the goals are long term, the process of building consensus around them tends to be a positive experience, creating a common purpose among stakeholders and citizens (World Bank, 2010). This greatly improves the chances of success. The goals also need to reflect the local conditions and socio-cultural values of the region and the surroundings. Many a time, goals of the central government will overlap with the goals set by the local authorities. Such overlaps can be better addressed if policy makers at all levels collaborate with each other (IEA, 2009).

Box 4.1 The Way Cities should be

Energy: Solar energy is becoming cheaper. Japanese solar electric roof tiles could make buildings in cities around the world largely self-sufficient. Another option is to simply use less power: electricity consumption could be cut by over 60% by adopting existing eco-friendly devices and practices. Stockholm, Stuttgart, and Helsinki generate some of their own electricity locally, with hot water as a by-product, by using combined town-center heat and power stations.

Food: Cities could grow more of their food. Shanghai is almost self-sufficient in vegetables and grain. Urban vegetable growing on wasteland and rooftops is popular in New York and Berlin. Trees absorb carbon and sulfur emissions, filter dust, and cool the urban environment. One tree can transpire 380 litres of water a day. They give off oxygen and help reduce carbon monoxide and dioxide levels.

Sewage: Traditionally, many towns and cities kept their farmlands productive by recycling human wastes. In Asia, using “nightsoil” to compost agricultural land helped ensure the ecological viability of cities. Human waste was collected by bucket and cart but now special vacuum trucks are used. Pipelines could transport urban sewage back to fertilize agricultural land and forests.

Transport: Efficient public transport reduces pollution. Zero-emission vehicles using hydrogen fuel cells or solar power are in use. Cycling is the cleanest and most energy-efficient option. Keeping private cars out of city centres improves environments.

Recycling: Cities with effective recycling schemes can recycle up to 75% of household waste. Today, some cities in Japan and the Netherlands recycle 50% of their paper, and 95% of Swedish cities recycle 80% of aluminum cans. In Cairo, over 500 small factories recycle plastics. New garbage management and recycling programmes create employment.

Source: Giradet, 1996 and Gilbert et all. 1996

5. Set Objectives

Setting clear objectives based on the vision statement will be the basis for defining actions and strategies for the implementation phase. Objectives define priorities of infrastructure development; they will serve as a matrix for decisions about future projects. It is important that objectives are absolutely clear since this will allow to translate them into actions and to evaluate the outcome.

STAGE C: How do we get there?

6. Identify Actions and Strategies

Once objectives are stated, a list of actions that will help achieving the objectives can be compiled. The most promising actions in terms of eco-efficiency and feasibility will be chosen. Identifying eco-efficient actions allows highlighting those interventions that generate multiple benefits. A group of actions to achieve a specific objective will provide the project team with a planning strategy.

7. Select Actions

Identify actions and strategies that best meet the identified objectives and fit with current urban planning priorities and gaps. It is important to assess the consequences of each action and to consider how a given action will perform in your local context (integration with other projects, eco-efficiency, available capacity and resources, etc.).

8. Implement Actions

In this phase ideas are translated into real actions. Often the efforts of planning and policy making do not get realized due to a lack of simple and clear mechanism as well as the presence of performance targets. A strong local political will, acceptance among the citizens and simple administrative systems and processes are crucial for this to be successful. Even if well-framed, sustainable development policies often do not get translated into successful implementations because of administrative hurdles and complexities (e.g. red tapism for net metering, building permissions, too many government departments that need to evaluate the same project, etc.). A lack of capacity building at the local level adds to the hurdles.

A catalyst project is a key part of managing change. Catalyst projects should be projects that offer substantial benefits to the most influential stakeholders and that may be completed relatively quickly at low risk to the city. (World Bank, 2010)

Identifying potential hurdles by the core planning team will greatly help in the implementation phase.

To ensure that objectives are translated into action and implementation, it is important to ensure that the planning process can be mainstreamed into existing local planning practices and government policies. By identifying the multiple benefits of the different actions and strategies and by linking these to established plans, programmes and processes, a stronger business case can be built. This will greatly help in realizing planning objectives.

But for most questions of ecological sustainability, it is governance that matters – the creation of institutions that support understanding, cooperation, and oversight. (Vattenfall, 2009)

It is advised to first start with pilot projects. These are projects that implement elements of the strategic plan on a smaller scale, be it at a district or at a neighbourhood level. This will help in promoting the acceptance among the population and will also serve as a test ground that provides a rich learning experience for later implementations. A successful pilot project will demonstrate the potential for wider implementation. It is important that all stakeholders are engaged and that various policy tools and instruments are considered.

STAGE D: Are we getting there?

9. Monitor and Evaluate

Effective monitoring is central to any strategic planning. It is a vital management tool which enables authorities to keep track of progress and manage urban change (Cities Alliance, 2005). As this involves data collection, analysis and reporting it is a time consuming exercise, but it is a fundamental tool to measure progress. The indicators chosen for monitoring must directly relate to the vision and the objectives. For instance, if the objective is to reduce electricity consumption per capita by half by promoting smart appliances and awareness campaigns, then the indicator for measuring progress will be the per capita electricity consumption per year. It is important that the target is achievable, and includes a time element and that it is measurable (City Alliances, 2007). For examples of indicators, refer to Annexes 2 & 3. The information gained in the monitoring process is used for an evaluation which will determine if interventions are meeting the objectives and if corrections need to be made.

Box 4.2 Eco-Budget as Monitoring Tool

Key characteristics: ecoBUDGET (eB) is a management system, focusing on the management of natural resources and environmental quality by cities. Paralleling the financial budgeting system on a periodic (annual) basis, ecoBUDGET routinely integrates environmental target-setting, monitoring and reporting into municipal planning, decision making and management (ICLEI, 2004). Every year a budget for natural resources and environmental quality is developed and approved by the city council. Accounts (indicators) are established for each natural resource, and annual targets as spending limits are derived from mid-term goals. The budget uses physical units, not monetary terms. Budget preparation involves the assessment of the expected environmental impact of ongoing operations and special projects in order to forecast the environmental expenditure and considers mitigation strategies. The municipal council discusses the draft budget, accompanied by media reports and public discussion. During the budgetary year, all departments manage their environmental expenditure, that is, the use or pollution of natural resources, within the spending limits. After the budgetary year a balance sheet is prepared and performance reported to the council and public discussion.

Source: City Alliances, 2007

10. Adjust and Modify

Objectives and plans need to be reviewed and updated on a regular basis. This allows responding to the rapidly changing reality of Asia's cities and to incorporate new information and knowledge related to people, environment and infrastructure needs.

Time requirements of strategic planning:
Determining the time requirement for each step of strategic planning is a big challenge. After having drawn the strategic plan, it is important to establish deadlines for completing each step. A sample is given in Annexe 4.

4.2 Integrated Planning

"Integrated planning is seen as a holistic approach and process to carry out energy planning by integrating all the sectors in an economy and linking these plans to the three pillars of sustainable development i.e. economic, social and environmental."

- Anare Matakiviti, Energy Adviser, SOPAC

Policy interventions that aim at reducing carbon emissions and make cities environmentally sustainable will have to address town planning. In chapter 2 we have seen the impacts of urban sprawl development on infrastructure costs, traffic increase and land use. Integrated urban planning can significantly reduce carbon emissions and energy demand by the transport sector by promoting high-density development, implementing widespread public transport systems as well as non-motorized transport solutions. It will also address processes that reduce, reuse and recycle waste, and it will help create jobs, alternative freight transport solutions and financial mechanisms for sustainable infrastructure development (Table 4.3).

Table 4.3 Process of Integrated Planning Approach, Example of Eco-City Dongtan, China

Indices used in Dongtan	Targets during Construction:	Targets during Operation:
- Air emissions (NOx, SOx, Particulates) - Water consumption - Energy consumption - Waste generation - Import/export - Land Use - Job Creation - Financial / economic viability	- Reduce predicted CO_2 emissions from freight and waste vehicles by 60 per cent - Reduce predicted freight and waste collection vehicle numbers in Dongtan by 50 per cent - Move 20 per cent of construction material and waste using alternative means of transport - Reduce construction waste by 40 per cent through control of material to, and on the site	- Reduce predicted CO_2 emissions from freight and waste vehicles by 60 per cent. - Reduce predicted freight and waste collection vehicle numbers in Dongtan by 50 per cent - Move 20 per cent of freight and waste using alternative means of transport - Maximum of 10 per cent to landfill

Adapted from: ARUP, 2009

There are various options available to authorities regarding policies and instruments that they can consider for sustainable development, as illustrated in Table 4.4.

Table 4.4 Overview of Instruments for Environmental Integration

Instrument type	Options	Tool examples
Policy Instruments	Information: Written, Internet, face-to-face advice, information offices, training, research and development, awareness-raising campaigns, clearing house mechanisms	Internet, electronic newsletters, outreach media
	Voluntary: Product labeling, branding, voluntary codes of practice or standards, externally accredited environmental management standards or voluntary agreements	EMAS, sustainable procurement, product life cycle analysis, eco-labelling
	Economic: Emission charges & taxes, tax refund schemes, deposit & refund schemes, tradable permits, public spending subsidies, fines, legal liability for environmental damage, bonds	City twinning projects will support climate-related initiatives in developing cities
	Regulatory: Controls on emissions, activities, resource use, toxic substance use through bans, permits, quotas and licensing, extended producer responsibility, mandatory environmental management standards, environmental audits, labeling or product standards, training and operator licensing	Regulations, polluter pays principle
Process Instruments	-Visioning -Participation	Metaplan, task forces, round tables, expert panels, workshops, etc.
Planning Instruments	-Environmental profiles -SWOT analysis -Rapid Ecological Footprint Assessment -Monitoring systems and Indicators -Strategic Environmental Assessment	Indicators, guidelines and documentation from a range of and organisations (for example, UNEP's GEO Cities, UN-Habitat's Rapid Urban Sector Profiles [RUSPs] ecoBUDGET
Management Instruments	-Environmental budgets and audits -Environmental quality management	Air quality management

Adapted from: City Alliances, 2007

4.3 Integrated Energy Planning

"Energy efficiency and renewable energy can reduce our dependence on fossil fuels by 70% by 2040"
- The Ecofys Energy Scenario, December 2010

Integrated Energy Planning [IEP] is ''an area based decentralized energy plan to meet energy needs for the development of alternate sources at the least cost to the economy and the environment" (NRDMS, 2009). It estimates ''how much energy all the different consumers (e.g. industry and households) will need in the future to deliver certain services; and then identify a mix of appropriate sources and forms of energy to meet these energy service needs in the most efficient and socially beneficial manner"(EL, 2009).

