Eco-City Tools
A Collection of Primary Tools
EC-Link Toolbox Series
February 2018
PREFACE

China’s Commitment to Mitigate Climate Change

In 2015, China was one of the first Asian countries – besides Japan and South Korea – to come out strongly with a commitment to combat climate change, and to adapt to eventual future impacts.

Context. With its population of about 1,300 million people, China is one of the world’s major emitters of greenhouse gases (GHG), and at the same time it is also one of the most vulnerable countries to the negative impacts of climate change.

Commitment. In preparation for the 2015 United Nations Climate Change Meeting (COP21) in Paris, the government of China has announced that its GHG emissions will peak in 2030. Equally, it is committed to reduce by 2030 by 60-65% the intensity of its carbon usage in relationship to its gross domestic product (GDP), compared to 2005 levels. It will take on the responsibility to increase substantially its forest cover, and will ensure that by 2030 some 20% of its energy requirements will be covered by renewable energy.

Actions. The country’s measures will include mitigation of its contributions to GHG emissions, and it will introduce adaptations measures to cope with negative impacts of climate change in food production, protection of its population, and in climate-proof infrastructure. China aims at biding climate change agreements under the COP21. The international community sees the proposed measures as ambitious but achievable. Since several years, China has started with low-carbon development. Today it is working towards a full-fledged program of green development of its economy.

Eco-Cities and Climate Change

China’s activities to create eco-cities must be seen as part of its contributions to low-carbon development with aim to mitigate climate change. Among the various support mechanisms which exist, to support low-carbon development, the Ministry of Housing, and Urban-Rural Development (MoHURD), is being supported by the European Union (EU) through the Europe-China Eco-Cities Link Project (EC Link).

Background. The main objective of the EC Link project is to serve as a support mechanism to the Ministry of Housing and Urban-Rural Development to implement its sustainable low-carbon urbanisation agenda. The project will support the Ministry in 4 strategic areas:

1) Demonstrate best approaches to implement low carbon solutions by introducing appropriate urban planning tools. Best practice low carbon planning will be identified in both Europe and China and made available nation-wide to municipal governments. Advanced planning tools will be deployed at the local level with the support of the project, with a view to refining proposed low-carbon planning models and to scaling them up across Chinese provinces.
2) Serve as testing ground for innovations in specific low-carbon policies (e.g. energy performance labelling for buildings, intelligent transport systems, smart cities, GIS planning tools, eco city labelling schemes) and technologies (in the 9 sectors selected by the project: compact urban development, clean energy, green buildings, green transportation, water management, solid waste treatment, urban renewal and revitalisation, municipal financing, green industries).

3) Improve Chinese Municipalities' potential to finance low carbon solutions and notably their ability to attract private sector financing in the form of public private partnerships. The EC Link will support MoHURD to define innovative financial schemes, support feasibility studies and the formulation of finance and investment proposals, better coordinate and leverage investments undertaken by EU Member States, or to link projects to European financing institutions (e.g. European Investment Bank) and to European companies.

4) Establish knowledge networks and test the functionality of the support mechanism by leveraging, scaling up, and integrating transformative actions supported by the policy and technology tools developed under the project. The Knowledge Platform will demonstrate how strategic objectives have been translated at local level and how results have been integrated at national level for the definition of long-term best practices. Results will be shared via training and capacity building at local level, and via the knowledge platform set-up by the project at national and international level.

The EC Link Tools. MoHURD and the EC Link Technical Assistance Team (TAT) have identified 9 specific sectors for which tools have been reviewed. This document presents a collection of primary tools for these 9 sectors.

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INTRODUCTION

**Eco-city sectors.** This book of Eco-City Tools covers 11 sectors that represent those priority sectors which the Ministry of Housing, Urban-Rural Development (MoHURD) has identified for its eco-city development work, namely: (i) eco-city development through compact urban development, (ii) clean energy, (iii) green building, (iv) green transport, (v) water management, (vi) solid waste management, (vii) urban renewal and revitalization, (viii) municipal finance, and (ix) green industries.

**Tools based on a vast amount of background materials.** The elaboration of this book was preceded by the formulation of nine position papers on the same sectors. These position papers do have a very broad coverage and large amounts of detail. This book is an exercise to destill primary tools from the vast scope of topics and instruments available for each sector.

**Sector overview.** The sections presenting the sector tools are preceded by a brief overview of the respective nine sectors, i.e. the sector perspective. This is followed by an overview of the main messages from a select group of illustrative EU cases, i.e. best and state-of-the-art practices which are inspiring international urban practice. These best practices have been made possible through innovative policies and regulations which are presented subsequently, and are mirrored by the existing Chinese policies and Five-Year Plan targets. Key message is that Chinese normative instruments are already supporting the conversion of Chinese cities into ‘green’ cities. However, as is being realized there exists a future agenda for further adjustment and evolution of policies, mechanisms and tools to fully unfold the potentials of the eco-city development.

**Target groups of tools.** The eco-city tools are primarily meant for city managers, related ‘urban’ professionals, and other interested stakeholders.

**Navigation tool.** The book is intended to become a ‘navigation instrument’ through the vast amount of materials and recommended tools existing. It shall help the interested target group to comprehend the recommended and most relevant approaches and tools.

1. **Eco-city development through compact urban development:** Many cities realize that their spatial development planning has a direct impact on the overall success of their low-carbon development. There is a direct connection between the urban form and urban efficiency, mostly represented though the need for transport and mobility. The nexus between urban form and density has far-reaching impacts for the functioning and ecological performance of cities (**Tool CUD 1: urban form – density nexus**). To capitalise on the density concept, spatial planners and transport planners have development Transit-oriented Development (TOD) concept which can help to maximise density benefits at or around transport nodes and intersections, and can create low-carbon impacts as has been demonstrated in many countries (**Tool CUD 2: Transit-oriented Development [TOD]**). Compact urban development can, however, not only be seen a (senseless) maximisation strategy, but should be accompanied by improved urban quality which allows decentralised land-use and highly diversified micro-level development at neighbourhood and district level (**Tool CUD 3: Urban design improvements for better urbanity and decentralized land use**). To achieve low-carbon development of cities, the conventional master planning methodology needs enhancement and refinement. The necessary steps, including the eco-development tools presented in this book, need to be integrated into one consolidated approach (**Tool CUD 4: Eco-low carbon planning methodology**).
2. **Clean energy:** Since the 2015 Paris Agreement on Climate Change cities are striving to do their part in achieving low-carbon development and de-carbonisation through a number of priority approaches, including the promotion of clean energy. The decarbonisation concept will be achieved through new energy technologies that provide clean energy in a decentralised fashion. Supported by large industries, the low-carbon approach is gaining rapid support worldwide and renewable energies prove to become more cost-efficient than the conventional carbon-based development approach. For cities it will be important to make informed choices for decentralised new energy systems (Tool CE 1: Technology options for decentralized new energy supply). Much of the eventual success of the new energy systems to be introduced will depend on the use of micro-grids which will supplement the existing systems of energy providers (Tool CE 2: Decentralised micro-grids). Since cities are engaging in a range of energy innovations which will help them to transform their energy production and consumption with considerable impacts for climate change, it appears necessary to consider joining the global campaign of cities, supported by the European Union. The key instrument of these cities engaged in the global campaign is the formulation of detailed plans (Tool CE 3: Sustainable energy action plans [SEAPs]).

3. **Green building:** Another key sector for eco-cities, besides clean energy and green transport, is green building which can impact 30-40 of current city emissions of CO₂. Green building is rapidly becoming an industry trend, and is receiving much attention by the private sector and corporate-institutional and private building owners. A consolidated body of experience with green building exists in Europe and increasingly also in China. Since the cold climate zones of China have similar energy efficiency requirements like northern Europe, China can benefit from much of the technology and instruments developed so far (Tool GB 1: Passive Building Design). However, since China has many distinctive climate zones, there is ample need to develop passive building design concepts further to service warmer and hot climate zones in the south and west of China equally through passive building technology which can be adjusted for these different circumstances (Tool GB 1: Passive Building Design). To achieve higher energy efficiency targets, the attention has even shifted to more ambitious energy-efficiency targets of building that produce the energy which they consume. The principle of active building design, or near-zero energy buildings is being introduced (Tool GB 2: Active Building Design). Since a large share of the existing building stock has a reasonable life expectancy, there is need for retro-fitting of these buildings to bring them at par with new buildings through upgrading or retrofitting measures (Tool GB 3: Retrofitting of Buildings).

4. **Green transport:** Green transport is expected to help reduce air pollution in Cities and to change the way people move around. The approach to decarbonisation of cities is complemented by the many ‘new energy’ vehicles and modes of transport which have come onto the market. The sustainable transport paradigms are best illustrated by the ‘avoid – shift – improve’ formula which calls for an integrated approach to city-wide transport planning (Tool GT 1: Integrated city-wide low-carbon transit plans). To decide for certain ‘new energy’ vehicles and transport strategies, it is crucial to be able to assess their contribution to reduction in emissions, upfront before investing in these technologies (Tool GT 2: Emission assessment of low-carbon transport modes). Complementary to the emission assessment, is the need to decide for the most adequate and cost-efficient environment friendly transport technologies (Tool GT 3: Technologies for low-carbon transport). Motorised transport technologies are as important as (the need for) non-
motorised transport (walking and cycling) which will make cities more lovable and healthy places (Tool GT 4: Planning for non-motorized transport).

5. **Water management**: Water is one of the most important requirements of life. Since many urban areas in China are ‘water-scarce’, water management (water supply, waste water treatment and flood management) is an essential part of their ecological development. Thus a prime concern is the provision of quality drinking water, ensuring water safety for all (Tool WM 1: Water Safety Plans). The provision and distribution of water is a prominent factor in cities’ energy consumption, and new technologies can reduce energy needs. Immediately related to waste water is the treatment of waste water which can be done through sophisticated technologies or nature-based decentralised technologies (Tool WM 2: Waste Water Options). To address the issue of flooding through a holistic low-impact development (LID) approach, the ‘sponge city’ has been conceived which covers water harvesting through non-conventional methods, the nature based treatment of waste waters, and drainage and flood management through adaptive measures (Tool WM 3: Sponge City Planning).

6. **Solid waste management**: Due to rising living standards and consumption levels, solid waste is increasing rapidly. The current conventional standards are low, and majority of waste ends up in uncontrolled dump sites, with little recycling and reuse. These conditions call for a more integrated approach of waste management (Tool SWM 1: Integrated Solid Waste Management Plans). One major underlying principle will be the introduction of waste reduction, recycling and reuse (3-R) practices (Tool SWM 2: 3-R Tools). A serious fact of the waste management situation is that there exist only few waste-to-energy projects in the country, and for those that exist there are no modern technologies for their closure known (Tool SWM 3: Management of Closure of Sanitary Landfills). A modernization of the waste sector is urgent, and a better use of the resources through recycling or conversion to energy needs to be developed with the help of private investors (Tool SWM 4: Management of Waste Incinerators).

7. **Urban renewal and revitalization**: Across China we can see the adoption of urban renewal measures inspired by overseas, mostly European city innovations. Retrofitting of old, existing building stock seems to be supported by economic rationale. However, the unprecedented urban wealth rather has encouraged the destruction and many older neighbourhoods and built environments. With the greening of the building sector, the challenge arises if the can be a green, energy-efficient retrofitting of entire neighbourhoods. Urban renewal is recommended through environmental measures (Tool URR 1: Environmental instruments for neighbourhood revitalisation), through measure which revitalise the local economy (Tool URR 2: Economic instruments for neighbourhood revitalisation), and the technical retrofitting of the building stock and infrastructure (Tool URR 3: Social instruments for neighbourhood revitalisation).

8. **Municipal finance**: China’s cities have relied in recent decades on sale of sub-urban land. Other revenue sources have taken back seat. In the context of the continuing and massive urban renewal and modernization of cities, there is a need to develop new non-conventional revenue streams to maintain existing investment dynamics (Tool MF 1: Green investment resource plan). In order to support low-carbon development in transport,
energy sector, buildings, water, waste management, greening of industries, there is also a need to develop green financing tools. Recently, China has seen an exponential growth of green bonds and other means of financial innovation which may help to put low-carbon urban development on more stable feet (Tool MF 2: Green investment financing plan).

9. **Green industries**: China is conceptually supporting the circular economy (Tool GI 1: New energy approaches for carbon replacement). This includes co-generation of energy for industrial or non-industrial purposes, and the recycling and reuse of all resources required for industrial production (Tool GI 2: Energy efficiency and cogeneration). A growing number of industries have come into existence to demonstrate the viability of the concept of clean industrial production (Tool GI 3: Circular Economy). A serious pursuit of the green industries´ concept is urgent as part of the national campaign for cleaner air (Tool GI 4: Green Industries and urban renewal-revitalisation).

### Classification of Eco-City Tools

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Primary tools to provide guidance and practical orientation. The wide thematic coverage makes it necessary to avoid too much technical detail of the tools. Obviously, these tools could be broken down further into detailed technical instructions which would exceed the intentions of this book.

Introduction to more detailed technical instruments. For those readers seeking more detailed technical content and guidance, bibliographies and specific references to other related handbooks are provided for further self-study and exploration.

Tools part of a concerted human resource development approach. Naturally, handbook like this, can provide only support to the approach in human resource development. For eco-city development to succeed a much broader agenda will have to be pursued, for which these tools can only be auxiliary in nature.

Which route next? Many people are asking themselves this question of the future directions. And there exist many suggestions of what could and should be done in the near future:

Suggestion for a concerted national agenda. The following four points summarise some of the possible avenues:

1. **Development of mandatory eco-city implementation guidelines**, with clearly defined targets for cities and for the private sector. Such a national agenda should become rolled out to all cities which are working with MoHURD and the National Development and Reform Commission (NDRC) on smart city or eco-city development.

2. **Translation of the national agenda (and Five-Year Plan goals) into city-level eco-city action plans.** Such plans should become part of the routine operations of cities, and their accomplishment should become part of the regular reviews by government. Additionally, such city-level eco-city action plans should become part of consultations with local stakeholders, i.e. the private sector, and be part of city-to-city networking and exchange.

3. **Creation of an eco-city development fund**, as part of a national financing initiative by government, and the creation of a set of well-targeted subsidies and investment incentives.

4. **Establishment of an eco-city campaign** which will select and award the best practice examples. The campaign will develop and publish good practices more widely through dedicated websites (for instance [www.eclink.org](http://www.eclink.org)).
1. COMPACT URBAN DEVELOPMENT
High-rise high density residential area in Beijing, Haidian District

Beijing - Suburban district – medium-density

Beijing – Medium to low-density districts

Source: F. Steinberg
Sector profile of Low-Carbon Urban Development through Compact Urban Development

Introduction. Compact urban development is important for eco-city development. Better urban planning decisions and decisions concerning urban densities will be critical. Spatially, this urban expansion can be accommodated through three spatial strategies: (i) densification in existing areas; (ii) horizontal urban expansion; and (iii) new town development, or a combination of these. Densities of compact urban development that are manageable and suitable will play an important role. Achieving compact and sustainable urban forms is possible where there is strong local government and policies for urban intensification. However, often the process of densification occurs in the absence of policies and control. China shows very clearly that a lot of precious agricultural land has been lost to urban sprawl, and that action is necessary to contain further unplanned expansion. More compact development thus seems paramount to achieve a better nexus between urban form and urban densities.

State of Demand in China. Chinese cities are hovering in their average density close to the threshold of 5000 inhabitant/km², with highly dense congested cores and a vast suburban expansion where the suburban area has been multiplied by 1.8 every 10 years for the last 2 decades. The overall densities in Chinese often are just about 50% of those of consolidated cities in Europe. If the present trends continue, Chinese suburban density will be around 2500 inhabitant/km² in 2030, with suburbs 36 times bigger in surface than the core, as the Shanghai case exemplifies. It would notably lead to a tripling of energy demand for transportation and contribute to increasing the infrastructure costs per capita. China needs an urgent and ambitious shift toward infill urban development to avoid the current trend of edge and leapfrog growth that feeds de-densification and urban sprawl. A rational densification approach needs to become the agenda for future eco-city development if ecological benefits are sought, through reduced carbon usage through reduced transport need and reduced network length of basic infrastructure. The popular approach of transit-oriented development (TOD) which densifies urban areas near public transport hubs, can energize densification benefits.

Policy Directions. The Government’s pronouncement of the 13th Five Year Plan objectives has stated three key objectives: (i) Increased efficiency of energy resources development and utilization; effective control total aggregate of energy and water consumption, construction land, and carbon emissions. The total emissions of major pollutants shall be reduced significantly; (ii) City development shall be in accordance with the carrying capacity of resources and the cultural context. Green planning, design and construction standards shall be applied; (iii) Support reduced emission standards, and implement demonstration projects of “near-zero” carbon emission. Several principles for compact urban development need to be highlighted:

- **Urban Growth Boundary:** Every city should establish an enforced urban growth boundary (UGB). The UGB should be set based upon a rigorous analysis of ecological sensitivities, environmental capacity, and the efficiency and productivities of various land uses. The boundary can expand beyond the existing urban footprint only if there are no suitable infill locations as indicated by an intensity of urban land use of at least 10,000 residents per square kilometer.
- **Mixed Use:** All residential units should be close to at least six kinds of amenities within 500-meter radius of building entrance (amenities include schools, post offices, banks, retails, clinics, activity centers, restaurants, etc.). The job-resident ratio (the number of people employed divided by the number of residents) should be between 0.5 and 0.7 over every commuting district, which should have a spatial area that is no more than 15 km². Normally, these commuting districts are bounded by physical barriers for pedestrians.
- **Small blocks.** Blocks should be less than or equal to 2 hectares and 70% of the blocks should comply with this standard. Exceptions are made for industrial areas.
- **Public green space.** Publicly accessible and usable green space should comprise 20-40\% of the construction areas (residential area should be at the higher end of this range). All residents should have accessible public space within 500 meters. ¹

- **Proposed urban density targets.** The Design Manual for Low Carbon Development² as per the China Sustainable Cities Program has made the attempt to quantify floor area ratios (FAR), or floor space indexes (FSI), for diverse type of developments, ranging from mid-rise residential to highly compact commercial developments. The range covers 10 storey to 50 storey developments, or FAR of 2.7 to 8.0.

**Best Practices in Europe.** The experience of eco-cities or eco-districts in Europe represents work in progress. More detailed assessments need to be done, particularly in terms of energy, buildings and transport performance. So far, the kaleidoscope of eco-cities or eco-districts in Europe seems ‘experimental’ in nature, but in some cases these eco-cities seems to inform public policy in the areas of energy, buildings, management of basic services (water; waste management), and motorized as well as non-motorized transport. In terms of densities, these eco-districts do follow the established local density patterns. None of these seems to have created an approach of higher density. However, the concept of compact mixed-use neighbourhoods and districts is very much at the heart of most of these eco-cities since non-motorised transport, walkability and good access to public transport of these districts is a cross-cutting principle.

**State of the art in low-carbon urban planning in Europe.** The EU has issued several important urban policy declarations, like the 2007 Leipzig Charter³, and the 2010 Toledo declaration⁴. The most recent document is the Pact of Amsterdam⁵. Cities are of huge importance to Europe. They are the powerhouses of economic growth, innovation and employment. 72\% of all Europeans live in cities. This percentage is expected to rise to 80 by 2050. Complex challenges related to the environment, transport and social cohesion are increasingly negatively impacting quality of life in cities. The Urban Agenda for the EU aims to address these challenges. To fully exploit the potential of cities, European policies and rules should be more in line with local practice in cities. This does not entail new or more competences for the European Union, but a better working method, focused on cooperation between Member States, cities, European institutions and other stakeholders.⁶ The most far-reaching European declaration in support of Eco-Cities is, however, contained in the Freiburg Charter of 2010 of Universal Principles for Creating a Sustainable City which underlines the need for compact urban development, of walkable cities.⁷

Several European cities have initiated eco-districts. These co-districts have become experimenting grounds for investments in a range of fields, covering green energy, green transport, green buildings, green services (water recycling, waste water treatment); green solid waste management, and green industries. All of these represent efforts at concrete project levels, as well as efforts to change life styles and consumer habits.

**Best Practices.** The most well-known European of eco-districts can be found in:
• Freiburg, Germany: Eco-District Vauban. Vauban is a new neighbourhood planned for 5,000 inhabitants and 600 jobs. It is high density as per German standards with a density of 1,497 pers/sqkm.

• London, United Kingdom: Eco-District Bed-ZED. The Beddington Zero Energy Development (BedZED) is an environmentally friendly housing development in Hackbridge, London, England. It is in the London Borough of Sutton, 2.0 miles (3 km) north-east of the town of Sutton itself. Designed to create zero carbon emissions, it was the first large scale community to do so.

• Stockholm, Sweden: Eco-District of Hammarby. Since 1995, the city of Stockholm has developed Hammarby Sjöstad (Hammarby Lake City), built on a previous industrial site at a harbor area which has been cleaned up, developed and converted into a modern and eco-friendly district. Hammarby Sjöstad is Stockholm’s largest urban development project with its own environmental programme incorporating energy supply, water and wastewater treatment and waste management. Hammarby is meant to provide 10,000 apartments for 35,000 inhabitants and it occupies 200 ha of land in Southern Stockholm.

• Grenoble, France: Eco-Quartier De Bonne. The eco-district (“eco-quartier”) de Bonne got its name from the late 19th century military barracks, the Caserne de Bonne, which occupied the site until 1994. This small neighbourhood, in between the Grands Boulevards and the historic centre, is noteworthy for its cutting edge ecological features, which follow the French green building codes of the HQE (Haute qualité environnementale (French) or High Quality Environment). This special development area is France’s leading eco-district.

• Helsinki, Finland: Eco-District Viikki. The eco-district in Viikki, Finland is the result of long-term work aimed at putting ecological principles into practice in actual buildings. Two design competitions were organised for the area and a number of seminars and debates. The master plan competition was won by a proposal based on a finger-like structure with alternating buildings and green open spaces. The layout permits functions to be combined naturally, nutrients and water to be recycled (composting, allotments, collecting surface water run-off), and the utilisation of solar energy. Eco-Viikki is part of the sustainable cities of Europe initiative.

• Pamplona Navarra, Spain: Sarriguren eco-city. Sarriguren is Spain’s first eco-city, planned as an expansion of the city of Pamplona, located 3 kms from the city. The eco-city of Sarriguren was promoted by the Navarre Government Department of the Environment, Spatial Planning and Housing, and was designed by Fundación Metropoli. It follows ten principles devised in terms of performance specifications, with specific

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9 http://www.cardiff.ac.uk/archi/programmes/cost8/case/holistic/viikki.html

10 http://en.wikipedia.org/wiki/Hammarby_Sj%C3%B6stad

11 http://www.plataformaarquitectura.cl/cl/799017/estocolmo


emphasis on the protection of natural areas, energy saving, integration of renewable energies and healthy construction.\textsuperscript{13}

\textbf{State of the art in low-carbon urban planning in China.} Some are high-profile international ventures led by the central government, such as the Sino-Singapore Tianjin Eco-City (SSTEC) and Caofeidian (Tangshan), while others are driven primarily by local authorities and local entrepreneurs. In 2017, the Government announced the creation of Xiong’an, new town in Hebei Province near Beijing. By one count, in 2008 there were 135 cities or local municipalities planning or developing some kind of ecological settlement.\textsuperscript{14} The Ministry of Environmental Protection (MEP) listed in 2009 some 389 counties and cities as approved National Ecological Demonstration Sites and 629 towns as Environmentally Beautiful Towns.\textsuperscript{15} The term “eco-city” today appears as a catch-all phrase for a variety of new urban development models. In China, a low-carbon eco-city is described as an innovative type of urban development model based on the principle of balance with the natural environment, defined as a low carbon eco-city aimed to minimize resource consumption and emissions generation, while focusing on environmental protection. An assessment of low carbon cities in China also identified three types of low carbon eco-cities: \textit{technologically innovative eco-city model} (which is usually neither replicable nor scalable and tends to require substantial funding); \textit{liveable eco-city model} (which is replicable and sustainable, typically designed for population of up to 300,000, employs green building technologies, focuses on developing services industries, emphasizes urban planning is based on transit-oriented development (TOD) model and green transport modes (e.g. walking, cycling, public transport); and \textit{progressive evolution of the eco-city model} (or “retrofit” model), which refers to rehabilitation and renewal of “old cities” towards more sustainable urban development.\textsuperscript{16}

\textbf{Low-carbon urban planning indicators - Proposed Urban Development Key Performance Indicators (KPIs)}\textsuperscript{17}

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average built-up area per capita (m\textsuperscript{2}/pers) [1]</td>
<td>≤85 m\textsuperscript{2}/pers [1] ≤100 m\textsuperscript{2}/pers [9]</td>
<td></td>
</tr>
<tr>
<td>Public green space [1; 3]</td>
<td>≥12 m\textsuperscript{2}/pe: rs [1]</td>
<td>By 2013 [3]</td>
</tr>
</tbody>
</table>


\textsuperscript{17} These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. \textit{Sino-EU Key Performance Indicators for Eco-Cities}. Beijing (unpublished draft)
<table>
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<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of green areas [5]</td>
<td>≥35%</td>
<td></td>
</tr>
<tr>
<td>Average land area for public facilities per capita [1]</td>
<td>≥5.5 m²/pers [1]</td>
<td></td>
</tr>
<tr>
<td>Proximity to amenities: schools, post offices, banks, retails, clinics, activity centres, restaurants, etc. [6]</td>
<td>≤500 m [6]</td>
<td></td>
</tr>
<tr>
<td>Proportion of green areas [5]</td>
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<td></td>
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<tr>
<td>Proximity to amenities: schools, post offices, banks, retails, clinics, activity centres, restaurants, etc. [6]</td>
<td>≤500 m [6]</td>
<td></td>
</tr>
<tr>
<td>Residential blocks [6]</td>
<td>≤ 2 ha (= 20,000 m²) [6]</td>
<td></td>
</tr>
<tr>
<td>Transit-oriented Development (TOD) around public transit systems [7]</td>
<td>≤ 500-800 m to major transit stations (metro or bus rapid transit (BRT)) [8]</td>
<td></td>
</tr>
<tr>
<td>Floor area ratio (FAR) [7]</td>
<td>≤ 500 m of nearest bus or transit stops (in case BRT or Metro is not available)</td>
<td></td>
</tr>
<tr>
<td>Great accessibility (pleasant walking amenities to transit system within 500-meter radius) [7]</td>
<td>For the city as a whole: ≤ 90% within 800m of public transit station. FAR 50% higher (big cities 70%) than the average FAR of the district. 90% ≤ 500 m radius [7] [8]</td>
<td></td>
</tr>
<tr>
<td>Heat island effect density</td>
<td>70% of road, building roof areas with reflection coefficient ≤ 0.4</td>
<td></td>
</tr>
<tr>
<td>Ambient noise meeting ambient noise standard GB 3096</td>
<td>≥80%</td>
<td></td>
</tr>
<tr>
<td>Flood prevention as per national design standards GB50201 and GB50805 [5]</td>
<td>100% [5]</td>
<td></td>
</tr>
</tbody>
</table>

Sources:
Outlook and future sector agenda. China’s cities will densify with about 1 billion people by 2030. With the proliferation of new cities in China, thousands of skyscrapers are expected to be built, illustrating the drive for higher densities. Eco-city development in China is still very much at an early stage. China’s decisions about land use will have a huge impact on energy consumption and carbon emissions. If China’s cities will live at high densities and use public transit, then the whole world will benefit. If they sprawl, then we will all suffer from higher energy costs and higher carbon emissions. The Eco-City experience in China, with these beginnings, will bear visible benefits in the next 30-50 years. This work is going to be a medium-term haul. Short-term challenge is to get it right on energy, transport, densities, and the building technologies, and to “leapfrog” to achieve at least the same results as their European peers. Better urban planning, with more mixed land-use and TOD can enhance the urban form-urban density nexus and strengthen low-carbon development. Eco-city low-carbon urban planning will have to take into account the positive contribution of more compact urban development.

China’s cities will densify. 30 billion sqm of housing will be’ built and a population of additional 800 million people will be urbanised over the coming 20 years through the creation of 200 towns, each housing over two million inhabitants. With the proliferation of new cities in China, thousands of skyscrapers are expected to be built, illustrating the drive for even higher densities. Eco-city development in China is still very much at the experimental stage. As can be gleaned from the case studies, appropriate management and policies to drive and support eco-city development are as important as, if not more so than, technology or financing factors.

- It appears that by comparison the dominant planning philosophies which are being promoted in Europe and China are similar.
- This trend of cities becoming more compact, coordinated and connected is mainly driven by the concern for the ecology of cities, and their performance in terms of carbon or emission reduction. The notion of more compactness, of higher transport efficiency is transforming the way the future of cities is being seen.
- Cities in China, will have to become more compact and efficient, as can be demonstrated.

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• The notion of citizens’ participation in city development should receive more attention. The role of citizens in the cities of the future will become more important. Their role will be to oversee that environmental targets are achieved, and that certain changes in lifestyle can be implemented.

• Changes in lifestyle will contribute to changes in the city: These changes in lifestyle are related to mobility, use of means of transport, and the walkability within cities, related to consumption, use of energy and the management of waste.
Tool CUD 1: Urban form – density nexus.

What this tool does: This tool relates urban spatial configurations (urban design) to urban density. It establishes a relationship which city planners need to manage well if they want to achieve positive urban performance, and want to create benefits of low-carbon development. The underlying assumption is that compact urban development can reduce travel and transit requirements, and that compactness also generates higher efficiency of urban infrastructure services.

How does it work:

<table>
<thead>
<tr>
<th>Key Strategies</th>
<th>20 Sub-strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Set explicit compact city goals</td>
<td>1. Establish a national urban policy framework</td>
</tr>
<tr>
<td>2. Encourage dense and contiguous development at urban fringes</td>
<td>2. Encourage metropolitan-wide strategic planning</td>
</tr>
<tr>
<td>3. Retrofit existing built-up areas</td>
<td>3. Increase effectiveness of regulatory tools</td>
</tr>
<tr>
<td></td>
<td>4. Target compact urban development in green field areas</td>
</tr>
<tr>
<td></td>
<td>5. Set minimum density requirements for new development</td>
</tr>
<tr>
<td></td>
<td>6. Strengthen urban-rural linkage</td>
</tr>
<tr>
<td></td>
<td>7. Promote brown-field development</td>
</tr>
<tr>
<td></td>
<td>8. Harmonise industrial policies with compact city policies</td>
</tr>
<tr>
<td></td>
<td>9. Regenerate existing residential areas</td>
</tr>
<tr>
<td></td>
<td>10. Promote transit-oriented development in built-up areas</td>
</tr>
<tr>
<td></td>
<td>11. Encourage “intensification” of existing urban assets</td>
</tr>
<tr>
<td>4. Enhance diversity and quality of life in urban centers</td>
<td>12. Promote mixed land use</td>
</tr>
<tr>
<td></td>
<td>13. Attract residents and local services to urban centers</td>
</tr>
<tr>
<td></td>
<td>14. Promote focused investment in public space</td>
</tr>
<tr>
<td></td>
<td>15. Promote focused investment in public space and foster a “sense of place”</td>
</tr>
<tr>
<td></td>
<td>16. Promote a walking and cycling environment</td>
</tr>
<tr>
<td>5. Minimise adverse negative effects</td>
<td>17. Counteract traffic congestion</td>
</tr>
<tr>
<td></td>
<td>18. Encourage the provision of affordable housing</td>
</tr>
<tr>
<td></td>
<td>19. Promote high-quality urban design</td>
</tr>
<tr>
<td></td>
<td>20. Encourage greening of built-up areas</td>
</tr>
</tbody>
</table>


Same Density in Different Layouts

### Development Standards Matrix as per the China Sustainable Cities Program

<table>
<thead>
<tr>
<th></th>
<th>Mid-Rise Residential</th>
<th>High-Rise Residential</th>
<th>Tower Residential</th>
<th>Mid-Rise Commercial</th>
<th>High-Rise Commercial</th>
<th>Tower Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum building Height</strong></td>
<td>10 storeys Max 46 m</td>
<td>20 storeys Max 91 m</td>
<td>33 storeys Max 149 m</td>
<td>16 storeys Max 96 m</td>
<td>30 storeys Max 180 m</td>
<td>50 storeys Max 300 m</td>
</tr>
<tr>
<td><strong>Total Maximum FAR</strong></td>
<td>2.7</td>
<td>3.5</td>
<td>4.0</td>
<td>4.0</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>Minimum/maximum Sidewalk Commercial / FAR</strong></td>
<td>0.12 / 0.4</td>
<td>0.12 / 0.4</td>
<td>0.12 / 0.4</td>
<td>0.3 / 0.65</td>
<td>0.5 / 1.3</td>
<td>0.5 / 2.0</td>
</tr>
<tr>
<td><strong>Building Coverage Max.</strong></td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>65%</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td><strong>Green Coverage Min.</strong></td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Street Frontage</strong></td>
<td>Min. 70% facing East/West streets</td>
<td>Min 60% facing North/South streets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum and Minimum Street Front Setbacks</strong></td>
<td>0-2 meters @sidewalk commercial</td>
<td>1-3 meters @office</td>
<td>3-5 meters @ residential</td>
<td>0-1 meters @ within 15 meters of intersection</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Solar Spacing – all ‘small blocks’</strong></td>
<td>North side- Building height limited to adjacent street right of way dimension plus building setback</td>
<td>Block interior – maximum 45 degrees from building to the bottom of the first residential floor of the building to he north (e)</td>
<td>Building elements 7-16 stories must be placed to provide 45 degrees solar setback to any residential property lines to the north</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tower elements – Maximum Floor Plate</strong></td>
<td>NA</td>
<td>NA</td>
<td>400 square meters for tower element above 20 storeys</td>
<td>NA</td>
<td>1,200 square meters for tower element over 16 storeys</td>
<td>1,200 square meters for tower element over 16 storeys</td>
</tr>
<tr>
<td><strong>Primary Pedestrian Entry</strong></td>
<td>Primary entry must be located on and directly accessible to the most important public space or street. Multiple entries are encouraged.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parking Structure</strong></td>
<td>Above grade structure must include sidewalk commercial use at ground floor where fronting street. Below grade preferred.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Parking Ration</strong></td>
<td>1 space per dwelling unit. Other uses as per existing code.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parking Entry</strong></td>
<td>No entry off major streets 50 meters or greater. No entry within 20 meters of intersection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Literature / further information:**
**Tool CUD 2: Transit-oriented Development (TOD).**

**What this tool does:** This tool provides city planners with an understanding of the density advantages of urban transport nodes for real estate development. TOD has become synonymous for revenue earning through development of public transport nodes, and in many TOD project these revenues have been able to finance other infrastructure components through cross-subsidies. The tool describes design parameters for commercial centres, urban centres, and town centres.

TOD is a planning strategy that aims to concentrate jobs, housing, and services around public transport stations. From Copenhagen to Singapore, this approach has helped many cities reduce their carbon footprint while becoming more productive and more liveable. However, TOD principles cannot be applied uniformly across an entire city or transit network. “Imagine a city that is more competitive, with higher-quality neighbourhoods, lower infrastructure costs, and lower CO2 emissions per unit of activity. This city has lower combined transportation and housing costs for its residents than other cities at similar levels of economic activity. Its residents can access most jobs and services easily through a combination of low-cost public transport, walking and cycling. Its core economic and population centres are resilient to natural hazards. It is able to finance improvements to public space, connectivity, and social housing by capturing value created through integrated land use and transport planning. Such a vision has never been more relevant for rapidly growing cities than it is today. TOD can play a major role in achieving such a vision.”

**7 Principles for Transit-Oriented Development.** By managing growth that is compact, coordinated, and connected, TOD prioritizes people over cars. TOD prioritizes the “3Cs”: compact, coordinated and connected. By following a TOD approach, decision makers and urban planners can strengthen their communities. Cities can ensure TOD by focusing on the following seven principles:

1. **Quality Public Transit.** High quality, convenient transport depends on dense and connected neighbourhoods. The goal of a transport system is to connect a high number of riders with the city in an efficient, comfortable, and affordable way.
2. **Active Transport.** Pedestrians and cyclists should be at the heart of urban planning. Many commuters already take two non-motorized trips on a daily basis by walking to and from transit hubs to their homes or cars. It is important to build on this and encourage non-motorized transport holistically.
3. **Car Use Management.** Car use and parking play an important role in creating a safe, human-oriented urban environment. Car infrastructure is supported with four times the amount of investment that public transit receives.
4. **Mixed-Use Neighbourhoods with Efficient Buildings.** Mixed-use neighbourhoods favour short trips by foot or bike. Similarly, buildings should minimize how much energy and water they consume and require for building and maintenance. A good mix of land uses enhances the local economy by densifying and diversifying the design of the community.
5. **Neighborhood Centers and Vibrant Ground Floors.** A built environment with adequate public space promotes social interaction between residents. Sustainable urban communities must be sufficiently dense and contain a variety of uses that are complementary to residential life. Public spaces should be connected to the urban transport network and serve as vibrant, human-centred places of activity.

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20 Transforming the Urban Space Through Transit-Oriented Development: The 3V Approach
6. Public Spaces. Public space is the place of encounter, exchange, and circulation within a community. The purpose of public space is not only to enhance public life and social interaction, but also to provide a safe environment for pedestrians and cyclists. All individuals have the right to access public spaces, regardless of personal, social, or economic condition.

7. Community Participation and Collective Identity. Community participation is essential to building a vibrant, inclusive neighbourhood that is safe and equitable. Stimulating community participation creates a more equitable, harmonious relationship between varying social groups living in the same area. Respecting the unique identity of local communities results in a higher share of residents engaging in civic, cultural, and economic activities, generating a sense of belonging and ownership of the city.

How does TOD work:

• Promoting higher densities and the concentration of jobs within relatively small areas, TOD creates agglomeration effects proven to boost a city’s competitiveness.
• This concentration creates vibrant communities with high-quality public areas and shorter commuting distances — making cities more liveable.
• Compact urban development and high-quality public transit also mutually reinforce each other: mass transit can support the large passenger flows that come with high density development, while the concentration of jobs and housing around stations helps make public transport financially viable.
• Proximity to mass transit improves access to TOD neighbourhoods, boosting their attractiveness and increasing real estate value.
• Cities can capture a part of these increases in value and use it to finance additional (transit) improvements, affordable housing, and other initiatives that promote sustainable inclusive growth.
• TOD can drive up property prices and accelerate gentrification. This can be offset by allocating a significant portion of the new development to affordable housing. This type of inclusive TOD approach enhances access to job opportunities and services for residents at all income levels.
• By concentrating jobs, services, and housing within the catchment area of transit stations, TOD makes public transport a more attractive and efficient option, while reducing dependence on private cars and promoting shorter commutes. As a result, TOD typically translates into higher productivity and a smaller carbon footprint, through lower GHG emissions per capita.
• When located in areas that are less exposed to natural hazards, the TOD approach can enhance resilience to disaster risks by supporting high-density housing and activities in lower-risk zones.

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TOD STANDARD KEY IMPLEMENTATION OBJECTIVES

WALK
DEVELOPING NEIGHBORHOODS THAT PROMOTE WALKING
OBJECTIVE A. The pedestrian realm is safe, complete, and accessible to all.
OBJECTIVE B. The pedestrian realm is active and vibrant.
OBJECTIVE C. The pedestrian realm is temperate and comfortable.

CYCLE
PRIORITY NONMOTORIZED TRANSPORT NETWORKS
OBJECTIVE A. The cycling network is safe and complete.
OBJECTIVE B. Cycle parking and storage is ample and secure.

CONNECT
CREATE DENSE NETWORKS OF STREETS AND PATHS
OBJECTIVE A. Walking and cycling routes are short, direct, and varied.
OBJECTIVE B. Walking and cycling routes are shorter than motor vehicle routes.

TRANSIT
LOCATE DEVELOPMENT NEAR HIGH-QUALITY PUBLIC TRANSPORT
OBJECTIVE A. High-quality transit is accessible by foot. (TOD Requirement)

MIX
PLAN FOR MIXED USES, INCOME, AND DEMOGRAPHICS
OBJECTIVE A. Opportunities and services are within a short walking distance of where people live and work, and the public space is activated over extended hours.
OBJECTIVE B. Diverse demographics and income ranges are included among local residents.

DENSIFY
OPTIMIZE DENSITY AND MATCH TRANSIT CAPACITY
OBJECTIVE A. High residential and job densities support high-quality transit, local services, and public space activity.

COMPACT
CREATE REGIONS WITH SHORT TRANSIT COMMUTES
OBJECTIVE A. The development is in, or next to, an existing urban area.
OBJECTIVE B. Traveling through the city is convenient.

SHIFT
INCREASE MOBILITY BY REGULATING PARKING AND ROAD USE
OBJECTIVE A. The land occupied by motor vehicle is minimized.

## Concentrating Density at Transit Stations

### Commercial Centre
**Definition:** The highest-density commercial area with mixed-use that acts as regional employment, retail and civic/cultural hub; with a variety of high density housing

**Localisation Criteria:** Located within 600 meters of at least two metro transit stops or a major BRT hub

**Minimum Density/Use Criteria:**
- Employment density (Jobs/Ha gross) = 500
- Population density (Pop/Ha gross) = 200

**Minimum Land Allocation (Percentage):**
- Parks: 10%
- Civic: 5%

### Urban Centre
**Definition:** A high-density mixed-use district that acts as sub-regional employment, retail and civic/cultural centre; with a variety of high and mid-density housing

**Localisation Criteria:** Located within 400 meters of a regional transit station that is a hub for several local transit lines

**Minimum Density/Use Criteria:**
- Employment density (Jobs/Ha gross) = 300
- Population density (Pop/Ha gross) = 200

**Minimum Land Allocation (Percentage):**
- Parks: 10%
- Civic: 5%

### Town Centre
**Definition:** A high-density housing area with retail, civic and open space amenities; with a mix of high and mid-rise buildings

**Localisation Criteria:** Served by a single regional transit station

**Minimum Density/Use Criteria:**
- Employment density (Jobs/Ha gross) = 50
- Population density (Pop/Ha gross) = 300

**Minimum Land Allocation (Percentage):**
- Parks: 10%
- Civic: 5%


**Example:**

**Illustration of Transit-oriented Development Densities**

A new world Bank Report allows decision makers to better understand the linkages between connectivity, accessibility, place quality, and market potential values around a given station. Cities can then identify the type of development for which they are best-suited. The “3V” Framework is applicable to large cities with extensive networks, and also smaller cities with only a few mass transit lines or a bus rapid transit system.

**Where, when, and how to implement TOD: the “3V” Framework.** TOD principles cannot be applied uniformly across an entire city or transit network, since densities of jobs and people vary widely across the urban space. In fact, experience has shown that only about 15% of transit stations and their surrounding area can support very high density development.

