Guidelines for Sustainable Cities and Communities in China

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Job No: DTI/2207/PA

Acknowledgements

This document was developed by the the United Nations Environment Programme (UN Environment) in collaboration and with the support and funding from SUC Institute (Beijing) Programme Management Center Co. Ltd

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UN Environment would also like to acknowledge the Cooperative Research Centre (CRC) for Low Carbon Living (Australia) for providßing crucial technical support for the preparation of this document.

This publication follows approaches and principles of the Global Initiative for Resource Efficient Cities (GI-REC) and the Sustainable Buildings and Climate Initiative

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Acronyms

ARI	Average Recurrence Interval
CGEC	Chinese Green Eco-city Code
CO2	Carbon Dioxide
CRC LCL	Cooperative Research Centre for Low Carbon Living
E/W	East and West
EV	Electrical Vehicle
EU DG MOVE	European Union Directorate-General for Mobility and Transport
GB	Guobiao Standards
GBES	Green Building Evaluation Standard, China
GDP	Gross Domestic Product
GI-REC	Global Initiative for Resource Efficient Cities
HVAC	Heating, Ventilating, and Air Conditioning
öICT	Information and Communications Technology
IFT	Implementation Framework and Toolkit
JCIM	JiaCui Investment Management Co. Ltd
KPI	Key Performance Indicator
kWh	Kilowatt-hour
LED	Light-Emitting Diode
NGCS	National Garden City Standards, China
NDVI	Normalized Difference Vegetation Index
NLA	Net Lettable Area
NMT	Non-motorized transport
NOx	Nitrogen Oxide
PM	Particle Matter
PMV	Predicted Mean Vote
SBCI	Sustainable Buildings and Climate Initiative
SDG 11	UN's Sustainable Development Goal 11
SDGP	Sustainable Development Guiding Principles
SO2	Sulphur Dioxide
SUC	Sustainable Urban Development and Liveable Garden Community China Programme
TVOC	Total Volatile Organic Compounds
UN CPI	UN's City Prosperity Index
UNEP	United Nations Environment Programme
VOC	Volatile organic compounds
WC	Water Closet
WSUD	Water Sensitive Urban Design

Introduction

Terms of Reference

This "Key Principles and Actions for Sustainable Cities and Communities" (hereafter referred as SUC KPAs), produced in accordance with goals of SUC, will be mainly applied to developing countries. In its early phase, the aim is to support the promotion and implementation of sustainable development of cities and communities in China.

SUC KPAs consist of three sections - Evaluation Criteria, Management Process and Key Action Points". The SUC KPAs are applicable to both existing built cities and communities in particular to new urban areas and new communities in the future. All the technologies, strategies and projects proposed in the entire SUC KPAs document should meet the national standards of China.

Evaluation Criteria

The first phase of the SUC KPAs identify and describe the key sustainability goals and evaluation criteria that drive sustainable development and delivers Key Principles for Sustainable Cities and Sustainable Communities based on a thorough review of Chinese and global best-practice sustainable development.

Management Process

The SUC Management Process (SUC MP) provides an operational structure for the implementation of urban sustainability by establishing key strategies. The five key strategies include:

- Step One: Understanding the Development Context
- Step Two: Goal Setting and Institutional Resourcing
- Step Three: Implementation Pathway
- Step Four: Monitoring Progress
- Step Five: Lessons and Knowledge Transfer

SUC Key Action Points

The SUC Key Action Points (SUC KAPs) provides concise technical objectives in order to achieve the identified Sustainable Cities and Sustainable Communities goals, addressing each key process in the urban development life-cycle, including: Resource Endowment Survey (Project Areas), Planning and Design, Product and Materials Selection, Building and Construction, Operation and Management and Future Strategic Planning, as well as outlining key performance assessment tools.

The SUC Key Action Points for Cities and Communities will outline the key technologies and strategies to achieve the sustainable development goals within different sectors and will provide practical guidance for built environment professionals and governments seeking to optimise development projects to achieve sustainable cities and communities across China.

Objectives

More than half of the world's human population currently lives in cities and is expected to be increased to three-fourths by 2050 (United Nations 2014). China alone is predicted to add more than 300 million urban inhabitants in the next three decades (United Nations 2014). This burgeoning urban population growth presents enormous developmental and environmental challenges that need to be addressed by a robust sustainable development framework. Making cities and communities sustainable is essential to achieve sustainable human futures and the Goal 11 of the Sustainable Development Goals (SDGs). This document provides a holistic and integrated sustainable development framework for the development of liveable, economically productive, socially inclusive and environmentally sustainable cities and communities in China. The framework identifies key objectives and principles to achieve urban sustainability and provides specific guidelines for implementation and performance assessment. This framework, which consists of sustainability goals, management process and key action points, will directly assist Chinese cities and Governments in achieving the highest international standards in sustainable cities and communities.

Performance Standards for Sustainable Development

There are significant opportunities for the future of Chinese urban development to lead and advocate the promotion of global sustainability. This document is informed by the Framework of the UN Environment-led Global Initiative for Resource Efficient Cities on City Level Resource Efficiency. The UN's Sustainable Development Goal 11 and associated targets are employed as a framework to set goals and key principles for sustainable cities. Additionally, the UN's City Prosperity Index (CPI) and the International Organisation of Standardisation (ISO) Sustainable Development in Communities (ISO37120 and ISO 37101) are adopted as references. This document aims to set an international performance benchmark and tailor them to the Chinese context for the development of China's sustainable communities that can be measured and valued at a global scale.

Document Structure

This document focuses on the introduction of the SUC KPAs. It first describes the relevance of sustainability goals and performance indicators in the implementation of urban sustainability, followed by separate descriptions of essential sustainability goals and lists of key principles for Sustainable Cities and Sustainable Communities in China. The document then provides an extensive description on the "Management Process" and the "Key Action Points" through which the sustainability goals can be achieved and managed. Finally, the document ends with some concluding remarks and references.

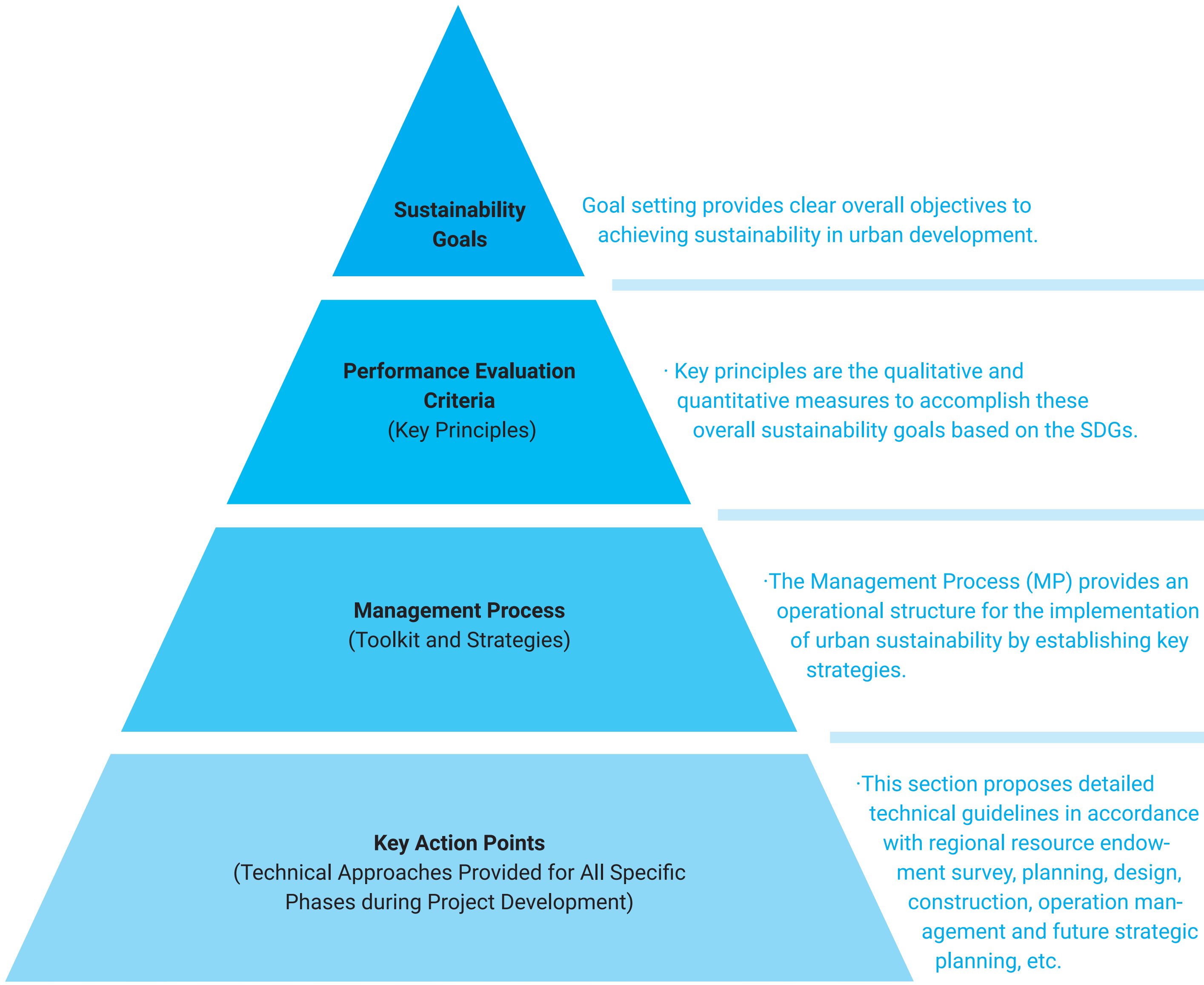


Figure 1: Illustration of document structure

Sustainability Goals and Performance Criteria

Sustainable cities generate economic activity, promote social interaction, facilitate knowledge and innovation sharing, enable communication via infrastructure networks and reduce ecological impacts through densification, low-carbon buildings, green space and efficient public transport (Revi and Rozenzweig 2013). To harness the potential of sustainable cities and to operationalize sustainability goals, this framework provides a comprehensive set of goals and measureable targets, combined into Key Principles. The principles a unique set for Sustainable Cities and Sustainable Communities – identify key areas and provide qualitative and quantitative performance criteria based on International and Chinese best-practices in sustainable urban development. The set of Key Principles presents high performance targets for sustainable cities and communities, which go beyond the baseline standards to promote best practices and high-performance sustainable development in China.

A Common Carbon Metric is considered for use in measuring and reporting on Greenhouse Gas Emissions (GHG) from cities and communities (see appendix). An 'Integrated Carbon Metrics (ICM)' tool, developed by the CRC for Low Carbon Living in Australia, is available for use in quantifying the carbon emissions for the various processes in the urban development.

Key Principles for Sustainable Cities and Communities in China

Sustainable Development Goals for Cities

- Make Cities and Human Settlements Affordable, Safe, Healthy, Resilient, Sustainable and Efficient

Sustainable Development Goals for Communities

- Make Liveable, Healthy, Proud, Safe, Productive, Inclusive, Self-reliant and Sustainable Communities

These Sustainable Development Goals are based on UN's Sustainable Development Goal 11 and associated targets as outlined in the Bangalore Outcome Document (United Nations 2015) and considered for a Chinese Context.

Safe and Affordable Cities

The growth of urban populations requires access to adequate, safe and affordable housing. This is achieved, among other things, through the improvement of living conditions in slums and informal settlements. (Refer to SDG11 Target 11.1)

Transportation and Accessibility

It is essential to provide access to safe, affordable, energy-efficient and accessible transport systems for all people and goods, improving road safety and expanding public and non-motorized transport, with attention to the needs of those in vulnerable situations. (Refer to SDG11 Target 11.2)

Land Use Efficiency

Sustainable urban development must address the relationships between land use and population growth, and promote land use efficiency covering economic, social and environmental benefits. The more equitable and efficient land use is achieved through participatory urban and regional planning and management. (Refer to SDG11 Target 11.3)

Healthy Environment

The reduction of the adverse impacts of city development is achieved through the preservation of biodiversity, the reduction and management of waste, and maintaining a high standard of air quality. (Refer to SDG11 Target 11.6)

Safe and Sustainable Green Open Spaces

Providing, maintaining and encouraging access to safe, inclusive public space encourages a diverse, healthy and sustainable city. Multipurpose public spaces for a diversity of users provide services and opportunities for marginalized inhabitants to establish healthy social cohesion. (Refer to SDG11 Target 11.7)

Resource Efficiency

Establishing a resource efficiency baseline provides the foundation for the development of sustainable cities. Energy efficient systems with the responsible use of renewable energy, water sensitive urban design (WSUD) with appropriate management and conservation, and food management and availability are all fundamental to sustainable city development. (Refer to GI-REC)

City Management and Policy

The preparation and implementation of a national urban and human settlements policy framework will facilitate economic growth, reduce poverty, improve the management of natural resources, and improve coordination within and between tiers of government. (Refer to SDG11 Target 11.a)

Increasing the number of cities implementing a wide-range community participation mechanism and integrated policies towards inclusion, resource efficiency, adaptation to climate change and resilience to disasters will form a cohesive national framework for future sustainable development. (Refer to SDG11 Target 11.b)
Supporting national, regional and local governments through financial and technical assistance in order to strengthen revenue streams, regulatory and institutional capacity. (Refer to SDG11 Target 11.c)

Sustainable Buildings

Sustainable or *Green* Building design involves careful consideration of the total life-cycle impacts of a building (and the building supply chain). This holistic approach includes reducing embodied energy and material transport, using non-polluting and non-toxic construction materials, limiting construction and operational waste, reducing operational energy and water demand through passive solar, ventilation, green envelope and water-saving design, aiming for zero-carbon energy supply and the adaptive re-use of existing building stock.

Inclusive Community Facilities and Service

Community Facilities and Service are essential factors to support the growth, security and diversity of a community for present and future generations. This involves a clear vision, formed by broad community participation, for any future infrastructure, services or facilities. Support for the elderly, young and women is established through strong standards of service and infrastructure that promote social equity, healthy and resilient communities.

Liveable Community Landscapes

Community landscaping provides ecosystems benefits, social connectivity and recreational opportunities. Accessible, safe, active recreation, walkability and social interaction enhance social cohesion and reduce the social and economic costs of non-communicable (lifestyle) diseases.

Economic Productivity

The generation of local employment opportunities and good transport networks to surrounding employment opportunities contribute to community sustainability. Local economic activity supports community and family cohesion by reducing commuting times and enabling community interaction. Inclusive local economic policy promotes youth employment and gender equity.

Safety

Safe and secure neighbourhoods are an essential component to achieving sustainable communities. A safe, attractive and enjoyable environment is achieved by reducing the community's vulnerability to crime and violence, providing emergence management and service, and solving food safety problems.

Proud and Educated Community

Education is fundamental to the promotion of liveable, healthy and sustainable communities. This involves providing services and infrastructure to support early learning, the education of girls and caregiver training, and sustainability awareness.

Community Management

Sustainable management of communities fosters smartness and resilience in communities and improves the contribution of communities to sustainable development outcomes. A sustainable management and performance assessment system is achieved through fulfilling the compliance obligations of ISO 37101:2016.

SUC Management Process

The SUC Management Process (SUC MP) provides an operational structure for the implementation of urban sustainability by establishing key strategies. The five key strategies include (figure 2):

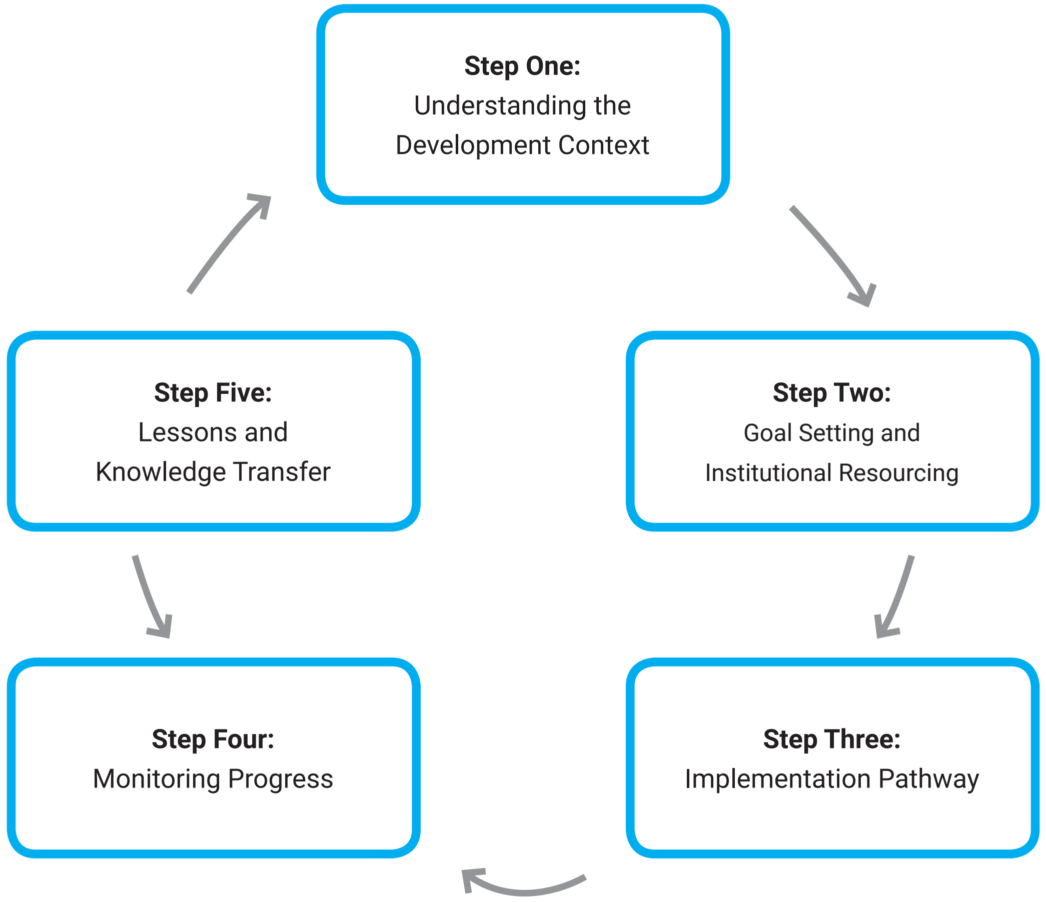


Figure 2: *Illustration of management process structure*

This process builds on global methodologies and strategies, which have been adapted to the Chinese context and which have the overaching goal of achieving more sustainable cities and communities. These provide a framework that can be used by cities and communities to facilitate an ongoing learning process that can support a better understanding local needs and progress towards sustainability goals.

Although cities and communities have some similarities and overlapping characteristics, there are also key differences that are important to their strategic management such as scale, stakeholders and priority areas. The steps are meant to be implemented in a sequential manner in order to achieve specific objectives that are in line with the local sustainability priorities.

SUC Management Process for Sustainable Cities and Communities

Step One: Understanding the Development Context

Objectives

- To understand the current baseline of key city and community sustainability indicators
- To understand the city's and the community's sustainability drivers, needs, opportunities and constraints

Description

This step aims to identify the key principles for sustainable cities and communities that can help regional/city government (provincial, prefectural or county) officials to better understand what the local sustainability opportunities and constraints are, and the main drivers and needs for their communities. At this stage, indicators are identified, processed and analyzed by city government officials and, when required, with the assistance of national government or global organizations. This strategy can draw from across the nine main categories identified in Key Performance Indicators (KPIs) for Sustainable Cities section. Although these indicators can be analyzed separately within each category, assessments across categories can also be carried out in order to understand synergies between different factors.

The regional/city government should designate a local institution responsible for the coordination of the data collection and processing. By measuring and monitoring these indicators on a regular basis, cities can actively manage their progress towards sustainability goals. Ongoing monitoring also allows government officials to identify areas of opportunity and strategy adjustments needed to address challenges as they arise based on a more current understanding of the city's context. The responsible institution could be either a government agency or a research/academic centre.

Stakeholders

The responsible organization appointed by the regional government would need to collaborate with national and local statistics organizations as well as other relevant data providers (may include local research institutions, survey providers, and others) to gather data on the key principles required in accordance with the guidelines provided.

Other stakeholders include current and future community residents and the neighboring residents. Local government officials should decide whether community planning, designing and managing public and private organizations as well as investors and developers should also be involved.

Step Two: Goal Setting and Institutional Resourcing

Objectives

- To identify priority areas for sustainability action to maximize outcomes and set target goals
- To assign responsibilities to stakeholders and ensure collaboration
- To identify governance and financing options for sustainability solutions

Description

This step is a key part of developing an effective sustainable city strategy because it provides a robust framework for decision-making based on local interest and stakeholder consultation. This can help create support for selected solutions and ensure that these are the most relevant and effective options for the city context. Each city has particular needs and opportunities, and thus priority areas, which will determine the approach taken to achieve this strategy's objectives.

Priority areas can be defined through:

- Guided workshops (or series of workshops) with the relevant stakeholders and decision-makers. These should be selected across a wide range of interest.
- Peer-to-peer learning programs. These could for example include knowledge and lessons learned exchange with other cities facing similar challenges to understand their experience thus far.
- Other stakeholder consultation options such as web-based consultation through interactive websites, internet surveys and forums, or sustainability/eco-charrettes (design charrettes). These are four to seven-day workshops that include stakeholders at critical decision-making points to collaboratively produce a plan for a sustainable community (Roggema, 2014).

Targets should then be assigned to each indicator within the selected priority areas for short, medium and long-term goals. This can be done within the same consultation framework. The definition of short and long-term may vary from one city to another but it is suggested: five years for short-term goals, ten years for medium-term and 30-50 years for long-term. Simple quantifiable goals are preferrable as they are easier to share across governance boundaries and can be integrated into planning cycles more easily. To set appropriate targets the group will require information about current baselines and good practices reference values for the indicators selected in Strategy One.

Having a representative cross-section of city stakeholders will promote an integrated holistic view of the issues at hand and potential solutions that may involve more than one sector or stakeholder group. Once targets have been assigned, a range of potential interventions to achieve the selected sustainability goals should be identified. Responsibilities should also be assigned to specific appointees to carry out further research about these possibilities. These should include representatives of multi-stakeholder groups. Alternatively, especial task groups could be identified to further investigate the selected solutions. The group should also discuss where and when this interventions could or should take place and what resource investment requirements they may entitle.

Financing options should also be discussed for each potential intervention in order to allow decision-makers to better evaluate the financial feasibility of each option. Access to finance, potential revenue streams (if applicable) and maintenance requirements should be considered. In addition to government sustainable development and infrastructure financing options, national and international funds such as the China Development Bank and the Asian Development Bank can provide financial support for this process, especially for clean energy options. Regional financial incentives offered by the central government such as those offered in 2011-15 for industrial facilities greening may be available as well as joint financial incentive schemes such as the energy service companies (ESCO) incentive program announce in 2010. Some initiatives may also be eligible for especial incentive programs such as the Chinese Strategic Emerging Industries fund and the Top 1000-Program. Financing through the Clean Development Mechanism and carbon trading schemes, if available could also be considered (Shen et al, 2013).

Stakeholders

Identifying the specific stakeholder groups that need to be engaged is an important step in this strategy. City government would need to develop a list of relevant stakeholder groups and analyze their interests and influence. Stakeholders can then be mapped on a quadrant chart where the axis are influence (low to high) and interest (low to high). Those rating high on both should be prioritized in the engagement process. The government would then convene a workshop (or series of workshops) with interest groups formed by city stakeholders organized according to priority groups. These interest groups could include commercial developers and local industry as well as researchers, NGOs and environmental groups.

UNEP and similar organizations could facilitate prioritization process and provide links to expert consultants as well as advice related to representation of interest groups and international financing options.

Step Three: Implementation Pathway

Objectives

- Expose city government to wide range of options to improve sustainability of the city and local communities, particularly around those that have been successful in other cities with similar contexts
- Identify most potentially effective solutions to increase the sustainability of the city
- Provide supporting data and information that quantify the potential impact of the identified interventions

Description

This step involves exposing city government decision-makers to the intervention options for each target and their financing alternatives. This process aims to assist government officials to make well-informed decisions when selecting the most suitable and effective intervention to achieve the targets. Strategy three is heavily based on data modelling and scenario analysis through sustainable city modelling tools across priority areas, economic modelling tools and financing options analysis tools.

Quantitative computer models that include both sustainability and economic factors can be used to identify the most benefitial option. This process can be further facilitated by compiling a database of case studies and other empirical data that can be incorporated into the modelling effort. In addition to specialized models that can be applied by academic research and consulting organizations, sustainability rating tools could be used to compare different alternatives.

Tools

There are a range of tools available to support the collection and review of city sustainability indicators. Examples of rating systems for cities include Japan's Comprenhensive Assessment System for Built Environment Efficiency (CASBEE) for Cities, Urban Development, and for Building and for Home. Standards are also useful as decision-making support tools. Examples which may be applied include: Ministry of Housing and Urban-rural Development (MoHURD)'s Eco-Garden City Standard, Ministry of Environment Protection (MEP)'s Eco-city standard, and National Development and Reform Commission (NDRC)'s Low-Carbon City (Zhou, et al., 2012).

