

Path to Green Growth: Sustainable Infrastructure Introduction

It is widely recognised that infrastructure provides the foundation for economic and social development. Infrastructure opens access to livelihood opportunities as well as delivers critical needs and services to communities: it is essential to achieving health, education, gender, and income poverty goals.

The development and expansion of infrastructure, however, often has serious environmental repercussions. Infrastructure is very intensive in resource use, including energy, water, materials and land. Without careful planning, infrastructure can lock countries into unsustainable production and consumption patterns that may prove difficult to reverse.

A sustainable infrastructure system is one that facilitates a higher-quality delivery of housing, transport, energy, water, waste and sanitation services, with less use of resources, to support social and economic development in an integrated, eco-efficient and inclusive manner.

The justification for sustainable infrastructure in Asia and the Pacific is clear.

Responsible for roughly 34 percent of global greenhouse emissions and home to two-thirds of the world's poor, the region hosts 1 billion people without access to electricity, more than 600 million without access to safe drinking water, and 1.5 billion without proper sanitation.

Infrastructure development in urban areas deserves special attention. Although urbanisation has been an integral part of the rapid economic growth experienced by Asia and the Pacific in recent decades, it also represents a considerable challenge to delivering cost-effective and affordable services to the population. Growing cities continue to face increased environmental problems associated with congestion, pollution and rising energy, water and raw material demands, all of which take a negative toll on economic competitiveness. Across the region, many of these impacts weigh most heavily upon the shoulders of the poor, particularly women, where an estimated 40 percent of urban dwellers currently reside in slums.

The following pages provide a strategic framework towards the planning, construction, operation and maintenance of sustainable infrastructure systems. Emphasis is placed on sectors with high potential for "green" job creation-employment that contributes to protecting and preserving the environment-identifying how these activities can accelerate the transition to Green Growth.



Module 1

Sustainable Master Planning



Objectives of the Module: To familiarise participants with policy measures to support cost-effective, sustainable construction plans, emphasising the environmentally-efficient delivery of services and regeneration of natural habitat.

► Construction, at its most basic level, is the process of assembling the structures and facilities that support human settlements and make infrastructure operational. Fundamental to social and economic development, construction shapes the way decisions are made about the production and distribution of goods and services and determines how the essential needs of a population are met. The construction of eco-efficient infrastructure- economically efficient, environmentally sustainable systems that provide citizens with safe and reliable access to shelter, energy, transportation, water, proper sanitation and disposal of wastes- is becoming increasingly critical in Asia and the Pacific.

High population growth, coupled with an ever-widening migration of people from rural to urban areas, has intensified the use of land and resources. While Asia's cities have brought vast opportunities for economic advancement, the rewards have not been shared equally- coming at the cost of enormous stress upon the environment which, in large measure, is disproportionately felt by the poor.

The mismanaged expansion of many Asian cities has contributed to the environmental degradation of the region, negatively affecting the quality of its air, soil and water, leading to the collapse of biodiversity, and leaving human settlements more vulnerable to the impacts of climate change. More than half of the world's new construction is occurring in Asia, following practices that continue to have an enormous negative impact on the environment. Construction is frequently planned and coordinated with little attention to environmental performance, often resulting in non-durable, energy inefficient designs that are assembled without regard for long-term sustainability or human health. A limited supply of quality, affordable housing constrains disadvantaged groups from securing adequate accommodation, many of which must resort to living in environmentally degraded or deteriorating areas, such as urban slums.



Sustainable master planning refers to a decision-making process whereby communities are involved in enhancing the efficiency of infrastructure services, as well as conserving and restoring local ecology, to better address the challenges women and men face in accessing land and basic needs. When developed alongside supportive vocational training and employment policies, sustainable master planning represents a primary vehicle in moving towards Green Growth.



This Module
is arranged
into three Subsections :

- Eco-efficient Construction
- Sustainable Renovation
- Ecological Restoration

Key concepts
and issues
to be addressed
include :

- Green Buildings
- Conservation Development
- Green Public Procurement
- Deconstruction
- Retrofitting
- Land Rehabilitation

Eco - Efficient Construction

Definitions

Land use mix: degree by which residential, commercial and institutional uses of land are located in the same area.

Eco-efficiency: emphasising the more efficient use of resources (materials, energy, water and land) to deliver goods and services that generate less waste and pollution, minimising environmental impacts and reducing social and economic costs.

Conservation development: land use development where the built environment is constructed in a manner that emphasises the preservation of the surrounding natural environment.

Environmentally-sound technology (EST): refers to a wide range of sustainable products, services and processes that deliver essential needs with minimal ecological impact.

Conventional planning approaches to infrastructure have shown to be ill-equipped in meeting the challenges of rapid urbanisation. Growing populations, along with a limited supply of readily available land, have dramatically expanded the dimension of Asian cities: sprawling metropolises that perpetuate the overconsumption of resources and energy at the expense of greater society and the environment. As settlements become more dispersed, governments face increasing difficulties in raising the capital investments necessary to carry infrastructure such as roads, water supplies, sanitation and power over long distances.

Mismanaging infrastructure brings major costs. Inefficient electricity distribution systems frequently lose a significant percentage of energy in transmission. Failing to adequately maintain roads over time not only can lead to environmental damage: it constrains economic growth, restricting access to essential goods and services. Building markets unable to cope with urban population pressures prevent disadvantaged groups from securing affordable housing; meanwhile, shoddily constructed buildings and inattention to existing building stock leads to structures that quickly fall apart. These problems most heavily burden the poor, particularly women, who often have no option but to reside in informal, illegal settlements—many which lack reliable infrastructure services.



And yet, incongruous as it may seem, cities in Asia and the Pacific are primed for sustainability. Despite having massive ecological footprints, Asian cities are widely characterised as having high urban densities and diverse **land-use mixes**, which provide opportunities to redirect negative development patterns through innovative master planning strategies.

Alongside the goal of improving the access and availability of vital services, **eco-efficient** construction is organised around principles of low-impact, **conservation development**: preserving natural resources with the aim of reducing vulnerability to the effects of climate and environmental change. It involves 'doing more with less' while promoting the assembly, implementation and maintenance of **environmentally sound technology (EST)** designed to be progressively integrated into larger public infrastructure systems.

As will be discussed, eco-efficient construction has wide potential to serve as a vehicle for skills training and enterprise development, which, when planned effectively can translate into enhanced livelihood options, particularly for low-income communities.



Taking the Whole System into Account

Eco-efficient construction is based on a **whole-systems approach**- various types of infrastructure (including transport, energy, water, shelter etc.) and the physical landscape are seen as comprised of interdependent components that interact with the greater natural, social and economic environment. By carefully assessing socio-economic and environmental impacts throughout the various stages of a project's **life-cycle**, eco-efficient construction practices seek to ensure that infrastructure operates in ways that optimise performance and cost, expanding the delivery of services to those most in need.

Definitions

Whole-systems approach: paradigm that emphasises the importance of viewing all parts of a system or process at once and analysing how these factors interact and feed into each other.

Life-cycle: refers to the total amount of inputs and outputs spanning the life of a product or service.

Retrofitting: refers to the addition or substitution of new technology, equipment or features to older systems with the aim of enhancing environmental performance.

Green buildings: buildings designed to use energy, water, materials and land efficiently with the objective of delivering necessary services whilst reducing negative impacts on human health and the environment.

Passive solar buildings: please see Glossary

Zero-energy buildings: please see Glossary

Autonomous buildings: please see Glossary

Energy-plus buildings: please see Glossary

Sustainable Buildings for Green Growth

Widely dependent on fossil fuels, buildings are notorious energy consumers- by some estimates, accounting for over 90 percent of all electricity use in certain countries. Along with being one of the highest emitters of global greenhouse gas emissions (GHGs), buildings and construction devour the largest percentage of natural resources per capita in their intake of land, water and raw materials. Given the above, it is not surprising that the construction and operation processes also typically produce massive quantities of waste and pollution.

In addition to **retrofitting** existing buildings for energy efficiency, the eco-efficient design, construction and operation of **green buildings** can be used to improve the environmental quality of infrastructure services in ways that reduce long-term utility costs while enhancing occupants' safety and health.

Sustainable building concepts extend over a diverse range, including:

- ▶ Passive solar buildings
- ▶ Zero-energy buildings
- ▶ Autonomous buildings
- ▶ Energy-plus buildings

Investing in green buildings not only can yield significant savings for households and businesses, it also has potential to promote opportunities for greater socioeconomic development. Employment in the building and construction sector often makes up a large percentage of the labour market. Accordingly, eco-efficient construction practices can encourage linkages with green businesses that offer environmentally-friendly products and materials, and deliver services such as the installation and maintenance of EST. Vocational education and job training is crucial in this regard.



Building Codes for Greener Places

Definitions

Ecological footprint: also known as carrying capacity, refers to measure of human demand on ecosystems; more specifically the area of land and water needed to supply resources and absorb wastes.

Governments are the primary driver in the development of green buildings, and building codes and standards are the most important ways to promote sustainability within the construction sector. Adopting and enforcing policies that set reduction targets on materials, water, and energy over time has the potential to substantially shrink the **ecological footprint** of new and existing buildings. Establishing regulations on green buildings has the added bonus of opening a market window for the introduction of energy-efficient appliances and EST. As these products gradually lower in price and become the norm, increasing numbers of people can be afforded access to sustainable infrastructure services.

