RETHINK CITIES

A FIDIC/EFCA White Paper for a holistic approach to urban development through cooperation, systems and synergies - Sept 2013

FIDIC SUSTAINABILITY PACK

FIDIC efca Svenska Teknik & Designföretagen almega

The **International Federation of Consulting Engineers (FIDIC)** promotes and implements the strategic goals of the consulting engineering industry on behalf of its Member Associations by publishing information and resources of interest to its members. Today, FIDIC membership embraces more than 95 countries worldwide. Furthering of its goals, FIDIC publishes international standard forms of contracts for works and for clients, consultants, sub-consultants, joint ventures and representatives, together with related materials such as standard pre-qualification forms. FIDIC also publishes business practice documents such as policy statements, position papers, guidelines, training manuals and training resource kits in the areas of management systems — quality management, risk management, business integrity management, environmental management, sustainability — and business processes — consultant selection, quality based selection, tendering, procurement, insurance, liability, technology transfer, capacity building, etc. www.fidic.org

FIDIC has collaborated with the United Nations Environment Programme (UNEP), the International Chamber of Commerce (ICC) and the International Council of Local Environmental Initiatives (ICLEI) in developing and publishing of environment management systems for industrial facilities and for urban administrations. FIDIC continues to be active in International Standards Organisation committees responsible for sustainable construction standards and is a founder member of the UNEP Sustainable Building and Climate Initiative. The federation also assists in the development of infrastructure rating systems that build upon the Project Sustainability Management (PSM) framework concepts, notably the Project Sustainability Logbook developed by SYNTEC, the FIDIC Member Association for France, and SIPRS, the infrastructure rating system being developed by the International Sustainability Institute, of which the American Council of Engineers, the FIDIC Member Association in the USA, is a partner.

The **European Federation of Engineering Consultancy Associations (EFCA)** is the European representative of the consulting engineering industry that designs a major part of the Europe's infrastructure and building construction. With member associations in 24 countries, the EFCA is the sole European federation representing the engineering and related services industry, which employs one million staff, the majority of whom are highly skilled across multiple disciplines. www.efcanet.org

The **Swedish Federation of Consulting Engineers and Architects** is the common trade and employers´ association for Sweden's architects, building and engineering consultancies *(Svenska Teknik&Designföretagen)*. Members include engineering consultancies within the building and civil engineering segments as well as the industrial engineering segment and architectural firms. Most companies are involved in building and civil engineering projects, from the early stages of community planning and general investigations to design and follow-up of investments. Within the industrial sector, represented companies develop products, production methods and industrial processes. www.std.se

According to a 2013 **EFCA-FIDIC** survey on the consulting engineering industry worldwide, demand for architectural, engineering, and related consulting services, amount to 12% of non-financial investments requiring such services. Most of this demand (52%) is supplied by the consulting engineering and architects industry. World 2011 Gross Fixed capital formation of $15 bn USD implicates around $1 tn USD in architectural and engineering services provided by the industry in the world.

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FOREWORD

Over time, industrialisation has brought about unsustainable development and rife over-consumption that at the present time **threaten and debilitate our natural resources.** Humanity faces a number of environmental sustainability challenges including but not limited to declining biodiversity, degraded land and soil, depleting natural resources, polluted air and water, and increasingly severe climate risks. Closely interlinked are issues of population explosion and rural-to-urban migration at an extraordinary pace: as of 2008, more than half of the global population have moved into cities. We are living through the largest wave of urban growth in history. This in turn puts immense pressure on resource supply and demand, globally, 80% of the energy we use comes from fossil fuels, thus further exacerbating climate hazards.

Dealing with these challenges will require increased cooperation, along with comprehensive systems that can create and maintain **synergies for sustainable urban societies** in which people want to work, live and achieve some standard of well-being. This calls for sustainable urban development through a holistic approach for cooperation, systems and synergies.

One facet of this adaptation process therefore entails, inter alia, the integrated and holistic planning, design, construction and maintenance of sustainable cities. A **sustainable city** is one that can nurture itself with limited reliance on the surrounding countryside, power itself with a strong renewable energy mix and efficient energy use, and promote its own well-being by building functional, cost-effective and resource-efficient infrastructure in harmony with vital socio-cultural and aesthetic dimensions. In the sustainable city, greenhouse gas emissions are low, planning is participatory, and design is compact and unique, based on principles of biodiversity, preserving both geographies and cultures. A sustainable city produces minimal waste and pollution while re-purposing or re-cycling waste as much as possible.

Envisioning and realising the sustainable city can be an overwhelming exercise that implicates many interlinked factors and complex questions: How can we create environmental friendly and resource efficient buildings (both new and existing)? How do we integrate well-functioning urban structures with efficient land use, or renewable energy production, distribution and use with efficient transportation and communication networks? How can we improve air and water quality, while reducing and repurposing waste? How can we sharpen disaster preparedness and response while building climate resilience? At the same time, however, we can choose to view these challenges as unique and exciting opportunities for innovation, creativity and prosperity.

It is to this end the International Federation of Consulting Engineers' (FIDIC), the European Federation of Engineering Consultancy Association's (EFCA) and the Swedish Federation of Consulting Engineers and Architects' primarily addresses its **White Paper on sustainable cities** policymakers, media, professionals, interested citizens, the consulting industry itself and aims to serve as an **inspirational guideline** at national, European and global levels.

The consulting engineering and architecture industries can and must contribute to society dealing with sustainability challenges, such as climate change and resource depletion, by raising awareness, retooling and developing new sustainable infrastructure, and creating improved and new design methodologies. Whilst a plethora of reports and evidence on the link between urbanisation and constraints in tackling climate change exist, our industry needs to devise a **holistic approach on the role of cities in addressing sustainability challenges.** All members thus have a crucial role to play in this process contributing to an environmentally sustainable society through research and development, knowledge sharing, planning, design, procurement, construction, operation, maintenance and disposal.

EXECUTIVE SUMMARY

Cities hold vital possibilities and opportunities for a more effective response to energy, climate and environmental challenges. Infrastructure investments in many countries are either falling below desirable level compared to GDP or they are being steered in the wrong direction, while many cities are growing faster geographically than their populations are.

A holistic approach toward urban functionalities means that cities – not just their buildings – acting as integrated, highly functioning structures that display an appreciation for aesthetics, land use, the social and economic environment, energy efficiency, density and variation, suitability to the local and global contexts, certification etc. in order to respond to the myriad sustainability challenges facing our world.

The International Federation of Consulting Engineers (FIDIC), The European Federation of Engineering Consultancy Association (EFCA) and The Swedish Federation of Consulting Engineers and Architects (Svenska Teknik&Designföretagen) are therefore proposing a new approach for sustainable urban development based upon improved cooperation, new synergies and integrated systems. As confirmed by several FIDIC and EFCA reports, to avoid irreversible damage to living conditions, we have a very limited timeframe to change the trends arising from the way we live today, resulting principally from the conditions under which society operates.

The main purpose of this on-going exercise is to 'rethink cities' by first examining the global sustainability challenges in more detail, and then developing city-based strategies to improve the ecological, social and economic environments by optimising their interconnectivity. Special focus will be placed on systematic working methods and synergies between different fields of action and industrial sectors. Climate risks and Sustainable growth form is a shared responsibility.

The considerations behind Rethink Cities are about the close relationship between Climate Risks – Infrastructure and Cities - Society's Economic Development:

The Rethink Cities White Paper illustrates that the following issues need to be urgently addressed:

- **Climate risks** - the magnitude and scope of the sustainability challenges we face are much more serious and comprehensive than current policy and/or action is managint to addressing.
- **Fight ing poverty.**
- Improved efficiency in using **limited resources,**
- **Reduced fossil dependency.**
- Improved **education** and enlarged **cooperation** between developed countries, emerging economies and lesser developed areas.
- **End of systematic under-investments in resource-efficient and environmentally friendly infrastructure.**
- **Resource efficient cities** through **turning urban challenges into opportunities;** optimising and **integrating environmentally friendly, climate-resilience and resource-efficient systems** for energy production, distribution and use; building and **city structures**, increased mobility and accessibility; water use and sewage; waste recycling etc.
- **An improved holistic and integrated approach to sustainability:** climate risks are global issues that require shared responsibility.

0.1 Cities are the key

Cities have a domineering effects on climate, the global environment as a whole, and the regions in which they are located, thereby constituting key factors in our future development. Indeed, they are increasing in geographic size more rapidly than their populations. Today, over half of the world's population lives in cities that covers roughly 2% of the Earth's land area yet use 75% of all energy and emit 80% of all carbon dioxide.

The development of cities, which cannot be separated from that of the surrounding areas, must be urgently re-evaluated from within the principles of sustainable development, particularly regarding major issues as limited natural resources, biodiversity, population growth and poverty, increased energy consumption, climate risks and rising greenhouse gas emissions.

Toward holistic development

Cities are complex structures in constant evolution and flux, so development policies should aim to channel this behaviour in a direction that enhances overall well-being — socially, economic ally and environmentally. Cities can also be regarded as social, economic, environmental as well as technical **systems**, where the right kind of **infrastructure** and right level of **investments** in citiy infrastructure are urgent keys to societies' abilities and possibilities to significantly lowering energy use and carbon dioxide emissions. Furthermore, taking the longer view, society has to meet unavoidable future rising **energy costs** with strategic investments in energy-efficient and environmentally friendly infrastructure, building construction and reconstruction.

Infrastructure investments in many countries are either falling below a desirable level compared against the Gross Domestic Product or they are being steered in the wrong direction, while many cities are growing faster geographically than their populations are growing. The combination of regulatory controls with voluntary measures like rating systems and the use of metrics and baselines focused on specific aspects of sustainable development are extremely useful in bringing about change. However, new or improved forms of global, regional, or locally-oriented development following more **holistic** paths, that cannot always be imposed or standardised, are furthermore inescapable.

We believe there are very strong relationships between:

1.Sound and environmental develop of **cities** and their technical and **infrastructural** systems,

2.Society's **economic development;** and

3.How we are facing **Climate Risks**

The first step is to plan, design, develop and maintain cities, buildings and (existing) infrastructure more **holistically**. There is an urgent need to redirect and refocus attention to achieve more fully integrated planning, design and development of cities, with the full involvement of all parties contributing to the process, regardless of industrial sector. The aim should be to bring about major changes in:

- Social approaches and behaviour (for example, 'Think carbon')
- Use of the best available technologies and infrastructure
- Methodologies and core values that emphasise life-cycle considerations.

Investments in **infrastructure** have, in relation to the GDP of many, been declining. A holistic approach implies an urgent need for investment in intelligent and environmental friendly infrastructure, as for examples:

- Urban renewable energy production, co-generated electricity with high performance district heating and district cooling, smart grid, remodelling and management of water and wastewater networks, improved waste management, and greener public transportation.
- Ensures redesign that considers life cycles and the promotion of a recycling/closed-loop economy.

0.2 Cooperation, synergies and systems

Climate risks and Sustainable growth form a shared responsibility - engineers, architects, planners and developers are uniquely placed to improve the built environment owing to deep experience and precedent. For instance, the building and construction sector has in many countries already moved in a more holistic direction via knowledge sharing to develop new skills, methods and tools for sustainable urban development.

Needed now are improved methods and processes for creating synergies in urban planning and between different infrastructure supply and management systems and for the urgent improvement of a large existing building stock. Technical consultants represented by the International Federation of Consulting Engineers' (FIDIC), the European Federation of Engineering Consultancy Association's (EFCA) and the Swedish Federation of Consulting Engineers and Architects (Svenska Teknik&Designföretagen) are therefore proposing a new approach for sustainable urban development based upon a systematic and coordinated improvement in cooperation, synergies and systems.

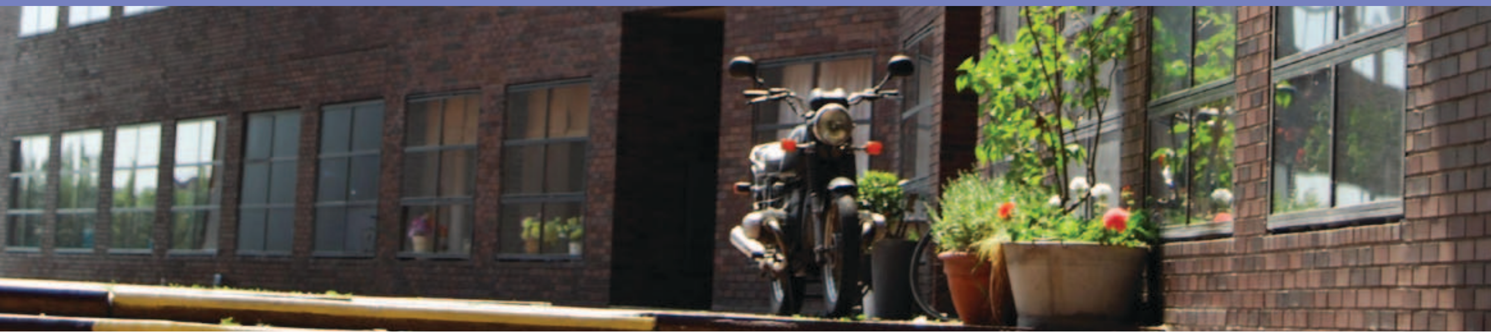
For example, specific, coordinated action plans have to be implemented by local governments to face up to the major challenges involving pollution and its risks, climate change, biodiversity, economic development, natural resources, and social welfare. These action plans have to define objectives at several levels on project-by-project basis in order to:

- Reduce ecological footprints and lower greenhouse gas emissions.
- Promote:
  - the use of renewable or recycled materials in buildings
  - information & communication technologies (ICTs)
  - biodiversity
  - sustainable administrative methodologies
  - 'smart living'
- Optimise and integrate systems for:
  - energy production, distribution and use
  - building and city structures
  - increased mobility and accessibility
  - water use and sewage
  - waste recycling.

0.3 With sustainability at the core

For the purpose of this paper, implementing sustainable development in a wider context, means creating synergies in urban planning and development that address ecological, social and economic functions simultaneously by considering the following core principles:

- Meeting the needs of the present generation without compromising the ability of **future generations** to meet their needs.
- Promoting an inclusive, mixed social structure that maximizes **human well-being;** social sustainability and affordability; family friendliness; safety and security; and reduced crime.
- Creating greener jobs, more value for money, affordable living, and new trade and business opportunities that are aligned with and contribute to ecological and social sustainability.



The coordinated action plans, implemented by local governments in partnership with the building and construction sector, must therefore enhance lifestyles, economic development, business attractiveness, employment, and job creation. Society’s costs of delaying actions on climate change will be very high.

0.4 Next steps

To clarify the necessary policies and to enable a shared vision of how to guide the dynamics of sustainable urban areas and the investments they entail, EFCA/FIDIC proposes the urgent development of a common language, set of values and a framework of methodologies for all actors at all levels. While this is a continuing process, the key considerations and concepts in this Rethink Cities described in further detail in order to promote a shared understanding of a holistic approach toward sustainable urban development across the engineering/architecture/planning sectors.

The International Federation of Consulting Engineers’ (FIDIC) and The European Federation of Engineering Consultancy Association’s (EFCA) have developed technical and organisational tools, **The Project Sustainable Logbook (PSL)** and **The Project Sustainability Management (PSM)**, to be dedicated to specific projects or programs that will follow during its/their entirely lifecycle. It favours cities and communities holistic approaches with the aim of synergizing urban planning and development.

‘A developed country is not a place where the poor have cars.

It’s where the rich use public transportation.’

Petro Gustavo, Mayor of Bogota

Collaboration with UNEP Global Initiative for Resource Efficient Cities GI-REC

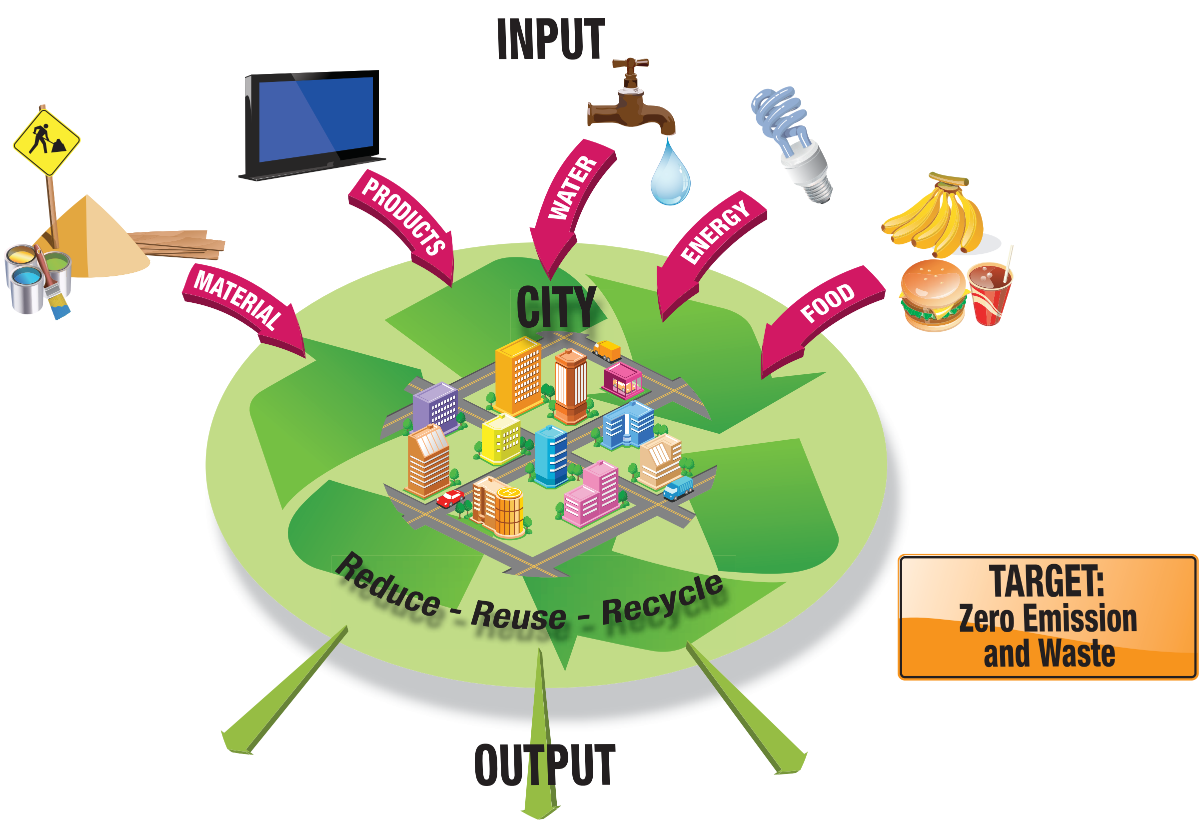
Resource Efficiency in Cities provides opportunities to address environmental and social challenges while creating major financial savings.

UNEP Global Initiative for Resource Efficient Cities GI-REC

The International Federation of Consulting Engineers (FIDIC) has been collaborating for years with UNEP DTIE in its Sustainable Building and Climate Initiative (SBCI) as one of the founding members and is now part of its new **Global Initiative for Resource Efficient Cities (GI-REC)** steering committee.

In order to respond to the needs of an increasingly urbanising world, UNEP supports cities inemphasising interventions that have both local and global benefits. Built environment activities promote resource-efficiency at city level within the context of sustainable development and poverty alleviation. Furthermore, they provide a global platform for the building sector stakeholders to discuss and develop the role of sustainable buildings in combating climate change, drawing on UNEP's unique capacity to facilitate collective action.

Extensive work in the sector has led UNEP to the conclusion that resource efficiency is key for cities to contribute to local and global sustainability and offer at the same time high potential for financial savings. For this reason, UNEP launched the Global Initiative for Resource Efficient Cities (GI-REC) last June 2012 at Rio+20. Activities under the Initiative encourage cities to combine greater productivity and innovation with lower costs and reduced environmental impacts.



The GI-REC aims at working with local and national governments, the private sector, civil society groups and the academia to promote energy efficient buildings, efficient water use, sustainable waste management and other activities. It is a platform for consultation and for sharing best practices among city practitioners. It develops common metrics for sustainable cities — e.g., for greenhouse gas emissions, city environmental performance assessments, Common Carbon Metric in the building sector, etc. It also promotes a holistic approach to resource use and consumption in cities.

The Initiative has already been backed by a broad range of international institutions, such as UN-Habitat, the World Bank, United Cities and Local Governments (UCLG), Local Governments for Sustainability (ICLEI), Cities Alliance, International Federation of Consulting Engineers (FIDIC), Veolia Environment Institute, Bioregional, Urban Environmental Accords Members Alliance, Sustainable Cities International (SCI), and International Institute for Environment and Development (IIED).

On-going activities of the GI-REC include (1) a review of existing methodologies for assessing resource efficiency, their applicability at city level, and how to use this to inform the development of practical tools and policy recommendations to promote efficiency improvements in cities around the world; (2) a global survey targeting more than 100 cities around the world to gather city's initiatives on resource efficiency and their needs; and (3) a mapping exercise of stakeholder organisations on resource efficient cities.

In summary the GI-REC will assist city practitioners in:

- Accessing **an extensive network of technical expertise,** knowledge and information on effective approaches to resource efficiency across sectors.
- Accessing support to **build the capacity of cities** to integrate resource efficiency at the local level. This includes potential assistance to pilot strategic activities that will promote resource efficiency in cities.
- Participating in and benefiting from **research on resource efficiency.** The GI-REC is committed to supporting its partners in translating research products into practical tools that will allow decision makers to promote and integrate resource efficiency at the city level.