Modelling tools such as geographic information systems (GIS) can be used to model, analyze and visualize sustainability indicators within their geographical context. GIS tools allow organizing indicator data in thematic interactive maps that can be used to create virtual environments and improve decision-making. Two examples of GIS-based modelling and visualization tools for sustainable development indicators include:

- The visualization package SIEVE (Spatial Information Exploration and Visualisation Environment) for example combines GIS, 3D CAD models and a game engine to provide a multi-user virtual environment for collaborative data exploration (Chen, et al. 2008).
- The MOLAND (Monitoring Land Use/Cover Dynamics) model developed as part of an integrated planning methodology for city-regions.This model has been applied in Europe to monitor the sustainability of regions and evaluate the impact and feasibility of adaptation measures and strategies (Lavale, 2009; Lavale et al., 2004).

Rating tools for individual buildings include China's Evaluation Standards of Green Building (GB/T50378- 2006), widely used in Hong Kong Building Environmental Assessment Method (BEAM Plus), Australia's Green Star Design & As Built and Infrastructure Sustainability rating tools, US' Leadership in Energy and Environmental Design (LEED).

Building information modelling (BIM) tools can additionally be used to analyze and communicate community and building sustainability indicators to assess the impact of difference scenarios. BIM can be used to carry out cost estimations in order to define the financial impact of different architectural or infrastructure solutions. There are a number of commercial modelling software packages available for this type of analysis which require a significant level of expertise.

There are a range of tools available to support the collection and review of community sustainability indicators. Examples of rating systems include STAR Communities, Audubon's Sustainable Communities, BEAM Plus Neighbourhoods, BREEAM Communities, Enterprise Green Communities, Australia's Green Star Communities.

Stakeholders

City Governments would work collaboratively with specialized institutions to use modelling software to compare different options and select the most appropriate set of initiatives to meet the targets set in the previous strategy.

Step Four: Monitoring Progress

Objectives

- Monitor progress towards sustainability goals
- Facilitate appropriate and timely corrective action in order to achieve goals

Description

Step four requires regular monitoring and re-assessment of the indicators chosen through Strategy One. Active monitoring of KPIs provides the means to justify investments made as well as comparing and ranking the impact of implemented interventions. It ensures accountability and provides a rich source of information based on which city officials can take remedial action by introducing changes in a timely manner. This can help correct situations that may be hindering the achievement of the goals set in previous strategies.

Regular monitoring will encourage implementing officials to develop proactive action plans to correct potential issues as they arise and developing a reflective culture that may lead to future improvements. Goals should also be reviewed on a regular basis in the context of the changing needs and opportunities of the city. Medium and long-term goals especially should be reassessed as cities grow and develop.

Alignment of targets with a reward schema is another key condition to ensure efficient accountability which has been shown to be successful in other countries aiming to achieve sustainable cities goals. Success should therefore be rewarded through for example public recognision of achievements and, if the initiatives involve the industry and general population, financial incentives may also be considered for exceeding targets.

Stakeholders

City and local community governments would work collaboratively with data providing institutions in order to carry out the progress monitoring. They would need to manage their relationships with research institutions and other data providers in order to ensure the indicator's information is delivered on time and at the required frequency.

Step Five: Lessons and Knowledge Transfer

Objective

- Optimization for National and Global Benchmarks

Description

This step consists of developing systems and programs that ensure lessons learned and knowledge accumulated from the implementation and monitoring of specific interventions are shared and re-used locally, nationally and internationally. Information about successes and failures of initiatives can help other cities develop more effective sustainability strategies and implementation plans. Lessons learned programs should outline the process as well as the outcomes and be captured in long-lasting databases that can be readibly accessed by other stakeholders. The most significant lessons can become best practices and shared as such.

In addition to leassons learned, the data from monitoring the Sustainable Cities KPIs can be used to establish benchmarks that allow comparing the effectiveness of different interventions and provide the basis for better informed succes criteria of future initiatives. Benchmarks are an integral part of evidence-based planning, active learning and continual improvement processes required to achieve more sustainable cities. Understanding past performance allows to measure future performance and success in order to improve future outcomes.

Stakeholders

City Governments can collaborate with interest groups and research/academic institutions to develop and publish lessons learned and benchmark systems. City government officials can also work through the central government and with other city governments to disseminate best practices and lessons learned.

UNEP and similar organizations could facilitate links between City Government and research institutions to the extend required by the City Government.

SUC Key Action Points for Cities and Communities

The SUC Key Action Points provide practical guidance for built environment professionals and governments seeking to optimise development projects to achieve sustainable cities across China within the lifecycle process. The proposed technoligies/strategies and selected international case studies are sourced from literature, stakeholder meetings organised in China, expert advices, CRCLCL research project outcomes, etc.

Action Point One: Resource Endowment Survey (Project Areas)

Introduction

Increasing urbanisation, economic growth, and the rising consumption pattern has been leading to more consumption of natural resources (e.g., land) per capita in cities. Natural resources are finite and it is therefore important to demonstrate that resource selection and use leads to added value for the city, the area concerend, the people in the city and other stakeholders as well.

Careful analysis, selection and development of project area offer ample opportunities to make significant progress in reducing CO2 emissions and ensuring sustainable development of the project. Choosing an appropriate site for a new project and developing it to make the optimal use of its natural resources yields significant economic, lifestyle and environmental benefits. In addition, projects that demonstrate the involvement of communities, residents and other relevant stakeholders have a much more greater chance of generating significant economic, environmental, lifestyle benefits, creating a meaningful learning experience where people feel that they can make a genuine contribution, create valuable opportunities for two-way learning and ensuring sustainable development of the project.

Key strategies and technologies

City and local governments should support the development of tools, plans and policies for informed decision-making on resource endowment survey of the project area. The tools and policies are to be developed to reflect the different components of a resource endowment survey:

- Develop indicators that prepares for a realistic projection of urban land needs, management of different land use patterns, including sorrounding farmlands, drylands, urban wetlands, and urban forests, and reduction of additional land-related resources, such as energy resources, ecosystems, water resources, etc.
- Develop vegetation plan that provides clear guidelines on a statutory basis and conditions that must be met in relation to trees, native vegetation or plant species to be protected or removed.
- Advance tools that helps in assessing climatic features of the project area, such as solar access or access to cooling breezes, and microclimate (e.g., seasonal temperatures, humidity levels, prevailing winds), in order of priority, in order to ensure that the climatic features provide opportunities for solar access (orientation of buildings, passive solar heating, passive cooling), mitigate increase in outdoor ambient temperatures, increase comfort and decrease energy use, and assess the impact of the existing climatic features and changing climate on the site planning (figure 3). Project areas can be challenging when the microclimate conditions negate climatic effects used in sustainable building design.

- Conduct research and surveys to get an idea of the local demographics (about the people who live where the project is proposed), building, site, and structural information, community environmental attitudes, knowledge, beliefs, understandings, and practices.
- Develop innovative approaches to involve communities and citizens in the project site assessment.
- Invite representatives of the target group to be involved in site assessment and project planning.
- Locate development site that is underused, vacant, abandoned, or contaminated.

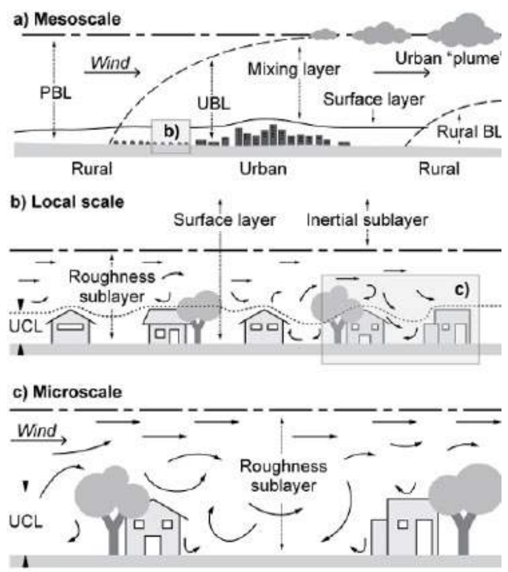


Figure 3: *Climate impact on site planning and design (Your Home)*

How and what to do

Surveys and focus groups – conduct surveys (personal or telephone) and focus groups to understand information about the project site, the local climate and environmental conditions, geographical location, natural and cultural heritage information, etc. Using photographs or short films, and showing examples of people participating in similar projects, the project developers and local governments can generate interest among the communities to share important information about the project area. The precise kinds of information that should be collected by a survey will depend on the project and its scale. While reconnaisance and intensive surveys are general methods of survey, they could be made innovative by involving activities such as (Derry et al. 1985):

- a "windshield survey" of the community-literally driving around the community and noting the general distribution of buildings, structures, and neighborhoods representing different architectural styles, periods, and modes of construction.
- a "walkover" archeological inspection, perhaps coupled with small-scale test excavations, to get a general idea of the archeological potential of portions of the community.
- a study of aerial photographs, historical and recent maps and city plans, soil surveys, and other sources of information that help gain a general understanding of the community's layout and environment at different times in its history.
- detailed inspection of sample blocks or areas, as the basis for extrapolation about the resources of the community as a whole.

Types of information collected from surveys

RECONNAISANCE SURVEY	INTENSIVE SURVEY
kinds of properties looked for	kinds of properties looked for
boundaries of the area surveyed	boundaries of the area surveyed
method of survey, including the extent of survey coverage	method of survey, including an estimate of the extent of survey coverage
kinds of historic properties present in the survey area	record of the precise location of all properties identified
Specific properties that were identified, and the categories of information collected	Information on the appearance, significance, integrity, and boundaries of each property sufficient to permit an evaluation of its significance
Places examined that did not contain historic properties	

Building (including groups of buildings)

- Notable examples of architectural styles and periods or methods of construction, particularly local or regional
- Buildings showing the history and development of such diverse areas as communications, community planning, government, conservation, economics, education, literature, music, and landscape architecture.
- Stores and businesses and other buildings that provide a physical record of the experience of particular ethnic or social groups.
- Complexes of buildings, such as factory complexes, that comprise a functionally and historically interrelated whole.
- Markets and commercial structures or blocks.
- Buildings by great architects or master builders and important works by minor ones.
- Institutions that provide evidence of the cultural history of a community (universities, art centers, theaters, and entertainment halls). Buildings where significant technological advances or inventories in any field occurred (agricultural experiment stations, laboratories, etc.).

Site

- Archaeological sites containing information of known or potential value in answering scientific research questions.
- Archaeological sites containing information that may shed light on local, regional, or national history.
- Sites of cultural importance to local people, such as locations of important events in their history, historic or prehistoric cemeteries, or shrines.
- Sites associated with events important in the history of the community as a whole.
- Cemeteries associated with important events or people, or whose study can provide important information about history or prehistory.
- Ruins of historically or archeologically important buildings or structures.
- Cemeteries important for the architectural or artistic qualities of their constituent structures and monuments,
- Constructed landscapes that exemplify principles, trends, or schools of thought in landscape architecture, or that represent fine examples of the landscape architect's art.

Structure

- Industrial and engineering structures, including kilns, aqueducts, weirs, utility or pumping stations, and dams.
- Transportation structures, including railroads, turnpikes, canals, tunnels, bridges, roundhouses light-houses, and wharves.
- Movable structures associated with important processes of transportation, industrial development, social history, recreation, and military history (ships, locomotives, airplanes, artillery pieces, etc.).

Object

- Objects important to historical or art historical research petroglyph boulders, bedrock mortars, statuary, rock carvings, etc.).
- Objects important to the cultural life of a community and related to a specific location (fountains, outdoor sculpture, monuments, etc.).

District

- Groups of buildings that physically and spatially comprise a specific environment: groups of related buildings that represent the standards and tastes of a community or neighbourhood during one period of history, unrelated structures that represent a progression of various styles and functions, or cohesive townscapes or streetscapes that possess an identity of place.
- Groups of buildings, structures, objects, and/or sites representative of or associated with a particular social, or economic group during a particular period.
- Groups of structures and buildings that show the industrial or technological developments of the community, State, or Nation.
- Groups of buildings representing historical development patterns (commercial and trade centers, mill towns).
- Groups of sites, structures, and/or buildings containing archaeological data and probably representing an historic or prehistoric settlement system or pattern of related activities.
- Groups of educational buildings and their associated spaces (school and university campuses, etc.).
- Extensive constructed landscapes, such as large parks, that represent the work of a master landscape architect or the concepts and directions of a school of landscape architecture.
- Landscapes that have been shaped by historical processes of land use and retain visual and cultural characteristics indicative of such processes.

Photo booths and workshops - Conduct photo booths and workshops with different target groups, such as all people living in a specific location (community, apartment building, a street, a district, etc), members of a representative organisation, women, families with young children, people who shop (or work) in the district, business owners, senior citizens and young people (NSW-OEH 2011). Local people are generally aware of the community and can identify the 'hot spots' relating to where the issues of concern with regard to the project area, such as the potential impact of the project on the natural area, the relevancy of the project in the proposed location, etc. Projects that build on the communities existing knowledge and practices can make meaningful contribution to sustainability.

Site visits: a great way to generate discussion is to take people on a site visit. Providing this direct experience encourages people to feel connected with the area, ask questions and sharing information. A site visit puts the issue into context. The location of the site visit depends on the project. If the project relates to healthy waterways, visit the local creek, river or ridgeline that forms the catchment boundary. Encourage discussion by asking questions such as 'How would you like this creek to look?', 'How could we make that change?' (NSW-OEH 2011). Other locations for site visits might include a community garden, bushland reserve, drinking water supply, rubbish tip, recycling facility, a sustainable house or eco-living centre. Ask people to map the places they visit and the activities they do in the local area. This is also a useful way of gathering information about the project area.

Project site location assessment – a regional analyis on the existing neighbourhoods can help in identifying land preservation and conservation strategies at the community level, identify vulnerable lands, and revitalisation strategies and preservation policies. Key strategies and guidelines for locating development are:

OBJECTIVES	GUIDELINES
Natural resource preservation	
Preserve and protect farmland, natural resources and habitat	Locate the development on a site that does not have wetlands, water bodies or land within 100 feet of these areas, prime agricultural soils, unique or prime forest soils, threatened or endangered species habitat, aquifer recharge areas
Environmentally sensitive areas protection	
Protect environmentally sensitive areas	Locate the development on land that does not have steep slopes greater than 15%, 100-year floodplains, and highly erodible soils
Enhance and protect the ecology of natural systems	Establish a mandatory no-development buffer at wetlands, floodplains, lakes, rivers and estauries
Existing development and infrastructure connections	
Capitalising on existing infrastructure	Locate the development on a site that has access to existing roads, water, sewers and other infrastructure and is within or contiguous to existing development
Redevelop and restore value of contaminated or underutilised land	To the greatest extent possible, locate the project on a greyfield, brownfield or other adaptive reuse/infill site
Minimise reliance on private septic systems	Discourage development on sites where private septic systems will be required.

Examples

Microclimate and Urban Heat Island (UHI) Mitigation Decision Support Tool, Australia:

The CRC for Low Carbon Living (CRCLCL) is developing a decision-support tool that that bridges the gap between research and practical application in urban microclimates by helping governments, developers and planners to mitigate vulnerability to urban heat island effects. The tool integrates building information models (BIM) and precinct information models (PIM) with GIS to identify the impact of varying urban form on the microclimate, predicts what-if scenarios of UHI mitigation performance under standard climate conditions, and provides 3D visualisation of analysis outcomes through a web-based platform

EVA-Lanxmeer, Culemborg, The Netherlands:
http://www.eva-lanxmeer.nl/

EVA-Lanxmeer is an international example of sustainable urban planning that also focuses on social and societal developments. The district with around 250 homes and small businesses has been realised with an extraordinary degree of integration from the project site assessment stage. The project implementing authorities created conditions for initiatives put forward by resident participation groups of future residents and users in the project. Participation by future residents and users was part of the interdisciplinary planning process from the start. It contributed to old landscape features and ecological qualities incorporated into the urban design. Important consultations of the residents include:

- Input from the future residents about the parcelling of the land and about home types, to allow people to get in touch with their atmosphere and feel, visits to the area were also organised;
- Residents' evenings to discuss the provisional design;
- The choice of a basic design (for financial reasons) with optional variations (such as balconies, sunrooms and solar cells);
- Meetings with the architect about individual modifications (after registration and payment of a guarantee); and
- Residents' meetings to discuss the organisation of courtyards (supervised by the landscape architect).

Hof van Heden, Hoogvliet, Rotterdam:

This is another unusual scheme of a co-housing project, where communities were involved at the initial stages and give their inputs on not only the design of the housing project, but also the gardens (Urban Green Blue Grids 2016h). A group of future residents were involved when the architects were selected. Their views of the building instructions, the site conditions and the shape given by the group through community workshops were considered. The conditions defining the design were the location and an urban planning vision that called for blocks of peripheral construction along Horsweg road, with different types of homes: 28 apartments and 32 ground-level homes.

Action Point Two: Planning and Design

Introduction

Rapid urbanization, urban population growth and urban land expansion have been ensuing inefficient land use patterns around the world. Carcentered urban development models, strict zoning policies and urban sprawl are unsustainable in the long run and have significant impact on environment, economy, infrastructure, public life and natural resources such as land and water (UN Habitat 2012).

Sustainable urban planning and design helps to coordinate the urban development process and takes advantage of all the opportunities sustainability has to offer.

Key Strategies and Technologies

- Develop a long term strategic plan (e.g., district level structure plan) that sets out the vision for how land should be developed, details the built form and conditions to be met by future land use and development, outlines site evaluation, site planning, and conditions for protecting and enhancing natural environment (water ways, vistas and ecosystems) and built environment (e.g., heritage, culturally significant streetscapes and buildings) and therefore enables a sustainable transition of non-urban land to urban land.
- Develop and implement an 'integrated urban design' that maximises bicycle and pedestrian permeability by creating pedestrian links, pedestrain friendly street scapes, natural traffic spaces, green grids/ greenways/trails, green cycle routes, super cycle highways, and public structures – such as athletic, recreational and cultural centres - which promotes social connectivity and diversity, thus making cities more cohesive, lively and sustainable (UN Habitat 2012).
- Embody 'localness' and encourage diversity of land use, with emphasis on sustainable development and increasing landuse productivity, and protect and enhance eco- and culturalinfrastructure, through transit-oriented development, transformational landuse, eco-cities and towns, lobe cities, 100% renewable energy cities, carbon neutral cities and districts, and zero and positive energy cities.
- Design and develop plans, policies and designs that foster sustainable urban development and promote smart and innovative systems for more compact, resource efficient, smart and intelligent, socially inclusive and better connected cities.
- Develop and design a self-sufficient neighbourhood design that act not only to establish a strong sense of place and community interaction, but also assist in providing functional, safe and aesthetically pleasing development solutions.
- Incorporate and integrate smart principles (e.g., Geodesign) into planning for better interaction between community groups and governments.
- Support varied use of activities and facilities such as employment centres, residential neighbourhoods, natural areas, parks, local trails, schools, and public places to promote a physical connection and to create authentic neighbourhoods.
- Develop smart technologies, easy-to-use growth assessment tools and codes to support smart growth and development.

How and what to do

Carbon positive and neutral districts – plan and design carbon neutral and positive districts characterised by maximising the use of sustainable building materials (materials with low embodied energy), more wind and solar electricity to the grid, energy efficiency technologies for buildings electricity and gas (biogas) needs and transport systems (fuel cell for vehicles), water recycle and storage systems, reuse and recycle of household waste, district heating and cooling, sustainable food production (community and rooftop gardens) and integrating sustainable architecture (e.g., building integrated solar PV systems, solar roofs, green roofs and walls, green spaces).

Figure 4: *Some features of a carbon neutral and positive cities and districts.*
Building integrated solar and wind systems (wikimedia Commons) (Treehugger) Green roofs and vertical gardens (CNN)

Innovative network of pedestrian and bicycle spaces (Green-Blue Networks or Green Grids) – A sustainable urban landscape design can be realised by creating links between the areas where people live and work, public transport hubs, and creating natural urban systems that support and permit growth (Urban Green Blue Grids 2016j). Opportunities for such an urban planning and design can be found in creating a network of connected green-blue structures – strategic corridors, links, open spaces and projects along the areas where people live and work.

Examples of urban green-blue networks

COMMUNITY OPEN SPACES	ECOLOGICAL LANDSCAPES	BLUE+GREEN INFRASTRUCTURES	PRODUCTIVE LANDSCAPES	TRANSITIONAL LANDSCAPES
Landscapes for recreation, social life and small-scale food cultivation	Landscapes that provide habitat and other environmental benefits	Landscapes that capture stormwater and clean air	Landscapes that generate new knowledge, grow energy and food, and create new urban experiences	Temporary landscapes that clean soil and enable new forms of social life and creative displays
• Playgrounds • Neighbourhood parks • Sports fields • Regional parks • Plazas • Recreation centres • Trails/greenways • Urban gardens • Farmers markets	• Nature parks • Industrial nature parks • Successional roads • Roads to rivers	• Large lake • Smaller retention ponds • Infiltration parks • Swales+infiltration medians • Road-side pond • Green industry buffer • Carbon forest	• Research landscape • Urban farm • Aquaculture and hydroponics • Algae-culture • Homesteads • campgrounds	• Event landscapes • Remediation fields • Art-scapes • Urban meadows

Place-making design – Place making approach emphasises bottom-up approach and community-scale planning with the objective to create qualitative, liveable environments that adhere to the principles of sustainability (figure 5) (Schlebusch and Cilliers 2013). The place-makingapproach can be employed to realise liveability by implementing various functions within one space. In order for this to realise, the main focus should be placed on current public spaces within communities in which people can socialize and interact. The structural elements of the place making design are interlinked and combine to create built environment that promotes healthy, safe and strong communities (figure 6).

Figure 5: *Elements of place-making design (Place Laboratory)*

Figure 6: *Pocket neighbourhood with streets, walkways and green infrastructure elements (Place Laboratory)*

Lobe cities - The concept of a lobe city was developed early in the 20th century (figure 4). The lobe plan is suitable as the basis for sustainable urban development and for blue-green urban planning. The green-blue lobes have a favourable impact on the urban climate: in the summer they hold less heat and so offer cooler areas. The difference in pressure between the hot and cool areas also causes airflow and ventilation. Lobe cities offer the possibility of combining the benefits of compactness with those of more open and green development. The growth potential of these cities is limited. For large urban conglomerates, green grids are a more viable solution.