Good governance in the energy sector requires transparent, predictable and enforceable political, social, economic rules. (UNESCAP, 2008)

Key requirements for integrated energy planning are inclusion of all energy service needs, and supply- as well as demand-side solutions, including energy savings and efficiency interventions. In describing possible future scenarios, in understanding the impact on the three drivers of sustainability, and in setting goals for the future, all costs and benefits – long term and short term – should be taken into consideration (EL, 2009). This also allows cities to compare the effectiveness of all energy alternatives on aspects of supply and demand, helping to account for their different financial viability, social acceptance and environmental characteristics. An Integrated Energy Planning process for the design of an Eco-City is elaborated in Figure 4.4. For the benefits of a demand-led approach refer to Annexe 5.

IEP is a new concept in most developing countries and is slowly gaining acceptance. Often, utilities make least-cost plans, but these have been least-cost supply schedules rather than integrated supply and efficiency plans (D'Sa, 2004). Through the application of an IEP, better performance-based revenues can be generated.

While each city/country has been using a slightly different IEP process, a broad indicative framework is given below:

Step 1. Reference Energy System (RES)

Understanding current energy demand in the region is important before attempting to change it. For most cities, historical data is easy to obtain, and can be broken up by region and/or by sector. This can be made as detailed as possible (for instance demand by housing, or demand for refrigeration, washing, cooking, etc.). Daily and seasonal variations in demand can also be identified (International Energy Agency, 2009, p. 95). Using standard energy units, data on primary energy supply (like oil and coal), its transformation, transportation, distribution and end-user consumption (in all sectors and subsectors) is collected. Data on conditions required to use a service as well as on trends that led to the current situation, are also collected. These help in the analysis of demand drivers, price mechanisms and correlation of price versus demand.

Step 2. Energy Forecasting and Scenarios

Various scenarios are created using available tools as mentioned in the previous section. These scenarios calculate cost and viability for various technological alternatives, which can be readily compared on the grounds of costs, environmental impact, and social acceptability.
Based on these scenarios, and a suitable time horizon, demand for energy in the future is forecasted and various supply sources to meet this demand are also explored.

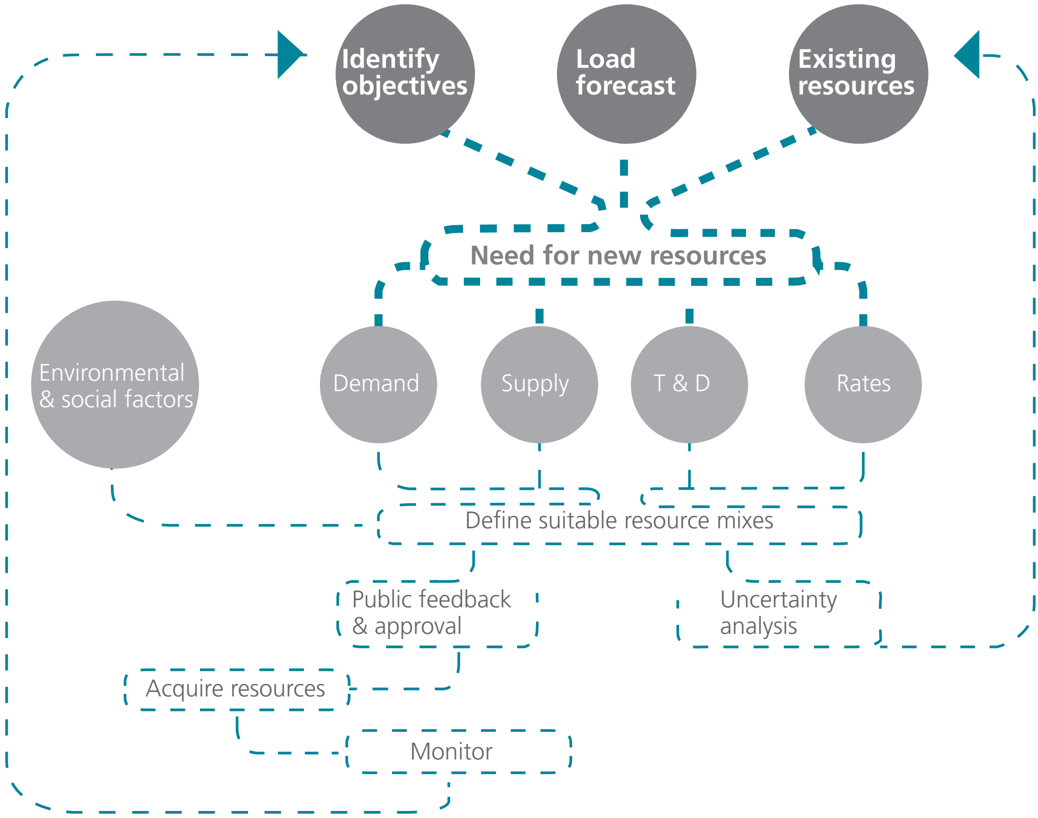
Scenario planning is an integral part of Integrated Energy Planning and can bring together various groups in order to reach a consensus on a vision for making the city sustainable. The celebrated success in sustainability at Freiburg in Germany was achieved through Scenario Planning and IEP.

Some key tools that can be used are (ADB, 2008):

- Area profiling using a SWOT analysis (strengths, weaknesses, opportunities, and threats) of the region
- Sector-based productivity and forecasting at the city level or regional level using econometric models, usually developed at the national level and disaggregated spatially
- Labour market analysis, including skills profiling and analysis of travel to work patterns
- Risk assessment analysis, including disaster preparedness.

The best investment returns (in terms of cost per tonne of CO_2 avoided) should be identified, and considered alongside other environmental and social drivers such as reduced air pollution, employment opportunities, lifestyle, tourism, poverty, health and sustainable development (IEA, 2009).

Figure 4.3 Integrated Energy Planning



Adapted from: India Infrastructure Report, 2006

Step 3. Planning

The strategy for a low carbon city begins with conceptualising an energy plan that has clearly spelt out energy goals, which could lead to writing of a local action plan and identifying tools and technologies to achieve those goals. Komor and Brazilian (2005) used these three steps for the renewable energy strategy for Ireland.

In the end it will be human power – insight, innovation, entrepreneurship, and most of all leadership – that rises to meet these challenges. (Vattenfall, 2009)

a) Setting the Energy Goals
Securing the availability of energy and making it affordable, while making sure that producing it does not sizably increase carbon emissions, should be the goals for any energy planning. This can be achieved by marking goals under three focal areas: social, environmental and economic. These goals need to be quantified further through measures and targets for short-term and long-term.

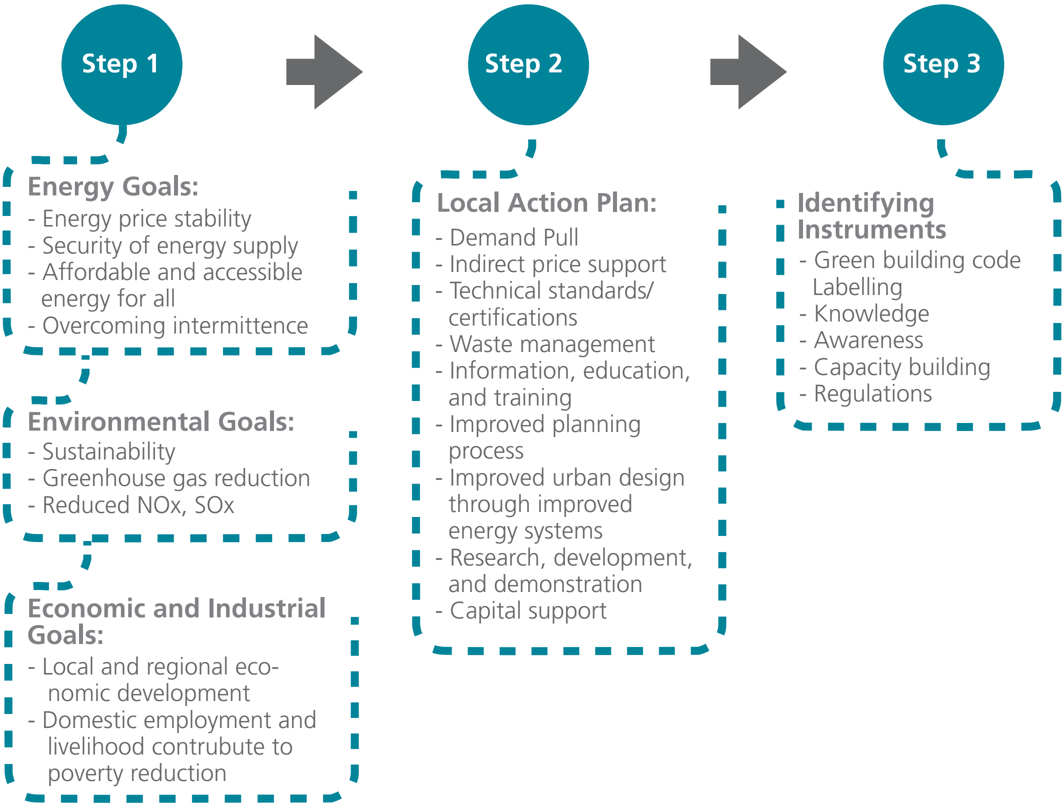
b) Setting up Local Action Plan
A strategy to achieve the goals decided in Step (a) is now crafted. This would be the "Local Action Plan" that synthesizes all the goals, provides a schedule and outlines the policies and measures that could be used to achieve the target. Ideally this plan incorporates public awareness and education campaigns.

c) Identifying Instruments and Technologies
The Local Action Plan is now taken up for implementation and is supported by new and emerging technologies that were discussed in the previous chapter (energy efficiency, renewable energy systems and other areas). Broadly these would include CO_2 reduction through demand-side management, CO_2 reduction in energy production, and changes in urban structure. Annexe 6 lists the impact of some instruments against these two factors. In spite of the best efforts roadblocks are bound to occur but many of them are predictable. To remove these barriers certain instruments prove effective and these can be found in Annexe 7.

It is clear therefore that local governments have a lot of potential to address local-level energy issues which can have enduring impacts on society. They are not only better connected with people; they can also influence entrepreneurs to enable fostering of the most sustainable energy solutions. They need not turn to the central government all the time for support. This kind of bottom-up approach would go a long way in attracting attention from the national government as well as foreign institutions by setting good examples of achievement through local efforts.

One should recognize that local governments, working in collaboration with stakeholders, are now on the front line in dealing with some of the most pressing development challenges and that, most often, they hold the key to solutions. (World Bank, 2010)

Figure 4.4 Sustainable Urban Energy Goals, Plan and Instruments



Adapted from: Komor and Bazilian, 2005

Preference should be given to Integrated Energy Planning over new proposals for power production and purely supply-side solutions. Risks should be identified and strategies evolved to counteract them. Environmental, economic and social impacts of strategies should be fully integrated into the decision-making processes.