To make informed decisions about TOD, research institutions and governments have developed a variety of methodologies that can help identify which station areas are good candidates for TOD, determine what level of density the area around a given station can absorb, and figure out what kind of development mix makes sense in a particular area, looking to strike the right balance between jobs, housing, and other amenities.

Building on these approaches, the report proposes a new framework for guiding TOD plans, by simultaneously assessing the “three values” (3V) of transit stations and surrounding areas:

- **The node value** describes the importance of a station in the public transit network based on passenger traffic, connections with other transport modes, and centrality within the network.
- **The place value** reflects the quality and attractiveness of the area around the station. Factors include the diversity of land use; the availability of essential services such as schools and healthcare; the proportion of everyday amenities that can be accessed by walking or cycling; pedestrian accessibility and also the size of urban blocks around the station.
- **The market potential value** refers to the unrealized market value of station areas. It is measured by looking at the major variables that can influence the demand for land (current and future number of jobs in the vicinity of the station, number of jobs accessible by transit within 30 minutes, current and future housing densities) as well as the supply (amount of developable land, possible changes in zoning policy, market vibrancy, etc.).

The report presents an approach to identify and address potential imbalances between node, place and market potential values to create new economic opportunities—for example, by improving the urban environment around a major transit hub, or by improving public transit service to a booming area. The tool provides a common framework of assessment for urban, transport, and economic planners, thereby facilitating conversations needed for better economic, land use, and transport integration. 23

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Literature / further information:


Tool CUD 3: Urban design improvements for better urbanity and decentralized land use.

What this tool does: This tool aims to create spatial hierarchies. Mixed land use and high densities are key principles that ensures highly varied urban spaces and decentralized land use.

How does it work:

- **Urban Growth Boundary**: Every city should establish an enforced urban growth boundary (UGB). The UGB should be set based upon a rigorous analysis of ecological sensitivities, environmental capacity, and the efficiency and productivities of various land uses. The boundary can expand beyond the existing urban footprint only if there are no suitable infill locations as indicated by an intensity of urban land use of at least 10,000 residents per square kilometer.

- **Mixed Use**: All residential units should be close to at least six kinds of amenities within 500-meter radius of building entrance (amenities include schools, post offices, banks, retails, clinics, activity centres, restaurants, etc.). The job-resident ratio (the number of people employed divided by the number of residents) should be between 0.5 and 0.7 over every commuting district, which should have a spatial area that is no more than 15 km². Normally, these commuting districts are bounded by physical barriers for pedestrians.

- **Small blocks**: Blocks should be less than or equal to 2 hectares and 70% of the blocks should comply with this standard. Exceptions are made for industrial areas.

- **Public green space**: Publicly accessible and usable green space should comprise 20-40% of the construction areas (residential area should be at the higher end of this range). All residents should have accessible public space within 500 meters. Example: Mixed land-use on ground floor and upper floors generates highly diversified environments.

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28
Quality Space between Residential Buildings – Letto Areal, Tuebingen, Germany


Affordable Green Housing for Mannheim, Germany

What needs to be done to make cities liveable, healthy, safe and sustainable?

This is a topic which has been addressed by Danish landscape architect Jan Gehl in his publications: Cities for People. Life Between Buildings, and The Human Scale (a documentary about his life's work). His research and theories have inspired a generation of planners and urbanists who are intent on reclaiming cities for people. Here his most prolific proposals:

"1. Stop building "architecture for cheap gasoline." "Two of the most pertinent macro issues that city planners can address today are climate change and public health...He attributes the problem to cars and the availability of cheap gasoline, which have dictated city planning for the past six decades. ...

2. Make public life the driver for urban design. In 2009, Copenhagen ... enacted a plan called "A Metropolis for People". It envisioned what the city should look like in the future. "The city council decided upon a strategy to make Copenhagen the best city for people in the world, and it is interesting to read what their arguments are: We have to walk more, we have to spend more time in public spaces, and we have to get out of our private cocoons more". "This becomes good for society, good for the climate, and good for health. They said that if people spend more time in the public spaces, the city becomes safer. It becomes more exciting and more interesting. And it furthers social inclusion. This is an important part of having a democratic society: having citizens who can meet each other in the course of their daily doings, and not only seeing different people on television or on screens."

3. Design for multisensory experiences. "We were created as a walking animal, and our senses have developed for slow movement at about three miles an hour, ... A good city is something built around the human body and the human senses so you can have maximum
use of your ability to move and your ability to experience. That is a very important issue. For many years, we have broken all the rules to make automobiles happy.”

4. Make transportation more equitable. Social equity is a great challenge in cities today, which is a by-product of rising demand for real estate and higher land values. This often pushes lower income people farther away from urban centers, where many jobs are located. … [A]ccess to efficient, affordable, alternative transportation (i.e., not in car form) is essential to promoting equality in cities. "Cars are leftover from another time."

5. Ban cars. "It's no secret that the good days of the automobile are over"... "In 2009, we saw the peak of driving in the world, and it's on the way down. The days of the automobile as something for everyone in the world are definitely over." To highlight how car-centric design is not an option for megacities approaching total gridlock… In a denser city, with walking and bicycling you can get anywhere quickly"…. "As far as I'm concerned, that is a much smarter solution in all the growing cities and the big cities than using old technology from 1905 Detroit. Cars are leftover from another time. And all these ideas of self-driving cars will not solve the problem of finding space and having friendly streets. They will just enable more cars to be on each street and that will not be a situation that's good for mankind. It would be good for the auto industry." (adopted from: 5 Rules For Designing Great Cities, From Denmark's Star Urbanist. 11 July 2016.


Literature / further information:
Tool CUD 4: Eco-low carbon planning methodology.

What this tool does: The eco-low carbon (ELC) urban planning methodology was prepared with support from China’s Ministry of Housing and Urban Rural Development (MOHURD) and co-funding from the UK’s Foreign and Commonwealth Office (FCO) Prosperity Fund. Preparation of the methodology was led by European consultants in close collaboration with the China Society for Urban Studies (CSUS). Based on both international and Chinese ELC urban planning best practice, the methodology is aimed at providing clear, practical guidance for ELC urban planning in China.

China’s National New Urbanisation Plan (2014-2020) issued in March 2014 emphasises the importance of sustainable development and sets out a clear vision of green eco-low carbon smart development. The process and outcome of urban development is to be changed to create new cities that are resource efficient, green and healthy places people want to live in. This means transforming and evolving the whole urban form – the transport systems and street layouts, the building forms and services, the green and public spaces and the energy infrastructure. The eco-low carbon urban planning methodology that was developed by MoHURD to plan cities that meet the aspirations of the New Urbanization Plan.

How does it work: The principle of the ELC approach is to follow step by step the traditional Chinese Planning process and then at each step to suggest the data, analysis and techniques that can be incorporated to the plan that will change the design from a conventional to a low carbon / resource efficient solution. It then sets out the communications for the approval process to get outputs from this new approach accepted at the different administrative levels of government as required. The technical, social and economic factors related to each area are described to help the planner to prepare and get approved a feasible planning application. Consideration is also given to the practicalities of the implementation phase, how the plan will be taken to detailed design how the project will be financed, constructed and finally its performance monitored.

Process: This ELC urban planning approach can be broken down into 6 steps

• STEP 1: Socio-Economic and Industrial Development Analysis
• STEP 2: Background Understanding and Eco-security Pattern
• STEP 3: Development Strategy Formulation
• STEP 4: Creating the Plan
• STEP 5: Detailing Urban Form
• STEP 6: Financing Implementation and Monitoring
Low-carbon ecological planning method combined with traditional planning and urban design process

The 15 Principles of Green Urbanism

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principle 1: Climate and context</strong></td>
<td>All urban development must be in harmony with the specific characteristics of its location. Plan for development that works with the urban climate and bio-regional context. Improving the urban comfort conditions and air exchange rate at pedestrian level, through specific characteristics of its location, maintaining ventilation corridors and control of wind velocity through adequate massing.</td>
</tr>
<tr>
<td><strong>Principle 2: Renewable energy for zero CO2 emissions</strong></td>
<td>The city should be a self-sufficient onsite-energy producer, using decentralised, district-based energy systems. De-carbonise the energy supply. Increase solar power to 10% of energy mix by 2020. Install small grids and make solar hot water mandatory. Generate at least 50% energy on-site using precinct-scale renewable sources.</td>
</tr>
<tr>
<td><strong>Principle 3: Zero Waste City</strong></td>
<td>The zero-waste city is a circular, closed loop ecosystem that limits the volume of materials from going to landfill or incineration. Implement “zero-waste city” ideas and plans. Increase resource recovery rates towards 100% and stop waste landfills.</td>
</tr>
<tr>
<td>Principle 4: Water Security</td>
<td>Use solar-powered desalination and recycle wastewater. Aim at keeping fresh water consumption below 125 litres per person per day.</td>
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<td>-----------------------------</td>
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<tr>
<td>Principle 5: Landscaping, gardens, green roofs and biodiversity</td>
<td>Continue to increase tree planting programmes. Constructing wetlands to purify and recycle grey water can improve landscaping and biodiversity.</td>
</tr>
<tr>
<td>Principle 6: Transport and public space</td>
<td>Invest over 6%* of GDP in public transport; expand tramlines and introduce free hybrid buses. Improve street by giving greater priority to pedestrians and cyclists.</td>
</tr>
<tr>
<td>Principle 7: Local Materials</td>
<td>Use engineered timber construction systems and make recyclability and re-use of construction elements compulsory.</td>
</tr>
<tr>
<td>Principle 8: Density and Retrofitting</td>
<td>Continue street upgrading and introduction of bike lanes. Make public space more useful with natural elements designed for active living.</td>
</tr>
<tr>
<td>Principle 9: Green Buildings and Districts</td>
<td>Re-introduce passive design principles and demand higher ratings. Promote energy-savings buildings designs and full home insulation. Offer better housing choices and more diversity in urban infill.</td>
</tr>
<tr>
<td>Principle 10: Liveability, healthy communities and mixed-use</td>
<td>Include minimum 25%* affordable housing in every development and use modular prefabricated construction systems. Reduce taxation of inner-city housing. Increase retrofitting and adaptive reuse.</td>
</tr>
<tr>
<td>Principle 11: Local Food</td>
<td>Introduce urban farming in at least 20%* of public parks. Maintain urban hinterland for food production.</td>
</tr>
<tr>
<td>Principle 12: Cultural Heritage</td>
<td>Consult and involve communities to ensure genuine commitment.</td>
</tr>
<tr>
<td>Principle 13: Governance and Leadership</td>
<td>Create public-private partnerships to facilitate change, involve community groups and NGOs.</td>
</tr>
<tr>
<td>Principle 14: Education, Research and knowledge sharing.</td>
<td>Invest minimum 3%* of GDP in research and innovation. Facilitate sustainable behaviour and provide incentives for long-term behaviour change by positively influencing values to reduced consumption.</td>
</tr>
<tr>
<td>Principle 15: Special Strategies for Cities in Developing Countries</td>
<td>Cities require adjusted strategies appropriate for the developing world, e.g. mass housing typologies.</td>
</tr>
</tbody>
</table>

* All suggested figures are benchmarks derived from current best practices.

Literature / further information:

2. CLEAN ENERGY
Beijing city centre - Cities will be clean only if energy sources are clean

Beijing – district heating reform is a key tool to introduce clean energy

Solar Water Heaters – Xixi’an, Xi’an

Photovoltaic building elements – Suntech

Wuxi

Wind energy – Weihai

Solar water heaters in Hutongs – Beijing

Source: F. Steinberg
Sector Profile of Clean Energy

Introduction. Energy is a cross-cutting issue that affects transportation, buildings, water supply, waste water treatment, solid waste management and other urban infrastructure. Developing an energy profile of a city enables the level of use, mix of energy types, and patterns of use by sector or end use activity to be considered. International pressures, national legislation and growing public awareness are causing us to change our approach to fueling our cities, and to hunt for solutions that are truly sustainable. While many cities traditionally have limited administrative power over energy, their carbon targets, vulnerability to climate risks and opportunities around green growth are spurring them to take a greater leadership role. Some model cities have enacted bold policies, supported by creative financing and investments to support a low carbon path. The future lies in alternative, clean energy sources which are effectively limitless and sustainable, and mostly free of geopolitical considerations. Renewable “new” energy is seeing unprecedented levels of growth, spurred on by dropping technology costs and strong policy support. A prominent feature of “new” energy often times is its decentralised nature, and the resulting need for the creation of micro-grids for distribution. Many cities have been adopting innovative energy programs, some for experimentation, others for massive application. World-wide the EU-backed Global Covenant of Mayors (GCoM) has triggered the formulation of city-level sustainable energy action plans (SEAPs) which promote the use of renewable clean energy in cities.

State of Demand in China. In 2014 the China was already the top location for renewable energy investment. The increased access to wealth and energy services in cities relative to the countryside is leading to higher per-capita intensities. Switching city focus from traditional, high polluting energy sources to green alternatives can bring numerous opportunities besides those benefits to the local and global environment. A number of cities have modified their energy generation and heating services. Cities have taken the most action in waste-to-energy, and landfill gas capture, mainly because cities generally have stronger control over their waste handling assets. Similarly, city influence over solar power was strong as cities generally show good control and influence over buildings where rooftop solar can be installed. The true “smart cities” of the future will be those that implement and incorporate as wide a range of these technologies as appropriate into their energy strategies, and consider carefully the linkages with other key drivers such as transport, buildings, waste and water management. The newly introduced GCoM is expected to foster the search for decentralised new energy supply forms, and the creation of city action plans.

Policy Directions. The Government’s pronouncement of the 13th Five Year Plan objectives has stated several key objectives for the energy sector:

- Increased efficiency of energy resources development and utilization; effective control total aggregate of energy and water consumption, construction land, and carbon emissions. The total emissions of major pollutants shall be reduced significantly.
- Pilot projects will be introduced to promote comprehensive use of combined heat and power, the wide-spread adoption of energy saving regulations in government agencies, and of municipal green lighting and other urban energy saving projects.
- Technical specifications for the safety of heat supply will be introduced, as well as strengthened regulatory frameworks supporting urban energy savings, environmental protection and improved sanitation.
- Related service quality standards and evaluation methodologies will be optimized.
- Consumption-based billing for residential households will be promoted nationally, and all newly built residential buildings will need to be equipped with meters for heating, while existing buildings will be gradually retrofitted to reach 100% metered heat provision.
- Support reduced emission standards, and implement demonstration projects of “near-zero” carbon emission.
- Promote district-level combined heat and power (CHP), green lighting, energy conservation in government departments; improve heat production efficiency; newly built
residential buildings must be equipped with individual measurement of household heating consumption, while that shall be gradually provided for existing residential buildings.  

- There should be 5-15% local renewable energy generation for residential areas and 2-5% for commercial areas.  
- Use smart lighting systems, and smart grid technologies which support higher energy performance targets.

**Best Practices in Europe.** The scenario of Europe’s expansion of renewable energy seems convincing, and the support (and subsidies) by various European governments have made the renewable energy sector more important than anticipated 10 or 30 years ago. European governments have agreed to commit to continued growth of the renewable energy sector. As more and more countries invest substantially in these infrastructures, it can be expected that the representatives of the renewable energy industries will gradually respond to these trends and establish technical standards and guidelines, and unified parameters for financial and institutional support. The energy consumption in the residential sector (space heating, cooking and water heating) will not stop its growth rate. Since the main savings potential in buildings can be achieved through improved thermal performance, increasing district heating efficiency and by tightening energy codes. The reforms in the energy sector have prompted the wide-scale application of decentralised forms of energy production through photovoltaic and wind energy, and the possibility to sell excess energy to the energy grid has encouraged private investments in home based facilities. The wide-spread introduction of SEAPs has created an unprecedented drive for energy innovations as cities want to contribute to the COP21 targets.

**State of the art in clean energy for cities in Europe.** The EU countries seek to generate by 2020 a 20% share of its total energy consumption requirements with renewable energy sources, and currently it is very well on track to achieve this target. In 2009 the EU’s Renewable Directive set binding targets for all EU Member States. The overall share of renewable resources shall reach 20% in 2020, and within the transport sector 10% of energy utilisation shall be from renewable energy. In the EU framework, member countries have agreed to overall RE targets for the power sector (20% in Gross Final Energy Consumption [GEFC]) by 2020 as part of the Renewable Energy Directive  

**Cities in 2050 – A European Vision.** The city of the future is run by the energy subsidiary principle. In 2050, cities are highly energy efficient. The low energy demand (heating, cooling and electricity) will mainly be supplied by diverse local and regional renewable energy sources as well as co-generation. Smart grids will ensure decentralized solutions. New buildings do not consume fossil fuels; most of them produce electricity. They facilities to park soft mobility vehicles like bikes. They come with a user guide, which is obligatory when letting any kind of building. Older buildings are refurbished and do not exceed a consumption of 50 kWh/m²/year. Fuel poverty has dramatically decreased.  

**Paris agreement on climate change.** Since the 2015 Paris agreement on Climate Change (COP21), many cities have issued statements to pronounce ambitious targets to stop using coal altogether, or to become carbon-neutral.  

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25 Extracted and translated from: http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm
EU CONCERTO and Smart Cities Information System. CONCERTO is a European Commission initiative within the European Research Framework Programme (FP6 and FP7). It aimed to demonstrate that the energy-optimization of districts and communities as a whole is more cost-effective than optimizing each building individually, if all relevant stakeholders work together and integrate different energy-technologies in a smart way. The EU initiative under of the European Commission's Directorate General for Energy started in 2005 and has co-funded more than €175 Million in 58 cities and communities in 22 projects in 23 countries. Currently, CONCERTO is discontinued and its results and experiences will be documented in a user-friendly way in the Smart Cities Information System.30

EU Smart Cities Initiative. The smart cities initiative 2010 – 2020 has the objective to demonstrate the feasibility of rapidly progressing towards our energy and climate objectives at a local level while proving to citizens that their quality of life and local economies can be improved through investments in energy efficiency and reduction of carbon emissions. The initiative fosters the dissemination throughout Europe of the most efficient models and strategies to progress towards a low-carbon future, and builds on existing EU and national policies and programs, including CONCERTO and Intelligent Energy Europe.31 This Initiative will support cities and regions in taking ambitious and pioneering measures to progress by 2020 towards a 40% reduction of greenhouse gas emissions through sustainable use and production of energy. This will require systemic approaches and organizational innovation, encompassing energy efficiency, low-carbon technologies and the smart management of supply and demand. In particular, measures on buildings, local energy networks and transport are the main components of the Initiative.

Energy Cities. The network of ‘Energy Cities’ is the European Association of local authorities engaged in energy transition. It represents 1000 towns and cities in 30 countries. Its main objectives are (i) to strengthen the cities’ role and skills in the field of sustainable energy, (ii) to represent members’ interests and influence the policies and proposals made by EU institutions in the fields of energy, environmental protection and urban policy, and (iii) to develop and promote your initiatives through exchange of experiences, the transfer of know-how and the implementation of joint projects. Energy Cities is advocating decentralized energy production and a switch from the “big-scale infrastructure” perspective to one of “aggregating the small units” of energy producers.32

The EU Covenant of Mayors. This covenant is an initiative that created a community of local governments focused on climate protection, since the 2009 signature ceremony in Brussels, over two thousand local authorities have opted to join the Covenant. World-wide this has become a sort of movement propelled by the global climate change conferences, and the activities of the EU and International Coalition of Local Environmental Initiatives (ICLEI).33 An ever growing number of cities are preparing Sustainable Energy Action Plans (SEAPs).34 Signatories of the Global Covenant of Mayors formally commit to achieve the ambitious targets set in the EU Climate Action and Energy Package. However, non-European cities may also join the covenant. The Climate and Energy Package aims to: (i) Reduce EU greenhouse gas emissions by at least 20% from 1990 levels by 2020; (ii) Increase the EU’s use of renewable energy to account 20% of total consumption; and (iii) Reduce energy consumption by 20% through increased energy efficiency. Upon signing the Covenant, local authorities commit

30 The Smart City Information System will be visible in the concerto website. www.concerto.eu
31 http://ec.europa.eu/energy/intelligent/
33 http://www.covenantofmayors.eu/index_en.html;
34 In 2016, this instrument was renamed as Sustainable Energy and Climate Action Plan (SECAP).
themselves to submitting their Sustainable Energy Action Plans (SEAPs). Each SEAP lays forth in greater detail how each local government intends to reach its CO₂ targets by 2020.  

**Best Practices.** Numerous best practice experiences in EU countries illustrate the ongoing changes in the energy sector. The below list represents only a limited sample of cases:

- **Austria - Linz**[36]: Solar city initiatives.
- **Austria - Salzburg**[37]: district heating.
- **Denmark – Malmo**[38], **Vaxjo**[39], or **Copenhagen**[40]: Low-energy neighbourhood projects.
- **France - Lille**[41]: Energy generation from non-conventional sources like waste for heating.
- **Germany – nation-wide**[42]: National energy transition programme.
- **Germany – various cities**[43]: Climate Change Action Plans.
- **Netherlands – Wieringmeer**[44]: Large scale wind energy projects.
- **Sweden**[45]: Fossil-free cities.
- **United Kingdom - London**[46]: Decentralised Energy Master Plan (DEMap) for London.
- **United Kingdom – Bristol**[47], **Woking**[48]: Energy generation from non-conventional sources like waste water and sludge.
- **United Kingdom**[49]: Reduction in energy usage of public buildings.

A growing number of cities, mostly from Denmark, Germany and the United Kingdom have been coming forward with commitments to become carbon-free by 2030, i.e. achieving an energy shift to 100% renewables, or even earlier.

**State of the art in clean energy for cities in China.** The publication of China’s Intended Nationally Determined Contributions (INDC)[50] not only announces the national targets for enhanced action on climate change for 2030 but also spells out policies and measures to implement them. Among these, the urban arena is explicitly mentioned several times as area for actions, most prominently in the section on regional policies and on controlling emissions from buildings and transportation. "The share of renewables in China’s energy mix was 13% in 2010, including an estimated 6% traditional use of biomass, and 7% modern renewables.

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[38] [https://www.irena.org/Publications/RE_Policy_Cities_CaseStudies/IRENA%20cities%20case%20%20Malmo.pdf](https://www.irena.org/Publications/RE_Policy_Cities_CaseStudies/IRENA%20cities%20case%20%20Malmo.pdf)


[42] [https://www.bundesregierung.de/Webs/Breg/EN/Homepage_/node.html](https://www.bundesregierung.de/Webs/Breg/EN/Homepage_/node.html)

[43] [http://www.hamburg.de/contentblob/4028914/6bdf8a2548ec96c97aa0b0976b05c5d9/data/booklet_englisch.pdf;jsessionid=FF0CD567F3392B2F679532696B6853F2.liveWorker2;fileadmin/Daten_BMU/Download/pdf/Klimaschutz/klimaschutzplan_2050_impuls Papier_en_pdf](http://www.hamburg.de/contentblob/4028914/6bdf8a2548ec96c97aa0b0976b05c5d9/data/booklet_englisch.pdf;jsessionid=FF0CD567F3392B2F679532696B6853F2.liveWorker2;fileadmin/Daten_BMU/Download/pdf/Klimaschutz/klimaschutzplan_2050_impuls Papier_en_pdf)

[44] [www.ergie-cites.org/db/wieringmeer_139_en.pdf](http://www.ergie-cites.org/db/wieringmeer_139_en.pdf)


[46] [https://www.london.gov.uk/sites/default/files/gia_migrate_files_destination/6_Decentralised%20Energy_JPEG_0.pdf](https://www.london.gov.uk/sites/default/files/gia_migrate_files_destination/6_Decentralised%20Energy_JPEG_0.pdf)

[47] [https://www.theguardian.com/uk-news/2015/mar/15/uk-first-poo-bio-bus-bristol-regular-service](https://www.theguardian.com/uk-news/2015/mar/15/uk-first-poo-bio-bus-bristol-regular-service)

[48] [https://www.woking.gov.uk/planning/service/energy](https://www.woking.gov.uk/planning/service/energy)


Hydroelectricity (3.4%) and solar thermal (1.5%) accounted for most of China’s modern renewable energy use.\(^5\)

“On combating climate change, China has already made its plans known with its declared goal of peaking carbon dioxide emissions by 2030. It also aims to increase its share of non-fossil sources in its primary energy consumption to 20% while reducing carbon intensity by 60 to 65% from 2005 levels.”\(^5\)\(^2\)\(^3\)

**Future sector agenda: policies, mechanisms and tools.** The future sector agenda can be grouped by the following headers: (i) renewable energy policy; (ii) power supply system and market design; and (iii) technology focused policies.

**Renewable energy policy:**
- Create a comprehensive national energy plan covering infrastructure needs for transmission and distribution of electricity, heat and gas;
- Develop taxation instruments, emission limits, and/or CO2 trading systems to counter the damage of CO2 emissions and air pollution from use of coal;
- Evaluate the impact of various new energy technologies on socio-economic development, energy security, health, land and water use;
- Establish renewable energy targets in industries, buildings and transport.

**Power supply system and market design:**
- Create the national power market, providing economic incentives for operations in renewable energy, and bringing in new investors in new energy;
- Reform the grid to better integrate renewable energy, enhance trade of renewables and deal with variability and fluctuations in supply.

**Technology focused policies:**
- Stimulate (national) government support for innovation, research and development to reduce renewable energy costs;
- Foster next-generation renewable energy technologies;
- Enhance knowledge and data collection on biomass and the feedstock market.

China’s energy use has grown rapidly in recent years, and by 2030 it will increase by another 60%. In a business as usual scenario, the country will not only be the world’s largest energy consumer by far, but also emit over twice the quantity of CO2 of the next largest emitter. Without increased deployment of renewable energy, China’s energy system will continue to result in high levels of air pollution, negatively affecting health, economic growth and the environment. Without the diversification of its energy system and a transition towards renewable energy, the country will become increasingly reliant on imported fossil fuels, affecting its national energy security and economic growth. If China acts decisively to increase the role of renewables in its energy system, it can significantly reduce the pollution of its environment, enhance its energy security, benefit its economy and play a leading role in mitigating climate change.\(^5\)\(^4\)

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### Sector indicators.

#### Proposed Clean Energy KPIs

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Coal utilization rate of city [1]</td>
<td>__ % of total energy consumption</td>
<td></td>
</tr>
<tr>
<td>2 Total residential energy input for heating and cooling within city boundaries. - Decentralised heat/cold generation (fossil energy sources, district heating and part electricity delivered to residential customers) - Delivery chain losses in district heating and electricity chain (distinguishing source of generation)</td>
<td>__ kWh/(m²a)</td>
<td></td>
</tr>
<tr>
<td>5 Emissions from district heating (based on renewable energy coefficient 0.8)</td>
<td>Reduced by 50% 105 kWh/(m²a) gross area</td>
<td></td>
</tr>
</tbody>
</table>

Sources:

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55 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. Sino-EU Key Performance Indicators for Eco-Cities. Beijing (unpublished draft)
Outlook and future sector agenda. The discussion in China on a transformation in the energy sector, seems largely limited to the introduction of technologies. Technological solutions are undoubtedly very important, but should not obscure the need for awareness raising about environmental behaviour among citizens, companies and institutions. Demand management across all sectors (energy, buildings, water, transport, and industry) will be important to encourage a culture of resource-consciousness. Environmental campaigns, as undertaken by local governments (and environmentalist nongovernmental organizations) in Europe can be important backbones to a strategy of greening of the environment and of Chinese cities. China’s commitment to the COP21 includes the introduction of cleaner energy. Renewables and city-wide action plans will be at the heart of future energy sector innovations.
Tool CE 1: Technology options for decentralized new energy supply.

Cities are in the frontline for cutting carbon emissions. Decarbonising urban buildings and transport is key to attain Paris climate goals, but slow progress will test governments’ commitment. Cities must take the lead in the transition to a low-carbon energy sector (IEA 2016). Cities can completely switch to renewable energy. This is particularly so since urban areas account for up to two-thirds of the potential to cost-effectively reduce global carbon emissions. "Cities today are home to about half the global population but represent almost two-thirds of global energy demand and 70% of carbon emissions from the energy sector, so they must play a leading role if COP21 commitments are to be achieved."... "Because cities are centres of economic growth and innovation, they are ideal test-beds for new technologies – from more sustainable transport systems to smart grids – that will help lead the transition to a low-carbon energy sector." (http://www.iea.org/topics/cleanenergytechnologies/)

100% Renewable Energy: a sustainable transition to 100% renewable energy

A VIABLE PATH

+300
cities, regions and municipalities across the world have demonstrated that transitioning to 100% RE is a viable political decision.

CLEAR TARGETS

1000
mayors and councillors pledged to reach the 100% Renewable Energy target within their municipalities.

BEYOND LOCAL

16
countries are planning to fully decarbonize their electricity system and achieve 100% renewable electricity within the next decades.


“…. designing urban growth around clean energy requires careful coordination. So, what actions should interested city leaders focus on? The campaign recommends these steps for a successful “100% RE” initiative:

• **Create implementation strategies:** Coordinated efforts that meld renewable commitments with broader development and environmental goals are more effective than isolated initiatives.

• **Mobilize resources:** Local governments should tap community groups, businesses, utilities, citizens and other stakeholders by forming coalitions of interested parties.

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Chart progress: Monitor shifts to renewable fuel with assessments of the quality, flexibility and costs of energy networks and benchmarks that measure accomplishments. Other key priorities include the creation of legal and regulatory frameworks that support energy transitions. The authors recommend policies that encourage “decentralized” and “inclusive” energy systems that allow households and neighbourhoods to generate small amounts of fuel for personal consumption and sell any excess for profit.\(^{57}\)

**What this tool does:** This tool tries to help local governments to select most relevant and energy-efficient technologies. There are four technology revolutions available today. In the last five years they have achieved dramatic reductions in cost and this has been accompanied by a surge in consumer, industrial and commercial deployment. Although these four technologies still represent a small percentage of their total market (e.g. electricity, cars and lighting), they are growing rapidly. The four key technologies this report focuses on are: (i) onshore wind power; (ii) polysilicon photovoltaic modules; (iii) LED lighting; and (iv) electric vehicles (see: US Department of Energy, 2013).

**Applications:**
- Urban buildings provide useful space to self-generate the electricity they consume: by 2050, rooftop solar could technically meet one-third of cities’ electricity demand. And those buildings offer significant demand potential for the roll-out of the most efficient technologies, like energy-efficient windows and appliances.
- Best electric vehicles and public transport can lead to a low-carbon mobility system while reducing investment needs compared with current development trends in cities.
- The total renewable energy capacity installed currently provides around 23% of global electricity generation, sustained by progress in solar PV and on-shore wind that pushed the growth of renewable energy capacity to a record high, exceeding 150 gigawatts in 2015. This is an encouraging trend in line with the 2°C goal of having in excess of two-thirds of electricity generated by renewables in 2050. China is the largest renewable energy market, accounting in 2015 for more than half of the world’s new global onshore wind capacity and one-third of the solar PV capacity installed. (see IEA: [http://www.iea.org/topics/cleanenergytechnologies/](http://www.iea.org/topics/cleanenergytechnologies/))

**How does it work:** The tool proposes to screen new or newly emerging technology options for the most cost-effective technologies for low-carbon cities.

- Technology screening.
- Review of alternative technology options.
- Comparison of new energy solutions versus conventional technology.
- Calculation of cost-efficiency of new energy solutions, taking into account:
  - Capital costs.
  - Life span of technology.
  - Maintenance costs.
  - CO\(_2\) impacts.
- Compare local with imported products.
- Availability of products on national/local market.
- Quality of maintenance services.

**Consider Smart Objectives**

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**Energy performance standard**  
S: Focus on specific product or product group  
M: Performance characteristics aimed for/set baseline  
A: Performance standard links to best available product on the market and is regularly updated  
R: Best available product is accepted by the target group  
T: Set clear target period

**Subsidy scheme**  
S: Focus on specific target group and on specific technologies  
M: Quantified energy savings target/set baseline  
A: Minimize freeriders  
R: Link the savings target to the available budget  
T: Link the energy savings target to a target period

**(Voluntary) Energy audit**  
S: Focus on specific target group  
M: Quantify the target audit volume (m2, number of companies, % of energy use, etc.)/set baseline  
A: Encourage to implement recommended measures, e.g. by offering financial incentives  
R: Ensure that sufficient qualified auditors have been assigned and financial incentives are in place to carry out audits  
T: Link the quantified target to a target period


**Literature / further information:**


- 100% Renewables (ed.). 2017. 100% RE building blocks: A practical toolkit for a sustainable transition to 100% renewable energy.  
  https://go100re.net/wp-content/uploads/2017/05/100RE-Building-Blocks.pdf

Tool CE 2: Decentralised micro-grids.

What this tool does: This tool will enable local decision makers to initiate the creation of decentralised micro-grids. The renewable energy sector will require micro grids if it wants to grow. This tool explains the importance of micro-grids, and how these can be developed.

“China has become the world’s largest market for power transmission and distribution (T&D), and is poised to become a major consumer of smart grid technology. Commitments by China’s political leaders to reduce the carbon intensity of its GDP by 40 to 45% by 2020 relative to 2005, and to increase the use of renewable power promise a massive transformation of the nation’s energy landscape… First, China’s commitment to green development will lead to a tremendous need for smart grid technologies. Second, China has a unique structural context that could enable it to leap ahead in the development of the smart grid.” (McKinsey 2010).


SmartGrids: Enhancing grid flexibility & robustness
• Compile tools of **proven technical solutions** that can be deployed rapidly and cost-effectively, enabling existing grids to accept power injections from distributed energy resources without contravening critical operational limits (such as voltage control, switching equipment capability and power flow capacity);

• Establish **interfacing capabilities** that will allow new designs of grid equipment and new automation/control arrangements to be successfully interfaced with existing, traditional, grid equipment;

• Ensure **harmonisation of regulatory and commercial frameworks** in Europe to facilitate cross-border trading of both power and grid services (such as reserve power, for instance Nordic hydropower), ensuring that they will accommodate a wide range of operating situations without creating perverse incentives or other unintended consequences;

• Establish shared technical standards and protocols that will **ensure open access**, enabling the deployment of equipment from any chosen manufacturer without fear of lock-in to proprietary specifications. This applies to grid equipment, metering systems, and control/automation architectures;

• Develop **information, computing and telecommunication** systems that enable businesses to utilise innovative service arrangements to improve their efficiency and enhance their services to customers.

Future Network Vision


**Literature / further information:**

  www.mckinsey.com/~/media/McKinsey/dotcom/client_service/EPNG/PDFs


- http://www.smartgrids.eu/
Tool CE 3: Sustainable energy action plans (SEAPs).

What this tool does: This tool guides through the preparation of Sustainable Energy Action Plans (SEAPs), the tool which is key to the implementation of the Global Covenant of Mayors (GCoM). The GCoM is being promoted by the EU.

“The Sustainable Energy Action Plan (SEAP) is a key document that shows how the Covenant signatory will reach its commitment by 2020. It uses the results of the Baseline Emission Inventory to identify the best fields of action and opportunities for reaching the local authority’s CO₂ reduction target. It defines concrete reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into action. Signatories commit themselves to submitting their SEAPs within the year following adhesion.”… “The Sustainable Energy Action Plan (SEAP) is a key document that shows how the Covenant signatory will reach its commitment by 2020. It uses the results of the Baseline Emission Inventory to identify the best fields of action and opportunities for reaching the local authority’s CO₂ reduction target. It defines concrete reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into action. Signatories commit themselves to submitting their SEAPs within the year following adhesion.”

Scope. The Global Covenant of Mayors concerns action at local level within the competence of the local authority. The SEAP should concentrate on measures aimed at reducing the CO₂ emissions and final energy consumption by end users. The Covenant’s commitments cover the whole geographical area of the local authority (town, city, region). Therefore the SEAP should include actions concerning both the public and private sectors. However, the local authority is expected to play an exemplary role and therefore to take outstanding measures related to the local authority’s own buildings and facilities, vehicle fleet, etc. The local authority can decide to set the overall CO₂ emission reduction target either as ‘absolute reduction’ or ‘per capita reduction’.

The main target sectors are buildings, equipment/facilities and urban transport. The SEAP may also include actions related to local electricity production (development of PV, wind power, CHP, improvement of local power generation), and local heating/cooling generation. In addition, the SEAP should cover areas where local authorities can influence energy consumption on the long term (as land use planning), encourage markets for energy efficient products and services (public procurement), as well as changes in consumption patterns (working with stakeholders and citizens)(1). On the contrary, the industrial sector is not a key target of the Covenant of Mayors, so the local authority may choose to include actions in this sector or not. In any case, plants covered by the ETS (European CO₂ Emission Trading Scheme) should be excluded, unless they were included in previous plans of the local authority.

How does it work:
• Build support from stakeholders: if they support your SEAP, nothing should stop it! Conflicting stakeholders’ interests deserve special attention.
• Secure a long-term political commitment.
• Ensure adequate financial resources.
• Do a proper CO₂ emissions inventory as this is vital. What you do not measure you will not change.
• Integrate the SEAP into day-to-day life and management of the municipality: it should not be just another nice document, but part of the corporate culture!
• Ensure proper management during implementation.
• Make sure that your staff has adequate skills, and if necessary offer training.

Learn to devise and implement projects over the long term.
Actively search and take advantage of experiences and lessons learned from other cities that have developed a SEAP.

Suggested List of Content for SEAPs

1. SEAP Executive Summary
2. Overall strategy
   A. Objective(s) and Targets
   B. Current framework and vision for the future
   C. Organisational and financial aspects:
      - coordination and organisational structures created/assigned;
      - staff capacity allocated;
      - involvement of stakeholders and citizens;
      - budget;
      - foreseen financing sources for the investments within your action plan;
      - planned measures for monitoring and follow-up.
3. Baseline Emission Inventory and related information, including data interpretation (see Part II of this Guidebook, chapter 5 Reporting and documentation)
4. Planned actions and measures for the full duration of the plan (2020)
   - long-term strategy, goals and commitments till 2020;
   - short/medium term actions.

For each measure/action, please specify (whenever possible):
- description
- department responsible, person or company
- timing (end-start, major milestones)
- cost estimation
- estimated energy saving/increased renewable energy production
- estimated CO₂ reduction


The Process:

Ten key elements to keep in mind when preparing the SEAP:

1. SEAP approval by the municipal council (or equivalent decision-making body)
2. Commitment for a reduction of CO₂ emissions by at least 20% by 2020
3. CO₂ baseline emission inventory (BEI)
4. Comprehensive measures that cover the key sectors of activity
5. Strategies and actions until 2020
6. Adaptation of city structures
7. Mobilisation of the civil society
8. Financing
9. Monitoring and reporting
10. SEAP submission and filling the template

Examples of Building Sector Interventions

<table>
<thead>
<tr>
<th>POLICY INSTRUMENTS AT DISPOSAL OF THE LOCAL AUTHORITY</th>
<th>PRIVATE BUILDINGS</th>
<th>PUBLIC BUILDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New</td>
<td>Renovated</td>
</tr>
<tr>
<td>Energy performance regulations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Financial incentives and loans</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Information and training</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Promote successes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demonstration buildings</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Promote energy audits</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Urban planning and regulations</td>
<td>X</td>
<td>+</td>
</tr>
<tr>
<td>Increase the rate of refurbishment</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Energy taxes</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Coordinate policies with other levels of authority</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

X = most relevant   + = somehow relevant   - = low relevance


Literature / further information:

3. GREEN BUILDING
Green building technologies in modern apartment buildings: passive building construction and geothermic heating – MOMA, Beijing

Chinese and international building materials industries offering products for green building – MOMA, Hefei

Post-independence housing stock: can it be made energy efficient? – Dongcheng district Beijing


Tianjin eco-city: green buildings

Source: F. Steinberg
Sector Profile of Green Building

Introduction. As one of the most visible features of eco-cities, a movement of green building has emerged internationally. There has been a big surge in energy-efficient engineering and construction technologies, and governments have taken the lead in designing tax incentives and stricter building codes for retrofitting and new construction. More so than ever, the contribution of buildings to the CO2 performance of cities is being recognized. Buildings contribute about 40 to 50% of urban CO2 emissions through the type of construction materials used—and carbon consumption in manufacturing these, their construction related cooling or heating requirements, their energy requirements for services like water supply, waste water and solid waste disposal, and their general energy efficiency. Tackling the energy demand of existing buildings is, therefore, a high priority on the path to green cities. Their conversion to greener buildings should start with the building materials and later extend to their internal infrastructure systems of water supply, cooling and heating systems, and their processing of waste water and solid wastes. “Passive” (and “active”) design solutions, as already proven by many innovative projects, have improved their energy performance.

State of Demand in China. The cities of China, and specifically the growing number of eco-districts or eco-cities, are set to become real laboratories of green architecture, and there is a new school of designers committed to developing sustainable green buildings, whether these are residential or other types of buildings. The last 10 years of green building in China demonstrate a fast learning process taking place. The Chinese government is committed to green building, and it is understood that for China’s cities, green building is an essential building block for environmental and economic sustainability. The recent global climate change negotiations have underlined the importance of eco-cities, and China’s response is positive and the drive to develop eco-cities will contribute to the global trend of eco-city building. In fact it looks as if China can become one of the leading countries in this field. Some Chinese companies have travelled to Europe to see “passive” houses, and have asked for cooperation. Chinese companies seem quick in developing new products, and construction products are no difference. When China will provide high-quality building products to the world market, costs will probably decrease to a reasonable level. The mainstreaming of “passive” building approaches seems a matter of time, after pilot projects of “passive” building have been implemented in different parts and climatic zones of China.

Policy Directives. The Government’s pronouncement of the 13th Five Year Plan objectives has stated three key objectives:

- At least 70% of buildings should be MoHURD One-Star, 20-40% of buildings should be MoHURD Two-Star, and 5-15% of buildings should be MoHURD Three-Star within any development. 59
- Use smart lighting systems, and smart grid technologies which support higher energy performance targets.
- Support reduced emission standards, and implement demonstration projects of “near-zero” carbon emission.
- Within 10 years, increase the rate of prefabricated buildings to 30%.

Best Practices in Europe. European governments, the private sector and the public at large will remain committed to green building, and as good practice spreads and reaches more and more people, the environmental and economic logic of green building will be understood and appreciated. Europe’s experiences to deal with difficult (and harsh climates), and the capacity of technological innovation is much appreciated internationally. Thus, many building officials and private sector representatives have been able to learn from Europe, and many business

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associations have started on the basis of these exchanges. Likewise, many European companies are interested to extend the know-how and practical experiences to new markets. If the trend continues, it can be expected that the coverage of the green building industry in Europe grows more exponentially, than linear. However, since most European cities do not expand much, it is more the retrofitting experience which matters to European cities than the creation of new cities. Europe’s experience with “passive” house design and technologies has gone mainstream, and building by-laws and financial support has encouraged the private sector to take this up enthusiastically. Encouraged by the results of “passive” building, the more advanced concept of energy-plus “active” building has started to attract new attention. In the case of “active” buildings, these are self-sustaining in most if not all of their energy requirements through renewable energy devices, and they may sell excess energy to the grid or service external devices, such as electrical vehicles (cars or bikes).