OBJECTIVES	GUIDELINES
Neighbourhood fabric and composition	
Encourage walking and reduce vehicle miles traveled by mixing uses and densities.	Incorporate a diverse mix of uses within the development or locate housing within a 5minute walk of commercial and retail districts within diverse, community-oriented services.
Maximise density levels to create optimal nodes of activity	Exceed existing density patterns or requirements for a residential and mixed-use development. Suggested minimum densities for new residential construction: • Six (6) units per acre for detached/semidetached houses • Ten (10) units per acre for townhomes • Twenty (20) units per acre for apartments
Minimise the negative impact of car parking and encourage healthy modes of transportation	Design car parking areas so that they are not primary visual components of the neighbourhood character by: • Providing opportunities for shared parking between structures • Reducing parking ratio requirements in areas served by public transit • Providing designated or discounted parking for car pools, van pools and low-emitting, fuelefficient vehicles • Providing bike racks and walking amenities (water fountains, benches,etc)
Maximise opportunities for passive solar heating and cooling	For new street blocks or buildings, take advantage of natural solar heating and cooling through solar passive design
Calm traffic and create desirable, pedestrian friendly, safe streets	Design safe, pedestrian-friendly streets by including elements such as: • Wide sidewalks on both sides of the streets (4 feet minimum width on residential blocks, 8 feet minimum width on non-residential or mixed-use blocks) • Street furniture (e.g., benches), street curb blub-outs • Adequate space for transit stops/shelters • Woonerfs (streets that give legal priority to pedestrians and cyclists) • Narrower streets to reduce speeds and impervious surfaces

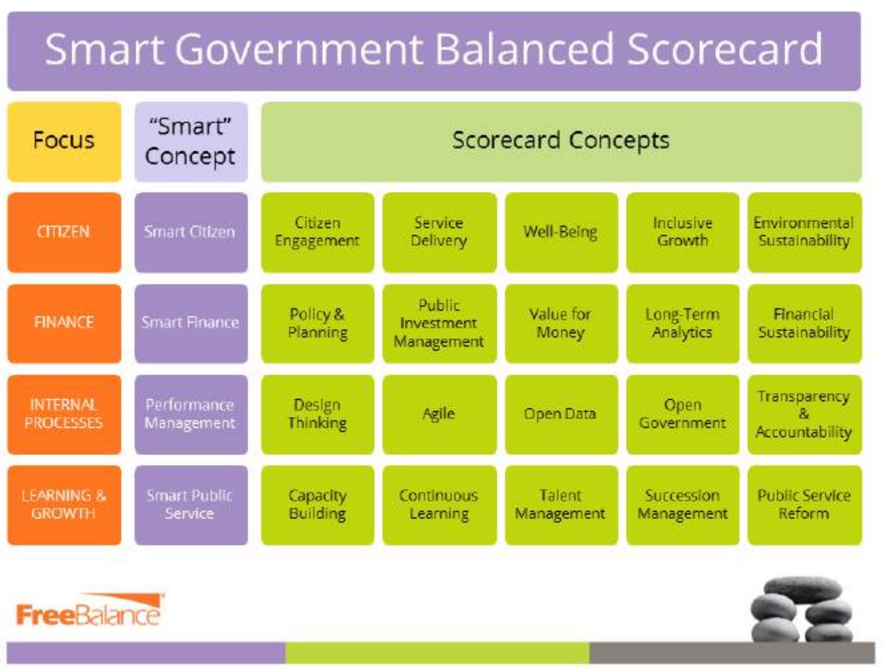
Community streets	
Create bike-friendly streets	Create a bike-friendly environment with continous, and if possible, separated bike lanes that connect to a large bike network, bike parking, and easily accessible bike racks
Enliven street frontages	Orient buildings towards the street and sidewalk with front facades and entrances a public space but not a parking area Locating front building facades near the property line Zoning for pedestrian oriented uses at the ground level (e.g., retail, community services, community centres etc)
Beautify streets with green infrastructure projects	Encourage green infrastructure practices as standard practice for community streets and public rights-ofway. Use appropriate tree species and ensure the trees have the correct soils and root and growth space to thrive
Nature and open space	
Create or enhance green open space networks	Design connected green space networks Dedicated open spaces for community garden in the development
Maximise access to local food sources	Planting edible landscapes as part of the landscaping plans
Equity, diversity and affordability	
Encourage housing type, tensure and income diversity	• Include a mix of housing types, income targeting and density patterns • Establish zoning regulations that allow accessory units
Create, where possible, adaptable and liveable housing (see building and construction, SUC for communities)	To the greatest extent possible, incorporate the following design strategies: • Atleast 32 inches of clear passage space for all main floor doors • Incorporate universal design strategies in the design of residential units (see building and construction, SUC for communities)

Smart growth scorecards or audits – municipal level smart growth scorecard or audits are use-to-use tools developed by local governments to assist communities assess their own situations in terms of their growth and development. The scorecard is arranged into certain number categories based on locally developed principles that describe smart growth (EPA 2017b). Each category has a series of multiple-choice questions that assign relative values to the chosen answers. The scorecard concludes with resources and suggestions communities can use when they have evaluated their current conditions (final score based on scale of each component, say 1- 3).

Some of the categories of the issues include: Compact centers, Encourage growth in existing places, Mix compatible land uses, Transportation, Housing affordability, Walkable communities, Natural resources, Open spaces, Fiscal analysis, Regional cooperation, Sense of place, Farms and forests, Business diversity, Public involvement, Make development decisions predictable, fair, Mixed-use districts, Live-work districts, Parking standards, Bicycle/multi-use trail facilities, and cost effective.

The Smart Growth Scorecard can be used by different groups:

- by planning and local officials for their own guidance.
- by community leaders to prepare for public meetings or planning sessions.
- as a tool for public involvement in planning and decision-making.
- by members of the community, interest groups, and/or the media



Smart Government Balanced Scorecard

Focus	"Smart" Concept	Scorecard Concepts				
CITIZEN	Smart Citizen	Citizen Engagement	Service Delivery	Well-Being	Inclusive Growth	Environmental Sustainability
FINANCE	Smart Finance	Policy & Planning	Public Investment Management	Value for Money	Long-Term Analytics	Financial Sustainability
INTERNAL PROCESSES	Performance Management	Design Thinking	Agile	Open Data	Open Government	Transparency & Accountability
LEARNING & GROWTH	Smart Public Service	Capacity Building	Continuous Learning	Talent Management	Succession Management	Public Service Reform

Figure 7: *Smart growth score cards*

Geodesign for Sustainability - Planners and urban designers use geographical information systems (GIS) to balance competing interests, fuse data from a variety of sources, and communicate their intentions to multiple audiences. Geodesign is a way of integrating geographic sciences and information technologies to produce data, information and knowledge to inform design professions and create a sustainable place for people (figure 8). By incorporating geodesign into planning, communities are better positioned to provide citizens a sustainable future that won't compromise the land, water, or air quality they hold dear.

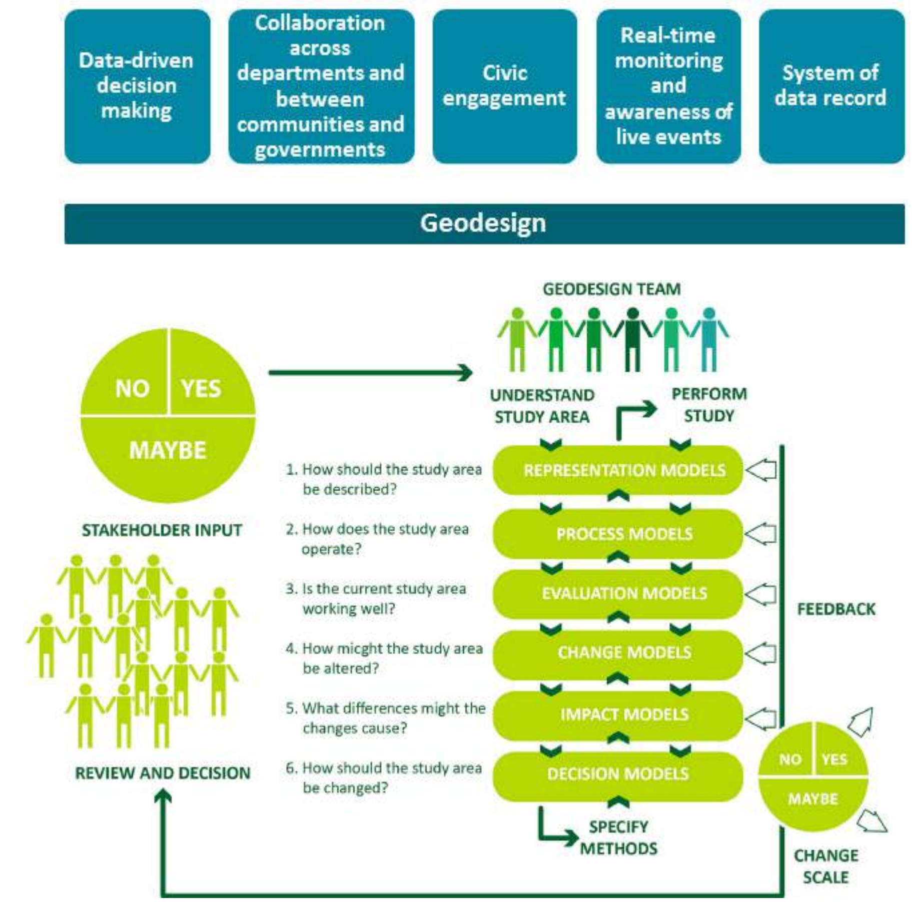


Figure 7: *Smart growth score cards*

Development codes for smart and sustainable growth development - Good codes are the foundation upon which great communities are built. Codes guide everything from permissible land uses to building densities, locations, and setbacks to street widths and parking requirements (EPA 2017a). Below is a compiled list of of adopted codes from around the world that support smart growth development. This list is not exhaustive but samples of good sustainable growth-supportive codes that communities could use as models to make updates to their zoning.

CODE	DESCRIPTION
Unified Development Code	A single document that includes all development-related regulations, including zoning and subdivision regulation.
Form-Based Code or SmartCode	A code that outlines a specific urban form rather than zoning by use. Categories are included for form-based codes for area plans and for citywide codes.
Transit-Oriented Development	Moderate- to high-density, mixed-use neighborhoods built around transit stops and designed to maximize access to and use of public transportation.
Design Guidelines	A set of standards that aims to maintain a certain level of quality and architectural or historic character, addressing features such as building façades, public spaces, or landscaping.
Street Design Standards	Guidelines and standards related to travel-lane width, bicycle lanes, on-street parking, medians, sidewalks, landscaping, lighting, crosswalks, pedestrian refuge islands, bulbouts, and accessibility ramps
Zoning Overlay	A set of zoning ordinances, optional or required, specifying land use and/or design standards for a designated portion of the underlying zoning within a defined district; typically used to keep architectural character and urban form consistent, make adjacent uses compatible, or accelerate the conversion of non-conforming land uses.

Examples:

Sponge cities, Changde, China:
http://www.changde.gov.cn/art/2017/4/22/art_8_1038579.html

“Sponge City” refers to the function of the city to absorb, store, infiltrate and purify rainwater and use the stored rainwater when needed just like a sponge so as to improve the city’s resilience to address climate change and natural disasters as well as to strengthen urban ecological system and reduce floods (figure 9). China first initiated the concept of “Sponge City” in April 2012. In October 2014, Ministry of Housing and Urban-Rural Development released Technical Guidelines on Construction of Sponge Cities developed by experts. China released 30 pilot cities funded by the state revenue by April 2015, mainly to address issues relating to water environment, water ecology and inner flood that emerged during urban construction.

One of the several cities promoted as sponge cities is the city of Changde. hangde first developed the Water City--the Overall Planning of the Development of Water Sensitive District and Sustainable Use of Water Resources on which the development of over 20 high-standard master plans and specialized plans is based. The city’s planning is based on the concept of 3 water circles and the 3-layered drainage pattern.

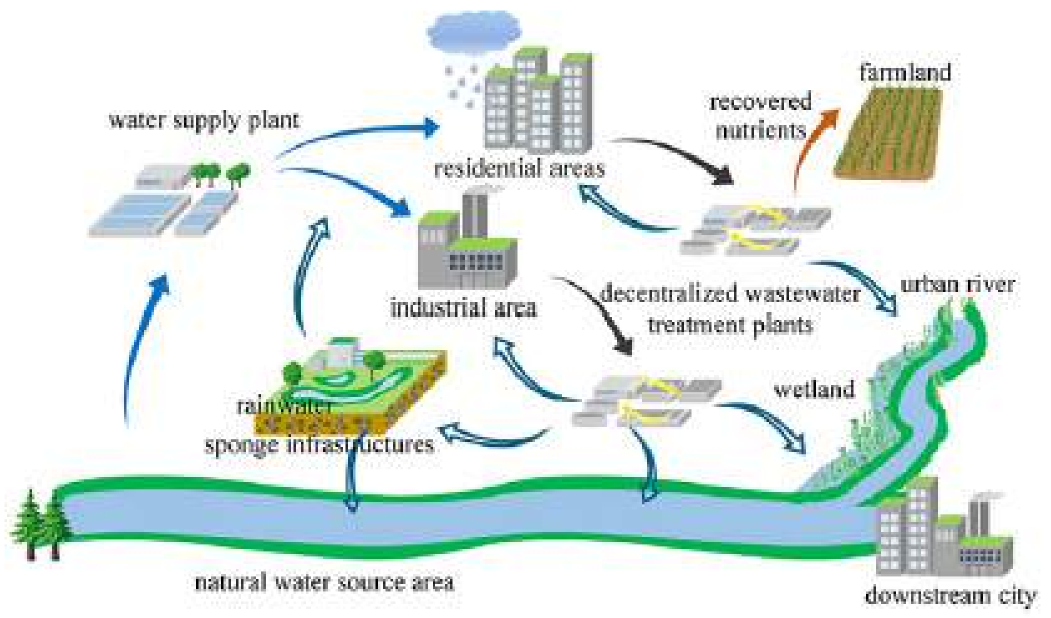


Figure 9: *Sponge city concept (Ren et al. 2017)*

Sydney Green Grid:
https://www.greater.sydney/digital-district-plan/958

The Sydney Green Grid is a spatial planning initiaitve to promote a healthier urban environment, improve public access to recreation and exercise, encourage social interaction, support walking and cycling connections, deliver better tools for future open space planning and improve the sustainability of Greater Sydney (figure 10) (Greater Sydney Commission 2017, p.99). It aims to integrate and provide connections between the green blue networks in Sydney, including the Blue Grid of Sydney’s beaches, estuaries and waterways, its variety of parks and open spaces and connections to bushland, from local pockets of native vegetation to Sydney Harbour.

Hammarby Sjöstad, Sweden:
http://www.hammarbysjostad.eu

Once a run-down, polluted and unsafe industrial and residential area, Hammarby Sjöstad is now one of the world's most successful urban renewal districts, and is a hallmark of sustainable design and planning. The attractive mix of residence, institutional, office and business spaces, with a focus on culture and entertainment gives Hammarby an inner city atmosphere. Traditional forms of urban planning in Stockholm are combined with varied modern architecture. Based on the strategy of a compact green town, a favourable balance has been found between construction and public spaces (figure 7). The district energy needs are satisfied from purified waste water, combustile household waste, and biofuel. The solar cells and fuel cells forms other important energy forms for building energy needs and transport systems. Energy efficient appliances reduces the amount of water consumed by 50%. Sustainability is one of the primary areas of focus in the planning and design of this water-integrated district.

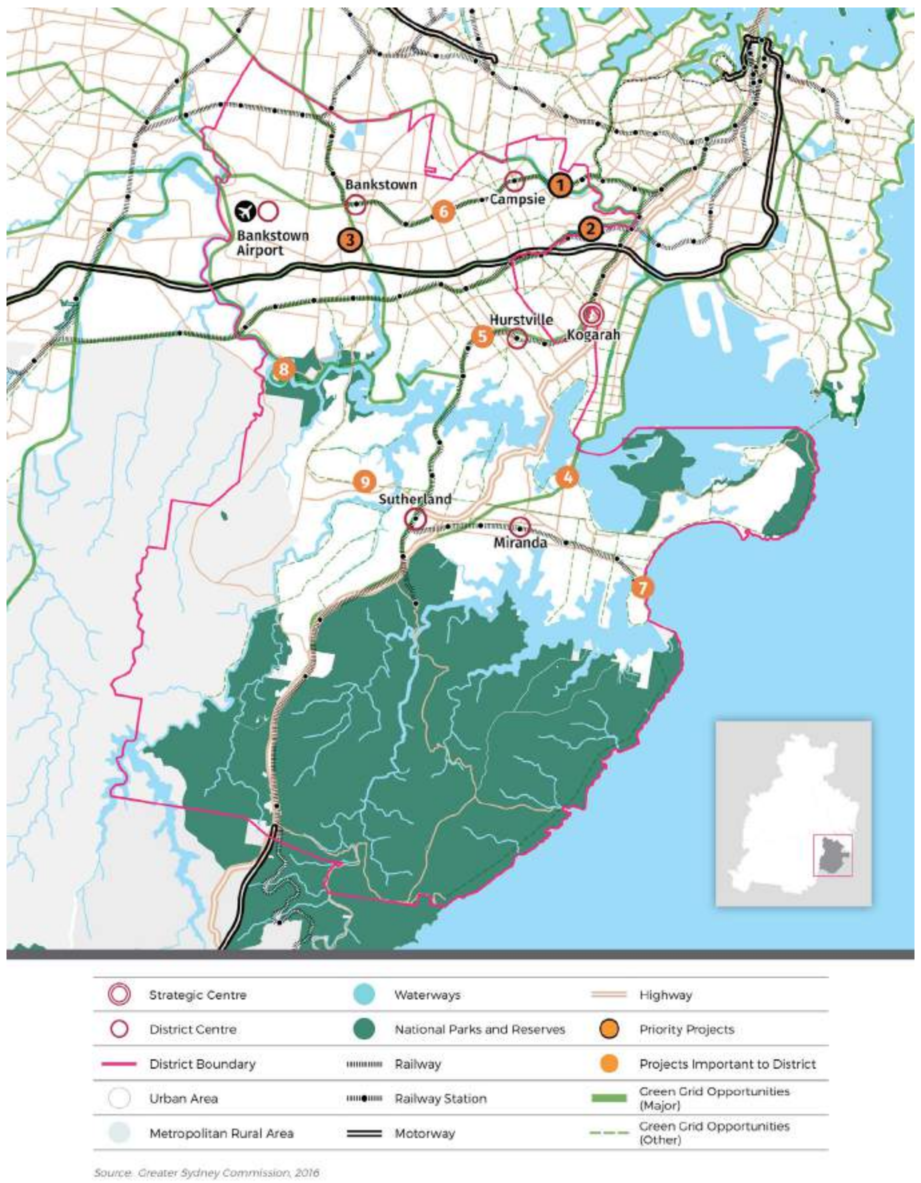


Figure 10: *A part of Sydney Green Grid proposal (Source: Greater Sydney Commission)*

Draft Greater Sydney Regional Plan:
https://www.greater.sydney/draft-greater-sydney-region-plan

The draft Greater Sydney Region Plan supports the vision for a metropolis of three cities and is guided by 10 overarching directions, which provide interconnected infrastructure, productivity, liveability and sustainability benefits to all residents (figure 11) (Greater Sydney Commission 2016). The plan is aimed to be implemented through district plans, which in turn will provide a bridge between regional and local planning. The vision seeks to meet the needs of a growing and changing population by transforming Greater Sydney into metropolis of three citise – the Western Parkland city, the Central River city, and the Eastern Harbour city (figure 9).

Figure 11: *Objectives of the Draft Greater Sydney Regional Plan*

Hammarby Sjöstad, Stockholm, Sweden:
http://www.hammarbysjostad.eu

Once a run-down, polluted and unsafe industrial and residential area, Hammarby Sjöstad is now one of the world's most successful urban renewal districts, and is a hallmark of sustainable design and planning (Urban Green Blue Grids 2016g). The attractive mix of residential, institutional, office and business spaces, with a focus on culture and entertainment gives Hammarby an inner city atmosphere. Traditional forms of urban planning in Stockholm are combined with varied modern architecture. Based on the strategy of a compact green town, a favourable balance has been found between construction and public spaces (figure 12). The district energy needs are satisfied from purified waste water, combustible household waste, and biofuel. The solar cells and fuel cells form other important energy forms/sources for building energy needs and transport systems. Energy efficient appliances reduces the amount of water consumed by 50%. Sustainability is one of the primary areas of focus in the planning and design of this water-integrated district.

Figure 12: *Hammarby Sjöstad urban design (visulogik) (Design for Health)*

Precinct Structure Plan (PSP), Cardinia Shire Council, Australia:
https://www.cardinia.vic.gov.au

The PSP guides the future urban land development and structure, the infrastructure and services planned to support the new community and how they will be delivered at a district scale. The plan establishes a framework for the development of an environmentally, socially and economically sustainable urban structure, and create an urban built environment with safe and efficiently designed neighbourhoods and precincts. The plan informs the use and development controls that apply to the Urban Growth Zone (UGZ) and what permits may be granted to the Zone, and provides developers, investors and local communities with certainty about future development.

URA Space, Singapore for smart urban planning visualisation :
https://www.ura.gov.sg/maps/

URA SPACE is a centralised integrated map portal developed by the Urban Redevelopment Authority of Singapore (URA) to deliver location-based services and information. It comprises a variety of mapping services and information, published by the URA. It is a 3D based online system with access to all land use plans, master plans, development control plans, government land sales, property use and approval, plannng decisions, conservation areas and buildings, urban design guidelines, and other data services.

Neighbourhood Planning, Singapore:
https://www.ura.gov.sg/uol/

Good neighbourhood planning and development helps to bring amenities closer to people. Time and money can be saved from traveling if there is already a good enough variety of basic services at the heart of our neighbourhoods. If a loaf of bread and some snacks are all you need, why not just pop downstairs to a void deck mamak stall instead of taking a bus into town? Singapore's approach to urban planning is very much based on this – it isn't just about practical solutions to cope with limited space and density – it is also about improving the citizens' everyday experiences and lifestyle,

Action Point Three: Products and Materials Selection

Introduction

Use of every natural resource, materials and products comes with an environmental cost of some sort. According to the United States – Environmental Protection Agency (US-EPA), sustainable products and materials are 'products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose…' (EPA 2006, p.11). They serve an ecological function and contribute to water saving, energy saving, contain recycled materials or are manufactured with a low embodied energy/CO2. They come with high durability, low maintenance and minimise the need for new materials over the building's life time. Careful selection and use of materials improve comfort, reduce cost, and mitigate the life cycle environmental impact.

Materials can be eco-friendly if they support one or several of the following properties (figure 13) (The Constructor 2017): –

- are derived from a renewable source (e.g., wood from certified forests);
- are part of a waste reuse, including salvaged products – old plumping, door frames, and recycled contents - agriculture/ industrial waste (e.g. Bagasse Board);
- require less energy input to produce them, including transporting them to the building site (Aluminium and steel has the most embodied energy);
- contribute to low VOC emissions (e.g. cement paints), prevent leaching and reuse waste that would otherwise have resulted in landfill (e.g. flyash Bricks);
- are energy efficient and also help reduce the dead load of a building (e.g. Ferrocement);
- are exceptionally durable, or require low maintenance (e.g PVC pipes);
- require less energy during construction (e.g. precast slabs) and reduce cooling and heating loads (e.g. aerated concrete blocks);
- conserve energy and water (e.g. CFL lamps, dual flush cisterns);
- decompose easily (e.g wood or earthen materials).

PROPERTIES	EXAMPLES
are derived from a renewable source	Wood from certified forests
are part of a waste reuse and includes recycled contents and recovered products from old plumbing, door frames, and agriculture/ industrial waste	Bagasse Board
require less energy during construction	Precast slabs
contribute to low VOC emissions (e.g. cement paints), prevent leaching and reuse waste and reduce landfill	Flyash Bricks
are energy efficient and help reduce the dead load of a building	Ferrocement
are exceptionally durable, or require low maintenance	PVC pipes
reduce cooling and heating loads	Aerated concrete blocks
conserve energy and water	CFL lamps, dual flush cisterns
decompose easily	Wood or earthen materials

Figure 10: *Properties of sustainable products and materials*

Key strategies and technologies

- Develop education programs on selecting products with more recycled materials, and contribute to conservation of materials and thereby develop community resilience to climate change and construction, maintenance, and end-of-life management of roads, buildings, and infrastructure.
- Engage communities and businesses through a range of activities to generate awareness on selecting sustainable materials and products.
- Develop good data on materials' environmental impacts and hands on tools that can help communities choose right materials according along with design requirements.

How and what to do

Ecolabelling schemes for all consumer products - availability of product environmental information provides an opportunity for consumers to choose more sustainable products and for designers to be rewarded for selecting more sustainable materials (e.g., food and consumer products). The products shoud include basic information about how the product should be recycled at the end of its useful life. More sophisticated environmental data such as an eco label, the amount of recycled content in the materials used, or details of the product's energy efficiency or carbon footprint can have implications for everybody – consumers and anybody involved in the design of products and the selection of materials (figure 14) (O'Hare 2012).

Figure 14: *Ecolabels (hellomaterialsblog) and Health star rating for food products (trulydeeply)*

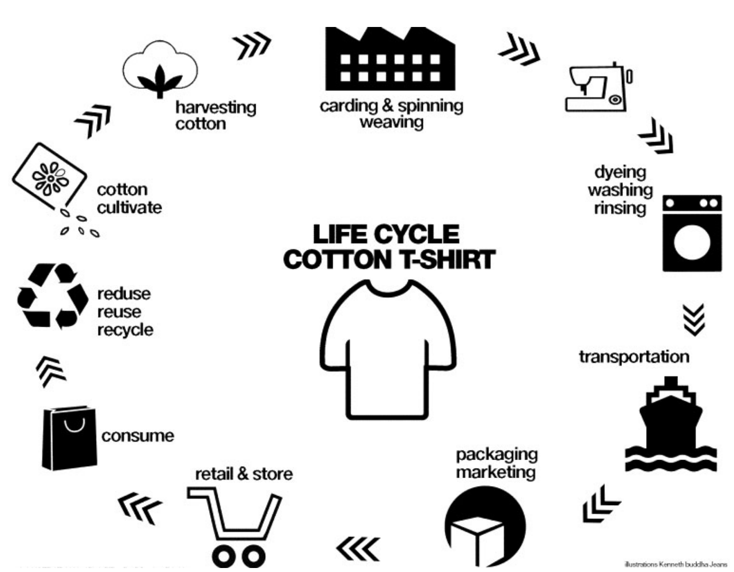


Figure 15: *Educational material on green life cycle of a t-shirt (evergreendesignco)*

Packaging criteria – develop a green rating or guide for raw materials of the products (focus on material, supplier practices and product end of life) based on the following criteria. Each of the criteria should have additional metrics associated with different packaging materials (Glass, paper, rigid plastic, metal). Final score should be made by averaging each criteria score and products are categorised on 'better'and 'best' scale (figure 16).