1.1 The unique role of cities

Cities are places where both sustainability challenges appear and solutions can be found. They are hotbeds of science and technology, culture and innovation, individual and collective creativity, and — most importantly – research on mitigating the impact of climate change. The world's cities are also growing exponentially. People are choosing cities over countryside whether they live in large or small countries, whether they are rich or poor. Economic opportunities are often better in cities, even for many of the disadvantaged. For the first time in human history; half of the world's population lives in cities, which only comprise 2% of the Earth's surface but use 75% of global energy resources and generate 80% of all CO_2 emissions.

Infrastructure investments compared to GDP are declining in many countries and many cities are succumbing to ecologically harmful suburban sprawl (when geographical area outpaces population). These developments put serious pressure on planetary resources and raise pressing questions. It is not **cities'** or urbanisation as such, that contribute to greenhouse gas emissions; it is the way in which people travel around the city, the sprawling growth pattern, the way the energy is generated and distributed, how citizens use energy at home and at work, how buildings are constructed, heated and cooled that make cities the great users of energy and emitters that cities are. How are we now going to cope with climate change migration and the development it requires? How will we make resources last? What decisions need to be taken today to create a sustainable tomorrow for future generations?

Alarming examples show us an environmentally disorientated world, in which global annual CO_2 emissions are increasing rapidly as the international community fails to come up with a functional plan to achieve meaningful emissions reductions. Infrastructure investments in Western countries are not at desirable level compared to GDP or steered in wrong directions and many cities are growing faster geographically than population-wise. Humanity's biggest challenge in history might be minimising threats posed by climate change.

According to the Intergovernmental Panel on Climate Change (IPCC) human activities have an increasing influence on the Earth's climate and the environmental pressures have reached a scale, where unwelcome global environmental change can no longer be excluded. IPCC argues in their 4th Assessment Report (AR4) that 'warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.' This means higher temperatures, more precipitation and rising sea levels that will affect the built environment not only through flooding, landslides and increased wear and tear on infrastructure, but also via health problems including new diseases and heat waves, which are exacerbated in densely populated urban areas. Furthermore, even if we substantially reduced emissions today, changes in climate would continue due to the self-reinforcing nature and inertia of the climate system. The challenge is therefore multiplied: we must consequently both reduce our impact on Earth's climate while simultaneously adapting to the climate-related changes that are inevitable. When building a sustainable society, this needs to be well thought-out and planned for.

Humanity's biggest challenge in history might therefore be minimising threats posed by climate change. The previous examples show us an environmentally disorientated world, in which the international community has failed and again to come up with a plan to achieve meaningful reductions. For instance, the EU adopted the Climate and Energy Package in April 2009. The Package sets out the objective of limiting the rise in global average temperature to no more than two degrees Celsius above preindustrial levels. To achieve this goal the EU committed to a unilateral emission reduction target of 20% by 2020 compared with 1990 levels, and agreed to a reduction of 30%, provided that other major emitters agree to take on their fair share of a global reduction effort. However, the EU has recently reaffirmed this commitment, which is largely viewed by the environmental community as insufficiently matched to the increasing severity of the climate change threat.

The world's nations have agreed to keep global temperature rise below two degrees. In order to achieve this goal all countries are required to reduce emissions further. The results of the latest UN Climate change conference, **COP18 in Doha in fall 2012**, contains a clarification of the process forward, but does not increase the aspiration that according to science is required by 2020 to meet the two degree target. Regarding the Kyoto protocol no moves were made in Doha to raise carbon-cutting ambitions. However the countries agreed on a route for negotiating the Durban Platform for Enhanced Action, a new climate deal to be agreed by 2015 and to be set in action 2020. The separate stands of negotiations on the Kyoto protocol closed leaving the Durban platform as the only negotiation forum for the 2015 agreement.

With the expiry of the final commitment period of the **Kyoto Protocol** in 2012, the international community had another opportunity to put a newer, stronger framework in place in order to reduce emissions of greenhouse gases at the 2012 United Nations Conference on Sustainable Development, also known as the Rio+20 Earth Summit. Taking advantage of that opportunity required open-minded leadership and cooperation among national governments to go beyond simply reaffirming the ground-breaking Agenda 21, yet the conference was largely regarded as a political failure with an even weaker text than the original 1992 Summit. However, cities were given a unique role in the 2012 text, titled 'The Future We Want', with four paragraphs dedicated to the promotion of 'sustainable cities and human settlements.'

> Of particular significance are paragraphs 134:
>
> *'We recognize that, if they are well planned and developed, including through* ***integrated planning and management approaches,*** *cities can promote economically, socially and environmentally sustainable societies. In this regard, we recognize the need for a* ***holistic approach*** *to urban development […]'*
>
> and paragraph 135:
>
> *'We commit to promote an* ***integrated approach*** *to planning and building sustainable cities and urban settlements, including through supporting local authorities, increasing public awareness and enhancing participation of urban residents, including the poor, in decision-making. We also commit to promote sustainable development policies that support inclusive housing and social services; a safe and healthy living environment for all, particularly children, youth, women and the elderly and disabled; affordable and sustainable transport and energy; promotion, protection and restoration of safe and green urban spaces; safe and clean drinking water and sanitation; healthy air quality; generation of decent jobs; and improved urban planning and slum upgrading. We further support sustainable management of waste through the application of the 3Rs (reduce, reuse and recycle). We underline the considering disaster risk reduction, resilience and climate risks in urban planning.'*

The international community has therefore officially acknowledged the necessity to improve the development of cities, infrastructure and buildings with such future conditions and holistic approaches in mind. The International Federation of Consulting Engineers' (FIDIC) is also well aligned with 'The Future We Want' and well positioned to carry out/implement the aforementioned policy considerations.

In practice, however, ambitions for new building construction are not sufficient enough and the rate of building refurbishment to achieve high standards of energy efficiency is far too low. Today's decisions do not just affect present society, but will also set boundaries for future generations. With these considerations in mind, we can further examine and clarify the meaning of sustainability by elucidating this concept in the context of urban development.

1.2 What is sustainability?

The Brundtland definition of sustainability of 1987:

> *The Brundtland definition of sustainability of United Nations. 1987.'Report of the World Commission on Environment and Development.' General Assembly Resolution 42/187, 11 December 1987. Retrieved: 2007-04-12.*

The Aalborg commitments of 1994:

> *Aalborg Charter is an adoption in 1994 of the sustainability embodied in the Charter of European Cities & Towns towards Sustainability principles of shared commitments to be jointly implemented by local governments across Europe.*

The Leipzig charter 24 of Mai 2007; The Leipzig Charter on Sustainable European Cities

The Leipzig Charter on Sustainable European Cities was adopted in Leipzig by the European ministers responsible for urban policy on 24 May 2007. To achieve the objective of sustainable cities, an integral approach to urban issues must be chosen. In addition, the European structural funds should be made available for local projects that embrace this integral approach.

The Toledo declaration in 2010:

The Ministers of Urban Development of the European Union formalised a commitment to apply a Spanish proposal for integrated urban regeneration, in a declaration bearing the name of the meeting-city, The Toledo declaration in 2010. The Spanish Minister of Housing, Beatriz Corredor, stated that the Toledo Declaration 'sets out the European Union's political commitment to defining and applying integrated urban regeneration as one of the key tools of the 2020 Strategy'.

The most widely accepted definition of sustainable development is found in a 1987 the report by the World Commission on Environment and Development, entitled 'Our Common Future':

> 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'

This document, also known as **The Brundtland Commission Report**, discusses concerns about the accelerating deterioration of the human environment and natural resources, as well as the social and economic consequences of that deterioration. A sustainable society, it argues, depends on a balance between environmental, social and economic development:

- **Economically sustainable development** means the creation of jobs, affordable living, trade and business opportunities that are aligned with and contribute to ecological and social sustainability. The use of natural resources and the contribution from raw material markets that respects the environment is an important part in achieving a sustainable economy. International, national and regional cooperation and coordination is vital.
- **Socially sustainable development** entails a well-functioning society in which the provision of basic needs (food, housing, welfare, education and work) being available to all, while nurturing factors including democracy, security and equality, along with preservation of cultural heritage.
- **Ecological sustainable development** concerns long-term conservation of the productivity of the hydrological cycle, nutrient cycles, soil and ecosystems, by reducing anthropogenic impact on the environment and using nature and its available resources in a way that does not engender negative impacts for future generations.

First known concrete building still serviceable - Pantheon in Rome, circa 120 AD.

With these long-term sustainability goals in mind, we must also consider the more immediate issue of mitigating and adapting to climate change, which is not only an intergenerational problem but also highly contentious due to the fact that the costs for industry, settlement and society will vary widely by location and scale. Many heavily populated areas and large cities are often located in low-lying coastal zones. The greatest number of people affected by climate change will be in the mega-deltas of Asia and Africa; small island states are also particularly vulnerable. In general, the nations that have emitted the least amount of greenhouse gases over time are the most vulnerable to the effects of climate change. Although developed countries carry the burden of historic responsibility for anthropogenic climate change, they also have the financial resources and technological competencies to initiate cuts in emissions. Taken together, this is known in the policy world as 'common but differentiated responsibilities' and must be one of the first concepts considered when talking about rethinking cities in terms of sustainable development.

This Rethink Cities white paper is attempting to highlight the importance of the following issues:

- ***Climate risks***

  - the magnitude and scope of the sustainability challenges we face are much more serious and comprehensive than current policy and/or action is addressing,

- ***Fighting poverty***
- ***Increased efficiency in use of limited resources***
- ***Reduced fossil dependency***
- *Improved **education**, and enlarged **cooperation** between developed countries, emerging economies and lesser developed countries*
- ***Ending systematic under-investments in resource-efficient and environmentally friendly infrastructure***
- ***Turning urban challenges into opportunities**; optimise and integrate systems for: energy production, distribution and use; building and city structures, increased mobility and accessibility; water use and sewage; waste recycling, and*
- ***Improved holistic and integrated approach to sustainability**: climate risks are global issues that require shared responsibility.*

2.1 Critical boundaries and our ecological footprint

Industrial evolution has contributed enormously to human development and prosperity. Higher standards of living, better health, and widespread education are of course very positive changes. However, industrialisation has also caused a major strain on our planet, leading to the over-exploitation of its finite resources. Put simply, levels of consumption and energy use are much too high in relation to our resource base and the carrying capacity of the natural environment. Our current way of living, use of fossil fuels and resource depletion are severe pressures leading to a rapidly changing climate, thereby threatening living conditions on Earth. The industrialisation has not stopped; **emerging countries** are hoping to create the same standard of living as wealthier countries. This continues to create a higher strain on our planet, which means an even larger need of measures for resource efficiency.

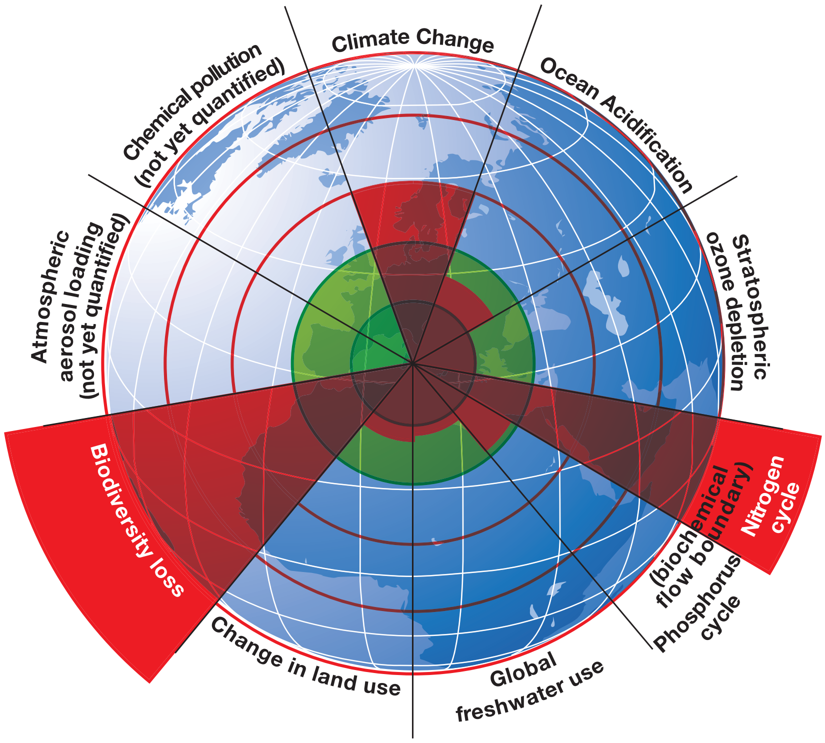


Figure 1 - Planetary boundaries. *The inner green shading represents the proposed 'safe operating space' for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change, and human interference with the nitrogen cycle) have already been exceeded.* Image credit: Nature 2009.

Rising temperatures, for instance, are expected to negatively affect glaciers, ice sheets and permafrost coverage, sea level, and the frequency of extreme weather events such as severe storms and hurricanes. Ecosystems and entire biomes are expected to experience changes in the range and distribution of flora and fauna. The total temperature increase from 1850 to 2005 was **0.76°C** and the global average sea level rose at an average rate of about **3.1 mm per year** from 1993 to 2003. For the next two decades, a warming of about 0.2°C per decade is projected by the IPCC. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected.

A possible outcome of rising temperatures is given by **World Bank Group** in their report 4°C **Turn Down the Heat,** published in November 2012. Their report provides a snapshot of recent scientific literature and new analyses of likely impacts and risks that would be possible with a 4°C warming within this century. They predict unprecedented heat waves, severe drought and major floods which would make serious impact on human systems, ecosystems and associated services.

Temperature rise is not the only pressing challenge we face. Researchers have identified **nine critical planetary ecological boundaries** with regard to climate change, stratospheric ozone, land use, fresh water, biodiversity, ocean acidification, nitrogen and sulphur emissions, atmospheric aerosols and chemical pollution. The three boundaries for climate changes, biodiversity and the nitrogen cycle have already been breached (see Figure 1 below).

Critical boundaries are not only about environmental impacts; they also speak to the **finite nature of resources** for an ever-growing population. When we talk about resources, beside fossil fuels we must also consider rare earth metals, minerals, and other substances essential to the manufacturing of many products, including environmental technologies as photovoltaic panels, wind mills, wave and tidal power infrastructure etc. Despite the fact that use of resources is decreasing in relative terms (i.e. per production unit), we can observe that the total or absolute demand for resources is increasing due to growth-based economic and trade policy and increases in population.

IT TAKES 1½ YEARS TO REGENERATE THE RENEWABLE RESOURCES USED IN 2008

A metric way to describe a growing resource usage is the **ecological footprint,** an indicator that accounts for the area of biologically productive land and water required to provide the renewable resources people use, and includes the space needed for infrastructure and vegetation to absorb waste carbon dioxide. According to the WWF, the global ecological footprint has exceeded the Earth's so-called **carrying capacity** by 50% in 2008, and that footprint has doubled since 1966. A large proportion of this is caused by carbon dioxide emissions, which in turn are essentially due to **fossil fuel based energy.**

Then again, not everybody has an equal footprint and there are enormous differences between countries, particularly those at different economic levels and levels of development. If everybody lived as people do in Europe and the United States, we would need much more than one planet to generate enough resources, since these regions use a greater share of resources than they produce. The environmental impacts from their consumption are then transferred to other countries.

WWF published their ninth **Living Planet Report in 2012,** which documents the changing state of biodiversity, ecosystems and humanity's demand on natural resources; it explores the implications of these changes for biodiversity and human societies. They report that biodiversity has declined globally, that human demands on the planet exceeds supply and that many river basins experience water scarcity. However, WWF draws the attention to the importance of change. They highlight the fact that our wealth, health and well-being are dependent on ecosystem services such as carbon storage, fuel wood, freshwater flow and fish stocks. The report highlights that current trends can still be reversed, through making better choices that place the natural world at the centre of economies, business models and lifestyles.

2.2 Greenhouse gas emissions

The Earth's climate is determined by incoming energy from the Sun and by the reflection, absorption and emission of energy within the atmosphere and at the Earth's surface. Anthropogenic or human-induced changes have occurred in the atmosphere and Earth's surface that alter the global energy balance and increase the risk of dangerous climate change. Among these are increases in **greenhouse gas (GHG) emissions** that raise both atmospheric absorption of outgoing radiation and aerosols (microscopic airborne particles or droplets) that reflect and absorb incoming solar radiation. The most important greenhouse gas in this respect is **carbon dioxide (CO_2)**.

The concentration of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) in the atmosphere has increased by 38% since industrialisation. According to The World Meteorological Organisation was for about 10,000 years before the industrial revolution, the atmospheric abundance of CO_2 nearly constant at ~ 280ppm (ppm = number of molecules of the gas per million molecules of dry air). The level of CO_2 was 2011 at 390.9 ppm (+39.6%) . The largest growth in **global greenhouse gas emissions** between 1970 and 2004 has come from the energy supply sector with 145%, transport 120%, industry 65 % and land use, land use change, and forestry (LULUCF) 40%. According to the Intergovernmental Panel on Climate Change (IPCC), atmospheric CO_2 concentrations had increased by only 20 ppm over the 8000 years previous to industrialisation.

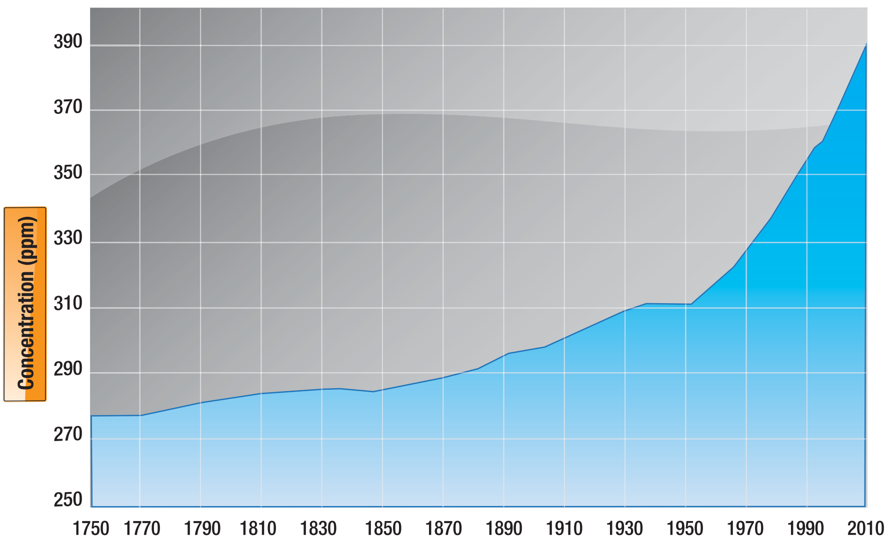


Figure 2 *Atmospheric concentration of Carbon dioxide (ppm).* Image credit: http://www.eea.europa.eu/data-and-maps/figures/atmospheric-concentration-of-co2-ppm-1

Historically, the burning of **fossil fuels** and the effects of **land use change** were the primary sources of increased atmospheric CO_2. Since 1750, it is estimated that about two-thirds of anthropogenic CO_2 emissions have come from fossil fuels and about one third from land use change. Other contributing factors include deforestation, which occurs at a rate of 13 million hectares annually, destroying important carbon sinks in the process. Between 1970 and 1990 direct emissions from **buildings** grew by 26%, and remained at approximately at 1990 levels thereafter. Buildings have a high level of electricity use and therefore the total of indirect emissions in this sector is much higher (75%) than direct emissions. Today, we can observe that in the EU, the largest share of carbon dioxide emissions comes from **electricity production** and **transport**.

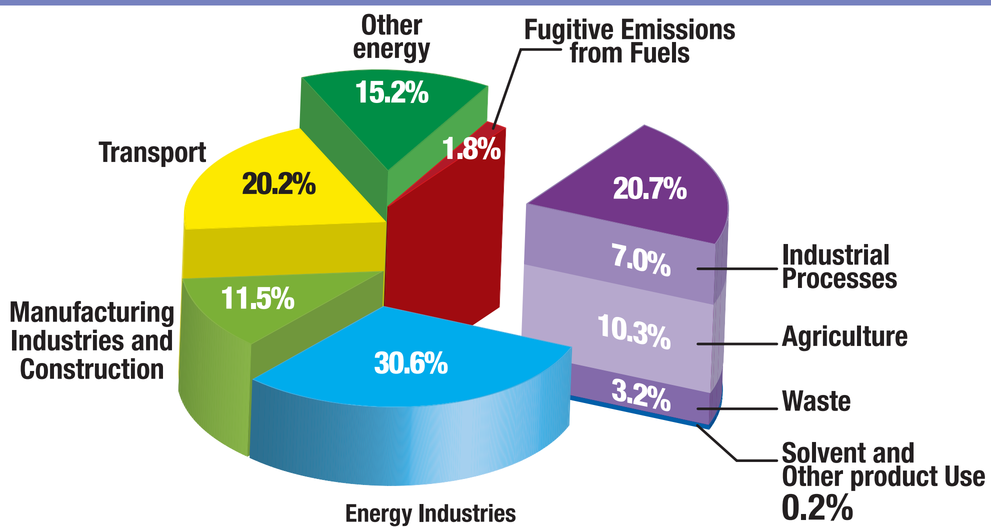


***Figure 3** – CO_2 emissions by sector.* Image credit: EEA, Eurostat.

Not only are we emitting too much greenhouse gas at present - the emissions are steadily increasing. **However, emissions of greenhouse gases vary substantially between different countries** depending on factors including life style, standard of living, climate, infrastructure, energy resources and land use. Per capita carbon dioxide (CO_2)-emissions are the highest in developed regions compared with sub-Saharan Africa which accounts for emission of 0.8 tonnes CO_2 per person and year.

According to **IPCC** scenarios, stabilisation at about **350-400 ppm** (445–490 ppm CO_2 equivalent) would limit **global temperature increases to 2-2.4°C** above pre-industrial levels, requiring emissions to peak within 10 years from 2007 and to be reduced by 50% from current levels by 2050. CO_2 levels increased at a rate of 1.9 ppm/year between 2000 and 2008.