With greater awareness, IEP is slowly being recognised as essential for better results. For example, Tianjin (China) follows the IEP process. It is one of the four municipalities that have provincial level status in China. It is experiencing tremendous growth and plans to develop an extension of the city as an Eco-city. The planning process would be based on 26 key performance indicators dealing with environmental, social, economic and regional coordination issues. The project will promote the use of clean and renewable energy with an optimized energy structure to achieve a highly efficient energy supply. An integrated energy plan taking into account seasonal variation in resource availability and energy demand could help achieve a goal of 20 per cent waste heat recovery and renewable energy share in the whole energy consumption cycle (ES, 2009) (Table 4.5).

Table 4.5 Integrated Energy Plan

Unplanned urban form	Sustainable urban form
- Haphazard land use and transport - Infrastructure frequently plays catch-up - Private vehicle-dominated cities - Poorly managed transport and traffic systems - Insufficient funding for public transport	- Sustainable policies and road maps relating to land use and transport - Managed movement: public transport and pedestrian focus - Improved management to make strategies happen - Raising appropriate amounts of long-term investment capital on the market
...and fragmented approach	**Sustainable environment**
- Informal areas underserved by infrastructure - Inadequate wastewater disposal and treatment - Poor air quality - Inefficient solid, hazardous, and construction waste disposal - Energy inefficient and non people-friendly buildings	- Basic infrastructure affordable to the poor - High water quality and treatment of waste water - Improved air quality and limits on greenhouse gases - Managed and recycled waste and industrial symbiosis - Sustainable buildings and neighbourhoods

Adapted from: ADB, 2008

4.4 Policy Instruments

"For every complex and difficult problem, there is an answer that is simple, easy, and wrong."
- H.L. Mencken US -American journalist and essayist

Policy instruments that help frame effective policies are crucial in sustainable development efforts. These depend on several parameters such as economic and environmental efficiency, stakeholder support and the ability to implement and enforce. It is important that the chosen tools balance the triple bottom line – the people, the planet and profit. These instruments can be economic, regulatory, educational, cooperation based and information based, as shown in Table 4.6 (GTZ, 2006). Also refer to Annexe 8 for policy directions and possible actions.

Table 4.6 Various Instruments that Policymakers can Adopt for Achieving Policy Goals

Economic	Regulatory	Education & Research	Cooperation	Information
- Environmental tax - Fees and user charge such as congestion charge - Subsidies - Environmental financing - Green Public procurement	- Norms and Standards - Environmental Liability - Environmental Control and Enforcement	- Research and Development - Training & Capacity Building - Encourage Sustainable Leadership	- Voluntary agreements - Facilitate Networks and Partnerships - Participatory - Planning	- Eco labelling - Sustainable reporting - Consumer advice centre - Information centre - Environmental quality and monitoring

Adapted from: GTZ, 2006

Economic Instruments

Economic Instruments that stimulate sustainable development have proven to be one of the most successful tools in the hands of policy makers and urban authorities. They provide the financial incentives for enterprises and individuals to act in a more environment-friendly and energy-efficient manner. They can either aim at internalizing environmental costs by increasing prices and hence support goods and services that are more sustainable, or they can

employ subsidies and incentives in order to reduce the cost of sustainably produced goods and services.
Economic instruments can be used for many sectors in the urban matrix, such as the waste, water, electricity and transport sectors. Public procurement, be it for green buildings, energy efficiency (smart appliances) or green shopping is also an effective tool to stimulate sustainable development in urban areas. It will help stimulate the local green economy and sets a good example to the urban citizens and the commercial sector as well. Often, there is a dependence on the central government for providing the funding for developmental projects at the local level. However, in cases where local corruption exists, such funding may be hard to receive (IES, 2009). A common method employed by local governments is a property-rating scheme to provide local services (water, waste collection, street lighting, etc.).

Box 4.3 Economic Instruments

There are some very innovative and enterprising methods of making revenues. Both Hong Kong's and China's rail systems—the Mass Transit (MTR) and Kowloon Canton Railways (KCR)—have used property to help finance capital investment costs. The Railway office buildings in Hong Kong and Kowloon houses major residential developments with 5,000 apartments, each built on podium structures over the rail depots, and other buildings along each line. The profits from the property portfolio have contributed about 15 per cent of the capital cost of their systems (USD 3.2 billion).

Source: ADB, 2006

One can explore taxation as a source of revenue. Higher taxation for polluters not only results in reduced pollution, it is also an interesting way for local governments to generate revenue that can in turn be reinvested in sustainable development. For example, Singapore implemented a number of financial disincentives like higher taxes and registration fees for motorized vehicles. This has not only resulted in a decrease in private vehicle ownership but also in substantial revenues for the city that could be reinvested into the public transport system.

It must be noted that taxes make companies less competitive; hence providing subsidies for the adoption of sustainable energy solutions could be more rewarding. An example for financial incentives or subsidies is the City of Ann Arbor (USA). The city has initiated a Municipal Energy Fund, a self-sustaining source of funds for investing in energy-efficient municipal projects, such as LED traffic lights, LED street lighting and solar energy systems. Through an initial allocation of USD 500,000 over five years, and by capturing 80 per cent of the resulting savings, the city has implemented en-

The institutional structures for managing the cities in the region are weak, even though the technologies are well known and abundant finance is available. The core capacities required for city management fall into three interdependent groups: planning and policy formulation, program and project formulation, and management of service delivery. (ADB, 2008) ergy efficiency projects in its buildings and throughout the city that pay back their investments in 3-5 years (A2G, 2009). Ann Arbor's Energy Fund has demonstrated that energy efficiency can pay for itself in the long term.

Raising energy prices to cost-covering levels is one of the least popular tools but can prove to be highly effective. Hungary spent only USD 5–10 million a year till 1997 on energy efficiency improvements. But in January 1997 when energy prices were hiked to market-based levels, citizens started investing in energy efficiency up to USD 80 million a year in just 2 years' time.

Procurement by governments and other institutional buyers can stimulate the diffusion of energy-efficient products. (UNESCAP, 2008)

Another successful programme is the BESCOM Efficient Lighting Programme (ADB, 2006) in one of the Indian States. It gives consumers an opportunity to replace energy inefficient incandescent lamps with energy efficient CFLs in high usage areas such as corridors, kitchens and porticos. BESCOM's domestic consumers have two purchasing options - direct sales at discounted prices or under instalments (9 equal instalments recovered through BESCOM monthly bills). In both cases the consumers get a 12-month warranty backed up by BESCOM (TWAS, 2008).

Table 4.7 Economic Instruments for National and City Governments

National and city governments should encourage the application of economic instruments to promote efficient use of resources. A number of economic instruments can be applied:

1. User Charges	They should be set so that utility resources like water and electricity are charged for at the full cost of usage, which includes the cost of providing supply, the cost imposed on the system by externalities caused by usage, and the opportunity cost of taking the resource from other potential users, including the ecosystem.
2. Emission (Effluent) Charges	These are charges for maintaining the environment itself and are in addition to user charges for the public service provided by government or industry. They can be based on the quality or quantity of waste, usually wastewater, processed to an agreed level.
3. Product Charges	These charges on products that pollute the ground or surface water during or after consumption are best set at a level that reflects the actual value of external damages caused by their use.

4. Tradable Rights

The establishment of markets for the rights to use a quantity of a resource—usually water— helps achieve efficient allocation between users, but there needs to be strong government, administrative, and legal structures to protect third-party and public interests.

5. Marketable Permits

These are tradable rights applicable to pollution sources. For example, government can define a total level of pollution and sell or grant emission rights to all actors involved. Each actor is then entitled to treat its wastes and sell the permit, or not treat the wastes and purchase more permits.

6. Deposit Refund Systems

For commodities packaged in nonreturnable containers to ensure that they are returned for proper disposal or reuse.

National government needs to set up the enabling environments before such instruments can be used. Two in particular—polluter pays and economic pricing of utilities— can be prioritized.

Adapted from: ABD, 2008

Regulatory Instruments

Regulatory instruments also known as 'command and control instruments' are legal instruments aimed at reaching desired energy targets. By regulation the behaviour of individuals or the commercial sector can be shaped towards more energy efficient and sustainable behaviour. The type of regulations passed by city and local governments will depend on the authority they are given by the national government. Sometimes difficult to implement, regulations can yield desired results if non-compliance is easily visible and consequences of non-compliance act as a deterrent. Experience has shown that regulatory instruments work best if they are supported by awareness campaigns and financial incentives. Having regulatory incentives in place is also a positive step that signals that energy and environmental concerns and procedures are being institutionalized.

Regulatory instruments and standards include the following

- Bans
- Mandatory rulings
- Minimum energy performance requirements
- Integrated energy management and environmental pollution prevention and control

- Product standards
- Building codes

An example of a regulatory intervention is the Vehicle Quota System (VQS) in Singapore, which allows the government to control the number of cars on the road. This is reviewed regularly and the quota gets changed every month, based on road conditions and the number of cars taken off the road in that month.

Table 4.8 Selected Regulatory Instruments for Different Sectors

Sector	Regulation
Built Environment	- Mandatory rain water harvesting - Mandatory Green Building Codes
Transport	- Ban on private vehicles in the city centre - Standards on emissions - Higher taxes for motorized vehicles - Standards on energy performance and/or emissions
Energy	- Mandatory purchase of a certain percentage of renewable energy for the commercial sector - Mandatory instalment of solar water heaters for commercial and public buildings
Industry	- Standards for production process, emissions and noise
Food	- Mandatory labelling of food miles

Another useful categorization of policies is given by the International Energy Agency (2009). Policies are grouped as Targets (that signal the goals intended by the authorities), Carrots (policies that offer subsidies and incentives), Sticks (restrictions, bans, taxes and any other forms of disincentives), Guidance (education and awareness campaigns, etc.) and Voluntary actions (cooperation and agreements between different stakeholders). Examples of such policy tools employed by a few cities are presented here for reference (Table 4.9).