The International Organization for Standardization's ISO 14000 standards, as well as the U.S. Green Building Council's rating system, Leadership in Energy and Environmental Design (LEED), are two internationally recognised frameworks for evaluating the environmental performance of green buildings. Rating systems are important in that they can be used to inform the development of building codes. What's more, when linked with financial and fiscal incentives, rating and certifying buildings serve as an effective driver for innovation and change in construction practices.

It is important to consider the socio-economic context. Many of the urban poor cannot afford or access adequate housing because they lack secure tenure over the land in which they occupy, ultimately pushing many into informal or illegal settlements. Clearly, it is unsustainable and inequitable to construct a massive, extravagant and expensive building- even if it has green features- next to a slum or squatter settlement housing the poor.



Green design should work to consider the needs of everyone, especially the poor



B

uilding for Life: Pre-design

Definitions

Charette: a collaborative decision-making session used to build consensus on issues related to community planning.

Land sharing: a legal compromise for resolving land conflicts whereby private or government land owners agree to share a portion of their property with poor communities who reside there.

Land readjustment: refers to a land-use strategy that involves re-plating several adjacent areas of land and eliminating property boundaries to allow for a new redevelopment project.

Integrated Sustainability Assessment (ISA): defined as 'a cyclical, participatory process of scoping, envisioning, experimenting and learning through which a shared interpretation of sustainability for a specific context is developed and applied in an integrated manner in order to explore solutions to persistent problems of unsustainable development'. (Please visit:

<http://www.matisse-project.net/projectcomm/index.php?id=643>)

The decisions made at the start of a new construction project often determine its environmental impact for years to come. Addressing potential challenges early in the planning stages can result in much lower costs than when introduced after construction has already begun.

Active involvement of the government is necessary to educate building owners, financiers, developers, installers and buyers about the benefits of environmentally-sound design. However, efforts to incorporate environmental management into project planning can be greatly enhanced by taking a multidisciplinary, collaborative approach to decision-making. Encouraging the regular formation of **charettes**- comprised of local policy makers, financiers, architects, site planners, utility company representatives, property developers, building owners, residents, etc.- as well as other relevant stakeholders, such as community based and non-governmental organisations- can help to build community support for project goals.

A stakeholder-driven process is crucial to understanding the priorities and challenges which must be taken into consideration prior to construction. Participatory mapping exercises can assist in collecting data on environmentally sensitive areas, updating public land records, and providing information on how potential development sites can best be integrated into municipal plans, such as through **land sharing** or **land readjustment** strategies. During this time stakeholders might make use of **Integrated Sustainability Assessments (ISAs)** to promote cooperation on problematic issues: determining which building sites stand to be most impacted by climate change, clarifying issues of land tenure, and, as a last resort, negotiating resettlement arrangements for vulnerable communities.



The Natural Choice: Site Selection

Definitions

Environmental impact statement: a decision-making tool outlining the positive and negative environmental effects of proposed plan of development.

Urban sprawl: poorly-planned or unplanned expansion of urban space into areas located on the periphery of a city; typified by an inefficient use of land resources and caused when land consumption disproportionately exceeds urban density.

Ecological restoration: using human intervention to renew a degraded, depleted or destroyed ecosystem and bring it back to health.

Brownfield: abandoned, underused or idle industrial and commercial facilities available sometimes characterised by environmental degradation and contamination; distinguishable from "greenfields", or undeveloped land found outside of urban areas.

Urban upgrading: assisting residents in slum or squatter communities to develop basic services to meet their needs, beginning with the establishment of land tenure over the property.

As discussed, the pre-design stage invites the opportunity to host public forums about the scope of an intended eco-efficient construction project. Impact assessments convey information about priority issues, such as environmental assets and risks, enabling policy makers to form consensus around the proposed development by considering the greater needs of the community.

Based on these criteria, policy makers can develop a statutory framework, such as an **environmental impact statement**, to direct decisions on identifying and selecting an appropriate project site. After carefully analysing how the project might affect local ecology in a chosen location- including a thorough review of any natural or human-induced hazards the site may face- stakeholders can work towards designing a site plan.

An effective site plan seeks to ensure that the planned construction has a minimal impact on the surrounding environment, emphasising compact land use- ideally in vacant lots within the town or city periphery- that locates buildings close to schools and health facilities, employment centres, and markets. This reduces the potential for **urban sprawl** while making the best possible use of existing infrastructure, such as public transportation systems. Designing plans that recycle and retrofit old buildings, encourage the **restoration** of **brownfield** sites and promote **urban upgrading** of slum and squatter settlements can also help to bring valuable skills and jobs to disadvantaged communities.



Step 1:

Location and Orientation

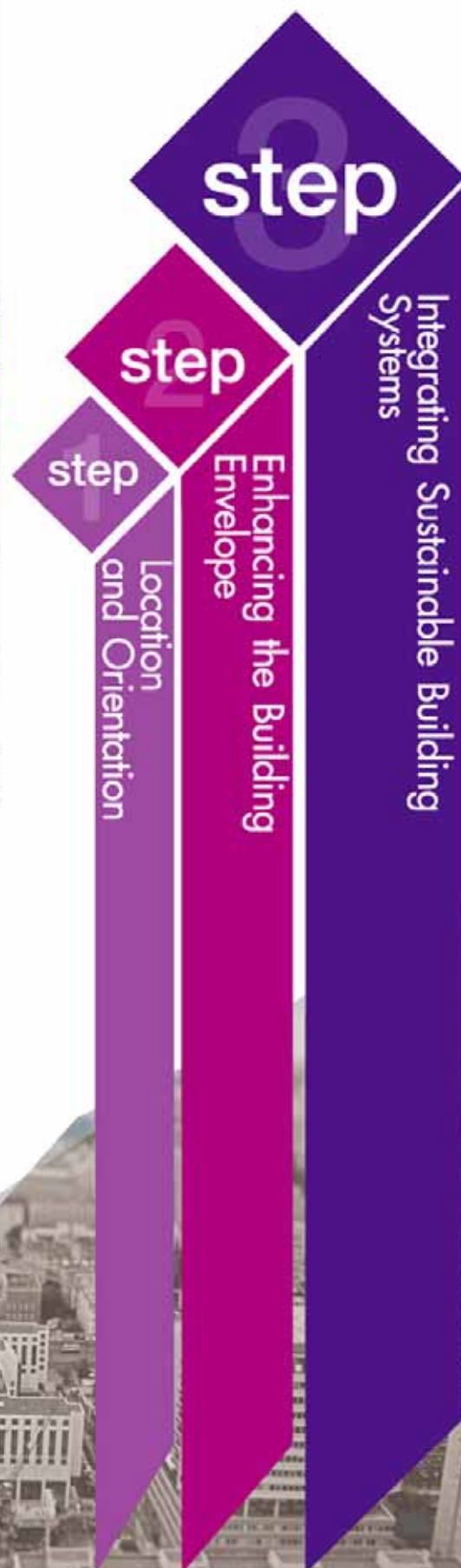
The location and surroundings of a building determine how it regulates its temperature and defines the amount of light it receives. Buildings should be positioned to take advantage of access to the sun for heating, lighting and power, as well as air flow for natural ventilation, by coordinating landscape decisions accordingly.

- Buildings can be oriented so that they maximise the use of natural lighting.
- Strategically placed trees and vegetation can cast appropriate shading, directing air towards buildings in hotter months, while serving to buffer against wind in colder months.
- Substituting native vegetation for paved areas around the building site can reduce excessive heat buildup- also known as the **urban heat island effect**- as well as help to conserve water; **xeriscaping** for instance has shown to be an effective stormwater management measure.

Definitions

Urban heat island effect: a metropolitan area that is significantly warmer than its surrounding rural areas as a result of urban land surface coverage that has limited amounts of vegetation.

Xeriscaping: refers to landscaping in ways that uses water more efficiently by using native and drought-tolerant plants, shrubs, and ground cover.



Definitions

Prefabricated/Modular buildings: a type of building where sections or components are manufactured off-site and later delivered and assembled on-site.

Daylighting: the practice of using natural light to reduce or eliminate electric lighting in building interiors.

Clerestory windows: a type of window above ground level that provides daylight, usually located along the upper part of a wall.

Light tubes: a device positioned in roofs and used to distribute natural light to a specific interior area of a building.

Louvers: a window, blind or shutter that contains a series of narrow openings, framed by overlapping fins or slats, angled to control the amount of light and air entering a building.

Light shelves: a horizontal shelf that is positioned onto the building or in windows to reflect or shield daylight.

Brise soleil: a horizontal canopy or structure that extends from the facade of a building and serves to prevent excessive sunlight from entering.

Trombe wall: a sun-facing wall that serves to absorb heat from direct exposure to sunlight and is used to redirect warm air.

Earth sheltering: the architectural practice of using earth against building walls to naturally heat or cool a building.

Living wall: refers to a type of wall that is partially or completely covered with vegetation and can be used for air and water filtration.