Global emissions of carbon dioxide (CO_2) – the main cause of global warming – **increased by 3% in 2011**, reaching an all-time high of 34 billion tonnes in 2011. The past decade saw an average annual increase of 2.7%.

In 2011, **China's** average per capita carbon dioxide (CO_2) emissions increased by 9% to 7.2 tonnes CO_2, which is comparable to the per capita emissions in the **European Union** of 7.5 tonnes in 2011, the year in which the European Union saw a decrease in emissions of 3%. In comparison, in 2011, the **United States** was still one of the largest emitters of CO_2, with 17.3 tonnes in per capita emissions, (a reduction mostly caused by the recession, high oil prices compared to low fuel taxes and a bigger share of natural gas). The top 5 emitters are China (share 29%), the United States (16%), the European Union (EU27) (11%), India (6%) and the Russian Federation (5%), followed by Japan (4%).

The **global emissions** of carbon dioxide continued growth in **2011** with 3% despite the fact that a decrease in the European Union by 3%, in the United States by 2% and in Japan by 2% – essentially due to weak economic conditions and high oil prices. CO_2 emissions from OECD countries today account for only one third of global emissions – the same share as that of China and India together, where emissions increased by 9% and 6%, respectively, in 2011. The increase in **China's** CO_2 emissions was mainly related increases in fossil fuel consumption. This increase in fuel consumption in 2011 was mainly driven by the increase in building construction and expansion of infrastructure. Domestic coal consumption grew by 9.7% and coal import increased by 10%, making China the world's largest coal importer, overtaking Japan.

Since 2000, an estimated total of 420 billion tonnes of CO_2 was cumulatively emitted due to human activities (including deforestation). Scientific literature suggests that limiting average global temperature rise to 2°C above pre-industrial levels – the target internationally adopted in UN climate negotiations – is possible if cumulative emissions in the 2000–2050 period do not exceed 1,000 to 1,500 billion tonnes CO_2. If the current global increase in CO_2 emissions continues, cumulative emissions will surpass this total within the next two decades.

Valuing carbon dioxide levels is a complex problem. Globalisation has contributed enormously to welfare development, but at the same time it has led to a far-reaching outsourcing of manufacturing from developed to developing countries. One result of this trend is that the more developed countries are 'exporting' increasing

Trends in CO_2 emissions 1990 – 2011, examples;

Countries	Emission 1990 billion tonnes	1990 tonnes per capita	Emission 2011 billion tonnes	2011 tonnes per capita	Trend per capita
EU 27	4.32	9.2	3.79	7.5	- 18.5%
USA	4.99	19.7	5.42	17.3	- 12.3%
China	2.51	2.2	9.70	7.2	+ 327%
India	0.66	0.8	1.97	1.6	+ 200%
Sweden	0.057		0.053	5.45	
Global	22.7	4.3	33.9	4.8	+ 11.6%

shares of their CO_2 emissions to the developing countries. Available statistics on CO_2 emissions per capita in different countries does not fully reflect the reality.

In the most recent **Greenhouse gas bulletin,** published by **World Meteorological Organisation** in November 2012, the state of greenhouse gases in the atmosphere is based on global observations through 2011. The report shows that the global average mole fractions of carbon dioxide, methane and nitrous oxide reached new highs in 2011. Carbon dioxide reached approximately 390 ppm, methane reached 1813 ppb and nitrous oxide 324 ppb. These values constitute 140%, 259% and 120% of pre-industrial levels respectively. The increase of carbon dioxide is similar to the average growth rate over the past 10 years and methane increased at a similar rate as observed over the last 3 years. However, for nitrous oxide the increase is greater than the average over the past 10 years.

2.3 Global population trends

The world's population has tripled since the Second World War and the global economy has grown ten-fold.

We are **7 billion** people living on Earth today and have increased by one billion only in the last **thirteen** years. The world's population has tripled since the Second World War and the global economy has grown ten-fold. Global GDP growth is around 3% annually, more for India and China, and less than 1.5% in the Eurozone. Developing countries are set to account for nearly 60% of world GDP by 2030, according to OECD estimates. Global population is expected to peak at around 9.3 billion by 2050, and plateau at 10 billion by the end of the century. The global population is also increasingly young: more than every fourth person in the world is only 15 years old or younger.

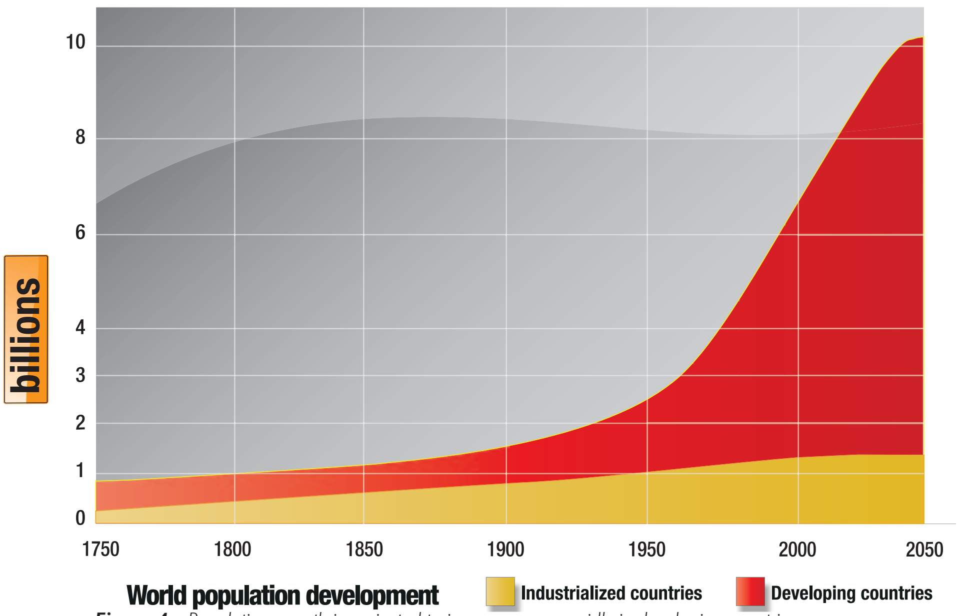


Figure 4 – Population growth is projected to increase more rapidly in developing countries.
Image credit: Philippe Rekacewicz, UNEP/GRID-Arendal

The world population became more urban than rural for the first time in 2007. In Europe, North America and Latin America more than 70% of the population lives in urban areas. Cities around the world take in 70 million new residents every year, but the most rapid expansions are being experienced in China, which is undergoing the largest internal migration in the history of the world. Since 2000, China's urban population has increased its share of the total population from 36% to 45% with an average yearly increase of 15.3 million people or over 41,000 persons a day. The global figure of people moving to cities daily is over four times higher. China has 45 large cities with populations of between 1–10 million people.

Growing urbanisation, not at least in Asia and Africa, risks leading to a significant increase in energy use and CO_2 emissions, where urban energy use is shifting from CO_2-neutral energy sources such as biomass and waste to CO_2-intensive energy sources.

Today, the **EU** has circa **half a billion inhabitants.** Eurostat projections forecast growing population mid-term, an increase of about 21 million people by 2035 compared to 2009. Beyond that, the size of the population is expected to decrease. The population of Eastern Europe has been declining since the mid-1990s. However, **ageing** will have consequences for the EU, influencing families and living arrangements, housing demand, and the need for healthcare services. In 2010, the population of urban regions in the EU27 grew by 5.2 ‰ inhabitants and intermediate regions by 2.2‰, while rural regions decreased by 80‰. In nearly all European Member States, it was in urban regions that the population grew most rapidly. Ireland was an exception with growth in its rural population, while the urban population declined. The highest population growth in urban regions in 2010 was observed in Sweden (+17.3 per 1000 inhabitants).

Out of over 3½ billion global urban dwellers today, approximately **1 billion are living in 'slums',** defined as habitation with insufficient clean water or durable housing. Due to the lack of access to clean water and sanitation, an estimated 1.5 million urban residents die each year, most of them young children. Around one billion people are **malnourished** (which is, paradoxically, fewer than the number of overweight). While the proportion of poor people is declining, the absolute number of economically disadvantaged in South Asia and sub-Saharan Africa is increasing. By 2005, the number of people living on less than $1.25 a day fell to 1.4 billion from 1.8 billion in 1990.

Billions of people, primarily in developing countries, take their **drinking water** from contaminated sources due to poor systems for sanitation and sewage. Further, many tonnes of sewage and other contaminated substances drain into the world's watersheds every day. For wastewater, only about 60% of the global population has sanitation coverage (functional sewage systems). For **wastewater treatment,** almost 90% of the population in developed countries but less than 30% in developing countries has improved sanitation (including sewerage and waste water treatment, septic tanks, or latrines). In parts of Europe drinking water is problematic and the effects of climate change will put further pressure on water resources.

2.4 Energy

The world's energy supply is still to more 80% dependent on fossil fuels and energy consumption overall increases. Fossil fuel use is subsidised in several countries.

About 40% of world electricity is produced by burning coal.

More than 80% of the world's energy supply is based upon fossil energy sources (oil 34%, coal 26% and natural gas 21%). The proportion of global renewable energy use is 8.5% (including hydroelectric power).

The annual average growth of global primary energy use was 1.4% per year in the 1990–2004 period and the share of fossil fuels dropped from 86% to 81%. The fossil dependency is about the same within the **EU** as globally with renewable energy sources account for only 10% of energy supply. However, the **USA's energy usage per capita (90, 000 kWh/year) is twice as high as Europe's (43, 000 kWh/year).** About 40 % of world electricity is produced by burning coal. The world's largest coal reserves are in the USA,

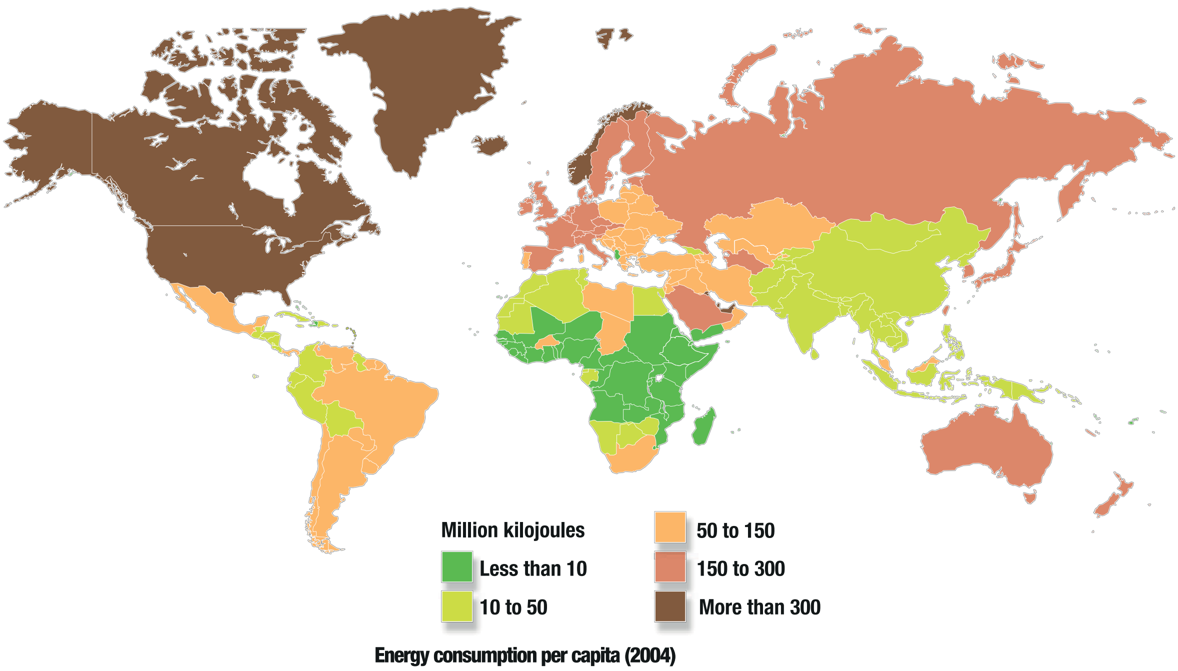


Figure 5 - *Global energy consumption in 2004 shows 'energy rich' North America in sharp contrast to 'energy poor' central Africa.*
Image credit: Emanuelle Bournay, UNEP/GRID-Arenda

followed by Russia and China. China produces almost half of the world's output of coal, and is also its largest user. For many years, Japan was the largest net importer of coal, but was overtaken by China in 2011, despite the fact that, until a few years ago, China was a net exporter of coal. The world's largest exporter of coal is Australia.

Large shares of renewable energy in final energy are used in Sweden (48%), Finland (31%), Austria (29%), and Portugal (23%) .

Important to note is that **'fuel poverty'** is a reality in some regions, especially Africa and Asia, and in some population groups (see Figure 6 below). Outlooks from both the IEA and World Energy Council estimate increases in primary energy demand between 40 and 150% by the year 2050 compared with today's demand, depending on the scenarios for population and economic growth and the rate of technology development.

Transportation activities are mainly driven by internal **combustion engines powered by petroleum fuels** (95% of world transport energy use in 2004). In 2004, transport energy amounted to 26% of total world energy use. In the developed world, transport energy use continues to increase at slightly more than 1% per year; passenger transport currently consumes 60–75% of total transport energy there. In developing countries, transport energy use is rising faster (3–5% per year) and is projected to grow from 31% in 2002 to 43% of world transport energy use by 2025.

Projections foresee a continued growth in world transportation energy use of 2% per year, with energy use and carbon emissions about 80% above 2002 levels by 2030.

GLOBAL ENERGY SUPPLIES ARE STILL MORE THAN 80% DEPENDENT ON FOSSIL FUELS

No single dynamism has had such a comprehensive effect on urban growth as the fossil fuel economy and its underlying network of production, distribution and consumption. The global oil price is from time to time considerable **volatile** and has fluctuated considerably during the last decades and the price of **oil** underwent a significant decrease after the peak of 145 USD per barrel in July 2008. In December 2008, WTI crude oil spot price fell to **30.28 USD** a barrel, the lowest since the financial crisis of 2007–2010 began. The oil price is at the time of writing (August 2013) is around **108 USD** per barrel. Not only does this price volatility have a negative effect on energy security and sustainability in general, but our reliance on fossil fuels in the Western World has dire environmental consequences as well as serious implications for security as many fields are located in unstable areas.

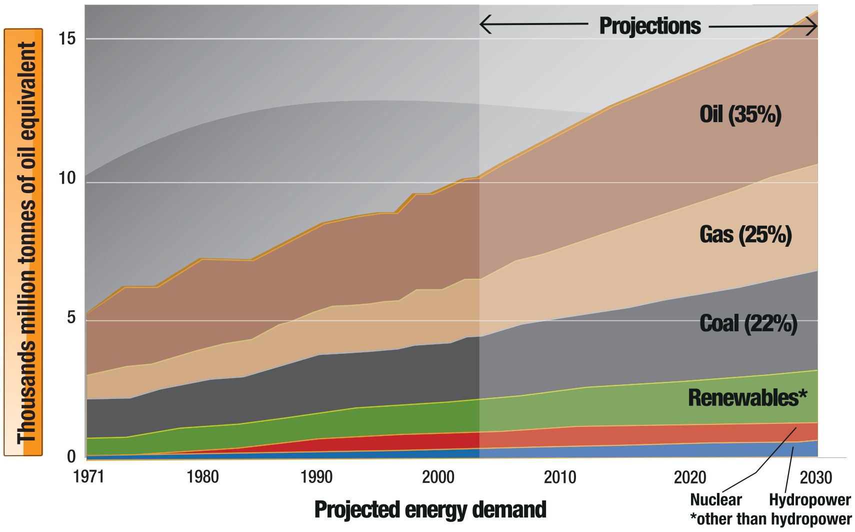


Figure 6 - *According to current forecasts the world's energy requirements will have risen by more than 50 per cent by 2030. Oil and natural gas will account for more than 60 per cent of the increase. During the same time period renewable energy growth is lower.*
Image credit: Emanuelle Bournay, UNEP/GRID-Arendal

Even though fossil fuels have a clear negative impact on our climate, there still are substantial **subsidies to fossil fuel energy** available. When G20 leaders met in 2009 they committed to rationalize and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption. In 2010 they reaffirmed their commitment, with timing based on national circumstances, while providing targeted support for the poorest. In 2011 about 250 different subsidies to fossil fuel energy was available in the OECD countries. Inefficient fossil fuel subsidies are costly to taxpayers, can damage the environment through increased emissions of greenhouse gases and other air pollutants, and by distorting the energy mix. Several studies have also found that subsidies to fossil fuel tend to benefit high income households more than poor, due to the formers higher per capita consumption. The biggest users of fossil fuel subsidies in 2010 were Iran, Saudi Arabia, Russia, India and China.

'Peak oil' refers to the point in time at which the possible maximum rate of global petroleum extraction is reached. According to some recent research and market analyses, we may have already passed that point. For instance, the Energy Watch Group claims that peak oil was already reached in 2006. A drop in production of at least 3% per year can be expected from that point onward, while demand continues to soar. Today are we speaking about the possibilities and consequences of availability of (cheap) energy in the next decades through hydro fracking. With most economic and energy demand growth taking place in emerging markets where **energy poverty** growing key concern, and improved energy access becomes more and more crucial. The volatility of the fossil fuel economy is a crucial point of concern for cities. However, we need without a doubt both the complementary small scale as well as reformed large scale solutions.

The implications of the fossil fuel-based economy are deeply intertwined with other sustainability challenges. The relatively cheap availability of fossil fuels and other natural resources allowed both to increase in population, especially since the beginning of industrialisation, and to the development of extremely resource-intensive and resource-dependent infrastructure. For example, the domination of road infrastructure for providing personal mobility or settlement patterns that stimulate suburban sprawl and promote individual ownership of sets of products as households' appliances etc. All of these trends combine to improved living standards for many who belong to the rising consumer groups, but almost half of the world's population, three billion people, still live in poor conditions and often living without basic services such as sanitation.

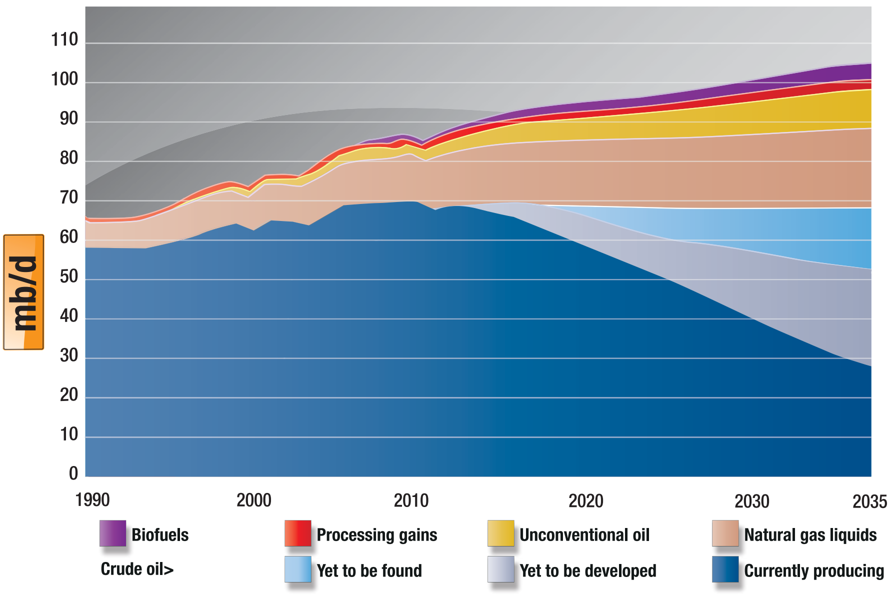
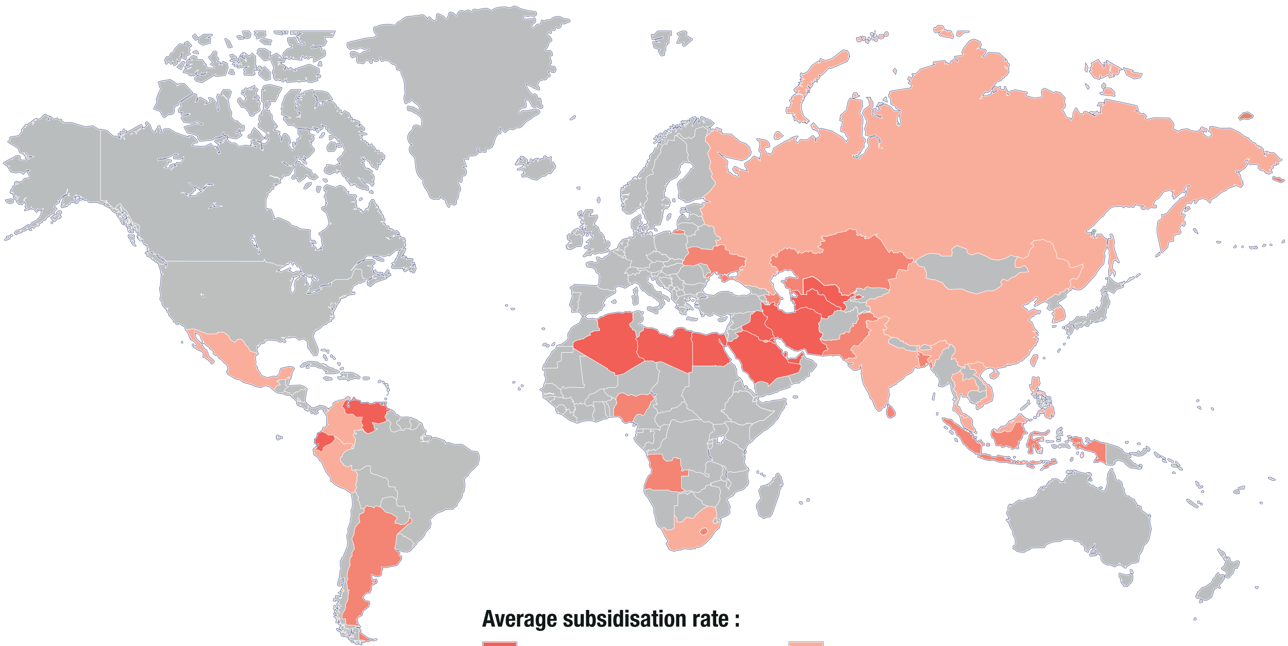
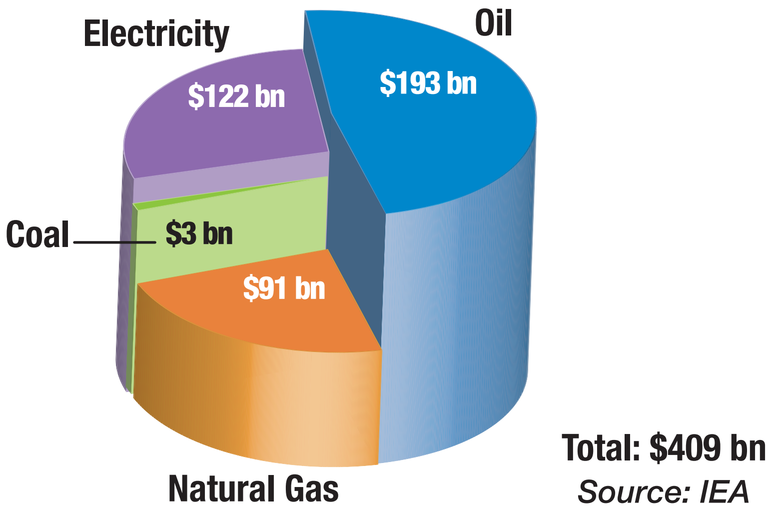


Figure 7 – *Projected global supply rates by type.* Image credit: IEA World Energy Outlook 2011



Fossil-fuel consumption subsidy rates as a proportion of the full cost of supply, 2011

Figure 8-1 *shows the consumption of fossil fuel subsidies worldwide during 2011.* Source: OECD/IEA .