Table 4.9 Relevant Policies – Case Study

City or town	Population	Policy classification: Target		Stick				Carrot						Guidance		Voluntary municipal operation			Voluntary role model		Comments
		Overall target	Sector specific target	Urban planning	Building codes/ regulations	Taxes	Standards & mandates	Capital grants & rebates	Operating grants	Investment	Soft loans & guarantees	Tax credits	Tax reduction/exemptions	Information/ promotion	Training	Procurement/ purchase	Investment	Utility	Demonstration land use	Voluntary agreements	
Tokyo	12 400 000	●	●		●		●							●		●	●				Wealthy mega-city
Capetown, South Africa	3 400 000	●	●	●				●						●	●	●					Poor mega-city
Nagpur, India	2 100 000	●	●		●							●	●	●	●		●		●	●	Poor large city
Adelaide, Australia	1 160 000	●	●					●						●		●	●		●		Wealthy large city
Merton, London, UK	200 000	●	●	●	●		●							●							Mega-city leading district
Freiburg, Germany	200 000	●	●	●	●		●	●			●			●	●	●	●	●	●	●	Medium town
Vaxjo, Sweden	78 000	●	●		●			●						●		●		●	●	●	Small town
Palmerston North, NZ	75 000	●	●														●	●	●	●	Small town
Masdar City, UAE	40 000		●											●		●	●	●	●		Urban plann-ing from new
El Hierro, Spain	10 000		●					●			●			●	●		●	●	●	●	One of Canary Islands
Samse, Denmark	4 400		●					●			●			●	●		●		●		Island for comparison
Gussing, Austria	3 800		●				●							●	●	●	●	●	●		Small comm-unity - rural
Greenburg, USA	1 600		●	●	●					●			●	●				●	●		Rebuilding after tornado

Adapted from: IEA, 2009

Policies can also be detailed by sector. The transport sector alone has numerous policy options that can effectively combat the high usage of fossil fuels. These are listed in Table 4.10. For further information refer to Annexe 9.

Table 4.10 Policy Options for the Transport Sector

Improve Transport Options	Incentives to Reduce Driving	Parking and Land Use Management	and Policy Reforms
- Alternative Work Schedules - Bicycle Improvements - Bike/Transit Integration - Car sharing - Flexitime - Guaranteed Ride Home - Individual Actions for Efficient Transport - Park & Ride - Pedestrian Improvements - Ridesharing - Shuttle Services - Small Wheeled Transport - Taxi Service Improvements - Telework - Traffic Calming - Transit Improvements - Universal Design	- Walking and Cycling Encouragement - Commuter Financial Incentives - Congestion Pricing - Distance-Based Pricing - Fuel Taxes - HOV (High Occupant Vehicle) Priority - Parking Pricing - Pay-As-You-Drive - Vehicle Insurance - Road Pricing - Speed Reductions - Street Reclaiming - Vehicle Use Restrictions	- Bicycle Parking - Car-Free Districts and Pedestrianized Streets - Clustered Land Use - Location Efficient Development - New Urbanism - Parking Management - Parking Solutions - Parking Evaluation - Shared Parking - Smart Growth - Smart Growth Planning and Policy Reforms - Transit Oriented Development (TOD)	- Access Management - Car free Planning - Commute Trip Reduction Programmes - Market Reforms - Context Sensitive Design - Freight Transport Management - Institutional Reforms - Least Cost Planning Regulatory Reform - School Transport Management - Special Event Management - TDM Marketing - Tourist Transport Management - Transport Management Associations

Adapted from: Litman, 2003

Education and Research

Education and research is a crucial tool for moving towards a more sustainable future. Urban authorities can actively support setting up research and development centres that focus on sustainable development by providing required resources, including financial support and land. Environmental education can also be included in the national curriculum, and relevant subsidies can be provided to the schools that incorporate it. Education, training and capacity building and research will strengthen the collective environmental awareness of urban residents. Focusing on research and capacity building will also stimulate the employment market positively and can create green jobs. In order to cope with the rapid change in city planning and the demand for an integrated planning approach, extensive capacity building will be crucial for the successful implementation of sustainable urban development.

Box 4.4 Voluntary Agreements

Voluntary agreements aim to encourage single firms, groups of companies or industrial sectors to improve their resource efficiency and environmental conduct and performance beyond existing environmental legislation and regulations. Basically, voluntary agreements encompass two dimensions: 1) business and/or industry participate voluntarily, and 2) there is an interaction between public authorities and business/industry. Voluntary agreements range from initiatives where participating parties set their own targets and often conduct their own monitoring and reporting, to initiatives where a contract is made between a private party and a public body or stakeholder group, such as a local community and/or a non-governmental or environmental group. By publicly making such commitments, voluntary agreements are expected to "stop a race to the bottom" and to "raise the bar" towards continuous improvement in the environmental performance of the industry. Further, voluntary agreements facilitate the formulation of policies that address environmental aspects beyond the compliance of laws. They are an important instrument to stimulate the environmental dialogue aiming to achieve sustainable consumption and production.

Source: GTZ, 2007

Cooperation

The aim here is to reach a consensus on policy goals and design voluntary measures to reach these goals. Cooperation can be achieved at different levels for the implementation of standards or energy conserving practices between city authorities and the private sector. This is particularly relevant when urban authorities do not have the mandate to pass legal regulations. It is important that the agreements are participatory in nature, allowing engagement of all stakeholders in a dialogue for achieving the targets. For example, an agreement for energy efficient buildings may need the involvement of the private sector, architects, constructors and policy makers (GTZ, 2006).

Policymaking and planning should be open and inclusive and should strive for a better balance between the economic, social and environmental pillars of sustainable development. (UNESCAP, 2008)

Information

For any government to succeed in meeting sustainability goals, mobilisation and active participation of citizens is crucial. Awareness campaigns should be at the heart of new policy strategies and should not only aim at making people aware but also rather aim at actual behavioural changes. This can be achieved by setting up specialized offices that provide the general public with information on resource and environmental issues. A special (energy and environmental) curriculum at schools can be an effective tool: it will not only educate and sensitize the future generations, but students will also bring their newly acquired knowledge back home and share it with parents. Special events such as car-free days or gardening workshops can be organized. The media can also be mobilized, with leaders and prominent persons being asked to actively promote energy and environmental issues. Awareness campaigns are most effective when coupled with other tools such as incentives for behavioural change, penalties and accessibility to alternatives.

Car free day in New York © www.brooklynvegan.com

Box 4.5 Promoting Sustainable Lifestyles

Sustainable consumption or lifestyles are a key element for shaping a sustainable urban future. Promoting a more sustainable lifestyle needs active participation of business, policy makers and civil society. Sustainable consumption needs to be mainstreamed through all policy areas and linked with existing policy plans and strategies (CSCP 2010). To choose the most effective policy instruments in promoting sustainable consumption, an understanding of the needs of companies wanting to apply sustainable consumption business strategies is needed. A dialogue with those companies will provide insights into what is needed in order to create change.

Green Jobs

Further demographic growth in Asia will present challenges for the employment market. With the current demographic trends the working age population in Asia will grow by 300 million by 2025 (UN, 2009b). This trend will mostly happen in fast developing countries like India, Vietnam, Indonesia, Malaysia and the Philippines. The challenge for those labour-rich countries will be to develop industries geared to absorb these workers. Cities have a crucial role to play in the creation of green economies that are pro-environment, pro-growth and pro-jobs. They can do this by investing in 'green' infrastructure development such as public transport, sustainable urban agriculture, renewable energy systems and technologies or thermal retrofitting of existing buildings. The green building sector and the renewable energy sector are especially promising for creating high skilled green jobs (Table 4.11).

Table 4.11 Jobs from the Renewable Energy Sector

Industry	Estimated jobs worldwide	Selected national estimates
Biofuels	> 1,500,000	Brazil 730,000 for sugar cane and ethanol production
Wind power	> 500,000	Germany 100,000; United States; 85,000; Spain 42,000; Denmark 22,000; India 10,000
Solar hot water	~ 300,000	China 250,000
Solar PV	~ 300,000	Germany 70,000; Spain 26,000; United States 7,000
Biomass power	-	Germany 110,000; United States 66,000; Spain 5,000
Hydropower	-	Europe 20,000; United States 8,000; Spain 7,000
Geothermal	-	Germany 9,000; United States 9,000
Solar thermal power	~ 2,000	Spain 1,000; United States 1,000
Total	> 3,000,000	

Adapted from: REN21, 2011a

4.5 Urban Authorities Leading the Way

"When the best leader's work is done, the people say: we did it ourselves!"
- Lao Tzu, Chinese Taoist philosopher

Although local leaders are not involved in the framing of all policies, they can certainly play a vital role in influencing them, as they are the implementing authorities for these policies. They can also offer valuable feedback and recommendation for future policies at the state and national level. They are in a unique position to see what can be beneficial to the city as a whole.

Leaders who take the lead in sustainable development are likely to encounter resistance from a number of people who doubt the benefits of the efforts. Strong leadership and determination will be required. Making unpopular decisions for the long-term benefit of a city requires courage. But it can be rewarding as well. Experiences in Seoul, Republic of Korea, or Curitiba, Brazil, demonstrate that in spite of initial resistance, sustainable development projects can be successful in terms of environmental outcomes and also in increasing the popularity of the leaders in pushing forward the agenda (UNESCAP, 2011).

Leaders can lead in many ways. They can initiate change by placing sustainable development high on their priorities. They can help create a vision for the city around the principles of energy and environmental sustainability. They can set up participatory processes and align everyone involved towards the right objectives. They can help mobilize funds for the projects. They can also empower people to make a difference and allow them to act as catalysts. They can promote transparency and accountability and can delegate responsibilities to partners to create a shared effort among political parties, government, the private sector and civil society (UNESCAP, 2011).

Outstanding Local Leaders

Charismatic mayors and governors can be spotted around Asia and the globe. These are officials who go that extra mile to seek correct advice, get informed in energy-efficient practices, improve the quality of life for their constituencies and implement commendable projects in their cities. Many dynamic mayors and governors who choose to strengthen public transport facilities instead of building infrastructure for privately owned vehicles show the way forward and showcase what individual leadership can achieve.

Fine examples of good leadership can be seen in cities like Curitiba (Brazil) and Rizhao (China). The Mayor of Rizhao (China) and his government adopted several measures and policies aimed at popularizing clean energy technology (ICLEI, 2009b) (NYT, 2007) (ITDP, 2009) (Torrie, 2002). Curitiba is an often named example of integrated city planning that the visionary Mayor Jaime Lerner executed (ICLEI, 2009b). It is best known for its impressive public transport system, the efficiency of which encourages people to leave their cars behind despite being the city with highest car ownership in Brazil. With the highest public ridership of any Brazilian city, it has the country's lowest rate of ambient pollution (ICLEI, 2009b). Builders get tax breaks if their projects include green space. People living in shantytowns can exchange their garbage for bus tickets and food. This city that recycles 70 per cent of its garbage is an exemplar in showcasing to the world the enormous possibilities open to local leaders (ICLEI, 2009b).