State of the art in green building in Europe.

EU Green Building Programme. In 2004, the European Commission initiated the Green Building Programme (GBP). This programme aims at improving the energy efficiency and expanding the integration of the renewable energies in the non-residential buildings in Europe on a voluntary basis. As a pilot phase in 2005-2006, the green building infrastructure was set up in ten European countries. The “Passivhaus” scheme in Germany, the British BREEAM provide certification. The European Commission’s Energy Efficiency Plan published the proposal that required the public authorities to improve the energy efficiency of at least 3% of their new buildings each year (as of March 2011). Europe’s Green Building Standards typically exceed the requirements of LEED of the US. Their projects put more emphasis on the energy use performance of the building. There is more of focus on Passive Design and building envelope configuration. Another perhaps better requirement, is that a buildings rating must wait for detailed energy use analysis after a year of occupancy. The implementation of the EU “Directive on the Energy Performance of Buildings (2002/91/EC), as from 2006, will permit a gain estimated at some 40 Mtoe (Megatons of oil equivalent) between now and 2013. The Commission must therefore monitor the rigorous application of the Directive.”


Best Practices. The practice of green building in Europe is growing rapidly. However, the most well-known European green building experiences can be found in a number of eco-districts:
• Freiburg, Germany: Eco-District Vauban. Vauban is a new neighbourhood planned for 5,000 inhabitants. Its passive housing projects were the first large scale demonstration on a large scale. 

• Heidelberg, Germany: Bahnstadt. The centrally located Bahnstadt has become Germany’s biggest passive-house project site. Various solutions are showcased here. 

• Hamburg, Germany: Hafencity. This urban renewal site of the Hafencity (‘harbour city’) has established its own green building and environmental guidelines, introducing standards higher than the general German DGNB standards. 


• Stockholm, Sweden: Eco-District of Hammarby. Hammarby Sjöstad is Sweden’s largest passive housing project of some 10,000 apartments for 35,000 inhabitants. 

• Grenoble, France: Eco-Quartier De Bonne. The eco-district (‘eco-quartier’) de Bonne has been awarded for its cutting edge ecological features, which follow the French green building codes of the HQE (Haute qualité environnementale (French) or High Quality Environment). This special development area is France’s leading eco-district. 

• Helsinki, Finland: Eco-District Viikki. The eco-district in Viikki, Finland is the result of long-term work aimed at putting ecological principles into practice in buildings. Eco-Vikki is part of the sustainable cities of Europe initiative. 

• Pamplona Navarra, Spain: Sarriguren eco-city. Sarriguren is Spain’s first eco-city, with specific emphasis on the protection of natural areas, energy saving, integration of renewable energies and ecological construction. 

• Various cities, Germany: Housing retrofitting programme. The German Development Bank (KfW) has launched a nationwide programme to support energy-efficiency measures in new construction and in retrofitting of historic or older residential areas. The programme’s main feature are subsidised loans for building or home owners. 

Key actions by cities to further green building. A recent study of the Ross Centre for Sustainable Cities at the World Resources Institute has identified eight actions for urban

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leaders, on how to accelerate building efficiency. The options for local government actions to improve the energy efficiency of the built environment fall into eight categories:

Eight Green Building Action Cities Can Initiate

<table>
<thead>
<tr>
<th>approaches</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building codes and standards:</td>
<td>Uniform requirements for new and existing structures ensure a “minimum level of energy efficiency”. Building codes promote long-term savings.</td>
</tr>
<tr>
<td>Energy-efficiency targets:</td>
<td>Municipalities can set mandatory energy-reduction goals for city-administered buildings and voluntary benchmarks that apply to all other structures.</td>
</tr>
<tr>
<td>Measure and track performance:</td>
<td>Audits, certification programs and disclosure requirements are among the tools cities can use to measure the energy performance of buildings.</td>
</tr>
<tr>
<td>Financial incentives:</td>
<td>Grants, rebates, mortgage financing, loans, credit lines and tax incentives are some approaches cities can introduce.</td>
</tr>
<tr>
<td>Lead by example:</td>
<td>City governments can initiate policies and projects that set an example for the community and foster greater acceptance and demand for energy-efficiency solutions. Start with city-owned buildings.</td>
</tr>
<tr>
<td>Engagement strategies:</td>
<td>Competitions, and awards that facilitate feedback are ways to spur dialogue among tenants, building owners and management.</td>
</tr>
<tr>
<td>Technical training:</td>
<td>Educational programs to develop skills to implement the latest energy conservation designs and innovative financing.</td>
</tr>
<tr>
<td>Partner with utilities:</td>
<td>Widen access to energy usage data through alliances with local utilities. Make smarter decisions about energy efficiency goals.</td>
</tr>
</tbody>
</table>


State of the art in green building in China. China needs a Zero Energy Building program. It’s a critical area to tackle for climate change mitigation and to minimize environmental problems. It’s important for China and the world. Though the emissions coming from the energy consumed by the Chinese buildings falls short from those of the industry, without an ambitious policy the situation may reverse in the near future. We can’t forget that buildings consume more energy than the transportation sector or the industry in many parts of the world (North America, Europe…). And if the cities that are being developed in China keep on using traditional standards, with such building stock it will be impossible to reduce energy consumption and to stop climate change. China needs to follow the Zero Energy Buildings policy that is being planned in the European Union and California: making all new buildings low carbon from 2020 onwards. Fortunately, China has started to implement a green building program. From 69.5 million sqm in 2012, it wants to expand the amount of 3-star rated green buildings to 1 billion sqm by end of 2015. All new public buildings are supposed to fulfil the 3-star rated green buildings certification. China is ready to create green architecture with Chinese characteristics.

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Future sector agenda: policies, mechanisms and tools. The rating systems, subsidies for green building, and the options for a set of mandatory green building describe the scope of the Chinese green building sector:

Three-Star Green Building System: MoHURD’s three-star rating system may need to be enhanced and upgraded to match other international rating and certification systems.

At central government level, a subsidy system for green building exist. Since 2012, the central government has clearly stated the availability of subsidies for green buildings in the policy.

- **Instruction on Promoting Green Building Development (policy [2012] No. 167),** issued in April 2012, by MoF (Ministry of Finance) and MoHURD, two main points are relevant to subsidy for green buildings/districts


- At local government level: The provinces and cities have issued policies for matching subsidy from local government. The subsidy standard is changing every year, here are some examples up to July 2016:
  - Beijing- CNY22.5/m² for 2-star green buildings, CNY40/m² for 3-star buildings.
  - Shanghai- CNY50/m² for 2-star green buildings certification for operation, CNY100/m² for 3-star.

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For other items, i.e. prefabricated building, energy efficiency retrofitting of existing buildings, window or sunshading retrofitting, integrated renewable energy in buildings, vertical green building, there are also subsidies.  

Issues to be addressed:

- **Low energy costs are problematic.** The fact that space heating and electricity is heavily subsidised contributes to low potential to save electricity or heating expenses through energy-efficient green building. The incentive to generate savings hardly exists in China. Thus, other factors will need to be identified.

- **Low levels of environmental awareness.** The low levels of environmental awareness contribute to a low level of willingness to invest in green building. However, if air quality and environmental cleanliness could be linked to the green building subject, this would probably convince more people about the value of green building.

- **Green building guidelines.** The government (MoHURD) is yet to issue binding standards for public sector and private sector construction projects. Private developers are currently able to under-perform and there is no mechanism yet to prevent this, and no mechanism exists to enforce retrofitting for below-standard projects. The green building subsidies which were introduced during the 12th Five-Year Plan for private builders (see box above) may be considered as extremely low. Other forms of support - preferential loans, or tax deductions have not yet been established.

- **Retrofitting of existing building stock.** Government-led retrofit programmes exist, but the scale is still rather limited due lack of funding.

- **Introduction of mandatory energy-efficiency standards.** The creation of mandatory green building standards for new construction or refitting of older existing buildings, like in the British or German building system, seems like a sensible scenario for the green building sector. As in the experience of Europe, a combination of incentives from central and local levels can be expected to provide best results.

- **Construction supervision and compliance mechanism.** Currently, there is no supervision or mechanism to enforce compliance with technical specifications of the green building standards, and no mechanism exists to measure post-construction performance, as done under the German ‘energy passport’ system. The existing certification system - the five ‘post-construction’ certificates do not (yet) cover green building.

- **Create a national plan for zero-energy buildings.** As has been introduced in the EU through the Directive on the Energy Performance of Buildings, it seems relevant for China to contemplate a similarly ambitious national programme.

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81 Five certificates are: land use permit, construction land planning permit, engineering planning permit, construction permit, sales permit. Local authorities issue two kind of reports: (i) Housing Quality Assurance Book, and the (ii) Instruction of Housing

## Sector indicators - Proposed Green Building KPIs

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
</table>
| 3 Passive house standard: Annual primary energy consumption for heating, cooling, lighting [6] | ≤ 60 kWh/m².a (or 7.4 kgce/m².a) [6]  
| | ≥ 30 m³/h.p [6] |
| 4 New buildings - Annual heating consumption: Severe Cold Climate Zone | ≤ 18 kWh/m².a [6] |
| 5 New buildings - Annual heating consumption: Cold Climate Zone | ≤ 15 kWh/m².a [6] |
| 6 New buildings - Annual heating consumption: Hot Summer And Cold Winter Climate Zone / Hot Summer And Warm Winter Climate Zone / Mild Climate Zone (National Standard GB 50189) | ≤ 5 kWh/m².a [6]  
- heating in winter ≤ 20°C [7]  
- cooling in summer ≥ 26°C [7] |
| 7 Annual cooling demand kWh/m².a | ≤3.5+2*WDH20+2.2*DDH28 Where  
| | WDH20 the hourly wet-bulb outside temperature higher than 20°C  
| | DDH28 the hourly wDry- |

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83 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. Sino-EU Key Performance Indicators for Eco-Cities. Beijing (unpublished draft)

84 Other indicators related to % of star-rated green buildings not considered relevant: 70% One-Star category; 20-40% Two-Star category; 15% Three-Star category [11].
<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
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<td>bulb outside temperature higher than 28°C</td>
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<td>9</td>
<td>Air tightness – Air change rate ≤ 0.6-1 at 50 Pa pressure difference</td>
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<td>11</td>
<td>Central heating coverage [10] ≥65% [10]</td>
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<td>12</td>
<td>Indoor air quality: radon density [8] More relevant for the building would be (meet national standard GB/T 18883-2002): - CO₂ - ventilation rates - TVOC - HCHO - Formaldehyde &lt;50Bq/m³ [8]</td>
<td>GB/T18883-2002: - Fresh air &gt;30m³/(h.p) - CO₂&lt;0.1% (1000ppm) - TVOC&lt;0.6mg/m³ - HCHO&lt;0.1mg/m³ - Radon&lt;400Bq/m³</td>
</tr>
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Sources:

Outlook and future sector agenda. “China is ready to harness the amount of energy consumed by its building sector, a new report finds, but homes, offices and factories will need
to become much more energy efficient. Energy consumed to supply heat and electricity to China’s vast building sector—energy that is mainly derived from coal—could start to peak by the end of the decade, says a new report from the Ministry of Housing and Urban-Rural Development, in line with the broader government target to cap use of the fossil fuel. Published in partnership with an academic panel, the report predicts that a cap on coal consumption of 4.3 million tonnes annually by 2020 would help China’s buildings sector peak in energy use at an annual 245 million tonnes of coal equivalent (tce) by the end of the decade. Energy consumption in buildings comprises 30% of China’s primary energy consumption, according to research from Tsinghua University and Germany’s Ministry of Industry and Commerce... A twofold effect is needed to deliver a peak in energy consumption from the building sector and then drive down consumption of heat and power up to 2030 and beyond... Firstly, the rate of energy efficiency in Chinese buildings needs to rise sharply from current levels. … [E]nergy-saving projects could reduce energy use by a total of 130 million tce, or 300 billion kilowatt hours. But achieving that scenario will require major investment—an estimated 3.6 trillion yuan (US$580 billion) between 2016 and 2030 if all potential energy savings are to be made. Efforts to develop green buildings in China have been thwarted by overlapping levels of government bureaucracy and the high costs of equipping, installing and monitoring energy efficient technologies such as insulation, smart metres and appliances, as well as small-scale renewable energy systems. China has already earmarked greener growth in cities as a major pillar of its 13th five-year plan (2016-2020) but may require tougher enforcement and stronger incentives to help deliver the results expected of the buildings sector.  

Investors from overseas and China itself will become more and more interested in the green building segment of the construction business. The German construction industry bulleted in China, ‘EcoNet¿, has noted that China has an urgent need for external thermal insulation. European construction firms are vying how to contribute industrialized green building materials for China’s fast expanding construction sector. In the coming years it can be expected that China’s green building sector will receive strong legislative boost, and that both the public and private building activity will receive technical and financial stimulus and support to adopt green building practices, both “passive” and “active” building. As China has a vast and fast growing building stock, retrofitting of this existing building stock will also become a priority area of interest.

Chinese companies seem quick in developing new products, and construction products are no difference. When China will provide high-quality [passive] building products to the world market, costs will probably decrease to a reasonable level.

Likewise, investors from overseas and China itself will become more and more interested in the Green Building segment of the construction business as witnessed in the EcoNet China event of 2014. German and other European construction firms are vying how to contribute industrialized green building materials for China’s fastly expanding construction sector. The Econet grouping has assessed a need for know-how and new technologies which German companies can supply. EconoNet has noted that China has an urgent need for external thermal insulation Composite Systems (ETICS) which can be utilized in building facades and windows, in particular. The Chinese President Xi Jinping has expressed his wish that Chinese standards should raise continuously in the next years, and possibly exceed the LEED standards. Hence, Econet and the other German entities, like the German Energy Agency (DENA) see great potential in China for Passivhaus solutions, and this can cover both existing building stocks and all new buildings. Further, there will be a massive potential for photo-voltaic technology applied to generate energy in buildings. In this regard, the German construction

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86 [http://www.eenews.net/stories/1060012314](http://www.eenews.net/stories/1060012314)

87 Bundesministerium für Umweltschutz, Naturschutz, Bau und Reaktorsicherheit/EcoNet China/German Chamber Network (DE). Beijing. [www.econet-china.com](http://www.econet-china.com)

industries have observed with interest that MoHURD has introduced in early 2015 new green building standards.

“By 2030, China will have 60 billion square metres of urban residential buildings, and 1 billion of its people will live in cities, … approaching the 70% typical of a country with China’s current income level per person... In 2012, per-capita energy consumption from residential buildings was only 0.5 tce—one-fifth of the figure for the US, one third of that for the OECD nations, and even below even the global average of 0.6 tce. While in a big country like China the total energy consumption for residential building is substantial, this means still that the per-capita consumption of overall energy consumption through buildings is relatively low.

In April 2015, there were 320 million square meters of green building space in the country, certified by either the domestic Green Building Evaluation Standard or the Leadership in Energy and Environmental Design standard of the United States Green Building Council. The figure is 154 times higher than in 2008, when the GBES was launched.”

While the current green building space accounts only for 1%, in 2020 it is expected to reach already 10% of the total.

The last 10 years of green building in China demonstrate a fast learning process taking place. The Chinese government is committed to green building, and it is understood that for China’s cities, green building is an essential building block for environmental and economic sustainability. The recent global climate change negotiations have underlined the importance of eco-cities, and China’s response is positive and the drive to develop eco-cities will contribute to the global trend of eco-city building. In Fact it looks as if China can become one of the leading countries in this field.

Tool GB 1: Passive Building Design.

**What this tool does:** The German term “Passivhaus” (= Passive House) stands for a rigorous energy-efficiency standard for buildings, covering residences, offices, commercial buildings, hotels, schools and any other public facilities. The Passive House concept entails that it reduced energy requirements, mostly heating for buildings through a design that ensures minimisation of energy losses through good insulation or even air tightness. Passive housing has been used for new buildings, but increasingly it is also used for building retrofits in urban renewal.

The concept passive house design is mostly applied for cold climate zones, but it can also be modified for use in moderate subtropical or tropical climates. In such climates, instead of good insulation and air tightness, it is rather the design features of shading and ventilation which are important.

The vast majority of passive houses have been built in Germany and Scandinavian countries, but it is also picking up in other European countries, like Austria, Spain, Switzerland, and the United Kingdom.

**How does it work:**

“The Passivhaus standard requires that the building fulfills the following requirements:

- The building must be designed to have an annual heating and cooling demand as calculated with the Passivhaus Planning Package of not more than 15 kWh/m² per year in heating or cooling energy OR be designed with a peak heat load of 10 W/m².
- Total primary energy (source energy for electricity, etc.) consumption (primary energy for heating, hot water and electricity) must not be more than 120 kWh/m² per year.
- The building must not leak more air than 0.6 times the house volume per hour (n₅₀ ≤ 0.6 / hour) at 50 Pa (0.0073 psi) as tested by a blower door, or alternatively when looked at the surface area of the enclosure, the leakage rate must be less than 0.05 cubic feet per minute.

By achieving the Passivhaus standards, qualified buildings are able to dispense with conventional heating systems. While this is an underlying objective of the Passivhaus standard, some type of heating will still be required and most Passivhaus buildings do include a system to provide supplemental space heating. This is normally distributed through the low-volume heat recovery ventilation system that is required to maintain air quality, rather than by a conventional hydronic or high-volume forced heating system.

In Passivhaus buildings, the cost savings from dispensing with the conventional heating system can be used to fund the upgrade of the building envelope and the heat recovery ventilation system. With careful design and increasing competition in the supply of the specifically designed Passivhaus building products, in Germany it is now possible to construct buildings for the same cost as those built to normal German building standards.

On average passive houses are reported to be more expensive upfront than conventional buildings - 5% to 8% in Germany, 8% to 10% in UK, and 5% to 10% in USA.

Evaluations have indicated that while it is technically possible, the costs of meeting the Passivhaus standard increase significantly when building in Northern Europe above 60° latitude. European cities at approximately 60° include Helsinki in Finland and Bergen in Norway. London is at 51°; Moscow is at 55°.
These facts have led a number of architects to construct buildings that use the ground under the building for massive heat storage to shift heat production from the winter to the summer. Some buildings can also shift cooling from the summer to the winter. At least one designer uses a passive thermosiphon carrying only air, so the process can be accomplished without expensive, unreliable machinery. (Source: https://en.wikipedia.org/wiki/Passive_house)

Example:

**Standard “Passivhaus”**

**Good Insulation**

through double or – better- triple glazing windows is essential

**Heat Exchanger**

How the Heat Exchanger works:

In addition to the heat exchanger (centre), a micro-heat pump extracts heat from the exhaust air (left) and hot water heats the ventilation air (right). The ability to control building temperature using only the normal volume of ventilation air is fundamental.

Source: https://en.wikipedia.org/wiki/Passive_house
### Features:

**Passive solar design and landscape.** Passive solar building design and energy-efficient landscaping support the Passive house energy conservation and can integrate them into a neighbourhood and environment. Following passive solar building techniques, where buildings are compact in shape to reduce their surface area, with principal windows oriented towards the equator - south in the northern hemisphere and north in the southern hemisphere - to maximize passive solar gains. However, the use of solar gain, especially in temperate climate regions, is secondary to minimizing the overall house energy requirements. In climates and regions needing to reduce excessive summer passive solar heat gain, whether from direct or reflected sources, *Brise soleil* trees, attached pergolas with vines, vertical gardens, green roofs and other techniques are implemented.

Passive houses can be constructed from dense or lightweight materials, but some internal thermal mass is normally incorporated to reduce summer peak temperatures, maintain stable winter temperatures, and prevent possible overheating in spring or autumn before the higher sun angle "shades" mid-day wall exposure and window penetration. Exterior wall color, when the surface allows choice, for reflection or absorption (Insulation) qualities depends on the predominant year-round ambient outdoor temperature. The use of deciduous trees and wall trellised or self-attaching vines can assist in climates not at the temperature extremes.

**Superinsulation.** Passivhaus buildings employ superinsulation to significantly reduce the heat transfer through the walls, roof and floor compared to conventional buildings. A wide range of thermal insulation materials can be used to provide the required high R-values (low U-values, typically in the 0.10 to 0.15 W/(m².K) range). Special attention is given to eliminating thermal bridges. A disadvantage resulting from the thickness of wall insulation required is that, unless the external dimensions of the building can be enlarged to compensate, the internal floor area of the building may be less compared to traditional construction. In Sweden, to achieve passive house standards, the insulation thickness would be 335 mm (about 13 in) (0.10 W/(m².K)) and the roof 500 mm (about 20 in) (U-value 0.066 W/(m².K)).

**Advanced window technology.** To meet the requirements of the Passivhaus standard, windows are manufactured with exceptionally high R-values (low U-values, typically 0.85 to 0.70 W/(m².K) for the entire window including the frame). These normally combine triple-pane insulated glazing (with a good solar heat-gain coefficient, low-emissivity coatings, sealed

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**Passive House in Berlin, Germany**


**Passive house in Shanghai, China**

argon or krypton gas filled inter-pane voids, and 'warm edge' insulating glass spacers) with air-seals and specially developed thermally broken window frames.

In Central Europe and most of the United States, for unobstructed south-facing Passivhaus windows, the heat gains from the sun are, on average, greater than the heat losses, even in mid-winter.

**Airtightness.** Building envelopes under the Passivhaus standard are required to be extremely airtight compared to conventional construction. They are required to meet either 0.60 ACH50 (air changes per hour at 50 pascals) based on the building's volume, or 0.05 CFM50/sf (cubic feet per minute at 50 pascals, per square foot of building enclosure surface area). In order to achieve these metrics, recommended best practice is to test the building air barrier enclosure with a blower door at mid-construction if possible.

Passive house is designed so that most of the air exchange with exterior is done by controlled ventilation through a heat-exchanger in order to minimize heat loss (or gain, depending on climate), so uncontrolled air leaks are best avoided. Another reason is the passive house standard makes extensive use of insulation which usually requires a careful management of moisture and dew points. This is achieved through air barriers, careful sealing of every construction joint in the building envelope, and sealing of all service penetrations.

**Ventilation.** Use of passive natural ventilation is an integral component of passive house design where ambient temperature is conducive — either by singular or cross ventilation, by a simple opening or enhanced by the stack effect from smaller ingress with larger egress windows and/or clerestory-operable skylight.

When ambient climate is not conducive, mechanical heat recovery ventilation systems, with a heat recovery rate of over 80% and high-efficiency electronically commutated motors (ECM), are employed to maintain air quality, and to recover sufficient heat to dispense with a conventional central heating system. Since passively designed buildings are essentially air-tight, the rate of air change can be optimized and carefully controlled at about 0.4 air changes per hour. All ventilation ducts are insulated and sealed against leakage.

Some Passivhaus builders promote the use of earth warming tubes (typically ≈200 mm (~7.9 in) diameter, ≈40 m (~130 ft) long at a depth of ≈1.5 m (~5 ft)). These are buried in the soil to act as earth-to-air heat exchangers and pre-heat (or pre-cool) the intake air for the ventilation system. In cold weather the warmed air also prevents ice formation in the heat recovery system's heat exchanger. Concerns about this technique have arisen in some climates due to problems with condensation and mold. Alternatively, an earth to air heat exchanger can use a liquid circuit instead of an air circuit, with a heat exchanger (battery) on the supply air.

**Space heating.** In addition to using passive solar gain, Passivhaus buildings make extensive use of their intrinsic heat from internal sources—such as waste heat from lighting, white goods (major appliances) and other electrical devices (but not dedicated heaters)—as well as body heat from the people and other animals inside the building. This is due to the fact that people, on average, emit heat equivalent to 100 watts each of radiated thermal energy.

Together with the comprehensive energy conservation measures taken, this means that a conventional central heating system is not necessary, although they are sometimes installed due to client skepticism.
Instead, Passive houses sometimes have a dual purpose 800 to 1,500 watt heating and/or cooling element integrated with the supply air duct of the ventilation system, for use during the coldest days. It is fundamental to the design that all the heat required can be transported by the normal low air volume required for ventilation. A maximum air temperature of 50 °C (122 °F) is applied, to prevent any possible smell of scorching from dust that escapes the filters in the system.

The air-heating element can be heated by a small heat pump, by direct solar thermal energy, annualized geothermal solar, or simply by a natural gas or oil burner. In some cases a micro-heat pump is used to extract additional heat from the exhaust ventilation air, using it to heat either the incoming air or the hot water storage tank. Small wood-burning stoves can also be used to heat the water tank, although care is required to ensure that the room in which stove is located does not overheat.

Beyond the recovery of heat by the heat recovery ventilation unit, a well-designed Passive house in the European climate should not need any supplemental heat source if the heating load is kept under 10W/m².

Because the heating capacity and the heating energy required by a passive house both are very low, the particular energy source selected has fewer financial implications than in a traditional building, although renewable energy sources are well suited to such low loads.

The Passive House Standards in Europe determine a Space Heating and cooling Energy Demand of 15 kilowatt hours per square meter of Treated Floor Area per year or 10 Watts per square meter peak demand. (Or in Imperial units 4.75 kBTU/sf*yr and 3.2 BTU/hr*sf respectively.) In addition, the total energy to be used in the building operations including heating, cooling, lighting, equipment, hot water, plug loads, etc. is limited to 120 kilowatt hours per square meter of Treated Floor Area per year (or in Imperial units 38.0 BTU/sf*yr.).

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Source: www.passiv.de/en/01_passivehouseinstitute/01_passivehouseinstitute.htm

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(adapted from: https://en.wikipedia.org/wiki/Passive_house)

Literature / further information:

Tool GB 2: Active Building Design.

What this tool does: The Active House (in German “Aktivhaus”) is a zero-net energy (ZNE) building. It is characterized by its zero net energy consumption. Through renewable energy sources within the building or on site, the ZNE house creates enough energy during the year to cover its total energy consumption. As such this is an active house that generates its own energy, or even an excess of energy, and it contributes to a reduction in green-house-gas (GHG) emissions. However, at times, the Active House may need energy from non-renewable fossil sources, while at other times it may have excess energy and may be able to power electric vehicles or sell excess electricity to the grid. The overall balance, however, may turn out to be net-zero. Buildings which produce surplus energy are sometimes also called “energy-plus buildings”, or “near zero energy buildings”, or “ultra-low energy houses”.

“The Active House … combines energy efficiency with specific attention to user health and comfort, indoor climate and the environment. Active House focus on Comfort, Energy and Environment, and require a holistic view. An Active House is evaluated on the combination and integration of the three main principles of Comfort, Energy and Environment. The evaluation has to be done in accordance with the Active House specifications and the performance are described through the Active House Radar showing the level of ambition of each of the three main Active House principles and their nine sub-parameters.

The integration of each parameter describes the level of ambition of the building. For a building to be considered as an Active House, the level of ambition can be quantified into four levels, with 1 as the highest and 4 the lowest.

The building must be evaluated and benchmarked on the nine sub parameters, (Daylight, Thermal Comfort, Air quality, Energy demand, Energy supply, Primary Energy, Environmental load, Freshwater, Sustainability) where each of them is evaluated in accordance with international standards, like EN15251, ISO14040 as well as national standards and methodologies for i.e. energy demand. Some of the parameters are included in building legislation and in this sense, the methodology used on national level can be reference.”

Like the Passive House, the Active House is also considered to contribute significantly to the lowering of carbon emissions, and the dependence on fossil fuels. Despite their initial higher investment costs, Active Houses are expected to gain bigger market shares with the expected decrease of decentralized technologies for generation of renewable energy, i.e. photovoltaic devices, wind energy devices, heat exchange pumps, and energy efficient lightning and home appliances including heating, ventilation and air conditioning (HVAC). Active Houses can be part of smart grids, thus contributing to the integration of renewable energy sources and integration of plug-in electric vehicles. The net-zero concept may also be extended to cover water and waste aspects of the house, and through storage devices also to disaster resilience.

**Site Boundary of Energy Transfer for Zero-Energy Accounting**

How does it work:

**Twelve Steps to Affordable Zero Energy Construction**

1. Design for Zero Net (integrate building design with energy concept).
2. Use Energy Modeling for the most cost-effective zero energy building.
3. Super-seal the building envelope
4. Super-insulate the building envelope
5. Minimize thermal bridging
6. Use highly insulated windows and doors
7. Use the sun for passive solar gain
8. Use the sun for electricity and hot water
9. Create an energy-efficient, fresh air supply and manage humidity
10. Use an energy-efficient heating and cooling system
11. Install energy-efficient lighting
12. Select energy-efficient appliances and electronics

(For more details refer to: [http://www.zerohomes.org/twelve-steps-to-zero/](http://www.zerohomes.org/twelve-steps-to-zero/))
Examples:

**Aktiv-Stadthaus, Frankfurt a. M.**

- **architect**: HHS Planer + Architekten AG, Kassel
- **client**: ABG FRANKFURT HOLDING
- **our services**: energy concept, EBS (phases 1-9), building physics, building acoustics, research proposal BMVBS
- **project data**: 74 residential units, 8,443 m² use area
- **execution**: 2012-2014

**Features of a net-zero home**

- Efficient Lighting
- Double Insulation
- Energy Management
- Heat Pump
- Heat Pump Water Heater (Efficient electric water heating)
- Heat Recovery Ventilation
- Photovoltaic Panels
- Low-Flow Water Fixtures
- High Performance Windows and Doors
- Exceptional Air Sealing
- Tier 3 Appliances

Efficiency Vermont
**Literature / further information:**


Tool GB 3: Retrofitting of Buildings.

What this tool does: Building and construction technologies for energy-efficiency are important elements of the conversion of homes to become passive (or active) houses. Their quality and efficiency determines whether energy-efficiency targets can be achieved. There is an ever growing market for such products, and users will require guidance and technical support to get best benefits and value for their money.

8 topics for retro-fit measures for the building stock

How does it work. Retrofitting an existing building can oftentimes be more cost-effective than building a new facility. Since buildings consume a significant amount of energy (40 percent of the many countries’ total energy consumption), particularly for heating and cooling (32 percent), and because existing buildings comprise the largest segment of the built environment, it is important to initiate energy conservation retrofits to reduce energy consumption and the cost of heating, cooling, and lighting buildings. But conserving energy is not the only reason for retrofitting existing buildings. The goal should be to create a high-performance building by applying the integrated, whole-building design process, to the project during the planning or public tender phase that ensures all key design objectives are met. For example, the integrated project team may discover a single design strategy that will meet multiple design objectives. Doing so will mean that the building will be less costly to operate, will increase in value, last longer, and contribute to a better, healthier, more comfortable environment for people in which to live and work. Improving indoor environmental quality, decreasing moisture penetration, and reducing mold all will result in improved occupant health and productivity. Further, when deciding on a retrofit, consider upgrading for accessibility, safety and security at the same time. The unique aspects for retrofit of historic buildings must be given special consideration. Designing major renovations and retrofits for existing buildings to include sustainability initiatives will reduce operation costs and environmental impacts, and
can increase building adaptability, durability, and resiliency. (adapted from: https://www.wbdg.org/resources/retro_sustperf.php)

**Deciding on interventions.** Before making what may amount to a major investment in the retrofit of existing buildings for energy and sustainability improvements, it is important to determine if the investment is worthwhile in perspective with other building conditions. Is the building structurally sound? Are seismic upgrades needed to meet current standards and local building code requirements? Do hazardous material like asbestos, polychlorinated biphenyls (PCB) and lead paint have to be contained and removed? Can the work be done in phases to minimize disruption to the occupants? Relocating occupants to other facilities can be a significant expense. If a vegetative roof is being considered, is the roof structure able to support the additional weight without costly reinforcement? Look for opportunities to reduce the cost of the work by recycling waste and demolition materials.

Once determined that other building conditions are not impediments to upgrading for sustainability and improved energy performance, have a plan and follow a sequence of activities in order to determine the best options for energy and sustainability improvements.

- **First,** determine if the existing systems are operating at optimum levels before considering replacing existing equipment with new higher efficiency equipment. This can be accomplished by performing an energy audit. Sometimes, considerable savings in utility costs can be gained by evaluating the performance of the building envelope and existing systems: leaks, clogged/dirty filters, stuck dampers, disabled sensors, faulty or incorrect wiring, or even lack of knowledge on how to properly operate and maintain equipment can all contribute to inefficiencies and increased costs. Audit the performance of the building's water systems as well; since leaking and inefficient systems not only waste water, they also use energy by needlessly running pumps and other electrical equipment.
- **Then,** if the building is metered, review utility bills from the last two years to determine if consumption (not cost) has risen.
- **Next,** determine air tightness of the building envelope by examining the building envelope, looking for leaky windows, gaps around vents and pipe penetrations, and moisture intrusion. Upgrading heating and air-conditioning systems without addressing problems with the building envelope will result in less than optimum performance of those systems.

**Sustainability and Energy-Efficiency Strategies**

- Recommission all energy and water systems to determine they are operating at optimum performance; then upgrade energy and water systems to minimize consumption.
- Develop a plan to optimize the recycling and reuse of demolition debris and construction waste to minimize waste sent to landfills.
- Evaluate occupancy patterns, then apply daylight, HVAC (heating, ventilation and air conditioning) and lighting sensors in appropriate locations. Incorporate energy efficient-lighting into the project as appropriate for the tasks and functions of the spaces.
- Determine if natural ventilation and fresh air intake are feasible alternatives to reduce heating and cooling loads.
- Investigate renewable energy options that can offset the purchase of fossil fuel-based energy.
- Consider solar shading devices for windows and doors, including those that generate electricity by photovoltaic (PV) devices.
• Replace existing windows with high performance windows appropriate for climate and exposure. If building requires security upgrade, evaluate blast resistant windows and films. If building is located in a high noise area, evaluate windows that also include adequate exterior to interior noise reduction.
• Analyse the benefits of distributed generation if the building is in a campus cluster or can share the on-site energy produced with adjacent buildings.
• Balance the project’s sustainable goals with its security goals including protecting the building and its occupants from natural and man-made disasters.
• Certain site renovations can improve the energy performance of the building including reducing the heat island effect.
• Determine if a cool roof or green roof are cost-effective ways to reduce heat island effect and storm water runoff.
• Employ green building rating systems for existing buildings like (DGNB, LEED, BREEAM, Chinese Star-Rating System, or other) to gage the building’s level of performance.
• For historic buildings, update systems appropriately to maintain a balance between the need for energy and water savings with the character of the original building fabric.
• Take the opportunity afforded by the building renovation to incorporate sustainable operations and maintenance practices and switch to green cleaning products and methods.
• To ensure a newly renovated building continues to perform as designed, measure the performance of the building regularly.
• If not already metered, plan on installing meters for electric, gas, water and other utilities. Smart meters and submeters are preferable to monitor real-time consumption, control demand and increase tenant accountability (cost control). (adapted from: https://www.wbdg.org/resources/retro_sustperf.php)
Technologies. The technologies in support of Passive and Active House concepts can be grouped into the following categories:

- Technologies of the building envelope – walls, doors, windows, roofs, foundations and flooring.
- Special technologies:
  - Green roofs
- Energy efficient heating technologies.
- Energy efficient cooling technologies.
- Warm water technologies.
- Decentralized renewable energy sources.
- Energy-efficient lighting.
- Energy efficient heating, ventilation and air conditioning (HVAC).
- Energy efficient water devices.
- Software to monitor in-door air quality and use of home appliances.

Deep Energy Retrofits of Old Buildings

“A Deep Energy Retrofit is defined as ‘a whole-building analysis and construction process that achieves much larger energy cost savings—sometimes more than 50% reduction—than those of simpler energy retrofits and fundamentally enhances the building value.’ They can be hard to do, working with an existing building with so many special conditions and limitations. There is also still a lot of science that has to be resolved, and no single pat solutions.” Empirical conclusion of retrofitting is that ‘airtightness trumps insulation’.
strategies for the upgrade of the building stock

- maintainance of the building stock
  - retro-fit
  - densification
- demolition of the building
  - replacement
  - new building
- addition of stories
- extension
- addition
- combination

spectrum of measures for the upgrade of the building stock

Quelle: Modernisierung von Mieth.- und Genossenschaftswohnungen, Oberste Baubehörde im Bayerischen Staatsministerium des Innern, 2012

一个标准中国公共建筑的全年冷热负荷
annual heating & cooling demand of a standard chinese public building

- severe cold climate A (incl. Harbin)
- severe cold climate A (incl. Xining)
- cold climate (incl. Beijing)
- hot summer and warm winter (incl. Guangzhou)
- hot summer and cold winter (incl. Shanghai)
Literature / further information:

4. GREEN TRANSPORT
The car-city can only be overcome with viable green transport alternatives – Dongcheng district – Beijing

Mass transit like underground lines are going to be the principal background of future cities - Beijing

Electric buses will be the major feeders and intermediaries between the metro-system and neighbourhoods

Electric motorbikes have become important source of neighbourhood mobility – Beijing

The pay-for-use bicycle – and the recovery of the ‘Kingdom of bicycles’ - Beijing

Electro-mobility for the elderly and handicapped - Beijing

Source: GIZ, and www.chinabus.org

Source: F. Steinberg (except for otherwise noticed)
Sector Profile of Green Transport

Introduction. Despite references to sustainable transport in the UN 2030 Agenda for Sustainable Development and the New Urban Agenda there is no globally agreed definition of sustainable or green transport. In urban areas, transport covers the movement of people and freight (e.g. goods, waste and service trips) to, from and within urban areas. Green refers to the environmental pillar of sustainability which may be direct local (e.g. noise or air quality) or national or global impacts (e.g. climate change). Urban Green Transport is the efficient, clean, safe and affordable movement of people and goods in urban areas. It is generally accepted that this can be done through widespread use of shared mobility (e.g. public transport, car sharing) supported by walking and cycling. In Europe although the broader term “sustainable transport” (including all three of the economic, social and environmental dimensions of sustainable transport) is widely used most attention is given to the environmental dimension – with generally less attention given to the economic (e.g. ticket prices, public subsidies) and social dimensions (e.g. access for people with disabilities, personal security) with the general exception of road safety.93

Conventionally, transport has been seen as a pre-condition for economic development. This has caused vehicles to take the centre stage, and most cities to become “car cities”. The aim was to make the use of vehicles as convenient as possible. Reducing the costs of using the private vehicle and the use of trucks for the transport of goods has long been considered a desirable development goal. Heavy investment in road infrastructure, low-density urban development and fuel subsidies are exemplary heritages of years of vehicle-centred policy making. Traditional planning of transportation infrastructure needs in cities was done mainly on a “predict and provide” basis. Planners predicted the growth in demand for the use of private vehicles and built the infrastructure to accommodate this growth. This put the movement of the vehicle in the centre instead of the movement of people or goods. Increasing congestion, environmental problems, reduction in the quality of public transport and increasing costs of sustaining the transport system have led to a discussion on the compatibility of liveable urban space and cars in Europe and elsewhere. A discussion that is more and more emerging in Chinese cities as well. The emergency of new paradigms in transport has made it imperative to implement the Avoid–Shift–Improve approach in transport. As cities adopt new transport policies and low-carbon technologies, it will become necessary to develop integrated low-carbon transport plans. As a tool for decision making, the assessment of co2 emissions will add a parameter in deciding in favour of low-carbon transport technologies. As part of integrated city-wide low-carbon transport plans, there will also be elements of non-motorized transport (walking and cycling).

State of Demand in China. In China, transport accounts for a significant share of total carbon emissions, representing a significant challenge to sustainable development. Recognising the challenges of rapid urbanisation and motorisation, China has committed to limit the growth of its greenhouse gas (GHG) emissions. Through the implementation of green transport policies, China is aiming to improve urban air quality, reduced congestions, and improved road safety. Applying the Avoid-Shift-Improve approach, China promotes alternative mobility solutions and develops sustainable modern transport systems in its public transport. Among these are underground metro systems, guided rapid bus transit (BRT) systems, innovations in motor vehicles, and non-motorized transport networks (for instance for bicycles). In international comparison, Transport policies in China are considered as strong and well oriented due to their commitment to green growth and heavy investment.

Policy Directives. The State Council has issued a roadmap for city development. Green transport is included under urban services:94

94 Extracted and translated from: http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm)
- **Complete urban public service.** The development of public transport enjoys priority. Until 2020, the share of super- and ultra-large public transport will reach 40%. See debate about this issue in China Daily [http://www.chinadaily.com.cn/china/2016-02/22/content_23593906.htm](http://www.chinadaily.com.cn/china/2016-02/22/content_23593906.htm).

- **Transit-oriented Development:** Cities should be built around their public transit systems. The area within 500-800 meters of major transit stations, such as the metro or bus rapid transit (BRT), or within 500 meters of nearest bus or transit stops (in case BRT or Metro is not available) should have FAR at least 50% higher than the average of the district. For big cities, at least 70% of residents should live in TOD areas characterized by convenient mass transit service. Great accessibility (pleasant walking amenities to transit system within 500-meter radius) must be offered.

- **Non-motorized Transit:** There should be dedicated and connected walking paths of at least 10Km in length per square kilometer, and dedicated and connected biking paths of at least 10 km in length per square kilometer in urban areas.

- **Public Transit:** All new developments must be within a 500-meter radius of a bus or rapid transit station. For the city as a whole, at least 90% of developments should be within 800-radius of a public transit station.

- **Car control:** Every city should have a strategy to cap car use. Where high-quality transit exists, there should be limits on parking.

**Best Practices in Europe.** Mainstream transport planning in Europe has not been based on assumptions that the private car was the best or only solution for urban mobility. European cities have known a far greater mix of walking, cycling, and public transport use. The social and economic sustainability of car-based urban planning has also been questioned. The alternative transport pathway for green cities is achieved through designing away the need for private motorized transport in the first place. The framework of Avoid-Shift-Improve articulates both the contents and priorities that seem to best present such an alternative. A synergetic package of mixed-use development, integrated spatial planning, quality public transport and non-motorized transport facilities, provide disincentives to car and motorcycle use. Clean vehicle technologies offers a way forward towards eco-cities. The market-driven nature of car-free communities, such as Vauban in Germany, means a percentage of the population indeed prioritized quality-of-life in opting against private car ownership.

**Best Practices.** The practice of green transport is rapidly changing the face of European cities. The examples below cover the themes of planning of dense and human scale cities; transit-oriented development, financing mass transit with land value capture, sustainable urban mobility plans, and new energy vehicles for public transport.