- Packaging minimisation
- Design for recyclability
- Design for reusability
- Sound materials section
- Increased use of post consumer recyled content
- Use of renewable resources
- Selection of printing methods and materials
- Selection of environmenally conscious supply partners

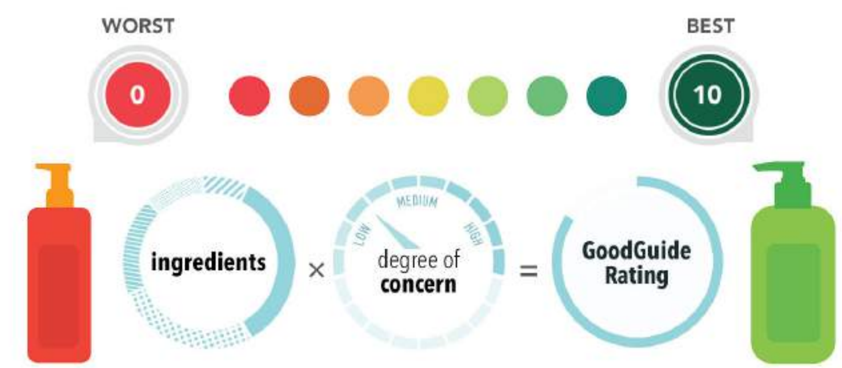


Figure 16: *Green rating for product ingredients (GoodGuide)*

Action Point Four: Building and Construction

Introduction

As buildings become more energy efficient and other impacts are offset through improvements in design and application, the role and impact of materials used to construct a building becomes more important, particularly over its lifespan (Morison et al. 2005). Choosing more sustainable materials often means making informed tradeoffs. It is therefore imperative that the construction sector as a whole must integrate solutions that contribute to an improvement in the quality of life in cities, while minimising the impact on environment.

Sustainable building construction plays an important role in reducing construction waste, increasing efficiency in the use of energy and water resources, saving time and materials, as well as leading to higher profitability. A sustainable building takes advantage of the climate (e.g., sun, breezes) to maintain a comfortable temperature, reduce or eliminate the need for auxilary heating or cooling (which may account for upto 40% of energy use in an average building), mitigate greenhouse gas emissions, reduce water consumption, and lessen the overall impact of the building construction on the environment. At the same time, smart growth approaches to building, with compact development, and the construction of healthy buildings using green, inclusive and sustainable building techniques and materials can help communities and their residents protect the environment and create more affordable neighborhoods (EPA 2018). They encourage building a range of housing types to meet the needs of families, young professionals, and the elderly. They encourage investing and redeveloping in existing communities, which uses existing infrastructure and adds amenities in areas that have suffered from disinvestment.

Key strategies and Technologies

- Design and build buildings that minimise the impact on climate (e.g., CO2 emission, urban heat) and buildings that adapt to the changing climate (e.g., flooding, sea level rise, storm surge), through carbon positive buildings, zero energy buildings and amphibious buildngs.
- Design and construct carbon zero, carbon neutral, zero energy or zero emission buildings using sustainable (e.g., green roofs, vertical gardens, building integrated solar and micro-wind systems) and intelligent technologies (e.g., to provide long-term solution to climate change.
- Design and construct buildings that are livable for people of all ages and abilities and adaptable to increase access and usability for varying degrees of physical ability (e.g., physically disabled, visually impaired).
- Construct buildings that include all people and foster greater human interaction to reduce issues of social insecurity and disharmony
- Encourage community partnerships, community committees, green voluntary organisations, and community ownership and management of all buildings to support local sustainable development practices
- Develop green communities criteria to bring the improved health, economic and environmental benefits of sustainable construction practices to low-income families.
- Create more energy-efficient and sustainable buildings and communities to reduce impact on climate change and save on household energy costs – using sustainable building materials, passive building design, energy efficient lighting and equipment, and integration of renewable energy (see building and construction – SUC for cities)
- Reduce the amount of waste and environmental footprint of buildings by using prefabricated products, materials with minimum waste rates (plywood, finger-jointed timber), and materials with recycled content (concrete with recycled aggregate, recycled steel reinforcement).
- Promote the implementation of locally sourced and recycled content sustainable materials, and construction solutions - rammed earth, earthcement, mortars and platers, mud blocks, durable bamboo, log walls construction, and lightweight framed construction.
- Encourage advanced sustainable building materials such as low carbon cements, bioconcrete, foam concrete, permeable asphalt, resin concrete, autoclaved aerated concrete, pervious concrete and insulating concrete.
- Adopt sustainable smart building materials and products that conserve energy and promote human well-being – building integrated solar and wind turbines, cool materials, home automation systems, lighting sensors and controls, powered vents and window openings, and powered window shutters and awnings.
- Adopt sustainable and smart building products that conserve water and promote human well-being – waterless toilets and urinals, batch composting toilets, self-contained composting toilets, dual flush toilets, low flow showers, motion sensor or low-flow taps, aerators, low flow high pressure fittings.

How and what to do

Zero energy or carbon zero or carbon neutral buildings - A Zero Energy Building (ZEB) produces as much energy as it uses over the course of a year, thereby reducing the use of non-renewable energy in the building sector (see carbon neutral districts). As a result, it is possible to reduce atmospheric carbon dioxide emissions. A zero-energy building can be achieved through a combination of green building technology, clever building design, intelligent energy efficiency strategies with renewable energy options, passive solar heating and cooling, passive design strategies (natural ventilation and lighting), reduces water use, and incorporates materials that enhance passive design strategy and have a low embodied energy (see materials) (figure 16).

Some important features of a zero-energy building –

- Solar passive design principles – ensuring effective orientation to maximise daylighting, appropriate glazing and window style, size and orientation to minimise summer heat gains and maximise winter solar heat gains, high thermal mass materials (reverse brick veneer and brick walling), high insulation valued roof and walls, pelmeted curtains;
- Natural daylighting and ventilation systems – mirror ducts, light shelves, light pipes, shading devices, glass bricks and solar assisted stack ventilation;
- Greenery Systems – Green roofs, Green walls, vertical gardens, local food production, vegetable gardens, home orchard, poultry, composting and worm farm system;
- Active and Smart lighting and ventilation systems – LED down lights, compact fluorescent globes, reversible ceiling fans, personalised ventilation, displacement cooling, motion sensors, and CO2 sensors;
- Solar energy – grid connected photovoltaic system, building integrated solar photovoltaic system, solar tubes, gas boosted solar water heating systems;
- Fixtures - High efficiency shower heads and tap ware, low volume dual flush toilets and hand wash basins
- Construction site management – locally sourced and salvaged materials for hard landscaping, permeable surfaces and paving
- Water efficiency and waste water management - direct diversion greywater systems, rainwater tanks, centrally controlled irrigation system, and weather monitoring

Figure 17: *Some features of zero energy buildings*

Amphibious buildings – the projected increase in rainfall intensity is likely to result in more flooding events. Possible impacts of such extreme events can severaly impact buildings. In places, where there is no alternative for avoiding building construction along river flood plains or on low-lying coastal areas, raising the floor heights, constructing multistorey buildings and using the lower level for non-living areas, using water resistant materials (e.g., concrete, fibre cement) and building a levee around the building can be adopted as simple adaptive strategies. A one step further to these simple strategies could be the amphibious buildings. The amphibious buildings are fastened to flexible mooring posts and rest on concrete foundations (Urban Green Blue Grids 2016a). If the river level rises, they move upwards and float. The floating homes are lowered when the water level drops and come to rest on concrete foundations. The fastenings to the mooring posts limit the motion caused by the water. The homes can handle fluctuations of up to 5.5 metres.

Amphibious buildings and the mooring posts (Maasbommel, The Netherlands)
Figure 18: *Amphibious buildings (atelier GROENBLAUW)*

Livable and adaptable buildings - A livable and adaptable building is based on the principles of 'universal design' — defined as the design of products and environments so that they are usable by all people, to the greatest extent possible, without the need for adaptation or specialised design (Palmer and Ward 2013). As the needs of individuals are specific to their personal circumstances there is no single solution to designing a building to meet changing needs; however, two major approaches exist:

Livable building: A livable building uses building features, fittings and products in combination to increase usability, benefiting people of all ages and abilities (Palmer and Ward 2013). It ensures that rooms and services within the home are of a size and type usable by as many people as possible. For example, slightly wider doorways or passageways are more easily navigated by users of mobility devices such as walking frames, wheelchairs or a child's pram. People with limited hand function find screw-type sink taps more difficult to use than lever-type taps, which can be used by everyone. The same applies to lever-type door handles and rocker electrical switches. Incorporating these fittings during construction reduces the need for later retrofitting.

Adaptable building: An adaptable building adopts the idea of a livable house but in addition is able to be easily adapted to become an accessible house if the need should arise (figure 19). Although such a need is unlikely in every home, by allowing enough space for wheelchairs, other equipment such as walking frames, prams and trolleys can be better accommodated.

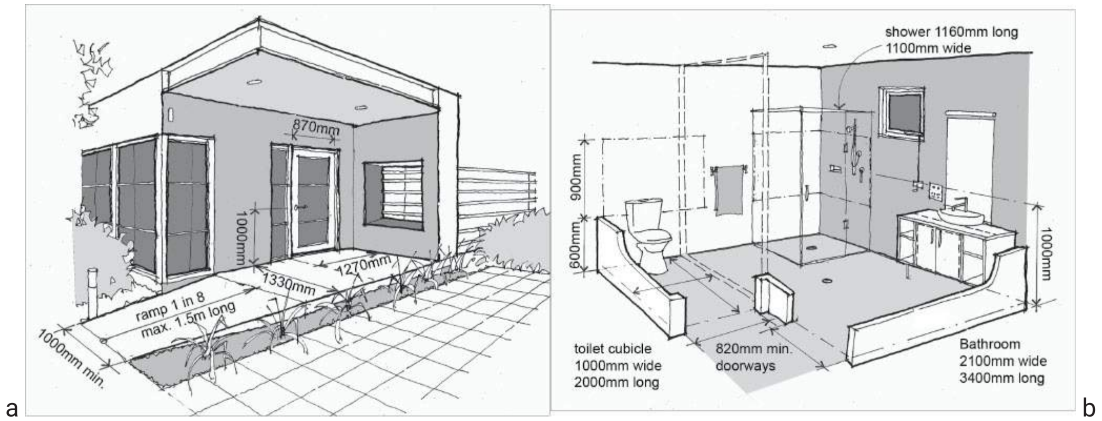


Figure 19: *Adaptable house: a. access b. wet areas (YourHome)*

Although single level homes seem an obvious choice for accessible housing, two or more storey houses and apartments can also be suitable for adaptation. The ground floor of a multi-level house can be accessible to visitors with a disability or even accommodate an occupant with a temporary disability. In addition to access between living, kitchen and bathroom spaces, include an accessible bathroom and a space appropriate for use as a bedroom on the ground floor. To facilitate multi-level access, floor plans should allow for the future installation of vertical lifts or staircase lifts.

Sustainable construction - sustainable building techniques make new and existng buildings healthier, more durable, energy and water efficient and help communities create housing that is more affordable for residents and more environmentally sustainable. Usng cost-effective methods to create high performance building envelopes advance local green building capacity and help households to save money on energy costs. The sustainable building guidelines are organised as follows:

- High performance buildings
- Sustainable and indigenous landscaping
- Green infrastructure
- Green construction, operations and maintence

Sustainable building construction

OBJECTIVES	GUIDELINES
High performance buildings	
Create high performance residential projects to reduce household water consumption, protect natural water suppl, and reduce energy consumption and greenhouse gas emission	Use water-efficient fixtures, such watersense labeled products • Showerheads with a flow of less than 2 gallons per minute • Toilets that use less than 1.6 gallons per flush (gpf), waterless or waterefficient toilets and urinals and dual flush toilets (2/4 litre or 4/6) • Urinals that are waterless or use less than 1 gpf • Implement, where possible, ENERGY STAR rated new residential buildings
Design and construct soumd building envelope	Complete thermal bypass checklist Incorporate skylights, mirror ducts, light shelves
Design and install high performance heating/ventilation/air conditining system	Install district heating system, solar assisted stack ventilation, continous reverse wind circulation system, and smart air conditioning systems, such as sensors, personal breathing zones and recycling of air for ambient cooling
Specify and install energy efficient appliances and lighting	Install water efficient washing machines, floor diffusers, aerators and low flow high pressure fittings and plumbing system, advanced lighting systems, such as task lighting.
Encourage construction methods that ensure healthy indoor air quality Install green walls, balcony gardens, CO2 sensors to monitor indoor air quality	Install green walls, balcony gardens, CO2 sensors to monitor indoor air quality
Green infrastructure	
Incorporate stormwater management aspects as part of neighbourhood design	• Use green infrastructure, such as bioswales, green roofs, biofiltration and pervious pavement • Minimise impervious pavers using gravel, block pavers, open grid pavers, and other pervious surfaces • Encourage green infrastructure features, such as community gardens, rain gardens and large canopy trees
Mitigate heat island impacts	Use high reflective cool roof and paving materials Encourage street trees to shade sidewalks and hard surface areas
Green energy production and supply	
Encourage community owned onsite energy production	Install renewable energy technologies, such as community solar, wind

Guidelines for building materials – sustainable buildings consider materials, products, appliances and techniques that not only conserve resources, but also reduce household energy and water costs. They should consider the lifecycle of materials, selecting efficient, recycled or recyclable construction and finish materials. To the greatest extent possible, use materials that have minimised environmental and health impacts over their lifecycle:

- Encourage recycled or recyclable building and finish materials
- Encourage locally available, indigenous materials and/or products that have been certified under a trusted green program
- Encourge healthier and durable materials. For example, some flooring options include:
  - Living areas and bedrooms – wood harvested from a certified sustainably managed forest, salvaged or reclaimed woods, cork (a fast growing, renewable material), and carpets certified
  - Entry way, kitchen, and other wet areas – ceramic tile, linoleum, rubber, sealed concrete
  - Basement – exposed slab with low-VOC stain
  - Bedrooms – natural fiber, green label carpets, and those suggested for the living areas

To consider reuse at the end of a product or building's life, consider using nails and screws instead of adhesives when practicable.

Building construction materials – there are many and varied sustainable building construction systems and materials (figure 20), and each has different features, benefits and advantages. The below provided list of construction solutions can contribute to overall sustainability in cities.

CONSTRUCTION SYSTEM	TECHNICAL FEATURES	BENEFITS	TYPES	MATERIALS USED
Lightweight framing	Light	Comfort, appeal, environmental performance		steel and timber
Brickwork and blockwork	High thermal mass, good compressive strength, light	Durable		brick, stone (e.g. marble, granite, travertine, limestone), manufactured stone, concrete, glass, stucco and tile
Concrete slab floors	High thermal mass	Thermal comfort	on-ground, suspended, or a mix of both	Concrete, cement 'extenders' (e.g. fly ash, ground blast furnace slag, silica fume), new cements (e.g. geopolymers, magnesium cements), and alternative forms of concrete (e.g. bioconcrete)
Insulating concrete forms	High thermal mass	Thermal performance		polystyrene or polyurethane foam, and filled with concrete
Autoclaved aerated concrete	Light, moderate embodied energy, high thermal mass	Fire barrier, thermal and sound insulation	blocks, storey-height wall panels, and floor or roof panels	Concrete
Mud brick	low embodied energy	thermal and sound insulation	Bricks or blocks	Earth, water, straw or other fibres
Rammed earth	High thermal mass	High strength (with a little cement)		ravel, sand, silt and clay

Durable bamboo (pxHere) *Autoclaved aerated concrete (pinterest)* *Compressed mud blocks and rammed earth constructions (emiworld, wikimedia commons)*

Figure 20: *Examples of sustainable construction materials*

Best Practices

Cool materials – cool materials are materials with very high reflectivity and a high emissivity value. Cool materials can mitigate urban heat islands, reduce cooling-energy use in air-conditioned buildings, increase comfort in unconditioned buildings, and improve outdoor air quality and outdoor thermal comfort (Despini et al. 2016, p.228).

Cool materials for roofs and façades: The common reflective materials applied to building surfaces are white and may be single ply or liquids (figure 21) (Santamouris 2015). Typical liquid products are usually white paints, elastomeric, acrylic or polyurethane coatings, while single ply products are EPDM (ethylene propylenediene tetrolymer membrane), CPE (chlorinated polyethylene), PVC (polyvinyl chloride), TPO (thermoplastic polyolefin), and CPSE, (chlorosulfonated polyethylene) (Santamouris 2015, p. 50). These products consist of silicone, acrylic, or polymer liquids that look and feel like a very thick paint. In the recent years, coloured thermochromics materials that become more reflective at higher temperatures have been developed (Akbari and Kolokotsa 2016). With these materials, building owners do not need to compromise on the aesthetics of their buildings (see appendix for a list of existing cool roof materials). Cool roof coatings on a low-slope roof might cost $0.75–$1.50 per square foot, while single-ply cool roof membrane costs vary from $1.50–$3.00 per square foot. The cost premium for cool roofs versus conventional roofing materials ranges from zero to 5 or 10 cents per square foot for most products, or from 10–20 cents for a built-up roof with a cool coating used in place of smooth asphalt or aluminium coating.

Cool materials for outdoor surfaces - The standard reflective paving materials used are fly ash (concrete additive), chip seal, slurry coating (also called 'micro-surfacing', 'fog coating', 'overlay'), reflective synthetic binders, and light-colour coating. In the recent years, very high reflective materials for pavements, including water retentive or permeable systems, infrared reflective coatings, heat reflecting coatings, colour changing coatings, nanotechnology additives (e.g., emerald coloured coating) and photovoltaicbased pavements, have been developed.

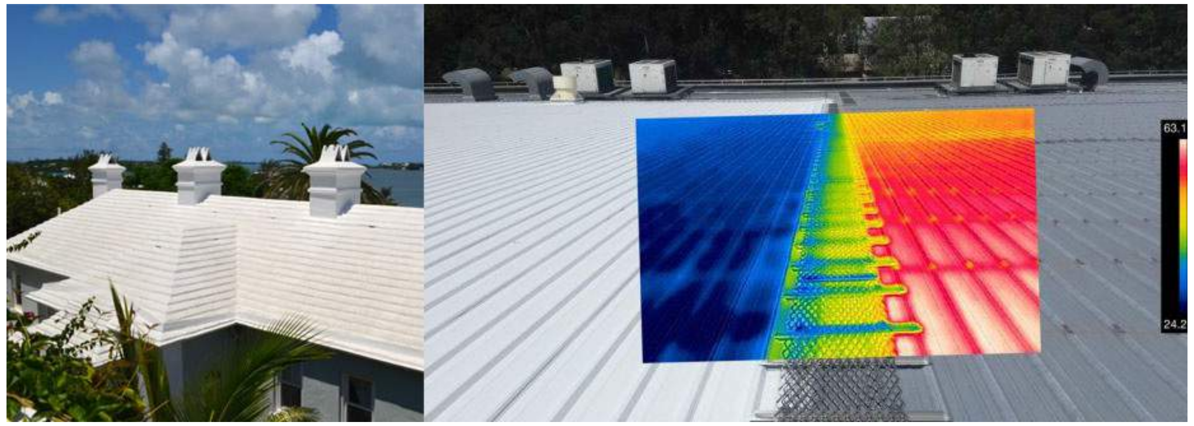


Figure 21: *Cool materials for buildings and outdoor surfaces (digital commons) (skycool)*

Permeable materials – urban surfaces can also be cooled via increased permeability. non-traditional cool pavements made from plastic, metal or concrete, filled with a variety of cool materials (even vegetation) and laid in place over a prepared base can be permeable (Osmond and Sharifi 2017). Being permeable and filled by reflective materials or vegetation, block pavers provide cool pavement products that can be used in low traffic areas such as driveways and shared pathways (figure 22). Permeable materials also facilitate water drainage and moisture evaporation more efficiently than conventional paved surfaces. This allows storm water to drain through permeable pavement and the water stored in the soil beneath the pavement can cool the pavement surface through evaporation. Permeable materials can decrease surface temperature by up to 20°C. Examples of permeable materials include foam concrete, permeable asphalt and resin concrete.

Figure 22: *Examples of permeable materials (flickr)*

Examples

Sustainable building construction, Aroville city, India:
Auroville, a city in South India, is one of the world's best example in earthern architecture. Over the last five decades, Auroville has been leading research, development, promotion and implementation of advanced earth-based building technologies. Auroville Earth Institute (AVEI) has been attempting to revive traditional skills and linking vernacular traditions of raw earth construction with the modern technology of stabilised earth through development of cost effective, low carbon, low embodied energy earthern technologies for sustainable development (figure 23).

Figure 23: *Earthen architecture in Auroville city (Auroville)*

Josh's House, Perth, Australia:
http://joshshouse.com.au/

The Josh's House project consists of two 10 star energy efficient, high performance and zero emissions homes located in the Fremantle suburb of Hilton, Australia. The homes are located on a 1160 square meter property site. The homes use 10% less energy than a typical Australian new house, saving the occupants an average of $2,000 per year in energy costs. The houses emit 10% less greenhouse gas emissions than normally emitted by Australian dwellings and use around 40% less water of a typical Perth home.

The project has an integrated monitoring system, with 70 individual channels of data logging to monitor temperature, wind, humidity, rainfall and solar radiation, internal room temperatures, as well as slab, ceiling and roof surface temperatures. It has metering of all water sources as well as gas and electrical supply (grid and roof-top solar) and their respective sub-metered usage. This will enable a detailed thermal and operational energy footprint to be determined for the complete site, including the energy footprint of all water supplies for example, thereby informing the performance of best practice sustainable design.

Figure 24: *Sustainability features of Josh's house (rainwater harvesting, productive garden) (josh'shouse)*

The project has an integrated monitoring system, with 70 individual channels of data logging to monitor temperature, wind, humidity, rainfall and solar radiation, internal room temperatures, as well as slab, ceiling and roof surface temperatures. It has metering of all water sources as well as gas and electrical supply (grid and roof-top solar) and their respective submetered usage. This will enable a detailed thermal and operational energy footprint to be determined for the complete site, including the energy footprint of all water supplies for example, thereby informing the performance of best practice sustainable design.

Singapore zero energy building:
https://www.bca.gov.sg/zeb/

The BCA Academy in Singapore is the first ZEB in South-East Asia retrofitted from an exisitng building. It was converted from a three-storey former workshop. The building saves S$84,000 a year in energy cost compared to a typical office in Singapore (BCA 2010). The building effectively makes use of simple natural daylighting and ventilation systems, such as mirror ducts, light pipes and light shelves to reflect daylight deep into space and provide shade against direct sunlight, solar assisted stack ventilation, advanced window glazing systems (e.g., electrochromic glass, photovoltaic glass, double glazed unit with internal operable glass) as well as green roofs and green walls.

Highlands' Garden Village – Denver, USA:

Highlands' Garden Village, developed by Jonathan Rose companies, is a mixed-use transit oriented development on the site of a former amusement park. The community's range of housing types and price points demonstrate that smaller, infill sites can accommodate diversity and also enhance economic and social viability.

The village is an early example of the extensive use of sustainable building and planning techniques at the neighbourhood scale. The single-family homes exceed ENERGY STAR program requirements. All of the buildings incorporated recycled materials, Low-VOC products and energy efficient windows. The neighbourhood's road beds are constructed from concrete recycled directly on site from the demolition of the amusement park. The landscaping consists of water-conserving native plants and special efforts were made to keep many of the site's existing trees. All of the community buildings are powered with alternative energy sources.

Bo01 district, Malmö, Sweden:

The Bo01 district in Malmö, Sweden, is supplied by 100% renewable energy and serves as an example for sustainable neighbourhood projects across the world. Bo01 was realised on a polluted former industrial estate/ port land. The gross area of Bo01 is 54 acres, with a population density of 43 people per acre (compared to 7.6 people per acre for the city of Malmö). 70 buildings accomodate 1,425 dwelling units, making the gross density more than 26 dwelling units per acre. The district is characterised by its use of recycled water, raw materials and waste, and natural resources such as sun and wind energy. By stimulating a great deal of diversity in the architecture without the usual restrictions, the district's planners have created an unusual living laboratory.

The Bo01 system produces 5,800 MWh of heath, 5,000 MWh cooling and 6,300 MWh electricity. Solar panels on the roofs (120m2) supply a fifth of the heat; the remainder comes from thermal heating and district heating system. Recyclable and organic materials contribute to energy production via the city's biogas plant. All dwellings and sorroundings have been built with sustainable and healthy building materials to reduce energy consumption. The district has been designed to provide heat and electricity to 85,000 m2 of living space. To restrict the usage of energy and heat, there were contracts made with the building developers. All homes have internet connections to enable quick access to water and energy consumption data.