Asian cities need better systems to manage road traffic, increase capacity of public transport systems to move people within and between cities, and promote sustainable and fuel-efficient vehicles. (ABC, 2010)

Curitiba public transport © www.treehugger.com

The Mayor of Bogota cancelled a massive ring road and used the money to build 300 km of bike lanes, a state-of-the-art bus rapid transit system, more libraries, playgrounds, and schools (NYT, 2007). The Mayor of Seoul (Republic of Korea), Lee Myung Bak also known as "Mr Bulldozer", built a bus rapid transit system, tore down an elevated highway in the city centre, restored waterways and pedestrian bridges, built more pedestrian zones and created extensive green spaces. As part of a traffic demand management policy, he introduced "a leave your car once a week" campaign, which encourages car owners to leave their cars at home and get tax breaks. His strategy called the 'push and pull strategy' is based on the practical experience that congestion actually increases as you build more and more roads. The bus rapid transit system along with the existing subway serves more than 4.5 million passengers everyday (ITDP, 2009). The Governor of Jakarta has already constructed three bus rapid transit lines (ITDP, 2009). Pedestrian zones are also springing up all over Chinese cities. Local leadership can certainly change the way a city runs or evolves.

When tax on petrol is increased, drivers may respond by reducing trips (or trip lengths), choosing more fuel-efficient vehicles, or relocating their homes closer to work. (ADB, 2009)

The Areas Where Leaders can Influence

Local governments can influence energy management through better planning and administration, the "how-to" of which are discussed in the subsequent sections. Interestingly many things are possible and can be in the purview of local governments without having to depend on any other agencies.

Torrie (2002) delineates some of the areas, that local governments influence directly:

- Management of energy utilities
- Use of fuels and electricity by administration
- Planning, operation, and policy framing for urban planning
- Enterprise and economic development
- Investment management in the community
- Environmental and public health and safety
- Zoning and urban planning needs of individual projects
- Regulation for built environment, including residential and commercial buildings, site layout
- Water supply and sewage treatment management
- Storm sewers and drainage management

- Solid waste management, recycling and landfill facilities
- Local roads, traffic management and parking
- Transportation other than roads
- Recreational, green space and cultural facilities
- Policing, fire fighting and protection of people and property
- Social welfare services

Different departments sometimes look after all these areas and all decision-making takes place within them. This gives huge scope for policies that address only one issue, say, solid waste management to be counterproductive for other public infrastructure like local roads and traffic management. Authorities need to think of a city as a unit and look at all the issues as part of an integrated whole. City Mayors and Councillors are in a position to play that central role which brings about integrated solutions and makes sure none of these departments, while trying to address individual issues, is counter-productive to the efforts of others.

4.6 Financing the Sustainable Development

"We know the problems.... and we know the solution; sustainable development. The issue is the political will."

–Tony Blair, ex-Prime Minister of Britain

Lack of finances is a major hurdle for city authorities. Some have access to more funds than others, either through own revenues or from higher levels of government, the private sector, or even by borrowing. However, these are unlikely to be sufficient sources, and other alternatives need to be explored. The local government needs to decide on a financing framework that can assist with the sustainable development . Local and international capital markets and Special Purpose Vehicles (SPVs) can be set up for this purpose (ADB, 2008). SPVs define the relationships between the stakeholders of the project and ideally they should include the private sector in their activities (ADB, 2008). More details of SPVs are given in Box 4.6.

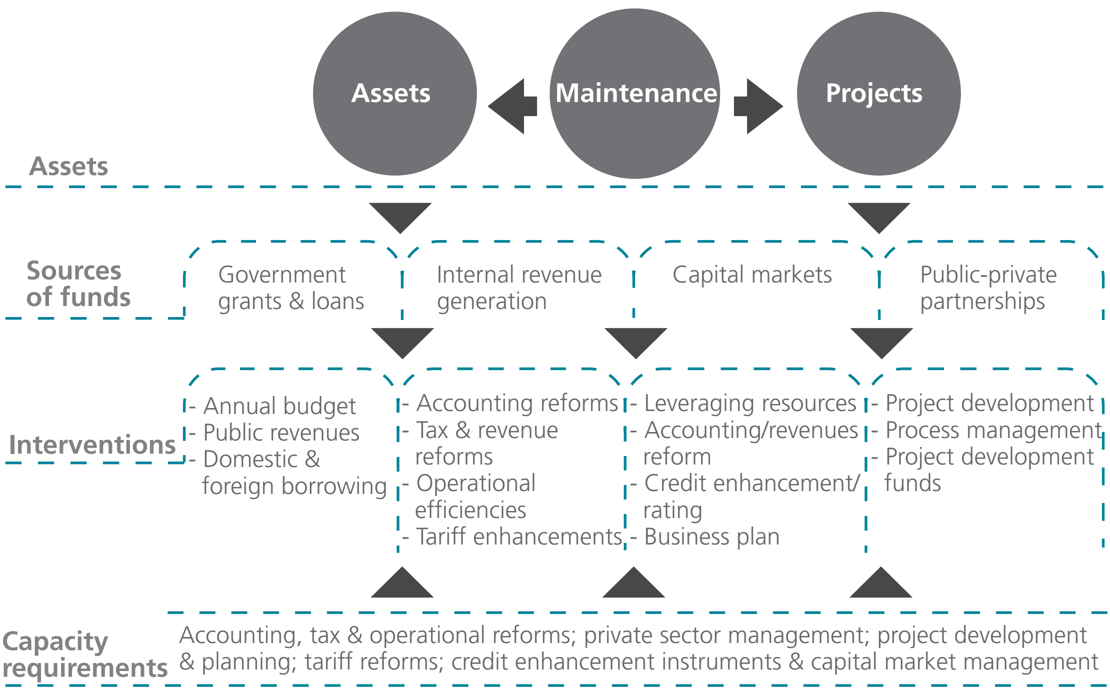
Box 4.6 Special Purpose Vehicles

"Special purpose vehicles (SPVs) or entities are companies established for a specific activity with powers limited to those required to attain its purpose and a life span that ends when this has been achieved. When a government or a company— commonly called the sponsor of the SPV—wants to achieve a particular purpose, it separates an asset, activity, or operation by forming an SPV. SPVs normally have three participants: (i) the transferor, originator, or sponsor that transfers the assets, liabilities, or rights that create the SPV; (ii) the transferee, which is the newly created SPV that receives the transferred assets, liabilities, or rights; and (iii) the investors that provide funding for the activities through loans to the SPV, often through the issuance of marketable securities. SPVs are relatively cheap to create and maintain while offering possible taxation, regulatory burden, and confidentiality benefits. SPVs are incorporated as companies whose articles of association limit business to the particular purpose, such as providing an infrastructure asset or service or the issue of securities. To maintain the integrity of the structure, the directors, officers, and the administrators of the SPV should be independent of the originator. The use of SPVs has spread to all sectors of the economy. In the public sector, the activities of SPVs are often undertaken through public–private partnerships, build-own- operate-transfer (BOOT) schemes, and joint ventures to construct infrastructure, manage financial assets or liabilities, or deliver services on behalf of government."

Source: Dipplelsmana, 2004

Financing sustainable urban development projects generally requires a detailed financial structure that incorporates the local government and mobilizes the private sector fund for infrastructure development. But the range of financing sources has never been wider. Own-source revenue and funding options need to be maximized, and the local government must be given the mandate to do so. Since governments can normally borrow at lower costs than the private sector, the real risks of the project are often not clear. When a government project has cost overruns, these are passed to the community through higher taxes. Hence, the lower borrowing rate provides no benefit to the community. Cost overruns are common in public projects undertaken in developing countries. But the private sector has an incentive to complete projects on time and under budget (ADB, 2008). Annexe 10 lists the impact of policies on sustainability and cost. Institutions and partnerships for urban development and initiatives from around the world are given in Annexes 11 & 12.

Figure 4.5 Urban Infrastructure Financing



Adapted from: ADB, 2008

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Annexes

01. How to Measure Eco-efficiency

The following ratio is used as a general equation to measure eco-efficiency

$$\text{Eco-efficiency} = \frac{\text{Product or Service Value}}{\text{Environmental Impact}} \quad \text{(Value unit/burden unit)}$$

Often the reverse ratio is used, as a measure of the pollution or resource intensity of the service or product provided

$$\text{Eco-intensity} = \frac{\text{Environmental Impact}}{\text{Product or Service Value}} \quad \text{(Burden unit/value unit)}$$

Adapted from: UNESCAP, 2011

02. Example of Sustainability Indicators in Urban Water Supply

Infrastructure policy issue	Suggested indicators
What is the trend in asset condition, and what is the capacity to meet future needs?	- Delivery capacity - Marginal cost of expanding capacity - Adequate signalling to community of any plans for expanding capacity
How reliable is the water supply utility?	- Record of service disruptions - Reserve capacity of existing infrastructure
What is the economic performance of the water supply? How efficient (including eco-efficient) is the utility? Does the utility address both supply and demand issues? Does the tariff structure encourage cost-effective water conservation? What are the needs and scope for promoting water demand management?	- Rate of return on water supply utility assets - Production cost (including labour) per cubic meter of water produced - Unaccounted-for (non-revenue) water (distribution losses, back-flushing) - Energy use for pumping and treatment per unit of supply - Water use trends by sector (including per capita residential use) - Price structure: volumetric rates, increasing block tariffs, seasonal charges - Ratio fixed/volumetric charges - Share of total cost covered by water bills, amount of cross-subsidization from general rates

Adapted from: Chapman and others, 2007

03. Urban Energy Sustainability Indicators

Type of Indicator	Theme	Energy Indicator	Components
Social-Equity	Accessibility	Share of households (or population) without electricity or commercial energy or heavily dependent on non-commercial energy	- Household (or population without electricity or commercial energy, or heavily dependent on non-commercial energy - Total number of households or population
	Affordability	Share of household income spent on fuel and electricity	- Household income spent on fuel and electricity - Household income (total and poorest 20% of the population)
	Disparity	Household energy use for each income group and corresponding fuel mix	- Energy use per household for each income group (quintiles) - Household income for each income group (quintiles) - Corresponding fuel mix for each income group
Economic	Overall use	Energy use per capita	- Energy use (total primary energy supply, total final consumption and electricity)
	Supply efficiency	Efficiency of energy conversion and distribution	- Losses in transformation systems including losses in electricity generation, transmission and distribution
	End use	Commercial energy intensity	- Energy use in commercial sector - Corresponding value added
		Industrial energy intensity	- Energy use in industrial sector and by manufacturing branch - Corresponding value added
		Household energy intensity	- Energy use in households and by key end use - Number of households, floor area, persons per household, appliance ownership