- **Helsinki, Finland:** Sustainable urban transport design and neighbourhood development principles.

- **London, United Kingdom:** Towards a more compact city. Transport as the foundation for compact city development.

- **Berlin, Germany:** Integrated urban transport planning. The Urban Transportation Development Plan was drafted in a consultative process and provides the roadmap for Berlin’s transportation policy, and forms today's framework for concrete transportation planning and measures on all levels across the city.

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96 [http://nrl.northumbria.ac.uk/15327/](http://nrl.northumbria.ac.uk/15327/)


100 [https://sustainabledevelopment.un.org/content/documents/3708kunst.pdf](https://sustainabledevelopment.un.org/content/documents/3708kunst.pdf)
• Nantes, France: Transit-oriented development (TOD) as part of an integrated planning process. 101

• London, United Kingdom: London Crossrail which is a TOD project case that funds transport investment through value capture from land development. 103

• Copenhagen, Denmark: Copenhagen Metro and Ørestad development scheme which also succeeded in generating land values from TOD development. 104

• Berlin, Germany: E-buses for Berlin as clean component of its public transport strategy. 105

• London, United Kingdom: The new hybrid buses will replace all old buses. 106

• Vienna, Austria: Innovative electric buses will dominate the public road transport. 107

State of the art in green transport in Europe. In 2015 as part of the agreed UN 2030 Agenda for Sustainable Development 108 all the 28 EU Member States and China agreed on Sustainable Development Goal 11 - Make cities and human settlements inclusive, safe, resilient and sustainable. Indicator 11.2 is to: “By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons”. In 2016 the EU Member States and China also agreed to UN Habitat III’s New Urban Agenda 109 where inter alia they committed themselves to: “sustainable and efficient transport infrastructure and services, where possible, achieving the benefits of connectivity and reducing the financial, environmental and public health costs of inefficient mobility, congestion, air pollution, urban heat island effects and noise.” The 2015 Paris Agreement on climate change sets a vision for the transition to a low carbon economy by 2050. Urban transport already accounts for approximately 10% of global energy related greenhouse gas emissions and faces an explosion in transport demand with an additional 2.5 billion urban citizens expected by 2050. Delivering on the Paris Agreement requires a fundamental transformation of urban mobility.

Europe’s experience developing and managing attractive and successful cities combined with the scale and speed of China’s urbanisation means that together the EU and China can define the future of urbanisation. The European Union and China have many similarities, the variety of climates and geography, the large distances, the diversity of cultures and languages as well as wide economic disparities between the richest and poorest regions. However, there are also a number of important differences.

Cities in the European Union. European cities are much smaller than Chinese cities, have more stable population and have historic 19th century layouts that only evolve very slowly. Levels of car ownership are higher and bike use is lower. Quality of urban life is a major concern for many cities which give a lot of attention to urban design and to environmental issues (e.g. noise, waste, air quality) especially in the wealthier and tourist cities. European cities are run by local directly elected governments, with elections every four or five years which puts a focus on local priorities. Cross border issues such as greenhouse gas reductions and air quality are regulated by binding EU wide rules. Countries that do not comply with EU law are prosecuted before the European Court and ultimately face large fines. While there is broad compliance with EU greenhouse gas reductions there are widespread problems with compliance with EU air quality laws in cities – largely due to road transport emissions. Each

102 http://www.eltis.org/resources/training/integrated-planning
104 https://dspace.iboro.ac.uk/dspace-ipsi/bitstream/2134/3418/1/enoch_tec_land_value_gains_fund_public_transport.pdf
109 http://habitat3.org/the-new-urban-agenda/
country in the EU can decide its own urban policy but in general there is a lack of national urban policies. Widespread problems such as congestion and road safety are widespread but as local issues they are not regulated by EU rules.110

State of the art in green transport in China. China has a huge number of very large, expanding, modern cities. Levels of car ownership are low but are rising fast, levels of cycling are still high but falling fast. Congestion and poor urban air quality are already a major concern across China. As pollutant emissions from industry and domestic combustion fall – emissions from road vehicles can be expected to become the dominant source of urban air pollution. The size and density of Chinese cities means that without a dramatic change in policy on urban car use; congestion and air quality will become far worse – reducing the economic efficiency or cities, quality of urban life and increasing impact on human health. The possibility to have a strong national urban policy offers a considerable opportunity to transform urban mobility across China. Cultural factors are also very important. Car ownership and use in China is still widely associated with economic success and social status for example the provision and use of official cars by Chinese officials is still widespread. Transforming urban mobility in China will require a change in attitudes towards wealth and status as well as a revolution in urban policy and practice.

Future sector agenda: policies, mechanisms and tools.

Clean energy vehicles. Like Europe, China is strongly committed to develop and promote clean energy vehicles. In 2011 the European Commission called to “Halve the use of ‘conventionally-fuelled’ cars in urban transport by 2030; phase them out in cities by 2050”111 – since then it has become increasingly normal for governments112 and cities113 to announce the gradual phase out of conventionally fuelled cars. Clear energy vehicles are particularly attractive to cautious policy makers as they have short term and easily quantifiable costs and benefits. It’s much harder to quantify and justify the benefits of alternative types of non-technological urban mobility interventions such as more bus lanes.

Managing the transition to low-carbon transport. While reducing greenhouse gas emissions may not be a locally driven priority (where issues of air pollution, congestion and road safety are more often a priority) both the EU and China are leading the international response to climate change by committing to reducing greenhouse gas emissions. Delivering on their reduction commitments will require dramatic action on urban mobility and will be a major challenge in both regions, but particularly in China.

Integrated approach for green transport: Urban transport patterns are determined by government policy. Urban planning decisions and broader public policy in areas such as health, taxation, land use, education, housing etc. together determine the demand for transport. The challenge for cities is to maximise their citizens’ access to social, cultural and economic opportunities while minimising the negative impacts of transport. City land use planning and design have a key role to play in avoiding un-necessary transport (e.g. through the local provision of goods and services) and in stimulating mode shift by making public transport, walking and cycling convenient and safe.

All aspects of urban planning and design contribute to transport avoid and shift strategies from macro decisions about the location of residential and commercial property, decisions on the use of public space (e.g. bike lane or parking space) to the detail design of paths and street

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111 COM (2011) 144, Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, 28th March 2011
112 e.g. June 2017 - India has signalled it will only sell electric cars from 2030
113 e.g. Paris, London, Athens, Madrid and Mexico City are introducing car bans.
lighting that help make walking and cycling safe and convenient all have an impact on transport demand and mode choice. In 2015, 23.85 million new cars were registered in China, taking car ownership up to 172 million. Considering the government’s aim to further accelerate the level of urbanisation from currently 53.7 per cent to 60 per cent in 2020 paired with the continuous increase in population and per capita income, urban mass motorisation is unlikely to stop anytime soon. Recent projections from the School of Environmental Studies of Tsinghua University, one of China’s leading academic institutions, forecast a four to six fold increase in private passenger cars until 2030. This would add at least 250 to 450 million more cars to the already clogged streets of Chinese cities.

**Sector indicators.**

**Proposed Green Transport KPIs**

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traffic related emissions reduced [1]</td>
<td>By 15%</td>
</tr>
<tr>
<td>2</td>
<td>Modern public transport systems in new residential areas</td>
<td>≥70% [3]</td>
</tr>
<tr>
<td>2</td>
<td>-person-km, or</td>
<td>≤40% of all new residential areas [9]</td>
</tr>
<tr>
<td>2</td>
<td>-ton-km</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Number of energy efficient cars per 10K vehicles [5]</td>
<td>_ /10K vehicles</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>≤45 minutes/trip [5]</td>
</tr>
<tr>
<td>7</td>
<td>Non-motorized traffic: Dedicated-connected walking paths [8]</td>
<td>≤10Km in length/km2 [8]</td>
</tr>
<tr>
<td>7</td>
<td>Dedicated-connected biking paths [8]</td>
<td>≤10Km in length/km2 [8]</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>≤1.5m [8]</td>
</tr>
</tbody>
</table>

117 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. Sino-EU Key Performance Indicators for Eco-Cities. Beijing (unpublished draft)
<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: values</th>
<th>indicative</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle lane width</td>
<td>[9]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources:

**Outlook and future sector agenda.** Due to rapidly expanding wealth and prosperity, the number of cars on China’s roads is rapidly growing, creating an ongoing pollution problem. China enacted its first emissions controls on automobiles in 2000, equivalent to Euro I standards, but a national roll-out appears more difficult. Cities in China that are currently reaching a point that integrated public transit systems and a mix of motorized and non-motorized transit can be considered against full motorisation. However, cities do not only differ in their transportation systems, but also in terms of their institutional capacity. Consequently, urban transport policy requires a highly localised approach. It is essential to consider the applicability of European transport policies given different socio-economical and institutional conditions. The concept of eco-city development challenges the growth paradigm of recent decades which aimed for massive private vehicle use, over public transport. The new approach, however, favours an expansion of public transport, the application of transit-oriented development (TOD) hubs, and the introduction of low-carbon or clean "new" energy vehicles. Growing demands for cleaner and healthier environments and lifestyles make it more likely that non-motorized transport will make a come-back in China hand in hand with the above low-carbon transport innovations.
Tool GT 1: Integrated city-wide low-carbon transit plans.

What this tool does: This tool takes a city wide perspective to transport. It advocates planning for all types of transport, public and private, motorized and non-motorized. This integrated planning of city-wide transit measures needs to be well coordinated with the existing urban master plan, or strategic plan.

How does it work:

The 11 steps of Sustainable Urban Mobility Planning

Example:

Urban Transport Policies and Packages

<table>
<thead>
<tr>
<th>Area of Activity</th>
<th>Basic Package Minimum requirements</th>
<th>Advanced Package Standard approaches</th>
<th>Deluxe Package Premium low carbon approaches</th>
</tr>
</thead>
</table>
| 1. Make roads people friendly | • Provide side walks  
• Reduce barriers such as bridges, underpasses and fences  
• Introduce speed limits  
• Provide bicycle lanes | • Establish pedestrian and bicycle short cuts  
• Diverse street environment  
• Trees along roads  
• Separated networks for bicycles and pedestrians (bicycle avenues) | • Public bicycle scheme  
• Shared space concepts |
| 2. Manage parking demand | • Prohibit side walk parking | • Replace minimum with maximum requirements for parking places for cars  
| | | • Provide minimum requirements for parking spaces for bicycles  
| | | • Pricing for existing parking places  
| | | • Reduce/limit parking demand  
| | | • Provide minimum parking requirements for number of parking places for cars  
| | | • Zero parking spaces for bicycles (except for special needs) in new developments  
| 3. Move to high quality public transit | • Make public transport clean and convenient  
| | • Increase speed through priority signalling | • Integrated ticketing / fares  
| | | • Information / marketing  
| | | • Green procurement of vehicles  
| | | • Bus-only lanes along high-density areas  
| | | • High quality interchange (Design of stations to have short transfer times)  
| | | • Level boarding, and off-bus/metro fare collection to speed up transit  
| | | • Comprehensive bus rapid transit system  
| | | • Urban rail network  
| | | • Full integration of public transport modes and with non-motorised transport  
| | | • Full integration with land-use  
| 4. Provide inclusive information | • Information campaigns | • Cooperation with companies (e.g. bike parking)  
| | | • Car-sharing schemes  
| | | • Bike-sharing schemes  
| | | • Car free days  
| | | • Travel information (Web 2.0)  
| 5. Reap the benefits of technological advancement | • Incentives to promote clean fuels and vehicles | • Use of Intelligent Transport Systems  
| | | • Green procurement for local fleets (buses, taxis, etc)  
| | | • Full prioritisation of public transport and non-motorised transport through priority signalling and ITS  
| 6. Change the role of cars | • Speed limits  
| | • Physical car restrictions to slow down speed (e.g. roundabouts, barriers) | • Reduce investments in car oriented roads  
| | | • Low emission zones  
| | | • Intelligent Transport Systems (ITS)  
| | | • Limitation of access to city centres  
| | | • Congestion charge  
| | | • Advanced city toll  
| 7. Reinvent mixed-used, high density cities | • Retain and reinvent dense urban fabric (mixed-use structures)  
| | • Forbid large retail and leisure facilities, that are not integrated in the settlement structure  
| | • Incentivize mixed-use city quarters (shopping, leisure, work, living) | • Land use regulation (e.g. restriction of greenfield shopping)  
| | | • Transit-oriented development (e.g. Curitiba developing in linear corridors along BRT)  
| | | • Green belts or corridors to keep dense areas (Hong Kong)  
| | | • Advanced integration of land-use and transport into planning  
| | | • Accessibility of public transit (maximum walking time to public transport station below 5 minutes)  

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The Future of Mobility in Cities: Multimodal and Integrated

Ten principles developed by international non-governmental organizations are designed to guide urban decision-makers toward the best outcomes for the transition to new mobility options.

1. **We plan our cities and their mobility together.** The way our cities are built determines mobility needs and how they can be met. Development, urban design and public spaces, building and zoning regulations, parking requirements, and other land use policies shall incentivize compact, accessible, livable, and sustainable cities.

2. **We prioritize people over vehicles.** The mobility of people and not vehicles shall be in the center of transportation planning and decision-making. Cities shall prioritize walking, cycling, public transport and other efficient shared mobility, as well as their...
interconnectivity. Cities shall discourage the use of cars, single-passenger taxis, and other oversized vehicles transporting one person.

3. **We support the shared and efficient use of vehicles, lanes, curbs, and land.** Transportation and land use planning and policies should minimize the street and parking space used per person and maximize the use of each vehicle. We discourage overbuilding and oversized vehicles and infrastructure, as well as the oversupply of parking.

4. **We engage with stakeholders.** Residents, workers, businesses, and other stakeholders may feel direct impacts on their lives, their investments and their economic livelihoods by the unfolding transition to shared, zero-emission, and ultimately autonomous vehicles. We commit to actively engage these groups in the decision-making process and support them as we move through this transition.

5. **We promote equity.** Physical, digital, and financial access to shared transport services are valuable public goods and need thoughtful design to ensure use is possible and affordable by all ages, genders, incomes, and abilities.

6. **We lead the transition towards a zero-emission future and renewable energy.** Public transportation and shared-use fleets will accelerate the transition to zero-emission vehicles. Electric vehicles shall ultimately be powered by renewable energy to maximize climate and air quality benefits.

7. **We support fair user fees across all modes.** Every vehicle and mode should pay their fair share for road use, congestion, pollution, and use of curb space. The fair share shall take the operating, maintenance and social costs into account.

8. **We aim for public benefits via open data.** The data infrastructure underpinning shared transport services must enable interoperability, competition and innovation, while ensuring privacy, security, and accountability.

9. **We work towards integration and seamless connectivity.** All transportation services should be integrated and thoughtfully planned across operators, geographies, and complementary modes. Seamless trips should be facilitated via physical connections, interoperable payments, and combined information. Every opportunity should be taken to enhance connectivity of people and vehicles to wireless networks.

10. **We support that autonomous vehicles in dense urban areas should be operated only in shared fleets.** Due to the transformational potential of autonomous vehicle technology, it is critical that all AVs are part of shared fleets, well-regulated, and zero emission. Shared fleets can provide more affordable access to all, maximize public safety and emissions benefits, ensure that maintenance and software upgrades are managed by professionals, and actualize the promise of reductions in vehicles, parking, and congestion, in line with broader policy trends to reduce the use of personal cars in dense urban areas.


**Literature / further information:**

**Tool GT 2: Emission assessment of low-carbon transport modes.**

**What this tool does:** This tool is very technical in nature, but it supports important policy decisions in favour of technology choices regarding investments in transport technologies. Its application is a specialist’s job, but the underlying principles are important.

**Steps for Data Collection and Development of Baseline, Impact Estimates, and Calibration over Project Lifetime**

Source: ITDP (see reference below).
How does it work:

### Emission factors

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Speed (km/h)</th>
<th>Fuel Type</th>
<th>Fuel Efficiency @ 50 km</th>
<th>CO₂ emissions factor per liter of fuel</th>
<th>CO₂ emissions per vkt</th>
<th>Average CO₂ emissions by vkt type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km/hour</td>
<td>Petrol</td>
<td>Diesel</td>
<td>kg CO₂/liter</td>
<td>kg CO₂/km</td>
<td>kg CO₂/km</td>
</tr>
<tr>
<td>Cars</td>
<td>22</td>
<td>99%</td>
<td>5%</td>
<td>100%</td>
<td>2.75/121</td>
<td>2.94/348</td>
</tr>
<tr>
<td>2-Wheeler</td>
<td>22</td>
<td>100%</td>
<td>100%</td>
<td>0</td>
<td>2.75/242</td>
<td>2.94/348</td>
</tr>
<tr>
<td>3-Wheeler</td>
<td>22</td>
<td>100%</td>
<td>100%</td>
<td>22</td>
<td>2.75/242</td>
<td>2.94/348</td>
</tr>
<tr>
<td>Taxi</td>
<td>22</td>
<td>30%</td>
<td>70%</td>
<td>8</td>
<td>2.75/242</td>
<td>2.94/348</td>
</tr>
<tr>
<td>Bus</td>
<td>22</td>
<td>100%</td>
<td>100%</td>
<td>1.8</td>
<td>2.75/242</td>
<td>2.94/348</td>
</tr>
<tr>
<td>LRT, MRT</td>
<td>22</td>
<td>100%</td>
<td>100%</td>
<td>6</td>
<td>2.75/242</td>
<td>2.94/348</td>
</tr>
</tbody>
</table>

Source: ITDP (see reference below).

### Calculating Direct GHG Emission Reductions for Transport Projects

1. **Does the activity in the project logframe include tangible installations?**
   - **No:** No direct reductions
   - **Yes:**

2. Sum of avg. annual GHG reduction from project activity

3. Average useful lifetime of investment in transport sector (years)

4. Secondary Direct Effects (totalled over a 20 yr. max. lifetime)

5. Lifetime Direct Reductions (for one activity)

6. Sum of all activity-level reductions

7. Total Direct Impact

Source: ITDP (see reference below).
Handbook of Emission Factors for Road Transport (HBEFA)

Framework to localise HBEFA

Emission modelling framework and formula

\[ \text{Emissions (kg)} = \sum_i \left( \text{Source Activity (VKT, km) \times Specific emission intensity (g/km)} \right) \]
Different national and international emission inventory models are being used in Europe and the USA including:

- Handbook of Emission Factors for Road Transport (HBEFA) for a number of EU countries
- COPERT for the EU and EU countries
- TREMOVE for the EU
- TREMOD for Germany
- MOVES for the USA
- EMFAC for California
- IVE for developing countries

HBEFA approach for development of country specific CO2 emissions in Europe (Source: INFRAS, 2013)
Literature / further information:


- GIZ [Shengyang Sun (GIZ), Martin Schmied (INFRAS), Daniel Bongardt (GIZ), Philipp Wüthrich (INFRAS), Urda Eichhorst (GIZ)]. 2015 (?). Modelling Urban Transport Emissions for Better Air and Climate Protection. Beijing. www.sustainabletransport.org


# Tool GT 3: Technologies for low-carbon transport.

**What this tool does:** This tool supports decision makers in their choices for low-carbon transport modes.

<table>
<thead>
<tr>
<th>Transport type</th>
<th>Low-carbon technologies recommended</th>
</tr>
</thead>
</table>
| **Public transport convenient and rapid** | Low-carbon or zero emission “clean” buses:  
- electric buses (from renewable sources)  
- trolley buses (electricity from renewable sources)  
- trolley and battery driven  
- methane gas technology  
- bio-diesel technology  
- gas (Liquified natural gas – LNG; or compressed natural gas - CNG)  
- fuel cell technology (or hybrid versions of fuel cells and batteries)  
Trams and urban trains:  
- electric trams (electricity from renewable sources)  
New Metro Systems – underground, overground, or mixed  
- electric metros (electricity from renewable sources)  
Supportive technologies:  
- intelligent information management systems for passengers  
- Intermodal exchanges between public transit systems |
| **Private vehicular transportation** | Cars:  
- electrical cars (electricity from renewable sources)  
- electrical cars with gasoline back-up motor (hybrid model)  
- fuel cell technology (or hybrid versions of fuel cells and batteries)  
Motorbikes:  
- Electro-bikes (electricity from renewable sources)  
Supportive technologies:  
- Carsharing  
- Bike sharing |
| **Non-motorized transit** | Bicycles  
- conventional bicycles (non-motorised)  
Walking |

Source: EC-Link
How does it work:
The following tables provides an overview of travel impacts, and greenhouse gas (GHG) reductions, and the relevance of these options for Chinese cities.

Table 2: Transport Demand Management

<table>
<thead>
<tr>
<th>Sustainable Urban Transport Policies</th>
<th>Travel impacts and GHG reduction</th>
<th>Relevance to Chinese cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public transit service improvements</td>
<td>Increases modal share of public transit and reduces car-driving for all travel purposes GHG reduction most effective, if implemented city-wide</td>
<td>Almost all Chinese cities upgrade their public transit systems. But in many of them, the overall travel-chain from-door-to-door does still not provide high levels of convenience.</td>
</tr>
<tr>
<td>Walking and cycling improvements (non-motorised transport)</td>
<td>Increases modal share of walking and cycling for short distance trips (up to 5 km) and reduces car-driving for all travel purposes GHG reduction especially high, if implemented in mixed-use city quarters or as feeder to public transit</td>
<td>Traditionally non-motorised modes were strong in China. Currently walking and cycling lack a positive image in society and infrastructure for bikes has been reduced. However, it is still better than in many other countries and there is a strong trend toward electric bikes.</td>
</tr>
<tr>
<td>Corporate Mobility Management programmes</td>
<td>Reduces automobile travel especially for commuting GHG reduction especially high, if major employers participate</td>
<td>Many employers in China do not yet apply corporate mobility programmes. A growing number of Chinese companies develop environmental or sustainability strategies.</td>
</tr>
<tr>
<td>Parking management and pricing</td>
<td>Reduces automobile travel GHG reduction most effective, if implemented city-wide and high quality public transit systems are in place</td>
<td>Parking is a key challenge in many Chinese cities. First steps have been taken but it still is a long way to comprehensive parking strategies. The growing numbers of automobiles require urgent action.</td>
</tr>
<tr>
<td>Efficient road pricing</td>
<td>Reduces urban-peak automobile travel, especially for commuting GHG reduction highly depending on zone where applied</td>
<td>Congestion pricing is so far not implemented in Chinese cities. There might be some potential in very congested areas, especially if combined with vehicle restrictions.</td>
</tr>
<tr>
<td>Vehicle restrictions</td>
<td>Reduces automobile travel in certain times or areas GHG reduction highly depending on time when or zone where applied</td>
<td>Many Chinese cities have experience with vehicle restrictions that are increasingly connected to fuel types (e.g. exemptions for EVs)</td>
</tr>
<tr>
<td>Smart growth land use policies</td>
<td>Shifts modes and reduces vehicle travel (VKT) simultaneously GHG reduction especially high in a long-term perspective of more than 10 years</td>
<td>Many Chinese cities are auto-oriented and separate living and working. Considering the rapid growth of urbanization (up to 15M people move to cities every year) such strategies are of utmost importance.</td>
</tr>
</tbody>
</table>

Rethinking the Street Space: Why Street Design Matters.

Source: [http://www.planetizen.com/node/39815](http://www.planetizen.com/node/39815)

A truly complete “Green” street

Source: [https://www.pinterest.com/pin/375980268873758500/sent/?sender=305682030866350581&invite_code=f6d340986382d68aba7369718252ae9](https://www.pinterest.com/pin/375980268873758500/sent/?sender=305682030866350581&invite_code=f6d340986382d68aba7369718252ae9)
Green Boulevard

Source: National Association of City Transportation Officials. “Global Street Design Guide”
https://www.pinterest.com/pin/495958977692572617/sent/?sender=305682030866350581&invite_code=e4ec13644752ba43261cd4292ae6f6b

Designing roads for Sustainable Transport - Public Transport, Parking and Cycle Lanes

Source: NATCO Urban Street Design Guide. “Global Street Design Guide”
https://www.pinterest.com/pin/548383692110860259/sent/?sender=305682030866350581&invite_code=90f8b48d82ea0b818839a45053a0648e
Roundabout design - Separated Bike Lanes. Visit the slowottawa.ca for detailed guides.

https://www.pinterest.com/pin/433964114077526651/sent/?sender=305682030866350581&invite_code=e7fa09669937da1c50b098341bc7c136

Literature / further information:

Tool GT 4: Planning for non-motorized transport.

What this tool does: Non-motorized Transportation (also known as Active Transportation and Human Powered Transportation) includes Walking and Bicycling, and variants such as Small-Wheeled Transport (skates, skateboards, push scooters and hand carts) and Wheelchair travel. These modes provide both recreation (they are an end in themselves) and transportation (they provide access to goods and activities), although users may consider a particular trip to serve both objectives. For example, some people will choose to walk or bicycle rather than drive because they enjoy the activity, although it takes longer.

How does it work:

There are many specific ways to improve non-motorized transportation:

- Improve sidewalks, crosswalks, paths and bike lanes.
- Correct specific roadway hazards to non-motorized transport – lack of signage, difficult level crossings, lack of traffic lighting.
- Reduce conflicts between users (pedestrians, cyclists, cars).
- Improve maintenance and cleanliness of cycle lanes.
- Design systems that accommodate people with disabilities and other special needs).
- Develop pedestrian oriented land use and building design.
- Increase road and path connectivity, with special non-motorized shortcuts, such as paths between cul-de-sac heads and mid-block pedestrian links.
- Street furniture (e.g., benches) and design features (e.g., human-scale street lights).
- Traffic calming, streetscape improvements, traffic speed reductions, vehicle restrictions.
- Plan and design roadways to increase walking and cycling safety.
- Safety education, law enforcement, promotion of cycling and walking.
- Integration of cycling with public transit.
- Parking facilities for bicycles.
- Manage security concerns of pedestrians and cyclists.
- Introduce and manage public, automated bicycle rental systems designed to provide efficient mobility for short, utilitarian urban trips.
- Build pedeways (“walkways”) which are indoor urban walking networks that connect buildings and transportation terminals.
- Create an information system (maps, digital application systems) to guide users to multi-modal transport systems which explain how to walk or cycle to a particular destination.


Examples:
Two-way protected cycle track
Source: Kittelson & Associates

Diagram of two-way cycle track
Source: NACTO Urban Bikeway Design Guide

Signal with push-button activator
Source: POC Inc. Engineers

Pavement markings indicating bicycle sensor location
Source: Kittelson & Associates

Literature / further information:

- Non-Motorized Transportation planning – Identifying ways to Improve Pedestrian and Bicycle Transport.
  http://vtpi.org/tdm/tdm25.htm


- Welle, B., Qingnan Liu, Wei Li, Adriazola-Steil, C., King, R., Sarmiento, C., and Obelheiro, Marta. 2017. Cities Safer By Design - Guidance and Examples to Promote Traffic Safety through Urban and Street Design.
  http://publications.wri.org/citiessafer/#c6 For full handbook, refer to:
  http://www.wri.org/sites/default/files/CitiesSaferByDesign_final.pdf (English version), and
5. WATER MANAGEMENT

(Water Supply, Waste Water Treatment, and Drainage and Flood Management)
Control and Management of water Pollution control is paramount to ensure sources is a complex task, even in water- water safety – Zhuhai rich cities – Zhuhai

Wastewater treatment Plan in Hefei

Wastewater treatment Plan in Hefei

Wetlands as part of the sponge city Neighbourhood flood management through concept – Luoyang natural drains – Xixi’an District, Xi’an

Source: F. Steinberg
Sector Profile of Water Management

Introduction. From a perspective of eco-city development, water supply cannot be limited to the simple supply of water in a specific location, its affordability or quality of service. From a perspective of resource efficiency, it is paramount to go beyond access to safe water – as a key requirements for safe and healthy living – towards maximizing the available water resources. Since drinking water has become a finite resource, the generation of water from non-conventional sources such as rainwater harvesting or recycling of water, i.e. the use of renewable and sustainable resource, will assume a new dimension in the future development of eco-cities. Rapid urbanization and climate change have impacted the quality of water resources and the patterns of supply and access. Demand-side issues involve more than just the provision of potable water: with increased population comes increased demand for water especially in the agriculture and industry sectors. There is a need to move from traditional water supply to non-conventional methods. Equally, waste water treatment, drainage and flood control need to be seen from their ecological dimension, and become part of an integrated system, or cycle.

State of Demand in China. Due to rapid and massive urbanization, water needs are increasing massively in China. Consumption levels have soared, particularly in cities and in better services new urban areas. However, the water supply situation is perturbed by water scarcity, and pollution and widespread contamination which has troubles many cities and the country side. There has been a big success in bringing piped water to the majority of households (about close to 100%), and even coverage of urban waste water treatment has reached high levels (about 90%). Water and waste water utilities are managed professionally and financially independent from city governments, but their fees are very low and they require subsidies for their operation. Much still need to be accomplished in the water sector, mostly in terms of making water drinkable on a 24 hours basis, and to provide full sewerage treatment coverage. The threat of increasing climate change impacts have led to the promotion of water conservation approaches under the ”sponge city” concept which aims at water harvesting, water recycling and reuse.

Policy Directions. The Government’s pronouncement of the 13th Five Year Plan objectives has stated for the water sector: effective control of water consumption.119
- **Build comfortable and livable environment.** Within 5 years … waste water shall be 100% collected and treated; for water deficient cities, the reclaimed water rate shall reach 20%.
- **Water Efficiency:** All buildings must have 100% adoption of cost-effective water saving appliances, and green spaces surrounding buildings must adopt low water-use plants. All water consumption should be metered and at least 20-30% of water supply must be recycled from either wastewater or rainwater.120
- **Smart Technologies can advance green development:** Save water through IoE technology and other water saving technology. Cities can improve water efficiency through smart storm and flood control equipment and water re-use.121

Best Practices in Europe. Water supply and sanitation in Europe is the responsibility of each member state, but in the 21st century union-wide policies have come into effect. Water resources are limited and supply and sanitation systems are under pressure from urbanisation and climate change, gradually there is a move for coordination. EU member states have

119 Extracted and translated from: [http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm](http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm)
enacted national legislation in accordance with these directives. The institutional organisation of public water supply and sanitation does not fall under the purview of the EU, but remains a prerogative of each member state. Today, water supply and sanitation work is guided by the concept of water safety plans. Recent development, related to climate change, like massive flooding, have triggered new concerns for green infrastructure, such as drainage, which traditionally have been addressed through hard engineering solutions (capture, redirection, and discharge).

State of the art in water management in Europe.

**Water supply.** The EU has developed an extensive portfolio of water initiatives, water strategies, legislation and guidance, research findings and other information. 122

**EU Water Blueprint for Water Security.** The water framework directive has been updated and focused on new water resource challenges by the EU Water Blueprint 2012. “The achievement of EU water policy goals is threatened by a number of old and emerging challenges, including water pollution, water abstraction for agriculture and energy production, land use and the impacts of climate change.” 123 The Blueprint encourages a move towards what we call ‘prevention and preparedness’. It will ensure a sustainable balance between water demand and supply, taking into account the needs of both people and the natural ecosystems they depend on. The EU reacted to the increased risk of drought with the following initiative and formal communication to Member States. The 2012 Water Scarcity and Droughts Policy Review led to the "Blue Print for Safeguarding European Waters". 124

**EU response to the European Drought of 2003.** Based on the periodical Follow-up results, assessment of the River Basin Management Plans and further information which has not been addressed so far, a Policy Review for water scarcity and droughts has been completed in November 2012.

**River Basin Management Approaches.** Integrated river basin management (IRBM) have been at the intellectual heart of the EU and Chinese approaches to water management, however, the maturity of approach and extent of application differ. The river basin approach is acknowledged in Europe as the best way to manage water.

**EU Water Framework Directive.** In 2000, the European Union took a ground-breaking step when it adopted the Water Framework Directive (WFD)125. It introduced a new legislative approach to managing and protecting water, based not on national or political boundaries, but on natural geographical and hydrological formations: river basins. These are known as River Basin Districts. IRBM needs clear coordination and collaboration between administrative authorities and stakeholders within the river basin. The WFD established a legal basis to protect and restore clean water across Europe and ensure its long-term, sustainable use. The general objective of the WFD is to make all water — for example, lakes, rivers, streams and groundwater aquifers — healthy. Through the WFD, establishes a key principle that all EU countries should move towards establishing ‘a full cost of water services’. This is the cost of abstracting water, treating it, pipe networks into the house and sewerage networks out. Also the cost of water treatment before discharge. The capital and revenue cost, plus borrowing costs must be taken into account in this ‘true cost of water service’. The EU-funded SWITCH

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The Integrated Urban Water Management (IUWM) concept has been launched by the Sustainable Water Improves Tomorrow’s Cities Health project. IUWM explicitly proposes a combination of new paradigms in water management. These include rainwater harvesting, recycling, and reuse of grey waters, as well as elements of low-impact development (LID), which is referred to as the “Sponge City” concept.

**Waste Water - The European Urban Wastewater Treatment Directive.** This directive, adopted in 1991, is the European Urban Wastewater Treatment Directive (91/271/EEC). It addresses the need to protect Europe’s groundwater, rivers, lakes, and seas from the impacts of poorly treated wastewater. The directive requires that all wastewater generated in areas with a population equivalent in excess of 2000 must receive at least secondary treatment. In addition, cities identified as being in vulnerable, or ‘sensitive’, areas face more stringent treatment requirements. The directive is closely related to the European Water Framework Directive (2000/60/EC), which requires that all waters in the European Union achieve good ecological status by 2015. Despite being introduced almost 20 years ago, the directive continues to pose a significant challenge for cities throughout Europe. In particular, the more stringent treatment requirements for big cities located in ‘sensitive’ areas are still a major issue and 50% of the load from these cities is still being discharged without adequate treatment.

**Flood Control - EU Floods Directive.** The core European policy position on flood risk is the EU Floods Directive. This directive provides a common approach to flood risk across the EU. It entered into force on 26 November 2007. This directive requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this directive, Europe also reinforces the rights of the public to access this information and to have a say in the planning process. The directive requires Member States to identify flood risk management practices in shared river basins, including with third countries, and to ensure that the flood risk in neighbouring countries is not increased. Member States need to take into consideration long-term developments, including climate change, as well as sustainable land use practices in the flood risk management cycle addressed in this directive. Approaches such as sponge-city, eco-city and Sustainable Urban Drainage Systems (SUDS) offer options to work with city planners to arrive at optimal and more sustainable solutions. However, in most cases, especially when applied to existing cities, these are in addition to conventional drainage infrastructure. There will always be a need to ensure public-health with the proper collection and treatment of sewage through large base remover sewage treatment plants.

**Centralized versus decentralized systems.** Many cities have become oriented towards “high-tech” solutions of centralized collection and treatment systems. Water supply on the one hand, and waste water collection (sewerage system) and treatment are two sides of the same coin. Urban areas which lack the necessary infrastructure to collect, treat, and dispose of wastewater face numerous human and environmental health problems. Environmental sanitation is necessary for proper management of urban environments and to improve and protect human health as well as the natural environment.

The majority of cities focus on centralised water supply and sewage collection networks. These are an essential part of city infrastructure and these major water supply and waste removal systems are the backbone of public health provision. These centralised systems are

usually developed and operated by municipalities, but in some countries these are privatized and operated by commercial organizations, with water charges being raised by the water companies to fund the provision. The trend is still to agglomerate water and sewage networks in order to optimize operation and reduce water charges. This is still the preferred model and commercial and competitive methods show this to be the case.

**Inadequate collection of waste water.** If sewerage networks are undersized or badly maintained then blockages and overflows occur. At worst this can cause sewer flooding and the backing up of sewage into households. Inadequate collection of waste water has a very strong impact on the natural environment. More so, the discharge of untreated effluent and industrial waste has strongly detrimental effects on the biology of watercourses and their ecosystem. Contaminated freshwater sources, degraded aquatic environment, and eutrophication through excessive nutrient discharge are all outcomes of poor wastewater and surface water management. Coupled with these challenges, inadequate drainage and preparedness for heavy rain events often means that wet season and instances of high rainfall are compounded by poor or absent solid waste management and exacerbate the challenges that cities face in managing water resources, as it impacted by through localized flooding, contamination of water resources (through effluent combined fresh water).

**Design Standard for Sewage Treatment Works and Networks.** The EU outlines the minimum standards for sewerage systems and sewage treatment works through the Urban Waste Water Treatment Directive 128. It is a fundamental guide to determine acceptable minimum standards for sewage systems. The EU Council Directive 91/271/EEC concerning urban waste-water treatment, was adopted on 21 May 1991. Its objective is to protect the environment from the adverse effects of urban waste water discharges and discharges from certain industrial sectors (see Annex III of the Directive) and concerns the collection, treatment and discharge of (i) domestic waste water; (ii) mixture of waste water; and (iii) Waste water from certain industrial sectors.

**Compliance with the EU Urban Wastewater Treatment Directive (UWWTD).** Compliance against the UWWTD standards is one indicator used across Europe. Member States must report this to the EU. 129

**EU Flood Action Programme.** Aligned with the Floods Directive is the EU Flood Action Programme 130. This preceded the Floods Directive and was important in shaping the approaches. Flood risk management aims to reduce the likelihood and/or the impact of floods. Experience has shown that the most effective approach is through the development of flood risk management programmes incorporating the following elements:

1. **Prevention:** preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land-use, agricultural and forestry practices;
2. **Protection:** taking measures, both structural and non-structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
3. **Preparedness:** informing the population about flood risks and what to do in the event of a flood;
4. **Emergency response:** developing emergency response plans in the case of a flood;
5. **Recovery and lessons learned:** returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population. 131

**Sustainable Drainage.** Traditionally speaking, climate adaptation seeks to lower the risks posed by the consequences of climate change, including flooding caused by extreme rain

events. However, when approached holistically it can also be used to address a number of other problems and create synergies to other areas of urban development. In this respect, Sustainable Urban Drainage Systems can play a key role in urban water management.

**The Precautionary Principle – EU definition.** The precautionary principle is detailed in Article 191 of the Treaty on the Functioning of the European Union (EU). It aims at ensuring a higher level of environmental protection through preventative decision-taking in the case of risk. However, in practice, the scope of this principle is far wider and also covers consumer policy, European legislation concerning food and human, animal and plant health. This Communication establishes common guidelines on the application of the precautionary principle. The definition of the principle shall also have a positive impact at international level, so as to ensure an appropriate level of environmental and health protection in international negotiations. It has been recognised by various international agreements, notably in the Sanitary and Phytosanitary Agreement (SPS) concluded in the framework of the World Trade Organisation (WTO).

**Recourse to the precautionary principle.** According to the Commission the precautionary principle may be invoked when a phenomenon, product or process may have a dangerous effect, identified by a scientific and objective evaluation, if this evaluation does not allow the risk to be determined with sufficient certainty. Recourse to the principle belongs in the general framework of risk analysis (which, besides risk evaluation, includes risk management and risk communication), and more particularly in the context of risk management which corresponds to the decision-making phase.

**Waste Water Treatment.** From the EU perspective, the focus is on continually improving methods and regulation that continuously drives innovation and new technologies. Overall the EU sets future targets in line with the evidence from the EEA and according to the EU Environmental Action Programme. Increasingly this follows an integrated approach, looking to optimise between Air, Land, Water and Waste, whilst preserving scarce natural resources.

**Energy Capture from Sewage Networks and Treatment Plants.** Digested sludge has been used to produce methane to power treatment works for many years. The processes are being progressively improved and optimized, in terms of the quality of the methane produced and the efficiency of the engines used to burn the methane. Sewage, water treatment and water pumping are energy intensive process so any methods to optimize this are important. These include, pump design, real time control systems and heat and energy recovery systems. The concept of carbon neutral STW is being developed, although none have yet reached this status. Significant development is continuing and this will be a major driver for future work, in terms of carbon reduction and cost saving.

**Diffuse Pollution Control.** One of the major challenges for environmental regulation is in addressing the sources and causes of diffuse pollution. Conventional engineering and permitting-based regulation works well for point sources of pollution, but has been ineffective at addressing diffuse sources such as pollutant runoff from agricultural practice, forestry, and urban hard surfaces. While in the EU there has been great progress in reducing point source pollution over recent decades, non-point / diffuse pollution, especially of nitrate and phosphorous from agricultural land, has generally remained stable or become worse. Awareness of this issue is often low with the majority of farmers not realising that they are major contributors to surface and groundwater pollution. There are often significant time lags between the application of fertiliser, pesticide or manures / sludge to land and its transport to rivers by surface or sub-surface routes. These will be dependent on weather, with site specific factors also affecting the pathways of pollutants to the receiving water.