Hoogeland, Naaldwijk, The Netherlands:

The district of Hoogeland in Naaldwijk is an example of sustainable buildings for low-income families through lower living costs on the one hand and fossil fuels use reduction on the other hand (figure 32). The district has 800 homes built on the heat from tomato greenhouses. The CO2 emissions from these homes are 40% lower than the emissions from comparable buildings. The project includes homes in every price range, for each desired group and there is a high level of facilities available. In the nearby greenhouses the summer heat surplus is stored underground. To retain the heat created in the summer, the greenhouses are not cooled in the summer by opening the windows but are kept closed. This also makes the extra CO2 that is brought into the greenhouses available for the plants. In the winter the stored heat is used to heat the greenhouses and the homes. All homes have floor heating and cooling. The cool air stored in the winter is used to cool both the greenhouses and the homes in the summer.

What is special about this system is that the homes have individual heat pumps. These water pumps draw heat from the lukewarm water network (16°C) that was installed in the district. This also produces warm tap water. The homes have no natural gas.

Action Point Five: Operation and Management

Introduction

Sustainable operation and management of cities and their infrastructure, including energy, waste, water, and public spaces, has been a key agenda for urban policy makers and professional practitioners. Planning efforts of many local governments from across the world show that new and innovative ways for sustainable city management is important for realising sustainable cities. Besides national and international organisations, such as such as the World Business Council for Sustainable Development, Global Reporting Initiative, Organisation for Economic Co-operation and Development's Sustainable Development Standards, and United Nation's Transforming Our World: the 2030 Agenda for Sustainable Development, academia and industry have also contributed to the development of tools, technologies and methods for sustainable urban management (Yigitcanlar and Kamruzzaman 2015).

Moreover, sustainable transport choices, initiatives and programs that foster community ownership, and community participation play an important role in smartness and sustainable management of communities. Any program on sustainable managemnt of cities and communities should focus on building strong relations within local communities, respecting heritage and culture, Creating real opportunities via direct and indirect employment, education and training, and cultural support and awareness (Cleanway 2017).. It should also provide opportunities for inclusion of communities of all sizes, structures and types, at their respective level of responsibility.

Key strategies and technologies

- Encourage innovative tools, indicators and technologies, such as smart information and alert systems, smart heatwave warning systems, urban heat island decisionmaking tool, cool roof calculator, to manage safe places and to support informed decisionmaking on safety and vulnerability.
- Encourage sustainable and low-carbon transport systems to manage traffic, air quality and accessibility – using electric vehicle cities and demonstration zones, hydrogen fuel-cell vehicles, and hybrid ferries.
- Undertake urban planning initiatives that promote, protect and protect local, natural, marine and other protected environments – using naturebased solutions, urban farming, urban wetlands, green infrastructure and green grids (see green grids).
- Develop intelligent energy initiatives to reduce energy demand and use and improve urban climate. An optimal energy infrastructure will ensure that the available energy is used and reused in the most efficient manner.
- Adopt and promote sustainable and smart technologies, such as green roofs, vertical gardens, smart air pollution systems, green grids to manage and improve quality
- Implement policies, programs and sustainable and smart technologies to manage waste (e.g., third-zone automated waste management system, recycled building materials), energy demand and use (e.g., home automation systems, building integrated solar and wind systems, smart energy management systems, smart building controls), water (e.g., pervious materials, green roofs, green water management systems, intelligent water sensing technologies), sanitation (e.g., membrane filtration, helophyte filters, living machines).
- Develop safe and sustainable local transport infrastructure and initiatives, including futuristic cycleways, street networks and public spaces (e.g., tree lined boulevards, extra-wide footpaths, low-speed inner streets, elegant street furniture).

- Develop state-of-the art community facilities (e.g., entertainment venues, cultural centres, disabled and elderly friendly facilities, public plaza or an open community living room, open space for public art, quiet recreation areas, picnic and play areas, boardwalks, all-weather sports fields) to create a vibrant civic and cultural life
- Design and implement public spaces for community gardens, children gardens, and other different types of urban farms to enhance community interaction
- Encourage community culture and activities and implement programs that support public health and lifestyle
- Enhance innovative participatory and integrated community education programs on sustainability and make relevant education and information resources available and accessible to encourage sustainable, healthy and environmental friendly behaviour.

How and what to do

Smart energy management system - Smart energy monitoring and management system can be a means to uninterrupted electricity supply, reduced energy consumption, lesser energy costs and improved ecological profile. A smart energy management system (SEMS) consists of two major subsystems: energy generation and energy management. Energy generation subsystem includes components required for generating electricity from multiple energy sources (photo-voltaic, wind turbine, thermal). Energy management subsystem includes energy storage and current conversion components, weather station and system control module. A SEMS is controlled by firmware and software packages that are embedded into control module (figure 25). It enables smart and contextual energy sharing that not only reduces energy consumption and subsequently CO2 emissions, but also ensures that energy is available and allocated to major urban facility systems as needed in the event of natural disasters or other events (Urban Land Institute 2018).

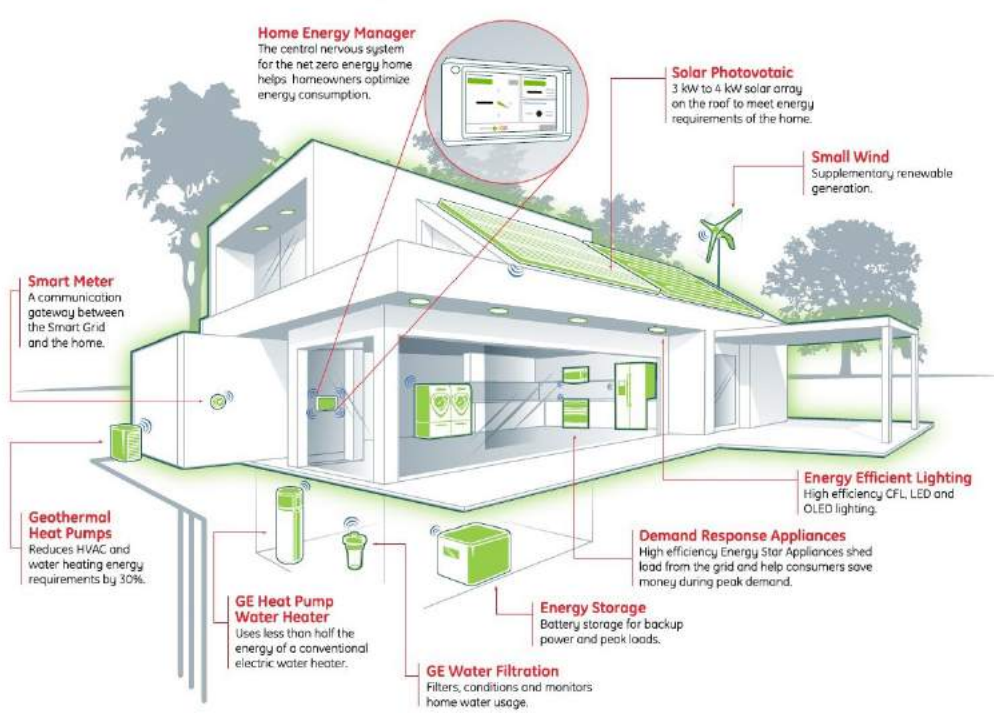


Figure 25: *S mart home energy management (wikimedia commons)*

SEMS comes in number of forms: (i) Advanced Metering Infrastructure (AMI), (ii) Community Energy Management System (CEMS), (iii) Home Energy Management System (HEMS), (iv) Building Energy Management System (BEMS), (v) Factory Energy Management System (FEMS), (vi) Area Energy Management System (AEMS), (vii) Distributed Energy Management System (D-EMS), (viii) Distribution Management System (DMS), (viii) Demand Side Management, (viii) Electric Vehicle Energy Management System, and (ix) Regional Energy Management System(REMS).

Stormwater management - The traditional model of stormwater management is based on the draining of urban runoff as quick as possible with the help of channels and pipes. This type of solution only transfers flood problems from one section of the basin to another section. A more sustainable stormwater management system not only manages freshwater, wastewater, and stormwater, but also improve water supply and consumption efficiency, mitigate urban heat island through retention of water, support wildlife habitat and improve property and public space values. Some innovative examples of stormwater management systems are discussed further below (figure 26).

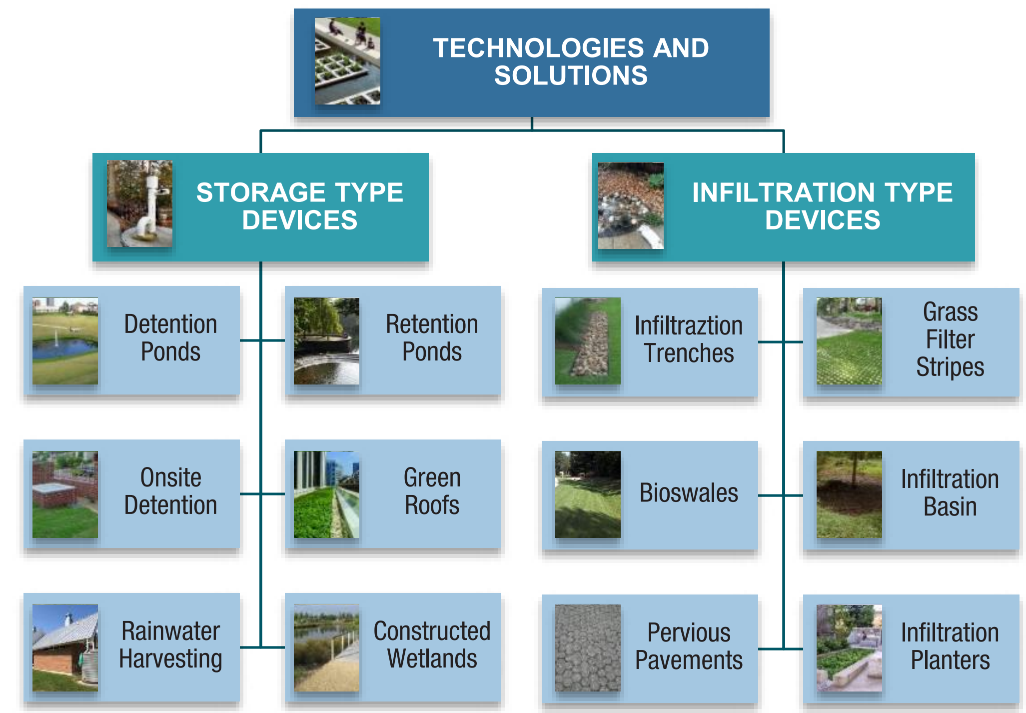


Figure 26: *Sustainable rainwater management solutions*

Bioswales - Bioswale is a ditch with vegetation and a porous bottom (figure 27). The top layer consists of enhanced soil with plants. Below that layer is a layer of gravel, scoria or baked clay pellets packed in geotextile. These materials have large empty spaces, allowing the rainwater to drain off. The layer is packed in geotextile to prevent the layer from becoming clogged by sludge or roots (Urban Green Blue Grids 2016b). An infiltration pipe/drainpipe is situated below the second layer. Bioswales are suitable for areas with porous types of ground and relatively low groundwater levels. The highest possible groundwater level at which a bioswale system can be introduced is -1.5 metres, and preferably even -2 metres.

Roads that carry more than 1000 vehicles per 24 hours must always have a connection to the sewer system. The area required to build a bioswale is approximately 16% of the total area of a new district. The banks of a bioswale should be no steeper than 1:3 to allow mowing.

Figure 27: *Bioswales and Green Roofs (wikimedia commons)*

Green roofs - 'Green roofs' is a collective term which includes moss/sedum roofs, grass/herb roofs and is used for walkable planted roofs and sloping roofs. In principle four kinds fo green roofs can be discerned. The major difference lies in the intensity of the required care as well as the different way of constructing. Green roofs can be installed on roofs with slopes ranging from 10 to 35°. At more than 35° extra provisions are required to prevent sliding. teeper roofs dry out faster due to the faster runoff of rainwater. For rainwater retention, a slope of up to 7° is most efficient.

Green roofs can also contribute to other benefits. The US Environmental Protection Agency (EPA) states that one green roof can capture 1 kg of particulate matter per m2, capturing it in the soil and in the vegetation. On summer days the temperature under a green roof can be 3°C to 5°C lower compared to similar spaces under a conventional roof. Green roofs can also reduce reverberation by absorbing sound by approximately 3 dB and can increase the soundproofing quality by approximately 8 dB. Green roofs have a positive effect on the quality of life in a city, but are also enrichment to the urban landscape with its visible, walkable natural areas.

Types of Green roofs

EXTENSIVE	SEMI-INTENSIVE	INTENSIVE	ELEVATED LANDSCAPE
			
Light weight	Combines extensve and intensive	Better insulation	similar insulation as existing ground surface
Low prostate vegetation	Greater plant diversity	Diversity biodiversity potential	greatest potential for biodiversity
Often inaccessible	Partially accessible	Accessible for greater use	New ground plane
50-150mm substrate depth	+/- 50mm – 150mm substrate depth	>150mm substrate depth	600mm substrate depth

'Rainwater ponds – Systems for buffering and purifying extremely polluted water should be sealed from the ground by means of a film. These systems are often used to pre-purify rainwater running off from busy roads and car parks. These systems have a ground filter that offers a good purification yield, and always feature an overflow that can be connected to surface water or an infiltration system (figure 28). Only if no surface water is available in the immediate vicinity and infiltration is impossible should the overflow be connected to the sewer system.

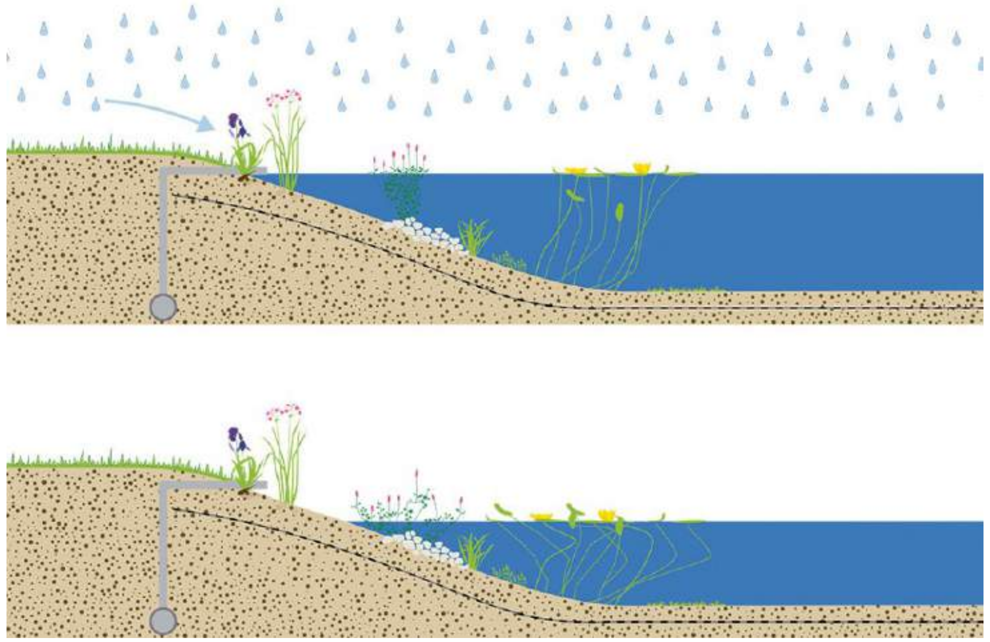


Figure 28: *Section of rainwater ponds showing higher water level (during rainfall) and with a lower water level during non-rainfall period*

Water squares - Water squares are generally used in densely built-up innercity areas where high groundwater levels make infiltration impossible (figure 29). These systems are linked to other urban functions such as playing areas, green areas and residential functions. The squares feature lower-lying areas that can be submerged in case of heavy rainfall (Urban green Blue Grids 2016p). The run-off from the surrounding district is connected to the square by open drains or rainwater drainage systems. After rainfall, the lowest parts of the water square fill up first, and the water remains there for long time. The great buffering height, combined with the low position compared with the level of the surrounding surfaces, mostly means that the square's lowest point is situated below the groundwater level. To prevent the square from filling with groundwater in these situations, the square's buffering facility has to be waterproofed.

Figure 29: *Water square design principles (atelier GROENBLAUW)*

Waste-water management – when managed properly and carefully through sustainable sewage treatment processes, wastewater, including blackwater, greywater and sewage, can be managed in a relatively safe and environmentally sustainable way. Traditionally, waste water is treated in a single large sewage treatment plant or decentralised small sewage treatment plant. However, in the recent years, a number of sustainable waster water treatment technologies have emerged. Some of the innovative examples are discussed here.

Helophyte Filter System - A decentralised Helophyte Filter facility is a cost effective, efficient and cleaner method for sewer water treatment in towns and cities. A Helophyte filter system is a natural water purification process. Helophytes are plants that are rooted in the soil, but with a relatively large surface area above the water surface. Tule, bulrush and reed are the most commonly used plants for these filters. There are three types of helophyte filter systems: vertical, aerated vertical and horizontal filters (figure 30). The benefit of the helophyte filter system is that it is not necessary to break open a series of streets and is financially attractive. The system uses uses no extra artificial energy supply or other necessary substances and requires little maintenance. The space required might present a disadvantage (up to 5 m²/for a vertical filter system), although it is easy to incorporate aesthetically and so enhances the quality of the surrounding area.

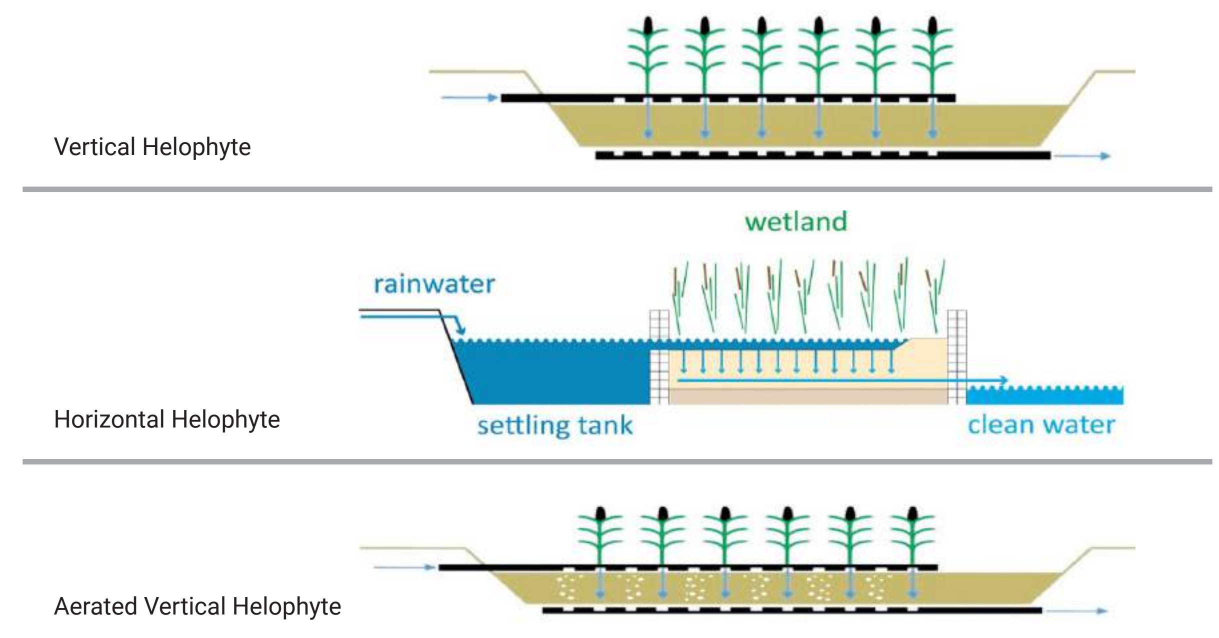


Figure 30: *Figure 30: Types of Helophyte Filters (atelier GROENBLAUW)*

Living Machine - The principles used in a Living Machine are the same as those of helophyte filters. However, in a Living Machine, part of the biological treatment takes place in a compact greenhouse (figure 31) (Urban Green Blue Grids 2016i). The greenhouse serves to protect the subtropical plants that make up part of the treatment process from the cold and so to increase their effectiveness.The protective atmosphere in the hot-house means that other plants and animals can also be incorporated into the treatment process, such as tropical plants, zooplankton, fish, vegetables, etc. Living Machines are relatively compact, and the subtropical vegetation in the greenhouses also makes them appealing to visitors.

Figure 31: *Living Machine (theecologist)*

Urban gardens - Urban gardens, also known as urban farming, refers to growing plants to produce food within a city and encompasses processing and then distributing that food throughout the city. Urban gardens are gaining much attention across the world not only for their contribution to the food supply of a city or a community but also for their role in the reduction of urban surface temperatures and therefore to the air tempeature, improvement in air quality, and more importantly developing social contact and engaging city residents and communities through food production.

A list of urban gardens

NO.	TYPE	YIELD USE	LOCATION
1	Micro-farming	Own consumption or is shared with friends and family	Square metre boxes, balconies, roof-top terraces, private gardens and window sills
2	Multi-cultural gardens or community gardens	Own needs and shared with community members	Community plots and vacant lots
3	Guerilla gardens	Own needs and shared with friends, family and community members	Vacant lots or roofs
4	Garden plots	Own needs and shared with friends and family	Specially-assigned land
5	Institutional gardens (greenhouses on institutional buildings)	Educational, therapeutic or social purposes	Hospitals, schools, prisons, etc.
City level			
6	Small-scale commercial or semi-commercial (including acquaponics)	Own use and for the market	Edge of the city
7	Small-scale commercial or semi-commercial stock-breading businesses or aqua-culture businesses	Own use and for the market	Edge of the city
8	Specialised businesses	Market	Edge of the city
9	Large-scale agro-businesses (including Greenhouse farming)	Market	Edge of the city
10	Multi-functional urban agricultural businesses	Market	Both edge of the city and in the city

Square metre garden: A “square metre garden” is a garden in a box. It has a surface area of 1 x 1 metre and is 20 cm deep. These mini-plots are very simple to construct and can often be especially suitable for growing herbs, vegetables and fruits.

Home or community vegetable gardens: a home or a community garden can provide just about all of a family or community’s fruit and vegetable needs (figure 32). A community vegetable garden are of three types and each one of them have the following measurements per person - i) partial selfsufficiency: 25 m2 (vegetables, fruit and herbs, including paths and composting), ii) extensive self-sufficiency: 70 m2, and iii) Complete selfsufficiency: 170 m2 of which, 20 m2 for vegetables for immediate consumption, 40 m2 for preserving and potatoes, 100 m2 for fruits and nuts, and 10 m2 for paths and composting (Urban Green Blue Grids 2016o)..

Figure 32: *Home or community vegetable gardens (wikimedia commons)*

Greenhouse gardens: The modern greenhouse gardening is an advanced system of urban gardening and is differently to old ones. There is a shade cloth to keep the light inside slightly subdued so that the plants do not burn. The walls are tapered out and the glass is furnished right to the bottom to allow the light to pour in at all levels. The floor is gravel as opposed to concrete to keep the indoor atmosphere wet by watering the floor. A range of different types of furniture, such as flats and benches for pots, and tables for potting plants is included. The average flat is about 10" x 20". So a 6 ft x 2 ft bench will hold about 7 flats. Greenhouses have an adjustable vent in the roof to allow hot air to escape. A 10 ft x 10 ft is the minimum size for a greenhouse, but a 6 ft x 6 ft greenhouse can also be implemented.

Rooftop gardens: there is a great potential for rooftop gardens in urban areas due to the limitation of space. Extra incentives for rooftop gardens include keeping the buildings cool and reducing the amount of energy used for air conditioning. For easy implementation and maintenance, the size of rooftop gardens shall not exceed 15,625 square feet (1,450 square meters) in size for any single area with a maximum dimension of 125 feet (39 m) in length or width. A minimum 6-foot-wide (1.8 m).

Aquaponics gardens: Aquaponics is a garden system in which aquaculture and agriculture exists together. The nutrients from the fish waste are used to grow plants. The most common types of acquaponic systems are media filled beds, nutrient film technique (NFT), and deep water culture (DWC) (Backyard Aquaponics 2012).

Nature playing areas for children: Natural playing areas help children's development, wellbeing and health. Improving the relationship between young people and nature is becoming an increasingly important task. Building huts from branches and clay, sailing in boats and on rafts, splashing around in water, catching tadpoles and building campfires – all of these activities are possible in a nature playground (figure 33). Natural playgrounds also offer ample opportunities for daydreaming and wonder, for hiding away from daily life and enjoying time and space (Urban Green Blue Grids 2016n).
Design elements that are part of a natural playground are varied topography, water features and waterways with rocks, a sandpit, trees for climbing, shrubs with paths running through them for hiding and loose branches for building huts; other elements that can be added are rafts, fire pits, paths with trees, tree huts, ponds with small islands, etcetera. Planting high fruit trees, nut trees and berries is a useful addition to introduce children to the concept of food production. These playing facilities might be part of the district's green facilities, and in existing districts traditional play areas can be transformed into natural playgrounds. Urban courtyards, schoolyards and unused residual spaces can also be transformed.