		Transport energy intensity	- Number of four wheelers per 1000 population - Number of two wheelers per 1000 population - Number of public transport vehicles (buses) per 1000 population
Environmental	Climate Change	GHG emissions from energy production (for the city) and the per capita energy use	- GHG emissions from energy production and use - Population
	Air Quality	Ambient concentration of air pollutants in city	- Concentration of pollutants in air
	Water	Energy used for bringing water to the city and pumping (including pumping at end use level)	- Energy bills at Water Utility for water services - End use energy for pumping water per capita or population
	Waste Water	Energy used for taking out waste water from the city and treating it	- Energy supplied to waste water utility - population
	Solid Waste	Transport energy spent on taking out waste from the city to landfills/ incinerators/recycling	- Fuel spent on trucks/lorries for population - Energy spent on creating and managing landfills and incinerators
Others	Street Lighting	Installed capacity Lighting intensity Energy consumed Timings of automatic switch on and off	- kW/km of road - Lux/Watt - kW/km per month
Educational	Energy Awareness	Awareness of energy related problems	- Surveys to check on energy awareness levels of people of different age groups, sectors, income-levels and class

Adapted from: IAEA, 2005

04. Strategic Planning Process

Stage	Step #	Step	Potential time required
A	1	**Get started**	Typically, 1 to 6 months. If strategic planning is new, this step could take months
A	2	**Identity stakeholders**	Could take a half-day session or up to several months, ongoing over the course of the project
A	3	**Analyse & assess**	A half-day kick-off workshop followed by 3 months to a year of study. External technical support may be required
B	4	**Establish a vision**	Could take a half-day workshop with stakeholders or up to a month or more
B	5	**Set objectives**	Initial objectives can be formulated in a one-day workshop. Often, however, this takes several meetings
C	6	**Identify actions & stragegies**	Initial identification of options can be done in a one to two-day workshop. Study and evaluation, depending on detail can take 1 day to several months
C	7	**Select actions**	Depending on the extent of the evaluation from a half day workshop with stakeholders to a 1 month or more for impact assessments
C	8	**Implement actions**	The development of an action plan can be straightforward, but the time for actual execution depends on the project specifications
D	9	**Monitor & evaluate**	Initial framework could be developed in a one-day workshop to determine the "who, what, when" of monitoring and evaluation. A date for a full evaluation should also be set
D	10	**Adjust & modify**	As plans and impacts evolve and change over time, adjustments in plans may be required

Adapted from: UN-Habitat and EPT, 2005

05. Benefits of Demand-led Approach

Deficiencies of a supply-led approach	Benefits of a demand-led approach
A disproportionate focus on the needs of the supply industry leading to inadequate consideration of the needs of the consumers	Consumer needs lead the way so supply is planned to fit needs.
A focus on income from the sale of energy sources and so a resistance to energy efficiency or fuelswitching measures.	Energy efficiency and appropriate means to meeting energy service needs (cooking, warm house etc.) become all important.
Potential for misjudging the future demand on energy supply.	Energy demand changes are tracked and can be anticipated timeously.
A poor understanding of suppressed demand – for example households may be able to afford solar water heaters if proper financing were available: a supply side focus would miss such opportunities.	As the focus is on a range of ways of meeting energy service needs, a wider range of users can satisfy their energy service needs
Little attention given to the management of demand (including behaviour change).	Attention is focused on managing demand and demand-side management is considered prior to supply side solutions.
The majority of users have no voice in the system.	There is constant interaction with users and users are empowered to make energy decisions and choices
The emphasis on supply makes the system vulnerable to energy scarcity and to escalating energy costs. In addition, users have little control over their energy expenditure.	The emphasis on diversity of means of meeting energy service needs and on efficiency means that the system is more flexible and robust. Energy users have much greater control over their energy expenditure.

Adapted from: UN-Habitat, 2009

06. Barriers to Effectiveness of Policies

Barrier category	Instrument category recommended	Recommended policy instruments as remedies
Economic barriers	- Regulatory- normative/ regulatory-informative - Economic instruments - Fiscal instruments	- Building codes, energy efficiency obligations, green procurement, DSM programmes, ESCOs, cooperative procurement, energy efficiency certificates - Taxation, public benefit charges, tax exemptions, incentives/rebates/grants
Hidden costs/ benefits	- Regulatory-normative - Economic instruments - Support action	- Building codes, ESCOs - Public leadership programmes
Market failures	- Regulatory-normative/ regulatory/informative - Economic instruments - Fiscal instruments - Support, information, voluntary action	- Building codes, energy efficiency obligations, green procurement, DSM programmes, ESCOs, energy efficiency certificates, - Taxation, public benefit charges, tax exemptions, incentives/rebates/grants, voluntary agreement, public leadership programmes, awareness raising, detailed billing
Cultural/ behavioural barriers	- Support, information, voluntary action	- Voluntary labelling, voluntary agreement, public leadership programmes, awareness raising, detailed billing
Information barriers	- Support, information, voluntary action	- Voluntary agreement, public leadership , awareness raising, detailed billing - Green procurement, DSM programmes, mandatory audits
Structural/ political	- Regulatory/informative	- Public leadership programs

07. Computer Models that Help with Energy Planning

Model Name	Origin	Type of Model	Other Information
BALANCE	IAEA, US-DOE[1]	Energy Supply & Energy System Model	A model for simulation of energy supply, belongs to ENPEP family
CO2DB	IIASA[2]	Energy Information System	CO^2 database
DECPAC/ DECADES	IAEA[3]	Energy Information System	Database and Technology Chain Analysis
EFOM-ENV	EU[4]	Energy Supply & Energy System Model	Energy Flow Optimization Model
EM	World Bank, GTZ[5]	Model of Life Cycle Assessment of Power Systems	Environmental model, a Simulation model
ENERPLAN	UNDTCD[6]	Modular Planning Instrument	It couples a macro economic model with a simulation model of energy sectors.
ENPEP	IAEA, US-DOE	Modular Planning Instrument	Energy and Power Evaluation Programme
ETA- MACRO	EPRI[7]	Energy- Economic Model	Energy technology Assessment- A dynamic model which couples the macroeconomic MACRO with the aggregated energy system model ETA
GEM-E3ME	EU	Energy- Economic Model	Computable General Equilibrium model for studying economic energy environment interactions.
GLOBAL 2100, GREEN. 12RT	OECD[8]	Energy- Economic Model	Dynamic model based on energy technology assessment with 5 world regions
HOVA	PROFU[9]	Model for the Analysis of Energy Conservations Potential	An EXCEL based database model
LEAP	SEI- Boston[10]	Modular Planning Instrument	Long Range Energy Alternative Planning- a simulation model with environmental database
MADE	IKE[11]	Model for the Analysis of Energy Demand	Model for Analysis of energy demand, a module of the ENPEP planning tool
MARKAL	ITSAP[12], IEA	Energy Supply & Energy System Model	Market Allocation model with a user support system
MARKAL-MACRO	BNL[13]	Energy- Economic Model	Linked models for Energy Economy Analysis
MARTES	PROFU	District Heating Model	A Simulation model for District Heating System
MEDEE	IEJE[14]	Model for the Analysis of Energy Demand	Model for evaluating the energy demand, a bottom up model
MESAP	IER[15]	Modular Planning Instrument	Modular Energy System Analysis and Planning

MESSAGE	IIASA	Energy Supply & Energy System Model	Optimization model for Energy Supply System
MIDAS	EU	Energy Supply & Energy System Model	A Modular Simulation Model
MODEST	IKP[16]	Energy System Optimization Model	Minimization of Capital and Operation costs of energy supply and demand side management
NEWAGE	IER	Energy- Economic Model	Quasi dynamic model with hybrid representation (bottom up and top down) of the technologies of the industry sector
PLANET	IER	Energy Supply & Energy System Model	Long term energy system simulation
POLES	EU	Energy Supply & Energy System Model	Prospective Outlook on Long term Energy Systems, a simulation model
PRIME	EU	Energy- Economic Model	A Computable Price Driven Partial Equilibrium model of the energy system and markets for Europe
SAFIRE	EU	Technology Assessment Model	Strategic Assessment Framework for the Implementation of Rational Energy, a simulation model for heat and power supply at the local and regional level for European countries
SEESAM	Aal-U[17]	Modular Planning Instrument	The sustainable energy systems analysis model for energy systems planning at local and regional scale
TEESE	TERI[18]	Modular Planning Instrument	TERI Energy Economy Simulation and Evaluation Model
TIMES	ETSAP[19], IEA	Energy Supply & Energy System Model	The Integrated MARKAL EFOM system and optimization model that produces least cost solutions; it is intended to replace MARKAL which has its origin in the late 1970s and no longer meets modern requirements and possibilities of up-to-date software engineering.
WASP	IAEA, US- DOE	Electricity Supply Model	Wen Automatic System Planning, an optimization model

1 United States Department of Energy
2 International Institutes for Applied Systems Analysis, Laxenburg, Austria
3 International Atomic Energy Agency
4. European Union
5. Gesellschaft fur Technische Zusammenarbeit mbH, Germany
6. United Nations, Department of Technical Cooperation for Development
7. Electric Power research Institute, Palo Alto, California, USA
8. Organization for Economic Cooperation and Development, Paris, France.
9. Projektinniktad Dorskning och utveckling-PROFU, Goteborg, Sweden
10. Stockholm Environmental Institute, Boston
11. Institut fur Kernenergetik und Energiesysteme, University of Stuttgart, Germany
12. Energy Technology System Analysis Project
13. Brrokhaven national laboratory
14. Institut Economique et Juridique de l' Energie, France
15. Institut fur Energiewirtschaft und rationelle Energianwendung, University of Stuttgart, Germany
16. IKP Energy System Institute of Technology, Linkoping, Sweden
17 Aaborg University, Denmark
18. The Energy and Resources Institute, India
19. Energy Technology Systems Analysis Programme, Italy

08. Policy Directions and Possible Actions

Areas	Guidelines and Policy Direction	Possible Actions and Tools
Capacity building & awareness	Promote application of systems or holistic approach in infrastructure development.	- Integrate infrastructure development plan using eco-efficient indicators. - Apply Asset Management and Multi-criteria Analysis.
	Consider development and use of national strategic infrastructure development plan.	- Develop national sustainable infrastructure plan. - Use of Life Cycle Assessment and Strategic Environmental Assessment.
	Disseminate the information on the importance and good practices of eco-efficiency in infrastructure development.	- Involve decision makers, planners, academics, etc. - Implement pilot projects based on good practices.
	Establish a network for capacity-building of sustainable infrastructure development in the region.	- Research covering good practices, indicators, and criteria. - Training focusing on planning, design, and evaluation.
	Develop guidelines for achieving eco-efficient infrastructure development in the region.	- Use of policy tools and strategies that are appropriate to different sectors and conditions.
Specific infrastructure sectors	Propose methodologies to improve eco-efficient infrastructure.	- Benchmarking and/or verification programme. - Use of available data and develop required data base.
	Develop eco-efficient infrastructure according to economic, physical/topographical, and demographic conditions.	- Develop and implement pilot projects based on good practices. - Target exchange programme.
	Integrate development sectors such as transport and land use systems.	- Apply at city or subregional level.
	Improve the quality of infrastructure services.	- Use of technologies and improved management. - Applying eco-efficient materials to be used in construction and maintenance of infrastructure. - Applying successful business models in service providing organizations.