World Fossil Fuel Consumption Subsidies, 2010

Figure 8-2 *World Fossil Fuel Consumption Subsidies, 2010*
Image credit: http://grist.org/fossil-fuels/world-governments-spend-1-4-billion-a-day-to-disrupt-climate/

2.6 Transport

Global transport work grows by circa 2% yearly and 95% of the energy use in the transport sector is fossil fuel-powered vehicles.

Global transport work grows with circa 2% yearly and 95% of the energy use in the transport sector is fossil fuel-powered vehicles. Rate of car ownership differs very much between countries and regions. **In developed economies, motor vehicle ownership approaches five to eight cars for every ten inhabitants.** (In 2009 world average automobile ownership were 170 per 1000 inhabitants; 802 in USA, 519 in Sweden, 47 in China and 18 in India.) In the developing world, levels of vehicle ownership are much lower; non-motorized transport plays a significant role, and there is a greater dependence on two- and three-wheeled motorized vehicles and public transport. The motorization of transport in the developing world is, however, expected to grow rapidly in the coming decades. In addition to GHG emissions, the motorization of transport has in large cities all around the world created congestion and air-pollution problems, particulate substances, traffic noise, barriers.

According to the European Environment Agency, **urban** transport accounts for 40% of Green House Gases GHG emissions and 70% of air pollutants from European road transport. Total passenger transport activities in the EU-27 averaged 13,000 km/person in 2007: including about 72% by car, 2% by powered two-wheelers, 8% by bus and coach, 6% by rail, and just over 1% by tram and metro. Intra-EU air contributed with nearly 9%. Transport was the only sector where emissions continued to rise 2000 – 2009 by 2.2% per year, which can be explained by increasing transport volumes and the lack of significant shift towards cleaner modes and fuels. More than 30% of the trips made by cars in Europe are for less than 3 km and 50% for less than 5 km.

As the same time as the effects of fossil driven transport infrastructure on the nature, landscape and biodiversity are negative; transport is necessary for the functioning of society and for individual well-being. It ensures mobility for the workers and flexibility for global production chains.

Households generally spend about 10-15% of their consumption on transport, as much as they spend on food or housing.

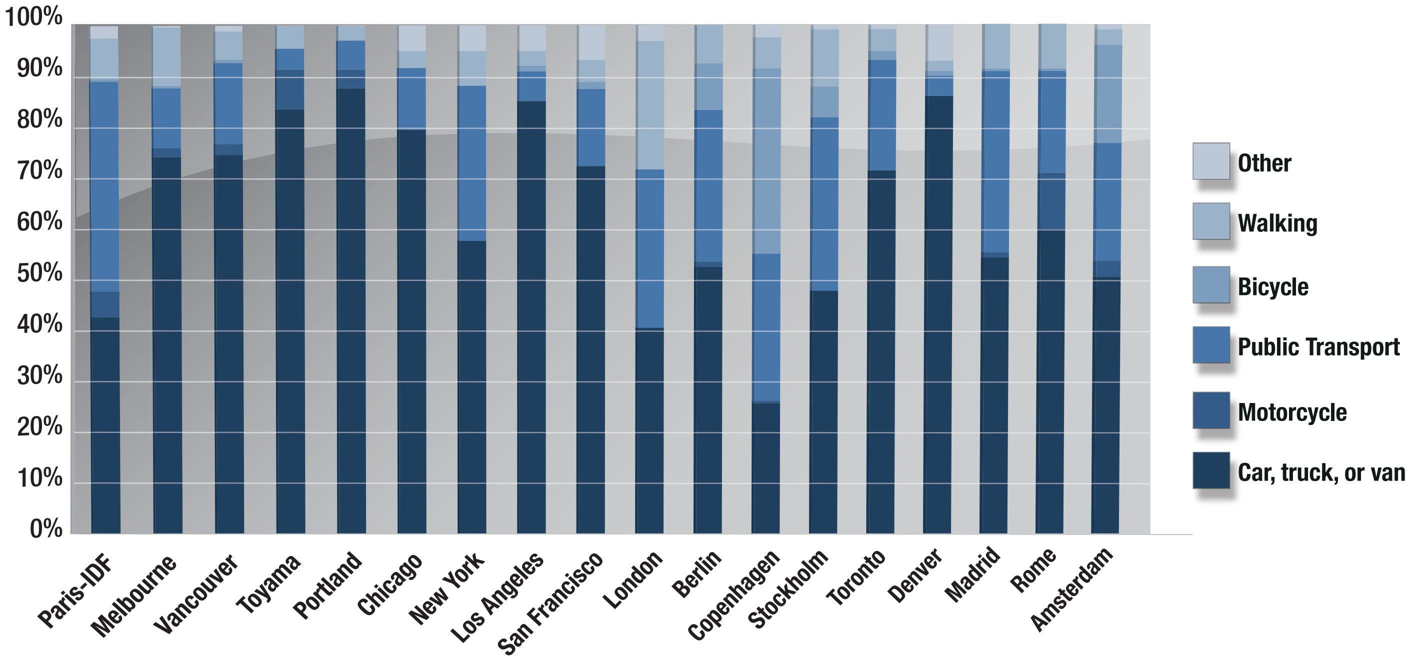


Figure 9 – *Modal share in a selection of OECD metropolitan areas. Units of analysis, sources and years: Paris-IDF (Paris-IDF region, Insee, Enquête Nationale Transport, 2008); Melbourne (Melbourne Statistical Division, Victoria State Government, 2007); Vancouver (Census Metropolitan Area, Census Statistics Canada, 2006); Toyama (Toyama-Takaoka Wider Urban Zone, 3rd Person Trip Survey, 2001); Portland (Metropolitan Statistical Area, American Community Survey, 2009); Chicago (Chicago Tri-state metro-region (MSA), American Community Survey, 2005-2009); New York, Los Angeles, San Francisco (OECD metropolitan regions definition, American Community Survey, 2005-2009); Londres (London Boroughs, Department for Transport, 2008-2009) ; Berlin, Copenhagen, Stockholm (Eurostat, 2003-2006) ; Toronto (Census Metropolitan Area, Statistics Canada, 2006) ; Denver (OECD metropolitan regions definition, American Community Survey, 2005-2009); Madrid, Rome, Amsterdam (Eurostat, 2003-2006).*

2.7 Waste

Waste has serious environmental and resource consequences and is a central part of the global **network of material flows,** and highly depended of global consumption trends, global regulations and initiatives related to waste management.

Today, the total amount of waste generated annually worldwide (municipal, industrial, hazardous) is more than 4 billion tons. Almost 45% of it is considered as municipal solid waste, while the rest is industrial waste, including hazardous waste. Both the increase of population and the GDP/capita growth create massive amounts of municipal, industrial and hazardous waste. Waste management industry has today around 40 million workers (including informal recyclers).

It is estimated that half the global population lives without access to sound waste collection and removal out of the residential areas, and controlled disposal in 'engineered' landfills.

1 ton of waste contains ca 3,000 kWh of energy.

In developing countries, millions of people are working in **informal recycling activities** making their living in difficult and risky conditions. On the other hand, their activities contribute to global recycling rates and create employment opportunities for marginalised populations. **Recycling** is one of the most important sectors in terms of employment creation and currently employs 12 million people in just three countries — Brazil, China and the United States. Since 2000, output in the EU27 **recycling industry** has grown at an average annual rate of 4.2%, far ahead of the industrial average over the same period (1.6%). As such this was the fastest-growing industrial sector during this period.

Waste leads to serious greenhouse gas emissions in the form of methane (CH_4) from landfill sites and wastewater handling, and nitrous oxide (N_2O) from human sewage. In terms of mitigating climate change, methane emissions are of particular importance as the global warming potential of methane is 21 times higher than that of CO_2. Waste-related methane emissions can be tackled by reducing waste volumes, diverting waste from landfill or diverting methane from waste for use as fuel (e.g. **biogas**). EU greenhouse-emissions from waste decreased by 22.5% in the decade 1999-2008. This marks a much stronger decline when compared to total EU-27 emissions over the same period, which decreased by 2.4%. Uncontrolled dumping presents also long-term threat to soil, ground water and surface water.

EU-27 municipal waste generation grew from 511 kilograms per capita in 1999 to 520 kg/capita in 2008, a 1.8% increase. In 2008, about 40% of the municipal waste was landfilled. The remainder was burned (19.3%), recycled (22.5%) or composted (16.9%) in roughly equal shares. In Sweden is less than 1% of the household waste put on landfill.

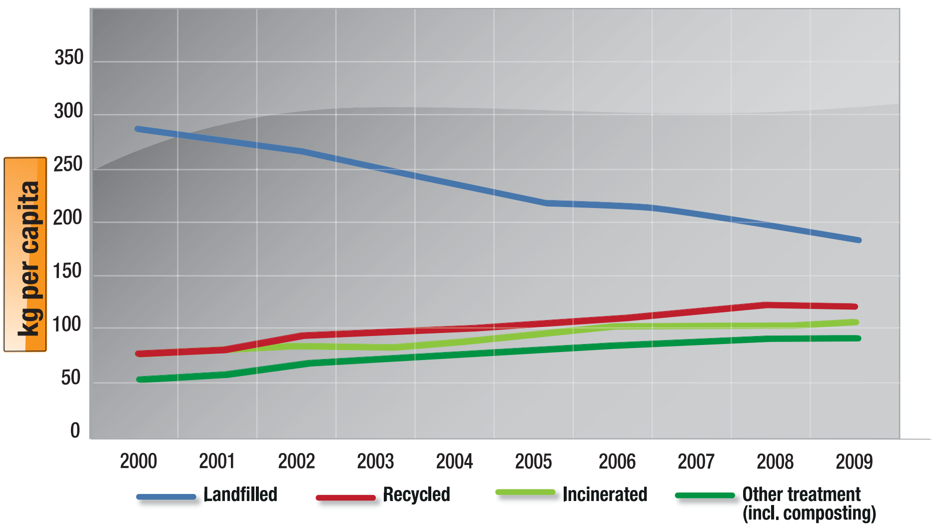


Figure 10 – *EU-27 municipal waste per capita by treatment.*
Image credit: Eurostat Waste Data Centre

2.8 Urban Infrastructure

Road infrastructure investments remained dominant - between 1999 and 2009 the share of investments in the infrastructure with lower environmental impacts (rail, maritime and inland waterways) slightly decreased in EU-27.

Transport and communication infrastructures, the housing stock and the built environment generally are, for most individuals and society as a whole, as much a fixed condition of life as is the 'natural' environment. Urban infrastructure is 'glue' that binds and connects the social, economic, environmental and technical systems of cities and can play a vital role in lowering energy use, reducing waste and mitigating carbon emissions. Thus, it is important to maintain and increase investments in these types of physical infrastructure in an intelligent and sustainability-oriented manner. However, **infrastructure investments** in many countries and cities are not at desirable level compared to GDP or steered in wrong directions and sometimes also **even** declined in relation to GNP including in Sweden. In Western Europe in 1980, infrastructure investments accounted for 2.4% of GDP and 1.8% in 2006. In the early 1980s, 2% of GNP was invested in new infrastructure in Sweden. However, by 2006 the investments had **fallen** to around 1.4% of GNP (see Figure 11).

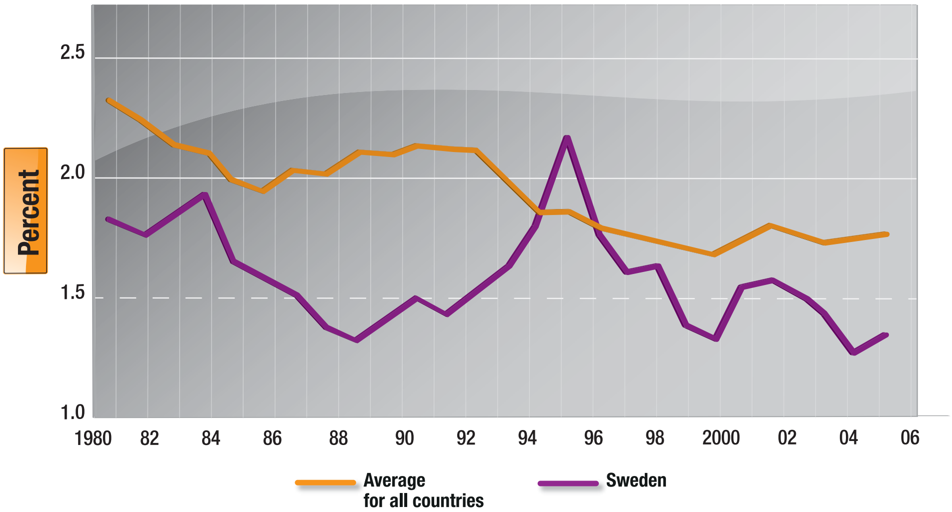


Figure 11 – *New investments in relation to GNP in Western Europe and in Sweden.*
Image credit: Nutek

Total investment in transport infrastructure, including new construction, extension, reconstruction and major repairs, reached about €94 bn in 2009. Between 2000 and 2009 the share of investments in the infrastructure of modes with lower environmental impacts (rail, maritime and inland waterways) slightly **decreased**. Road infrastructure investments remained dominant (see Figure 14 below).

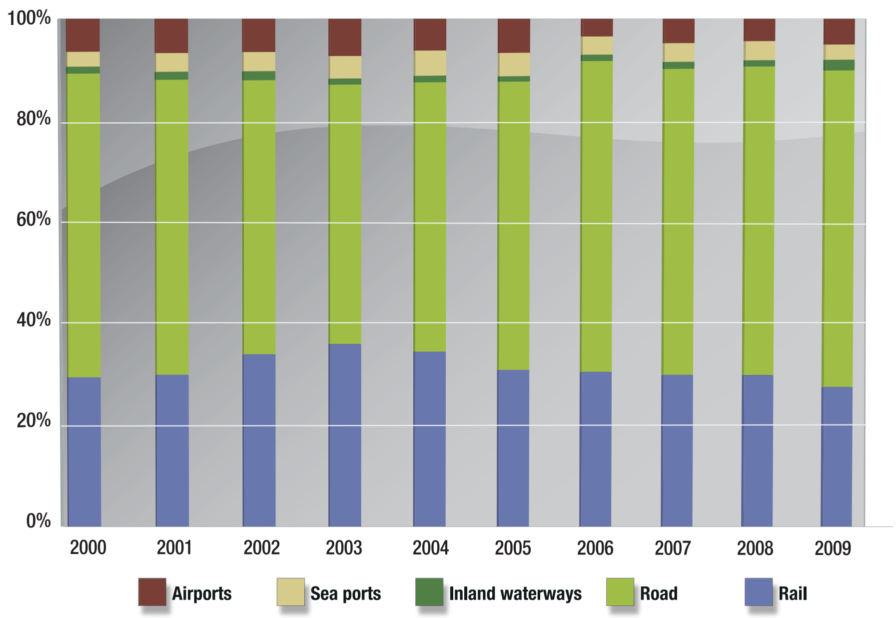


Figure 12 – *EU investment in transport infrastructure by mode.*
Image credit: International Transport Forum.

If a long-term perspective could be maintained: society can use strategic investments in energy-efficient, sustainable infrastructure to avoid or reduce possible rising operating and energy costs in the future. It is difficult to enthuse developers, infrastructure investors, civic leaders and the urban public about ecological urban redevelopment or renewal. Large investments into these areas stimulate the desire of the investors to speed up the return on their investments. In addition, physical infrastructure has a relatively long life and therefore can old investments become a barrier for environmental needed upgrades. This relates to road and bridge networks, public transportation, electricity plants and grids etc. At the same time, cities must avoid problem of possible duplication of infrastructure systems – energy, telecom, water, transport etc.

Leaking district-heating pipes, New York

For examples; a good sustainability-oriented urban development strategy for developing countries is to 'leapfrog' earlier stages of infrastructural development and directly invest in mobile network systems, smartphone/grid integration and wireless communications in general.

Further examples of such activity can be found in emerging economies such as the BRICS countries (Brazil, Russia, India, China and South Africa), especially China which over the last few decades had the world's highest investment ratio for infrastructure. According to World Bank estimates, in 2015 half of all building activity worldwide will be taking place in China. For example, China is investing about $100 bn annually in railway construction. The share of railway infrastructure investment allocated to high-speed rail has risen from less than 10% in 2005 to a stunning 60% in 2010. By 2012, China plans to have built 42 different passenger lines and to have about 17,000 km of high-speed track in operation.

The surge of infrastructural activity in China, as well as in the other BRICS countries underscores the need for action by the West, which still uses considerably energy per capita and must reduce that consumption drastically to remain credible with regard to climate policy and to promote urban sustainability in general. In the context of promoting investment in sustainable urban infrastructure, this would entail linking innovations in energy engineering and ecology with ideas to strengthen local business communities and to mobilize the resident population, and with forward-looking social and educational concepts. For instance, although Spain only entered the high-speed rail world in 1992, its network grew rapidly to become the longest in Europe. Since European cities are presently facing a myriad of challenges ranging from climate change to jobs and the social and cultural integration of increasingly diverse urban society, planners must look to ecological innovation and investment in climate protection as the key to strengthening their cities' economic and social fabric.

In Europe new buildings represent only about 1% of the housing stock annually (and less than 10% of road vehicle stock is newly registered each years), which means that introducing new technologies in existing cities will take a long time. Summarizing; right kind of **infrastructure** and right level and sort of **investments** in infrastructure are instead very important keys to the possibilities to significantly lowering energy use and carbon dioxide emissions.

2.9 Cities

Half of the world's population live in cities covering 2% of the Earth's land area, yet they use 75% of all energy, and generate 80% of all CO_2.
In the European Union some 73% of the population live in cities.
City areas have a tendency to grow geographically faster than their rate of population increase.

Global trends of migration to cities seem unlikely to slow down. One reason for this is that standards of living and economic opportunities can be better in cities, even for many disadvantaged. At a global level there are 70 million (circa 190,000 per day) new urban residents every year.

The environmental impact of cities is enormous, due to their increasing demographic weight and to the amount of natural resources they consume, from the billions of people driving vehicles on their daily commute, to the energy required to either heat or cool buildings and to bring in food and goods, sometimes from the other side of our planet. Energy supply based on fossil fuels and low energy efficiency in buildings and car transports with cars are often major causes for critical environmental problems. The effects of global warming accelerate risks and vulnerabilities of urban areas especially cities situated on low elevated floodplains or in coastal areas, which run the risk of flooding.

It is important to note that it is not **cities** or urbanisation as such, that contribute to greenhouse gas emissions; it is the techniques we travel around the city, what urban sprawling growth pattern there is, the what way we use energy at home and how our buildings are constructed, heated and cooled that risk making cities to great

consumers of energy and emitters that cities are. It is also very important to point out that **not only new built** development has to be dealt with - the **existing urban structure, infrastructure and existing building stock** must also be significantly improved. According to the Worldwatch Institute, buildings account for more than 40% of total energy use throughout their total life cycle.

Urban environmental problems can have many sources as rapid growth in population and area, which is not replicated in investments in services, and unsatisfactory technology in industry, increasing and environmentally unsustainable transport, insufficient sewage systems causing direct emissions of wastewater from industries and households into rivers and lakes, unsatisfactory waste management. Millions of people, who live around the world's poorest cities, do not have access to modern energy services or sanitation, and the demand for energy is often resolved in unsustainable ways. On the other hand, urban sprawl, high dependence on motorised transport and urban lifestyles that generate excessive waste and use large amounts of energy are some of the major contributors to the global increase in greenhouse gas emissions.