**Nature-based solutions.** The EU has sponsored research on nature-based solutions as part of the EU innovation policy agenda. There is a growing awareness that nature can help to develop viable solutions which use and deploy the properties of the natural eco-systems, making them a new form of smart infrastructure systems, e.g. ‘engineering’ natural, ‘green’ and ‘blue’ solutions. These ‘nature-based solutions’ are designed to bring more nature and
natural features to develop cost-effective, sustainable solutions. Green infrastructure can contribute to cost reductions, to reduction in energy use, can help to reduce heat island effects (through green roofs, green walls, decreasing heating and/or cooling needs). Co-benefits include reduced air pollution, flood control, and recreation. An integrated eco-system approach can provide cost-effective solutions for urban sustainability and resilience. 132

Best Practices. The practice of green water management in Europe is evolving rapidly, aided by smart technologies. Some of the most well-known European green water management experiences can be found in the following cities:

• **Copenhagen, Denmark:** Rain water Harvesting. The Danish project “The Soul of Nørrebro” won the Nordic Council of Ministers’ Nordic Built Cities Challenge. The challenge is aimed at the development and visualization of Nordic innovative solutions for livable, smart and sustainable cities. 133

• **Cardiff, United Kingdom:** How a polluted bay became one of Europe’s best water fronts. To clean up the bay, the strictest environmental standards were applied — and still are. Diverting raw sewage to be treated before reaching the bay. Cardiff’s transformation isn’t complete. But it’s a far cry from the scenes of polluted desolation that gripped this place a generation ago. 134

• **United Kingdom:** engaging water customers in water saving. The concept of ‘push’ is about setting standards for water-using devices. ‘Pull is about rewarding customers for using water wisely, and ‘Nudge is about understanding consumer behaviour and using it to promote change. 135

• **Stockholm, Sweden: Waste Water Treatment Plant.** Henriksdal wastewater treatment plant serves approximately one million people, and operated by the Stockholm Water Company. The facility is one of the world’s biggest underground WWTP. The project will enable the city to meet the effluent requirements set under the Baltic Sea Action Plan (BSAP) and EU water directive. 136

• **EU: Sludge to power – Converting Human Waste to Power.** There are thousands of sewage sludge digestion and biogas plants in Europe. However, properly integrated urban waste management schemes are rarer. The approach is an important for integrated solutions that have higher financial rates of return to the operators. These approaches will allow Local government to let Private Partnership contracts that will allow the construction of infrastructure for low carbon and sustainable solutions that are financeable in the long term even where public finances are severely indebted. 137

• **London, United Kingdom: Thames water – Struvite / Phosphate Recovery.** A state-of-the-art nutrient recovery facility that removes struvite, a compound containing phosphorus and ammonia, from sewage at Slough sewage works, turning it into premium-grade fertilizer. 138

• **Berlin, Germany: Switching to Digital Control Technology in a Waste Water Treatment Plant.** During its 20-year service life, Teleperm M enabled the reprocessing of 220 million m³ of wastewater per year at the Berliner Water Company’s wastewater treatment plants. The 104 automation systems have now been converted to the Simatic PCS 7 process control system, thus ushering in a new era at one of Europe’s largest water supply and waste disposal companies. 139
• **Rotterdam, Netherlands: Resilient Rotterdam – Ready for the 21st Century.** In 2030, Rotterdam will be a city where climate adaptation has penetrated into mainstream of city operations and water has added value for the city, the water management system is cyberproof. 140

• **London, United Kingdom: Sustainable Urban Drainage Management (SUDs).** SuDs provides an assessment of the capacity of urban areas, either already built or in the design phase, to be adapted to deliver better urban drainage responses and act as “Sponge Cities” for enhanced water resource utilisation and better water quality. 141

**State of the art in water management in China.**

**Water Use.** The McKinsey Report “Preparing for China’s Urban Billion” concludes that: ‘Water Use is very likely to be a severe challenge, particularly for the Mega-cities in the North that will need water transfer projects to meet their needs. However, it is fair to note that most water consumption will still be in agriculture.’ The McKinsey Study has demonstrated that urban water use is only 4.1% of the overall water available. The challenge will not be the matching of demand and supply, but rather the geographical imbalance. 142 The Ministry of Water Resources estimated the annual water availability per person as 2,000 m3 which is only about 25% of the world’s per capita average. 143 Due to continued population growth, the per capita availability of water is expected to drop to 1,700 m3 by 2030, due to continued population growth. 144 China could save up to 40% of its water if water-saving measures were introduced, for instance dealing with leakages in the distribution system.

**Water availability.** On a per capita basis, China’s water availability of 2,114 m3 per person (2003-2007) is very low, suggesting the potential for water stress as demand for usable water rises with growth in population and per capita income. Water pollution has further contributed to water shortages. To deal with the water shortages, the need to recycle water through more reliable and cost-effective waste water and sewerage treatment, and more appropriate sewerage wastewater charges. 145 146

**Water price.** It should be noted that China’s business and domestic water price is far below a real cost, providing no incentive for water saving. Water tariffs in China are exceptionally low, with a cost of $0.5/m3, which ranks very low in an international comparison.

Access to an improved water source and improved sanitation has increased significantly in China over the past two decades in parallel with economic growth. Between 1990 and 2008 alone more than 450 million Chinese gained access to an improved water source, based on estimates by the Joint Monitoring Program for Water Supply and Sanitation of the WHO and UNICEF that are based on household survey data. Access to an improved water source was 89% and access to improved sanitation was 55% in 2008. Having access to an improved

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140 [http://www.100resilientcities.org/page/-/100rc/pdfs/strategy-resilient-rotterdam.pdf](http://www.100resilientcities.org/page/-/100rc/pdfs/strategy-resilient-rotterdam.pdf)
141 [http://www.thameswater.co.uk/about-us/2833.htm](http://www.thameswater.co.uk/about-us/2833.htm)
water source, however, is not the same as having access to safe water. Many of those who have access to adequate infrastructure suffer from poor water quality due to faecal contamination; high levels of naturally occurring fluoride, arsenic, or salts; and growing industrial and agricultural chemical pollution. Furthermore, seasonal water shortages occur.

**Waste Water Treatment.** 147 According to statistics, 639 cities in China had flood control works, of which the cities with the flood control standard less than that of 10 years frequency accounted for 15.6%, and of which 403 cities did not meet the flood control standards stipulated by the state. The drainage facilities were not complete, and rainstorm waterlogging was an increasing prominent problem. In 2012, 184 cities in China were water flooded or waterlogged, and the mega cities, such as Beijing, Chongqing and Tianjin, suffered the most.”

The “Regulation on Urban Drainage and Sewage Treatment (herein after referred to as the Regulation), released according to Order of the State Council (No. 641), came into force on January 1, 2014. The Regulation … standardizes the planning, construction, maintenance and protection of urban drainage and sewage treatment facilities, and defines the legal responsibility of the relevant action entities. The Regulation proposes that urban drainage and wastewater treatment should follow the principles of respecting the nature, overall planning, construction of supporting facilities, safety, and comprehensive utilization, to embody the concept of ecological civilization and sustainable development. In order to solve the funding gap, it is especially stipulated in the Regulation that the state encourages franchising and government procurement of services and some other forms to attract social capital to participate in the investment, construction and operation of urban drainage and sewage treatment facilities.” 149

**Massive Programme for Wastewater Treatment.** Over the past 20 years, China has engaged in what is possibly the largest program to build wastewater treatment plants in history. Despite the substantial achievements of this program, many challenges remain. As per the 13th Five-Year Plan, sewerage processing capacity in cities reached 91% in 2015, and it is projected to reach 95% by 2020.

**Water Pollution.** In April 2015, the government declared that will wage a war against water polluting industries. This was declared in spite of fears that local governments and industries would oppose the move towards more environmental control of polluting industries, due to cost increases. This move will mean the levying of heavy fines for polluters, and the threat of eventual shut-down of industries. The government is convinced that positive impacts of greener and cleaner industries will eventually translate into a tremendous growth as the iron and steel making industries will become internationally competitive, and that benefits reaped could be in the order of 5.7 trillion RMB ($910 billion), in the industrial sector, and 3.9 million non-rural jobs. 150 The Action Plan for Water Pollution wants to contribute to make more than 93 % of water drinkable. Factories which are too weak to comply with these regulations will be shut down from 2016 onwards. From 2016 onwards, the government planed to establish a blacklist of polluters. The amount of black and smelly water in urban areas will be reduced to 10% by 2020, and should largely disappear by 2030, according to this Action Plan for Water Pollution. To reach these goals,
outdated production capacity will be phased out in water polluting industries, the efficiency of water use will be increased, and market forces will be allowed to further optimize water consumption. The greening of the water sector is considered to become a possible additional engine of economic growth.

**Surface Water and Flood Control.** In recent years, heavy rains, floods and gradually evolved into a chronic disease of large and medium cities. Today, 99% of Chinese cities are in the fast discharge mode. Rainfall on the hardened, impermeable ground only relies on fast discharge through pipes. When there are strong rains, quickly it is obvious that under-dimensioned pipes are not enough.

Many of the cities do have serious shortcomings in water supply, but rain water is usually just quickly drained away. **Sponge City Initiative.** China has developed a strategic initiative to reduce surface water flooding and improve water resource security. It is known as the Sponge City initiative. The sponge City initiative aims to show that urban drainage and water shortages could be turned around to harvest this wealth of the existing water resources. Thus, the concept of the sponge city, is an analogy of ecological water management: rainfall can be absorbed locally or nearby, be saved in storages, infiltrated, purified, and used water can be fed back into the groundwater after (decentralized) cleaning. The concept will allow improved regulation of the water cycle: in drought when water is in short supply, it can be released, and it can be stored when in oversupply. The construction of sponge cities implies a reversal of concepts. Traditional city-building has used too many hard surfaces with fast run-offs of water. At the time of rain, this relies on drainage infrastructure, pumping stations and other "grey" facilities for drainage which mean to eliminated water excess rapidly, instead of being conducive to its usage.

Eco-city development should give emphasis to soft surfaces (permeable surfaces), such as grass, rain gardens, sunken green spaces and other "green" measures to organize drainage to slow the draining and release, of water. It suggests decentralized control of the water and waste water.

The physical implications of the "sponge city" concept would be a series of water bodies - rivers, lakes, ponds, green spaces, gardens, permeable pavements, and cavernous underground structures for water storage. While this concept may be feasible in new districts ("greenfield” development), in urban renewal ("brownfield” development) it is more complicated and costly to introduce, as observed by the China Academy of Urban Planning and Design. Nevertheless, there exist ideas about the application of the sponge concept in historically grown built environments, through rain gardens, sunken green, combined roads-cum-green belts, permeable paving, and green roofs.” Business as usual is no longer the way to think about urban water. An integrated water management approach is, from an overall perspective, the most cost-effective route in dealing with urban water and climate challenges.

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154 Department of Housing, Urban and Rural development, Promoting the "sponge city" : The next big rain again will not "see the sea" http://www.enews163.com/2014/11/03/department-of-housing-and-promoting-the-sponge-city-the-next-big-rain-again-will-not-see-the-sea-89687.html
### Proposed Water Management Key Performance Indicators (KPIs)

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Water quality at centralized source reaches standard [2]</td>
<td>100% [2]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100% [1]</td>
<td></td>
</tr>
<tr>
<td>4 Water from taps with drinking water quality [1]</td>
<td>100%</td>
<td>immediate</td>
</tr>
<tr>
<td></td>
<td>100% [3]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤8 % [5]</td>
<td></td>
</tr>
<tr>
<td>6 Rate of reuse of reclaimed water (%) [2]</td>
<td>In water-scarce areas ≥25%; in areas without water scarcity ≥15% [2]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥60% [6]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water deficient cities: ≥20% [7]</td>
<td></td>
</tr>
<tr>
<td>7 Domestic water consumption [1]</td>
<td>≤ 120 liters / day.pers.[1]</td>
<td>By 2013 [1]</td>
</tr>
<tr>
<td>8 Water supply from non-traditional sources [1]</td>
<td>≥50% [1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-30%[4]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥85% [18]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥10% [5]</td>
<td></td>
</tr>
<tr>
<td>9 Water permeability of surface areas [8]</td>
<td>≥50% [8]</td>
<td></td>
</tr>
</tbody>
</table>

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These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. Sino-EU Key Performance Indicators for Eco-Cities. Beijing (unpublished draft).
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Grey water treatment and reuse</td>
<td>50%</td>
</tr>
<tr>
<td>13</td>
<td>Sponge city infrastructure contributes to water harvesting</td>
<td>30% of water supply</td>
</tr>
<tr>
<td>14</td>
<td>Drainage and sponge city measures eliminate urban flood events</td>
<td>100%</td>
</tr>
</tbody>
</table>

Sources:

Outlook and future sector agenda. Water supply needs to be linked to city master plans. For this Chinese cities will need to develop long term water strategic plans taking into account supply and demand balance and options to reduce risks. Quality water supply needs to be planned for, costed (based on a cost-recovery concept) and required infrastructure be developed in a phased manner. Through regulation cities need to ensure that water is not polluted and is fit for use.

Provision of high quality sanitation for all – in homes and through public toilets in the interim, will require an assessment of current infrastructure and sewerage systems, especially combined sewer overflows and foul sewage discharges. The old practice of untreated discharges will have to come to an end. At the same time, municipal sewage treatment has to take into account provision and future need of improved water resources and environmental clean-up. Ecological monitoring programmes need to be created which cover water sources, discharges and receiving environment. In the case of industrial pollution, the condition of water resources needs review, including rivers, their impacts on city systems (upstream and downstream). Much more needs to be done to monitor and enforce regulations and permits. The environmental protection and improvements to water resources should be considered: biological and fish monitoring can be used as public focus for water resource improvement. Improvements to recreation, in and near water and possible bathing waters.

For integrated drainage and flood control, cities need to ensure that new development plans incorporate sponge city concepts and water sensitive design. This links into cities’ climate change adaptation strategies. They need to take into account changing weather patterns, sea level rise and population growth, and have to consider flood mitigation and the use of ‘making space for water’ options. River restoration and ‘soft’ engineering will improve habitat potential for citizens and wildlife.
There is increasing need to engage stakeholders in the water planning process. Engage other Ministries especially Ministry of Water Resources and Ministry of Environmental Protection as they have responsibilities for elements of water planning and delivery. Engage key business and property developers, also community leaders and general public. Will need to develop knowledge and capability in the city planning department and key stakeholders to achieve this.

For the sake of financial sustainability, a key objective will be to move away from the dominant subsidy culture, and strengthen water economy. There is considerable potential to utilise economic instruments and incentives to assist change. They must be used to complement good regulatory practice and to reinforce change. Water should be self-financing and a goal should be to move towards society paying full cost of water service. Water tariff structures can reduce demand and waste. Inward investment may help finance and mechanisms to assist in expensive and core infrastructure provision may be needed. Cities can consider privatisation and other financing mechanisms. Benefits assessment methods and understanding will assist in developing the business case, but not all can be monetized.

Lastly, staff development and capacity building are fundamental to implement this approach of modernisation of the water sector.

What this tool does: This tool supports decision makers in development of Water Safety Plans. Water Safety Plans are increasingly a key element of reducing risks to drinking water, ensuring drinking-water quality from catchment to the consumer. A Water Safety Plan (WSP) is the most effective way of ensuring that a water supply is safe for human consumption and that it meets the health based standards and other regulatory requirements. It is based on a comprehensive risk assessment and risk management approach to all the steps in a water supply chain from catchment to consumer.

How does it work:
The overall goal in water safety plans is the provision of safe, reliable and affordable supply of sufficient quantities of water for all.

Components of Water Supply Services

There is a key difference between a conventional or an integrated approach. The integrated approach is supposed to achieve better performance:

- Increased supply will be possible even in an environment of difficult demand.
- Freshwater supply will in future consist of a mix of freshwater and alternative sources.
- Improved treatment technologies will be used, and be complimented by control of pollution at source.
Conventional or Integrated Approach to Water Supply

<table>
<thead>
<tr>
<th>Aspect of water supply</th>
<th>Conventional approach (supply driven)</th>
<th>More integrated approach (demand driven)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply-demand balance</td>
<td>Increased demand is met through investments in resources and infrastructure to increase supply</td>
<td>Options to reduce demand, harvest rainwater and reuse</td>
</tr>
<tr>
<td>Treatment</td>
<td>Treatment technologies are improved in line with the type of pollutant that needs to be removed</td>
<td>Pollution control at the source and natural pre-treatment techniques are sought before new technologies are invested in</td>
</tr>
<tr>
<td>Leakage reduction</td>
<td>Leakage detection and repair is driven by economic factors</td>
<td>Leakage detection and repair is driven by economic, social and environmental factors</td>
</tr>
<tr>
<td>Pricing</td>
<td>Users are charged for water based on a fixed cost or, if available, the recorded volume they use</td>
<td>Users can be charged based on tariff systems that account for different volumes of use, purpose of use, season, etc.</td>
</tr>
<tr>
<td>Resource planning</td>
<td>Predicted resource availability is based on past hydrological records</td>
<td>Predicted resource availability includes adjustments for different climate change scenarios</td>
</tr>
<tr>
<td>Demand forecasting</td>
<td>Future water demand is forecast using historical trends, demographic estimates and projected economic growth</td>
<td>Future water demand is forecast by analyzing future end uses in different sectors and is acknowledged as being uncertain</td>
</tr>
<tr>
<td>End use requirements</td>
<td>Water of potable quality is supplied for all uses</td>
<td>Water of potable quality is provided only for uses that require it. Alternative sources are sought for non-potable demand</td>
</tr>
</tbody>
</table>


Examples of application:

Additional benefits are:

- More efficient treatment of drinking water: Control of pollutants and the use of natural systems (such as riverbanks) to produce water of drinking standard.
- Economic savings: Reducing water demand results in less water to be treated and distributed. Savings in chemical and energy costs.
- Environmental protection and enhancement: reduced demand will result in less water to be extracted from the natural environment. It will help to maintain or restore ecosystems and natural watersheds.
- Improved services: Reduced demand and the use of alternative supplies relieve pressure on resources such as reservoirs and aquifers that may be scarce during dry periods. This reduces risks of water restrictions and supply interruptions for households, businesses and industry.
- Reduced carbon emissions: managing demand and source pollution will result in less energy consumed for the abstraction, treatment and distribution of water. This reduces use of non-renewable energy.
- Flood control: the collection of rainwater from roof surfaces for non-potable water supply reduced the volume of runoff that has to be managed by a city’s drainage system. Reduced downstream flood and erosion risks.
- Reduced volume of wastewater: Low-flush toilets and grey water reuse for non-potable purposes reduces the volume of wastewater to be collected and treated. This improves the performance and economic efficiency of the waste water process.

- Greater resilience: Uncertainty surrounding future demand and availability of supplies complicate decision-making for water supply investments. Solutions that target demand reductions and the use of alternative sources rather than resource development and infrastructure expansion make it easier to cope with inaccurate forecasts and predictions.

Literature / further information:

Tool WM 2: Waste Water Options.

What this tool does: This tool supports decision makers to make right choices for waste water treatment in their cities. There exist conventional centralized systems, and non-conventional decentralized systems. The comparison of the systems indicates that non-conventional methods can increase the potential for water-use for non-potable purposes, can make available sludge nutrients for fertilizer and biogas, and generate energy from waste water.

How does it work:

Conventional Waste Water Treatment

Comparison of Conventional with Integrated Waste Water Treatment Options

<table>
<thead>
<tr>
<th>Aspect of wastewater management</th>
<th>Conventional approach (wastewater management as a linear process)</th>
<th>Integrated approach (wastewater management as a cyclical process)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>Facaces, urine, greywater and stormwater are combined and conveyed through an expensive sewer network to a centralised treatment facility.</td>
<td>Facaces, urine, greywater and stormwater are collected separately and managed close to the source.</td>
</tr>
<tr>
<td>Treatment</td>
<td>Centralised treatment of combined wastewater elements based on energy- and chemical-intensive infrastructure and technology.</td>
<td>Separate wastewater elements are treated using innovative, decentralised technologies and natural systems.</td>
</tr>
<tr>
<td>Treated effluent</td>
<td>Treated effluent is discharged downstream to receiving water bodies such as rivers, lakes and estuaries.</td>
<td>Treated effluent is reused locally for non-potable water supply purposes.</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Nutrients are disposed of in the environment through discharged effluent and sludge.</td>
<td>Nutrients are recycled and reused locally through the recycling of urine and creation of biosolids from faecal sludge.</td>
</tr>
<tr>
<td>Sludge by-product</td>
<td>The sludge by-product is disposed of in landfill or through incineration.</td>
<td>Sludge is digested to create biogas and converted to biosolids for use as fertiliser and soil conditioner.</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>Large amounts of energy are used for treatment and pumping.</td>
<td>Energy consumption is minimised through the use of natural treatment processes.</td>
</tr>
</tbody>
</table>


The impact of the use of non-conventional methods to waste water treatment is:

- Increased access to sanitation for all.
- Water savings.
- Flexibility to population growth and urbanization.
- Recycling of plant nutrients.
- Financial savings.
- Employment generation.
- Energy recovery.
- More cost-efficient treatment through decentralised methods.
- Urban biodiversity and amenity.

Example:

The sewage treatment process can be describes by the following stages:
Stage 1: Catchment area/ Sewerage System
Stage 2: Inlet and Screening
Stage 3: Primary Treatment
Stage 4: Secondary Treatment
Stage 5: Tertiary Treatment
Stage 6: Sludge Treatment
Stage 7: Energy Recovery
Stage 8: Sludge Recycling
Simplified Sewage Treatment Works Processes

Examples of Waste Water in the Urban Water Cycle

Wastewater and stormwater management
In many cities stormwater collection is linked to wastewater management through combined sewer systems. Heavy rainfall increases the volume of water needing to be treated and can result in overflows from the system. This causes untreated sewage to be released to the environment.

Wastewater and domestic water consumption
Household water use is directly related to the volume of wastewater to be treated. Rising consumption through the installation of high water use appliances increases the volume of wastewater to be treated while reducing the concentrations of human waste within it.

Wastewater and water quality
Treated effluent discharged from centralised wastewater treatment works typically contains high levels of nutrients causing an increase in algal blooms in receiving water bodies. Poorly treated discharges and overflows of untreated effluent can also cause severe pollution to ground and surface water resources. In many occasions this same water is reabstracted downstream for potable uses.

Wastewater and non-potable water supply
Wastewater (treated and untreated) is a cheap source of non-potable water that may be used for supply purposes. Greywater and treated effluent can be reused for irrigation, industrial uses, toilet flushing and to recharge aquifers. Wastewater reuse is particularly valuable in cities that suffer from water scarcity and drought.

Literature / further information:

• SWITCH. Training Kit – Integrated Urban Water Management in the City of the Future. Module 5-Waste Water - Exploring the Options.
Tool WM 3: Sponge City Planning.

What this tool does: This tool represents an interdisciplinary approach to low-impact development (LID) in cities. The management of rain waters, drainage and flood control through hydraulic engineering and ‘water architecture’ has been labelled in China as the ‘sponge city’ approach. It represents the intention to maximise the use of water, and to recycle and reuse it for non-potable purposes. This tool consists of a series of engineering and architectural elements which are used at surface levels or as underground installations. Sponge City planning – as a “water sensitive urban design” – is a concept that aims to integrate urban water management, particularly stormwater, into modern urban design and landscape planning.

Stormwater Flows and the Urban Environment

How does it work:

The sponge city planning approach perceives stormwaters as a resource:

Water catchment or harvesting ("non-conventional water sourcing") can increase the available water sources in urban areas. These waters can be utilized – after proper treatment – for potables usage.

Otherwise, stormwater can be recycled and be reused for non-potable purposes for toilets, for gardens and public green areas.

A set of physical design makes use of this resources for urban irrigation. Detention ponds and lakes can serve as catchment and storage areas.

Examples:

<table>
<thead>
<tr>
<th>Alternative approach – stormwater as a ‘resource’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater is attenuated and retained at source allowing it to infiltrate into aquifers and flow gradually into receiving water bodies</td>
</tr>
<tr>
<td>Stormwater is treated using decentralised natural systems such as soils, vegetation and ponds</td>
</tr>
<tr>
<td>Stormwater infrastructure is designed to enhance the urban landscape and provide recreational opportunities</td>
</tr>
<tr>
<td>Urban ecosystems are restored and protected through the use of stormwater to maintain and enhance natural habitats</td>
</tr>
<tr>
<td>Stormwater is harvested for water supply and retained to support aquifers, waterways and vegetation</td>
</tr>
</tbody>
</table>

Source: SWITCH (see below)

Literature / further information:

6. SOLID WASTE MANAGEMENT
Proper closure of (sanitary) landfills is complicated and a major environmental issue – Zhuhai

Recycling of waste products - Fly-ash serving as base materials for construction materials – Zhuhai

Traditional labour-intensive neighbourhood waste collection – Zhuhai

Modern waste compacting station – Zhuhai

Waste cardboard recycling – Dongcheng District, Beijing

Plastics recycling – Wangfujing area, Downtown Beijing

Source: F. Steinberg
Sector Profile of Solid Waste Management

Introduction. Solid waste management refers to the collection, transfer, and disposal of waste. Eco-cities’ solid waste management should adopt the 3R approach - reduce, recycle, and reuse. As cities develop and increase their waste collection coverage, they graduate from disposal of waste via landfills and composting facilities, to increase recovery of recyclables. On a higher technology level, cities operate waste-to-energy (WTE) plants. The composition of waste from various generators and the availability of conventional or new technologies is critical for the establishment of city level waste management schemes.

State of Demand in China. Despite the relatively high capital cost of WTE, the central government of China has been very proactive with regard to increasing WTE capacity. One of the measures brought in provided a credit of about $30 per MWh of electricity generated by means of WTE rather than by using fossil fuels. The term ‘harmless treatment’ in China describes conventional solid waste management practices: the disposal of municipal solid waste by recycling, composting, WTE and sanitary landfilling. The ‘harmless treatment’ rate is defined as the percentage of the weight of total municipal solid waste treated with these methods. The generation of municipal solid waste, and also the ‘harmless treatment’ have been increasing over the past 30 years in China. Most of the air pollution control systems built in the Chinese WTE plants are based on US technology. A potentially major problem of the incinerators are high dioxin emissions, and abatement techniques are often not well known.

Policy Directions. The State Council issued a roadmap for city development which mentioned solid waste management as part of ‘complete urban services’.157

- **Build comfortable and livable environment.** Within 5 years, set up the system of collection and reutilization of kitchen and building waste. Until 2020, in all cities above prefecture level, waste water shall be 100% collected and treated.

- **Waste Management:** All buildings should have waste classification facilities. All household waste must be sorted and collection of hazardous waste must be prioritized. At least 30-50% of waste should be composted and 35-50% recycled or reused.158

- **Smart waste management.** Smart Technologies can advance green city management: smart technologies can improve waste flows and contribute to the implementation of integrated waste management practices.159

Best Practices in Europe. Europe currently uses 16 tons of material per person per year, of which 6 tons become waste. Although the management of that waste continues to improve in the EU, the European economy currently still loses a significant amount of potential 'secondary raw materials' such as metals, wood, glass, paper, plastics present waste streams. In 2010, total waste production in the EU amounted to 2.5 billion tons. From this total only a limited (albeit increasing) share (36%) is recycled, with the rest landfilled or burned, of which some 600 million tons could be recycled or reused. Just in terms of household waste alone, each person in Europe is currently producing, on average, half a ton of such waste. Only 40% of it is reused or recycled and in some countries more than 80% still goes to landfill. Turning waste into a resource is one key to a circular economy. The objectives and targets set in European legislation have been key drivers to improve waste management, stimulate innovation in recycling, limit the use of landfilling, and create incentives to change consumer behaviour. If we re-manufacture, reuse and recycle, and if one industry's waste becomes another raw

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157 Extracted and translated from: [http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm](http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm)


material, we can move to a more circular economy where waste is eliminated and resources are used in an efficient and sustainable way.

**State of the art in solid waste management in Europe.** EU Directives must be seen as minimum requirements. Every member-country is obliged to implement the EU Directives in their national law.\(^{160}\)

**Waste Framework Directive.** The EU Directive 2008/98/EC\(^ {161}\) sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery for the EU Members States. It explains when waste is considered to be waste and when it becomes a secondary raw material, and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU member states shall apply as a priority order the waste management hierarchy.\(^ {162}\)

The European Commission has also published “Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste”. This guidance document is intended to assist both national authorities and economic operators with the aforementioned legislation, which includes some guidelines in implementing the Directive on national level\(^ {163}\). The European Union’s approach to waste management is based on the "waste hierarchy" which sets the following priority order when shaping waste policy and managing waste at the operational level: prevention, (preparing for) reuse, recycling, recovery and, as the least preferred option, disposal. In line with this the 7th Environment Action Programme sets the following priority objectives for waste policy in the EU:

- To reduce the amount of waste generated;
- To maximise recycling and re-use;
- To limit incineration to non-recyclable materials;
- To phase out landfilling to non-recyclable and non-recoverable waste;
- To ensure full implementation of the waste policy targets in all member states.

The development and implementation of EU waste policy and legislation takes place within the context of a number of wider EU policies and programmes including 7th Environment Action Programme\(^ {164}\), the Resource Efficiency Roadmap\(^ {165}\) and the Raw Materials Initiative\(^ {166}\). The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. In order to give more long-term direction it sets out a vision beyond that, of where it wants the Union to be by 2050. The European Union does not quantify its strategy. It is the task of the member states to establish country targets.

The present Directive, which replaces EU Directive 2006/12/EC on waste and Directives 75/439/EEC and 91/689/EEC regarding waste oils and hazardous waste, respectively, introduces the "polluter pays principle" and the "extended producer responsibility and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition

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Municipal Waste Collection. When looking at the management of waste generated by households, the picture is more simple and clear although, even this system may vary across Europe. A municipality in EU is responsible for the handling of the waste generated by the households. The municipality can issue local directives, which defines the level of service, how the household shall sort and store waste before collection, and how the household shall pay for the service. According to EU is a municipality allowed to collect the household waste using their own vehicles and workers, if the vehicles and workers are organised as a department in the municipality, but if the work is organised in a municipal enterprise, the work shall be open for competition. Almost every municipality have today contracted their waste collection activities to private operators. The reason for doing so is, that the municipalities cannot afford to have municipal funds tied up in waste collection vehicles and containers, when the local investment budget also have to provide for schools, elderly care taking, etc. On the bottom line is the annual operation costs the same whether the task is organised by the municipality or tendered to a private operator when including financial costs like interests and depreciation.

Best Practices. The practice of green and smart solid waste management in Europe is evolving rapidly. Some of the most well-known European green waste management experiences can be found in the following cities and countries:

• **Denmark: Focusing on Resources in Danish Waste Management.** Cities in Denmark are preparing Municipal Solid Waste Management Plans as a part of the national strategy "Denmark without waste". These plans want to ensure that valuable materials are not lost. 167

• **Finland: Waste Collection Using Smart City Management Tools.** Based upon the data send from the individual waste container, the system can automatically generate collection schedules and optimise routes based several parameters (future fill-level projections, truck availability, traffic information, road restrictions etc.). Collection based this type of smart planning tools can significantly reduce costs, emissions, road wear, vehicle wear, noise pollution and work hours. 168

• **Lund, Sweden: Collecting four different Waste Fractions at once.** Domestic waste which has been separated at source is being collected using specially designed vehicles.

• **Denmark and Sweden: Vacuum Systems.** Both countries are pioneering vacuum collection piping systems, and vacuum collection vehicles. 169

• **Braunschweig, Germany: Material Recovery Facility.** This facility receives 120,000 tons of waste, annually. Its income is mostly from the sale of materials, a subsidy from the national recycling campaign (“Green Point”). 170

• **Denmark: Aiken Technology.** This technology is Denmark’s largest supplier of compost, growth media and turf care products. The system separates hydrolysis ("leaching out") and methane generation, the two main processes that constitute what is generally known as dry anaerobic digestion. 171

• **Copenhagen, Denmark: REnescience – a pilot project to decompose waste with enzymes.** This technology converts unsorted household waste to a bio-fluid that can be used to produce everything from biogas to bio-ethanol, electricity and heat. 172
• **Denmark: I/S Reno Nord – Incinerators.** I/S Reno Nord is treating MSW from 225,000 inhabitants from 7 municipalities in the northern part of Denmark. I/S Reno Nord is a partnership owned by the 7 municipalities. 173

• **Guldborgsund, Denmark: Sorting of Construction Waste.** Construction waste must always be sorted at the source - irrespective of volume - either directly on site or at a reception facility approved for the separation of construction and demolition waste. 174

• **Germany: Gasification – Waste to Energy.** The thermolytic cracking process ensures a very high energy utilisation of substantially not further treatable organic waste. The patent-secured INTEC Technology involves a closed and thus completely emission-free thermal waste treatment primarily consisting of the procedural steps degassing/smouldering (thermolysis) and gasification. The procedure achieves utilisation by more than 99 % of the energy content of the waste material applied. 175

**State of the art in solid waste management in China.** China is one of the largest nations in the world, encompassing a vast area, with diversified nationalities and cultures, and a very large population. It is also the largest developing country and which has relatively poor infrastructures and an underdeveloped industry. China has been undergoing a rapid urbanization, resulting in the enormous generation of municipal solid waste (MSW). In terms of municipal solid waste management, no country has ever experienced such a rapid increase or such large in MSW quantities that China is now facing. Along with this rapidly growing waste stream, MSW treatment technology has been improved, environmental legal framework has been established and developed, and public environmental awareness has also been promoted in the past three decades, although the MSW management in China still facing many challenges. 176

With rapid urbanization and urban residents accounting for more than half of the total population, China is experiencing rapid increase in solid waste generation and growing pressure for solid waste management in cities. The quantity of municipal solid waste collected and transported surged from about 31 million tons in 1980 to 157 million tons in 2009, and is projected to reach 585 million tons in 2030. As it is increasingly difficult to build more landfills and incineration facilities due to land scarcity and public concern, China has been exploring alternative approaches for solid waste management, including waste separation and recycling. However, the challenges to waste separation in Chinese cities include a lack of:

• adequate facilities for distinct transport, sorting and recycling;

• effective regulatory and policy instruments including financial incentive tools for waste minimization and recycling, and

• public awareness and participation in waste separation at source. 177

China recently surpassed the US as the world’s biggest municipal solid waste generator. In 2004, the urban areas of China produced approximately 190,000 tonnes of municipal solid waste. By 2030, this amount will increase to at least 480,000,000 tonnes. No country has ever seen as large or as rapid an increase in solid waste. The implications both for China and for the world are enormous.

174 www.guldborgsund.dk; http://www.guldborgsund.dk/
Critical issues are:

a) **Waste Quantities:** unsurpassed rate of growth in waste generation, dramatically changing composition, and minimal waste reduction efforts;

b) **Information Availability:** lack of reliable and consistent waste quantity and cost data makes planning for waste management strategies extremely difficult;

c) **Decision-Making Process:** lack of consistent policy and strategic planning toward technology selection, private sector involvement, cost recovery, inadequate public access and participation in the planning process;

d) **Operations:** facilities do not always meet design standards, particularly in pollution control, and facility operations are deficient, waste collection operations are often not rationalized;

e) **Financing:** inadequate cost recovery through user charges and tipping fees;

f) **Institutional Arrangements:** inadequate decentralization of collection and transfer services, inadequate municipal capacity for technology planning and private sector involvement, and inadequate clarity on mandates between government agencies, e.g. MOC and SEPA, and inadequate delineation between central and local government responsibilities;

g) **Private sector involvement:** The government’s goal of increased private sector participation in solid waste services is hindered by unclear and inconsistent ‘rules of engagement’, non-transparent purchase practices, non-sustainable subsidies, inadequate municipal cash flows, unclear and inconsistent cost accounting practices, and an unclear regulatory framework; and

h) **Carbon financing:** Increasing in importance in the Chinese MSW sector. China’s cities could generate as much as $ 1 Billion per year from sale of carbon emissions reductions, resulting from landfill gas recovery, composting, recycling, and anaerobic digestion.

### Proposed Solid Waste Management KPIs

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Domestic waste generation [1]</td>
<td>≤ 0.8 kg / day / person [1]</td>
<td>By 2013 [1]</td>
</tr>
<tr>
<td>2 Garbage collation ratio [2] - Household waste - Businesses, institutions - Other activities</td>
<td>100% [2]</td>
<td></td>
</tr>
<tr>
<td>3 Treatment to render hazardous and domestic solid waste non-toxic [1]</td>
<td>100% [1]</td>
<td>Immediate [1]</td>
</tr>
<tr>
<td>6 Waste conversion to energy [4]</td>
<td>% of total waste % of energy produced</td>
<td></td>
</tr>
</tbody>
</table>

Sources:

178 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. Sino-EU Key Performance Indicators for Eco-Cities. Beijing (unpublished draft)
Outlook and future sector agenda. Along with this rapidly growing waste stream, municipal solid waste treatment technology has been improved, environmental legal frameworks have been established and developed, and public environmental awareness has also been promoted in the past three decades. Nevertheless, municipal solid waste management in China still facing many challenges. For cities to progress in the field of waste management, the national government level will need to develop comprehensive solid waste management policies. Such policies should encourage cross-agency jurisdiction and coordination, and facilitate use of economic instruments like collection of revenues for improving waste management. An integrated waste management approach with consistent and holistic concept; waste minimization, collection, transfer, treatment, recycling, resource recovery and final disposal. Cities need to be encouraged to pursue waste minimization strategies, generate credible and comprehensive waste management data (especially costs and quantities), and serve as ‘centers of excellence’ for waste management technologies, and waste practices.

Cities need to decide about using the integrated approach to waste, developing Integrated Solid Waste Management Plans, and using the 3-R concept. Among the more technical concepts of relevance are the proper ecological closure of old saturated (sanitary) landfills. The treatment of massive amounts household waste require the full socialization of the 3-R concept (Reduce-Recycle-Reuse), and management of waste incineration without harmful side-effects. The management of construction waste, a growing environmental nuisance in a nation with such rapid urbanization, requires additional attention.

With regard to the SWM sector China we can paraphrase UNEP’s statements:

1. the increasing volume and complexity of waste associates with economic growth are posing major risks to ecosystems and health;
2. the growth of the waste market, increasing resource scarcity and the availability of new technologies offer opportunities for greening the waste sector;
3. there is no one-size-fits all when it comes to greening the waste sector, bit there are commonalities;
4. investing in greening the waste sector can generate multiple economic benefits; and
5. greening the waste sector requires financing, economic incentives, policy and regulatory measures, and institutional arrangements.179

Thus, an integrated waste management approach with consistent and holistic concept; waste minimization, collection, transfer, treatment, recycling, resource recovery and final disposal are necessary for eco-city development. Special attentions also need to be given to the technical issues of composting, processing of biomass, incineration, special waste treatment, and clean-up of brownfields and old dump sites. The application of the solid waste management approaches and technologies are expected to achieve a substantially higher, measurable impacts on urban environmental performance. It will trigger increased investment, reduce energy consumption and CO2 emissions, and augment the number of jobs in the sector.

Tool SWM 1: Integrated Solid Waste Management Plans.

What this tool does: Integrated Solid Waste Management Plans (ISWMPs) are an important tool for urban management. These ISWMPs organize waste streams and processing procedures at a city-wide level. The ISWMPs will seek full waste collection coverage for a city, ensure proper application of required environmental safeguards for collection, interim storage, onward transport, disposal to sanitary landfills or incinerators or waste recycling plants (Materials Recovery Facilities - MRF).

“[D]eveloping countries face uphill challenges to properly manage their waste with most efforts being made to reduce the final volumes and to generate sufficient funds for waste management. If most of the waste could be diverted for material and resource recovery, then a substantial reduction in final volumes of waste could be achieved and the recovered material and resources could be utilized to generate revenue to fund waste management. This forms the premise for Integrated Solid Waste Management (ISWM) system based on 3-R (reduce, reuse and recycle) principle. ISWM system has been pilot tested in a few locations (Wuxi, PR China and others) and has been well received by local authorities. It has been shown that with appropriate segregation and recycling system significant quantity of waste can be diverted from landfills and converted into resource.” (UNEP)

Concept of Integrated Solid Waste Management (ISWM)

How does it work: A hierarchy of planning documents – urban master plan, integrated solid waste management plan, urban landfill schedule - need to address a city's SWM aspects. A ISWMP will cover the following principles:

1. Upholding the right of every citizen to a clean and healthy environment.
2. Protection of the common public goods for current and future generations.
3. The importance of addressing economic and social value addition to waste management in terms of job creation and income generation.
4. All citizens contributing to the growing problem and the potential to be part of the solution.
5. Primary focus on the promotion and implementation of the 3-R principles (Reduction → Reuse → Recycle).
6. Awareness and education with a focus on resource reduction and waste-to-resource conversion.
7. Building upon existing local capacities and experiences.
9. Putting the necessary policy and institutional framework in place.
10. Developing a built-in adaptive mechanism for the continuous monitoring and improvement of the system.
(Source: UNEP)

**Process:**

*Steps in Strategic Planning for ISWMP*

![Diagram of Steps in Strategic Planning for ISWMP]

Source: UNEP
Examples:

Detailed Planning Process of ISWMP

Source: UNEP
## Common Issues and Solutions in Information, Education and Communication Campaigns

<table>
<thead>
<tr>
<th>SWM Concept</th>
<th>Issues and Solutions</th>
<th>Household and/or Neighborhood Actions</th>
<th>Municipal Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste avoidance</td>
<td>Buy in bulk and refill reusable containers; avoid toxic plastics and excess packaging, pressure packs, tiny service-size washing powder, etc.</td>
<td>Advise on refillable alternatives; encourage shops to refill containers; encourage cooperatives if repackaging has legislative limitations</td>
<td>Information, education, and communication campaign and support local companies, shops</td>
</tr>
<tr>
<td>Environmental management</td>
<td>Burning garbage causes air pollution and health risks illegal disposal of garbage into drains, rivers, and vacant lots</td>
<td>Explain the environmental damage caused by open garbage fires; Explain the environmental damage caused by uncontrolled garbage dumping</td>
<td>Ordinances; Ordinances</td>
</tr>
<tr>
<td>Waste segregation</td>
<td>Essential if recycling and composting schemes are to be efficient, but costly to have the necessary different receptacles and collection services</td>
<td>Start at the neighborhood and household levels; possibly use neighborhood workers to collect compostables and recyclables with only one municipality pick-up service; or involve/formalize the informal sector</td>
<td>Legislation requires segregation</td>
</tr>
<tr>
<td>Waste minimization</td>
<td>Purchasing products with least amount of packaging, reusable glass rather than throw away non-closure plastics. Encourage cloth nappy laundering service</td>
<td>Educate on benefits of lower cost of collection and wasted materials and landfill space consumed.</td>
<td>Container deposits</td>
</tr>
<tr>
<td>Waste toxicity</td>
<td>Reduce toxicity of products purchased</td>
<td>Educate on alternatives to certain chemicals, e.g., natural toilet cleaners or LED lighting rather than compact fluorescent light globes</td>
<td>Legislation to ban or limit specific toxic chemicals</td>
</tr>
<tr>
<td>Reuse</td>
<td>Reusing containers, such as jars and bottles; provide a tire wall cutter to allow tires to be used for erosion control and home composting stacks without causing an insect and mosquito microbreeding hazard.</td>
<td>Educate on benefits of packaging reduction and other sources; set up cooperatives to allow bulk buying and refilling; install drinking water refill stations for PET water bottles at markets Established cloth nappy reuse service possibly with hospital laundry services at lower cost than disposables</td>
<td>Legislation</td>
</tr>
<tr>
<td>SWM Concept</td>
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<tr>
<td>Recycling</td>
<td>Recycling containers, such as polyethylene containers and plastic bags for garbage containers or outdoors furniture, rot-proof decking, bollards, and road marker posts</td>
<td>Educate on benefits as per the above Call or market for better prices (e.g., plastics and glass) and obtain market access (e.g., for sale of tin cans); negotiate discounted sea freight for returning containers and lead acid battery export to the Republic of Korea or similar recycler</td>
<td>Support local companies</td>
</tr>
<tr>
<td>Drop-off centers for selected items</td>
<td>Consider a centralized system for white goods, garden or green waste, hazardous waste, etc.</td>
<td>Support local companies</td>
<td></td>
</tr>
<tr>
<td>Composting</td>
<td>Determining the level at which composting should be done (household versus neighborhood)</td>
<td>Provide training on methods and equipment required, do market development for neighborhood products Consider starting at neighborhood level and then go to households; also consider vermiculture if climate is suitable; look at local insect control culture and on-site use of compost; otherwise, neighborhood or regional processing will be required</td>
<td>Establish sustainable markets for compost Concentrate on erosion control for government-level landscaping, followed by municipal gardens, poor soil areas for agriculture, and lastly domestic uses</td>
</tr>
<tr>
<td>Green waste</td>
<td>Deciding how to manage yard and tree clippings</td>
<td>Equip with chippers at neighborhood level as input to composting, chipping for mulch not composting is also an option</td>
<td>Consider ways to fund the chipper Collection volume reduction of typically 14 times will make mobile chipping affordable in municipal collection in some countries</td>
</tr>
<tr>
<td>Energy recovery</td>
<td>Need for fuel or combustion support for institutional or industrial users</td>
<td>Collect plastic bags, polyethylene, PET containers, and tires</td>
<td>Convey to hospital incinerators; tires and plastic to cement kilns; to furnaces for cold climate central heating for schools, etc. Support local companies, such as charcoal producers</td>
</tr>
</tbody>
</table>

PET = polyethylene terephthalate, SWM = solid waste management.