	Improve implementation, monitoring and evaluation of infrastructure projects.	- Use of Environmental Assessment (EA) and Environmental Management System (EMS).
	Increase the use of public transport and low energy-consumption vehicles.	- Investment of new rail lines and new bus system such as BRT. - Provision of facilities to promote non-motorized vehicles and integration with transit.
	Develop methodology to estimate traffic congestion, environmental and social costs.	- Apply social cost-benefit analysis. - Develop and maintain required databases.
Stakeholder participation	Governments and policy makers look at areas in relation to other stakeholders to achieve sustainable infrastructure development.	- Use of innovative financing and economic instruments. - Country and regional workshops to share good practices.
	Integrate capacity-building and technical support activities to enhance partnerships among sectors and stakeholders.	- Apply good practices from the private sector. - Target counterpart exchanges.
	Involve civil society in formulating government policies and major actions.	- Use of community and participation techniques. - Information library and websites.
	Education and awareness on adopting sustainable management practices.	- Information, education and communication (IEC) campaign. - Publication of good practices and research results.
	Promote dialogue, consultation and consensus building among stakeholders.	- Participation of stakeholders including local authorities, citizens, local organizations, NGOs and private enterprises.
	Improve environmental management capacities of local authorities.	- Capacity-building and human resources development. - Enhancing technical and financial capacities.
	Governments can be prepared to gradually shift their role from principal financier and operator to overseer and regulator.	- Use of public-private partnership. - Development of regulatory framework and guidelines.
	Promote the development of eco-technology and environmental industry.	- Consider the use of economic instruments. - Provide research funds.

Adapted from: UN, 2007

09. Designing the Future of Transportation in Cities

Existing condition	Prospects & ambition	Future resource needs	Transport agenda	Sustainability achievable
Non-motorized vehicular (bicycle) city—low income; modest resource base	Develop into a bus city	Modest	- Development of a bus system - Traffic management - Parking control, mainly in the centre. Road maintenance, complete secondary road network and new development roads in fringe areas	High
Bus city—modest income; modest resource base	If good prospects - develop into a transit city adopting the smart growth paradigm	Moderate, with private sector interest	- Maintain non motorized vehicular facilities. Bus priorities -> bus ways -> bus road transit - Parking policy -> road pricing - Traffic management and control strengthened - Strategy circular and development roads, secondary roads, and removal of bottlenecks - Progressive private sector development - Smart growth, transit-oriented development encouraged	High
Traffic saturated bus city—the Bangkok syndrome	Relatively affluent; substantial resources; living with congestion	Substantial, with significant private sector investment	- Grade-separated expressways - Metro networks - Road investment to complete hierarchy (secondary mainly) and to guide future city growth - Transit-oriented development (retro-fitted) - Integration of transport systems	Moderate "living with congestion"
Transit city—moderate/ High income	Very good prospects—continuation of policies	Substantial finance and capacity	- Preserve and enhance non-motored vehicular and pedestrian facilities - Sophisticated traffic restraint and road management, using technological developments - Investment in mass rapid transit (metro) and public transport integration - New road investment to ensure congestion remains controlled - Private sector participation, including outsourcing	Sustainable

Adapted from: ADB, 2007

10. Impact of Policies on Sustainability and Cost

Policy Instrument	Energy Sustain-ability	Cost Effective-ness	Special conditions (For success, major strengths & limitations, co-benefits)
Demand Pull	High	High	Can be effectively used to demonstrate new technologies and practices. Mandatory have higher potential than voluntary ones. Factors for success: strong labelling backing and continuous improvements with new energy efficiency measures, short term incentives to transform markets
Indirect Price Support	Low to Medium	Low to Medium	Successful only when combined with other tools and when there is price elasticity. Rebates or tax reductions however have a higher rate of success than just tax.
Technical Standards/ Certifications	Medium to High	High	Mandatory are better. Transaction costs can be high. Institutional structures needed. Expertise in the field will need to be established and well oiled with changing scenarios. Periodical monitoring and updating for relevance is essential. Should be combined with education, awareness building, capacity building, etc.
Waste Management	Medium	Medium	Should be combined with financial or other perceived incentives with a threat of regulation.

11. Information and Support

1. United Nations Environment Programme (UNEP)
www.unep.org

UNEP aims to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. UNEP-supported initiatives of particular relevance to cities and climate change include the following:

- Sustainable Buildings and Construction Initiative (SBCI)
www.unepsbci.org

- Partnership for Clean Fuels and Vehicles (PCFV) www.unep.org/pcfv
- Climate Neutral Network (CN Net) www.unep.org/climateneutral
- Road Design and Finance for Safety, Sustainability, and Accessibility

www.unep.org/urban_environment/NMT_Roads

2. United Nations Human Settlements Programme (UN-Habitat)
www.unhabitat.org

UN-Habitat's mandate is to promote socially and environmentally sustainable human settlements development and the achievement of adequate shelter for all. Several initiatives address the role of cities and climate change:
- Sustainable Urban Development Network (SUD-Net) www.unhabitat.org/sudnet
- Cities and Climate Change Initiative (CCCI)
- Sustainable Cities Programme (SCP) www.unhabitat.org/scp
- Localizing Agenda 21 (LA21)

3. Intergovernmental Panel on Climate Change (IPCC)
www.ipcc.ch

The IPCC assesses the scientific, technical and socio-economic information on climate change, its potential impacts and options for adaptation and mitigation.

4. The World Bank
www.worldbank.org/climatechange

The World Bank incorporates considerations of climate change into all of its development operations.

5. Global Environment Facility (GEF)
www.gefweb.org

The GEF supports activities that protect the global environment, including efforts to combat climate change. It is also the United Nations body that operates the Least Developed Countries Fund, Special Climate Change Fund, and a potential future Adaptation Fund under the United Nations Framework Convention on Climate Change.

6. Cities Alliance
www.citiesalliance.org

The Cities Alliance is a global partnership for urban poverty reduction and the promotion of the role of cities in sustainable development.

The Cities Alliance prioritizes support to cities, local authorities, associations of local authorities and/or national governments that are committed to:
- Improving their cities, and local governance, for all residents;
- Adopting a long-term, comprehensive and inclusive approach to urban development;
- Implementing those reforms necessary to effect systemic change, and to achieve delivery at scale; and
- Decentralizing resources to empower local government

12. Strategies to Pick up from Initiatives Around the World

1. ICLEI - Local Governments for Sustainability
www.iclei.org

ICLEI - is an association of over 1220 local government members who are committed to sustainable development. The members are from 70 different countries and represent more than 569,885,000 people.

ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. ICLEI's basic premise is that locally designed initiatives can provide an effective and cost-efficient way to achieve local, national, and global sustainability objectives.

2. C40 Cities
www.live.c40cities.org

The C40 Cities Climate Leadership Group (C40) is a network of large and engaged cities from around the world committed to implementing meaningful and sustainable climate-related actions locally that will help address climate change globally. The organization's global field staff works with city governments, supported by technical experts across a range of programme areas.

3. The Aalborg Charter
www.sustainable-cities.eu

The charter helped prepare a local action plan. Over 200 local authorities signed it. They committed to create a sustainable local action plan. Many activities were initiated towards this, including publication of guidance manual for local planning, training courses, help with networking and creation of databases on good practices.

4. Global City Indicators
www.cityindicators.org

The Global City Indicators Facility provides an established set of city indicators with a globally standardized methodology that allows for global comparability of city performance and knowledge sharing. This website serves all cities that become members to measure and report on a core set of indicators through this web-based relational database.

5. International Solar Cities Initiative
www.isci-cities.org

The International Solar Cities Initiative was created for sustainable action in urban energy management worldwide. It does this through partnership between cities and researchers involved in climate research, renewable energy systems and urban design.

6. Cities Development Initiative of Asia
www.cdia.asia

CDIA is a regional initiative established in 2007 by the Asian Development Bank and the Government of Germany, with additional core funding support of the governments of Sweden, Austria and Spain and the Shanghai Municipal Government. The Initiative provides assistance to medium-sized Asian cities to bridge the gap between their development plans and the implementation of their infrastructure investments. CDIA uses a demand driven approach to support the identification and development of urban investment projects in the framework of existing city development plans that emphasize environmental sustainability, pro-poor development, good governance, and climate change.

To facilitate these initiatives at city level, CDIA provides a range of international and domestic expertise to cities that can include support for the preparation of pre-feasibility studies for high priority infrastructure investment projects as one of several elements.

7. Sustainable Urban Transport Project (SUTP)
www.sutp.org

SUTP Asia is a partnership between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Bangkok Metropolitan Administration (BMA), CITYNET and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). It aims to help developing world cities achieve their sustainable transport goals, through the dissemination of information about international experience, policy advice, training and capacity building and targeted work on sustainable transport projects within cities.

8. Alliance to Save Energy
www.ase.org

The Alliance to Save Energy was established in 1977 as a non-profit coalition of prominent business, government, environmental, and consumer leaders who promote the efficient and clean use of energy worldwide to benefit consumers, the environment and economic growth. The Alliance supports energy efficiency as a cost-effective energy resource under existing market conditions and advocates energy-efficiency policies that minimize costs to all sectors of society, including industry, and that lessen greenhouse gas emissions and their impact on the global climate. ASE demonstrates the cost-effectiveness of energy efficiency under market conditions, while striving to improve those conditions by encouraging investment in the most cost-effective energy resources.

9. Kitakyushu Initiative Network
www.kitakyushu.iges.or.jp
This was formed between members from 61 cities in 18 countries in the Asia-Pacific region. It holds an important role in fostering the capacity building of local staff. Many pilot projects are conducted and there is a healthy interchange of experience and

information amongst member cities. The Network outlines eight of its functions as follows:

- Enabling, conceptualising and implementing of plans with indicators.
- Periodical monitoring against quantitative indicators.
- Dissemination of information among members.
- Offering a platform for the transfer of technology.
- Networking for financial support.
- Capacity-building of staff.
- Enabling environmental education through student exchanges.
- Enabling private enterprises to participate in infrastructural development and environmental quality enhancement program.