Green roof: a rooftop that is partially or completely covered with vegetation and soil that can be used to improve the heating and cooling requirements of a building, as well as assist in air and water filtration.

Grey water recycling systems: internal plumbing systems that recycle residential, commercial and industrial wastewater and reuse it for other purposes.

Earth cooling/earth warming tubes: an architectural feature that works to maintain comfortable interior temperatures in a building by drawing air from underground.

Solar chimneys: a vertical ventilation shaft that works to channel air into a building by making use of heated airflows.

Wind catchers: an architectural feature that serves to enhance natural ventilation in buildings by capturing moving air.

Step 2:

Enhancing the Building Envelope

The building envelope- referring to the external surface of a structure, including the walls, windows, doors, roofs and floors- largely governs how energy-efficient a building is.

Although local conditions require different design strategies, the envelope is critical to maintaining a comfortable indoor temperature because it moderates the amount of heat that enters or escapes a building. Efficient building envelopes strike a balance between managing their intake of heat and daylight while at the same time allowing for proper ventilation.

- Compact building designs that make use of energy-efficient windows, properly sealed doors and additional insulation can provide for significant energy savings, particularly in colder climates. **Prefabricated/Modular green buildings** prove to have many advantages in this regard.

- Lighting constitutes a large percentage of a building's energy usage. It is well established that **daylighting** strategies can enhance the health and productivity of building occupants. Properly located, insulated windows and **clerestory windows**, as well as skylights and **light tubes**, accompanied by the use of appropriate shading techniques, such as **louvers**, **light shelves**, and **brise soleil** can help to control heat and excessive brightness by distributing natural daylight into a building's interior.

- In warmer climates, light coloured building surfaces can be used to reflect sunlight; in colder temperatures, dark colours can soak up and transmit heat. Similarly, incorporating concrete, tile, stone or brick floors into locations exposed to direct sunlight can also gradually absorb and release heat into a building. Water storage containers set into walls are another viable option, trapping excess heat in the winter, storing it during the day and cooling it at night during the summer months. Solariums and **trombe walls** are also effective ways to capture or release heat: when combined with below-floor venting systems, the air that is generated can be channeled to warm or cool the building, depending on the season.

- **Earth sheltering**, when constructed in a sustainable manner, is a practice that can substantially reduce heating and cooling requirements in residential buildings. On a smaller scale, **living walls** and **green roofs** also use natural landscaping techniques to maintain comfortable temperature levels; additional benefits include the ability to filter pollutants from the air, protect groundwater, and provide habitat for local wildlife. In urban settings these methods have also been credited for their capacity to insulate against outside noise. When combined with **grey water recycling systems**, living walls and green roofs can bring significant water savings.

- Naturally ventilating buildings is by no means straightforward task, greatly depending on the specific climate, location and type of structure in question. **Earth cooling/earth warming tubes**, ventilation shafts, such as **solar chimneys**, and **wind catchers** are proven ways to encourage airflow into buildings without the use of mechanical systems.





Step 3:

Integrating Sustainable Building Systems

There are a wide range of high-performance EST systems currently available that may be considered to further improve the sustainable operation of buildings. In areas disconnected from centralised infrastructure services, these strategies may prove essential to meeting basic needs.

Many of the following features can be combined to optimise green building design:

- Rainwater harvesting and grey water recycling systems, including hot water heat recycling- such as the utilisation of **solar water heaters**- are water and power saving measures that can be used to conserve local resources. Introducing **urine diversion** and **composting toilets** has demonstrated to be very successful in rural agricultural areas, where wastes are added with fertilizer to improve product yields.

- A large majority of a building's energy is spent on heating, cooling, ventilation and lighting systems. **Active solar collectors**, such as **solar roof ponds**, can meet both heating and cooling requirements in a building and also be designed to desalinate water for drinking. More effective are those that combine both space and water heating by employing pumps and fans to distribute air.

- In addition, renewable technologies, such as **photovoltaic (PV) panels**, **micro-hydro** and small-scale **wind power** can serve as primary sources of energy or can offset some of the building's energy requirements.

- As unsavoury as it may sound to some, there is great potential in also harnessing human excreta to power **biogas** plants, especially in rural areas; these systems can then be applied towards **trigeneration** in buildings, recycling waste heat to effectively **close the loop on waste**.

Definitions

Rainwater harvesting: the above or below-ground collection, storage, and reuse of rainwater to serve human needs.

Solar water heaters: internal plumbing systems that absorb heat from the sun to meet the hot water needs of a building.

Urine diversion toilet: toilets unconnected to sewage systems or septic tanks, used to promote water conservation by redirecting urine into the soil.

Composting toilet: toilets unconnected to sewage systems or septic tanks, used to promote water conservation and reduce pollution by breaking down human waste and that can later be distributed into the soil.

Active solar collector: a device used to harness the thermal energy of the sun so that it can be stored utilised in buildings.

Solar roof pond: a type of rooftop solar energy collector that can be used for desalination, heating and cooling purposes in buildings.

Photovoltaic (PV) panels: please see Glossary

Micro-hydro: please see Glossary

Wind power: please see Glossary

Biogas: please see Glossary

Trigeneration: the simultaneous generation of mechanical power, heat and cooling from a single source, involving making use of the "waste heat" byproduct that results from this generation.

Closed-loop system: a type of process that promotes the cyclical flow of materials with the aim to minimise or eliminate waste.





Definitions

Resource productivity: involves maximising the amount of a good or service that can be obtained from the use of a given quantity of resources.

Green public procurement: roughly defined as a policy of incorporating environmental and social considerations alongside conventional criteria of price and quality into purchasing decisions.

Life-cycle assessment: a methodology used to evaluate the total amount of inputs and outputs spanning the life of a product or service to determine its full environmental cost and inform about the best options for improving efficiency.

Life-cycle cost analysis: a methodology used to evaluate the expected operating, maintenance and replacement costs involved with utilising a type of building material or building component and inform about the best options for improving efficiency.

Full cost resource pricing: refers to the pricing of (natural) resources and the services that they provide at a rate that equals the cost of maintaining sustainable environmental standards, or to some accepted degree, internalises negative environmental externalities.

Material flow analysis: defined as a quantitative methodology for analysing the flow of materials and energy throughout an economy.

Greening the supply chain: please see Glossary

Landfill mining: an environmental management strategy through which previously-disposed solid waste in landfills is excavated and processed, both to reclaim salvageable materials and upgrade the landfill space.

Construction and demolition (C & D) debris: nonhazardous solid waste and materials from construction, deconstruction, renovation or demolition operations that have the potential to be reused.

Choosing for Sustainability: Materials Selection

Because of its durability, safety and efficiency, the long-term economic value of a green building most often proves greater than that of a conventional building. Along these lines, **resource productivity** is the primary consideration in the selection of green building materials. Accordingly, this section will discuss how **green public procurement** can be used to strengthen eco-efficiency in the construction sector.

Given the varying availability of products and services, the selection of materials for green buildings will inevitably differ between countries. Promoting the formation of green building advisory boards and/or associations-administrative bodies made up of architects, builders, suppliers, members of the local chamber of commerce, waste haulers, non-governmental representatives, and ministerial officials, for example can assist policy makers in making inventories of available green materials for slated construction projects.

Equipped with a clear picture of the amount of materials and energy inputs which are involved in bringing goods to market, stakeholders are positioned to make the most eco-efficient choices. By evaluating the entire sequence of processes and activities that go into the extraction, manufacture, transportation, production, and disposal of materials, **life-cycle assessments**, **life-cycle cost analyses**, and **full-cost resource pricing** are three tools that work together to balance environmental, social and economic costs. These efforts can be strengthened by undertaking a **material flow analysis** at the national level. Altogether, these instruments are a crucial part of **greening the supply chain**.

The building sector is a major consumer of energy-intensive materials and processes- accounting for nearly three billion tonnes of raw materials each year. Green public procurement promotes the incorporation of locally-sourced labour and materials, such as post-consumer recycled products in building design. As many of these activities are often very labour-intensive, there exists a high potential to generate employment around the remanufacturing and recycling of products that can be salvaged as green building materials. **Landfill mining** provides a relevant example.

There is a wide spectrum of **construction and demolition (C & D) debris** and other recyclable wastes that can be integrated into the building process to great effect. The following list, while by no means exhaustive, includes a number of possible options.



Definitions

Eco-labeling: a labelling system for products and services that indicates they are manufactured or conducted in a sustainable manner.

Full-depth recycling: an on-site construction process that rebuilds old or degraded concrete and asphalt pavements by recycling existing roadway materials

Fly-ash: residue generated from the industrial use of coal that can be captured and reused in the building and construction process.

Product taxes: please see Glossary

Mining taxes: please see Glossary

Landfill taxes: please see Glossary

Workfare: a form of welfare in which participants perform work as a condition of receiving aid.

Deposit programmes: please see Glossary

Variable tip fees: please see Glossary

Deconstruction: a process of carefully dismantling or removing useable building components, to maximise the recovery of materials for re-use, recycling, and waste management.