Figure 33: *Nature playing areas for children (wikimedia commons)*

Green squares – designing green squares using a combination of vegetation and water features can be a comprehensive solution that also helps to reduce heat stress, enhance biodiversity, naturally improve the aesthetic value and connect people. The design is generally based on the principle that the square should have its own highly useful and aesthetically pleasing identity. The mostly green should have a lowered and paved central area that can be designed as a buffer for rainwater (figure 34). This subtle approach can be adapted to virtually any urban situation. The square can become attractive in terms of connecting the metropolitan scale with the finely-meshed human scale of the square, but also in terms of focus on creating a pleasant urban climate. The outcome is a greener and more appealing community with more water storage.

Figure 34: *Public Green square, Paris (wikipedia)*

Sustainable transport infrastructure – the co-location of sustainable transport infrastructure and public spaces can increase human interaction over places and at the same improve community environment. Develop a package of sustainable transport infrstructure, such as (Complete streets). ! Median and refuge island: refuge medians allow people crossing the street to have chance to safely wait for traffic

- Mid-block crossing and curb extensions: sidewalk 'bump-outs' reduce the time needed to cross the street and increase safety
- Pedestrain signage: pedestrian signs help provide information/direction, and help celebrate the community brand
- High-visibility crosswalks: increase awareness of places where people cross the street
- Outdoor dining and street furnishings: places to sit and rest along the street provide comfort for pedestians
- Side walks: minimum sidewalk widths create space on the street for amenities and gathering

More natural traffic spaces – For traffic spaces the adage is: only pave if necessary, and make the pavement as porous as possible for water and air. As such, green verges and zones along roads make the city more habitable and provide space for flora and fauna (figure 35). This is also better for water management and for public recreation. Alternatives for the average traffic load are pavement with larger seams or stabilised sand. Footpaths can also be made with materials such as shells, gravel or lava stone, or as sandy walkways. In the Netherlands, clinkers with sand are a tried and true pavement type that can replace asphalt in many cases (Urban Green Blue Grids 2016k).

Green ventilation grids - A grid of parks and small areas of vegetation that are connected to one another not only affects the microclimate and the residential buildings adjacent to the green areas, but in periods of heat stress will offer more pleasant places for people to be and a pleasant network for slow-moving traffic (figure 35). Green grids connected with the cooler countryside make it possible for air to move. The vegetation in these green grids should not be planted too close together, to make it possible for the wind to pass through them.

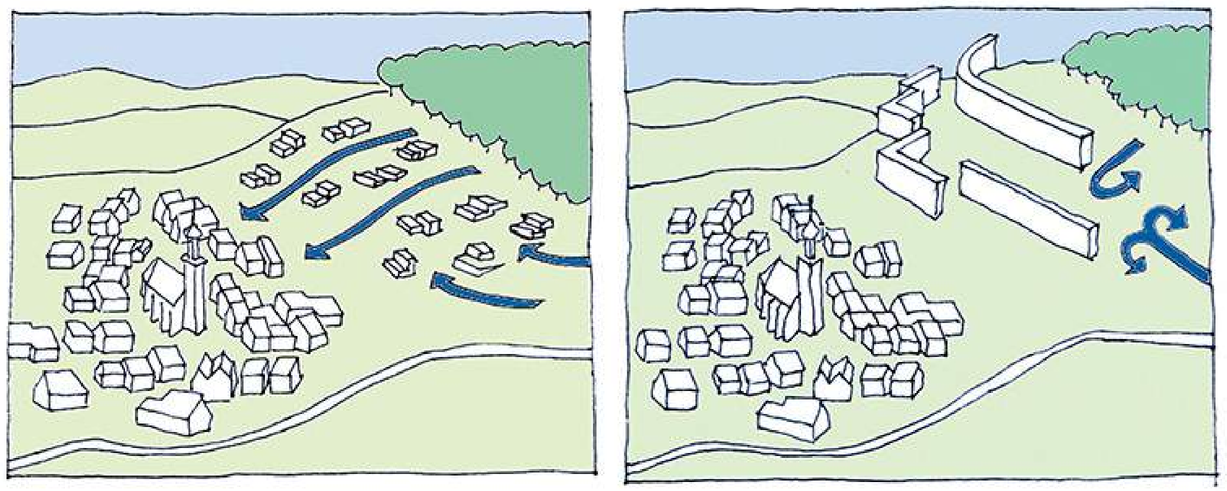


Figure 35: *Design pattern of green grids (atelier GROENBLAUW)*

Examples

Smart Energy Management in Kashiwa-no-Ha Smart city, Japan:
http://www.kashiwanoha-smartcity.com/en/concept/environment.html

Kashiwa-no-ha Smart City optimizes energy usage for the entire city. The smart center controls energy by absorbing variations in a local community's power consumption and manage peak cuts (Urban Land Institute 2018). It optimises energy supply to buildings and industries through controlling energy infrastructure and demand schedule operation, and visualises energy consumption at building level in residences, retailers, offices, and other areas—and provides advice on use, consumption forecasts based on past patterns, and even weather advisories— thereby empower residents of their impact on the environment in terms of CO2 emissions and of the need to manage their energy use. The center has also started operating Japan's first smart grid that shares solar, storage cell, and other distributed power sources between districts.

Joint Emergency Management, Nanning City:
http://cerc.nanning.gov.cn/

Nanning City in Guangxi Province was awarded the Habitat Scroll of Honour Awards in 2007 due to the fact that the city implemented the very first set of "joint city emergency response system" in China. established China's first city emergency response joint system, integrating police patrol, fire alarm, medical first aid, traffic warden as well as emergency rescue of flood, earthquake, air defense, residential water, electricity and gas leak etc under uniform command and dispatching system. It only takes 2 seconds to response to emergencies. The UN-Habitat recognized the system excellent and replicable and regarded as a benchmark for promoting "safer Asia urban plans".

This System consists of wired and wireless communication, satellite communication and computer network. It achieves uniform command and dispatching system, integrating police patrol, fire alarm, medical first aid, traffic warden as well as emergency rescue of flood, earthquake, air defense, residential water, electricity and gas leak etc. Citizens only need to dial a service line to call for help or complain. Meanwhile, the system adopts advanced computer communication to obtain detail address of citizens who call for help and rescue resources distributed nearby. According to categories of incidents, information network will automatically provide related background and optimal solution; the chief will immediately command based on these information even cross police regions, divisions and classification; once receiving the command, related joint bodies will go onsite to solve the problems. In this way, these decentralized resources will be connected and shared to maximumly reduce damage and loss of people's lives and national properties.

Rainwater storage below buildings, Rotterdam:

The Rotterdam municipal authorities have realised an underground rainwater storage facility linked to the new parking garage beneath Museumplein square (figure 36) (Urban Green Blue Grids 2016m). The underground water storage has a volume of 10,000m3 and has been incorporated into the design of the parking garage. It is a separate reservoir, part of which utilises residual spaces beneath the parking garage, such as the space below the entrances and exits. With the realisation of this reservoir, Rotterdam has created 12% of the water storage capacity needed for the city centre.

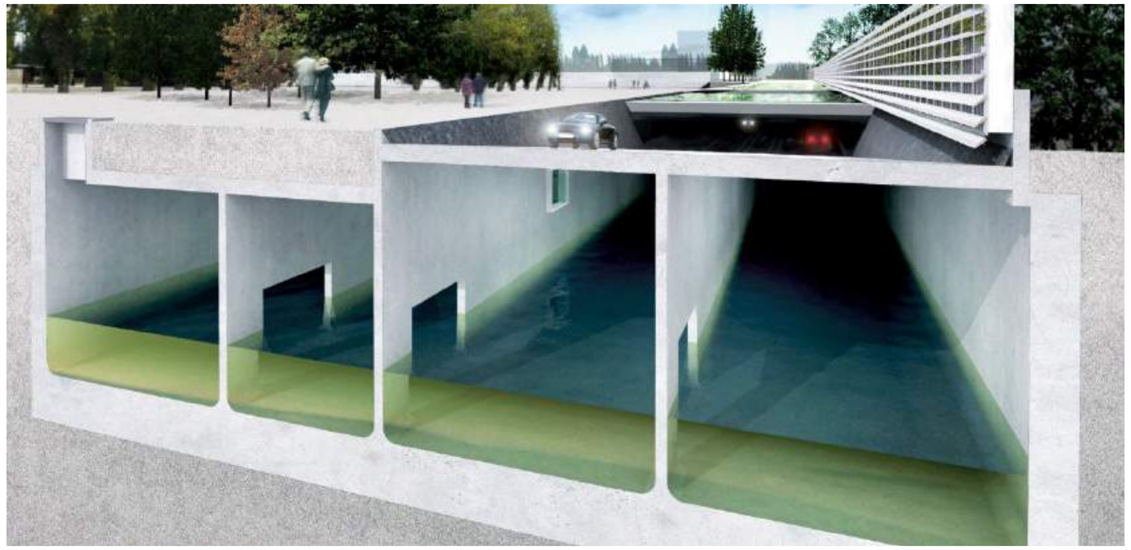


Figure 36: *Underground rainwater storage system (atelier GROENBLAUW)*

Innovative community initiatives, Singapore:

Singapore is a city state with one of the highest population densities in the world. Only Monaco has a similar density. This densely populated city state has set itself the target of realising an ambitious and comprehensive programme to increase sustainability and quality of life. As part of the process of increasing the amount of vegetation in the city, Singapore supports a number of private initiatives for realising traditional gardens, roof gardens, and other innovative initiatives. For example, the city already hosts more than 300 common gardens. Incentives exist for building green roofs (figure 37). Other community facilities include Neighbourhood incubator - The neighbourhood incubator is a community space that facilitates community efforts and initiatives, and hosts flexible events/workshop space. The function of this community living space is to be determined collectively by the community depending on their needs and aspirations.

Social linkways – The Social Linkway is a long common walkway energised by adjacent new social spaces to promote community interaction. Introduction of social functions and facilities linked to the linkways to encourage residents to linger and therefore facilitate the chance of incidental neighbouring and interaction.

Figure 37: *Innovative green features in Singapore (chuttersnap)*

The edible city, Andernach:

Andernach, a district community in Germnay, has created something new with the "edible city" concept. The district motivates its citizens to help plant and maintain urban vegetation, for example by planting fruits and vegetables that anyone can harvest. Vegetables such as carrots, beans, fruits and berries, herbs and flowers are planted in the public green areas, resulting in a completely new vision of urban green. Planting these edible crops helps make healthy food available for everyone. The edible gardens are located along the old city wall in the city centre. The advantages of the case include:

- Promoting forgotten fruit and vegetables,
- sustainable cultivation methods,
- New value in public spaces
- Improvement of the city's climate through more green surfaces
- Lower cost of maintaining green
- Active and involved citizens

International garden community - Arcadia Community in Shenzhen :
http://www.lii.com.cn/

As a community close to the mountains and the seas in Shenzhen, China, Arcadia covers an area of 1.16km2 with a floor area of 1800,000m2. There are already 50,000 residents living in the community. It has become an international and cultural community with ideal living conditions featuring high life index, mutual care, help and good social morals.

Arcadia won the International Award For Liveable Communities (LivCom Awards) in 2005 for its remarkable achievement, innovation and replication in the 6 areas of natural and cultural landscapes, arts, culture and heritage, best environmental practices, public engagement and empowerment, healthy lifestyles and strategic planning.

It has formed a harmonious community governance model that is administered by the government, invested by enterprises and jointly developed by the residents through creation of the community organization and management, welfare, cultural, educational, public service systems. In Arcadia, every resident has a health profile and every resident over 60 years old can enjoy a free health check-up annually.

Action Point Six: Future Strategic Planning

Introduction

A strategic plan should include future vision, strategic directions, objectives, actions and targets and project ideas which translate the vision into reality. Encouraging future sustainable city planning and implementation starts with strategic planning itself. This offers opportunities for excellent progress in terms of sustainable management and developing partnerships between various municipal and city-based organisations (ACT Government 2017). The strategies and actions manage development and change in a particular area over time. They work within the context of what is important about a place and how to enhance its character and quality.

In addition, the inclusion of the community in the strategic plan should set a clear and visible direction for the governments at different levels and in different, yet, interrelated areas - economic, environmental, social and cultural aspects – as well as capture the role between the governments and its partners so as to build inclusive, connected and dynamic communities across the region and the nation. It should strive to achieve a balance between the four pillars that defines a sustainable community and express the community's vision (figure 38). The vision should be based on the four pillars of a sustainable community.

Figure 38: *Pillars of a sustainable community*

Key strategies and technologies

- Create new innovative, dynamic and integrated policy and strategic frameworks that stimulate sustainable development, renewal and design, sustainable innovations in building construction, resource and infrastructure management, and sustainability and innovation in economy.
- Encourage strategic plans, policies and programs through open process and creative participatory methodology to foster the development of globally competititve, innovative, cultural, creative and connected city.
- Ensure a community that makes it easy for people to make a more sustainable livng choices and has the resourcefulness and capacity to manage
- Develop a community where can take advantage of its network of centres, open spaces and modes of travel to enjoy a sense of well-being and participate in a vibrant civic and cultural life.
- Create a community that becomes a centre for innovative, prosperous region that has established a diverse 'clean' economy and has a wide choice in jobs and lifestyles.
- Develop a community that is recognised for the quality of its public places and buildings that reflect its unique climate, character and identity.
- Create a community will be at the centre of a region that demonstrates the benefits of good stewardship of the land, its resources and the beauty of its rivers, mountains and plains.

How and what to do

A strategic plan for sustainable cities and communities should embed a vision for long-term urban sustainability and key strategic directions that reflects aspirations and qualities that the cities must build on (figure 39).

Figure 39: *Key strategies for a sustainable city*

Different strategies are needed to achieve the future we want a future that is sustainable. The strategic directions and actions have been identified to provide a framework for action. With each strategy there is a list of actions – some could be new, others could be already existing; some could be urgent, others could be important to consolidate sustainable city planning progress (ACT Government 2017). The vision and key strategies could be advanced by focusing effort on the four key pillars of environment, social, cultural, and economy. This part describes the strategic framework that can be applied to both the regional and sub regional plans. The framework is articulated through a set of key directions. Underpinning each key direction is a series of recommended strategic priorities for action. A key list of strategies and actions are listed below:

Environment:

Conserve the region's natural resources in order to protect their intrinsic values and support sustainable communities. Plans for urban growth and rural land use change will ensure that they do not impact adversely on the region's important natural assets, including biodiversity and water resources.

Key actions

- Anticipating and adapting to the effects of climate change
- Managing our water resources sustainably
- Protecting native habitat and biodiversity
- Harnessing renewable energy sources, reducing greenhouse gas emissions and pursuing innovative waste management approaches

Sustainable urban development renewal and design

- Prepare territorial, spatial and/or district plans to support sustainable built form. The plans should provide clear principles and guidelines on the design of new buildings and spaces, and existing natural and cultural heritage
- Create compact and efficient city by focusing urban intensification in town centres. Prepare an 'urban amenity plan' that sets out principles and directions to inform transport planning, land lease and management of urban public amenities.
- Focus on transit oriented development by implementing regulations that allow for higher densities close to stations and ensure that large offices can only be located within 500m of a station. Implement a 'finger plan' (five designated fingers following train and major routes with open space between them),
- Connect streets, parks and squares to public life and invest in attractive urban green and blue infrastrcucture to increase land value. Implement 'Green Grid' initiative to connect a network of interlinked multi-purpose green and blue infrastructure to public life.

Sustainable resource and infrastructure management

- Develop and establish a system of environmental performance indicators to inform decisions on public works and to monitor the land use (ACT Government 2017).
- Prepare strategic plans and policies that contribute to the reduction of energy demand and use, water and waste management and foster resilience to climate change, such as 'cool roof policy', 'green infrastructure policy', and 'deposit refund scheme' for waste recycling.
- Support exemplars that incorporate and test new designs, innovations and technologies in water, energy and waste management (e.g., zero and positive energy buildings, clean technology marketing programme).
- Develop common land management strategies and agreements, and renovation of urban farms through the concept of cradle to cradle concept to encourage urban gardens and local food production, consmption and management.

Sustainable transport planning and management

- Invest in strategic sustainable transport infrastructure and create optimal facilities for bicycles and pedestians, such as super cycle highways, bike stations, green cycle routes, parkways, and public spaces.
- Develop walking plans or green grid network plans to ensure the green transport infrastructure networks covers the residential areas and links them to centres, public spaces and public transport routes (ACT Government 2017). Green grid can also improve connectivity of ecosystems, improve air quality and urban microclimate, regenerate water systems, promote biodiversity, and create wildlife.

Economy:

Capitalise on the region's competitive advantages, opportunities and strengths, in order to continue to deliver prosperity and vitality. New infrastructure and enhancements to existing infrastructure will support the future competitive potential of commerce and industry. Improving access to key transport corridors will expand opportunities for manufacturing, ura=ban agriculture and tourism business development. Supporting development of a skilled workforce will augment and stimulate industry growth. Settlements across the Hume Region will have access to advanced Information and Communications Technology (ICT).

Key actions

- Strengthening a capable workforce
- Adapting and diversifying agriculture in an environment of change
- Facilitating research and innovation in tourism, manufacturing and industry to encourage new and evolving business
- Developing ICT and energy infrastructure that builds on existing competitive advantages

Sustainable economy and innovation

- Create and showcase inspiring projects to bring a lot of people tgether, so that they can motivate and inspire one another and exchange knowledge and experiences (e.g., eco-innovation districts).
- Incorporate the triple bottom line 'People Planet and Profit' concept into financial products can bring paradigm shift in greenification of the business operations.
- Innovation requires knowledge. Launch initiatives to create and promote platforms for knowledge between the government, knowledge institutes and the corporate sector (e.g., Knowledge Alliances, Innovation Pioneers program, Innovation Chain).

Sustainable business management

- Encouraging sustainable business management starts with the greenification of the city administration itself. Encourage mandatory greenification of city administration operations, municipal buildings, entertainment buildings (e.g., shopping centres).
- Develop a vision on sustainable management and implement sustainable purchasing policy

Social and Cultural:

Strengthen communities by enhancing their liveability and sense of connectedness. Access to services, facilities and other opportunities will lead to more healthy, vibrant and resilient communities. The capacity and quality of leadership in our communities will continue to be exceptional and its value will be recognised.

Key actions

- Embracing learning for life
- Providing appropriate and accessible social services and infrastructure
- Developing innovative and flexible service delivery models
- Strengthening communities, increasing resilience and enhancing liveability

Examples

U-City model, Korea:
The U-city (smart city) model is equipped with cutting-edge IT, enabling smart capabilities and services. For example, these include: real-time public transport information service, intelligent unmanned security and monitoring of mountain fires, monitoring via sensors and CCTVs, telemedicine and personal medical advice, remote lecturing, presence check with RFID, U-classroom, and searching and reserving books and digital items. As a "Smart City" plan extended the U-City initiative, new smart city projects using ICT were identified. These include, for example: smart parking (parking spaces identified in realtime and payment of parking fees via a smart phone application), smart crossroad (safety fence installed in front of the elementary school to detect traffic violations), smart streetlamps (CCTV and WIFI function added to save energy and prevent crimes), smart buildings (building monitoring to reduce energy consumption), and situation-based smart home (identifies the safest escape point during a fire). To achieve these actions, the government has developed a comprehensive u-city plan with vision, goals and strategies (figure 40).

VISION		
Construction of cutting edge information city Increasing quality of life and competitiveness of city		
GOALS		
Effectiveness of Urban Management	Foster as new growth power industry	Advanced urban services
STRATEGIES	IMPLEMENTATION ACTIONS	
Preparation of institutions	Specific standards for u-city planning, construction and management Personal information and u-city infrastructure protection measures u-city technology criteria and standards information distribution and networking methods	
Development of core technology	Information collection, processing and utilisation technologies	
Support for industry growth	Create successful domestic u-city model Build bases for supporting u-city model Nurture u-city exports	
Creation of sensible service	Intelligent administration system Customised transport services Advanced medical, educational and knowledge services Intelligent crime/disaster prevention systems One-stop culture and tourism services Global logistics systems Others	

Figure 40: *U-city Strategic Plan*

Sustainable Sydney 2030: Community Strategic Plan
http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0005/99977/66 45_Final-version-Community-Strategic-Plan-IPR-Document_FA4-1_lowres. pdf

Sustainable development is not just about the physical environment, but about the economy, society and cultures as well, and how addressing each, with bold ideas and good governance, will result in better outcomes for current and future communities. Sustainable Sydney 2030 expresses the community's vision and the city's commitment to a green, global and connected city (figure 41). It was originally developed with broad community involvement and support.

GREEN	GLOBAL	CONNECTED
• green with trees, parks, gardens and linked open spaces • green by example and green by reputation	• in economic orientation • in links and knowledge exchange • open-minded in outlook at attitude	• physically, walking, cycling, high quality public transport, world-class telecommunications

Figure 41: *Vision of Sydney's community strategic plan*

The community strategic plan, Cairns regional council
http://www.cairns.qld.gov.au/__data/assets/pdf_file/0019/41734/ComDev-Strategic-Plan.pdf

Cairns Regional Council has a vision for the future where the region thrives and inspires in the way it balances economic development, environmental management and social well-being. This Plan supports that commitment to deliver the community outcome priorities expressed in the Corporate Plan. Through this plan, the Community Development Unit aims to:

- Respond to social inclusion and Community Development priorities highlighted in the Council Corporate Plan
- Set clear directions as to how these priorities will be achieved, measured and monitored
- Strengthen the capacity of the Unit to better meet the needs of vulnerable groups in the community who traditionally have difficulty being heard.

Figure 42: *Goals of Cairns regional council community strategic plan*

City and Community Performance Assessment Tools

Introduction

For city leaders seeking clean air, reliable power supply, and free-flowing traffic, making the right infrastructure investments is critical. As such performance assessments usually demand models or tools based on indicators grounded on a suitable conceptual framework that explains and prioritises relationships within and between criteria and allows the assessment of systemic performance (Sellitto et al. 2015). The process of assessment involves collecting and processing information, usually on an ongoing basis, and must provide conclusions on what policies or actions are more likely to improve city performance.

As the 'building blocks' of cities, communities represent the scale at which urban design needs to make its contribution to city performance: as productive, liveable, environmentally sustainable and socially inclusive places. Community design constitutes a major area for innovation as part of an urban design protocol. Consequently, their development and scope to date represents the interests of both government and industry. Community performance assessment tools can demonstrate the cost, environmental and social benefits directly attributable to the built environment and provide decision support to a range of stakeholders involved in property development.

How and what to do

Criteria and data required for city performance assessment tools
Assessments of performance at city scale are typically broader than those for buildings. There is a range of significant criteria and related indicators and data that are requried for city performance assessment and rating systems. Some of the indicative criteria for the performance dimension of cities include: productive, competitive, liveable, sustainable and socially inclusive, governance, and resilience (Newton et al. 2013). The indicative criteria are assessed through individual or combinations of leading indicators or indexes revealed by bivariate mapping and graphing; for example, sustainability and liveability; happiness and GDP; health and income inequality; sustainability and equity among others.

Required data for city performance assessment tools include a range of private and public sector data related to transport, health services, environment, building scale data representation of land use (residential, commercial and special use buildings), urban infrastructure, etc. Some of the more common examples of urban data that support urban management and performance assessment tools are (figure 43):

- Urban Forms
- Urban Resource Flows
- Urban Function and Performance
- Urban Infrastructure
- Human Settlements
- Evolution of Cities with Time

Urban Form (pininterest)

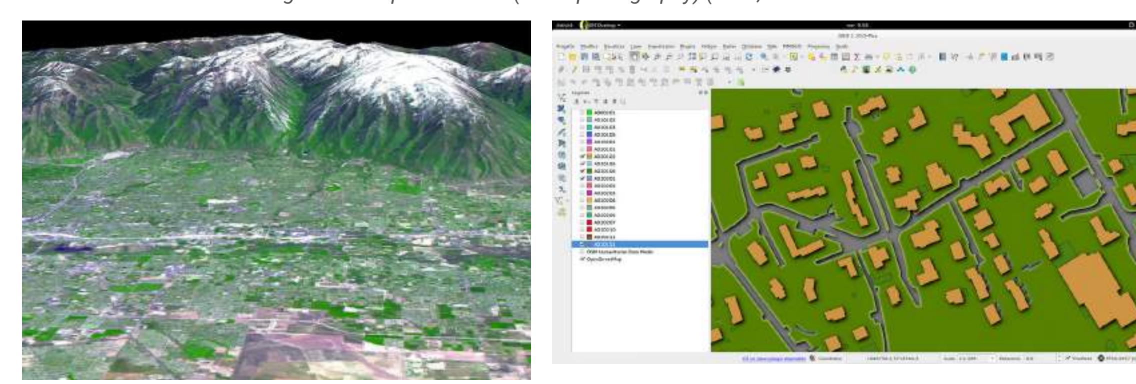
Landuse change over time (flickr)

Figure 43: *Examples of data required for performance assessment tools (urbangreenbluegrids)*

Urban data is available and represented in a number of ways to support city scale indicator development and modelling (figure 46):

- ***Image based representation:*** e.g. aerial photography (Pictometry) , satellite imagery (Google Earth), remote sensing (LiDAR), etc;
- ***Spatial data representation:*** e.g. 2D and 3D GIS data (cadastral data, terrain data, census data covering social, economic and demographic information, building footprints, road networks, etc);
- ***Urban semantic information representation:*** e.g. CityGML;
- ***Urban dynamic information representation:*** e.g. urban mobility, real-time sensor data, evolution of cities with time, etc.