13. Training Activities

Training activity for Chapter 1: Energy is all Pervasive

Session 1: Introduction
Theatre games
- Ice breaker sessions and introduction to the course
- Introduction round with participants.
- What does each hope to learn from the workshop

Session 2: Urbanization in Asia and in the World
Objective:
To make participants understand the general trends of urbanization in the world and the characteristics of urbanization in Asia

Medium:
Presentation and group discussion

Activity:
A group discussion could be started based on the memories of participants on how their hometown/city has developed since their childhood. What has changed? How did it change? What got lost? What has improved? Major points will be highlighted on a flipchart. The group discussion can be rounded up with a presentation on urbanization in Asia and the World.

Session 3: The Energy Needs of Cities
Objective:
Cities are huge consumers of Energy. Energy is all pervasive. Participants will get to understand the energy needs of cities.

Medium:
Video, presentation and reflection

Activity:
Videos and a presentation will highlight the energy needs of cities and the challenges associated with it. The session will conclude with a question and answer session and some time will be allocated for a collective reflection process.

Session 4: Observing the reality of urban centres
Objective:
To activate the information gained in the previous session.

Medium:
Visit of a local town

Activity:
Trip to a local town. Participants will use their information from the previous sessions and reflect on the apparent developments in a nearby town. The session ends with an informal sharing of what has been observed.

Training activity for Chapter 2: Cities hold the keys to Energy Sustainability

Session 1: Energy Conservation and Energy Efficiency
Objective:
To make participants understand the importance of energy conservation and energy efficiency interventions.

Medium:
Presentation, video, group discussion
Activity:
Audio files circulated amongst groups of participants. These would be in the form of snippets of news, video or audio files, all related to urban energy crisis. Each group would be given a specific set of information:
Group 1: Power generation, power cuts, etc.
Group 2: Traffic congestion, fuel prices, air pollution
Group 3: Industry, rising costs of raw materials, energy, etc.
Group 4: food security, food prices, food waste

Participants in each group will present their solutions for the energy crisis. The facilitator then introduces the concept of energy conservation and efficiency.

Session 2: Prosumption
Objective:
To make participants understand the potential of producing energy and other energy related resources themselves.

Medium:
Group discussion, brainstorming

Activity:
Starts with a discussion on consumption patterns and then contrast this with the concept of prosumption. In a group session, participants will brainstorm on potential prosumption areas, and list vision, challenges and solutions on a flip chart. The facilitator will conclude the session with a few examples from the sourcebook.

Example: Renewable Energy

Vision	Challenges	Solutions

Session 3: Circular economy - closing the loop
Objective:
Understanding the value of a circular economy

Medium:
Video, presentation, individual concept development

Activity:
The facilitator introduces the concept of the circular economy, which mimics nature's eco-system along with a few examples. Participants are than asked to come up with one example for implementing this model in their city.

A video that inspires will close the session.

Lack of systemic approach will be handled in this session. In spite of efforts at planning, why do policy-makers often fail? What do they lack in their approach?
Choose 'the best Mohammad Bin Tughlaq?' Each group would be given a card having issues in a particular city related to energy management like increasing private vehicle ownership, increasing demand for electricity, increasing load shedding, increasing the divide between the energy used between the rich and the poor and increase in domestic consumption of energy. Along with a description and a set of clue cards that have information of some ideas of solutions promoted by imaginary city leaders under relevant situation would also be given. The clues would contain both sensible and bizarre solutions. For example, increasing private ownership could have the clues that would be as follows:
- Build multi-storeyed flyovers
- Lay regulations to cut down number of cars plying on the road

at any given time
- Introduce heavy emission taxes and increase cost of private vehicles
- Build better public transport systems
- Remove parks and fill up lakes to build more roads

Participants will have to choose the most bizarre non-systemic approach. They will then have to build a case on this approach and each group would present their cases with imaginary situations and stories with figures, numbers and characters to the others and to a panel of judges. The most non-systemic group will get the prestigious title of the ruler from the past.

Session 4: Transport and Urban Planning

Objective:

Make participants aware of the nexus between Urban Planning and Urban Transport systems. To introduce potential solutions to reduce energy consumption in the transport sector.

Medium:

Game of Chance

Activity:

The previous session involved the bloomers leaders could make. This session would involve intelligent governance. Each group would be given a sheet containing issues in urban energy. Each issue would have multiple choices as answers carrying points.For example, one of the issues could be low supply of fuel for electricity in an island country. The choices as answers could be as follows:
- Import fuel from neighbouring country, which is rich in fuel mining (Marks: -100 points)
- Resort to wind energy. (Marks: 100 points)
- Introduce DSM programmes and recover energy through polygeneration in industries (Marks: 200 points)
- Allow citizens to cope by themselves (Marks: -50 points)

The participants would be given a single dice with numbers from 1-6. Any participant can start the game and the rounds can go in a clockwise manner. The participant rolls the dice to decide the fate of the answer luck would choose for him/her. The points collected corresponding to the answer would be added to the group's collective points. Finally the group that gains the most points would be the winner.

Training activity for Chapter 3: Best practices

Session 1: Best practices and closed loop systems
Objective:
To make participants understand closed loop systems and good practices within energy consuming sectors.

Medium:
Card activity

Activity:
The trainer could briefly explain about closed loop systems and the good and bad practices in the various sectors. The activity using cards could follow this. Each group will be given the same set of cards. The cards would form 2 categories. One set of heading cards and one set of playing cards. The headings would include,
1. Closed loop within individual buildings
2. Closed loop within neighbourhood
3. Closed loop within locality
4. Closed loop within the city
5. Good practices in building sector
6. Bad practices in building sector
7. Good practices in transport sector
8. Bad practices in transport sector
9. Good practices in energy production
10. Bad practices in energy production
11. Good practices in appliance designing
12. Bad practices in appliance designing

The other set of cards would include systems that could go under any of these categories, which can be picked up from chapter 3. For example one card could have the phrase "wet waste". This would fall under the "closed loop within individual buildings" category. Managing wet waste within buildings that produce them would remove the strain on local governments of picking up, segregating and transporting wet waste of the whole city that form as much as 60% of all household waste. There could be at least 2-6 such cards under each category.

Participants in each group take turns to form clusters of these cards under various categories, one at a time, one by one. The chance passes on to the next participant and the rounds go on till all cards are used up. Sorting should happen without discussion.

Then the participants can take around 3-4 rounds to rearrange the cards if they see fit, one by one changing what their predecessors had placed. After a couple of such rounds, the facilitator will now instruct the participants that they can discuss and again go through the rounds to sort cards. Once everyone is satisfied with the sorting, each team would present the sorting to others. The facilitator then performs the sorting on board for all to see, with consensus from groups to arrive at the correct sorting.

Session 2: Best practices in energy
Objective:
Present best practices in the field of energy.

Medium:
Presentation, video

Activity:
Use of renewable energy systems and energy efficiency technologies to solve energy problems will be the focus of this session. Participants will break up into groups; each group will be given a case study of a city and will be asked to find solutions to solve issues related to energy. Each group would prepare a one-page poster that documents solutions referring to policy interventions, financial mechanism, market transformation and awareness building. Participants will give each other feedback and suggestions. To round up the session the whole group will try to find key points and recommendations for implementing sustainable energy in urban Asia.

Session 3: Renewable Energy Systems
Objective:
To give participants an insight into small-scale renewable energy systems.

Medium:
Site Visits and interaction with experts

Activity:
Participants will be taken to installations of renewable energy systems (solar PV and wind turbines). They will interact with experts about capacity, system design and challenges regarding finances and grid metering.

Session 4: Awareness and training
Objective:

To understand the importance of awareness campaigns and education

Medium:
Video, presentation, discussion

Activity:
Any policy intervention needs to have support from the people. In this session successful awareness campaigns and training initiatives are introduced.
Participants will share awareness campaigns and educational with a focus on sustainability from their city, region and country and narrate to which extent it was successful or not. The group then picks an issue that can be targeted by an awareness campaign, a matrix of stakeholders is listed and each participant takes on the role of a stakeholder, representing a specific interest and sensitivity/ insensitivity to a subject.

Training activity for Chapter 4: Policymaking

Session 1: Where can you help?
Objective:
To make policy makers understand areas where they can help

Medium:
Analysis, assimilation and presentation

Activity:
Groups would be asked to discuss amongst themselves and come up with various areas that they feel they can influence to bring about urban energy sustainability. They should also be able to state the kind of impact they could induce. Each team member should be able to help others come up with better ideas and once discussions are over, each group could present their analysis to the others. The facilitator could fill in gaps and conclude that energy sustainability can be enhanced through better local governance.

Session 2: Revenue Bearing Models for City Sustainability
Objective:
To make participants understand appropriate revenue models of energy sustainability.

Medium:
Auction activity

Activity:
What would participants bet on as the most successful solutions for generating revenue? A team of auctioneers will be chosen and the rest of the participants would be bidders. For a problem read out by an auctioneer, a set of solutions would be read out. For each set of solutions there would be only one correct solution. Participants will make a choice and bid (in small money) for it. There can be other bids for other solutions if some other participant thinks that some other solution is right. The auctioneer can encourage the bidding and the highest bidder will have to pay the money and if his bidding object coincides with the correct answer, he would be given twice his money back. Concepts of correct revenue models will be brought out in this manner.

Session 3: Integrated Energy Planning
Objective:
This module will enable participants to see the value of integrated energy planning.

Medium:
Problem solving

Activity:
Participants form groups and are given problems to solve. The groups are divided into technicians, social engineers, administrators and other experts. Each team will be given 'expert clues' to the problem pertaining to their core area of competency, which they will need to discuss and develop into better solutions.
In the second round, participants are reorganized into mixed teams with each member representing a different group and asked to synthesize their earlier ideas together. Each new group will present their findings to the rest of the group and the facilitator could conclude with final touches and with closing statements on importance of integrated energy planning which would have anyway happened with integration of so many thoughts during this activity.

Session 4: Closing
The facilitator closes the workshop with a presentation of key concepts that need filling in. The session can end with a commitment for networking and mutual support of participants.

SUSTAINABLE URBAN ENERGY

A Sourcebook for Asia

For cities to confront the challenges of fossil fuel depletion, increasing energy costs and rapid climate change, it is inevitable to develop and implement urban energy management solutions for their sustainable future. This publication is a training companion developed originally for training courses at the International Urban Training Centre in the Republic of Korea.

This Sourcebook addresses sustainable urban energy solutions from a system's perspective, as a three-step process - energy conservation, energy efficiency and renewable energy. Energy conservation asks the question, "do we need to consume a given good/service?" Energy efficiency asks, "what would be the best possible way to consume the same good/service", while renewable energy asks, "could there be sustainable renewable energy alternatives for fossil fuels".

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