Recyclable Building Materials

- ▶ Timber (initially sourced from **eco-labeled** suppliers)
- ▶ Metals: steel, aluminium
- ▶ Stone
- ▶ Aggregates
- ▶ Plastics
- ▶ Polystyrene
- ▶ Gypsum
- ▶ Ceramics
- ▶ Ceiling tiles
- ▶ Glass
- ▶ Concrete and asphalt (particularly for road construction, known as **full-depth recycling**)
- ▶ Waste by-products: **fly-ash**, sewage sludge

Policy makers have a number of fiscal instruments at their disposal, such as **product taxes**, **mining taxes** and **landfill taxes**, to shift public demand towards more sustainable building materials. To ensure that they are not disproportionately felt by the poor, revenues generated from these taxes can thereafter be reinvested in social programmes, such as, for instance, vocational skills training or **workfare**. Implementing **diversion deposit programmes** and **variable tip fees** at landfills have also shown to be effective in reducing the amount of materials that enter the waste stream.

Deconstruction for Reconstruction

Although recycling C & D materials present many opportunities to reduce waste and cost for green construction activities, the most eco-efficient buildings are those designed to be **deconstructed** and reused at the end of their useful life.

There are many benefits to deconstructing buildings as opposed to simply demolishing them. In addition to saving natural resources by exploiting fewer materials, reusing building components can divert significant amounts of waste from landfills. Deconstruction also lessens the amount of contaminants that enter the air typically associated with demolition.

Waste reduction techniques practiced on construction sites can assist the deconstruction process while also cutting down GHGs. For instance, collecting, separating and storing materials prior to transporting them to market can greatly reduce traffic to and from the site. Coordinating deliveries with waste-hauling also helps to moderate the amount of vehicles that are on the road.





Definitions

Community Development Funds (CDFs): refers to a wide array of financial facilities that work to deliver loans and grants to low-income communities, often for micro-finance activities.

Sites and services: a government housing strategy that provides low-income communities with a designated parcel of land with a limited amount of infrastructure services with the expectation it will be further developed by the communities themselves.

Community contracts: defined as a contract awarded to a community organisation by a government agency to carry out a slated construction project.

Earmarking: please see Glossary

Recycled revenue: please see Glossary

Feebates: please see Glossary

Revenue-neutral: please see Glossary

Commissioning: the procedure by which a completed building is certified to be in efficient operating condition.

Constructing for the Future

Policy makers can ensure the construction process is conducted in an sustainable manner by establishing appropriate guidelines over the use and protection of site resources, the management of materials, and the monitoring of work safety practices accordingly. Performing quality control over green building operations can result in overall cost savings from more efficient processes while providing a healthier workplace for those employed in the construction sector.

Potential interventions that can assist in achieving more sustainable construction practices include:

- Designating a percentage of public land for low-income housing development within urban plans;
- Strengthening the technical capacity of land administration and land record agencies to promote more secure tenure, especially for groups living in slums and illegal settlements, through community title or lease arrangements;
- Simplifying administrative procedures to make the buying and selling of land more convenient;
- Introducing and enforcing land and property taxes on both developed and undeveloped sites to discourage bottlenecks in the supply of serviceable land;
- Supporting the mobilisation of **Community Development Funds (CDFs)** to co-finance organisations and other actors promoting community development initiatives, such as urban upgrading or **sites and services** programmes;
- Drawing up **community contracts** that ensure a certain percentage of the local population is employed in designing and implementing a given construction project;
- Working with advisory boards and industrial associations to review construction policies and propose relevant environmental procedures;
- Identifying manufacturers and distributors of recycled building materials to speed up green construction schedules;
- Establishing material recycling vendors should none exist;
- Requiring that construction contractors follow a precise site management plan to minimise environmental impacts;
- Encouraging training about principles of green design on and off the construction site, such as through the establishment of certification centres;
- Enforcing environmental and occupational safety regulations;
- Designating existing vegetation for protection early in the construction process; and
- Promoting deconstruction and recycling of C. & D debris to generate local demand and reduce transportation costs.

Financing the construction of green buildings can come from several sources: partially **earmarked** funds, **recycled revenue** from savings gained by investing in efficiency, and performance-based contracts- which rewards building design teams that develop the most environmentally-sound projects. When combined with other instruments, such as **feebates**, performance-based contracts can offer a **revenue-neutral** solution to green construction.

Quality Assurance for Sustainability

Ensuring the efficient operation of green buildings is an ongoing process that requires both planning and cooperation of stakeholders. Regularly commissioning green buildings over the course of their life-cycle is a cost-effective strategy that, along with environmental monitoring activities, can be used to evaluate and verify long-term building performance. **Commissioning** is critical to extending the life of green building systems: this requires developing a necessary skill base to meet the potential demands for maintenance and repair.



Definitions

Eco-city: also called a sustainable city, refers to an urban area planned and designed with the aim of minimising its ecological footprint and promoting equal opportunities to the greatest extent possible.

Urban growth boundaries: please see Glossary

Smart growth policies: please see Glossary

Inclusionary zoning: refers to planning ordinances that require that a minimum percentage of new construction to be affordable to people with low to moderate incomes.

Compost: a mixture of decaying vegetation and wastes that is used to enrich soil.

Crime prevention through environmental design (CPTED): please see Glossary

Urban agriculture: the practice of growing, processing and distributing food and other products in or around cities.

Vertical farms: please see Glossary

Permeable pavements: paving materials used for roads, lots, and walkways that permit stormwater and wastewater runoff to naturally infiltrate the soil below.

Constructed wetlands: an engineered marsh or swamp, used to treat wastewater, stormwater runoff or sewage treatment, that also serves as habitat for wildlife

Bioswales: landscape features filled with vegetation, designed to trap sediment and pollution from storm/wastewater runoff, with the aim of facilitating its more natural treatment.

Stream daylighting: redirecting channels of water into above-ground areas to help restore them to a more natural state.

Ecological restoration: please see Glossary

Building-integrated photovoltaics: solar energy systems that are integrated into the design of a structure and serve to replace conventional building materials.

Central solar heating/cooling: refers to the use of a range of solar collector systems to meet heating, cooling and hot water needs at the community or district level

Concentrated solar power: please see Glossary

Renewable portfolio standards: please see Glossary

From Green Buildings to Eco-Cities

As discussed, eco-efficient construction works to guide the development of infrastructure that can better respond to public needs. Given that more than half the global population currently resides in urban areas, eco-efficient construction, guided by sustainable master planning processes, can serve as a blueprint for the establishment of eco-cities in Asia and the Pacific: cities that are not only environmentally-friendly, but competitive, socially-equitable, and more resilient to the shocks of climate change.

A number of very innovative ideas related to the construction of eco-cities are currently being explored:

- Imposing **urban growth boundaries** and utilising **smart growth policies** to encourage more compact settlements around mass-transit systems
- Promoting cross-subsidy schemes, such as **inclusionary zoning**, to address the housing needs of vulnerable women and men
- Encouraging the organisation of community **compost** centres to improve solid waste management practices
- Implementing **crime prevention through environmental design (CPTED)** to foster safer communities
- Supporting livelihood generation through urban agriculture grown on green roofs, and/or constructing **vertical farms**
- Addressing stormwater management by integrating **permeable pavements**, **constructed wetlands**, **bioswales**, and **stream daylighting** into the urban environment
- Using **ecological restoration** to convert degraded land into recreational space
- Utilising **building-integrated photovoltaics**
- Building **central solar heating/cooling facilities** to better meet the demands of communities and, on a larger scale, **concentrated solar power** systems
- Obligating utility companies to produce renewable energy through **renewable portfolio standards**
- Incorporating **titanium dioxide** into construction materials to absorb greenhouse gas emissions
- Making use of flooring systems for municipal sidewalks that generate electricity from peoples' movements
- Designing **smart grids** and guiding the development of **microgeneration** in communities through **net metering** policies

Titanium dioxide: a compound that has shown to be effective in reducing the concentration of airborne pollutants and, under certain conditions, remediating wastewater.

Smart grids: term used to describe utilities that make use of modern electricity transmission and distribution systems, which deliver energy efficiently and reliably via enhanced monitoring and control mechanisms.

Microgeneration: refers to the small-scale generation of heat and power from renewable sources, enabling individuals, small businesses and communities to meet their own needs.

Net metering: please see Glossary





Definitions

Technical Vocational Education and Training (TVET): interventions, often government led, used to bring about learning that can enable individuals to become more productive in the world of work; involves the study of technologies and the acquisition of skills and capacities associated with various occupations in different economic and social sectors.

Eco-Industrial Parks for a Greener Tomorrow

In the transition to a global low-carbon economy, employment markets will face increasing pressure as governments work to upgrade the skills and competencies of their labour force. In addition to keeping resources in closed loops by means of companies working together, eco-industrial parks present a compelling opportunity to enhance **Technical Vocational Education and Training (TVET)** systems, particularly through Public-Private Partnerships, in order to meet the growing demand for green skilled workers.



The UK's Ambitious Agenda for Green Buildings

With nearly a quarter of the United Kingdom's carbon emissions coming from homes, the UK Government has passed sweeping legislation mandating that all new homes built in the UK are to be zero-emission on heating and cooling by 2016. The UK Government's 'Code for Sustainable Homes' sets binding regulations for reductions in energy with staggered targets: 25 percent more efficient by 2010, 44 percent by 2013, and 100 percent, or zero emissions by 2016. In line with this code, homes are currently being designed to feature solar panels, biomass boilers and water efficiency systems such as rainwater harvesting.