Literature / further information:


Tool SWM 2: 3-R Tools.

**What this tool does:** This tool introduces the necessary steps to deal with waste in a non-conventional manner. It treats waste as potential resource. The waste hierarchy refers to the “3-Rs” – Reduce → Reuse → Recycle which classifies waste management approaches according to their desirability.

**Benefits.** Waste is not something that should be discarded or disposed of with no regard for future use. It can be a valuable resource if addressed correctly, through policy and practice. With rational and consistent waste management practices there is an opportunity to reap a range of benefits. Those benefits include:

1. **Economic** - Improving economic efficiency through the means of resource use, treatment and disposal and creating markets for recycles can lead to efficient practices in the production and consumption of products and materials resulting in valuable materials being recovered for reuse and the potential for new jobs and new business opportunities.
2. **Social** - By reducing adverse impacts on health by proper waste management practices, the resulting consequences are more appealing settlements. Better social advantages can lead to new sources of employment and potentially lifting communities out of poverty especially in some of the developing poorer countries and cities.
3. **Environmental** - Reducing or eliminating adverse impacts on the environmental through reducing, reusing and recycling, and minimizing resource extraction can provide improved air and water quality and help in the reduction of greenhouse emissions.
4. **Inter-generational Equity** - Following effective waste management practices can provide subsequent generations a more robust economy, a fairer and more inclusive society and a cleaner environment. ([https://en.wikipedia.org/wiki/Waste_management](https://en.wikipedia.org/wiki/Waste_management)).

The 3-Rs are meant to be a hierarchy, in order of importance.

![The Waste Hierarchy.](source: UNEP)
How does it work:

3-R Initiatives

A. Generation, Collection and Transportation.
   1. Establishment of a waste inventory.
   2. Development of local policies on segregation and collection.
   3. Development of awareness raising tools for 3-R waste management.
   4. Supply of waste bags for segregation of food waste.
   5. Construction / provision of collection points.
   6. Development of primary collection systems.
   8. Development of operational plan for collection and transportation.

B. Sorting, Treatment and Disposal
   1. Upgrading of transfer stations for material recovery.
   2. Development of biogas plant.
   3. (Upgrading of) Incineration plant with resource recovery.
   4. (Upgrading of) sanitary landfill with landfill gas utilisation.
   5. Establishment of waste exchange platform.
   7. Development of monitoring system for ISWMP. (Source: UNEP)

Literature / further information:

Tool SWM 3: Management of Closure of Sanitary Landfills.

What this tool does: This is a very technical issue, of a relevant environmental issue that is often and easily overlooked when investing in sanitary landfills: The eventual closure of sanitary landfills, and the associated costs of this additional investment and even monitoring costs.

How does it work:

"What does it mean to "cap" a landfill? The principle cause of groundwater pollution at landfills is the infiltration of water - rainwater and snowmelt - into the refuse. This water filters through the refuse, which dissolves a wide range of water-soluble pollutants out of the refuse, and encourages microbiological decay which releases even more contaminants. This mix of dissolved and suspended chemicals and rainwater is called "leachate." Modern sanitary landfills are designed with liners of plastic and clay, leachate collection systems, and leachate storage facilities designed to intercept, collect, and contain the leachate, and hold it for treatment at the site or elsewhere. In unlined landfills, nothing but natural earth materials retard the migration of leachate into the groundwater. Some natural processes help reduce the concentration of many chemicals once leachate has migrated from the landfill, but in many instances groundwater contaminated by unlined landfills has been found to contain one or several chemicals at concentrations above the drinking water standards...

In order to mitigate this environmental damage and threat to public health, landfills are permanently closed with low-permeability caps which cut off the infiltration of water into the refuse. Caps are useful even at lined sites, because they limit the amount of leachate that must be treated. At unlined sites, they are even more critical, and serve as a principal remedial technique to limit or prevent leachate migration, and reduce the need for other expensive techniques such as groundwater pumping.

What does a cap cost? Installation of a cap can be quite substantial. The actual costs depend largely on the local availability of materials used to construct the cap, the topography and ease of installation at a particular site, the design selected, and cost reductions associated with bulk-buying. For example, if substantial quantities of clay are available nearby, and the clay is suitable for this use, it can eliminate the cost of purchasing the low permeability layer - although it will still entail excavation, installation, compaction, and testing costs. Where gravel is present, then the drainage layer could be composed of locally-available material.

Process: Procedures governing landfill closure, normally prescribe that landfills must be monitored. It is necessary to inspect and maintain the landfill and its protective systems for at least 30 years following facility closure. This includes operation of the leachate collection system, extensive groundwater monitoring, inspection and repair as needed of the cap and other protective systems, and maintenance of the financial assurance bond or other security. Also, facilities which develop groundwater contamination have to institute remedial activities such as groundwater pumping and treatment, expanded monitoring, and additional financial assurance. Finally, in addition to water pollution, landfills have another by-product: landfill gas. This gas is created by the anaerobic decay of putrescible materials such as food waste, paper and wood, and is largely composed of carbon dioxide (CO2) and methane (CH4). Methane can migrate through the soil, and concentrate in enclosed structures, causing natural gas explosions and flash fires. Volatile Organic Chemicals (VOCs) such as benzene, chlorinated solvents, and Freons which are present in domestic refuse in small amounts can travel with the landfill gas, and degrade the ozone layer. Controls on these gases involve the installation of collection wells under the cap. Blowers and header pipes are used to collect the gas at a central point, where it is flared off (destroying the methane and VOCs) or used as fuel. Some facilities in Maryland recover some cost back by using the landfill gas to fuel boilers or generators, or even treat the gas and provide it to the local gas utility. The installation of gas controls is being expanded due to increased requirements to control non-methane VOCs.
under the federal Clean Air Act. However, the additional systems needed to collect and destroy or use the gas create additional costs.

What goes into a cap? A cap is constructed of several layers, applied one at a time over areas of the landfill until the entire filled area is covered. Over the last layer of refuse, a two foot layer of soil called the "final cover" is installed to protect the cap from damage by sharp objects or settlement of the waste. This surface is graded to a 4% minimum slope to insure drainage, and compacted for stability. Then, a low permeability layer consisting of 12 to 18 inches of clay with a maximum permeability of 1x10^{-5} cm/sec, or more frequently a flexible membrane of PVC, HDPE, or a similar plastic is placed on the landfill. For clay, the permeability, density, and moisture content is measured and adjusted to assure minimum permeability; for plastic, the seams are sealed and tested to insure a leak-free cap. A 6" drainage blanket of sand or gravel, or sometimes a plastic drainage media, is applied on top of the liner. This blanket must have a minimum permeability of 1x10^{-3} cm/sec. Often a permeable geosynthetic fabric is placed between the collection blanket and the low permeability layer, to protect the layer and to provide additional support to the overlying elements of the system. This drains any precipitation which infiltrates the cap to be drained off to discharge to nearby streams without becoming contaminated through contact with the waste. Often another permeable geosynthetic is placed on top of the drainage blanket, to keep it from being clogged by fine soil particles from the final layer. Finally, another 2' layer of soil is applied, to protect the cap and allow for vegetative stabilization.

(adapted from: http://www.eolss.net/Sample-Chapters/C09/E6-65-02-05.pdf)

Examples:

<table>
<thead>
<tr>
<th>Section of a typical landfill closure cap</th>
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<tbody>
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</tbody>
</table>

Literature / further information:
Tool SWM 4: Management of Waste Incinerators.

What this tool does: Incinerators have become popular in China for processing of household waste. However, apart from their high capital costs, there is a lot of debate about the acceptability of this technology. Many cities are seeking advice, and express need to share experiences.

“A waste treatment technology, which includes the combustion of waste for recovering energy, is called as “incineration”. Incineration coupled with high temperature waste treatments are recognized as thermal treatments. During the process of incineration, the waste material that is treated is converted into gases, particles and heat. These products are later used for generation of electricity. The gases, flue gases are first treated for eradication of pollutants before going in to atmosphere. Among waste-to-energy technologies, incineration stands taller. Other technologies are gasification, PDG, anaerobic digestion and Pyrolysis. Sometimes Incineration is conducted without the reason for recovering energy. In [the] past, incineration was conducted without separating materials thus causing harm to environment. This un-separated waste was not free from bulky and recyclable materials, even. This resulted in risk for plant workers health and environment. Most of such plants and incinerations never generate electricity. Incineration reduces the mass of the waste from 95 to 96 percent. This reduction depends upon the recovery degree and composition of materials. This means that incineration however, does not replace the need for landfilling but it reduced the amount to be thrown in it. Incineration comes with a number of benefits in specific areas like medical wastes and other life risking waste. In this process, toxins are destroyed when waste is treated with high temperature. Incineration or thermal treatment of waste is much popular in countries … where there is scarcity of land. The energy generated by incineration is highly demanded in countries like Denmark and Sweden. In year, 2005 it was estimated that 4.8 percent of the electricity as is consumed by Danish nation was produced by incineration and the amount of heat was some 13.7 percent out of total. Other then Denmark and Sweden many European countries are recovering heat and electricity from waste.”

(adapted from: http://www.wrfound.org.uk/articles/incineration.html)

How does it work:

“Incinerators and their types: Incinerator can be understood more precisely as a furnace where waste is burnt. Modern incinerators are equipped with pollution improvement systems, which play their part in cleaning up the Flue gas and such toxicants. Following are the types of plants for burning waste:

Moving Grate: The incineration plant used for treating MSW is moving grate. This grate is capable for hauling waste from combustion chamber to give way for complete and effective combustion. A single such plant is capable for taking in thirty-five metric ton of waste every hour for treatment. Moving grates are more precisely known as incinerators of municipal solid waste. This waste is poured in the grate with a help of crane from and opening or throat. From here, the waste has to move towards the ash pit. Waste is further treated and water locks wash out ash from it. Air is then flown through the waste and this blown air works for cooling down the grate. Some of grates are cooled with help of water. Air is blown through the boiler for another time but this time comparatively faster than before. This air helps in complete burning of the flue gases with the introduction of turmoil leading to better mixing and excess of oxygen. In some grates, the combustion air at fast speed is blown in separate chamber. European Waste incineration Directive is of the view that an incineration plant must be designed so that operating worker must know that flue gases are reaching the temperature of eight fifty degrees centigrade with in two seconds. This would ensure complete and required breakdown of toxins of organic nature. In order to achieve this every time backup auxiliary burners must be installed.
1. **Fixed Grate:** This was the fixed and much older version for grate. This kind generally is lined with the brick while lower or ash pit is made up of metal. This grate generally has an opening at the top and for loading purpose; a side of the grate is left open. A number of fixed grate were first formed in houses, which today are replaced by waste compactors.

2. **Rotary-kiln:** Industries and municipalities generally use this sort of incinerator. This incinerator consists of two chambers i.e. primary and secondary chamber.

3. **Fluidized Bed:** In this sort of incineration, air is blown at high speed over a sand bed. The air gets going through the bed when a point come where sand granules separates and let air pass through them and here comes the part of mixing and churning. Therefore, a fluidized bed comes in to being and fuel and waste are then can be introduced. The sand along with the pretreated fuel or waste is kept suspended and is pumped through the air currents. The bed is thus mixed violently and is uptight while small inert particles are kept suspended in air in form of fluid like form. This let the volume of the waste, sand and fuel to be circulated throughout the furnace, completely.

4. **Specialized incineration:** When it comes to the furniture factory for incineration of the waste, they need to take special precautions, as they have to handle inflammable material. For this purpose, they have incinerators, which are installed with burn back prevention systems and are very much necessary for the dust suspensions when they are more able to catch up the fire.

5. **Use of Heat:** The heat that is produced by an incinerator can be used for generating steam, which is used for driving a turbine in order to produce electricity. The typical amount as is produced by Municipal waste per ton is 2/3 MWh for electricity and two MWh for heating.

6. **Pollution:** Incineration is conducted with a number of outputs, which include ash and flue gas emission. Before the flue gas cleaning systems were introduced, the flue gas has to move to atmosphere thus leading to pollution.

7. **Emission of Gases:**
   - **Furans and Dioxins:** The biggest most concern, which has caught thoughts of environmentalists about MSW’s incineration, is production of a huge amount of furans and dioxins. These are considered staidly injurious to health. Modern generators are equipped with special equipment to clean emission of gases from these injurious components. There was a time when no governmental regulation were there to bound incineration and save environment and atmosphere from this hazardous emission of gases but today there are strict and rigid rules and regulations to follow and conduct incineration.
   - **Carbon dioxide:** Incineration while being conducted produces a vast amount of Carbon dioxide. Carbon dioxide plays a due role in global warming, as this is the green house gas. It has been observed that almost everything which has carbon in its composition is when processed by incineration evolves out as carbon dioxide.
   - **Extra Emissions:** Some other emissions of gases by waste processing are sulfur dioxide, hydrochloric acid, fine particles and heavy metals.

8. **Cleaning out Flue Gas:** A number of processes are involved for the cleaning up of flue gas. The mixture of flue gas is collected by means of Particle filtration and this filtration is conducted using electrostatic precipitators and baghouse filters. Baghouse are very effective for fine particles. The next step of the processing and cleaning of flue gas is processing of scrubbers, which are critical for the removal of hydrochloric acid, nitric acid, mercury, hydrofluoric acid, lead and residiary heavy metals. With the reaction of lime, sulfur is converted in to gypsum. The wastewater, which comes out of scrubbers, is then passed through wastewater treatment plant. Desulphurization is a process that is used to remove sulfur dioxide with the limestone slurry injection directly in to flue gas. Nitric component or gases are reduced with catalytic reduction with help of ammonia application. Heavy metals are removed with the help of active carbon injection. Particles are the collected at filters.

9. **Solidify Outputs:** Flue ash and Bottom ash is produced with the processing of waste materials and settle at the bottom of the incineration plant. The ash, which is produced, is four to five percent of total weight of the waste processed while the flue ash makes up some ten to twenty percent of total weight of waste material. The heavy metals, which are contained in the flue or bottom ash, are lead, cadmium, zinc and copper. A small amount of furans and
Dioxins are also produced. It is to mention here that bottom ash seldom have heavy metals in it. Flue ash is hazardous while bottom ash is not that dangerous or injurious to health.

**Other issues related to Pollution:** Older models of incinerators have inconvenience that this produce odor pollution. However, in modern plants are saved from producing dust and odor pollution. They are designed to store waste in enclosed containers along with a negative pressure to keep from odor and dirt dispersal. Another issue that is affecting community is increased load of traffic due to weighted call value (WCV) for hauling waste materials. This is the issue, which has forced incinerators to move in to industrial areas. “

(adapted from: [http://www.wrfound.org.uk/articles/incineration.html](http://www.wrfound.org.uk/articles/incineration.html))

**A debate over Incineration:**

“Usage of incineration is for waste management is divisive. The debate for incinerators generally involves business interests, regulations of government, activists if environment and citizens.

**Arguments supporting incinerations:**

- The first concern for incineration stands against its injurious effects over health due to production of furans and dioxin emission. However, the emission is controlled to greater extent by developing of modern plants and governmental regulations.
- Incineration plants are capable for producing energy and can substitute power generation plants of other sort.
- The bottom ash after the process is completed is considered non-injurious that still is capable for being land filled and recycled.
- Fine particles are removable by processing through filters and scrubbers.
- Treating and processing medical and sewage waste produces non-injurious ash as product.

**Arguments against incinerations:**

- Extremely injurious matter needs adequate disposing off. This requires additional miles and need special locations for land filling this material.
- Although after a lot of regulations and restrictions and developments concerns are still alive about emission of furans and dioxins.
- Incinerating plants are producers of heavy metals, which are injurious even in minor amounts.
- IBA is consistent over a considerably high level of heavy metals and can prove fatal if they are not disposed off, or reused properly.
- Initial investment costs are only recovered through long periods of contract for incinerating plants.
- Local communities always have opposed the presence of incinerating plant in the locality.

The upheld view is to recycle, reuse and waste reduction instead of incineration.”

(adapted from: [http://www.wrfound.org.uk/articles/incineration.html](http://www.wrfound.org.uk/articles/incineration.html))
Examples:

**Consumat Controlled Air Furnace (CONSUTECH)**

**Rotary Kiln Incinerator (INTUSER)**

Source: http://www.esaker.co.jp/waste1.htm
Fluidized Bed Incinerator (INTUSER)

FLUIDISED BED INCINERATOR
Source: Southern Cross University (SCU), Australia

Source:
http://www.users.abo.fi/jwerkeli/OOK%20I%202010/Knox%20-%20Overview%20of%20Incineration%202005.pdf

Literature / further information:
7. URBAN RENEWAL AND REVITALISATION
Post-independence residential areas are candidates for urban renewal – Luoyang

Private sector-driven gentrification of hutong houses - near Drum Tower, Beijing

Ancient dilapidated neighbourhoods (hutongs) are in equal need of revitalisation – Dongcheng, Beijing

Gentrification of lake-front hutongs – Nanluoguxiang, Beijing

Improved construction for energy-efficiency in hutong houses - Nanluoguxiang, Beijing

Improved windows / doors for energy-efficiency in hutong houses - Nanluoguxiang, Beijing

Source: F. Steinberg
Sector Profile of Urban Renewal and Revitalisation

Introduction. Many cities in the developing world have undergone wholesale transformation of their urban economies, a phenomenon that has typically led to a dramatic shift in the composition of economic activity and the spatial pattern of land use in the urban core. The historic areas of such cities become transformed into tracts of land, highly valued by commercial users. This typically leads to continually increasing pressure to eliminate any remaining vintage housing stock. Most cities in the developing world have paid—and continue to pay—very little attention to urban renewal and revitalisation (URR) of their historic urban core areas, and the housing stock therein. As a result, these areas continue to decline, both in terms of their overall quality and their potential contribution to the city's housing market and overall economy. Eco-cities should build a bridge between the URR and the concepts of eco-city development.

State of Demand in China. China’s unprecedented urban extension has drawn in recent years again the attention to urban renewal and revitalisation (URR), especially in historical cities. URR in China has been discussed since the creation of the People’s Republic of China. Many studies and attempts have existed to launch larger URR programmes in Beijing, Shanghai and other cities. Many Chinese cities still do have a historic city centre left, though this may be disappearing rapidly. The dramatic urban surge which China has experienced, however, has meant massive destruction of old neighborhoods across all cities. The advent of the car for mass transit, the need for more circulation space has meant the end for many old neighborhoods (hutongs), for instance in Beijing, and tenement housing areas in Shanghai, for example.

Policy Directions. The New Urbanization Policy of 2016 specifically called for action to identify historic cultural blocks and historic building in all cities, and encouragement of integrated urban renewal and revitalisation. (In addition, the new policy has pointed out that within the 13th Five Year Plan all illegal constructions need to be dealt with.)

MoHURD Strategic Objectives, Pronounced at the 2015 Central Urban Work Conference. In December 2015, the following directives were issued in regard to urban renewal and rehabilitation: Complete the ongoing renovation of urban substandard housing, underdeveloped areas in cities, and dilapidated housing by 2020;
• Enhance urban management to build smart cities;
• Adapt the historical heritage into urban strategies. Overall city planning shall consider reforms, technology and culture in order to improve urban sustainability. Cities shall strive to promote the reform of the planning, construction, management, household participation, and other aspects of planning. Cities shall consider the promotion of stable employment and life of the resident population as the primary task… Cities shall protect the traditional Chinese culture, and rehabilitate the city’s historical context, as well as protect the cultural heritage. To combine their historical heritage, regional culture, cities shall promote their own profile.
• Accelerate the reconstruction of urban shantytowns and the transformation of the old districts. Urban development shall take into account nature and ecological restoration. This implies control of the intensity of urban development, promotion of the formation of green low-carbon production. Urban transport, energy, heating, waste water management shall act according to the concept of low-carbon green development.
• Encourage private enterprises and citizens to participate in development and management of their cities. 180

Best Practices in Europe. In Europe there have been meaningful experiments with ecological urban renewal, and it is felt in China that the eco-city approach should also be considered for renewal and revitalisation of historic or older urban areas which warrant investment and upgrading. It is assumed that in the context of URR, eco-city concepts can

180 MoHURD. Meeting notes. 20-21 December 2015.
have an important place and role to play. Like in Europe, there should be scope to build into URR in Chinese cities elements of clean energy, green building technologies, resource-conserving means of water supply, energy-efficient and chemically un-harmful means of waste water treatment, environmentally friendly means of solid waste management, and green industries. This represents the recognition of the interrelationship and the interdependency between sustainable development and heritage conservation. Maintaining as much of the original fabric as possible is maintaining the character of the historic neighborhood. That’s cultural sustainability, also part of sustainable development. URR in Europe has been multi-dimensional, addressing environmental improvements, the local economy, and social rehabilitation. The recent drive for energy-efficiency in the buildings sector has lead to a wide-spread application of energy-efficient retrofitting programmes (‘green building’ techniques) in the old housing stock.

The following policies have been formulated for URR in Europe.

- **The Leipzig Charter on Sustainable European Cities.** The Charter has indicated the need for modernisation of infrastructure networks and improved energy efficiency, and that deprived neighbourhoods be upgraded. 181
- **The Toledo Declaration.** This declaration, highlighted the strategic importance of integrated urban regeneration to achieve a smarter, more sustainable and inclusive urban development. 182
- **The Freiburg Charter – Universal Principles for Creating a Sustainable City.** This Charter has stressed that urban redevelopment will be of special importance in the future. 183

**Best Practices.** European practices of urban renewal and revitalization cover physical development, environmental and socio-economic development. Some of the most well-known European urban renewal experiences can be found in the following cities and countries:

- **Germany: Cautious urban renewal/ preservation of listed building.** Since the late 1070s a nation-wide area-based participatory urban renewal program of small towns and villages has been implemented. 184
- **Berlin-Kreuzberg, Germany: Ecological urban renewal.** In the 1980s, the German City-State of Berlin implemented the International Building Exhibition which focused on careful urban renewal of old residential blocks. 185
- **Copenhagen, Denmark:** Good example of improvement of thermal performance. The energy demand of this property can be reduced by 73% through the combination of different measures. 186
- **Germany: Urban Neighbourhood Renewal Programme.** German Development Bank (KfW), European Union subsidies, city budgets, and the citizens’ own contributions (of up to 30%). 187

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• **Copenhagen, Denmark: Copenhagen Green Roofs Program.** In 2008 the City of Copenhagen began exploring alternative ways to handle rainwater in the city. Since then initiation of the programme, the city has mandated green roofs.\(^{188}\)

• **Vienna, Austria: ‘Sargfabrik’ Urban Renewal Project.** It is one of the pioneer projects in creating apartments on a former factory site. Applied concepts are: optimized energy consumption (energy-saving technology, good insulation), composting, solar water heating, heating for the pool is secured by PV panels, large windows allow maximum use of sunlight. Parking spaces are reduced to minimum.\(^{189}\)

• **Bologna, Italy: Area-wide traffic restraint.** Under a slogan of "A City for Living" the authorities have recently tightened again access to streets in the historic central district while improving bus, trolley, and metro services.\(^{190}\)

• **Frankfurt, Germany: Noise Action Plan 2010.** The Frankfurt Noise action plan of 2010 concerns mostly mobility, with the goals established at "reducing noise pollution so as to maintain and improve the city's residential quality".\(^{191}\)

• **Vienna, Austria: ecological block renewal programme.** Building renewal opportunities are supported with a maximum of 30 % financial contribution from the EU URBAN fund.\(^{192}\)

• **Gothenburg, Sweden: the first city in the world to issue green bonds.** The Green Bond Programmes and funds are used primarily to support projects that counter or help adaptation to climate change.\(^{193}\)

**State of the art in urban renewal and revitalisation in China.** China’s unprecedented urban extension has drawn in recent years again the attention to urban renewal and revitalization (URR), especially in historical cities.\(^{194}\) **URR in China has been discussed since the creation of the People’s Republic of China.** Many studies and attempts have existed to launch larger URR programmes in Beijing, Shanghai and other cities.\(^{195}\) Many Chinese cities have a historic city centre left, though such historic urban areas may be rapidly disappearing under to the pressures of real estate development, or the influx of migrant workers which bring their village to the city.\(^{196}\)

The dramatic urban surge which China has experienced, however, has meant massive destruction of old neighbourhoods across all cities. The advent of the car for mass transit, the need for more circulation space has meant the end for many old neighbourhoods (hutongs) in Beijing and tenement housing areas in Shanghai.\(^{197}\)

Prior to the Olympics in 2008 the international attention was drawn to wholesale destruction of entire neighbourhoods. This has happened despite the Beijing Municipal Government

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\(^{188}\) http://www.klimallpausing.dk/media/031048/green_roofs_copenhagen.pdf
\(^{189}\) http://www.doi-serbia.nb.rs/img/doi/0350-7599/2013/0350-75991304057C.pdf
\(^{191}\) http://www.frankfurt-greencity.de/en/environment/frankfurt/noise-in-frankfurt/
\(^{192}\) http://mirror.unhabitat.org/bp/bp.list.details.aspx?bp_id=2402
\(^{195}\) http://paper.researchbib.com/?action=viewPaperDetails&paperid=34887
(BMG)’s plan for the conservation of 25 historic areas in Beijing’s Old City, which had been endorsed in 2002.\footnote{Beijing Municipal City Planning Commission. 2002. Conservation of 25 Historic Areas in Beijing Old City. Beijing Municipal Institute of City Planning and Design. Beijing.}

Also in other cities, the path to urban revitalization is a complicated one. This can also be illustrated by the case of Baishizhou, Shenzhen. After large parts of Baishizhou were destroyed, in 2016 intervened and stopped further destruction. It seems that MoHURD’s new interest in urban renewal and revitalization of valuable historic areas has had some positive impact.

**Problems of land values.** The explosion of urban land values since the early 1990s has meant that historic residential areas have become an object of speculation and investment interest of private developers who have developed many new real estate schemes on the sites of historic residential areas. For many if not most of these this has meant that original population has been compensated and resettled to other, mostly far-off, alternative locations.

**Tendency of gentrification.** In URR, gentrification is a quite controversial outcome of renewal and revitalization processes. “Gentrification” means that the nature of social and economic character of an urban renewal area is radically changed with the effect that higher class social and economic standards are being introduced which usually are associated the exclusion of the former resident population and small or medium businesses.

**Government sponsorship needed.** To avoid and control the possible impact of gentrification, government’s support is very much needed if URR is to succeed, and if continuity of the original resident population and small or medium-sized businesses is aimed at. Obviously, most URR schemes intend to introduce higher quality of urban spaces into the old urban fabric, a renewed quality of technical infrastructure, housing, and social services. The tendency will be to bank on the concept of mixed-use compact development which will be adaptable for modern uses and new clients. However, such mixed-use development should ensure a place for the original resident population and small or medium-sized businesses. This is not easy under the pressure to maximize the returns on development of precious, well-located inner-city land, and even if the government will attempt to enforce such policy or approach, in reality it may be difficult to achieve.

**Linking Urban Renewal and Revitalization with Eco-City Development.** MoHURD’s eco-city programme and the work of some cities to preserve historic areas has brought to the fore the possibility of “ecological” urban renewal and revitalization in old neighbourhoods.

This will be no easy task since it will mean to confront the pressures of market development, the commercialization of land, and the aims of developers. Instead it will have to deal with the resident population which is under threat of relocation and poor compensation by the conventional URR approach. Ecological URR is (still) a theoretical possibility, it needs yet to be put in practice in China.

Some of the recent URR projects in Beijing seem to clearly to be illustrations of gentrification, replacing old building stock, and generating as per the old pattern high-end replicas for economically more advanced owners (examples in Nanluoguxiang, Beijing) and an outright conversion into “culture streets” and shopping malls (Dashilar/Qianmen area, Beijing). None of these seem to have considered eco-principles (yet).
Entry point for the “greening” of today’s URR can be: (i) renewable energy with solar elements (challenge to marry architectural conservation guidelines with technology requirements); (ii) utilization of “Passivhaus” technology (better insulation of walls, windows, and roofs), (iii) rain water collection (rain water harvesting) facilitated by sloping roofs and open courtyard spaces; (iv) neighbourhood-based waste separation and participation in ecological waste management schemes; and (v) greening of industries through the use of renewable “new” energy sources, and clean(er) production processes. Additionally, there seems to be reasonable good scope for urban agriculture activities in such traditional inner-city areas.

**Proposed Urban Renewal and Revitalization KPIs**

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Identify cultural heritage areas and buildings in all cities [1]</td>
<td>100% [1]</td>
<td>By 2020 [1]</td>
</tr>
<tr>
<td>3 Annual heat demand: Existing buildings</td>
<td>≤ 45 kWh/(m²a) [15]</td>
<td></td>
</tr>
</tbody>
</table>

Sources:

**Outlook and future sector agenda.** The eco-city approach offers something like a new opportunity for historic inner-city areas, and for modern heritage districts. The first wave of URR has affected many heritage areas with the impact of modernization and gentrification. The new potential of new approaches to URR, guided by eco-city principles could mean new chances and opportunities for urban heritage areas. In the absence of clear policies, it will require bold local initiatives by city administrators and investors to promote the eco-approach in urban renewal and revitalisation. As soon as “eco” will be universally fashionable (“chic”), there is good scope that this new approach will have large(r) scale applications. Retrofitting of

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199 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. *Sino-EU Key Performance Indicators for Eco-Cities*. Beijing (unpublished draft)
old buildings as per energy-efficiency criteria does is a new direction which European green building practices have provided. In China’s old neighbourhoods and old building stock, the green building practices of “passive” housing are yet to come; much will depend on government support, in terms of implementation and financing.

**Ecological URR - a new dimension of urban renewal and revitalization.** The eco-city approach offers something like a new opportunity for historic inner-city areas, and for modern heritage districts. The first wave of URR has affected many heritage areas with the impact of modernization and gentrification. The new potential of new approaches to URR, guided by eco-city principles can mean new chances and opportunities for urban heritage areas. In the absence of clear policies, it will require bold local initiatives by city administrators and investors to promote the eco-approach in urban renewal and revitalization. As soon as “eco” will be universally fashionable (“chic”), there is good scope that this new approach will have large(r) scale applications.

“China has achieved notable results and gained extensive experience in this area, particularly in: prioritizing urban regeneration, and strengthening top-level design and planning; focusing on regenerating specific types of cities, such as old industrial cities and resource-based urban areas; integrating the renewal of old city districts with the development of new urban areas, optimizing the distribution of urban space, and enhancing the functions of cities; stressing the role of industries and innovations in urban regeneration; and promoting green urban development and preserving cultural heritage of across cities.”

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Tool URR 1: Environmental instruments for neighbourhood revitalisation.

What this tool does: This tool lists and describes a number of approaches of environmental instruments which can be used for neighbourhood revitalisation. These approaches draw upon extensive European and Chinese experiences in urban renewal.

How does it work: Environmental approaches can be converted into a large variety of project initiatives, as listed in the second column, below. These environmental initiatives can be applied in historic neighbourhoods, or in more recent modern heritage contexts. These environmental approaches can be part of an integrated ‘area approach’, or they can be implemented as single-sector interventions.

<table>
<thead>
<tr>
<th>Area of Activity</th>
<th>Type of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of Non-Renewable Energy Demand</td>
<td>• Retrofitting through thermal roofs;</td>
</tr>
<tr>
<td></td>
<td>• Additional floors with new high quality roofs</td>
</tr>
<tr>
<td>Energy – Recycling</td>
<td>• Area conservation with high-tech energy concepts</td>
</tr>
<tr>
<td>Clean and renewable energy</td>
<td>• Use of embodied energy through heat exchangers;</td>
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<tr>
<td></td>
<td>• Biogas from waste products;</td>
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<tr>
<td></td>
<td>• Smart solutions for district heating</td>
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<tr>
<td>Land recycling, brown field redevelopment</td>
<td>• Redevelopment through adaptive use of industrial land</td>
</tr>
<tr>
<td>Land reclamation</td>
<td>• Reclamation of unutilized land for expansion of settlement</td>
</tr>
<tr>
<td>Micro climate improvement / Heat island reduction</td>
<td>• Greening of streets and outdoor spaces;</td>
</tr>
<tr>
<td></td>
<td>• Greening of roofs;</td>
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<tr>
<td></td>
<td>• Greening of facades</td>
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<tr>
<td>Flood protection</td>
<td>• Sustainable urban drainage system;</td>
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<tr>
<td></td>
<td>• Water proofing of ground floors and access above street levels</td>
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<tr>
<td>Drought prevention</td>
<td>• Rainwater harvesting;</td>
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<tr>
<td></td>
<td>• Green Roofs;</td>
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<tr>
<td></td>
<td>• Climate Adaptation Action Plans</td>
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<tr>
<td>Combating resource depletion</td>
<td>• Municipal waste and resource management</td>
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<tr>
<td>Preserving Biodiversity</td>
<td>• Community gardens;</td>
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<tr>
<td></td>
<td>• Promotion of diversity of species;</td>
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<tr>
<td></td>
<td>• Urban forestry;</td>
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<tr>
<td>Healthy cities – healthy living</td>
<td>• Urban agriculture;</td>
</tr>
<tr>
<td></td>
<td>• Urban outdoor spaces for communities</td>
</tr>
<tr>
<td>Clean and fair building materials</td>
<td>• Green procurement of building materials</td>
</tr>
<tr>
<td>Air pollution control</td>
<td>• Control of air pollution from local industries;</td>
</tr>
<tr>
<td></td>
<td>• Reduction of motorized traffic in residential neighbourhoods through traffic barriers, and outdoor land use</td>
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<tr>
<td>Noise pollution control</td>
<td>• Traffic calming;</td>
</tr>
<tr>
<td></td>
<td>• Road closures</td>
</tr>
<tr>
<td></td>
<td>• Noise action plans</td>
</tr>
</tbody>
</table>
### Neighbourhood infrastructure
- Improved water, sanitation and waste collection services;
- Improved district heating and cooling services;
- Improved information technology (IT) services – TV and internet

### Transport
- Improved access to public transport
- Pedestrianization
- Pro-cycling infrastructure (cycle paths)
- Bicycle rental stations

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**Neighbourhood Improvement with Citizens’ Participation in Stuttgart, Germany**

**Stadtsanierungsprojekt 28 - Bebelstraße**

**Process:** The preparation of urban renewal and revitalisation projects follows the following procedure:
- Preparation of a project brief, for inclusion in the city’s urban master plan (or similar planning document);
- Preparation of draft project design;
- Public consultation with local stakeholders (residents; local business; infrastructure service providers; business associations, etc.);
- Endorsement of urban renewal/revitalisation project as part of master plan;
- Preparation of detailed project design;
- Second round of public consultations;
- Preparation of improved urban renewal-revitalisation plan.
Literature / further information:

Tool URR 2: Economic instruments for neighbourhood revitalisation.

What this tool does: This tool lists and describes a number of approaches of economic instruments which can be used for the economic neighbourhood revitalisation. These approaches draw upon extensive European and Chinese experiences in urban renewal.

How does it work: Economic approaches can be converted into a large variety of project initiatives, as listed in the second column, below. These economic initiatives can be applied in historic neighbourhoods, or in more recent modern heritage contexts. These economic approaches can be part of an integrated ‘area approach’, or they can be implemented as single-sector interventions.

<table>
<thead>
<tr>
<th>Public-private partnerships</th>
<th>Soft renewal through private owners, encouraged by public Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green economy</td>
<td>Promotion of local green business enterprises</td>
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<td></td>
<td>Playing the globalization game: international awards</td>
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<tr>
<td></td>
<td>Green banking</td>
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<td></td>
<td>Green bonds</td>
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<tr>
<td>Economic revitalisation and stronger global integration</td>
<td>Place branding and iconic architecture;</td>
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<td></td>
<td>Green business and leadership</td>
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<td></td>
<td>Mixed land use</td>
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</tbody>
</table>

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- Endorsement of urban renewal/revitalisation project as part of master plan;
- Preparation of detailed project design;
- Second round of public consultations;
- Preparation of improved urban renewal-revitalisation plan.

Literature / further information:

  [http://www.usearchmedia.com/download/?kw=The%20Economics%20of%20Historic%20Preservation%20-%20A%20Community%20Leader%20%20Guide&ad_domain=ads.ad-center.com&ad_path=/smart_ad/display&prod=141&ref=5022292&sub_id=ipdf.website&seed=3799210938&s=books_c&adserver=0.16.0-rc1&m=books&system_controller=signup&system_action=index]
Tool URR 3: Social instruments for neighbourhood revitalisation.

What this tool does: This tool lists and describes a number of approaches of social instruments which can be used for the social revitalisation of neighbourhoods. These approaches draw upon extensive European and Chinese experiences in urban renewal.

How does it work: Social approaches can be converted into a large variety of project initiatives, as listed in the second column, below. These social development initiatives can be applied in historic neighbourhoods, or in more recent modern heritage contexts. These social approaches can be part of an integrated ‘area approach’, or they can be implemented as single-sector interventions.

| Access to adequate shelter | Neighbourhood contracts and other governmental subsidy schemes; Mass housing projects; |
| Tackling the land question | Cooperative housing schemes |
| Location and ease of mobility | Better and affordable public transport connectivity; Revival of urban tramways; Planning and Infrastructure for cycling; Pedestrianisation Integrated mobility concept |
| Poverty alleviation | Targeting of Urban Renewal and Rehabilitation programs to the poorest neighbourhoods; Social City Programs Focused income generation programs |
| Social inclusion | Neighbourhood service centres |
| Fighting stigmatization | Positive discrimination; Community-led urban renewal programs; Social engineering; Mix of housing programs |
| Cultural identity | Participation in preparation and implementation of community events |
| Crime and violence prevention | Conventional policing approach; Shared community space concept Community centres and promotion of community participation |

Process: The preparation of urban renewal and revitalisation projects follows the following procedure:
- Preparation of a project brief, for inclusion in the city’s urban master plan (or similar planning document);
- Preparation of draft project design;
- Public consultation with local stakeholders (residents; local business; infrastructure service providers; business associations, etc.);
- Endorsement of urban renewal/revitalisation project as part of master plan;
- Preparation of detailed project design;
- Second round of public consultations;
- Preparation of improved urban renewal-revitalisation plan.

Literature / further information:
Tool URR 4: Green building and retrofitting in neighbourhood revitalisation.

What this tool does: This tool lists and describes a number of approaches of green building instruments which can be used for improved energy-efficiency of older neighbourhoods. These approaches draw upon extensive European and Chinese experiences in urban renewal.

How does it work: Green building approaches can be converted into a large variety of project initiatives, as listed in the second column, below. These green building initiatives can be applied in historic neighbourhoods, or in more recent modern heritage contexts. These green building approaches can be part of an integrated ‘area approach’, or they can be implemented as single-sector interventions.

Entry point for the “greening” of neighbourhoods:

(i) renewable energy with solar elements (challenge to marry architectural conservation guidelines with technology requirements);
(ii) utilization of “Passivhaus” technology (better insulation of walls, windows, and roofs),
(iii) rain water collection (rain water harvesting) facilitated by sloping roofs and open courtyard spaces;
(iv) neighbourhood-based waste separation and participation in ecological waste management schemes;
(v) greening of industries through the use of renewable “new” energy sources, and clean(er) production processes;
(vi) urban agriculture activities.

<table>
<thead>
<tr>
<th>Area of Activity</th>
<th>Type of Projects</th>
</tr>
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</table>
| Reducing Non-Renewable Energy Demand | • Retrofitting through thermal roofs;  
• Additional floors with new high quality roofs |
| Energy – Recycling | • Area conservation with high-tech energy concepts |
| Clean and renewable energy | • Use of embodied energy through heat exchangers;  
• Biogas from waste products;  
• Smart solutions for district heating |
| Micro climate improvement / Heat island reduction | • Greening of streets and outdoor spaces;  
• Greening of roofs;  
• Greening of facades |
| Flood protection | • Sustainable urban drainage system;  
• Water proofing of ground floors and access above street levels |
| Drought prevention | • Rainwater harvesting;  
• Green Roofs;  
• Climate Adaptation Action Plans |
| Clean and ecological building materials | • Green procurement of building materials |
Process: The preparation of urban renewal and revitalisation projects follows the following procedure:

• Preparation of a project brief, for inclusion in the city’s urban master plan (or similar planning document);
• Preparation of draft project design;
• Public consultation with local stakeholders (residents; local business; infrastructure service providers; business associations, etc.);
• Endorsement of urban renewal/revitalisation project as part of master plan;
• Preparation of detailed project design;
• Second round of public consultations;
• Preparation of improved urban renewal-revitalisation plan.

Literature / further information:

8. MUNICIPAL FINANCE
Green financing for low-carbon urban development

Eligible urban investment sectors

Greening of Chinese Economy

Graph: F. Asseline

Graph: Climate Bonds Initiative 2015

Graph: China Daily
Sector Profile of Municipal Finance

Introduction. There is a sequential set of considerations which, if carefully done, will maximize the potential financing envelope for a city. These financing options (i) maximize existing revenue sources and potential new ones; (ii) leverage additional resources from the private sector; and (iii) access funds that are available. Green finance is a phenomenon that combines the world of finance and business with environmentally friendly behaviour. It is an arena for many participants, including individual and business consumers, producers, investors, and financial lenders. Green finance can be expressed differently depending on the participant, and it may be led by financial incentives, a desire to preserve the planet, or a combination of both. Financial institutions that extend lending to individuals, small businesses, or large corporations can do so in an environmentally friendly manner. In this type of green finance, loans are used to promote the proliferation of renewable energy, for instance. A lender could finance the development of a solar power plant that generates power from the sun, and the installation of solar panels on the roof of a building or residence. Wind power generation is another type of business that would win favour with green financiers. These companies develop expensive wind farms that use large turbines onshore and offshore to capture the wind and generate energy. For the municipal finance context it will be necessary to develop better management practices that make more efficient use of existing revenue collections, or those which offer new income flows. A systemic approach to improved municipal finance suggest the creation of revenue improvement action plans. Since eco-cities will require financial innovation, the most promising financing approach that exists seem to be the issuing of green municipal bonds. The ‘muni bond’ system has been tested in various countries, but wider-scale applications are yet to happen.