City areas have a tendency to spread geographically faster than their increase of population. The acceleration of urbanisation since the mid-half of the last century has been accompanied by **urban sprawl,** with urban land area doubling in the OECD and growing by a factor of five in the rest of the world. The expansion of built-up areas through suburbanisation is still growing in OECD metropolitan areas (66 out of the 78 largest OECD cities experienced a faster growth of their suburban belt than their urban core over 1995-2005). Increasing density could significantly reduce energy use in urban areas and CO_2 emissions. For instance, Japan's urban areas are around five times denser than Canada's, and the use of energy per capita (as measured by total primary energy supply) in Japan is around 40% that of Canada's. If we take countries in the same geographical context with similar heating needs, such as Denmark and Finland, the link is still visible: Denmark's urban areas are denser than Finland's by a factor of four and people in Denmark consume 2.5 times less energy than the Finns.

SINCE THE MID-1950s, EUROPEAN CITIES HAVE EXPANDED BY 78%, YET TOTAL POPULATION ONLY GREW BY 33%

Since the middle of the 1950s, cities in **Europe** have expanded **geographically** by an average of 78% while the **population** has grown by 33%. American cities have an even larger geographic spread than those in Europe and Asia, and use considerably larger amounts of energy.

In the last three decades the population in, for example, Stockholm County, has increased by around 25 %, the number of cars by about 65%, road traffic by 80% and travelling on public transport by 35%. And housing has become far more geographically dispersed while workplaces are more concentrated in the city. Those kinds of figures are probably representative for many modern cities today.

A geographic expansion of the city requires consecutively more infrastructure and more energy for transport and causes increased travelling time. Other infrastructural development such as district heating, water and sewage systems, and telecoms become more spread out, costly and less effective. The increasing demand for transport and roads require bigger roads and faster access, more parking facilities and uses significantly more land, which further contributes again to sprawl out the city. This vicious cycle often leads to traffic and construction barriers and more local and global environmental impacts increase. There is a general correlation between energy consumption (in gigajoule per inhabitant) and **urban density** (in inhabitants per hectare).

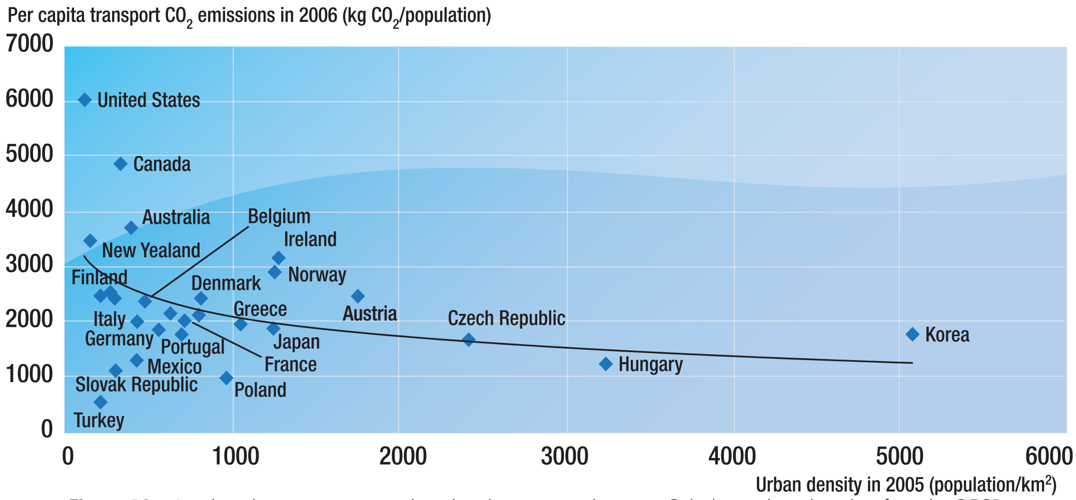


Figure 13 – *As urban density increases, carbon dioxide emissions decrease. Calculations based on data from the OECD Regional Database and IEA CO2 Emissions Data from Fuel Combustion.* Image credit: OECD/IEA

According to the OECD, CO_2 emissions from transport decrease as urban density increases (see Figure 13).

In many **developing countries** the lack of functioning urban public transport systems in many cities and a rapidly growing number of cars are generating severe health problems. Air pollution caused by motorisation is a serious problem due to old buses, trucks and two-wheelers. The exhaust gases from cars cause emissions of carbon dioxide particles, sulphur dioxide, nitrogen oxides etc.

Although the proportion of the urban population living in slums in developing countries has declined, the total number of slum dwellers rise. According to 2005 figures, slum dwellers in developing countries amount to a third of all urban residents. When urban privileged moves to gated compounds in the suburbs, they tend sometimes to worry less about slum problems and more about household security and construction of road systems.

In the EU, **construction activities** are estimated to consume more raw materials by weight (as much as 50 %) than any other industrial sector and produce Europe's largest waste stream (40%—50%), most of which is **recyclable**. Buildings are also responsible for 40% of EU energy use, more than either industry or transport, and for 36% of EU CO_2 emissions. Of the 210 million existing buildings in the EU, about 2.52 million are renovated each year. An industry task force is urging renovation targets of 50 million buildings in order to reach the EU 2020 Strategy goals by 2020, equivalent to about 5 million buildings a year over the next 40 years.

People both live and work in cities, and in our everyday life we consume food, clothing, and other goods of all kinds. The industrial sector represents a significant part of global CO_2 emissions, although the share of industrial emissions varies widely between countries. There are also major differences between nations and cities with respect to the development trend of CO_2 emissions (see Figure 14).

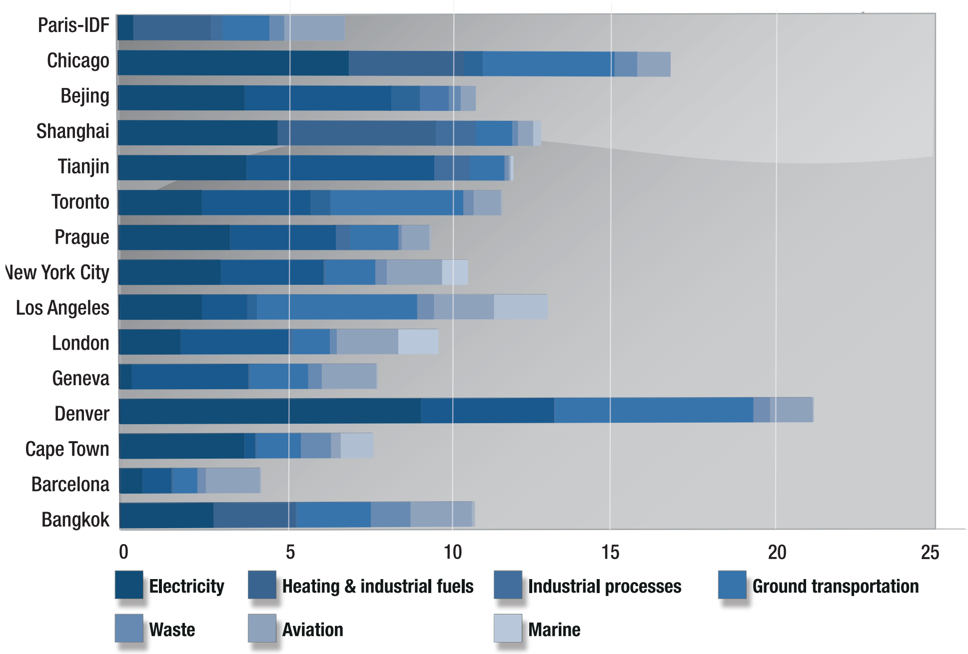


Figure 14 – *CO_2 emissions per capita in major cities.* Image credit: Christopher Kennedy, based on data from Centre for Neighborhood Technology, 2009.

3.1 Urban function: a holistic approach

Resource Efficiency in Cities provides opportunities to address environmental and social challenges while creating major financial savings.

UNEP Global Initiative for Resource Efficient Cities GI-REC

Resilience: 'The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.'

Definition given by the International Panel on Climate Change.

Cities have a key role to play in the global agenda for addressing the challenge of climate change.

It is in and around cities that it is possible to address climatic and environmental challenges in new ways. Cities with their higher density also offer economically and geographically scale and basis for efficient public transport, recycling of water, waste and materials as well as for efficient energy production, distribution and use. However, the city's opportunities are irregularly realised. Urban resilience is an expression that refers to the long-term capacity of cities and towns to respond to threats and challenges, while continuing to change and develop. In a time of increased stress on ecological and social systems, understanding how to strengthen such systems is essential.

The planning of cities offers the opportunity to create a stronger relationship with the ecological, economic and social aspects of sustainability including demographic matters in the process of considering function, dimensioning, location, mix, density and design of residential, commercial, educational, industrial, traffic, infrastructure, landscape and other vital urban functions. To put it concisely, it is easy to understand that modern buildings can be advanced technical systems, but then again cities can in a similar way be regarded as, on a larger scale, as technical systems coming to services, functions, spatial form, infrastructure constructions, support, maintenance, emissions etc.

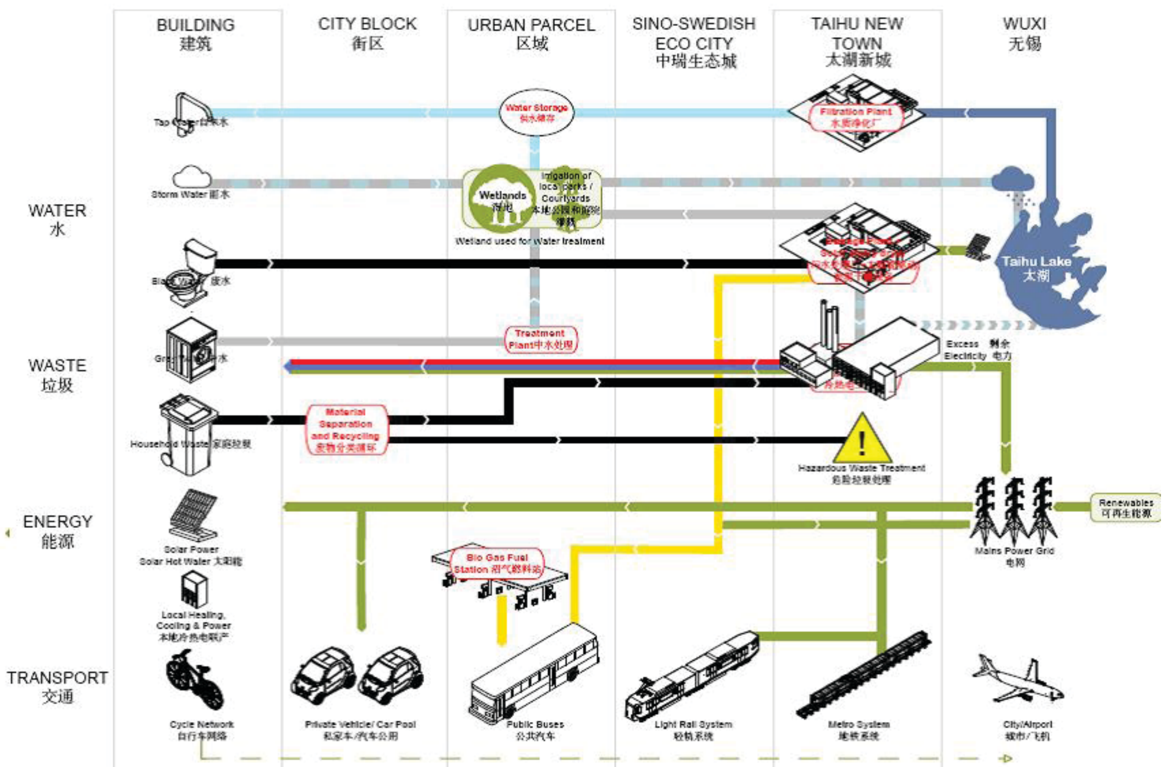
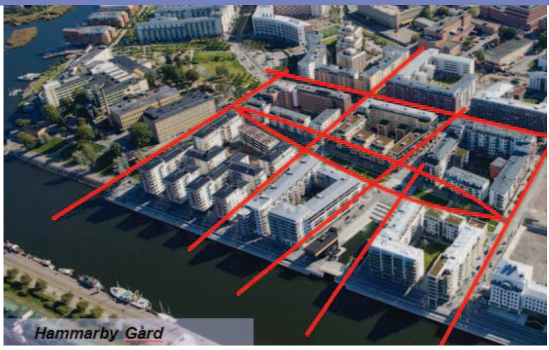
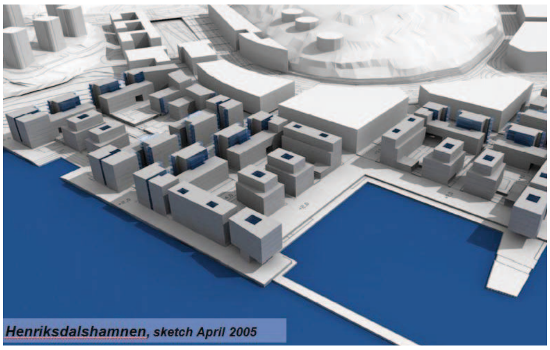


Figure 15 – *Wuxi SinoSwedish EcoCity Tengbom architect www.tengbom.se & AF technical consultant www.afconsult.com*

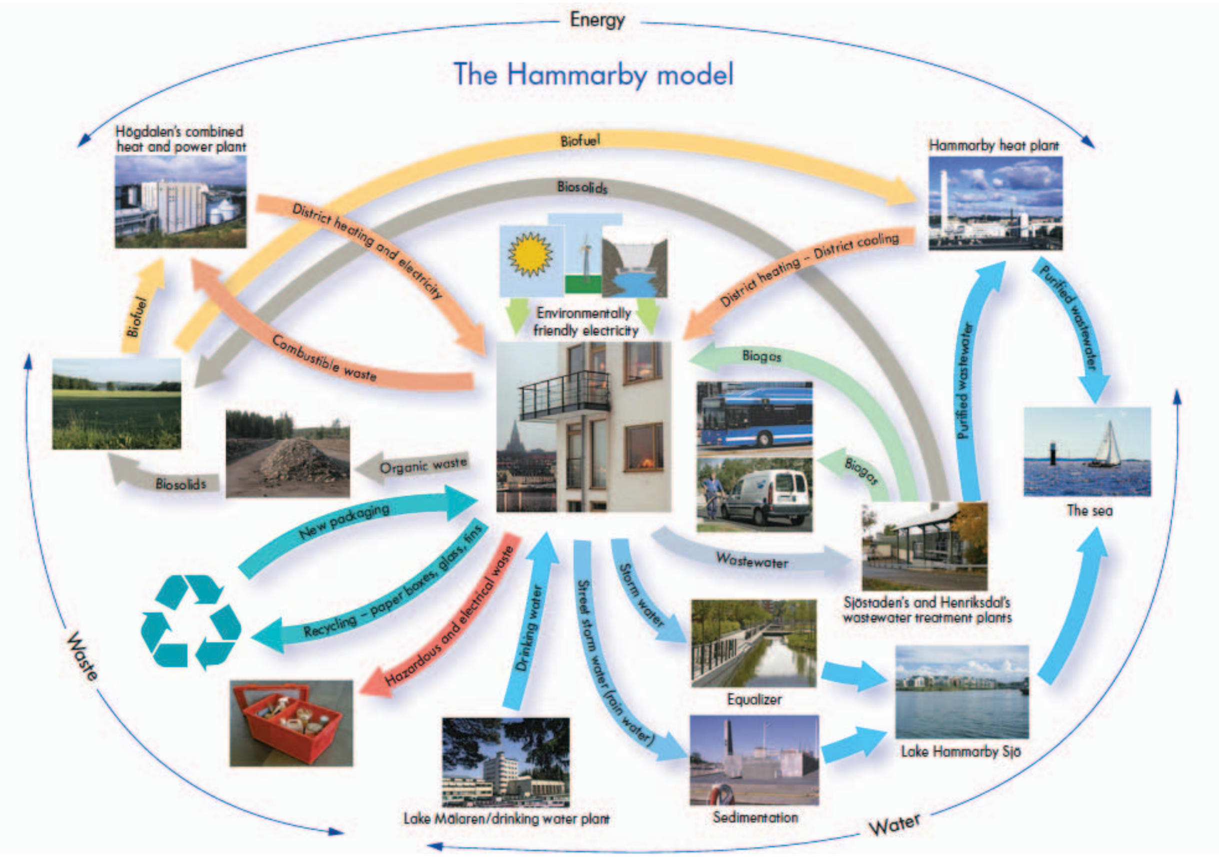




There are major incentives to create cities that employ resources efficiently, places where transportation and infrastructure are both effective and attractive, where land is used optimally and where the impact on water and the natural environment is limited. An environmentally friendly city has a sustainable energy system based on efficient and renewable energy end use in buildings, transportation and infrastructure, district-heating, closed cycles that utilise waste heat, waste, waste water etc. The city must also enclose green spaces that protect biological diversity and ecosystems. This requires increased investments, careful planning and improved infrastructure. Buildings must be designed to ensure that energy usage is limited through low heat losses, low cooling load, and the efficient use of heating, cooling and electricity.

Many energy and climate solutions are to be found in improved technology, synergies in system solutions, further expansion of infrastructure, an efficient transport system and properly constructed buildings and attractive, functional, well-planned cities. The total built environment (not just the individual buildings) requires sustainable overall solutions – ones that form synergies in solutions for society, buildings, infrastructure, and technical systems. This is necessary to facilitate their full potential in terms of efficiency and productivity, saving natural resources and reducing maintenance costs. Cooperation and synergies require more, and more coordinated, solutions, as well as better new construction and energy efficient transport vehicles. By creating synergies between different solutions we can achieve a comprehensive approach. Sustainable development can both reduce emissions and cities' vulnerability to climate change and many impacts can be avoided, reduced or delayed.

Planning for integrated land use for different and mixed urban functions should be closely coordinated with the planning of the transportation system in order to reduce the need for, and needs of transportation. Urban density, well-planned land use and functional urban structure are further important conditions for the possibilities for developing efficient and attractive public transport systems and other infrastructural service systems. Developing an urban pattern with higher urban density at nodes and along transportation corridors



Hammarby Environmental Model; The City of Stockholm. Photo Lennart Johansson, Stockholm City Planning Department

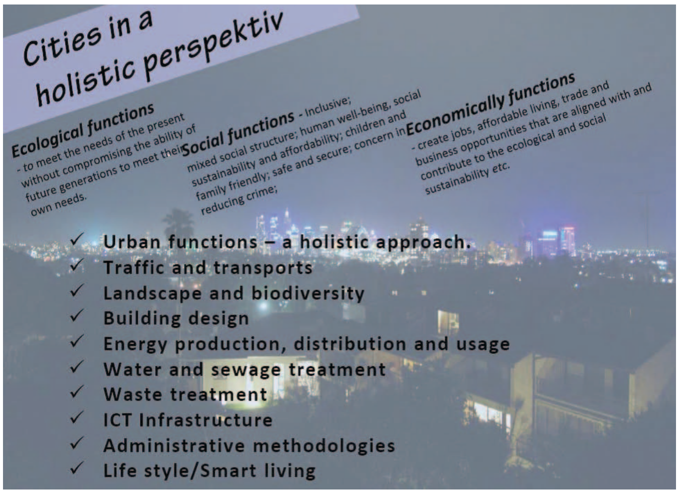
Envac Vacuum Waste transport system

Hammarby District Heating and Cooling plant

can be an efficient way of promoting travel by public transport. Further; society has, likely in an open planning process and in public-private partnership, to provide attractive, safe, human scaled family friendly compact residential and mix use areas with constructive possibilities for good service, attractive public transportation and energy efficient supply as alternative to an extensive urban sprawl.

Well-managed urban structure is essential to create jobs, attract businesses and bring together the resources to generate new ideas, innovations and an increasingly productive use of technology. There has been positive links between economic development and urbanisation in many countries. People in urban areas generally have greater access to jobs, services, education, markets and culture compared to their rural counterparts. It is easier and cheaper per capita to provide services and technical infrastructure to people living in cities than to those living rurally, being often spread over larger geographic areas. In the past, according to UNDP, investments in infrastructure and basic services for the poorest have drastically reduced urban poverty levels.

Social sustainable development centres on the social environment for people who live in the cities, areas or neighbourhoods etc. A well-functioning society must deliver a range of services for people to feel good, thrive and develop. It concerns both basic needs such as food, affordable housing, welfare and human well-being, education and work but also softer factors such as democracy, safety and security, concern with reducing crime, children and family friendly, equality and gender equality and the preservation of our heritage.



Society should encourage education and creativity that leads to development of the human capital. A social and inclusive sustainable development strives for a society, where all people in a mixed social structure, regardless of gender, age, socio-economic class or cultural background have the same opportunities to take advantage of social positives. While the physical environment cannot simply create this, it remains an important condition in promoting social development by providing venues, secure areas and security, and at the same time avoiding segregation.

3.2 Transportation: integration, access and efficiency

Mixed pedestrian and light rail street in Bordeaux, France.

More fuel efficient vehicles both for public or individual transportation; hybrid electric vehicles; bio-gas transit buses, bio-diesel vehicles and biofuels offer opportunities for greenhouse gas mitigation. One of the main goals for a sustainable strategy is to reach a balanced shift towards more environmentally friendly transport systems and solutions. Achieving sustainable transport and lower emissions requires infrastructural investments and development in modes with lower environmental impacts.

The energy requirements of urban transport are strongly influenced by the density, land use and spatial structure of the built environment, as well as by the location, extent and nature of the transport infrastructure. Large-capacity buses, light-rail transit and metro or suburban rail are necessary for the expansion of public transport.