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Sustainable Renovation

Roughly 80 to 85 percent of a building's energy is used in its everyday operation- heating and cooling, ventilation, lighting water heating, and appliances- altogether making up a major source of GHGs. This is due in large part to the fact that, over time, building components inevitably become worn out, inefficient, and in need of replacement. Renovating or refurbishing existing buildings for energy efficiency and **energy conservation**, also referred to as **retrofitting**, comprise a series of cost-effective measures that can be used to improve the environmental performance of the building sector. In addition to increased energy savings and reduced pollution, a well-defined retrofitting project can also serve to guide skills development and generate employment, particularly among micro, small and medium size enterprises (MSMEs).

Definitions

Energy conservation: refers to the practice of reducing the quantity of energy used, whether through the more efficient use of energy or by decreased energy consumption habits

Retrofitting: refers to the addition or substitution of new technology, components, accessories or features to older buildings, machines or systems to make them more energy-efficient

There are a number of economic advantages to investing into the energy-efficiency of buildings. Capital outlays into energy-efficiency are generally much lower than those required to increase energy supply, and do not carry the additional operating costs associated with expanding production capacity. Moreover, the time needed to bring energy to the market- in other words, the "lead time"- is comparatively much shorter with energy-efficiency improvements. This is very important to consider in areas where energy demand outpaces available supply.

In line with the above, investing into efficiency often has a high rate of return, compensated by the energy savings that are gained over the long term. Most retrofitting of buildings can be done at little or no net cost, primarily with existing technology, offering significant benefits for consumers, businesses and industries.



Getting the Gears Turning

Definitions

Different or "split" incentives: relates to the idea that, depending on the type of lease, either tenants or landlords (but not necessarily both) benefit from energy efficiency. For example, if a tenant signs a lease, a landlord has no incentive to make the space more energy-efficient because the tenant reaps all the rewards. Alternatively, if the landlord leases a space to a number of tenants, occupants have no incentive for upgrading the space because the landlord capitalises on the tenant's efficiency.

Market failures: describes when a market, left to its own devices, does not efficiently allocate resources.

Energy service companies (ESCOs): companies that serve as an intermediary between energy utilities and ratepayers, performing a broad range of functions including the design and promotion of energy-efficiency projects, installation of energy systems, performing energy audits, and conducting energy risk management.

Energy audits: a process of determining the energy consumption of a building or facility through inspection, survey and analysis of energy flows.

The first step in designing an appropriate framework for retrofitting buildings involves mobilising multiple stakeholders to identify the regulatory and financial barriers that stand in the way of promoting energy-efficiency. Working in consultation with sector stakeholders helps to properly define the targets of a retrofitting strategy, increasing the likelihood that the project will be effective over the long-run.

Potential barriers to energy-efficiency may involve:

- **Different or "split" incentives** between suppliers and consumers
- Lack of appropriate financing
- **Market failures** that discourage the introduction of energy-efficient measures
- Lack of public awareness about the issue
- Lack of technical capacity to carry out energy-efficiency initiatives
- Unavailability of energy-efficient technology and services

Potential stakeholders might include local policy makers, energy utility companies and regulators, **energy service companies (ESCOs)**, industry association representatives, financial organisations and investors, developers and contractors, equipment manufacturers, construction agencies, architects, business leaders, major commercial building owners, landlords and tenants, as well as community organisations, among other concerned groups.

During this time stakeholders may examine a range of issues related to existing building stock: building codes, as they apply to different market sectors (i.e., residential/commercial/industrial), size, age, composition of materials, occupancy levels and ownership status. Independent **energy audits** can be used during this time, which can support the development of building performance benchmarks and help to establish appropriate targets for future energy savings.

Of course, formulating a long-term framework for energy-efficiency requires setting realistic timelines for action, supported by effective monitoring and enforcement of policies. This might involve forming a specialised national agency or bureau, tasked with designing regulatory guidelines on efficient building performance. As discussed below, potential responsibilities of this statutory body might involve regularly amending building codes, scheduling ongoing energy audits, promoting the introduction of energy-efficient technology and practices, and organising public education and training seminars, among others.





Opening the Toolbox

Of all climate change mitigation measures, retrofitting projects have the greatest potential to reduce GHG emissions in the building and construction sector.

Accordingly, there exist a large number of interventions that can be used to enhance the efficiency of buildings. Policy makers can work to promote energy-efficiency in existing buildings, both by clearly specifying in building codes that retrofitting activities take place during any major renovation, or mandating that it happens at selected times, such as point of sale. These efforts can be supported through fiscal incentives, such as granting tax credits to property developers and construction companies that exceed minimal standards.

Several retrofitting strategies are outlined below. Note that the following guidelines are often most cost-effective when carried out at the same time.

Opening
the Toolbox



Definitions

Daylighting: the practice of using natural light to reduce or eliminate electric lighting in building interiors.

Clerestory windows: a type of window above ground level that provides daylight, usually located along the upper part of a wall.

Light tubes: a device positioned in roofs and used to distribute natural light to a specific interior area of a building

Light shelves: a horizontal shelf that is positioned onto the building or in windows to reflect or shield daylight.

Louvres: a window, blind or shutter that contains a series of narrow openings, framed by overlapping fins or slats, angled to control the amount of light and air entering a building.

Brise soleil: a horizontal canopy or structure that extends from the facade of a building and serves to prevent excessive sunlight from entering.

Compact fluorescent light (CFL): a type of fluorescent light bulb that uses about 25 percent of a conventional incandescent bulb, delivering the same amount of light and lasting up to 10 times longer.

Green public procurement: roughly defined as a policy of incorporating environmental and social considerations alongside conventional criteria of price and quality, into purchasing decisions.

Eco-labelling: a labelling system for products and services that indicates they are manufactured or conducted in a sustainable manner.

Solar water heaters: internal plumbing systems that absorb heat from the sun to meet the hot water needs of a building.

Grey water recycling systems: internal plumbing systems that recycle residential, commercial and industrial wastewater and reuse it for other purposes.

Urine diversion toilet: toilets unconnected to sewage systems or septic tanks, used to promote water conservation by redirecting urine into the soil.

Opening the Toolbox



A retrofitting project might include any combination of the following measures:

- **Weatherising buildings:** Improving the insulation in buildings is a relatively simple procedure that can reduce energy losses in older buildings anywhere from 20 to 50 percent. Attention should be given to sealing air leaks around windows, doors, walls, roofs and other areas, as well as preventing against water leakage.
- **Coupling high-performance windows with solar shading techniques:** Depending on the climate, glazed windows should be selected to strike a balance between reflecting natural light (also known as daylighting), managing the intake of heat, and allowing for proper ventilation in buildings. Installing **clerestory windows**, skylights and **light tubes** in addition to strategically-located shading devices, such as **light shelves**, **louvres**, and **brise soleil** are several key options. Planting native trees around buildings provides shade and protection from wind, and helps to facilitate the natural drainage of wastewater.
- **Installing energy-efficient lighting and appliances:** The potential gains from making use of energy-efficient lighting in buildings are enormous; it is estimated that 400 million tonnes of carbon-dioxide emissions could be saved by 2030 alone from a global move to replace one in five light bulbs. In addition to improving **daylighting** in a building, switching to **compact fluorescent lights (CFLs)** from incandescent bulbs represents a huge energy saver, particularly in non-residential buildings. In this regard, retrofitting can be an important driver for **green public procurement:** introducing efficiency standards and **eco-labelled** goods, namely appliances and equipment, into different building sectors. For instance, in industries, improved energy-efficiency might take the form of installing high-performance motors, boilers, transformers and turbines. Other retrofits might include integrating low-flow faucets and showerheads into residential or commercial buildings, installing **rainwater harvesting**, **solar water heaters** and **grey water recycling systems**, and promoting the use of dual-flow, **urine diversion** and/or vacuum toilets.



Definitions

Energy-recovery ventilation: refers to the process of exchanging the energy contained in space air that is exhausted from buildings and using it to treat the incoming air which is ventilated from the outside.

Trigeneration: the simultaneous generation of mechanical power, heat and cooling from a single source, involving making use of the "waste heat" byproduct that results from this generation.

Active solar collector: a device used to harness the thermal energy of the sun so that it can be stored utilised in buildings.

Solar air conditioning: refers to any type of air conditioning system that operates from the use of solar energy.

Opening
the Toolbox



- **Improving ventilation and heat/cold recovery systems:** The largest percentage of energy used in buildings often powers heating, ventilation and air-conditioning (HVAC) systems. HVAC systems should be monitored on a regular basis to ensure they are functioning smoothly. Techniques such as **energy-recovery ventilation** and **trigeneration** can be utilised to recycle the waste air and heat that are produced by buildings to improve their overall efficiency. Installing **active solar collectors** in buildings- such as those equipped to drive **solar air conditioning**- is another, more advanced option.
- **Integrating renewable energy systems:** PV panels and small-scale wind power, for example, are two renewable energy systems that are becoming increasingly available for on-site residential and commercial use. The cost of installing these systems can be largely offset by the savings generated through energy-efficiency measures.
- **Modifying structures to make them more resistant to climate/environmental change:** This includes measures such as building small flood levies, reinforcing or elevating buildings so that they are more capable of withstanding floods, high winds, earthquakes, etc.