State of Demand in China. China has set an ambitious goal of peaking national carbon emissions around 2030, wisely recognizing that economic growth and fighting climate change go hand in hand. Against this new economic climate, actively developing green finance seems like an inevitable choice for China. At the heart of the challenge lie the rules that govern finance. The transition will carry substantial costs. Recently, the cost of cleaning up China’s Cities has been estimated to reach $1 trillion. “A new research report series Green Finance for Low-Carbon Cities, authored by the Paulson Institute, Energy Foundation China and the Chinese Renewable Energy Industries Association, estimates that 6.6 trillion RMB ($1 trillion) will be required over the next five years to build low-carbon cities in China.”

Policy Directions. The Government’s pronouncement of the 13th Five Year Plan objectives made no specific mention about municipal financing. However, it is assumed that green municipal financing will become a requirement if eco-city development targets are to be achieved. Other pronouncements have pointed at the need for a national green development fund and green bonds.

Green Development Fund needed. A 2016 report from the China Council for International Cooperation on Environment and Development recommends that China launch a national green development fund, develop long-term sources of finance by promoting green bonds and

201 Source: http://www.bloomberg.org/press/releases/1-trillion-usd-investment-needed-five-years-build-low-carbon-cities-china
support the development of a green finance risk guarantee mechanism, including environmental liability insurance.  

**Best Practices in Europe.** Producers and consumers are increasingly willing to invest in, and buy, ‘green’ products. But often, financiers see such investment as ‘unproven’ and are reluctant to invest. Increasing numbers of private equity and debt funds are targeting green investments – from waste water treatment to solar energy. Central to upscaling this activity is to find ways of providing a better enabling framework within the global and national capital markets. Green finance must influence all aspects of consumption and investment. To do that green priorities need to permeate the range of products offered by the financial system – the banking system and the ‘wholesale’ funds markets which supply the longer term funds needed for environmental investments.

**State of the art in green municipal finance in Europe.** Green municipal finance (GMF) in Europe is embedded in a complex system of various legislations, strategies and supporting measures. The basis for GMF is the Europe 2020 strategy. It is part of Europe’s overall objectives for smart, sustainable and inclusive growth. The EU is subscribed to limit Global Warming to below 2°C compared to the average temperature in pre-industrial times to prevent the most severe impacts of climate change and possibly catastrophic changes in the global environment. To deliver, the strategy focusses on 5 key areas being employment, innovation, education, poverty reduction and climate/energy. Europe 2020 represents an integrated approach to climate and energy policy that aims to combat climate change, increase the EU’s energy security and strengthen its competitiveness. Known as „20-20-20” the following targets have been set for 2020:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels
- Raising the share of EU energy consumption produced from renewable resources to 20%
- A 20% improvement in the EU’s energy efficiency

The climate and energy package is binding legislation, meaning that EU member countries need to adopt and implement it through their national legislative procedures. Currently the EU has 28 member countries. Each of them has or is in the process of adopting their individual climate policy. How this is done differs a lot and depends on a whole range of factors such as historical setting of decision making processes, current baseline scenarios, economic and financial situation, legislative framework etc. To ensure that the Europe 2020 strategy pushes through, a strong and effective system of economic governance has been set up to coordinate policy actions between the EU and national levels.

The climate and energy package comprises four pieces of complementary legislation which are intended to deliver on the 20-20-20 targets: (i) Reform of the EU Emissions Trading System (EU ETS); (ii) National targets for non-EU ETS emissions; (iii) National renewable energy targets; and (iv) Carbon capture and storage. Energy efficiency targets are not included in this packed, but addressed though the 2011 Energy Efficiency Plan and the Energy Efficiency Directive.

In addition and to extrapolate Europe 2020 the following main policies and strategies have been adopted which have an impact on GMF:

- The 2030 Framework, which was agreed upon in October 2014 foresees to reduce GHG emissions by 40% compared to 1990 baselines and also sets a target of at least
27% for renewable energy and energy savings by 2030. The law is comprehensive and unifies various aspects of climate change. The extension of the EU 2020 package was felt to be necessary to provide regulatory certainty for investors, acknowledging the great importance of the private sector and to help coordination efforts between member countries.

- The 2050 roadmap\(^{207}\) set the longer-term perspective already in 2011 looking beyond short-term objectives. It aims at a reduction of GHG emissions by 80-95% below 1990 levels through domestic reductions alone by 2050 as part of the Resource Efficient Europe flagship initiative. It provides a perspective how the main sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy most cost-effective.

- The EU Adaptation Strategy which was formulated in April 2013 was the strategy supports action by promoting greater coordination and information-sharing between Member States, and by ensuring that adaptation considerations are addressed in all relevant EU policies.

- The Energy Efficiency Directive of 2012 is a legally binding measure to step up the use of more energy efficiency measures at all stages of the energy chain. Measures include the requirement to establish energy efficiency obligations schemes (or equivalent alternative measures), a 3% annual renovation obligation of central government buildings, the promotion of energy audits and others.

**EU Funding.** To implement its various policies, the EU provides funding in support of the EU 2020 strategy. At least 20% of the EU's €960 billion budget for 2014 to 2020 (about €180 billion) should be spent on protecting the climate. This is on top of funding from individual EU countries.

To comprehend GMF in Europe it is important to understand the leverage effect and impact EU funds have. Most EU funds are designed to either co-financed or supporting financial instruments that attract a multiple of funds from financial institutions and other investors. This lead to an “EU mobilized size” of funds of €2 trillion or 2% points of GDP, i.e. two times the investment\(^{208}\). Based on this experience e.g. the energy and external action related funds such as the European Energy Efficiency Fund and others are expected to increase the fund size from €1 billion in EU support to €25 billion. Funds and projects under the EU-funds are therefore measured as to the leverage effect they have.

The European Investment Bank (EIB)\(^{209}\) plays an important role in financing GMF as it is the bank for the European Union representing the interest of the EU. More than 90% of the overall activity is focused on Europe, where the multilateral bank finances sustainable investments as part of the EU policies. The instruments used are

1. Lending: The vast majority of the financing is through loans, but guarantees, microfinance, equity investment, etc. are also offered
2. Blending: Through the EIB support financing from other sources is unlocked, particularly from the EU budget. This is blended together with banks' own funds to form the full financing package.
3. Advising: EIB takes to role of an advisor to help with administrative and project management capacity which facilitates investment implementation.

Climate finance is one of their four strategic focus areas. Municipal finance in regard to urban environment, sustainable transport, energy and water is available through two main EU funds by the name of JESSICA and JASPER. At the same time the EIB is manager of a number of


\(^{208}\) Source: [http://www.ceps.eu/system/files/SR%20No%2086%20Effects%20of%20the%20EU%20Budget.pdf](http://www.ceps.eu/system/files/SR%20No%2086%20Effects%20of%20the%20EU%20Budget.pdf)

\(^{209}\) Source: [http://www.eib.europa.eu/about/index.htm](http://www.eib.europa.eu/about/index.htm)
municipal funds in other countries such as Turkey. These funds are partly funded by the EIB and leverage with national resources.

Another major European bank is the European Bank for Reconstruction and Development (EBRD). It was founded in 1991 to create a new post-Cold War era in central and Eastern Europe, furthering progress towards market-oriented economies and the promotion of private and entrepreneurial initiative. It is owned by 64 countries, the European Union and the European Investment Bank. As such, part of the funds used by the EBRD are also EU budget related financial sources.

The Covenant of Mayors generated a table of available sources from the EU that support them best, see Figure 22. The programs help in the planning and/or in the implementation process of the SEAP. In addition to these EU funding sources, other financial programs can be tapped some of which support municipal finance directly, some of which target climate finance and include municipalities as eligible recipients such as the aforementioned JESSICA and JASPER.

**Best Practices in Europe:** European practices of green finance provide a glimpse of pioneering work which is to emerge on a bigger scale in years to come. The examples can be found in the following cities and countries:

- **Italy: Cat Bond, The Azzurro Re I Ltd.** The Azzurro Re I Ltd. cat bond is sponsored by Italian primary insurer UnipolSai Assicurazioni S.p.A., a first-time entrant to the cat bond market seeking reinsurance coverage from the capital markets in securitized form for its portfolio located across Italy. The Italian insurer is seeking at least €150m of reinsurance protection from the issuance by Azzurro Re I, a recently registered Irish domiciled special purpose vehicle, of a single tranche of European quake risk linked notes. The fully-collateralized reinsurance protection provided by the cat bond will protect UnipolSai against losses from earthquakes occurring in Italy, metropolitan France (but not overseas territories), Corsica, Austria, Switzerland, Slovenia and Monaco. The focus of the protection is however on Italy. The reason for including surrounding countries within the covered area is to capture earthquakes that could occur in a neighboring country, but which cause losses to UnipolSai’s portfolio.

- **EU: Urban Development Fund Lithuania.** The urban development fund is an example how national budgets together with professional support through the EU fund Jessica can leverage finance from commercial banks. The government of Lithuania sought the support of the EU Funding source JESSICA to set up an urban development fund to achieve the objectives of the national plan and refurbish 24000 apartment block buildings by 2020. After the refurbishment, it is estimated that the average energy savings for a single house will be approximately 50 per cent or 125 MWh a year.

- **Barcelona, Spain: Barcelona Province Funding Sources.** This example showcases how with very little own funding energy efficiency projects were implemented through the involvement of energy service companies (ESCOs) and the development of public-private partnerships for renewable energy investments in public buildings.

- **London, United Kingdom: London Green Fund (LGF).** The LGF is an example of JESSICA supporting the development of green infrastructure to contribute to London’s

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211 Source: [http://www.ebrd.com/home](http://www.ebrd.com/home)

212 [http://www.artemis.bm/deal_directory/azzurro-re-i-limited/](http://www.artemis.bm/deal_directory/azzurro-re-i-limited/)


ambitious carbon reduction targets. The LGF consists of three urban development funds targeting investment in energy efficiency, waste and greener social housing.  

- **Hannover, Germany: Pro Klima.** In 1998 the cities of Hannover, Hemmingen, Laatzen, Langenhagen, Ronnenberg und Seelze in the North Germany founded the ProKlima fund together with the public utility enercity. The objective of the fund is to finance climate relevant measures that go beyond the usual.  

- **Almada, Portugal: Almada less carbon fund.** This is an example of innovative financing instruments and Energy Performance Contracting. The Municipality of Almada created the Local Energy Agency of Almada, AGENEAL representing the most important service sectors – energy, water and solid waste utilities, public transport, education, service providers, building and public work companies. The fund has supported investments in a municipal fleet of electric bicycles, energy efficiency measures in public buildings and a change to LEDs in public lightning.  

The EU’s reflections on the future of EU finances declares that at least 20 % of the EU budget for 2014-2020 are committed to climate action, and to achieving 0.7 % of GNI as official development assistance within the framework of the 2030 agenda. A large part of the EU expenditure for climate change, smart transport, smart energy grids, and environment protection is being spent through the EU’s cohesion policy (directed at EU member states). To enable these investments, the EU is committed to mobilise new own resources for the achievement of its policy objective, among others through green financing (e.g. green tax, financial transaction tax, common consolidated corporate tax base).  

**State of the art in green municipal finance in China.**  

**Green Development Fund needed.** A 2016 report from the China Council for International Cooperation on Environment and Development recommends that China launch a national green development fund, develop long-term sources of finance by promoting green bonds and support the development of a green finance risk guarantee mechanism, including environmental liability insurance.  

**Objective of green municipal finance.** The overarching objective of green municipal finance (GMF) is to support the development of cities to provide necessary infrastructure in a socially and environmentally sustained and long-term manner. GMF is instrumental to the higher objectives of livable green cities in an overall country context. It is embedded in the larger picture of national policies, the regulatory environment and the institutional framework under which it works. These cornerstones enable local decision makers to pull the right strings when it comes to prioritizing municipalities green expenditures as well as design proper green revenue sources. The policy aspects will be discussed in more detail below.  

**From financing necessities to new opportunities.** While most Chinese cities have financed a large part of their recent developments through land sales, and transfers of national subsidies, the future may hold many innovations through tax reforms. Property taxes, value capture tax, tax increment finance, fees and charges, development charges, municipal green bonds, private sector financing, and public-private partnerships will become indispensable new avenues for municipal finance.

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216 [http://www.proklima-hannover.de/ueber_proklima/](http://www.proklima-hannover.de/ueber_proklima/)  
Green bonds. The issuance of bonds increases the level of indebtedness of municipalities and at the same time helps to leverage private finance. To make these “green” bonds, cities have to use the proceeds of the bond to finance green projects. Often it is a combination of various projects and undertaken ranging from greenfield developments to the renovation of existing infrastructure. Since the bond has to be repaid at end maturity most of the projects financed under a bond are income earning and thus fall under the mitigation categories. When national government support the bond issue (through takes exemptions or subsidies) adaptation projects are likely to be included.

The amount of green bonds to refinance municipalities remains small, but the World Banks has for example issued green bonds. 20% of the proceeds were invested into municipal infrastructure. Municipal bond schemes enable qualified local government issuers to borrow money at attractive rates to fund energy conservation projects such as

- Reducing energy consumption in publically owned buildings
- Implementing green community programs (including loans, grants, or other repayment mechanisms) such as efficient street lighting replacements and loan programs for residential energy efficiency improvements
- Developing rural capacity, specifically involving the production of electricity from renewable energy resources

Green bonds usual require a close cooperation between local governments and the national level. One reason is the above discussed matter of contingent liabilities: what happens if the bond cannot be repaid by the city, will the national level take some sort of liability? The second point is that the rating of the national government is usually better than that of second or third tear cities and thus impacting the level of interest rate at which the bond is priced. It would be just more economical, if the national government raised the debt. Though green bonds are still in the minority as compared to the overall quantity of bond issues.

**Leveraging private sector finance.** For municipalities to attract private sector co-finance for infrastructure measures requires a number of things:

- The business case for the private sector needs to be convincing
- The return on equity needs to be clearly defined
- The risk for the private sector needs to be containable

Because the municipal market as compared to the national market is relatively small, municipalities are well advised to communicate their aspirations well. To create a win-win situation meaning that the advantages for the municipalities and the private sector are clearly defined, this process needs a long and thorough planning period. It must be analyzed for what reason the private sector is invited to participate. This will determine the sort of arrangement between the public and the private sector. Below the most common forms are introduced.

**Public-Private Partnerships.** In the past public-private partnerships (PPP) were the most prominent form of leveraging private sector finance. A PPP is a partnership between the public and the private sector in which the private party provides a public service and assumes substantial financial, technical and operational risk. To green PPPs the objectives must change. A good example is for example to include energy efficiency obligations (EEOs) for utilities are set qualitative targets such as the amount of water that need to be reused. The PPP arrangement as such remains, but the objectives are formulated in a way that internalizes externalities. EEO is part of the so-called demand side management, whereby energy companies and utilities are obliged to fund measures that lead to energy or carbon reductions.

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220 For example, US $100 million bonds were issued for the city of Wuhan, China to develop an integrated, safe, and environmentally-friendly urban transport system that supports coverage and quality services, and the safety of pedestrians and cyclists. The project will reduce 459,000 tons of CO2eq. emissions annually. http://treasury.worldbank.org/cmd/pdf/ProjectExampleinChina_WuhanSecondUrbanTransport.pdf


A penalty will be levied on the company if energy savings targets are not met. In other words, utilities are made to make their clients save energy. For example energy companies give or finance advice to their customers how to save energy and install the relevant measures. These actions are measurable and can be verified. Subsidies may be provided initially for each kW/h saved.

The results of such actions are quantified in energy saving accreditations back to the energy company or so called White Certificates. They state how much energy has been saved and can also be produced by third parties such as energy service companies and other firms like insulation companies. In some countries these certificates can be traded, helping the energy company to meet the targets. White Certificates can be issued for electricity savings, gas savings and other fuel source savings depending on government objectives. Some forms of EEOs are also called on-bill finance because the utility takes the (high) upfront costs and the customer is repaying the investment with the energy bill.

**Current developments and the future agenda of the Chinese banking sector supporting green finance development.** The China Banking Regulatory Commission (CBRC) has issued a directive on strengthening the corporate social responsibility (CSR) of financial institutions. This directive or ---opinion on Strengthening Banking Financial Institutions Corporate Responsibility --- introduces a number of social safeguards to protect clients of financial institutions but also environmental due diligence to ---protect and improve the natural ecological environment. In addition, the CBRC has issued a much needed special instruction to protect Small and Medium-Sized Enterprises (SMEs) from falling victims to too harsh bank lending policies. SME-friendly flexible policies are essential in order for this innovative branch to not be unduly penalized by regulations and their administration, which places a disproportionate burden on them when compared to big State groups and their interests.

**Lessons learnt.** For green municipal financing to work for cities in China, there is a need for a system of various mechanism: low carbon subsidies from the national government; tax and other incentives to procure low carbon products which have undergone certification; and preferential credit mechanisms from financial institutions for green investments. The development of tailored financing modes supportive to green investments shall broaden financing options, these should include government awards for extending financial support to green investments through debt promotion in infrastructure and land-based investments. Cities shall explore the greening potential of financing vehicles like PPP and BOTs. Additionally, special funds and diversified instruments are needed for guarantees to secure private capital investments. For guarantee purposes, assistance through land allocation, licensing, and green certification shall be provided to ensure low-carbon design and low-carbon operations.

**The challenge is clear.** The foundations for green growth will lie primarily in the development of low-carbon cities, cities that combine integrated solutions for their energy provision, the development of transportation networks, for waste recycling, for energy efficient buildings. The financing requirements will be enormous and municipalities in China will require new financial instruments to respond to the challenge. Cities are challenged to explore new forms of green financing. The existing mechanism described above present a fruitful arena for such financing innovations. It can be expected that in the coming years, reforms of the municipal taxation systems, will empower cities to levy property taxes also, and, thus, become much more capable to reduce their dependence on central government transfers. The application of smart green financing is expected to support the investments required for more urban efficiency, reduced energy consumption, and low-carbon development.
## Proposed Municipal Finance KPIs

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Access to finance</td>
<td>National support __ (¥ bn) – as % of total investments.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Own revenues __ (¥ bn) – as % of total investments.</td>
<td></td>
</tr>
<tr>
<td>2. Green finance (special fund; green bonds) [1]</td>
<td>__ (¥ bn) – as % of total investments [1]</td>
<td></td>
</tr>
</tbody>
</table>

Sources:

### Outlook and future sector agenda.

For green municipal financing to work in China, there is a need for a system which provides low carbon subsidies, procures low carbon products which have undergone certification, and preferential credit mechanisms for green investments. The development of tailored financing modes supportive to green investments shall broaden financing options; these should include government awards for extending financial support to green investments through debt promotion in infrastructure and land-based investments. Government should explore the greening potential of financing vehicles for private sector participation. Additionally, special funds and diversified instruments are needed for guarantees to secure private capital investments. For guarantee purposes, assistance through land allocation, licensing, and green certification shall be provided to ensure low-carbon design and low-carbon operations.

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[223] These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. *Sino-EU Key Performance Indicators for Eco-Cities*. Beijing (unpublished draft)
Tool MF 1: Green investment resources plan

What is a GIRP?

A green investment resources plan (GIRP) analyses past revenue performance and demonstrates which financial resources are needed in the coming three years and how the city, utility or service unit will generate this amount. This means that a clear strategy should be presented, detailing from which sources urban administrations can generate their own revenues to cover their expenses. The particular focus of this tool is on greening of investments. All capital investments in a city should be “green” in that all should be assessed for their potential to include low carbon or pollution abating elements in design (see other Tools contained in Position Papers) and should be resilient against the impact of climate and other risks.

The responsibilities and timelines for the implementation of a GIRP should also be clearly defined. All main revenue sources include taxes, service charges and fees should be included in the analysis. At the same time, when preparing GIRPs, city administrations should pay attention to expenditure requirements, financial balance at hand and revenue enhancement options. This approach will help city administrations to identify the resource gap for green investments. The definition of planned expenditure needs (what do I need to spend) when set against investment plans, sets a precise target for the revenue amount to be generated.

Structure of the Tool

The tool is structured by the main steps in the preparation of a GIRP:

1. Step One sets out key issues relating to the policy and legal framework which need to be considered before beginning detailed planning.
2. Step Two studies past revenue performance and emphasises past difficulties. The trend analysis gives important inputs for further planning and is the basis for the coming gap analysis.
3. Step Three critically examines past expenditures. The aim of revenue enhancement is to cover the cost of essential services for citizens. Therefore, revenue generation and expenditure are directly linked.
4. Step Four provides recommendations on areas for improvement of revenue administration. Based on the previous step, lessons learnt that need to be transformed into strategies should be developed.
5. Step Five presents a way to allocate costs among city services.
6. Step Six offers an assessment of potential additional means increasing municipal revenue.
7. Step Seven critically analyses the space for financing to cover running and future costs.

Why is revenue enhancement important?

The capacity for city administrations to supply urban services and undertake the necessary green infrastructure development is naturally constrained by limited financial resources. Insufficient revenue generation is most commonly the result of a combination of factors, including:

1. **Tax base**: The tax base for important sources, such as the property tax and the business tax, is artificially small. This is because the city administrations and municipalities have not been updating their records and informal businesses and properties are not included in the base.

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224 This tool is substantially based on the framework, adapted for Chinese conditions, provided by the GIZ Revenue Enhancement Planning methodology used in Ethiopia.
2. **Tax coverage**: Determined taxes, charges and fees are partly out of date, with no relation to current incomes and costs. A significant amount of economic activities are currently left untaxed.

3. **Tax assessment**: In the local tax administrations, tax assessment is one of the most problematic areas. This is even worse for lower income groups as they do not maintain books of accounts to demonstrate their exact performance.

4. **Collection efficiency**: Collection rates are poor in many city administrations and municipalities and they vary significantly from year to year. In fact, tax collection is still low relative to its tax base. As a result, the default rates and cumulative arrears are significant. The problem appears mostly in the case of land lease, trade and service taxes.

5. **Payment procedure**: Payment procedures are slow and inconvenient for taxpayers.

6. **Enforcement mechanisms**: Enforcement mechanisms are almost non-existent and the procedural legal basis to support enforcement is deficient. This further encourages defaults and adversely affects efforts to settle arrears.

7. **Weak human resources**: The above problems in the system of tax administration are worsened by the weak human resource capacity of revenue staff and poor incentives for enhancing performance.

Combined with pressure on some traditional forms of financing (for example land transfer taxes), the massive accumulation of new infrastructure requirements and the substantial need of resources to maintain, renovate and replace older, deteriorating equipment has compounded the above-mentioned problems. This calls for generating more revenue from own and external sources such as grants, intergovernmental transfers, revenue sharing and borrowing. The major objective is to maintain a steady increase in own (municipal) revenue that is at least equal to increased inflation and population growth rates. This approach would help to offset the decline in purchasing power with inflation.

**How is the GIRP linked to strategic objectives?**

[review China process] All cities in China have development plans, consisting of strategic development objectives and structure plans. Guided by City Climate Plans, city development plans imply a set of investments that are implemented by city line-offices, city agencies and companies.

In their yearly plans, the line offices submit a budget proposal including a recurrent budget (e.g. salaries) and investment proposals in order to fulfill strategic objectives (e.g. building a school). These proposals and other capital projects, such as the rehabilitation of assets, constitute the capital investment plan – which as discussed above should incorporate green aspects in all investments. We thus term it the Green Investment Plan.

To implement this plan, additional revenue is always needed. Revenue is also needed for the maintenance requirements and costs, which are then consolidated in the maintenance budget. However, not all wishes from the GIP can be fulfilled. In order to match available resources with investment needs, the city will prioritise capital investments proposals by sector as a basis for determining financing priorities (see Tool 2 Green Investment Financing Plan) which sets out the financing for priority investments.
Both capital investments and maintenance expenditures require financial resources, which are to be generated by the Revenue Authority as planned in the GIRP. Therefore, at the beginning of each calculation the amount of available revenues should be indicated. By subtracting the recurrent expenditures the city administration can calculate its operating surplus, i.e., own resources available for capital investments. In China, some external resources are available from the national government or by donors add to this and are available for the CIP.

\[
\text{Recurrent Revenues} \quad \text{minus} \quad \text{Recurrent Expenditure} = \quad \text{Operating Surplus} \quad \text{plus} \quad \text{Other Resources} = \quad \text{Green Investment Resources}
\]

**STEP 1: Considerations before GIRP drafting**

Each city administration must bear in mind that their GIRP should be in line with the requirements of the federal and regional constitutions and not contradict the framework of national laws when it devises its own local financial improvement policies. City administrations need to consult the following set of policies and government reform programs:

- Fiscal Policy
- Tax and Investment Policies
- Urban Development Policy
- Other Institutional Strengthening Needs

Further, they need to gather and integrate regional and local frameworks.
In order to prepare the GIRP, a task force has to be set up, comprising of a pool of experts from different relevant disciplines.

**Fiscal Policy**

- Mobilisation of own revenue is a necessity but can also obstruct economic growth if citizens are over-taxed;
- Management of own revenue and expenditure of a local government should contribute to a fair distribution of income and wealth between citizens;
- GIRPs should not negatively affect the stability of the local economy, employment and inflation. These plans should not impair the allocation of local resources;
- City administrations are required to follow sound financial principles that strengthen fiscal responsibility, ensure sustainability of resources and spending, apply limits to local expenditure and create meaningful relations between local policy and expenditure patterns. Value for money should be produced through transparency and accountability.

**Tax and Investment Policies**

- GIRPs should be in line with the national and provincial investment and tax policies, which provide incentives to smallholder farmers, domestic entrepreneurs and direct foreign investors, stimulating in turn economic growth and prosperity;
- The private sector should be strongly supported by transparent and accountable services rendered with regard to delivery and pricing.

**Urban Development Policy**

- City administrations should use different methods for the full recovery of land development costs such as:
  - an appreciation tax for increases in land values;
  - full cost recovery charges for the capital costs of services provided to developers and land holders; and
  - public acquisition and development of land.
- City administrations should apply charges and fees (cost sharing principle) reasonably well on occupants of new areas or redeveloped areas for the provision and installation of utilities such as electricity, supply of water, drainage, sanitations, refuse collections, schools, clinics and amenities such as parks and sport grounds;
- Cities should have a reliable inventory of their land;
- Cities should update the value of their land.

**Other Institutional Strengthening Needs**

- Cities should have an Expenditure Management and Control system which cities should consider;
- City administrations should harmonise and implement the expenditure management and control mechanism, which contains the reform of accounting, budgeting, procurement, auditing, and internal control principles in the preparation of the financial improvement plans;
- City administrations should formulate and introduce performance appraisals and incentive systems in relation to the objectives of the GIRPs;
- City administrations should put systems in place to take care of the quality of local services including the establishment of complaint handling mechanisms and the participation of citizens in urban affairs;
- City administrations should select and train suitable staff to manage these plans and their objectives;
- City administrations should include the GIAP context in a chapter of their code of conduct to prevent potential corruption.

**STEP 2: Analysis of Past Revenue Performance**

The first exercise for developing a revenue plan is analysing past revenue performance. To do so, a list of all revenue items should be produced and their past performance assessed. This includes: (a) Tax revenues from municipal services, (b) municipal rent revenues and investment incomes, (c) municipal service charges, (d) revenues of sales of goods and services and (e) other capital receipts.

The trend analysis provides important inputs for further planning. It is also the basis for the subsequent gap analysis. Performance changes registered within a time span of three years are averaged out. In assessing past performance the following factors are taken into consideration: Appropriateness of valuation and assessment, timely billing, collection efficiency and enforcement mechanisms.

The city’s administration collection efficiency is reviewed using two indicators: Actual efficiency and billing efficiency respectively. The key indicator used for measuring the performance is per capita revenue collection. The table below sets out the key tasks.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 List all revenue items</td>
<td>Identify all municipal revenue items and list them • Tax revenues from municipal services • Municipal rent revenues and investment incomes • Municipal service charges • Revenues sales of goods and services • Other capital receipts</td>
</tr>
<tr>
<td>2.1 Assess past performance of revenue titles</td>
<td>Perform collection efficiency analysis • Calculate the average performance of the last 3 years of the revenue items • Compare the per capita revenue collection of the city with other cities</td>
</tr>
<tr>
<td>2.3 Identify main difficulties in past revenue performance</td>
<td>List main problems encountered • Perform risk analysis • Rank the problems according to their impact on the revenue performance</td>
</tr>
</tbody>
</table>

**STEP 3: Examination of expenditure management**

Enhancing the well-being of citizens via the provision of public services is the most important responsibility of cities. Hence, an assessment of the potential revenue sources is made on the basis of public services identified as essential.

City administrations are also required to align their revenue plan with the existing National and Provincial Governments’ guidelines on Expenditure Management and Control and its cardinal principles of efficiency, effectiveness and economy. This includes eliminating unnecessary recurrent expenditures or costs. Put differently, city administrations are told to strive towards attaining the twin goals of providing quality urban services and customer satisfaction by maximising the sustainable flow of their stream of income and bolstering up their investment into municipal services.

As an integral component of expenditure management a prudent and participatory budget planning regime geared towards indicating clearly the revenue and expenditure layouts is required.

Measurable performance indicators need to be developed and implemented accordingly. Further, an estimate of cash flow broken down on a quarterly basis is being proposed. The table below sets out a checklist of key tasks for this step.
### 3.1 Align with Expenditure Management and Control Reform Programme

- Follow the principles of Efficiency, Effectiveness and Economy
- Analyse value for money
- Develop mid-term fiscal planning
- Prepare strategic plan for 3-5 years
- Involve the public when preparing strategic plans
- Implement cost-centre budgeting (see also Step 5)
- Avoid misuse of public funds
- Get annual audit reports within 6 months after the end of every fiscal year
- Consider the goals and objectives established in the GTP
- Review expenditures thoroughly if financial balance is negative

### 3.2 Budgeting process

- Ensure public participation
  - Use the participation manual of MUDC
  - Mobilise public participation in forms of cash, labour and skill
  - Seek active community participation in the preparation of 3 years strategic plan
  - Use ‘top-down’ and ‘bottom-up’ processes for budgeting.

### 3.3 Assess expenditures of cities

- Clearly distinguish capital and operating expenditures
- List and analyse items of recurrent and capital expenditures of last three years
- Assess sources of finance for each type of expenditure
- Compare the planned expenditures against the actual performance
- Calculate the per capita expenditure of the past 3 years and compare data with another, similar city
- Identify the controllable and uncontrollable costs of the city
- If costs overrun, try to balance budget by reducing unnecessary expenditures

### STEP 4: Strategies to increase revenue enhancement efficiency

In step 4 problems related to the efficiency of revenue administration are identified. Plausible strategies to increase revenue administration efficiency need to be examined:

- Initially the amount of revenue generated from each financial source (tax, charge or user fee) needs to be calculated.
- Utilising the equation made up of the five tax item components, the potential revenue yield can be estimated.
- Key areas of revenue administration such as tax base, tax rate, tax coverage, tax valuation and tax collection have to be examined regarding potential improvements.
- Further, elements impacting on the revenue yield such as payment procedures, enforcement mechanisms, human resources and tax administration capacities have to be assessed.

The table below sets out a checklist of key tasks for this step.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate potential revenue yields through improved administration</td>
<td>Calculate: Tax Revenue = Tax Base x Tax Coverage Ratio x Valuation Ratio x Tax Ratio x Collection Ratio&lt;br&gt;Hold tax base and tax rate constant and calculate potential increase of tax revenue through improving tax coverage, tax valuation and tax collection</td>
</tr>
<tr>
<td>4.1 Broaden tax base</td>
<td>Examine the option of broadening the tax base&lt;br&gt;More of a concern for macro-economic planners</td>
</tr>
</tbody>
</table>
- Increasing tax base needs to be directly related to economic growth measures and pro-economic development strategies

<table>
<thead>
<tr>
<th>4.2 Increase tax coverage</th>
<th>✓ Start to collect relevant information on tax coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Use 'Standard Integrated Government Tax Administration System' (SIGTAS)</td>
<td>✓ To improve revenue administration efficiency</td>
</tr>
<tr>
<td>✓ Setup better communication between agencies</td>
<td></td>
</tr>
<tr>
<td>✓ Train inspection teams</td>
<td></td>
</tr>
<tr>
<td>✓ Give rewards for loyal customers</td>
<td></td>
</tr>
<tr>
<td>✓ Consolidate database with other tax agencies</td>
<td></td>
</tr>
<tr>
<td>✓ Use Tax Identification Number (TIN)</td>
<td></td>
</tr>
<tr>
<td>✓ List the registered tax, user charge and fee payers</td>
<td></td>
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<tr>
<td>✓ Analyse the collected data of potential taxpayers</td>
<td></td>
</tr>
<tr>
<td>✓ Perform continuous inspections</td>
<td></td>
</tr>
<tr>
<td>✓ Compare the status of coverage for each tax item</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.3 Consider tax rate and ratio</th>
<th>✓ Monitor the appropriateness of tax rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Assess tariffs and rates of all services at least once in two years and contact the regional BUDC to request revision of a tariff whenever necessary</td>
<td></td>
</tr>
<tr>
<td>✓ Assessment of tariffs and rates must consider the economic situation</td>
<td></td>
</tr>
<tr>
<td>✓ Conduct a survey to measure taxpayer capacity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.4 Valuate and assess tax</th>
<th>✓ Establish mechanisms for assessing taxpayers</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Compare any economic unit with its market value continually</td>
<td></td>
</tr>
<tr>
<td>✓ Create a clear procedure and encouragement for self-assessment</td>
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<tr>
<td>✓ Implement tax education programmes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>4.5 Maximise collection ratio</th>
<th>✓ Summarise recent tax arrears, evaluate arrears using annex 1, table 7 on CD</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Observe large, medium and small size businesses that have trouble paying taxes</td>
<td></td>
</tr>
<tr>
<td>✓ Identify basic reasons for non-compliance</td>
<td></td>
</tr>
<tr>
<td>✓ Create strong and continuous tax awareness campaign</td>
<td></td>
</tr>
<tr>
<td>✓ Abolish small and inefficient taxes</td>
<td></td>
</tr>
<tr>
<td>✓ Evaluate both uniform and timely cases of arrears</td>
<td></td>
</tr>
<tr>
<td>✓ Compile accurate information</td>
<td></td>
</tr>
<tr>
<td>✓ Allocate sufficient resources for revenue collection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.6 Evaluate payment procedure</th>
<th>✓ Shorten payment procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Encourage self-assessment</td>
<td></td>
</tr>
<tr>
<td>✓ Establish different means of payment</td>
<td></td>
</tr>
<tr>
<td>✓ Organise payment schedule</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.7 Implement appropriate enforcement mechanism</th>
<th>✓ Clearly communicate the enforceable legal codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Create a clear and uniform appeal process</td>
<td></td>
</tr>
<tr>
<td>✓ Conduct regular information forums for tax payers</td>
<td></td>
</tr>
<tr>
<td>✓ Distribute explanatory materials on the benefit of tax compliance and consequences of non-compliance; Additionally use other media (e.g. Radio, TV) to create awareness</td>
<td></td>
</tr>
<tr>
<td>✓ Produce timely data on defaulters and take appropriate legal actions</td>
<td></td>
</tr>
<tr>
<td>✓ Review fines</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.8 Develop human resources and capacities</th>
<th>✓ Equip the revenue staff appropriately with knowledge and material</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Allocate reasonable annual budget to enable offices to perform their task</td>
<td></td>
</tr>
<tr>
<td>✓ Fill existing vacancies</td>
<td></td>
</tr>
<tr>
<td>✓ Introduce staffing plan and produce terms of reference for each employee</td>
<td></td>
</tr>
<tr>
<td>✓ Revise staffing plan when necessary</td>
<td></td>
</tr>
</tbody>
</table>
STEP 5: Determining the true cost of service provision – allocating costs

Cities have no cost accounting system that operates on its own and correctly reflects the full costs of services and products. Hence, cities are institutionally handicapped to competently price their services and products.

In due recognition of this deficit, city administrations should set up a functional cost accounting system. When putting this system in place, the first step is to set up cost centres for clearly defined municipal services. The costing department of each utility/unit captures all costs, calculates them and allocate these to cost centres. To that effect, cities are advised to employ a cost centre approach whenever preparing their annual budgets. After having created cost centres, the costs of the services these cost centres provide have to be calculated.

The table below sets out a checklist of key tasks for this step.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Details</th>
</tr>
</thead>
</table>
| 5.1 Create cost centre for services | Create cost centres  
  - Clearly assign responsibilities to officials  
  - Analyse the city administration’s organisational structure and work processes for mapping the cities financial resources  
  - Include all major service centres in cost centres  
  - Put unclassified cost services as auxiliary combined into one cost centre  
  - Create line cost centres at least for the following services  
  - Environmental protection and regulatory services  
  - Infrastructure services  
  - Auxiliary services |
| 5.2 Calculate the cost of services | Select services to be costed  
  - Define service or product and quantity provided  
  - Define nature of unit for calculation of unit cost  
  - Capture all costs and calculate costs for municipal services by summarising  
  - Direct cost of particular service  
  - Indirect cost to provide this service  
  - Calculate annual service charge according to the following formula:  
  - Annual service charge = Annual total cost divided by the number of customers  
  - Annual service charge at 80% cost recovery = Annual cost – 20% annual costs divided by the number of customers |

STEP 6: Analysis of other means of increasing revenue

After having improved revenue administration (Step 4) and calculated the costs of services (Step 5), tax rates, user charges and fees may be adjusted under careful consideration of their impact on citizens. Additionally, new revenue sources should be identified.

Public-Private Partnerships (PPPs) may help to reduce costs by outsourcing public services to competitive and cheaper private actors. Private actors can cross-subsidise some municipal projects that in return generate revenue through taxes, charges and user fees.

To continue raising revenue from taxpayers, resources mobilised must be transparent and be seen to contribute towards the delivery of services required by taxpayers.

A prioritisation of capital investment projects will be needed based on the Capital Investment Plan???. Revenue collection and investment in projects have to be interlinked directly. The table below sets out a checklist of key tasks for this step.
**Tasks** | **Details**
--- | ---
6.1 Increase tax rate and adjust user charges and fees | - Evaluate tax rates, user charges and fee rate adjustments
  - Consider socio-economic dynamics of the city
  - Raise institutional capacity of finance and revenue departments
  - Balance tariffs with their cost of service delivery
  - Consider inflation
  - Involve the public in the tax adjustment process
  - Make sure that the increase in tax or tariff is in support of the local development strategy and translates into additional and improved services
  - Review own ability to effectively raise revenue level
  - Identify the reason for the increment of the tax base of a certain item
  - Clearly show which tax or tariff is planned to be increased (which, when, how)
  - Give reasons for the changes
  - Describe the actual situation of revenue and expenditure (cost centre approach)
  - Describe the outcome of inaction

6.2 Introduce new taxes, user charges and fees | - Identify potential new taxes, user charges and fees
  - Give attention to items that have high yields

6.3 Consider Public-Private Partnerships | - Evaluate the pros and cons of PPP
  - Carefully analyse which services can be effectively delivered to the public in this mode (e.g. waste disposal, cemeteries, …)
  - Differentiate services to be provided by the government alone and services to be left for private sector involvement
  - Relentlessly analyse risk factor and conduct feasibility study

6.4 Choose the right option | - Explore all options available to properly justify charges for services

**STEP 7: Estimating the funding base for financing investment**

Only after having analysed all ‘internal’ possibilities of revenue enhancement as well as potential cooperations with the private sector, city administrations should turn to external funds for delivering services and products to the citizens.

Loans or credit finance are regarded as a natural sources of capital financing. To utilise those sources credit-worthiness is vital. Further, good governance principles such as accountability and transparency need to be applied. A thorough assessment must take place prior to the decision to borrow. Debt management must be taken into account before an arrangement with a financial institution is made.

Hence, city administrations are advised to:

- limit their borrowing to capital expenses, large and costly projects as well as income earning investments,
- explore sources and methods of borrowing, • assess their borrowing capacity, and • consider the debt management afterwards.

A checklist for Step 7 is set out below.

**Tasks** | **Details**
--- | ---
7.1 Understand the purpose and extent of borrowing | Borrowing should be restricted to:
  - Long-term loans for capital expenses
  - Large and costly projects which have long term utility
  - Investment which is expected to earn income
Urban authorities should not borrow at any rate, especially not to cover:
- Short-term cash-flow deficit
- Deficit in the annual operating budget

### 7.2 Sources and methods of borrowing

**Potential sources:**
- (a) city administrations credit enhancement facility
- (b) sinking fund investment bond
- (c) intermediary lending institutions
- (d) city administration bond market
- (e) city administration borrowing subsidisation grant

Since the borrowing process is long, get approval:
- At city level: city cabinet and city council
- At regional level: Board, BoFED, regional government council and regional council
- At federal level: MoFED

### 7.3 Assess borrowing capacity

- Only borrow to the limit you can service your debt
- Answer the following questions critically:
  - Does the investment financed by a loan actually lead to economic growth?
  - How long does the expected economic growth take to materialise?
  - Does such economic growth increase the specific revenue, which the borrowing authority does or can exploit?

### 7.4 Consider debt management

- No long-term debt for current expenses
- Retire short-term debt within 12 months
- Limit yourself to the maximum per capita loan
- Limit long-time borrowing to capital investment
- Fix your annual debt service so it will not exceed the limited percentage of the total operating revenues
Tool MF 2: Green investment financing plan

What is a GIFP?

A green investment financing plan (GIFP) provides a systematic approach to deciding on the most appropriate financing structure for the city’s green investments. In the context of the investment plans of the city, utility or service unit, and the context of the available finding (Tool 1) and the local capital markets, the tool will generate a financing plan for the investment pipeline. This will provide the basis of a clear strategy to be carried out by the finance unit of the entity concerned.

The responsibilities for its implementation should also be clearly defined. Some financing sources will require specific legal structures and these both need to be costed into the project and to be established in a timely fashion. The main revenue sources for funding, potentially including taxes, service charges and fees, need to be assured (“ringfenced” in the case of PPPs) so as to repay financing over time.

Structure of the Tool

The tool is structured by the main steps required to prepare a GIFP:

- **Step One** sets out the key information that needs to be assembled by the unit coordinating the GIFP, in particular: the estimated project costs, broken down by major component; the sectoral priority of the project (derived from a structured project prioritisation exercise); documents potential financing sources and funding context (see Tool 1 GIRP) including the flow of grant finance linked to particular types of project types.

- **Step Two** is a structured analysis of all projects and their main components to determine which projects and/or components could recover their costs from user charges or other means and could thus be implemented/financed by the private sector.