Public transportation, walking and cycling as alternatives to individual road traffic positively affect energy usage and reduce carbon dioxide emissions as long as they are coupled with integrated spatial planning and higher urban densities. Public transport is an efficient way to transport people, from both land- and energy-efficient points of view. Transfers from cars to public transport enable road efficiency and reduce emissions of air pollution, greenhouse gases as well as land use.

Transit agencies operate lines of buses and rail; and some, both. As they look to reduce their carbon emissions, many are seeking forms of mass transit that have lower emissions as with alternative fuel buses or electric rail. Within the bus transit sector, although diesel remains the dominant fuel, the hybrid electric and natural gas buses are estimated to be growing at global level annually with 19.8% and 8.2% respectively between 2010 en 2016. And natural gas buses can be converted without difficulty to bio-gas fuel.

PASSENGER TRANSPORT

	EU-27	USA	JAPAN	CHINA	RUSSIA
billion pkm	2010	2009	2010 (1)	2010	2010
Passenger car	*4 738*	5828.4 (2)	766.7 (3)	1491.4 (4)	
Bus + trolley-bus + coach	*510.1*	490.1	87.0		147.7
Railway	403.8	40.1	393	876.2	139.0
Tram + metro	*90.1*	17.9	(5)		49.1
Waterborne	*38.1*	0.6	4.3	7.2	0.9
Air (domestic / intra-EU-27)	*524.2*	887.9	73.8	403.2	147.1

Passenger transport 2012 Superscript numbers indicate statistics older than 2012. Japan tram+metro are included in railway. Image credit: EU transport in figures Statistical pocketbook 2012

This graph shows that passenger car still is the dominant mode of transportation.

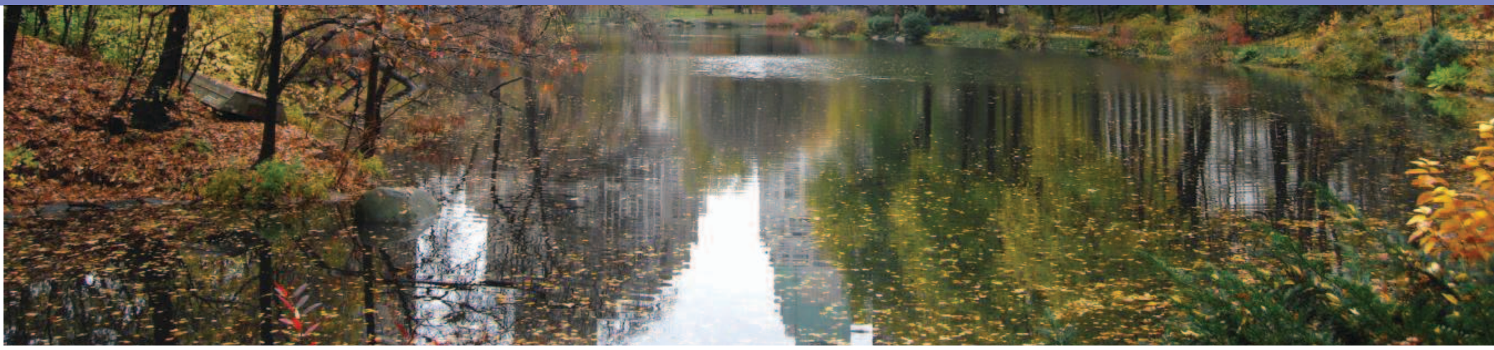
There are also soft measures, such as the provision of information and the use of communication strategies and educational techniques encourage change in behaviour leading to a reduction in car use. In addition, a uniform ticketing system may be introduced across the city to allow multi-transfer journeys on one ticket. Innovative public transport organisation is aimed at a system that will provide the citizens with safe, comfortable, convenient and affordable services. Congestion-free zones are another complementary method and already exist for instance in London, Singapore, Stockholm and Oslo.

3.3 Landscape and biodiversity

Landscape and biodiversity - attractive areas for stay, play, green and public spaces and parks, biological diversity, protection of sensitive habitats and species, plantations, trees and water environments in the public sphere, protected residential yards, shaded locations, local management of storm water, the opportunity for public life and meetings, secure and energy efficient lighting.

Biodiversity, which is normally defined as genetic diversity within a given biome, species diversity and ecosystem diversity, is an essential consideration in landscape design. By enriching the variation of life forms within the city, the urban planner can provide the city residences a harmonious living environment with better health conditions, better air quality and a better climate performance and adaptation compared with a city with poor biodiversity. Furthermore, biodiversity also brings more values and attractions to the city. Combining 'grey (technical/engineering) infrastructure' with green infrastructures has the potential to deliver robust and flexible urban solutions as lower energy needs due to lower cooling requirements, and of course attractive public areas and so forth.

Cities need 'cooperation' with nature in order to recycle cities' waste products into usable inputs for farming, gardening and energy production. Appropriate urban planning, including high quality green areas, courtyard gardening and street plantation as well as green roofs in cities, has proved to be an efficient way of limiting the 'heat island' effect, thereby reducing cooling needs and in certain instances also urban fires.



Central Park in New York

Life on earth is in every respect dependent on our rich and complex ecosystems, but recent decades have seen a serious decline in biodiversity. An approach for sustainable landscape planning may involve:

- Using trees, plantation and gardening as natural design element in the urban and human context, and if needed also to minimise the experience of traffic noise, barriers, and disturbances.
- Wet land purification of storm water and possible grey water likely joined to recreation and biodiversity, development of green areas and the reducing of storm water in attractive open ponds and ditches, and treated grey water for irrigation use.
- Restoration of waste-land 'brownfield management' and former land-fills turned into green areas and parks for recreation.
- Finding and saving green areas where wildlife can be left undisturbed, protecting sensitive habitats and species. Green areas as lungs of the city important for the reduction of air pollution. Green wedges and green corridors should be planned in coordination with paths for bicycling and walking.
- Promoting awareness of the value of biodiversity, using green areas to help understanding the connections between ecology, biodiversity and the environment.
- The topography, vegetation and other factors concerning the green structure are important to the micro-climate which should be taken into consideration when planning and designing areas for housing and industry as it can influence energy demand, the spread of air pollution, comfort level due to sun exposure, sun shading or wind exposure for cooling winds in summertime or wind protection in wintertime, with the help of green roofs, street plantation, court yard plantation, parks and park systems (heat-island effects), tranquil locations etc.

Additionally, forests have to play a key role in the global strategy to reduce carbon emissions. Forests provide materials as well as they store carbon, help regulate the climate, mitigate the impact of floods, landslides, and purify water. They also contain nearly 90% of the world's land-dwelling biodiversity, and wild relatives of many agricultural crops.

3.4 Building design

Building design — energy efficient buildings — both new and existing, passive heating and cooling, efficient mechanical systems; sound, recyclable material and minimum quantities, maximum use of non-polluting/non-toxic materials and substances, environmentally-maintained building sites, optimisation of construction in relation to local conditions, green building certifications systems etc.

The development of an energy, waste and water strategy at building level will promote opportunities for achieving sustainability at the urban level.

Energy efficiency options for new and existing buildings could considerably reduce CO_2 emissions with additional environmental and economic benefits. Available technical systems are environmentally necessary and already often cost-efficient. Opportunities for making reductions in the building sector exist worldwide but are often inhibited by barriers such as the availability of technology, financing, poverty, higher costs of reliable information, limitations inherent in building designs or policies and programmes. One challenge of the utmost importance to meet is that most of the buildings we are going to use in the future already are present in the existing building stock. For instance, a substantial proportion of all windows in the EU are still single glazed.

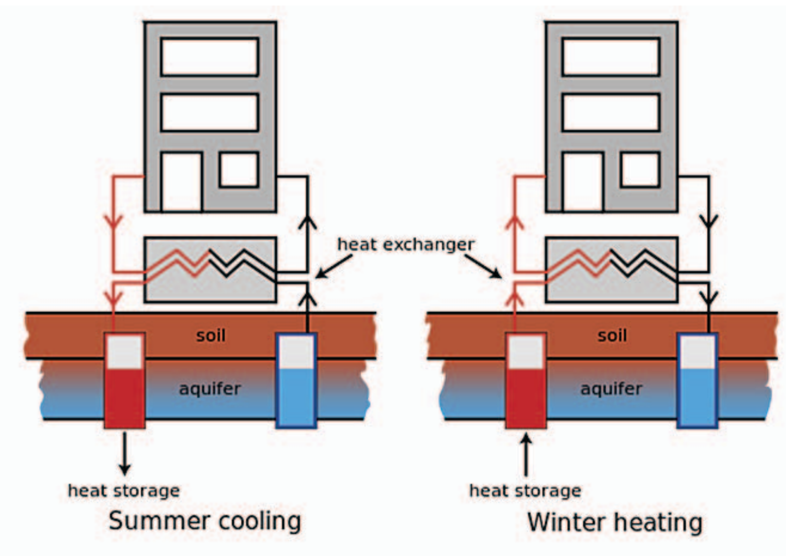
Residential building, with Photovoltaic panels and exterior sun shading, in the Bo01-area, Malmöe, Sweden.

In new building construction, it is possible to achieve considerable energy savings compared with many standard examples, often at limited extra cost. Realising these savings requires an integrated design process involving architects, engineers, contractors and clients, with full attention to the opportunities for reducing the energy demands.

The design of walls, roofs and floors (insulation, airtightness and design of windows, etc.) are the most important factors for the reduction of energy demand and operating costs. Important and available energy-saving solutions besides well-insulated and air-tight building envelops are efficient lighting and day-lighting; efficient electrical appliances and heating, thermal mass and cooling devices; heat recovery equipment, improved cook stoves, passive and alternative cooling methods, intelligent meters that provide feedback and control, material recycling and substitution. More buildings will also be designed to effectively produce energy and even deliver to the main power and heating grids using passive or active solar design for heating and cooling, solar photo-voltaic panels and micro wind generators integrated in buildings. Seasonal heat store retains heat deposited during the hot summer months for use during colder winter weather, and of course vice versa for cooling. Waste management and sewage treatment can be combined with bio fuel, electricity, and heating or cooling production.

The building and construction process offers great possibilities for reducing building material waste and environmental impacts. In the initial design process preference should be given to building materials with low environmental load and with the option of being ultimately reused or recycled. In the construction phase efforts to reduce the waste of materials on the construction site as well as efficient transports offers beneficial opportunities.

Advantages for microclimate (sun shading, sun exposure, wind exposure, wind protection) and energy demand can be achieved by careful building design in synch with the surrounding landscape. Green roofs will reduce storm water flow and contribute to cooling in summer.



Seasonal heating and cooling storage.

Buildings and their immediate surroundings should be designed with regard to the source separation and collection of waste, for example by facilitating waste management centres on the ground floors of multi-family housing. Local smart power grids may avoid peak loads, save electricity, and make use of multiple energy sources. Efficient water systems make it possible to reuse grey water and water treatment techniques can be so sophisticated that even household wastewater can be a resource for drinkable water production.

Over the past years, many countries have introduced new building rating and certification tools as ISO, CEN, LEED , BREEAM , HQE, Minenergie, DGNB, and the EU Green Building Program in order to improve the knowledge and methodology about the level of sustainability in building stock. These systems are tremendously important; but need to be further developed as it has also created some difficulties for stakeholders, including property investors, to understand differences between different markets and


Natural ventilation in a double glazed façade building.

building labelling. There are about 250 or more different rating systems around the globe. It is important to understand that all rating tools may contain in-built goal conflicts, and that strive for simplicity, may detract from a holistic view.

The International Federation of Consulting Engineers (FIDIC) recognises the importance of sustainability guidelines and tools, like FIDIC's Project Sustainability Management (PSM), in reducing the risk perceived by project teams of adopting sustainability during project development. This Report offers a global review of the tools currently available on the market. These can be grouped into the four categories: Rating & Certification Tools, Decision Support Tools, Calculators and Guidelines, which differ mainly in their origin and intended use. (See also Chapter 3.9.)

LEED from US Green Building Council and BREEAM from British BRE are available both for buildings and communities/urban areas. Rating schemes assessing infrastructure are also available, one example is the British tool CEEQUAL and Envision™ Sustainable Infrastructure Rating System is another important world recognised rating system dedicated to infrastructure.

Furthermore, ISO standards can contribute towards a holistic approach to urban planning and function. Works in progress, with the involvement of FIDIC, on sustainable cities and communities, deal with indicators, management and smart infrastructures. ISO standards improve energy efficiency, increase safety, contribute to planning of sustainable urban development, develop of reliable road networks and effective means of transportation, reducing pollution and dealing with water and wastewater management.

However, when formulating the requirements in building codes and other important legislation documents, it is important to bring about a holistic perspective (neighbourhood, regional, national, total) and to be aware of potential goal conflicts. If for instance we are only focusing on efficient energy end-use for individual buildings, we risk ending up with a larger primary use on an aggregated level. This may particularly be the case in Sweden, Denmark and Finland, where there is a large share of co-generation of electricity and heating. And in these national energy systems a switch from district heating to electricity may lead to an increased primary energy use even though an individual measures would lead to a significant decrease of energy end use. Buildings are normally built to last for 50 years or more, a natural first step is to put requirements on the energy demand. Energy systems may change considerably faster, and even though it may be difficult it is necessary that the requirements on the building also take energy supply options into account.

3.5 Energy production, distribution and use

Energy production, distribution and usage — efficient energy end use, renewable energy generation, efficient distribution, storage and use, district heating and district cooling, combined production of power, heat and cooling, and passive energy systems.

Society has, in the long term, to meet unavoidable future rising energy operating costs with strategic investments in energy efficient and environmental friendly infrastructure and building construction – strategic investments in efficient infrastructure today to meet inescapable rising energy and maintaining cost of tomorrow. (Severe oil-price fluctuation brought, for instance, the 1996 $20 USD price to a peak in the summer of 2008 of $147 USD, falling to $30 USD by December 2008; today it stands at $100 USD.

The energy sector can shortly be described as 1) production, 2) distribution and 3) energy use. In a sustainable society or city, environmentally safe supply of energy from renewable energy sources should be given priority as well as energy efficient use in all phases of energy flows.

Most importantly in the process of achieving sustainable energy solutions is to minimise energy demand by energy-efficient buildings, industrial processes and transports; food production, electrical equipment, and lifestyles. By minimising energy demand, optimal energy solutions for distribution of renewable energy can be encouraged.

Important examples are improved energy supply and distribution efficiency; fuel conversion from coal to gas; from natural gas to biogas; forestry products for bioenergy to replace fossil fuel use; more efficient end-use electrical equipment; heat and power recovery, passive energy systems; renewable heat, cooling and power (hydropower, solar, wind, geothermal and bioenergy), combined heat, cooling and power production (CCHP), smart grid functions, Carbon Capture and Storage (CCS); biodegradable waste, food waste, wastewater sludge or other bio materials in ananaerobic digestion processes to biogas (Methane NH4) for fuel production. Biogas will be utilised for heating purposes or to produce electricity or as vehicle engine fuel.

It took 12 years, from 1992 to 2004, to double the share of renewable energy from solar, wind energy and biofuels from 0.5% to 1%, but only 6 more years to double again to 2.1% by 2011. Including hydropower, total renewable energy sources today supply 8.5% of all the energy that is used, globally.

Biogas is produced primarily from local raw materials such as waste or sewage sludge. A certain amount of waste is also digested together with plant material. However, in response to increased demand, other raw materials for anaerobic digestion, such as straw or waste, can be imported. The raw materials are first digested to produce a crude gas, the quality of which must be upgraded before it can be used as motor fuel gas or for admixture with natural gas.

In Sweden, biogas is at present upgraded to natural gas quality in about 30 plants throughout the country. In many cases, biogas pumps at petrol stations are owned by the producer or distributor of the gas. Today, Sweden has 107 public outlets for motor fuel biogas.

District solutions, for instance, are a good option for both heating (in regions with cold climates) and cooling in densely populated areas. Instead of every building having its own boiler, district heating is supplied by a central plant which can use advanced methods to run on many different fuels or recover heat from other sectors, thus benefiting households, industry and the environment. One idea behind modern district heating can be to recycle surplus heat which otherwise would be wasted – from electricity production, from fuel- and biofuel-refining, and from different industrial processes. Furthermore district heating can make use of many kinds of renewables (biomass, geothermal, solar thermal).

Solar Thermal panels in Guizhou province, China and in Sao Paulo, Brazil

There are more than 5,000 district heating systems in Europe, currently supplying more than 9% of total European heat demands. In Sweden, district heating supply more than 50% of the heat needed in the housing sector.

Digester gas refinery to biogas fuel and a Cogeneration plant for district heating and electrical power.

District cooling is also used mainly in offices, public and commercial premises, as well as for cooling various industrial processes. The most common means of production is to use waste heat or lake water as the heat source for heat pumps, with the cooled water from which heat has been abstracted providing the district cooling water, while the heated output water from the heat pumps is sometimes used for district heating. Another common method of production is simply to use cold bottom water from the sea or a lake, i.e. free cooling. A further alternative is to install absorption refrigerant plant, powered by district heating, on or near a customer's premises, which therefore increases the load factor of the district heating system in the summer.

3.6 Water use and treatment

Water and sewage treatment — protecting water resources, minimising use of fresh water, reusing grey water; utilising waste water energy for production of heat, biogas and nutritive substances; recirculation of nutrients, local management of storm water, etc.

Water makes up around 70% if the Earth's surface, but only about 1% is fresh water (ground water, lakes and streams).

We need water for our basic survival, cultivating crops, generating energy and for industrial processes and domestic needs. A growing challenge is to secure enough quality water in a way that doesn't destroy our ecosystems from which we take our water supplies – rivers, lakes and aquifers. Since cities are growing, pressure on water resources supplying cities increases accordingly, in terms of water needs but also in terms of pollution and land use. Choices need to be carefully considered with sustainability aspects applied in water conservation, water and groundwater pollution, health and hygiene, recirculation of nutrients, social and cultural aspects and affordability.

Poor sanitation and water supply conditions have direct health implications on societies, and negative environmental impacts on rivers, lakes, shores and ground water. The lack of basic sanitation services leads also to over-fertilisation of lakes by sewage, and contamination of surface and ground water are resulting in changed fauna and flora or even extinction of species, besides making them useless as a source of drinking water. It is estimated that 884 million people are facing drinking water scarcity , and over 2.6 billion people lack access to flush toilets or other forms of basic sanitation.

The European Environment Agency (EEA) considers nine European countries as water stressed: Belgium, Bulgaria, Cyprus, Germany, Italy, the Former Yugoslav Republic of Macedonia, Malta, Spain, and England and Wales. Many European cities are over exploiting their groundwater reserves.

The minimisation of fresh water use is an urgent matter in many parts of the world, which calls for both technical solutions and for behavioural changes. Technical solutions within the buildings should promote efficient water use through the implementation of, for example, efficient toilets, taps and showers as well as dishwashers and washing machines. Also, other sources to supply non-potable water must be considered, such as rainwater harvesting and grey water reuse systems. Changes in water consumption control and charging policies have also shown to be efficient tools to reduce water use by punishing excessive consumption.

Local storm water treatment in Seoul.

Membrane-purification of waste leakage water, Duyun China.

It is also essential that the infrastructure of water supply, which can result in substantial loss of water due to leaks and uncontrolled illegal consumptions, be correctly maintained to avoid those problems. In drought-prone areas, rainwater harvesting helps to conserve water. Management at the household level must be more focused on improved efficiency, re-use of treated water, and even rooftop rainwater catchment. Solutions to promote sustainable water use are required at household, municipal and industrial levels and must be framed within the context of the complex interactions between other factors and systems, notably energy, food, and climate change.

Storm water systems traditionally drain water from urban areas directly to a recipient or to treatment plants. Often, the dimension of the pipes can only handle a certain amount of water and, in periods of intense rainfall, flooding can occur. Instead of traditional drainage pipe systems, sustainable storm water solutions can redirect the water on the surface, which allows for much more space and prevents flooding. Solutions including trenches, ponds and flooding areas can also add design and recreational values. Ponds, lakes and reservoirs can save rainwater from wet periods to dry periods, and provide water for irrigation of public green areas. Green roofs, which absorbs and delays the rain water before it reaches the storm water system is also a measure that should be considered in the architectural design of urban buildings and households. These roofs can also be an added value for biodiversity and reduce the urban heat island effect.

3.7 Waste management

Waste treatment — infrastructure for recycling and energy production; reduction, replacement, recovery, composting, biogas production, incineration for energy production and, as a last resort, landfill.

Waste management is a vital infrastructure system that needs to be well integrated into city planning and designed to be efficient with convenient collection that encourages cautious and hygienic sorting and separation, ideally as close to the source as possible. Sustainable waste management includes actions to minimise waste, to reuse, recycle and use waste for energy recovery. The waste system needs to be well-developed, in a way that different categories like food-waste, glass, paper, plastics and metals, electronic devices etc can be sorted and collected for recycling. However, waste collection generates a rather high transportation burden. New techniques have been developed to minimise transports, for example vacuum waste collection systems, which both avoid heavy traffic and facilitate convenient separation of waste at the source.

A suitable waste hierarchy has five steps: prevention/reduce amount; preparing for re-use; recycling; other recovery, e.g. energy recovery; and latest disposal.

Waste minimisation and recycling provide important benefits through the saving of energy and materials. Waste can have an economic advantage in comparison to many biomass resources because it is regularly collected at public expense. The energy content of waste can be most efficiently exploited through combustion where energy (district heating and electricity) is gained directly from waste's biomass (paper products, wood, natural textiles, food) and from fossil carbon sources (plastics, synthetic textiles).

Organic waste from restaurants and grocery shops as well as from households, toilet waste, sludge from septic tanks or wastewater treatment plants and manure from agriculture adjacent to cities, can be utilised for the production of biogas in a biogas reactor. This anaerobic digested biogas contains methane (NH4), which can be used for heating, cooking, district heating and electricity production or, after refinement, also as fuel for vehicles. Depending on the quality, the residue can be used as fertiliser in agriculture. Also landfill methane gas and digester biogas can provide important local sources of supplemental energy. Old dumpsites need to be stabilised and closed and new landfills with higher environmental and safety standards need sometimes to be constructed.