Recruiting for Green Jobs

A successful retrofitting project can be used to engage local businesses, encourage entrepreneurship and promote economic development. Policy makers can work to ensure such a project supports the local economy by maintaining that materials and labour are, to the greatest extent possible, sourced from the community.

Potential building and construction jobs created by a retrofitting project might include:

- General construction workers
- Engineers
- Designers
- Energy auditors
- Estimators
- Electricians
- Plumbers

Definitions

Green Jobs: any job that contributes to preserving or restoring environmental quality

Employment outcomes can be further reinforced by establishing national vocational training and certification centres, aimed at recruiting workers and strengthening their skills both for retrofitting and other types of **green jobs**.





Definitions

Energy-demand management: refers to a number of measures used to promote the more efficient use of energy among consumers.

Broad-based energy taxes: please see Glossary

Demand response: a type of programme that encourages electricity customers to reduce their consumption at critical times to allow for greater conservation of energy.

Power purchasing agreement: refers to a legal contract between electricity utilities and site owners, usually residents or businesses, involving the purchase of renewable energy or capacity provided that the utility provider assumes the risk and responsibility of operating and maintaining the renewable energy system over the course of the contract.

Steering towards Sustainability

Despite clear environmental, social and economic rewards, improvements in efficiency underline a troubling phenomenon- namely, that the economic gains brought on by advances in efficiency may actually lead to a faster consumption of resources, also known as the rebound effect. For this reason, policy makers should aim to implement **energy-demand management** programmes in conjunction with any large-scale retrofitting project.

Systematically checking and reporting on energy usage through ongoing metering practices, as well as providing regular maintenance to appliances and equipment, are two common examples of energy-demand management strategies. Likewise, **broad-based energy taxes** can provide an effective signal in which to moderate energy consumption. **Demand response** initiatives offer financial incentives to encourage **energy conservation** practices among those connected to the electrical grid. Similar arrangements can be extended to renewable energy technologies, such as offering consumer rebates to those who install onsite systems and encouraging utilities to develop **power purchasing agreements**.

Delivering Change

Imposing national energy performance standards on existing buildings can provide a strong signal for energy and emissions reductions in the building sector. In addition to the measures mentioned above, policy makers should work towards updating, enforcing, and monitoring building codes, placing emphasis on energy-efficiency for existing buildings in these requirements.

Regularly updating building codes and standards, and making use of rating systems and certification programmes (such as those supported by the World Green Building Council) tied to appropriate economic incentives can help to provide support for national legislation on energy-efficiency, raise public awareness about its benefits, and spur competition and innovation in the building sector. Stakeholders can collaborate on developing public information and education campaigns around these programmes, aimed at influencing property developers and landlords to incorporate energy-efficient technology and designs into their buildings. Showcasing successfully retrofitted demonstration sites might be one example of such a campaign.



Case Study: South Africa's Kuyasa Clean Development Mechanism Pilot Project

Established in 2005, the Kuyasa Clean Development Mechanism (CDM) Pilot Project involved the retrofitting of solar water heaters, insulation, and energy efficient lighting in over 2,300 low-income households in Khayelitsha, Cape Town, South Africa. The resulting energy savings are estimated to reduce greenhouse gas emissions by roughly 2.85 tonnes per household/ per year.

The project has had an immediate impact on the social, health and economic well-being of residents.

Benefits include:

- Economic savings of approximately 100 USD per household/per year
- Health benefits from reduced reliance on combustible fuel sources
- Employment creation from the local manufacture and installation of environmentally-sound technologies for low-income households
- Awareness-raising linking environmental consequences of energy consumption

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Definitions

Ecological restoration: using human intervention to renew a degraded, depleted or destroyed ecosystem and bring it back to health.

Payments for Ecological Services: a financial instrument that is negotiated between the public and private sector, used to allow the costs of environmental services to be reflected in the economy.

Ecological Restoration

Ecological restoration refers to a range of interventions aimed at rehabilitating degraded, damaged or destroyed ecosystems. There are multiple benefits of ecological restoration: in addition to improving habitat, such as those affected by contamination, pollution or natural disaster, it also can serve to beautify the natural and human environment. More directly, ecological restoration can be used as a means to lessen and buffer against the impacts of climate change. Many of these activities are often very labour-intensive and therefore can serve as an important source of livelihoods for low-income and vulnerable communities. In particular, ecological restoration can offer valuable alternatives to the exploitation of natural resources.

Policy approaches such as **Payments for Ecological Services (PES)** can provide valuable opportunities for local stakeholders to work in partnership with indigenous communities towards the promotion of ecological restoration.



Definitions

Reforestation: the process of replanting, with native tree stock, existing forests and woodlands which have been depleted or converted to some other use.

Afforestation: the process of seeding or planting a forest on land that is not a forest, or has not been a forest for a long time.

Compost: a mixture of decaying vegetation and wastes that is used to enrich soil.

Biochar: charcoal derived from plant matter, usually agricultural waste, which can be used to nutritionally supplement soil while at the same time addressing climate change by capturing CO₂ emissions.

Sustainable agriculture: a socially just, humane, economically viable, and environmentally sound system of farming that works to minimise damage to soil, water sources, species habitat and biodiversity through environmentally-friendly practices.

Brownfield: abandoned, underused or idle industrial and commercial facilities available sometimes characterised by environmental degradation and contamination; distinguishable from "greenfields", or undeveloped land found outside of urban areas.

Green belt: a strategy of designating undeveloped or agricultural land surrounding or neighbouring urban areas for protection, sometimes as recreational parks, in order to define and restrict the growth of a city.

Bioremediation: treating waste or pollutants in water, soil and air through the use of living organisms.

Constructed wetlands: an engineered marsh or swamp, used to treat wastewater, stormwater runoff or sewage treatment, that also serves as habitat for wildlife.

Soil aquifer treatment: the process of purifying water by percolating it through soil into an underground aquifer.

The following list outlines a number of common ecological restoration strategies:

- Waste collection in environmental cleanups
- **Reforestation** of watersheds
- **Afforesting** with native plants in environmentally appropriate areas
- Adding **compost** and **biochar** in certain amounts to depleted soil, as in **sustainable agriculture**
- Promoting the organic control of weeds and other invasive species
- Restoring urban **brownfield** sites into recreational areas, such as **green belts**
- **Bioremediation** of contaminated sites, such as through the use of restorers or **constructed wetlands**
- Recharging aquifers with wastewater, such as through **soil aquifer treatment**

Case Study: the Ecological Restoration of Chilka Lake, India

The Chilka Lake, located in the east coast of state of Orissa, India is the largest lagoon and salt water lake in Asia. Unsustainable agriculture practices had contributed to soil erosion around the lake, pollution and the rise of invasive species, negatively affecting the livelihoods of the many communities that derived their income from its resources.

Following a integrated, participatory approach, the local government collaborated with local stakeholders to restore Chilka Lake. Several interventions were implemented simultaneously, including reforesting the areas around the lake, establishing a wildlife sanctuary for native birds, and managing weeds with community participation (subsequently used for biogas feedstock). In addition to the improvement of water levels, agricultural productivity rose, fish stocks increased, and invasive species declined, bringing both social and economic benefits to the villagers in the area. The restoration of Chilka Lake is testimony to how participatory management of environmental resources can be used to great effect.

Review Questions:

1. In what ways might the construction of green buildings better meet the needs of your country's population? Which groups have the most to gain from the development of these systems? How? Please be specific.
2. Does your country currently have building codes in place? Are they enforced? How might they be developed to better emphasise eco-efficiency?
3. How might national policy makers work more closely with local officials to develop vocational training centres for jobs in eco-efficient construction? What other institutions or organizations might be involved in this process?
4. Does the building and construction sector in your country currently incorporate C&D debris? If not, which building materials in your country might have the highest potential for recycling?
5. Are there any environmental areas in your country that hold opportunities for ecological restoration?



Sustainable Master Planning

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Module 2

Sustainable Transportation and Mobility



Objectives of the Module:
To familiarise participants with ways to design environmentally-efficient, people-centred transportation systems towards enhancing the health, safety and mobility of urban populations.

►► Transportation is a key driver for economic growth; however, poorly planned or mismanaged transportation systems can undermine the potential for long-term gains by locking countries into unsustainable development patterns. In Asia and the Pacific, ineffective land-use planning and pricing measures have accelerated the expansion of cities, promoting urban sprawl and motorisation at the expense of the natural environment.

Rapid urbanisation is increasing traffic congestion and impacting air quality, leading to a greater frequency of vehicular accidents and health-related disorders. At the same time, high vehicle emissions- attributed to the widespread use of inefficient fuel technologies and practices- are taking their toll on the ecology of the region, depleting natural resources and further contributing to climate change. Beyond these factors, energy demand for transport in Asia and the Pacific is likely to increase by four to five percent until the year 2020.

Given its high urban population density, it is not feasible for Asia's major metropolitan areas to continue developing transportation systems based around the personal automobile. Yet, private motor vehicle ownership in the region continues to outpace development of transportation infrastructure.