Image based representation (aerial photography) (flickr, PxHere



Spatial data representation (terrain data, GIS base data layers) (NASA, flickr)

Figure 44: *Examples of city data representation*

Approach to the design of community performance assessment tools The design of community performance assessments can be guided by a threetiered approach (Newton et al. 2013):

- the overall frameworks and principles - address sustainability, resilience and carbon intensity;
- an assessment system - establishes performance indicators for evaluating urban indicators;
- the rating system - assigns a score to the entire project based on the performance of a set of core indicators for certain benchmarks.

Best practices

City peformance assessment tools allows urban decisionmakers to select tailored technologies that offer their own cities maximum environmental and economic benefits. There are a number of performance assessment tools that have been developed by private sector to assist government and private consortia optimise development decisions. These are emerging as strong mechanisms to enable consultants and design professionals to deliver more robust city level design solutions.

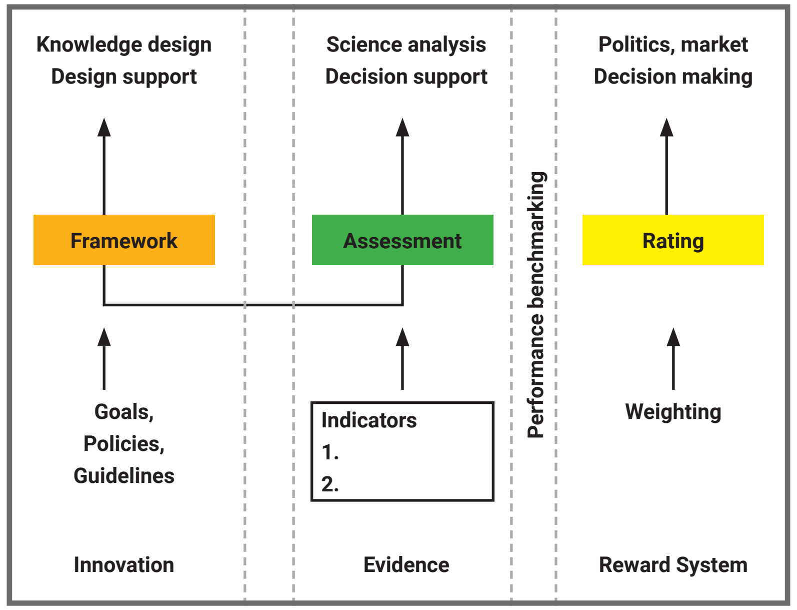


Figure 45: *Three levels of approach to design community performance assessment tools (© Newton et al 2013)*

Indicators for community performance assessment tools

Over the several years, a number of sustainability studies have developed a range of individual indicators, principally within the three domains of performance: sustainability, liveability and resilience.

Sustainability indicators: The core sustainability indicators relevant to community design performance can be identified as (Newton et al. 2013)–

- Social and human capital-related: education attainment (access to schools with above average NAPLAN scores); employment to population ratio (local employment opportunities); feelings of safety (composite indicator of local crime statistics)
- Natural capital: GHG emissions; air quality; ground cover; water consumption; recycling rate
- Economic capital: income disparity (social mix); housing supply (but needs to be differentiated by type); housing affordability (housing price points); mode of transport to work; VKTs

Liveability indicators: Important liveability indicators relevant to community design performance include (Ley and Newton 2010)–

- Human well-being: Housng quality, affordability, transport access, mobility, human health (physical and mental), human capital and social capital
- Urban environmental quality: ambient air quality, indoor air quality, noise, solar access, water quality, and green space (private and public)

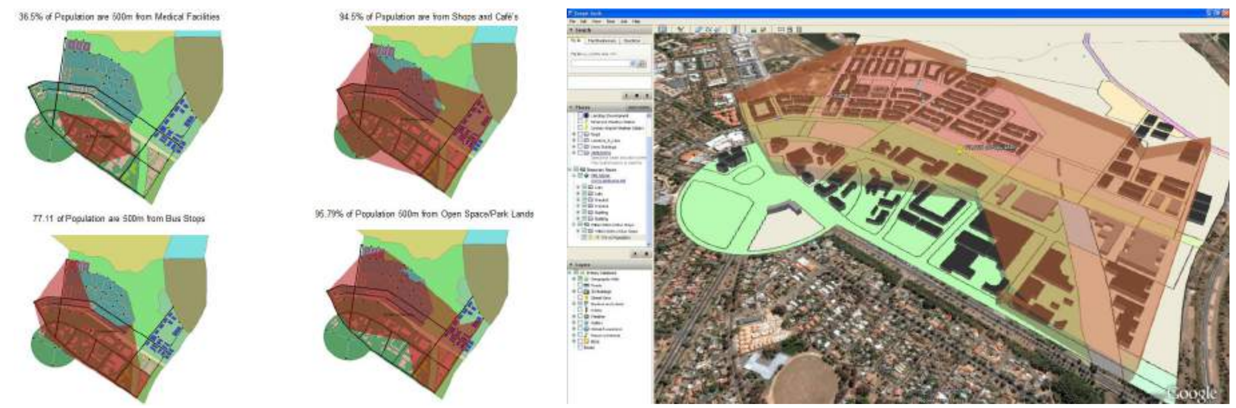
Resilience indicators: Resilience indicators need to reflect actions capable of being taken to reduce vulnerability, including preparedness for an extreme event as well as recovery capacity. The major indicators can be distinguished as (Newton et al. 2013) –

- Socio-economic change: Included here are economic crisis, conflict, terrorism, poverty, political instability/change, health pandemic.
- Climate change impacts: extreme weather, increased temperature, heatwaves, increased daily rainfall, sea level rise, extreme weather, bush fires, etc.

Data representation for community performance assessment tools

Within the most representative types of community assessment tool, the information is modelled using standard GIS data structures, irrespective of whether the computational engine being used is a spreadsheet or a GIS-style application (Figure 48). The community assessment information model consists of a set of well-defined data object types. Geographic regions are treated as closed polygonal boundaries with an associated set of properties or common attributes. An example might be a land use zone (industrial, commercial, parkland, etc.) or it may represent a walkability zone around a transport hub. Geospatially located urban entities are represented as features, again with associated properties stored as name/value pairs.

Examples would be amenities such as schools, post offices or medical services. Another example of such a feature might be buildings of a defined type, such as low rise residential, or even a cluster of buildings such as an industrial park. These latter examples may typically have a footprint, represented as a polygon. Transport or urban services distribution systems can be represented by networks consisting of connected nodes in any topological structure. Those provide the ability to measure connectedness or operational distances between nodes or other geospatially defined features. It is important to recognise that these data constructs are also commonly used to hold reference data drawn from external data sources such as aggregated census data, existing geographic features and contextual information (e.g. location of urban amenities that lie outside the precinct).



Spatial analysis *GIS and 3D integrated data representation*

Figure 43: *Examples of data required for performance assessment tools (urbangreenbluegrids)*

Data required for community performance assessment tools

This section provides information of the data requirements for community objects, taking as a starting point the fairly coarse level of granularity typical of community analysis where an entire building is treated as a single community object (Newton et al. 2013).

COMPONENT	DATA REQUIREMENT OF LIFE CYCLE					EXAMPLE DATA REQUIREMENT
	Design	Construction	Operation	Maintenance	End of Life	
Parks	√	√	√	√	√	Type, area, planting, material, energy, water and carbon emissions (embodied, operation), waste generation etc.
Green space	√	√	√	√	√	
Other open space (reserve etc.	√	√	√	√	√	
Building	√	√	√	√	√	Type, material/energy/water consumption, carbon emission (embodied and operation) etc.
Transportation	√	√	√	√	√	Mode (rail, road, water), distance and travel time (to job, shop, home etc.), energy use and source
Water	√	√	√	√	√	Material (pipe network), water supply and demand, water/energy consumption (embodied and operation)
Energy	√	√	√	√	√	Energy supply (renewable and grid), demand (embodied and operation)
Waste		√	√	√	√	Waste generation (embodied and operation)
Other type of infrastructures	√	√	√	√	√	
Values		√	√	√		Construction, operation and maintenance cost for each of components (building etc.)
Employment			√			Employment rate (%) in precinct
Others		√	√	√		

Examples of data requirements for community assessment models (Newton et al. 2013)

Examples

City peformance assessment tools allows urban decisionmakers to select tailored technologies that offer their own cities maximum environmental and economic benefits (Benetto et al. 2018). There are a number of performance assessment tools that have been developed by private sector to assist government and private consortia optimise development decisions (Newton et al. 2013). These are emerging as strong mechanisms to enable consultants and design professionals to deliver more robust city level design solutions.

Siemens' City Performance Tool
https://www.cyptportal.siemens.com/#!/welcome

Siemens' City Performance Tool (CyPT) helps city planners to deliver detailed insight into the reduction of greenhouse gas (GHG) emissions and air quality improvements their city can achieve. Using exclusive data to analyze the effects of more than 70 diverse technologies on a city's performance, CyPT calculates the impact on emissions – along with capital and operational expenditure (CAPEX and OPEX) – of the adoption of each technology.

CyPT assesses the impact of technologies in the building, energy, and transport sectors at different time periods and implementation rates, quantifying GHG emissions as well as air pollutants such as particulate matter (PM) and nitrogen oxides (NOx). CyPT works from each city's individual baseline to identify technologies that match specific needs. Users start by collecting data on their city's energy, building, and transport infrastructure to customize the model. Around 400 city-specific data points are used for those three main sectors.

MUtopia
http://mutopia.unimelb.edu.au/

MUtopia is a tool developed by the University of Melbourne. Integrated domain models (energy, water, waste, transport, social, economic) inform a 3D spatial platform supporting urban infrastructure modelling (Newton et al. 2013) in the context of sustainable design. Models are simulated under alternative scenarios to generate customisable 2D and 3D reports. Outputs are provided for a wide spectrum of themes and indicators, e.g. liveability, GHG emissions, water consumption, travel time, waste generation and life cycle cost. The key features of the tool are:

- Open architecture, scalable and adaptable, cloud-based
- Integrated GIS + BIM using Precinct Information Model (PIM)
- Advanced visualisation capabilities for rendering and reporting
- Predictive modelling capabilities, what-if scenario simulation
- Multi-user architecture, collaborative design and simulation platform
- Public engagement capabilities via a web portal for community consultation
- Monitoring capabilities with sensor networks
- Data security

MUtopia can be used to assess a whole city approach, a large precinct or an individual suburban development in terms of economic, social and environmental factors. Users (land agencies, developers, architects/urban planners, engineering consultants, community) determine the scope for analysis in the form of user requirements, which shape the MUtopia platform. The tool can be used in multiple phases of a development project: preliminary planning; stakeholder communication; master planning; community consultation; design; monitoring (Newton et al. 2013).

Sustainable Systems Integration Model (SSIM)
http://www.aecom.com/News/Innovation/_projectsList/Sustainable+Systems+Integration+Model+

Sustainable Systems Integration Model (SSIM) is an urban sustainability analysis tool that was developed by AECOM to assist clients to understand the environmental, social and cost implications of decisions. It is focused on optimising sustainability decisions master planning and infrastructure delivery. SSIM has developed over the last seven years as a set of models that have been designed to work together to allow ongoing support through an urban planning and infrastructure decision making cycle. The following points highlight the staged approach.

Stage 1 – Master Plan Comparison (Urban Design)

Stage 2 – System Alternatives (Infrastructure Design)

Stage 3 – Program Optimisation

The output results include total resource reduction and/or reuse and ultimately show reduction in greenhouse gas emissions, water and waste use and reuse potential. Economic outputs include total initial and recurring costs. Social outputs include provisions for social infrastructure, balance and social and economic diversity.

Community Performance Assessment Tools

A number of community assessment tools have emerged in recent years, many via leading urban design and planning organisations (private sector and government) that have clients seeking decision support and evidence that their development projects meet certain performance targets.

Green Star Communities
https://www.gbca.org.au/green-star/green-star-communities/the-rating-tool/

Green Star Communities is Australia's leading sustainability rating system for the built environment at community level (Figure 58). It has been established by the Green Building Council of Australia (GBCA) in two stages. First, as a 'national framework for sustainable communities' that propose national best practice principles for guiding their future development. Sustainability principles are at the heart of this framework:

- Enhancing liveability
- Creating opportunities for economic prosperity
- Fostering environmental responsibility
- Embracing design excellence
- Demonstrating visionary leadership and strong governance
- Recognising innovation

Second as a rating tool, providing a set of indicators against each principle with benchmarks and associated credit points that can be assigned depending on the level of performance achieved by the community design. Also, a set of governance processes by which rating certification can be achieved.

PrecinX , NSW, Australia
https://kinesis.org/ccap-precinct/

PrecinX is a planning and design tool developed for the NSW government (Landcom) and other government land organisations (GLOs) to evaluate the sustainability of a neighbourhood or large urban development project. It was designed to assist land developers, urban planners and regulatory authorities make decisions about new urban development. Originally targeted at greenfield precinct development, it is now being employed in urban redevelopment projects in NSW and interstate (via GLOs, local governments, utilities and private developers). The tool comprises several key modules, predominant among them being: transport, energy, embodied CO2, water, housing yield, operational affordability and financial analysis (capital and recurrent costs) – reflecting the principal interests of government and the private sector in these areas. It provides the capacity to compare the performance of a precinct as designed, against a set of government planning targets. Its focus on embodied as well as operating carbon emissions established PrecinX as a leader in the area of urban carbon auditing, driven by government's need for a carbon assessment and reporting tool.

LEEDnd (LEED for Neighborhood Development)
https://www.usgbc.org/guide/nd

The US Green Building Council (USGBC), the Congress for the New Urbanism (CNU) and the Natural Resources Defense Council (NRDC) have collaborated to develop a rating system for neighbourhood planning and development based on the combined principles of smart growth, New Urbanism, and green infrastructure and building. The goal of this partnership is to establish a national leadership standard for assessing and rewarding environmentally superior green neighbourhood development practices. Prerequisites and credits in the LEED-ND rating system address five high level topics (Figure 60):

- Smart Location and Linkage
- Neighbourhood Pattern and Design
- Green Infrastructure and Buildings
- Innovation and Design Process
- Regional Priority Credit

In a similar fashion to Green Star Communities, there are a set of performance criteria and benchmarks under each major topic that can attract credit points.

BREEAM Communities, UK
https://www.breeam.com/communities/

Building on the knowledge and principles embodied in the BREEAM family of tools, BREEAM Communities has been launched as an independent, third party assessment and certification standard for development projects at a community level. It is a framework for considering the issues and opportunities that affect sustainability at the earliest stage of the design process for a development as well as subsequent detailed design.

Issues for assessment and rating by BREEAM Communities are grouped into five impact categories and a sixth category that promotes the adoption and dissemination of innovative solutions (Figure 49):

- Governance: Addresses community involvement in decisions affecting the design, construction, operation and long-term stewardship of the development
- Social and economic wellbeing: Addresses societal and economic factors affecting health and wellbeing such as inclusive design, cohesion, adequate housing and access to employment
- Resources and energy: Addresses the sustainable use of natural resources and the reduction of carbon emissions
- Land use and ecology: Addresses sustainable land use and ecological enhancement
- Transport and movement: Addresses the design and provision of transport and movement infrastructure to encourage the use of sustainable modes of transport
- Innovation: Recognises and promotes the adoption of innovative solutions within the overall rating where these are likely to result in environmental, social or economic benefit in a way which is not recognised elsewhere in the scheme.

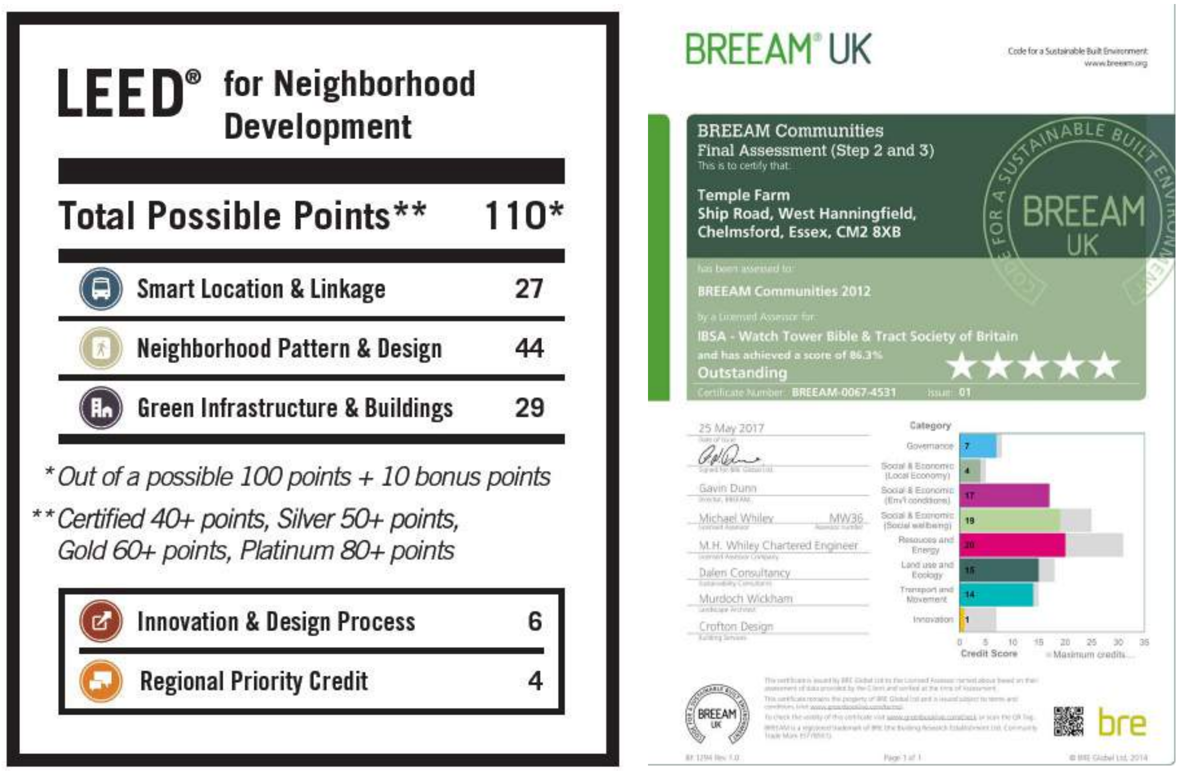


Figure 47: *LEED ND and BREEAM communities final assessment*

Summary

The "Guidelines for Sustainable Cities and Communities" have been produced in accordance with goals of SUC. This document can be mainly applied in the context of developing countries. In its early phase, this document can support the promotion and implementation of sustainable development of cities and communities in China.

SUC Guidelines consist of three sections - Evaluation Criteria, Management System and Technical Guidelines". The SUC Guidelines are applicable to both existing built cities and communities in particular to new urban areas and new communities in the future.

Evaluation Criteria

The first part of the SUC guidelines identified and described the key sustainability goals and evaluation criteria that drive sustainable development and delivers Key Principles for Sustainable Cities and Sustainable Communities based on a thorough review of Chinese and global best-practice sustainable development.

Management Process

The SUC Management Process (SUC MP) provided an operational structure for the implementation of urban sustainability by establishing key strategies. The five key strategies include:

- Step One: Understanding the Development Context
- Step Two: Goal Setting and Institutional Resourcing
- Step Three: Implementation Pathway
- Step Four: Monitoring Progress
- Step Five: Lessons and Knowledge Transfer

SUC Key Action Points

The SUC Key Action Points (SUC KAPs) provided concise technical objectives in order to achieve the identified Sustainable Cities and Sustainable Communities goals, addressing each key process in the urban development life-cycle, including: Resource Endowment Survey (Project Areas), Planning and Design, Product and Materials Selection, Building and Construction, Operation and Management and Future Strategic Planning, as well as key performance assessment tools.

The SUC Key Actions Points for Cities and Communities outlined the key technologies and strategies to achieve the sustainable development goals within different sectors and provided practical guidance for built environment professionals and governments seeking to optimise development projects to achieve sustainable cities and communities across China. The Key Actions Points also provided a brief practical guidance on the design of performance assessment tools for both cities and communities.

Appendix A

The following content provides a relatively comprehensive set of indicative key performance indicators for building sustainable cities and communities. It could be used to guide cities and communities to develop sustainability-related goals as well as conduct monitoring and evaluation. They have not gone through a peer-review process are meant to be indicative key performance indicators that can be applied by cities and communities as reference according to the local context.

Key Performance Indicators (KPIs) for Sustainable Cities

The following provides a set of Key Performance Indicators (KPIs) for sustainable cities.

CATEGORY: SAFE AND AFFORDABLE CITIES

Indicators / Measures		Source	Secondary Indicators / Measures	Source
Total city population (Number)		ISO 37120 / GI-REC		
Population density (People per urbanized km²)		ISO 37120 / GI-REC		
Annual population change (%)		ISO 37120 / GI-REC		
Areal size of informal settlements as a percent of city area (Percent)		ISO 37120 / GI-REC		
Percentage of urban population living in slums or informal settlements		SDG 11 Indicator 11.1	Proportion of population that spends more than 30% of its income on accommodation	SDG 11 Indicator 11.1 Secondary Indicator
Housing Affordability	Number of total houses available in the lowest price quartile of the local market for new housing	Best Practice		
	Minimum 5% of project total offered to accredit not-for-profit housing providers for affordable rental housing	Best Practice		
	Housing security rate 90%	Best Practice		

CATEGORY: TRANSPORTATION AND ACCESSIBILITY

Indicators / Measures		Source	Secondary Indicators / Measures	Source
Percentage of people within 0.5km of public transport, running at least every 20 minutes Share of income spent by urban households on transport (by income quintile)		SDG 11 Indicator 11.2	Modal share (public/NMT) and/or average trip length by mode	SDG 11 Indicator 11.2 Secondary Indicators
Infrastructure Supporting Green Transport	Kilometres of high capacity public transport system per 100,000 population	ISO 37120 / GI-REC	Percentage of commuters using a travel mode other than a personal vehicle	ISO 37120 / GI-REC
	Kilometres of light passenger public transport system per 100, 000 population	ISO 37120 / GI-REC		
	Kilometres of bicycle paths and lanes per 100, 000 population	ISO 37120	At least 70% of inhabitants have access to bicycle parking facilities	Best Practice
	State of existing public and non-motorized transport infrastructure	Proposed / GI-REC	Average daily travel time (minutes)	UN CPI
	Road Network: • 90% green trips by 2020 • 100% barrier free accessibility • Walkability	Best Practice Street intersection density	Street density	UN CPI
	Liquid fuels purchased by the city and its inhabitants for passenger transport and freight (Litres per capita per annum)	Proposed / GI-REC		
Intelligent Transportation System (ITS)	Transport systems are capable of increasing transport efficiency and logistics by means of ITS	Proposed	% change in peak hour journey time along routes where ITS has been implemented. Report by vehicle type where possible	EU DG MOVE
			% change in journey time variability on routes where ITS has been implemented -as measured by coefficient of variation. Report by vehicle type where possible	EU DG MOVE
			% change in number of reported accidents along routes where ITS has been implemented. Report by accident severity where possible	EU DG MOVE
			% change in annual CO2 emissions (Tons) on routes where ITS has been implemented	EU DG MOVE

CATEGORY: LAND USE EFFICIENCY

Indicators / Measures	Source	Secondary Indicators / Measures	Source
Ratio of land consumption rate to population growth rate at comparable scale	SDG 11 Indicator 11.3	Proportion of cities with legislation that promotes participatory mechanisms related to urban planning and local decision-making that ensure a fair representation of the urban population, including slum dwellers and informal workers	SDG 11 Indicator 11.3 Secondary Indicator
Dwelling density per km² (Number of dwellings)	ISO 37120 / GI-REC	Residential density (population/area)	UN CPI
Land use mix: Diversity of land use per square kilometre	UN CPI		
Policies restrict development zones in order to make space for protection of eco-infrastructure and planning of future eco-cities	Proposed		

CATEGORY: CULTURAL AND NATURAL HERITAGE

Indicators / Measures	Source	Secondary Indicators / Measures	Source
Urban planning policies promote and protect cultural and natural heritage	SDG 11 Indicator 11.4	Percentage of budget provided for maintaining cultural and natural heritage	SDG 11 Indicator 11.4 Secondary Indicators
Site construction does not destroy the local heritage, natural water, wetlands, farmland, forests and other protected areas	GBES		