Also green areas are needed to deal with residual products. Combining conscious landscape planning including water resources with both wastewater treatment and waste management has provided successful ecological solutions. Former areas for dumping of waste can be planned and designed into recreational areas. The cleaned water can be used in cultivated areas, allotment gardens or as a stream through the green structure.

3.8 Information and communication technologies (ICTs)

ICT Infrastructure (Information Communication Technology Infrastructure) has the possibility to make energy use more efficient. It is a vital and necessary tool for sustainable social and economic development in 21st-century cities.

Intelligence and innovation in urban infrastructure are essential to reach the EU's climate change and energy policy objectives: cities have to become smarter and more integrated, both in design and action.

ICTs (information and communications technologies) enable energy production, distribution and more efficient use while encompassing any communication devices or applications, including smart grids, radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with the above.

ICTs can be a vital part of green growth in various economic sectors, a means to tackle environmental challenges, and foster sustainable consumption patterns. The application of ICTs has the potential to influence processes of production, transport, consumption all of which occur/are vital in urban settings, such as through product-specific improvements leading to energy savings as efficient building climate control systems and mechanics. Also potential to influence consumer behaviour/choice – reduced travel via teleconferencing, reduced energy use due to smart technologies implemented into transport and buildings. Also implementation of ICT also depends on technology use, which can in turn lead to increased energy consumption, so it is important to ground these developments in renewable sources of energy at the outset. When assessing the environmental impact of the medium and long term adaptability of behaviour and structures resulting of ICT services, one also must consider facts related to efficiency gains. Plus, various effects related to ICT are directly related to product life cycle: production, use, disposal (E-WASTE) – open and complex questions related to ICT and its contribution to sustainability. Therefore, ICT itself must become a greener sector with its in itself consumption of 8 — 10% of the EU's electricity. That's more or less the total electricity consumption of the Netherlands.

Photovoltaic street lighting, Guizhou Province, China

Smarter cities with integrated ICTs could cut resource use by putting intuitive tools into everyone's hands and improve quality of urban life. Examples include street lights that detect the presence of people — and adjust accordingly. Home heating systems that respond to their environment, and that can be controlled remotely and electric vehicles that are fully integrated with the grid. Such devices could then be further integrated using smart grid technology.

Smart grids are networks that can intelligently integrate the behaviour and actions of their users and shareholders to ensure optimised sustainable, economic and secure operation (electricity, gas or any other energy supply and use for example) thanks to the widespread incorporation of intelligent communication monitoring and management systems and possible interoperation.

A smart grid uses ICTs to turn the traditional 'one-way' grid into a more dynamic 'two-way' electricity system. The goal is to improve electricity distribution and use across the entire power grid, from generation to end-users. Smart grids allow power companies and consumers to see how power is being used in real-time, allowing companies to better match supply to demand and consumers to make more informed decisions about their energy use.

Such technical innovations can furthermore be applied to buildings and in their steering systems, in which temperature, humidity and illumination can be automatically controlled and managed by specialised software that can optimise energy production, distribution, and use. Over 200 smart grid projects and counting are currently being rolled across Europe, and can be viewed on an interactive map at www.smartgridprojects.eu, an online knowledge-sharing platform developed by the EU Joint Research Commission and EURELECTRIC.

Using existing communications infrastructure, build links across the energy distribution chain (which will require creative collaboration between communications and energy sectors). The European Council is already taking steps to capitalise on these synergies, for instance through its 'Smart Cities and Communities Initiative'. This necessity of synergy between sectors means market potential waiting to be exploited. ICT, transport and energy sectors, especially at local and regional levels, need to work together and collaborate on building infrastructure, integrating existing solutions, and creating services and business models. Companies that know how to process huge amounts of data in real time can offer important value to the implementation and management of 'smart grids'.

3.9 Integrated planning methodologies

Administrative methodologies — integrated planning methodology that comprises physical planning, infrastructure planning, and environmental programming; but also public-private partnership, dialogue with users, purchasers, authorities and the public procurement; laws, ordinances and standards; participatory processes, certification, life-cycle analyses and life-cycle costs.

The UNFCCC (United Nations Framework Convention on Climate Change) and the Kyoto Protocol have been a significant establishment of a global response to the climate problem, stimulation of national policies, creation of an international carbon market and the establishment of new administrative mechanisms that may provide the changes for future mitigation efforts. The 1992 Rio de Janeiro conference was of important assistance to put sustainable development on the political agenda. Twenty years later the Rio+20 event held in June 2012, where the international community met again to discuss these issues and drive progress forward.

The United Nations has annual multi-lateral meetings of governments held in different locations around the world under the sponsorship of the United Nations that serve as a forum for countries to discuss climate change matters.

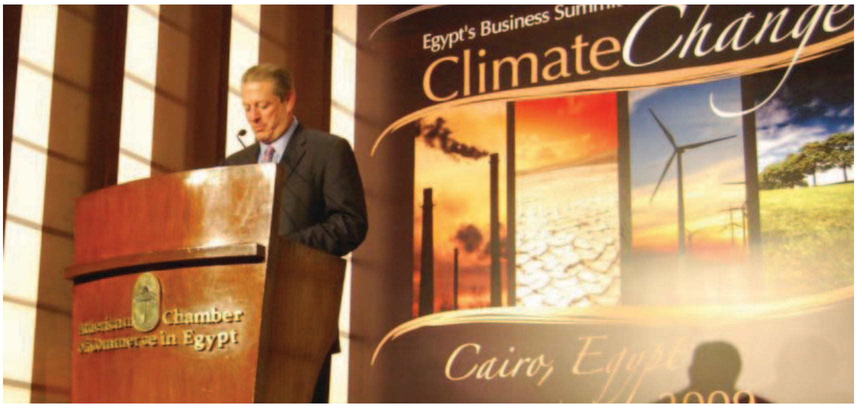
DOHA 2012
UN CLIMATE CHANGE CONFERENCE
COP18·CMP8

The conferences seek to address the threat of global warming caused by greenhouse gas emissions. The 2012 United Nations Climate Change Conference was the 18th yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 8th session of the Meeting of the Parties (CMP) to the 1997 Kyoto Protocol (the protocol having been developed under the UNFCCC charter). The COP18 conference took place in December 2012, in Doha.

Governments, institutions, educational institutions as well as local authorities have a crucial responsibility in providing improved social and ecological environmental development through institutional, policy, legal and regulatory frameworks, tariffs, taxation programmes, financing and investment flows, organisational structures, communication and coordination, technology transfer, land use regulation and enforcement, urban governance, urban planning, public sector leadership programmes and procurement, training and education. Without these measures it will be impossible to achieve emission reductions at a desired scale.

Public authorities as well as private organisations can also make important contributions through public-private partnership and by using their procurement or purchasing power imposing mandatory requirements to define the characteristics of the work, products or services that best fit fighting climate change, reducing energy consumption, and safeguarding the environment etc (e.g. optimum levels of energy and resource use, rating levels and standardization, eliminating harmful substances, higher levels of recycling etc).

SWOT-analysis and traffic planning workshop in China



Mr Al Gore talking in a conference in Cairo 2009

Furthermore, civic, NGOs, and other organisations and media play a decisive role in stimulating sustainable development and are needed critical actors in raising awareness for and implementing sustainable development policy and promoting behavioural changes. They can also stimulate policy action by filling the gaps and providing policy services, including in the areas of policy innovation, monitoring and research. Interactions can take the form of partnerships or be through stakeholder dialogues that can provide citizens' groups with a lever for increasing pressure on both governments and industry.

The private sector is of course a fundamental player in ecological and sustainable development. There have been significant increases in the number of companies that are taking steps to address sustainability issues at either the firm or industry level; with in the company's organisations, their deliveries, influence, market activities, etc. Although there has been progress, the private sector has the capacity to play a much greater role in making development necessarily more sustainable.

All the above mentioned actors should synergise in the process of sustainable development. In a specific project or in municipal or regional planning, different administrations, disciplines, developers, consultants, contractors and interest groups can together set agendas for a sustainable exploration. A common vision and a program with specific goals and requirements are needed. When exploration may take place on public owned land the municipality can have far-reaching goals and requirements, in order to enhance a sustainable development.

Mr Jan Inghe , Stockholm City Planning Department conducts a meeting regarding a new residential area in a multidisciplinary design team 2005 in Stockholm. Photo Lennart Johansson, Stockholm City Planning Department

The International Federation of Consulting Engineers' (FIDIC) and The European Federation of Engineering Consultancy Association's (EFCA) have developed two administrative design tools; The Project Sustainable Logbook (PSL) respectively The Project Sustainability Management (PSM II).

The Project Sustainable Logbook aims to facilitate discussions between political authorities, clients, project managers, engineers, designers, contractors, operators and all stakeholders of sustainability. However, it does not replace certification and rating systems. Instead it offers them a consolidated and organised overview of issues and objectives of specific projects and programs for monitoring them all along their lifecycle. In addition, the Project / Program Sustainability Logbook aims to accompany a built asset, a group of identified buildings, infrastructure or equipment, consisting an urban area, part of it, a block or related to specific urban functions as public transport, water and sewage, waste, heating or cooling etc.

The Project Sustainability Management (PSM II) process searches to expand design boundaries, looking for collaboration with stakeholder and their organisations, in order to identify sustainable design objectives. PSM II is, first and foremost, a list of issues that engineers should consider when carrying out projects in a sustainable way. Each item on the list brings with it a set of perspectives, which are the sustainability considerations that affect the way these issues should be considered on the project. The goal for each issue (of which there were 43) are measured against regulation and current practice, and identified the need for innovation as a mechanism to achieve improved performance towards an undefined target of sustainable practice. A good part of this manual consists of descriptions of the aspects of sustainability that each perspective represents and an indication of the range of possible project responses to these aspects.

3.10 Smart living

Life style/Smart living - among many thing; involves knowledge, information and communication - it must be easy to act correctly.

Technical solutions facilitate changes when individuals take responsibility and make contributions. Citizens, individuals, residents, users etc must be able to 'interpret' possibilities, processes and needs and receive clear feedback on actions and activities.

The way we live and the choices we make are decisive for developing a more sustainable society. Changes in lifestyle and behaviour patterns can of course contribute to climate change mitigation across all sectors. The way the city is planned can affect residents' lives and the choices they make, but it is also vital for citizens to understand why and how to make sustainable choices as producer or consumer, employee or employer etc and at different position and periods, considering all stakeholders, as described for example in 'Corporate Social Responsibility' new concept recognised in ISO standard 26.000, an holistic approach of a city, has to consider.

Bike sharing in Washington DC

Construct buildings with low environmental impact, low and renewal energy use, water saving installations and smart systems and devices for visualisation and monitoring, user-friendly waste system to facilitate sorting, collection and recycling are necessary steps towards the individual's environmentally smart living. In the design of buildings or urban areas conscious solutions make it easier for residents to make the right choice without overly substantial efforts.

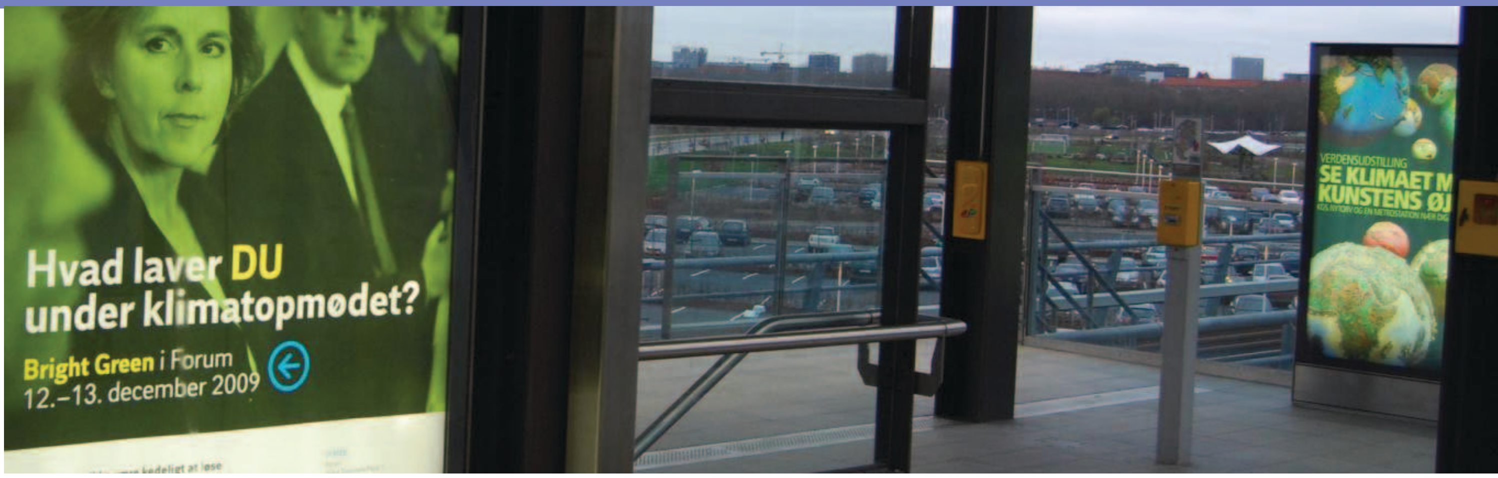
When building new city areas or revitalising existing areas, the structures, which will enhance sustainable living, should be in place when people start to move in or move back. Important examples, beside upgraded buildings and technical systems, are; attractive transport systems those promote energy efficient transports as public transportation, car sharing, bicycles and walking and avoid the pattern of giving priority to individual car transport work. These areas could also facilitate conscious choices by the presence and promotion of car pools, convenient bicycle networks and parking, attractive and safe pedestrian pathways and attractive public transportation. Other needed examples are waste sorting facilities, local storm water treatments systems, premises for social activities and service,


Sorting waste in different fractions.

In well-designed mixed-use areas, there will be many of the everyday needs available as service, culture, recreation, sports, business, and of course jobs, which both reduce travel and travel distances, while also providing a sense of community within the area.

To actively influence people to make smart choices, we need information, knowledge and feedback. A basic knowledge of what sustainability means and what you can do yourself is the first step.

By monitoring systems for energy and waste, for example, and providing its feedback one can easily show how different choices make a difference and can engage people. Modern technology also offers new opportunities, such as apps on smartphones when, for examples, organising carpools.



'What do YOU promise under the climate meeting?' Advertised in Copenhagen during COP15, 2009.

For industrial production or construction life cycle thinking also makes it easier to recognise the major environmental impacts in each step and to streamline the production in every phase. When looking on the total life cycle, in general, the phase with the highest environmental impact is the user phase, in a building being represented by the time we live in or use the house. This underlines the importance of energy efficient buildings. Life-cycle assessment (LCA), also known as life-cycle analysis, is a technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave — from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling). LCAs can help avoid a narrow outlook on environmental concerns.

'… we need more productive, sustainable and 'smarter' cities.'

Mr Getachew Engida, Deputy Director of UNESCO,

May 16th 2013 in Gwangju,

South Korea at Human Rights Cities conference.

This Rethink Cities white paper is attempting to demonstrate the following:

- ***Climate risks***

  - the magnitude and scope of the sustainability challenges we face are much more serious and comprehensive than current policy and/or action is addressing,

- ***Fighting poverty***
- ***Increased efficiency in use of limited resources***
- ***Reduced fossil dependency***
- *Improved* ***education****, and enlarged* ***cooperation*** *between developed countries, emerging economies and lesser developed countries*
- ***Ending systematic under-investments in resource-efficient and environmentally friendly infrastructure***
- ***Turning urban challenges into opportunities****; optimise and integrate systems for: energy production, distribution and use; building and city structures, increased mobility and accessibility; water use and sewage; waste recycling, and*
- ***Improved holistic and integrated approach to sustainability****; climate risks are global issues that necessitate shared responsibility.*

Conclusions:

1.Climate risks

- The magnitude and scope of the sustainability challenges we face are much more serious and comprehensive, than current policy and/or action is addressing.

2. Fight poverty

3. Increase efficiency in use of limited resources,

- We borrow today, as never before, limited natural resources and life opportunities from our future generations. Our fossil-fuelled prosperity cannot continue to expand without serious consequences. We must therefore use our resources without miss-using.

4. Reduced fossil dependency

- Growth-based, fossil fuel-driven economic development with increasing energy use and increasing greenhouse gas emissions is going the in the wrong direction, despite growing public awareness and concern.

5. Increased education, and enlarged cooperation between developed countries, emerging economies and lesser developed countries.

6. Ending of systematic under-investments in resource-efficient and environmentally friendly infrastructure,

- Society has under a number of years, compared with the gross national products in many Western Countries, been investing less in infrastructure, instead of investing more.

7. Turning urban challenges into opportunities

- The future city must be built to considerably better meet future conditions and climate changing - through optimising and integrating infrastructure systems for energy production, distribution and use; in synergy with efficient water use and sewage; waste recycling and reduction and improved building and city structures, increased mobility and accessibility, social inclusiveness and life qualities and enhanced economic development etc.

8. An improved holistic and integrated approach to sustainability

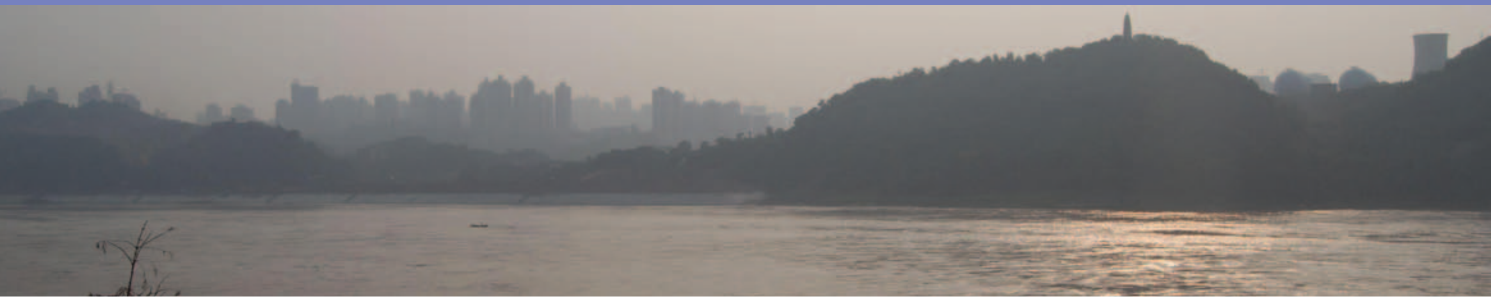
- Smart technical solutions and sectoral integration are necessary to achieve holistic and sustainable urban development. Improved methods and routines for synergies between different infrastructure supply systems are required. Through developing and better use of fundamental experiences, science-based knowledge and technologies, which actually often already exist, we can built a more sustainable society for ourselves and most important for our children. A broad portfolio of technologies can be projected to play a role in meeting and managing the risk of climate change and broad range of research and strategic investments are needed. We must improve the coordination of the sectoral policy areas and develop a new sense of responsibility for integrated urban development policy.

A favela in Brazil

Climate risks are global issues that require shared responsibility. Technologies in the absence of climate policies may have as great an impact as, if not greater than, the influence of the climate policies themselves. The protection of biocapacity and ecosystems must be a priority in our quest to build a stronger, fairer and cleaner world economy. Rich nations must find ways to live much more lightly on the Earth – to sharply reduce their footprint, particularly their reliance on fossil fuels. The rapidly-growing emerging economies must also find a new model for growth – one that allows them to continue to improve the wellbeing of their citizens in ways that the Earth can actually sustain. Wealthy nations have major opportunities to set good examples of well-functioning and environmentally friendly cities. Adaptation and mitigation are two types of policy response to climate change, which can be complementary, substitutable or independent of each other.

Global energy use and supply – the main drivers of greenhouse gas emissions – is projected to continue to grow, especially as developing countries follow industrialisation. Industrialised nations are the source of most greenhouse gas emissions and have also the technical and financial capability to act. On the one hand vulnerability to climate change is framed and strongly influenced by development patterns and income levels. On the other hand, climate change itself, and adaptation and mitigation policies could have significant positive impacts on development in the sense that development can be made more sustainable. Major technical adjustments and infrastructure investments are required if the world will be able to restrict global emissions sufficiently to limit the rise in temperature to a maximum of 2°C above the pre-industrial level.

Cities make it possible to respond to climate challenges in new ways through promoting an integrated and holistic approach to planning and building sustainable cities through support to local authorities, efficient transportation and communication networks, greener buildings and an efficient human settlements and



Yangtze River, Chongqing, China

service delivery system, reduced climate and environmental impact, improved air and water quality, reduced waste, improved disaster preparedness, response and increased climate resilience.

An ideal city should have sustainable energy systems based on effective use of energy, cogeneration, closed loop systems, and to utilise and produce energy from waste, sewage water and other residues from other cycles. The resulting benefit is that the city's profile in terms of political, economic and social importance is raised. Major challenges in urbanism are to create a city, which has effective resource utilisation and where transportation and need of infrastructure has been efficient and minimised, as much as possible. Land must be used optimally to the most appropriate and in best need for the city. Impact on water and the natural environment must be as small as possible.

Sustainable development can be tackled as a framework for jointly assessing social, environmental and economic dimensions. Decisions about trade, poverty, community rights, social policies, governance etc, which may seem unrelated to climate policy, possibly will also have considerable impacts on emissions. New energy infrastructure investments in developing countries and upgrades in developed countries open opportunities in the energy mix in order to lower greenhouse gas emissions.