- **Step Three** classifies and prioritises projects by investment size into those that are a) small and urgent and thus must use current revenue, and b) those that are large or that are small but less urgent and can be “bundled” into larger investment packages - these will need to be at least partially financed.

- **Step Four** is a “market sounding” relating to a) the likelihood of attracting private investors and/or finance to those projects identified for private sector implementation and b) the cost and timing of potential private and public financing (international – including all costs – and national) of non-private investments.

- **Step Five** plots needed financing for prioritised projects (net of small urgent projects) and potential tied external grants, among projects according to their economic IRR and urgency as determined by the GAM approach in Step 3 over the investment period (including phasing of projects/components).

- **Step Six** allocates recurrent revenue surplus (net of small urgent projects) and potential tied external grants, among projects according to their economic IRR and urgency using a GAM approach – the GIFP.

- **Step Seven** describes the process of establishing the legal and other structures required to implement the plan – and for monitoring the performance of financing.

---

225 The capital markets provide finance (equity and debt) for periods of over one year – all largescale projects will need access to such finance.
226 That is, legally separated or guaranteed stream of revenue tied to a particular project or programme.
227 Potentially a Tool 3 similar to CDIA’s City Investment Programming and Prioritisation Tool.
228 If there is no interest, or if the likely charges are deemed unacceptable, then the project(s) revert to public sector implementation and the process reverts to Step 2.
evaluating its effectiveness and reallocating resources as circumstances change (on a quarterly basis).

**Why is planning for financing important?**

The capacity for city administrations to supply urban services and undertake the necessary green infrastructure development is naturally constrained by limited financial resources and the level of development of the local capital market. Ineffective performance relating to financing is most commonly the result of a combination of factors, including:

8. **Revenue base and yield:** Given the capacity of a city or entity to repay financing is constrained by its net income, this issue is the basis of financing and is addressed in Tool 1 – the Green Investment Resource Plan. Of particular importance in respect of PPPs are caps on user charges.

9. **Procurement Process Efficiency:** Over-detailed and lengthy procurement processes that can be “second-guessed” by oversight agencies add to time and costs and thus to financing costs.

10. **Restrictions on borrowing etc:** Although prudential standards are essential, artificially restricting access to capital markets stifles both city investments and the development of the capital markets.

11. **Efficiency and access to local capital market:** Access complex, lengthy and then very short term. Some instruments eg bonds, have high transactions costs for small amounts. Institutions restricted in the types of investments they can finance.

12. **Transparency and contract execution failures:** Undertaking financing in a non-competitive manner potentially increases the cost of financing – thus reducing the amount of financing that can be undertaken. Experiences of non-transparency in procurement and/or abrogating contracts also increases the cost of finance as financiers and private investors increase their risk premium.

13. **Weak human resources:** The above problems in the finance system are worsened by the weak human resource capacity of financial planning staff and poor incentives for enhancing performance.

Building the capacity for a transparent finance planning process provides the opportunity to maximise the effectiveness of financing (in terms of cost and timing) and to minimise the negative implications of some of the above contextual failings. The massive accumulation of new infrastructure requirements and the substantial need of resources to maintain, renovate and replace older, deteriorating equipment has compounded the urgency of this process. The major objective is to maintain a steady increase in the sustainable financing available to the city or entity, enabling investments to keep pace with population growth rates and the expectations of citizens for a better quality environment.

**How is the GIFP linked to strategic objectives?**

All capital investments in a city should be “green” in that all should be assessed for their potential to include low carbon or pollution abating elements in design (see other Tools contained in Position Papers) and should be resilient against the impact of climate and other risks. Guided by City Climate Plans, city development plans imply sets of investments which require financing. Cities in China have many different agencies and other entities that engage in investment. But the financial impact of investment financing costs, and associated operating and maintenance costs implications needs to be consolidated into city financing plans so that such plans will be sustainable. This is the role of Tool 1. Tool 1 and this tool can also be used by a sub-set of the city government – a utility or a urban development investment company for example.
STEP 1: Information base for GIFP drafting

Step One sets out the key information that needs to be assembled by the unit coordinating the GIFP, in particular: the estimated project costs, broken down by major component; the sectoral priority of the project (derived from a structured project prioritisation exercise), documents potential financing sources and funding context (see Tool 1 GIRP) including the flow of grant finance linked to particular types of project types.

Fmt for costs

<table>
<thead>
<tr>
<th>Project</th>
<th>Component</th>
<th>Cost ($m)</th>
<th>Sector priority</th>
<th>Narrative Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
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<tr>
<td>etc</td>
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</tbody>
</table>

Financing potentials

Undertake analysis of the national capital market and potential international financing potentials.

\[^{229}\text{Potentially a Tool 3 similar to CDIA’s City Investment Programming and Prioritisation Tool.}\]
The figure below shows the breadth of options.

### Format for documenting funding potentials

<table>
<thead>
<tr>
<th>Funding source</th>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Local Revenue (may need to be subdivided if not fungible across capital costs)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Grant Type 1</td>
<td></td>
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<td></td>
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<tr>
<td>Grant Type 2 etc</td>
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<td></td>
</tr>
</tbody>
</table>

### Format for financing sources (include LG funding at opportunity cost)

<table>
<thead>
<tr>
<th>Financing Source</th>
<th>Maximum Yield</th>
<th>Processing Time</th>
<th>Interest Rate</th>
<th>Transactions cost (MRV etc)</th>
<th>Comments (safeguards etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
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<td>Y</td>
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<td>etc</td>
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</tbody>
</table>
STEP 2: Private sector potential

Step Two is a structured analysis of all projects and their main components to determine which projects and/or components could recover their costs from user charges or other means and could thus be implemented/financed by the private sector.

Format for Private Sector Analysis

<table>
<thead>
<tr>
<th>Project</th>
<th>Components</th>
<th>Potential for full cost recovery (describe issues)</th>
<th>Cost ($m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>Strong, Some, None</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
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<tr>
<td>etc</td>
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<td></td>
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</tr>
</tbody>
</table>

STEP 3: Project triage

Step Three classifies and prioritises projects by investment size into those that are a) small and urgent and thus must use current revenue, and b) those that are large or that are small but less urgent and can be "bundled" into larger investment packages.

Step 3A: bundle small, non-urgent projects according to technical feasibility within sectors.

Step 3B: conduct a cross-sectoral Goals Achievement Exercise (CDIA CIIPP-based) of all large projects.

Appendix: Description of GAM methodology

STEP 4: Market sounding

Step Four is a "market sounding" relating to a) the likelihood of attracting private investors and/or finance to those projects identified for private sector implementation and b) the cost and timing of potential private and public financing (international – including all costs – and national) of non-private investments.

Appendix: Market sounding from VFM guidelines

STEP 5: Investment timeline

Step Five plots needed financing for prioritised projects (net of small urgent projects) and potential tied external grants, among projects according to their economic IRR and urgency as determined by the GAM approach in Step 3 over the investment period (including phasing of projects/components) against financing/funding limits as determined in Step 1.

Capital Expenditure < borrowing limit < split up into projects/components

If there is no interest, or if the likely charges are deemed unacceptable, then the project(s) revert to public sector implementation and the process reverts to Step 2.
**STEP 6: Financing vs Investment timeline**

Step Six allocates recurrent revenue surplus (net of small urgent projects) and potential tied external grants, among projects according to their economic IRR and urgency using a GAM approach from Step 3 versus the available, lowest-cost financing set out in Step 1 and confirmed, in respect of the private sector, in Step 4 – the GIFP.

![Diagram: Capital Expenditure < borrowing limit < split up into projects/ components < split up into financing sources](image)

**Decision rule:**

1. Apply cheapest applicable\(^{231}\) funding first Subject to:
   
   2. Aligning timing of availability with scheduled\(^{232}\) start of project(s)\(^{233}\)
   
   3. Aligning tenor of financing repayment with lifespan of project\(^{234}\) or likely time to exit/ refinance in relation to PPPs.\(^{235}\)

One financing source (such as Green bonds) can cover more than one project. In this case, reporting systems required of financiers need to be considered in the design of management systems for each project.

**STEP 7: Implementation structure**

Step Seven is the process of establishing the legal and other structures required to implement the plan – and for monitoring the performance of financing, evaluating its effectiveness and reallocating resources as circumstances change (on a quarterly basis).

*A Decision Tree helps select institution type and financing vehicle (if any)*

The key questions are:

- What is the nature of the “enterprise” or service?
- Does implementation of the investment program involve multiple projects or is it focused on one investment type?

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\(^{231}\) Obviously a grant given for water supply cannot be used on a bus station

\(^{232}\) The schedule should include realistic estimates of time for land acquisition, design and documentation, and approvals.

\(^{233}\) If the project is urgent then MDB/ GCF finance – which takes a minimum of one year to process and approve – is unlikely to be used unless there is an existing financing facility with unused capacity for which the project is eligible

\(^{234}\) This is not binding – projects can be, and usually are, financed with tenors shorter than the project life, but the cost will usually be higher the shorter the tenor, and if the financing is structured so as to “roll over” the principle there is significant refinancing risk that should be taken into account.

\(^{235}\) The refinancing risk, if it applies to the local government, should be factored in to likely cost of finance.
• Is it geographically focused on one area of the city (e.g., a public transport corridor) > Development Corp; or is it metro wide (e.g., usually water supplies) > Metro Utility?
• Is the investment (or sub-investment) cost recoverable?
• Does the LG have the mandate to use private sector equity/finance? > PPP or not
• Need for SPV? etc

The process is set out in the diagram below.
9. GREEN INDUSTRIES
Old and abandoned industrial sites are a physical asset – an urban challenge: Cannon factory, Zhuhai

Green products are becoming prime concern of new and green industries – Toshiba in China

Old industrial facilities as locations for creative industries, culture and entertainment – 798 Art District, Beijing

The major asset of old factories is their neighbourhood location: ideal for clean production – Nanluoguxiang, Beijing

Adaptive re-use: cultural institution in old factory complex - 798 Art District, Beijing

Creative activities and non-polluting industries in old factory buildings – 798 Art District, Beijing

Source: F. Steinberg
Sector Profile of Green Industries

**Introduction.** Manufacturing and construction activities generate a lot of waste—as much as four times produced by households. One way to overcome this problem is to mimic nature, where waste produced by one organism is often reabsorbed by another as part of symbiosis. Industrial symbiosis offers the same kind of solution, whereby the waste or by-product of one enterprise becomes the resource or input of another. Green industrial complexes and eco-industrial parks have defined ambitious targets for reducing energy consumption, waste generation and carbon emissions. A more proactive and larger scale approach is being taken in ‘Circle Economy’ (CE) Cities in China.

**State of Demand in China.** Cities with effective recycling schemes can recycle up to 75% of household waste, but manufacturing and construction activities generate four times as much waste as households. One way to overcome this problem is to mimic nature, where waste produced by one organism often is reabsorbed by another. Industrial processes can follow a similar path, turning the waste or by-product of one enterprise into the resource or input of another. This is the approach being taken by “circle economy” cities in China. China’s rapid economic growth over the past decades has been accompanied by substantial depletion of natural resources and serious environmental pollution. The objective of the CE approach is to achieve the decoupling of economic growth from natural resource depletion and environmental degradation. Successful implementation requires government involvement and effective institutional arrangements. Although introducing the CE approach initially imposes some increased costs and often requires substantial investments from both government and private entities, many of the CE solutions also turn out to be economically advantageous when the costs of environmental externalities that are avoided are fully taken into account. The legislation, policies, and pilot programs already in place demonstrate the potential of CE.

**Policy Directions.** The Government’s 13th Five-Year-Plan addresses these challenges through an ambition of achieving “green and inclusive growth” and specifically in the environmental area of promoting clean production, setting up green and low-carbon industry systems, promoting green finance, and establishing a green development fund. Key tasks mentioned include setting up a nationwide, real-time online environmental monitoring system and an emissions permit system that will cover companies with static pollution sources as well as including environmental protection in outgoing officials’ performance evaluation.

**Industrial policy framework.** Green industries form part of the general industrial policy framework, but have strong linkages to energy, housing, transport, land-use and resource policies as well. This paper looks at green industries from the perspective of urbanisation and how to promote sustainable urban development. The intention is thus not to cover all aspects of industrial policy, but to present the elements that are most relevant to city representatives, urban planners and developers in shaping an ecological and low-carbon urban development.

**Best Practices in Europe.** In January 2012, the rationale for a circular economy concept in Europe was articulated. It was the first of its kind to consider the economic and business opportunity for the transition to a restorative, circular model. The report details the potential for significant benefits across the EU. It argues that a subset of the EU manufacturing sector could realise net materials cost savings worth up to $630 billion p.a. towards 2025—stimulating economic activity in the areas of product development, remanufacturing and refurbishment. Towards the Circular Economy also identified the key building blocks in making the transition to a circular economy, namely in skills in circular design and production, new business models, skills in building cascades and reverse cycles, and cross-cycle/cross-sector collaboration.

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236 China Daily, 3 November 2015 regarding the Adoption of the CPC Central Committee’s Proposal on Formulating the Thirteenth Five-Year Plan on National Economic and Social Development
Best Practices in Europe: European practices of green industries demonstrate a determination to switch to clean energy and an adaptation of the circular economy concept. Some of the examples can be found in the following cities and countries:

- **Jämtland County, Sweden: The fossil fuel-free region.** The county of Jämtland has implemented a long-term programme to become a “fossil fuel-free region”. The county claims to be the first European county to have all its operations certified with ISO 14001 and EMAS. This is mainly done by taking advantage of the regional assets to develop renewable energies, mainly wind power and biomass.  
  
- **Galicia, Spain: Business and Innovation Centre Tecnópole.** This science & technology park that was not originally conceived as an eco-park, but since 2009 it participated in the ECOMARK project and part of its activities focuses on eco-innovation. The park includes a technologic centre, a business incubator, and consists of companies operating in various sectors including: automotive, electronics, ITC, services, renewable energies etc.  
  
- **Landskrona, Sweden: Industrial Symbiosis.** The project involved 21 businesses, mostly SMEs, covering various sectors such as agriculture, chemistry, metal works, auto parts, printing, packaging, waste management, recycling, transport and logistics. The intention is to establish “a collection of long-term, symbiotic relationships between and among regional activities involving physical exchanges or materials and energy carriers as well as the exchange of knowledge, human or technical resources, concurrently providing environmental and competitive benefits".  
  
- **Kalundborg, Denmark: Sustainable city / symbiosis.** The scarcity of water was the motivation factor behind the project and led to cooperation among the different economic players. By using surface water from a nearby lake for a new oil refinery, the limited supplies of groundwater were saved. The reduction of costs led to even more innovative approaches. The focus was especially on how to income-produce uses for “waste” products.  
  
- **Barcelona, Spain: Industrial area 22@Barcelona.** This project was launched in 2000 to regenerate an industrial area inside Barcelona city by attracting new environmentally friendly businesses and foster sustainable urban and economic development. 22@Barcelona focuses on five knowledge-intensive economic clusters and sectors: ICT, media, biomedical, energy and design.  
  
- **Emmen, The Netherlands: Emmtec Industry & Business Park.** The companies at Emmtec Industry & Business Park use residual heat and cooling and process water is recycled. Besides, residual substances are used as raw material and packaging materials are taken back by the suppliers.  
  
- **Turin, Italy: Conversion of Incet Factory –Barriera di Milano.** This redevelopment takes place in the former headquarters of a company known as Incet, which made electric cables and was active until 1968. After acquiring the campus of giant white buildings, city authorities briefly used it as a pound for confiscated vehicles before letting it sit vacant for decades. Now, Turin is renovating the buildings into a hub of what officials here call “open innovation” — and perhaps, a spark plug for a new post-industrial economy.

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• North-Rhine Westphalia, Germany: Converting a Coal Mine Into Giant Battery Storage for Surplus Solar and Wind Power. The Prosper-Haniel coal mine in the German state of North-Rhine Westphalia will be converted into a 200 megawatt pumped-storage hydroelectric reservoir that acts like a giant battery. The capacity is enough to power more than 400,000 homes.  

State of the art in green industries in Europe. In July 2014, the European Commission adopted a Circular Economy Package including an overall paper: “Towards a circular economy: a zero waste programme for Europe” and communications on sustainable buildings, green employment, SMEs, and waste review. The package had a strong focus on waste management and in early 2015 the package was redrawn and the waste part was replaced by a more ambitious proposal to promote the circular economy, i.e. exploring synergies with other policies and how to address more concretely the country specific implementation issues. A hearing and consultation process in connection with the development of a white paper on Circular Economy was put in place from June to August 2015 with the aim of developing a comprehensive approach in the EU before the end of 2015. In December 2015 the Commission presented the new Circular Economy Package in the form of an EU Action Plan for the Circular Economy.

The CE package set long-term waste targets and presents a list of concrete actions to be carried out before 2020 management and recycling. Key elements of the revised package include:

• A common EU target for recycling 65% of municipal waste by 2030;
• A common EU target for recycling 75% of packaging waste by 2030;
• A binding landfill target to reduce landfill to maximum of 10% of all waste by 2030;
• A ban on landfilling of separately collected waste;
• Promotion of economic instruments to discourage landfilling;
• Simplified and improved definitions and harmonized calculation methods for recycling rates throughout the EU;
• Concrete measures to promote re-use and stimulate industrial symbiosis - turning one industry's by-product into another industry's raw material;
• Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g. for packaging, batteries, electric and electronic equipment, vehicles).

Successful CE implementation requires government involvement and effective institutional arrangements, but first it requires knowledge about practical solutions and benefits. Although introducing the CE approach initially imposes some increased costs, many CE solutions also turn out to be economically advantageous when the avoided cost of environmental damage and saved operational costs are taken into account. The legislation, policies, and pilot programs already in place demonstrate the potential of CE to make a difference. Such projects must according to the CE approach focus on improving the effectiveness and efficiency of CE policies:

244 http://www.ecowatch.com/coal-mine-hydroelectric-2321724350.html?utm_source=EcoWatch+List&utm_campaign=4a468a195a-MailChimp+Email+Blast&utm_medium=email&utm_term=0_49c7d43dc9-4a468a195a-86067345
actively involving the production sector, local government, community groups, industrial associations, professional networks, and nongovernment organizations in establishing a CE;

building capacity for CE implementation and monitoring through enhanced training and dissemination of local and international experience; and

strengthening governance by establishing high-level leadership, coordinating CE efforts across sectors and ministries, and promoting and enforcing private CE activity rather than directly implementing such activity. 246

Promotion of green energy – renewable energy and energy efficiency - is a cornerstone of the EU climate change policy and prerequisite for the move towards a circular economy. The policy framework for EU for climate and energy therefore deals with three areas: Greenhouse gas emissions, renewable energy and energy efficiency.

The EU Directive on renewable energy sets a binding target of 20% of final energy consumption from renewables by 2020. All member states have adopted national renewable energy action plans that detail the actions they intend to take to meet their individual targets. The individual targets vary substantially between the member states from 10% in Malta to 49% in Sweden. In 2014, the share of renewable energy reached 15% and thereby reached the interim target towards 2020. The progress of the member states is assessed every two years.

As part of EU’s energy and climate goals for 2030, EU countries have agreed a new target for 2030 of at least 27%. To reach the 2030 target the Commission has identified that in sectors such as housing, other transport modes and electrical equipment there will be a need for a significant acceleration of current efforts to tap what the Commission calls ‘a significant unexploited potential’. It is foreseen that large investments will be needed in the building sector (leading to lower running costs), as well as framework conditions and information that encourage consumers to take up innovative products and services. Ambitious EU-wide Energy Efficiency Standards for appliances, equipment, buildings and CO2 standards for vehicles will be needed. To avoid distorting energy prices and the market, EU has issued guidance on support schemes to help governments design and revise support schemes. The guide focuses on renewable energy for electricity generation.

A third area that is strongly related to the green industry agenda is the promotion of green growth or greening of the economy— green employment, promotion of green technologies exports, and development of new technologies and practices through innovative procurement. In 2014 the European Commission launched its Green Employment Initiative: Tapping into the job creation potential of the green economy. The Commission label the potential of employment creation linked to the production of energy from renewable sources, energy efficiency, waste and water management, air quality, restoring and preserving biodiversity and developing green infrastructure as significant and resilient to changes in the business cycle.

Small and medium-sized enterprises (SMEs) are the backbone of the European Union as the 20.7 million companies represent more than 99% of all European businesses. 85% of new

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248 European Commission, European Commission guidance for the design of renewables support schemes, Brussels, 5-11-2013

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jobs over the past 5 years were created by SMEs and they provide 67% of total employment. The European Commission promotes the growth of SMEs through the Small Business Act for Europe. The Act includes an initiative to raise SMEs awareness of environmental and energy-related issues and to assist them in implementing legislation, assessing their environmental and energy performance and upgrading their skills and qualifications. The European Commission has collected examples of good practice in various areas e.g. in "Enable SMEs to turn the environmental challenges into opportunities".

**State of the art in green industries in China.** Industries form an integrated and important part of the fabric that cities are made of. At a national level, a country’s industrial sectors pay a crucial role in moving the national economic output and growth towards achieving the objectives of sustainable development. The behaviour and decisions made in and in relation to the industrial sector form the cities, the people living in them and conditions and environment in which they live. If managed well, urbanisation and industrialisation can bring important benefits for development. Cities are an efficient way of organising populations; they enable economies of scale and reduce the need for transportation, thereby making economic activity more environmentally friendly.

**Negative externalities.** Higher population density, however, also creates challenges in terms of negative externalities especially if urbanisation is rapid and poorly-planned. The availability and quality of infrastructure are at the core of many of the challenges faced by rapid developing cities. Further issues that are likely not to be able to keep pace with growth and expectations of cities include air pollution, access to sufficient and clean water and dealing with wastes.

**Industries and environmental degradation.** China’s rapid economic growth over the past decades has been accompanied by substantial exploitation of natural resources and serious environmental pollution. The increasing concern about environmental pollution in urban areas, especially air pollution from industry and energy generation, is leading to changes in the approaches to planning and integration of industries. E.g. the promotion of high tech and light manufacturing in the East of China and relocation of heavy industries to the Mid and West China. The potential for improving the environmental conduct of the individual industries and clusters of industries remain, however, largely untapped.

**Cities and high carbon emissions of carbon-based fuels.** Cities in China are large procurers of materials, energy and infrastructure. The cost of materials for building construction is an increasing concern, as construction activities are taking place at a high pace and little experience exists in recycling of building materials. The energy demand for cement and metals production is enormous and the rapid developing housing sector thus has a direct impact on energy demand and emissions. Improving energy efficiency in the construction sector, especially in the production of building materials and recycling of materials, will have a significant positive impact on the environment.

[250 Ec.europa.eu/growth/smes]
Development choices. In the next 15 years, China will face a series of important choices, which will shape both China’s future and that of the world:

- China has the opportunity to become a high-income economy, but sustainable economic growth is needed over the next 20 years to avoid the middle-income trap.
- China has an opportunity to lead the world in developing new and renewable energy solutions, but will need major reform of the energy system to build safe, efficient, clean and low-carbon energy supply and consumption systems.
- China has the opportunity to play an important role in global low-carbon development and to move upstream in the industry chain, but will need to further limit greenhouse gas emissions and manage the risks of climate change.
- China has the opportunity to optimise economic growth through environmental improvement, but needs to improve environmental management.

Commitment to reduction of fossil fuels. China’s commitment to increase the share of non-fossil fuels in primary energy consumption is strong and has been confirmed through several important agreements. The principal commitment is to increase non-fossil fuels to around 20% by 2030. One of the measures is promotion of trade in green goods through e.g. encouraging trade in sustainable environmental goods and clean energy technologies; focus on smart low-carbon cities and smart low-carbon growth technologies.

China’s new normal. The notion “China’s new normal” was introduced in June 2015 to describe the Chinese shift in strategy towards structural change, better growth and peak emissions. A good example of the shift is seen in international cooperation efforts in the promotion of renewable energy that is now receiving increased attention, e.g. the cooperation agreement between China State Grid Energy Research Institute and the US Department of Energy’s National Renewable Energy Department (NREL) in relation to developing mechanisms to ensure achieving the full benefits of the large investments in renewable energy already made, e.g. integration of fluctuating renewable energy sources into the grid.

Circular Economy. Circular Economy (CE) is a relatively recent economic concept, seeking to ultimately decouple global economic development from finite resource consumption. It enables key policy objectives such as generating economic growth, creating jobs, and reducing environmental impacts, including carbon emissions. The CE model is developed as a reaction to the linear ‘take, make, dispose’ model that relies on large quantities of easily accessible resources and energy. The model acknowledges that working towards efficiency – a reduction of resources and fossil energy consumed per unit of economic output – will not alter the finite nature of their stocks, but can only delay the inevitable depletion, wherefore a deeper change of the operating system is needed.

Circular Economy for China. Promoting a circular economy was identified as national policy in China’s 11th five-year plan starting in 2006 and China’s Circular Economy Promotion Law came into force in January 2009 with the purpose of promoting CE, raising the resources utilization rate, protecting and improving environment and realizing sustained development. The use of the terminology CE in China is close to the use in the EU of ‘green economy’ or ‘sustainable development.’ The CE Promotion Law aimed to decouple economic growth from resource consumption and pollution and also shifted the traditional view on solid waste treatment to the idea of closed-loop materials flows addressing reuse and recycling. Finally,

the law introduced policies and instruments for controlling the total quantities of resource consumption and pollutant discharge.

**The circular economy cycle.** The CE is perceived as a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. In its more comprehensive version the CE is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.

**Principles.** The Circular Economy rests on three key principles:

1. Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows—for example, replacing fossil fuels with renewable energy or using the maximum sustainable yield method to preserve fish stocks.

2. Optimise resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles – for example, sharing or looping products and extending product lifetimes.

3. Foster system effectiveness by revealing and designing out negative externalities, such as water, air, soil, and noise pollution; climate change; toxins; congestion; and negative health effects related to resource use.

**Proposed Green Industries KPIs**

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Investment in Clean Industries</td>
<td>(¥ bn)</td>
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</tr>
<tr>
<td>2 Relevance of Clean Industries</td>
<td>Value of industrial production (¥ bn)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value of commerce (¥ bn)</td>
<td></td>
</tr>
<tr>
<td>3 Share of green industry [1]</td>
<td>≥20% [1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazardous waste treated [1]</td>
<td>___ % of hazardous waste treated</td>
</tr>
</tbody>
</table>

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These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. *Sino-EU Key Performance Indicators for Eco-Cities*. Beijing (unpublished draft)
Environmental impact of industries

Indicators: indicative values

(asperEnv. Assessment)

Impact

Sources:

Outlook and future sector agenda. China’s pathway to a green economy is about (i) waste recycling and reutilization; (ii) clean technologies; and (iii) renewable energy. With its huge public investment, China’s environmental protection industry is expected to continue growing at an average of 15-20 per cent per year. These investments come to consolidate a massive fiscal stimulus that China committed in response to the economic and financial crisis. In absolute terms, China’s green stimulus of US$ 218 billion was the largest in the world. China is taking considerable steps to shift to a low-carbon growth strategy based on the development of renewable energy sources. But one would be wrong to think that improving air quality, creating jobs and reducing carbon-dioxide output are the main drivers of the pursuit of clean energy. It’s really about energy security. China realizes it can (literally) manufacture its own energy security in wind-vane and solar-panel factories or it can tramp around the world competing with other energy-thirsty countries for oil, gas and coal. China’s pursuit of clean energy is really about energy security. China is the world’s second-biggest economy and its phenomenal growth has been driven almost entirely by the “black” fuels. As long this fuel is not replaced, one cannot yet speak of a real greening of the industries. Thus, green industries, which represent the circular economy approach, will need to replace carbon-based technologies, and seek more energy efficiency. The retrofitting and refurbishment of old industrial complexes and their conversion to new functions opens an opportunity to develop projects of green industries which are low carbon-based, such as creative and cultural industries. Such industrial redevelopment activities represent also a form of urban renewal and revitalisation.
Tool GI 1: New energy approaches for carbon replacement.

What this tool does: This tool helps industry and city CEOs to decide about new energy choices for existing or new industries in their city. The tool helps to optimise how (i) individual industries design or retrofit their processes and deal with energy consumption, materials and waste; and (ii) they interact with other industries and sectors for overall sustainable development, and (iii) the products produced in relation to energy and materials consumption.

How does it work: Industries – new or existing - will need to decide on:

- Industrial policy change in the organisation;
- New energy model to be utilized (wind, photovoltaics, gas, fuel cells, etc.);
- Increased environmental performance through improved efficiency in resource use (energy, water soil, air);
- Reduced management costs and increased competitiveness of businesses;
- Reduced risks and enhanced security for persons and goods inside and outside (neighbours) the industrial area.

The new energy approach requires feasibility studies with an assessment of the new energy model in terms of:

- Technical suitability;
- Financial feasibility;
- Economic feasibility;
- Environmental feasibility and concurrence with existing norms and legislation.

Literature / further information:

- [http://www2.giz.de/network/eid-toolbox/info/abfrage.asp](http://www2.giz.de/network/eid-toolbox/info/abfrage.asp)
**Tool GI 2: Energy efficiency and cogeneration.**

**What this tool does:** This tool helps industry and city CEOs to decide about the use of cogeneration new (or existing) energy choices for new industries being developed in their city.

**How does it work:** Infrastructure needs to be developed which shares energy production and distribution adapted to industrial on-site demand, and off-site city demand: shared production and production of heat and steam for industrial processes (e.g. through efficient cogeneration plants fuelled by waste and biomass) and shared infrastructures for electricity production is using renewable energies. Developing shared infrastructures for wastewater collection and (pre-)treatment to mutualize water management is an additional feature of the design of cogeneration infrastructure. CHP is most efficient when heat can be used on-site or very close to it. Overall efficiency is reduced when the heat must be transported over longer distances. This requires heavily insulated pipes, which are expensive and inefficient; whereas electricity can be transmitted along a comparatively simple wire, and over much longer distances for the same energy loss.

According to the IEA 2008 modeling of cogeneration expansion for the G8 countries, the expansion of cogeneration in France, Germany, Italy and the UK alone would effectively double the existing primary fuel savings by 2030. This would increase Europe’s savings from today’s 155.69 Twh to 465 Twh in 2030. It would also result in a 16% to 29% increase in each country’s total cogenerated electricity by 2030.

“Cogeneration or combined heat and power (CHP) is the use of a heat engine or power station to generate electricity and useful heat at the same time. Trigeneration or combined cooling, heat and power (CCHP) refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector.

Cogeneration is a thermodynamically efficient use of fuel. In separate production of electricity, some energy must be discarded as waste heat, but in cogeneration some of this thermal energy is put to use. All thermal power plants emit heat during electricity generation, which can be released into the natural environment through cooling towers, flue gas, or by other means. In contrast, CHP captures some or all of the by-product for heating, either very close to the plant, or—especially in Scandinavia and Eastern Europe—as hot water for district heating with temperatures ranging from approximately 80 to 130 °C. This is also called combined heat and power district heating (CHPDH). Small CHP plants are an example of decentralized energy. By-product heat at moderate temperatures (100–180 °C, 212–356 °F) can also be used in absorption refrigerators for cooling.

The supply of high-temperature heat first drives a gas or steam turbine-powered generator and the resulting low-temperature waste heat is then used for water or space heating as described in cogeneration. At smaller scales (typically below 1 MW) a gas engine or diesel pump engine may be used. Trigeneration differs from cogeneration in that the waste heat is used for both heating and cooling, typically in an absorption refrigerator. CCHP systems can attain higher overall efficiencies than cogeneration or traditional power plants. In the United States, the application of trigeneration in buildings is called building cooling, heating and power (BCHP). Heating and cooling output may operate concurrently or alternately depending on need and system construction.

Cogeneration was practiced in some of the earliest installations of electrical generation. Before central stations distributed power, industries generating their own power used exhaust steam for process heating. Large office and apartment buildings, hotels and stores commonly generated their own power and used waste steam for building heat. Due to the high cost of early purchased power, these CHP operations continued for many years after utility electricity became available.” ([https://en.wikipedia.org/wiki/Cogeneration](https://en.wikipedia.org/wiki/Cogeneration)).
Energy Flows in the global electricity system (TWh)

Efficiency Gains of CHP – one example (all values HHV)


Literature / further information:
### Tool GI 3: Circular Economy.

**What this tool does:** This tool helps industry and city CEOs to decide about the use of the circular economy model of enterprises (new or existing).

**How does it work:** Three principles of the circular economy are translated into a set of six business actions called the ReSOLVE framework:

#### The ReSOLVE framework by Ellen MacArthur Foundation

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>Regenerate</strong></td>
<td>Shift to renewable energy and materials; reclaim, retain, and regenerate health of ecosystems and return recovered biological resources to the biosphere.</td>
</tr>
<tr>
<td><strong>Share</strong></td>
<td>Keep product loop speed low and maximise utilisation of products, by sharing them among different users (peer-to-peer sharing of privately owned products or public sharing of a pool of products), by reusing them through their entire technical lifetime (second hand), and by prolonging their lifetime through maintenance, repair, and design for durability.</td>
</tr>
<tr>
<td><strong>Optimise</strong></td>
<td>Increase performance/efficiency of a product; remove waste in production and supply chain (from sourcing and logistics, to production, use phase, end-of-use collection etc.); leverage big data, automation, remote sensing and steering. All these actions are implemented without changes to the actual product or technology.</td>
</tr>
<tr>
<td><strong>Loop</strong></td>
<td>Keep components and materials in closed loops and prioritise inner loops. For finite materials, it means remanufacturing products or components and recycling materials.</td>
</tr>
<tr>
<td><strong>Virtualise</strong></td>
<td>Dematerialise resource use by delivering utility virtually: directly, e.g. books or music; or indirectly, e.g. online shopping, autonomous vehicles, virtual offices.</td>
</tr>
<tr>
<td><strong>Exchange – together</strong></td>
<td>Replace old with advanced non-renewable materials, apply new technologies (e.g. 3D printing or electric engines) and choose new products/services.</td>
</tr>
</tbody>
</table>

There are two broad, complementary policymaking strategies that can help accelerate the circular economy. The first is to focus on fixing market and regulatory failures. The second is to actively stimulate market activity by, for example, setting targets, changing public procurement policy, creating collaboration platforms and providing financial or technical support to businesses. These approaches are complementary and policymakers can determine where to put the emphasis, taking inspiration from the most applicable aspects of both approaches.

The methodology presented for policy makers to accelerate the transition towards circular economy includes three main steps – each of which is detailed further in the toolkit.

- Align on starting point, ambition and focus. As in any strategic project, relevant stakeholders need to be mapped and engaged early on in the process. Based on an understanding of the national circularity and policy context, a realistic ambition level and sector scope needs to be defined.
- Assess sector circular economy opportunities. Once the focus sectors have been selected, the sector-specific assessment can begin. This step can be conducted in parallel sector working groups, and heavily relies on the involvement of businesses. The most relevant circular economy opportunities need to be mapped and prioritised. For the
prioritised opportunities, sector-specific economic impact needs to be assessed, barriers limiting their realisation identified and policy options to overcome these barriers mapped.

- Analyse national implications. Once the sector-specific circular economy opportunities have been assessed, they can be aggregated and the economy-wide implications analysed. This step will typically be driven by a core group of policymakers, policy and economics experts and with the participation of multiple government agencies. The sector-specific impact assessments could be aggregated in one overarching whole-economy impact assessment to support the mandate for policy intervention. Sector-specific policy options could be complemented by economy-wide policy options. The set of sector-specific and economy-wide policy options needs to be prioritised and assembled into coherent policy packages. (www.ellenmacarthurfoundation.org; www.circulareconomy.com)

**Process:** The World Business Council for Sustainable Development has, as part of its Energy Efficiency in Buildings initiative formulated a number of recommendations and an easy-to-read interactive roadmap providing overview of recommended action at all stakeholder levels split into long-term, medium-term and short-term actions. The overall recommendations are:

- Strengthen building codes and energy labelling for increased transparency;
- Use subsidies and price signals to incentivize energy efficient investments;
- Encourage integrated design approaches and innovation;
- Develop and use advanced technology to enable energy saving behaviour;
- Develop workforce capacity for energy savings;
- Mobilize for an energy-aware culture.

The interactive tool, Transforming the Market, is an addendum to the initiative’s main report. The roadmap as well as other tools such as the Sustainable Mobility Project 2.0 to be used with cities to support the development of their sustainable mobility plans, are available at the WBCSD website [http://www.wbcsd.org](http://www.wbcsd.org).

**Examples:**

**Example 1: Circular Economy toolkit**

In June 2015, the Ellen MacArthur Foundation published a toolkit for policy makers: Delivering the circular economy. The toolbox is in three parts:

1) Justification/motivation for working with circular economy,
2) Methodology to accelerate the transition, and
3) A national case study from Denmark looking both at the national perspective as well as five sectors (food & beverage, construction & real estate, machinery, packaging and hospitals).

The toolkit looks at the circular economy opportunity from a country and policymaker perspective and aims to provide policymakers with an actionable toolkit to help accelerate the transition towards the circular economy.

In the circular economy approach launched by the Ellen MacArthur Foundation the circular economy rests on three key principles as presented earlier:

- **Preserve and enhance natural capital** by controlling finite stocks and balancing renewable resource flows—for example, replacing fossil fuels with renewable energy or using the maximum sustainable yield method to preserve fish stocks.

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• **Optimise resource yields** by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles – for example, sharing or looping products and extending product lifetimes.

• **Foster system effectiveness** by revealing and designing out negative externalities, such as water, air, soil, and noise pollution; climate change; toxins; congestion; and negative health effects related to resource use.

**Example 2: Eco-Industrial Development (EID) Toolbox – GIZ tool for Sustainable Industrial Areas.** GIZ established a working group on Sustainable Industrial Areas in 2006 in cooperation with its international partners. The group has since gathered information on the subject and disseminated information on best practice and lessons learned under the heading of Eco Industrial Development. The work has an international perspective, albeit a strong focus on Asia. The Eco Industrial Development Tool Box is a collection of tools by GIZ, structured along five major topics:

• **New Industrial Parks**: site suitability assessment, site master planning, service concept for new parks, marketing

• **Industrial Area Transformation**: strategy, infrastructure development, monitoring and control

• **Company Improvement**: process improvement, resource efficiency, energy usage, disaster risk management

• **Management Structure**: industrial park information systems, industrial area management, stakeholder participation, CSR

• **Climate Change**: tools related to adaptation to impacts of climate change and mitigation of GHG emissions addressing industrial areas as well as individual companies ([http://www2.giz.de/network/eid-toolbox/info/abfrage.asp](http://www2.giz.de/network/eid-toolbox/info/abfrage.asp))

**Literature / further information:**

Tool GI 4: Green industries and urban renewal-revitalisation.

**What this tool does:** This tool helps city CEOs to decide about the conversion of existing polluting industries within urban areas the use of the circular economy model of enterprises (new or existing).

**How does it work:** As part of an urban renewal and revitalisation programme or project, an agenda of retrofitting or conversion of existing industrial areas is being initiated.

Pathway 1 – Retrofitting: This approach seeks to re-design polluting industrial enterprises in the urban renewal locations. These existing industries will need to decide on:

- Industrial policy change in the organisation;
- New energy model to be utilized (wind, photovoltaics, gas, fuel cells, etc.);
- Increased environmental performance through improved efficiency in resource use (energy, water, soil, air);
- Reduced management costs and increased competitiveness of businesses;
- Reduced risks and enhanced security for persons and goods inside and outside (neighbours) the industrial area.

Pathway 2 – Conversion into new non-polluting enterprise. This can assume the closure of the old enterprise and reopening in form of a new non-polluting enterprises. Such industries can new technology producers, creative industries, or social and cultural facilities.

The urban renewal approach involving a conversion or redefinition of polluting industries, and the creation of clean industries and creative industries instead, has been conceptualized in the ‘Creative City’ approach.

**Creative City.** “The creative city when introduced was seen as aspirational; a clarion call to encourage open-mindedness and imagination implying a dramatic impact on organizational culture. Its philosophy is that there is always more creative potential in a place. It posits that conditions need to be created for people to think, plan and act with imagination in harnessing opportunities or addressing seemingly intractable urban problems. These might range from addressing homelessness, to creating wealth or enhancing the visual environment. Its assumption is that ordinary people can make the extraordinary happen if given the chance. Creativity is seen as applied imagination. In the creative city it is not only artists and those involved in the creative economy that are creative, although they play an important role. Creativity can come from any source including anyone who addresses issues in an inventive way be it a social worker, a business person, a scientist or public servant.

It advocates that a culture of creativity be embedded in how urban stakeholders operate. By encouraging legitimizing the use of imagination within the public, private and community spheres the ideas bank of possibilities and potential solutions to any urban problem will be broadened.

This requires infrastructures beyond the hardware - buildings, roads or sewage. Creative infrastructure is a combination of the hard and the soft. The latter includes a city’s mindset, how it approaches opportunities and problems; its atmosphere and incentives and regulatory regime. To be a creative city the soft infrastructure includes: A highly skilled and flexible labour force; dynamic thinkers, creators and implementers. Creativity is not only about having ideas, but also the capacity to implement them.

The creative city identifies, nurtures, attracts and sustains talent so it is able to mobilize ideas, talents and creative organizations. The built environment – the stage and the setting - is crucial for establishing the milieu. A creative milieu is a place that contains the necessary requirements in terms of hard and soft infrastructure to generate a flow of ideas and inventions. A milieu can be a building, a street an area, a city or a region.
The popularity of creativity came about because of the increased recognition that the world and its economic, social and cultural structures was changing dramatically. This was driven in part by information technology revolution. The old way did not work sufficiently well. Education did not prepare students for the demands of the new world; organization, management and leadership with its control ethos and hierarchical focus did not provide the flexibility, adaptability and resilience to cope in the emerging competitive environment; cities whose atmosphere, look and feel were industrial and where quality of design was low were not attractive and competitive. Coping with these changes required a re-assessment of cities’ resources and potential and a process of necessary re-invention on all fronts."

(https://en.wikipedia.org/wiki/Creative_city)

Examples: Creative Industries: CURE was an EU-funded project (INTERREG IVB NWE) running from 2010 to 2014, bringing together 8 project partners in Germany, Belgium, France, the Netherlands and the UK. Many examples exist in Europe about such conversion of polluting industries in the context of urban renewal. China does have its first such cases in Beijing as well.

The Creative Zone Innovator: four dimensions

![Diagram showing the Creative Zone Innovator: four dimensions](https://en.wikipedia.org/wiki/Creative_city)

CURE: Creative Urban Renewal

Literature / further information:


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中欧低碳生态城市合作项目由欧盟资助与住房与城乡建设部合作
由德国国际合作机构等提供技术支持