Sustainable transport and mobility describes transportation systems designed to minimise the use of carbon-intensive fuels, lowering greenhouse gases and pollution with the aim of providing safe, affordable options for delivering goods and moving people. Policies can support sustainable transport and mobility by working towards more efficient land use, promoting the use of public transit, designing urban areas which encourage pedestrian-friendly modes of transportation, and effectively managing transportation demand. ◀◀





This Module
is arranged
into three Subsections:

- Effective Urban Land Use Transit Planning
- Transportation Demand Side Management
- Promoting Alternative Modes of Transportation

Key concepts
and issues
to be addressed
include :

- Transit-oriented development
- Smart growth policies
- Traffic management
- Shared Space

Effective Urban Land Use Transit Planning

An important precursor to the development of a sustainable transportation and mobility system involves ensuring that policies on land use are well-integrated, following what is often referred to as the 3 "D's" :



Retaining **Density**
Maintaining **Diversity**
Promoting Sustainable **Design**

Urban land use policies oriented around the 3-D's can work to facilitate **transit-oriented development**: tightly compacted urban environments that encourage pedestrian-friendly forms of mobility, including walking and bicycling, in areas organised around public transportation systems.





Density

3

1

Urban Density : Quantity Matters

Urban density is calculated as the percentage of a population occupying a given urbanised area, or the number of individuals concentrated in a specific urban location at a particular point in time. Densely populated cities, with closely condensed arrangements of residences, jobs and services, are generally more accessible by walking and other forms of **non-motorised transport** than urban environments spread across a wide area. Cities with high urban densities also provide an opportunity to develop public transportation services that can draw on large numbers of potential customers.

Cities across the Asia-Pacific are characterised as having very high densities. However, due to the limited amount of physical road space available per person, effective urban planning has proven to be a challenge for cities that have pursued **motorisation** in place of public transportation. **Figure 1** illustrates the clear and growing demand for private automobiles across the region which has occurred over the last two decades. The

rise of private automobile ownership (and to a lesser degree, motorcycle ownership) has led traffic congestion to spiral out of control in many tightly compacted Asian cities. High traffic volumes have resulted in air, noise and water pollution, created health and safety risks, and have shown to take a negative toll on economic competitiveness.

In their attempts to respond to these pressures, many Asian cities have heavily invested in expanding their road infrastructure. These measures have largely been unsuccessful: given the low amount of space allotted per person, any increase of road capacity in areas of high urban density is simply unable to accommodate a corresponding rise in automobiles. For traffic-saturated cities, expanding roads is a short-term solution with long-term negative consequences. As new roads are constructed to relieve congestion in densely populated areas, the landscape gradually becomes more dispersed, automobile dependence intensifies, vehicle traffic continues and **urban sprawl** becomes commonplace.

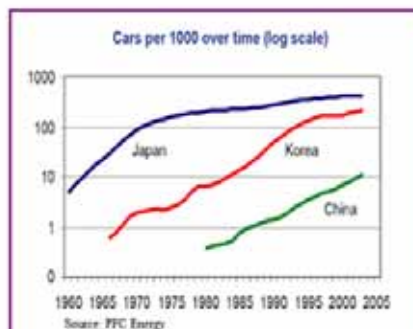


Figure 1

Definitions

Non-motorised transport: includes all human-powered forms of transportation, including walking, bicycling and the use of wheelchairs.

Motorisation: refers to the process of developing transportation systems to accommodate the use of automobiles.

Urban sprawl: poorly-planned or unplanned expansion of urban space into areas located on the periphery of a city; typified by an inefficient use of land resources and caused when land consumption disproportionately exceeds urban density.



Land Use Mix: Diversity is Better

Because of their high density, it is no surprise that residential and commercial districts in many large Asian cities are found very close to each other. On the one hand, this is advantageous: it allows for a greater use of walking and cycling, improving urban mobility. Yet, as noted above, an increasing reliance on private motor vehicles in the region has given way to more scattered patterns of development, rendering non-motorised transport in many areas all but impossible. For this reason, maximising urban **land use mix**- ensuring that homes, businesses, and other centres of community activity are in the same vicinity- is another important component of a sustainable transport and mobility strategy.

Diverse land use mixes can assist in stemming urban sprawl. Because land use mixes ensure shorter **vehicle kilometres travelled (VKT)** between destinations, they can increase the likelihood that non-motorised and public transport will be used over private vehicle travel. Lowered VKT is therefore a key factor in supporting **green business** practices by limiting the amount of greenhouse gas emissions required in the production, manufacture and delivery of goods and services. In coordination with other **transportation demand management (TDM)** measures, cities emphasising compact development can reduce traffic volumes, improve air quality, and enhance local business opportunities by promoting accessible, pedestrian-friendly urban environments.

In identifying central areas of urban activity, policy makers, along with traffic engineers, land use and transport planners, can develop an index of the **jobs-to-housing** balance that exists in different locations throughout the city. Zones that are recognized as having intense land use mixes, with high levels of housing and employment, can be slated as future public transportation nodes. **Value capture** has shown to be particularly effective in increasing incentives for private development in areas surrounding transit services.

Definitions

Land use mix: degree by which residential, commercial and institutional uses of land are located in the same area.

Vehicle kilometres travelled (VKT): a distance measure, in kilometres, of vehicle operations across a given geographical area.

Green business: defined as business practices that observe market trends and demands for ecological sustainability and considers environmental protection a fundamental part of its growth strategy.

Transportation demand management (TDM): the application of strategies and/or policies that improve the efficiency of transportation systems by reducing automobile travel demand

Jobs-to-housing balance: relates to the distribution of employment relative to workers in a given location, calculated by dividing the number of jobs in an area by the number of available housing units.

Value capture: public financing mechanism whereby increases in private land values generated by public investments in infrastructure are all or in part secured through taxes on land in order to cover investment costs and/or other public projects.



Design

3

Sustainable Design is Smart Design

As we have seen, because land use and transportation decisions are intertwined in a number of ways, challenges and obstacles can often be quickly magnified. Asian cities that address problems of traffic with more roads may give rise to settlement patterns that reinforce dependence on private motor vehicles. The resulting noise, pollution and congestion from automobiles can be a major disruption for communities.

Fortunately, the opposite also holds true for urban design strategies that support sustainable transport and mobility: by encouraging a reduction in automobile use, cities can promote a more sustainable use of land and habitat.

One way policy makers can achieve this is by establishing **urban growth boundaries**. Urban growth boundaries designate fixed areas for urban use, preserving the land which falls outside their periphery from sprawl, often supported by the demarcation of **green belts**. In conjunction with TDM, such as improved access to **alternative modes of transportation**, urban growth boundaries can encourage high density development to better support the integration of transit-oriented policies.

Road networks can be better designed to enhance the mobility of urban populations. Interconnected urban grid patterns defined by short, straight streets with multiple intersections, allow for more route choices than branching, disconnected road networks. Plotting frequent junctions between streets, grid plans disperse motor vehicle traffic, expanding access for pedestrian activities and affording more space for public transit.

Definitions

Urban growth boundaries: a growth management tool that encourages a more efficient use of land by mapping borders around a city, separating it from surrounding areas with the aim of promoting more compact urban development.

Green belt: a strategy of designating undeveloped or agricultural land surrounding or neighbouring urban areas for protection, sometimes as recreational parks, in order to define and restrict the growth of a city.

Alternative modes of transportation: refers to types of transport that can be used in place of private automobiles, including but not limited to rapid bus transit and rail.

Sustainable Design
is Smart Design





3

Sustainable Design
is Smart Design



Definitions

Traffic management/traffic calming: the practice of using physical structures on roads to deliberately reduce vehicle speeds and traffic, thereby improving street safety.

Urban heat island effect: a metropolitan area that is significantly warmer than its surrounding rural areas as a result of urban land surface coverage that has limited amounts of vegetation.

Car-free: refers to zones that prohibit automobile traffic to facilitate greater transit and mobility.

Critter crossings: passageways that allow wildlife to avoid motor vehicle traffic in areas where roads crosscut natural habitat.

Shared space: a concept involving the removal of conventional separations between motor vehicles, pedestrians and other road users by eliminating traditional road management devices and signals such as curbs, lines, and signs, under the reasoning that road users will be influenced to share areas with consideration for the other users of the space, thus improving road safety.

Living streets: a street where the needs of car drivers are secondary to the needs of users of the street as a whole.

Smart growth policies: planned development policies that promote complementary land uses and support a variety of transportation choices, with the greater aim of diverting construction from environmentally-sensitive areas and protecting open space.

Studies have shown that pedestrian-friendly, transit-oriented environments encourage less aggressive driving, lowering the rate of vehicular accidents. At the street level, **traffic management techniques**, also known as **traffic calming**, offer ways to slow motor vehicle traffic and improve the safety for pedestrians and cyclists. Changing the surface materials of streets, such as into brick, restricting and/or narrowing road lanes, and adding speed bumps/humps/tables/cushions are several examples of traffic calming measures that have been used to lower traffic volumes. Public transportation systems designed along grass lined railways is an example of urban design that works to reduce pollution while lessening the **urban heat island effect**.