CATEGORY: CITY DISASTER RESILIENCE

Indicators / Measures	Source	Secondary Indicators / Measures	Source
Percent of cities with more than 100,000 inhabitants that are implementing risk reduction and resilience strategies informed by accepted international frameworks Proportion of population living in high-risk zones Number of deaths, injuries, and displaced people caused by natural disasters annually per 100,000 population	SDG 11 Indicator 11.5	Economic losses related to GDP caused by disasters	SDG 11 Indicator 11.5 Secondary Indicators
Response time for emergency response services from initial call	ISO 37120		

Indicators / Measures		Source	Secondary Indicators / Measures	Source

CATEGORY: **HEALTHY ECO-ENVIRONMENT AND CLIMATE MITIGATION**

Air Quality	Fine particulate matter (PM2.5) concentration	ISO 37120 / SDG 11 Indicator 11.6 Secondary Indicator		
	PM10 level meet China's National Ambient Air Quality Grade II Standard for at least 347 days per year	Best Practice		
	The air quality in the city should meet at least China's National Ambient Air Quality Grade II Standard for at least 310 days per year	Best Practice		
	The SO2 and NOx content in the ambient air should not exceed the limits stipulated for China's National Ambient Air Quality Grade 1 standard for at least 347 days per year	Best Practice		
	All refrigerants have an Ozone depleting potential of 0	Best Practice		
Waste Management	Percentage of urban solid waste regularly collected and well managed	SDG 11 Indicator 11.6	Percentage of city population with regular solid waste collection (residential)	ISO 37120
			Percentage of the city's solid waste that is recycled	ISO 37120 / GI-REC
			Percentage of the city's solid waste that is disposed of in a sanitary landfill	ISO 37120 / GI-REC
			Percentage of the city's solid waste that is disposed of in an incinerator	ISO 37120 / GI-REC
			Percentage of the city's solid waste that is burned openly	ISO 37120 / GI-REC
			Percentage of the city's solid waste that is disposed of in an open dump	ISO 37120 / GI-REC
			Percentage of the city's solid waste that is disposed of by other means	ISO 37120 / GI-REC
			Organic waste fraction of landfill waste	Proposed / GI-REC
			Percentage of waste classification rate	Best Practice
			State of existing solid waste management infrastructure	Best Practice
			Use of on-site waste management system	Best Practice
			100% non-hazardous treatment	Best Practice
			Usage of waste for electricity generation	Best Practice
			Proportion recycled from municipal waste	SDG 11 Indicator 11.6 Secondary Indicators
			GHG emissions tons/capita	

Indicators / Measures		Source	Secondary Indicators / Measures	Source

Construction Materials	Construction materials imported from more than 100km beyond the city boundary (Tons per capita per annum)	Proposed / GI-REC		
	Amount of the city's demolition and construction waste that is re-used (Tons)	Proposed / GI-REC		
	Construction waste fraction of landfill waste by volume (Percentage)	Proposed / GI-REC		
Biodiversity	Percentage change in number of native species Comprehensive Species Index >= 0.5 Local Species Index >= 0.85	ISO 37120 Best Practice		
	Percentage of site with high biodiversity value where biodiversity management plans are actively implemented	Best Practice		
	Urban planning policies preserve natural wetlands in the city	Best Practice		
	Waterway rehabilitation plan for catchments > 60 hectares to address urban impacts on stream ecology, geomorphology and vegetation	Best Practice		
	Normalized Difference Vegetation Index (NDVI) from satellite data indicates areal extent and health of vegetation	Best Practice		
	At least 70% of the plant varieties in the city should be native plants/vegetation	Best Practice		
Climate	Average annual temperature (°C)	ISO 37120 / GI-REC		
	Average annual rainfall (mm)	ISO 37120 / GI-REC		
	Average annual snowfall (cm)	ISO 37120 / GI-REC		
	Annual solar radiation (kWh/m2)	Proposed / GI-REC		

CATEGORY: **SAFE AND SUSTAINABLE PUBLIC SPACES**

Area of public space as a proportion of total city space	SDG 11 Indicator 11.7	Proportion of total public space in a city that is assigned to support livelihoods of the poor	SDG 11 Indicator 11.7 Secondary Indicators
		Proportion of urban areas located fewer than 300 metres away from an open public space	
		Number of reported crimes (homicides, injures and theft rates) committed annually in urban areas, per 100,000 population	
		Square metres of public outdoor recreation space per capita (m²)	ISO 37120 / GI-REC
		Accessibility of open public areas	UN CPI
		Amount and spatial distribution of public open space (Ground floor area)	Proposed / GI-REC

Indicators / Measures		Source	Secondary Indicators / Measures	Source
Green area per 100,000 population (Ha)		ISO 37120 / GI-REC	Green area > 9.50 m²/person in average for the city with construction land area < 80 m²/person in average	NGCS
			Green area > 10.00 m²/person in average for the city with construction land area between 80 - 100 m²/person in average	NGCS
			Green area > 11.00 m²/person in average for the city with construction land area > 100 m²/person in average	NGCS
Urban Energy	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption	ISO 37120 / GI-REC	Renewable energy percentage >= 15%	Best Practice
			80% of electricity purchased from verified green power or equivalent renewable energy supply sources. Onsite renewable or gas energy generation encouraged to supplement 80% target	Best Practice
	Total electrical energy use per capita (kWh per capita per annum)	ISO 37120 / GI-REC	Total residential electrical energy use per capita (kWh per capita per annum)	ISO 37120
			Energy consumption of public buildings per year (kWh/m²) Government and public building energy demand density < 90 kWh / (m2 x year)	ISO 37120 Best Practice
			Per GDP energy demand < 0.83 t coal / 10kRMB	Best Practice
	Percentage of city population with authorized electrical service	ISO 37120 / GI-REC	Energy diversity: each city has at least 3 different types of energy generation	Best Practice
			Effective management of 10% of peak demand	Proposed
			Energy security: minimum 3 hours of energy storage reserve for percentage of buildings in each city for disaster / military action resilience	Best Practice
Urban Water	Total water consumption per capita (litres/day)	ISO 37120 / GI-REC	Total domestic water consumption per capita (litres/day)	ISO 37120
			Percentage of water loss (unaccounted for water)	ISO 37120 / GI-REC
			Per GDP water demand < 70m3 / 10kRMB	Best Practice
	Percentage of city population served by wastewater collection	ISO 37120 / GI-REC	Percentage of the city's wastewater receiving primary treatment	ISO 37120 / GI-REC
			Percentage of the city's wastewater receiving secondary treatment	ISO 37120 / GI-REC
			Percentage of the city's wastewater receiving tertiary treatment	ISO 37120 / GI-REC
			Percentage of the city's wastewater that has received no treatment	ISO 37120 / GI-REC
			Amount of energy captured from methane emitted by landfills and wastewater treatment works (Joules per capita per annum)	Proposed / GI-REC

Indicators / Measures		Source	Secondary Indicators / Measures	Source
	100% access to safe drinking water	ISO 37120	Percentage of city population with potable water supply service (% of population)	ISO 37120 / GI-REC
			Percentage of city population with access to improved sanitation	ISO 37120
			Percentage of city population with sustainable access to an improved water source	ISO 37120
			Water bodies in the city should meet Grade IV of China's latest national standards by 2020	Best Practice
			Water bodies in centralized drinking water sources meet China's national standard 100%	Best Practice
			Water bodies in city environmental corridor meet China's national standard 100%	Best Practice
	Stormwater treated to achieve pollutant load reductions (as compared to untreated urban stormwater) of: • 80% reduction in total suspended solids, • 45% reduction in total nitrogen and total phosphorous, • 70% reduction in litter.	Best Practice		
	Provide flow retardation for ecological & flood protection of public & private assets through achieving: pre development peak flow rates for a 1.5 year ARI storm event and pre development peak flow rates for a 100 year ARI storm event following development	Best Practice		
	50% of public open space irrigation to be supplied by alternative water sources. Initiatives may include dual supply pipe with recycled water from: • A treatment plant • Sewer mining • Stormwater reuse • Onsite treatment	Best Practice		
Policy Framework	Presence of a national urban and human settlements policy framework	SDG 11 Indicator 11.a		
	Sub-national government revenues and expenditures as a percentage of general government revenues and expenditures	SDG 11 Indicator 11.c		

Indicators / Measures		Source	Secondary Indicators / Measures	Source
Economy and Employment	City product as a percentage of country's GDP (Percentage)	ISO 37120		
	City product per capita (USD)	ISO 37120		
	Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties	ISO 37120		
	Number of businesses per 100,000 population	ISO 37120		
	Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue)	ISO 37120		
	Number of convictions for corruption and/or bribery by city officials per 100,000 population	ISO 37120		
	Jobs / housing ratio	ISO 37120		
	City's unemployment rate	ISO 37120		
	Percentage of persons in full-time employment	ISO 37120		
	Percentage of women employed in the city government workforce	ISO 37120		
Eco-City	Planning of new urban areas focuses on harmony between human and environment. Eco-city (areas) will be built in accordance with principles of resource efficient cities and sustainable buildings to reflect future sustainable innovations. Eco-city area >=5 km2	SBCI CGEC		
Telecommuni-cation	Number of internet connections per 100,000 population	ISO 37120		
	Number of cell phone connections per 100,000 population	ISO 37120		
	Number of landline phone connections per 100,000 population	ISO 37120		
	City wireless network coverage percentage	Best Practice		
Smart City and Technological Innovation	Policies that promote smart mobility systems are in place (e.g. through integration of urban information systems, application of ICT to transport infrastructure management, data mining for improved interconnectivity, etc)	Proposed		
	Policies that promote intelligent use of resources are in place	Proposed		
	Advanced ICT infrastructure and services are available and used to improve the quality of life	Proposed		
	Ability to create new sources of employment demonstrated through presence of innovative companies, good quality universities and advanced research institutes	Proposed		

Key Performance Indicators (KPIs) for Sustainable Communities

The following provides a set of Key Performance Indicators (KPIs) for sustainable communities.

CATEGORY: SUSTAINABLE BUILDINGS

Indicators / Measures		Source	Secondary Indicators / Measures	Source
Indoor Environment Quality	Residential: Residential building layout ensures indoor ambient sunlight, lighting and ventilation to meet the current China's national standard "Urban Residential Area Planning Design Code" GB 50180, and the requirements for residential buildings sunlight standards	GBES	Bedroom, living room (Hall), study, and kitchen lighting coefficient is greater than existing China's national standards "Architectural lighting design standards" GB / T 50033	GBES
			Apartments to have ≥ 60% of living spaces with an average Daylight Factor of 2.5%.	Best Practice
			All living areas to have facade exposure and operable windows	Best Practice
	Commercial: Buildings to maximize the use of natural ventilation to meet fresh air requirements, capture sunlight, and provide for CO2 monitoring of return air systems	Best Practice	Commercial working space to have ≥ 60% NLA with an average Daylight Factor of 2.5%.	Best Practice
			Commercial: • 20% of each floor's window façade area to be operable.	Best Practice
			Enclosed car parks to have mechanical ventilation systems with CO2 monitoring and variable speed fans	Best Practice
	Commercial: Air conditioning systems & building systems to be designed so that PMV (ISO 7730 standard) levels are between -1 & +1 for 98% of the year when the building is occupied.	Best Practice		
	Indoor air pollutant concentration of free formaldehyde, benzene, ammonia, and TVOC comply with the current China's national standard "civil indoor environmental pollution control norms" GB50325	GBES		
Energy	Total annual electricity used	Best Practice		
	Total annual renewable energy generated	Best Practice	Renewable energy use accounts for more than 10% of the total building energy consumption	GBES
	Maximize use of natural systems (e.g. solar access, natural ventilation and natural light). This can be represented as the total energy harnessed from renewable sources as a percentage of the maximum renewable energy potential of the city	Best Practice	South solar access to be maximized for all lots including apartments.	Best Practice
			70% dual aspect apartments to have no air-conditioning to demonstrate natural ventilation	Best Practice
			% of spaces using natural light	Proposed

	Indicators / Measures	Source	Secondary Indicators / Measures	Source
	All heating and cooling provided with high energy star rating	Best Practice		
	Heating or air conditioning energy consumption is not higher than 80% of the China's national approval or registration of building energy efficiency standards	GBES		
	When choosing a central air conditioning system, modular chillers or HVAC coefficient of performance and energy efficiency rate must in line with current China's national standard "public building energy efficiency design standards," the value of the relevant provisions of GB 50189.	GBES		
	Residential building thermal design and HVAC design in line with China's national approval or registration of residential building energy standard requirements	GBES		
	For residential centralized heating or central air conditioning systems, set the temperature regulation and heat metering facilities	GBES		
	Lighting efficiency to be equivalent or better than 35 Watt low voltage down lights with electronic transformers for task lighting. Compact fluorescent lamps, fluorescent lamps, LED's for general lighting and/or task lighting.	Best Practice		
	Average lighting power density of 2.5W/m2/100Lux.	Best Practice		
	Gas and/or solar gas hot water heating only.	Best Practice		
Water	Total annual potable water used	Best Practice	Total water consumption per capita (Litres per person per day)	
	Total annual rainwater used	Best Practice	Percentage of water loss (unaccounted for water)	
	Total annual greywater used	Best Practice	Percentage of city's wastewater that has received primary treatment	
	Total annual recycled water used	Best Practice	Percentage of city's wastewater that has received secondary treatment	
	Total annual wastewater used	Best Practice	Percentage of city's wastewater that has received tertiary treatment	
	Total consumption to be modelled ≤ 160 L/person/day in residential developments and 40L/person/day in commercial developments. Address: • Water efficient appliances and fittings, • Rainwater harvesting for reuse (e.g. for gardens & or hot water), • Grey water harvesting and reuse (e.g. for WC flushing), • Dual supply pipe with recycled water from a treatment plant, sewer mining or stormwater reuse (e.g. for garden, toilet and laundry use).	Best Practice	Percentage of city's wastewater that has received no treatment	

	Indicators / Measures	Source	Secondary Indicators / Measures	Source
	Adoption of water-saving appliances and equipment, water-saving rate of greater than 8%	GBES	Amount of energy captured from methane emitted by landfills and wastewater treatment works (Joules per capita per annum)	
	Landscape water use do not source from the municipal water supply or groundwater wells	GBES		
Materials	Building materials content of harmful substances in line with the current China's national standard GB 18580 ~ GB 18588 and "building materials radionuclide limits" requirement as of GB 6566	GBES		
	Building projects do not contain any of the Living Building Challenge Red List materials or chemicals.	Best Practice		
	In ensuring the safety and without polluting the environment, the weight of recyclable materials account for more than 10% of the total weight of construction materials.	GBES		
Smart Green Building	Number of Green Building accredited under China's national scheme	Best Practice		
	Ratio of Green Building to all constructed building finished in the city of the year	Best Practice		
	Implementation of smart technologies (e.g. smart meter, smart building management systems, and smart control of appliances)	Best Practice		
	Development of waste management system for effective control of the logistics of garbage on the classification of waste collection, to prevent unordered dumping of garbage and secondary pollution	GBES		
	Quality assurance reporting of construction engineering	Proposed		

CATEGORY: INCLUSIVE COMMUNITY FACILITIES AND SERVICE

Aged Care and Disability	New facilities are accessible, visitable and adaptable for person with a disability	Best Practice		
	Access to quality and affordable aged care and carer support services for older people including through subsidies and grants, industry assistance, training, and regulation of the aged care sector Development of aged care assessment plan	Best Practice		
	Number of aged care positions per 1k elder population > 30	Best Practice		
Community Services	Funds allocated for community development Long term management plan identified for community infrastructure	Best Practice		
	Per citizen public service facilities area >= 5.5 m2	Best Practice		
	Social security satisfactory rate >= 85%	Best Practice		

Indicators / Measures		Source	Secondary Indicators / Measures	Source
	New facilities promote community interaction and participation	Proposed	Early integration of future residents in planning process and continuous participatory process to involve them in the community development	Proposed
			Encourage the formation of people oriented community committees	Proposed
			Support building of a green voluntary organization in each community	Proposed
			Integrate community in planning and management of public open spaces	Proposed
			Community platforms exist to encourage social exchange, and communicate with property management	Proposed
			Official announcement and news are available to the general public	Proposed
			Availability of consumption and emissions information service on household level, and develop reward systems to promote sustainable consumption behaviour	Proposed
	Presence of Community Culture and Activity Centres	Proposed	Number of attractive cultural activities in the community, celebrate traditional festivals organized per year	Proposed
			Number of facilities and organize activities for children and adults per 10,000 residents	Proposed
Healthy Lifestyle	Provision and enforcement of smoking and non-smoking areas	Proposed		
	Policy promotes drug-free communities. Success can be measured through the percentage of drug-using population or the number of drug-users that join recovery programs	Proposed		
	Responsible use and service of alcohol. This can be measure through the number of police reports related to alcohol abuse per year	Proposed		
	Implementation of community health management plan including regular physical checks and encouraging regular sport activities	Proposed		
	Local health services are provided and easily accessible	Best Practice	Number of doctors per 1k residence > 2.8	Best Practice
			Number of in-patient hospital beds per 100 000 population	ISO 37120
	Affordable medical insurance plan for residents are available	proposed		

Indicators / Measures		Source	Secondary Indicators / Measures	Source
CATEGORY: LIVEABLE COMMUNITY LANDSCAPE				
Recreation	Ensure passive and active open spaces which meet the objective incorporated in the development master plan and design documents	Best Practice		
	Square meters of public indoor recreation space per capita	ISO 37120		
	Number of open public spaces that can act as the focal point for the community to facilitate social contact, and to create an attractive and safe urban environment, increasing opportunities for social interaction	Best Practice		
	Access to free recreational and sports amenities within a walking distance of 500m	Best Practice		
	Link public green spaces: Green transport options to commute between community and regional public green spaces are avaialble	Proposed		
	Percentage of walkways and cycle paths constructed that are convenient, well-lit and safe. Alternatively, number of walkways and cycle paths built to promote recreational and daily commuter activity	Best Practice		
Building Site Conditions	Building site selection has no floods, landslides and soil containing threats to the atmosphere	GBES		
	No electromagnetic radiation hazards and hazards of fire, explosion, toxic substances within the construction site	GBES		
	Per capita residence land index: not more than 43.2 m2 for low rise buildings, not more than 28 m2 for medium rise buildings, not more than 15 m2 for high rise buildings	GBES		
	Residential green land rate greater than 30%, per capita public green area greater than 1 m2.	GBES		
	Construction process need to develop and implement specific measures to protect the environment, control air pollution, soil pollution, noise, water pollution, light pollution caused by the construction and the impact on the site surrounding areas	GBES		

Indicators / Measures	Source	Secondary Indicators / Measures	Source

CATEGORY: ECONOMIC PRODUCTIVITY

Economic density (Community product/geographical area)	UN CPI	Product per capita	
Economic Specialization	UN CPI	Mean household income	
Employment ratio to population	UN CPI		
Presences of a plan for mixed use to maximize opportunities for local economic development	Best Practice		
Policies that promote local employment and job creation are in place	Best Practice	Number of jobs created during construction, and upon completion, within the project	
		50% of the employable residents are employed in the community (precinct)	Best Practice
		Days to start a business	UN CPI
Presence of good public and road transport, cycle and pedestrian access to employment opportunities in local and surrounding areas	Best Practice		

CATEGORY: SAFETY

Number of police officers per 100 000 population	ISO 37120		
Number of homicides per 100 000 population	ISO 37120		
Crimes against property per 100 000	ISO 37120		
Provide emergency shelters for residents	Proposed		
Food safety monitoring systems are in place	Best Practice	Food poisoning prevention systems have been implemented	Proposed

CATEGORY: PROUD AND EDUCATED COMMUNITY

Education and Training Services	Percentage of students completing primary education: survival rate	ISO 37120		
	Percentage of students completing secondary education: survival rate	ISO 37120		
	Policies that aim to deliver the best possible education and training services and outcomes for the community are in place	ISO 37120	Availability of free cultural services to community, e.g. book corner, information material on local heritage and culture	Proposed
Sustainability Education Program	Number of public speeches and education activities on healthy and sustainable lifestyle per year	Proposed		
	Green Publicity: Availability and accessibility of publications and information material with educational tips to encourage sustainable, healthy and environmental friendly behaviour (e.g. Low-carbon promotion plan, tips for greening the community)	Proposed		

CATEGORY: COMMUNITY MANAGEMENT

Implementation of strategies, programmes, projects, plans and services to foster sustainability and resilience in communities	ISO 37101		ISO 37101
Establishment of organisational framework and providing the resources to support the management of environmental, economic and social performance outcomes.	ISO 37101		

A list of existing cool roof materials with their reflectance and emittance values, and in comparison, to conventional roof materials.

WARM ROOF OPTIONS	REFLECTANCE	EMITTANCE	COOL ROOF OPTIONS	REFLECTANCE	EMITTANCE
Built up roof					
with dark gravel	0.08–0.15	0.80–0.9	with white gravel	0.30–0.50	0.80–0.90
with smooth asphalt surface	0.04–0.05	0.80–0.90	with gravel and cementitious coating	0.50–0.70	0.80–0.90
with aluminium coating	0.25–0.60	0.20–0.50	smooth surface with white coating	0.75–0.85	0.80–0.90
Single ply membrane					
Black (PVC)	0.04–0.05	0.80–0.90	white (PVC)	0.70–0.78	0.80–0.90
			colour cool pigments	0.40–0.60	0.80–0.90
Modified Bitumen					
with mineral surface capsheet	0.10–0.20	0.80–0.90	white coating over a mineral surface	0.60–0.75	0.80–0.90
Metal Roof					
unpainted, corrugated	0.30–0.50	0.05–0.30	white paints	0.60–0.70	0.80–0.90
dark-painted, corrugated	0.05–0.08	0.80–0.90			
Asphalt Shingle					
Black/dark brown with conventional pigments	0.04–0.15	0.80–0.90	"white" (actually light grey)	0.25–0.27	0.80–0.90
Liquid Applied Coating					
smooth black	0.04–0.05	0.80–0.9	smooth white	0.70–0.85	0.80–0.90
			smooth off-white	0.40–0.60	0.80–0.90
			rough white	0.50–0.60	0.80–0.90
Concrete Tile					
dark colour with conventional pigments	0.05–0.35	0.80–0.90	white	0.70	0.80–0.90
Clay Tile					
dark colour with conventional pigments	0.20	0.80–0.90	terracotta (unglazed red tile)	0.40	0.80–0.90
			white	0.70	0.80–0.90
Wood shake					
painted dark colour with conventional pigments	0.05–0.35	0.80–0.90	bare	0.40–0.55	0.80–0.90

A list of existing cool paving materials with their reflectance values.

COOL MATERIAL OPTIONS FOR PAVEMENTS	TYPE OF PAVEMENTS	REFLECTANCE
asphalt pavement	Asphalt	0.05
Aged asphalt pavements (depending on the type of aggregate used in the asphalt mix)	Asphalt	0.10–0.18
light-coloured (low carbon content) concrete	Concrete	0.35–0.40
White high reflective paint on concrete tile	Concrete	0.8-0.9
White reflective paint based on calcium hydroxide coated on concrete tile	Concrete	0.76
Infrared reflective paint on concrete tile	Concrete	0.2-0.7
Dark infrared reflective paint coating on asphalt together with hollow ceramic particles	Asphalt	0.5
Infrared reflective pigments for asphaltic pavements	Asphalt	0.27-0.55
reflecting paint to cover all aggregates of the asphalt	Asphalt	0.25–0.57
thermochromics colours for concrete pavements	Concrete	Coloured: 0.51–0.78 Colourless: 0.71–0.81
70per cent of slag is used as cement replacement	Concrete	0.58

Common Carbon Metric
http://www.ccmbuildings.net/

The Common Carbon Metric is the calculation used to define measurement, reporting, and verification for GHG emissions associated with the operation of buildings types of particular climate regions. While it is not a building rating tool, it is consistent with methods for assessing the environmental performance of buildings used globally such as the World Business Council for Sustainable Development (WBCSD), World Resources Institute (WRI) GHG Protocol, and International Standards Organization (ISO) 15392:2008 Sustainability in Building Construction and general principles of ISO 14040/44:2006 on Life Cycle Assessment.

The Common Carbon Metric is applied to the specific inventory of the buildings under study. Such an inventory can be developed from a top-down or bottom-up approach, depending on the scope and goal of the investigation. Monitoring carbon mitigation measures on a regional or national scale would require a top-down approach while assessing individual building projects would require a bottom-up approach.

The following METRICs should be used to compile consistent and comparable data:

- Energy Intensity = kWh/m2/year (kilo Watt hours per square meter per year)
- Carbon Intensity = kgCO2 e/m2 /year or kgCO2 e/o/year (kilograms of carbon dioxide equivalent per square meter or per occupant per year)

This globally harmonized method for MRV energy use and GHG emissions provides the basis for establishing baselines, performance benchmarking, and monitoring building performance improvements.

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