Other techniques, such as establishing **car-free** zones, planting trees along roadways, expanding curbs and sidewalks, and providing pedestrian crossings and bicycle lanes can also effectively support the movement of pedestrians and cyclists. Similarly, designating **critter crossings** along roads helps to protect wildlife by linking natural habitat. Areas with very concentrated land use mixes can work towards the development of a **shared space** between motorists and other road users. For small, tightly-compacted areas, adopting a **living streets** model might be more appropriate.

Taken together, the 3-D's demonstrate how **smart growth policies** can be used to reduce automobile dependence and promote a wider range of travel choice in urban areas. Multi-sectoral cooperation should be pursued at all levels to ensure that decision making on transportation supports environmental, economic and health objectives.





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Promoting Alternative Modes of Transportation

Along with other TDM strategies, efforts can be made to enhance transport choices, increase the affordability of services, and improve the efficiency of alternative modes of transportation. Alternatives to private automobiles range from individual, non-motorized forms of travel to public transportation systems geared towards moving large numbers of passengers, such as **light rail transit (LRT)**, and **bus rapid transit (BRT)**.

Definitions

Light rail transit (LRT): a high capacity, high frequency form of urban rail public transportation that operates on electric power.

Bus rapid transit (BRT): a broad term given to mass transit systems that, through improvements to infrastructure such as upgraded vehicles and scheduling, convenient fare collection systems, and dedicated rights-of-way, attempt to use buses to provide higher-quality services than conventional bus lines.

Regressive: a tax is considered regressive if it levies a proportionately larger amount from lower income individuals and households.

Although personal automobiles are often viewed as a trademark of economic progress, transportation studies suggest the contrary: not only have most developed Asian countries experienced their highest rates of economic growth during periods of minimal automobile ownership, evidence has shown that excessive automobile use tends to constrain sustained economic development. Global greenhouse gas emissions from transport are the fastest growing among all economic sectors, with road transport comprising the bulk (74 percent). Measures to promote alternative modes of transportation are therefore a driver for Green Growth, opening opportunities for jobs in the design, construction and operation of low-carbon transit systems while reversing the **regressive** effects transportation policies typically have on the poor.



► Transportation

Improvements are Everyone's Business

Definitions

Transit-oriented development: refers to compact communities that are designed to maximise mobility and transit, involving reductions in automobile use.

Streetcar: a wheeled vehicle, operating on rails and running on electricity, designed to transport passengers on streets with mixed traffic, both within and between towns, villages and cities.

Personal rapid transit (PRT): a mode of public transportation comprised of small, independent vehicles that operate on a network of specially-built guideways.

Transportation Management Associations: non-profit, member-controlled organisations established to provide more effective transportation services in a particular area.

Vehicle sharing: refers to a range of mobility practices that promote a more shared use of automobiles.

Carsharing: a model of cooperative automobile rental where people rent cars for short periods of time, involving shared costs between multiple motorists.

Ridesharing: a shared use of a motorised vehicle by a driver and one or more passengers, usually for commuting.

Shuttle services: scheduled transportation services that use small buses or vans to enhance public mobility, usually in areas where mass transit is not available.

Paratransit: an alternative mode of flexible passenger transportation, distinct from conventional transit, that provides on-demand services, usually in areas where mass transit is not available.

Green business: defined as business practices that observe market trends and demands for ecological sustainability and considers environmental protection a fundamental part of its growth strategy.

Commute trip reduction programmes: refers to transportation programmes, usually implemented by employers, which provide incentives for individuals to reduce their use of automobiles.

Improving public transportation infrastructure has numerous benefits: in addition to providing valuable opportunities for workforce training and job creation, mass transit has the potential to lead significant savings in public expenditures by reducing overall health and transport costs.

Because low-income households are often most dependent on public modes of transportation for their mobility, they have much to gain from investments in transit systems. However, many of these individuals also make their income as transportation service providers, such as taxi, motorcycle, and rickshaw drivers- often in the informal economy- who stand to be negatively impacted by employment shifts towards public transit. Policy makers can work to ensure that public transit serves as an employment pathway for persons already engaged in the transport sector.

Mass Transit: ◀ the Less Wheels, the Better!

Investments in transportation infrastructure are essential to ensure that public mobility is made affordable, efficient, convenient and comfortable: key components of **transit-oriented development**. An effective transit system integrates various transit modes, providing clean, safe and reliable transport options to improve the overall accessibility of the urban environment. For example, linking LRT and BRT along major commuting corridors can increase ridership in areas where residents routinely travel by automobile. Likewise, electric **streetcars** and **personal rapid transit (PRT)** systems that connect neighbourhoods to different activity centres can encourage reductions in vehicle traffic while influencing more people to walk or bicycle.

Of course, much of this depends on the site itself-an area's unique geography, population and degree of land use mix will determine the size and potential level of service delivered by public transit. Yet, regardless of where a town or city is located, coordinated measures can be taken to improve the quality, and the environmental performance, of public transit. Policy makers and transport planners, together with **Transportation Management Associations**, may collaborate on lowering fares, expanding routes and transfers and increasing the frequency of services to attract more users. Transport facilities can be upgraded in a number of ways: redesigning vehicles to make them more comfortable, providing enclosed shelters with accessible washrooms and seats at terminal stops and stations, and ensuring scheduling information is well displayed. Combustible vehicle engines can be retooled to operate more efficiently, or reengineered altogether to operate on clean fuel.

Whenever possible, **vehicle sharing** programmes such as **carsharing**, **ridesharing**, **shuttle services** and **paratransit** should be coordinated with mass transit to extend services to areas where public transportation is not readily available. **Green businesses** can have an important role in this regard by supporting **commute trip reduction programmes** that offer employee incentives for the use of alternative modes.



► People-Powered Transportation

Non-motorised transportation improvements are also an important option that should not be overlooked. Public transit systems can better accommodate the use of bicycles, for example, by incorporating ramps at stations and bicycle racks on buses and trains, as well as designating pedestrian crossings and bicycle parking areas around transit stops. **Community bicycle programmes** can assist in reducing congestion while offering a healthy, cost-effective way to promote mobility.

Definitions

Non-motorised transport: includes all human-powered forms of transportation, including walking, bicycling and the use of wheelchairs.

Community bicycle programmes: a bicycle hire programme, implemented at the local or city level, that aims to reduce automobile use through the provision of publicly owned bicycles, either free of charge or on a rental basis.

Smart growth policies: planned development policies that promote complementary land uses and support a variety of transportation choices, with the greater aim of diverting construction from environmentally-sensitive areas and protecting open space.

Parking management strategies: refers to any number of strategies aimed at making more efficient use of parking supply, including but not limited to increasing regulations on parking eligibility, parking duration, raising fees, and/or improving parking pricing methods.

Road Safety Begins ◀ with Changing Road Space

Designing communities in accordance with **smart growth policies** helps to ensure that transit and land use planning have mutually-supporting goals. For example, enforcing that pedestrian crossings and wide-outside lanes are respected by motorists fosters wider public acceptability for alternative modes of transport. Allocating road space to extend priority to high-occupancy vehicles, such as by setting traffic lanes on a gradient and establishing toll lanes, can assist in deterring traffic congestion and delays to public transit. Similarly, by emphasising more clustered land-use, **parking management strategies** can improve access and mobility for pedestrians in highly motorised areas.





Case Studies:

Ramsgate Train Station in Kent, England is a busy transport hub with direct connections to London. In the past, transport modes around the station were not well integrated. Located some distance outside town, travelling to and from the station was mainly conducted by bus or taxi, and changing modes proved inconvenient and costly. A public-private partnership formed between local officials and train and station operators worked to enhance the overall accessibility of the station. Bus stops were upgraded, pedestrian crossings and bicycle paths were designated and parking areas were renovated with a view to connect different transport modes, bringing benefits to pedestrians, cyclists, transit passengers and motorists.

With the expressed aim of increasing the connectivity of alternative modes of transport in the greater city area, while discouraging the use of private automobiles, the City of Lyon, France, instituted a comprehensive sustainable mobility action plan. In addition to developing a public transit system that now offers a broad range of transportation options, including metro trains, streetcars and buses, a community wide bicycle rental programme has been instituted.

In Bogota, Columbia a series of coordinated transportation measures has successfully improved transit and mobility. An extensive network of bicycle lanes has been constructed, connecting residential, employment, and other urban centres to areas outside the city. Since the lanes have been designated, bicycle use has increased exponentially. In combination with improved parking measures, vehicle restrictions during peak hours, as well as car-free regulations have helped to make Bogota more accessible by non-motorised transport. Lastly, an affordable and rapid bus transit system, supported by legally enforced bus-lanes, has made the city a prime example of how sustainable transport and mobility can be implemented to great effect.

Review Questions:

1. What does it mean to have well-integrated transportation policies and why is it important?
2. What transportation challenges does your particular country face and how might transportation demand management strategies be effective in addressing them?
3. What are Transportation Management Associations? Which groups might be involved?
4. Given your country's particular circumstances, what alternative modes of transportation might be most effective in reducing the number of private vehicles on the road? What measures might be taken to facilitate this?
5. What are some of the benefits of promoting sustainable transport and mobility, and which employment sectors stand to be most impacted in your home country?





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Notes:



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