A strategy for sustainable urban development requires an awareness of the overall results of the various coordinated public and private responsibilities, on social environment, land use and urban planning that is incorporated with environmental scheduling and coordinated development for infrastructure. This is what an integrated planning methodology consists of. This design philosophy is characterised by a holistic integrated approach to sustainability, one that discovers synergies between social, inclusive and economic responsibility by working in conjunction with different urban systems of structure and functions. Not to mention energy production, distribution and consumption, waste management, water supply and sewage treatment, traffic and transportation, landscape planning, building design, environmental standards and also saving natural resources and maintenance costs. Each part of a city must be seen as part of the contiguous city as well with the city's rural and semi-rural surroundings.

An integrated planning process needs to follow a holistic thinking from overall planning to construction and completion.

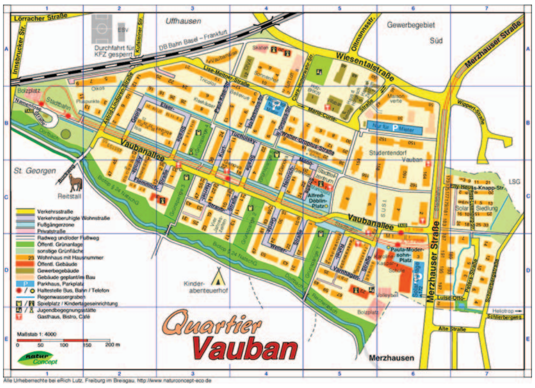
Turning urban challenges into opportunities

*– through a holistic approach en route for over synergies for urban functions; optimise and **integrate systems** for energy production, distribution and use; water use and sewage; waste recycling; building and **city structures**, resource efficient mobility and accessibility, social inclusiveness etc.*

5.1.Urban functions

– the city in its entirety (not just its buildings) well-functioning structure and system as social, economic and ecological environment with sense of aesthetic values, efficient land use, resource and energy efficiency, density and variation, adaptation to the local context etc.

5.1.1. Vauban, Freiburg, Germany



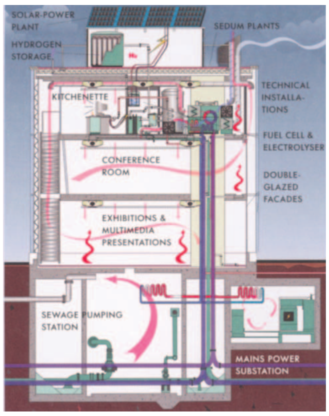
Vauban in the South of Freiburg, Germany, on the former area of a military barrack site, a new district is being developed for more than 5,000 inhabitants and 600 jobs in an area of 38 hectares.

The main goal of the project is to implement a city district in a co-operative, participatory way which meets ecological, social, economic and cultural requirements. Major driving forces for the development of Vauban are the ideas, the creativity and commitment of the people involved and the common goal to create a sustainable, flourishing neighbourhood. The fields of energy, traffic / mobility, building and participation / social interaction / public spaces new concepts are successfully put into practice.

http://www.vauban.de/

5.1.2. Hammarby Sjöstad, Stockholm, Sweden

Hammarby Sjöstad, Stockholm



Hammarby Visitor Centre designed by Tengbom architects.

Hammarby Sjöstad is Stockholm's largest urban development project, and has since 1990s, been expanding and when completed in 2017, the area will hold about 11,000 residential units, housing some 25,000 people. The planning has been conducted by the City of Stockholm but most investments are made of some 30 developers together with many infrastructure providers.The idea behind Hammarby Sjöstad is to show a unique opportunity to expand the inner city with a focus on water, while transforming an old industrial and harbour area into a modern neighbourhood.

Hammarby Sjöstad has its own eco-cycle, the Hammarby Model, which outlines environmental solutions for buildings, traffic, waste, energy, water and sewage. One of the key-drivers behind this is a strong Swedish tradition of public-private co-operation between planning authorities, developers, architects, engineering and environmental specialist, etc. Environmental examples are; a sensible dense residential and mix use urban area; family friendly neighbourhood; well-insulated buildings; waste to energy - incineration of sorted waste is cogenerated into district heating and electricity; generation of district heating and cooling with heat pumps; attractive and green public transportation; biogas fuel for city-buses, cars and approximately 1,000 stoves is extracted in an anaerobic digestion of sewage sludge; automated waste transport system; GlashusEtt-visitor centre for implementation of the environmental program; international visitors every day.

http://international.stockholm.se/ www.hammarbysjostad.stockholm.se

5.1.3. Western Harbour, Malmö, Sweden

The goal for City of Malmö has been to create a sustainable district with a high level of quality in terms of its architecture, public environment and materials. A considerable amount of the energy used in the area is produced locally through wind and solar power and ground and seawater heat extraction. A water pump draws energy from natural water reservoirs/aquifers, in the underground rock. The system stores warm water from the summer to heat buildings and water in the winter and cold water from the winter to cool buildings in the summer. According to the plans; there will be some 10,000 residents and 20,000 employees and University students in the area. Many of the apartments have their own electricity and district heating meters that allow residents to monitor and adjust their own energy consumption. Storm water is treated locally and does not pour down into the sewer system.

http://www.malmo.se/English/Sustainable-City-Development/Bo01---Western-Harbour.html

5.1.4. BedZed, London

BedZED, London is a mixed use sustainable community, with 100 homes, office space for around 100 workers and community facilities. Completed in 2002, BedZED is still the inspiration for low carbon neighbourhoods with 81% reduction in energy use for heating, 45% reduction in electricity use compared to local average, water use 72 litres/person/day, 60% waste recycled.

http://www.bioregional.com/flagship-projects/one-planet-communities/bedzed-uk/

5.1.5. The Tangshan Bay Eco-City

The Tangshan Bay Eco-City Project is located 220 kilometres east of Beijing and will be a new city for 1,5 million inhabitants in 150 km2, with first step 12 km2 planned for 160 000 inhabitants in 2015. An eco-cycle model includes proposal for integrated management of energy, waste and water.

Image by Sweco

http://en.tswstc.gov.cn/

5.1.6. Favela's upgrading - improved living conditions in informal settlements

Favela upgrading outside Cubatão, Brazil

In their one hundred year history of Favelas, these informal settlements with self-build houses have developed for a number of reasons as and varies greatly in their location, size, form, construction materials, topography etc. and are very much associated with poverty, health, and criminal activities. However, the favelas have become permanent features in Brazilian cities, a symbol between formality and informality, legality and illegality, order and chaos. In recent years, central and local governments have attempted to reduce those strains by investing in the urban renewal of favelas. Streets and alleyways have been paved, health clinics and community centres have been built, and urban services such as light, water, and sewage systems have been istalled.

5.1.7. Euroméditerranée, Marseille

Euroméditerranée is an urban redevelopment project running 2009 - 18 including design within a team of architects (François Leclercq), Groupe SETEC, owner Etablissement Public d'Aménagement d'Euroméditerrannée and other stakeholders. The project area covers 170 ha and include 14 500 housing, 470 000 m² office, 50 000 m² shop and 150 000 m² equipments.

The energy strategy is based on a generation with heat pumps on sea water and heat of waste water, and supported by storage of energy and building design that takes advantage of the wind and the solar contributions. In the confluence of three hydrological ponds, the project is challenged by risk of flooding, so a park will absorb possible flooding, treat grey waters and limit island of heat.

5.2. Transports

- main goal for a sustainable transport strategy is to reach a shift towards more environmentally friendly systems and solution as fuel ***efficient vehicles****; hybrid electric vehicles; bio gas transit buses, bio diesel vehicles; biofuels etc offer etc., appropriate* ***infrastructural investments*** *and development in modes with lower environmental impacts and* ***urban areas*** *with higher density, mixed land use and an efficient spatial structure of the built environment etc.*

5.2.1. Energy efficient vehicles

Electrical mini-vehicles and an electrical charging pole with green electricity.

5.2.2.Bus Rapid Transport

Bus Rapid System BRT- systems using buses to provide faster, more efficient service than an ordinary bus line. Often this is achieved by making improvements to existing infrastructure, vehicles and scheduling. The goal of these systems is to approach the service quality of rail transit while still benefiting cost savings and flexibility of bus transit.

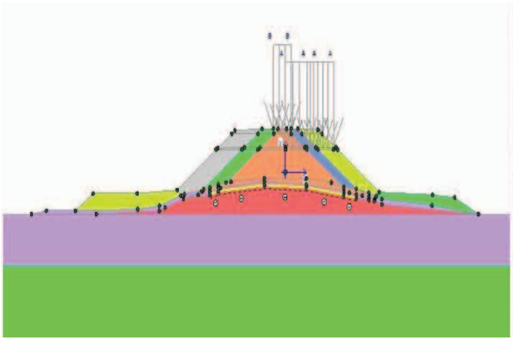
Bus Rapid Transport in Medellin, Colombia

5.3. Landscape and biodiversity

*– attractive areas for **public life**, play, green spaces and parks, **biological diversity**, protection of sensitive habitats and species, plantations, trees and water environments in the public sphere, protected residential yards, shaded locations, local management of storm water, the opportunity for public life and meetings, secure and energy efficient lighting.*

5.3.1. Improving coastal protection and accessibility at the port of Oostende Technum

A project in **Oostende** will protect the city against high water during heavy storms and to improve the accessibility to the harbour. This project will limit the effect of the waves by raising the ground level of embankment with support of a new step-formed dyke at the Klein Strand and with a protection dam on the west side of the entrance channel. Also on the east side of the channel is a protection dam constructed in connection with a recreation beach. The accessibility of the port is improved by partially straightening and deepening of the entrance channel.



Dyke constructions in Oostende, Belgium

5.3.2. Egis Pilot Project:

Adaptation to Climate Change and Natural Disaster Preparedness in the Coastal Cities of North Africa. World Bank Pilot Project (2010-2011)

Flooding in Tunis, 2009

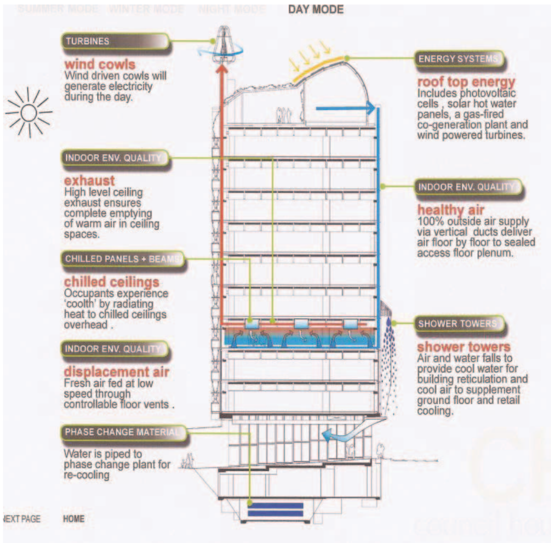
The World Bank is increasing its assistance to Governments in Middle East and North Africa region to face the increasing threats of climate change and natural disasters, and to incorporate the appropriate responses in their development plans. In this region, coastal cities, which in 2000 were the home to over 60 million people and are expected to grow to 90 million by 2030, stand out as the most productive metropolitan areas, but also the most affected by climate change. Governments need to develop appropriate adaptation and risk mitigation strategies.

5.4. Building design

– Resource and energy efficient buildings – both new and existing, passive heating and cooling, sound, recyclable material and minimum quantities, maximum use of non-polluting/non-toxic materials and substances, environmentally-conscious building sites, optimisation of construction in relation to local conditions etc.

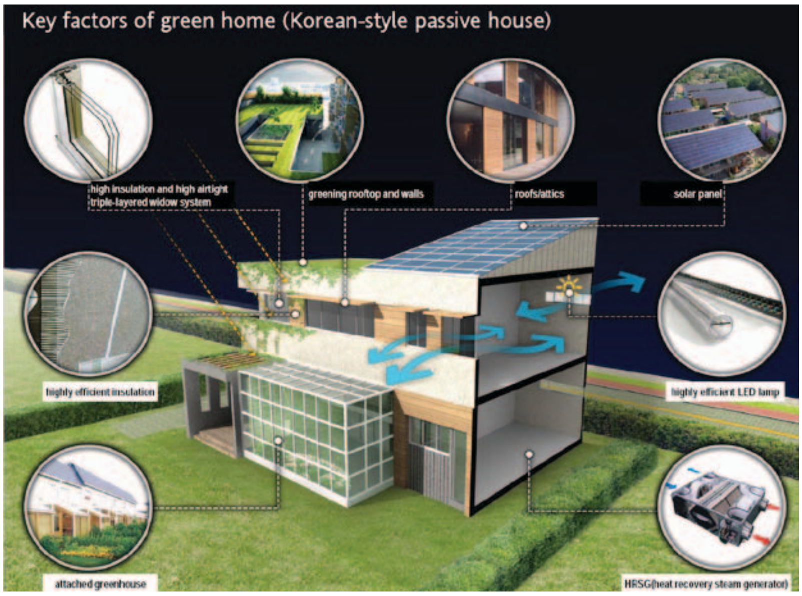
5.4.1. Council House 2 (CH2), Melbourne

Council House 2 (CH2), completed 2006, is a 10-storey office building housing approximately 540 City of Melbourne staff, with ground-floor retail spaces and underground parking. Gross floor area (GFA): 12,536m^2. CH2 was Australia's first '6 Star Green Star – Design' certified rated commercial office building by the Green Building Council of Australia. All fit-out materials are recycled and/or nontoxic which is expected to improve the health of staff. CH2 is projected to pay off its environmental features in approximately six years. Architect: City of Melbourne and DesignInc Pty. Ltd and Environmental engineering: Built Ecology.



CH2 Building in Melbourne designed by DesignInc - Image credit; City of Melbourne and DesignInc Pty

5.4.2. Korean Low Carbon House Town



YoungDeok-dong, Yongin City, South Korea Demonstration of complex model of Green city by President's Committee on Green Growth. 52 homes (31 households in single houses, 21 households in row houses) in an area of 26 000 m2.

5.4.3. Passive house standard

The Passive House has become an international acknowledge standard for sustainable construction It was originally developed in Germany (Passivhaus) and the City of Darmstadt houses The Passive House Institute www.passiv.de Passive House is now a world standard in energy-efficient construction and allows energy savings of over 75% compared with many average new constructions in central Europe. Passive Houses require less than 15 kWh/m²/ yr. for heating or cooling (relating to the living space).The Passive House requires high standard insulation, thermal bridge free design, airtight construction, heat recovery ventilation and highly insulating windows.

One of the original 1990 Passive Houses, Darmstadt.

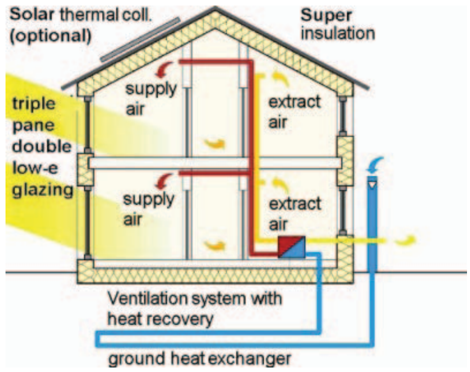


Image credit: The Passive House Institute.

5.4.4. Other examples

Western Harbour, Malmö; Tomt 10; Architect (phase 2): Urban Vision AB, Developer : Midroc PropertyDevelopment AB (phase 2), Utvecklingsbolaget Harmoni AB (phase 1) - left

Bank of America Towerfrom 2008 at 42nd St, New York designed by COOKFOX Architects Adamson Associates Architectsis the first skyscraper getting a Platinum LEED Certification - right

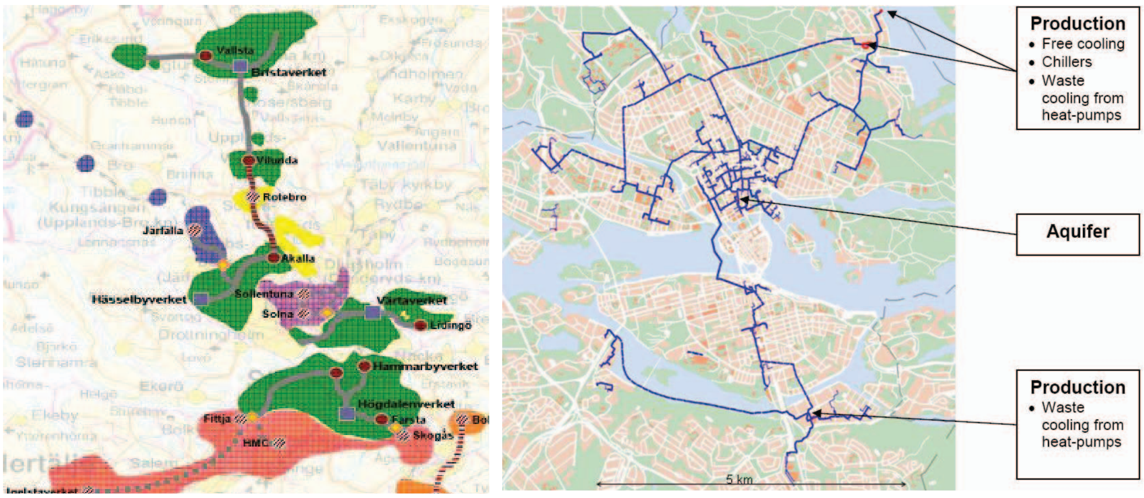
Recycled brick, Daedam, South Korea

5.5.Energy production, distribution and use

– efficient energy end use, renewable energy generation, efficient distribution, storage and use, district heating and district cooling, combined production of power, heat and cooling, passive energy systems etc.

5.5.1. 2010 Sweden's proportion of energy use from renewable sources was 48%

In 1990, Sweden's proportion of energy use provided from **renewable** sources was 33.3% and by 2010 it had increased to **48%**. Sweden uses the highest proportion of **renewable** energy in relation to final energy use of any country in the EU. The greatest contribution made by renewable energy sources is that of **electricity** production, of which a major proportion is supplied by hydro power. The next largest user of renewable energy is the **industrial** sector, followed by **district heating** production and the **residential** sector. **District heating** is in Sweden the most common form of heating in apartment buildings, with about **82% of apartments being heated by it in 2008**. Oil was used as the sole heat source for 1% of apartments.



The district heating respectively district cooling networks in Greater Stockholm.

Hammarby district heating and cooling plant

District heating started in Stockholm 1953 and produces today **80%** of all space heat required in Stockholm and in combination with electricity production CHP. **80%** of the fuel is based on renewable sources. Combustible waste is incinerated in Stockholm since 1971. Stockholm was appointed European Green Capital for 2010 and one of the major reasons was Stockholm's big use of district heating. **District Cooling**, starting in Sweden in the early 1990's, has had a rapid development and has grown to the same size as the production of wind power and without any subsidies. The cooling business in Stockholm is run by the energy corporation Fortum and 7 000 000 square meters of commercial area in Stockholm are supplied via the cooling distribution network.

5.5.2. Bern cogeneration plant – wood and waste to energy

The new Waste to Energy Plant **Forsthaus in Berne** is the most modern wood and waste cogeneration energy plant in Switzerland. The waste treatment facility is with a wood district heating and power plant (CHP) and a gas and steam combined energy power plant (CCGT) combined.

5.5.3. Other examles

Photovolaic panels covering a large parking area in Gwangju, South Korea

5.6. Water and sewage treatment

- protecting water resources, minimising use of fresh water, reusing grey water; utilising waste water energy for production of heat, biogas and nutritive substances; recirculation of nutrients, local management of storm water etc.

5.6.1. A portable unit for heating and treating water using the sun

Solvatten is a portable unit for heating and treating water using the sun. It is a patented, scientifically-proven Swedish invention which combines filtration, UV-disinfection and heat-pasteurisation. The householder fills the Solvatten unit with water, exposes the unit to the sun and waits until an indicator turns green, 2-6 hours later. 11 litres of water can be treated at a time, and in the best conditions Solvatten can be used three times a day.

www.solvatten.se

SOLVATTEN is a portable 11 liter container that is harnessing sunshine to heat and treat water at household level. Put Solvatten in a sunny place; expose for 2-6 hours and the water will be drinkable. An indicator shows when it is safe to drink. Solvatten can also be used as a solar water heater, providing hot water for cooking and hygiene.

5.6.2. Inkerman Oasis greywater recycling system, Melbourne

Grey water recycling system operating in Melbourne.

Inkerman Oasis/Inkerman D'LUX, is a medium-high density residential development in St Kilda, Melbourne and was constructed 2000-2005. The site was previously a municipal depot including a transfer station for recycling. To recycle stormwater from the site plus domestic grey water from

50% of residential units is reused on gardens and for flushing toilets. Grey water is firstly treated in an aeration balance tank to remove solids. Storm water is diverted directly to the wetland with no prior treatment except via gross pollutant traps. Grey water is treated via two duplicated Membrane Bioreactor (MBR) tanks for biological and physical filtration. Storm water goes directly from the wetland to the MBR tanks. After storage in an underground tank, the combined grey and storm water passes through an ultraviolet disinfection system before being used for sub-ground garden irrigation and toilet flushing across the development.

http://wsud.melbournewater.com.au/projects/projectcasestudies/74/Inkerman.pdf

5.6.3. The Heriksdal wastewater treatment plant in Stockholm

Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. It is a process that occurs spontaneously in nature. In the **Heriksdal wastewater treatment plant in Stockholm** organic material is separated from the wastewater and is collected in large digestion tanks. This digested gas consists of about 65% methane and 35 % carbon dioxide. For use as vehicle fuel gas must the digester gas be purified to approximately 98% methane, compressed to about 200 bars and used as vehicle fuel.

Henriksdal biogas refinery

Biogas bus

5.7. Waste treatment

*- infrastructure for **recycling** and **energy production**; reduction, replacement, recovery, composting, biogas production, incineration for energy production and, as a last resort, landfill.*

5.7.1. Stationary pneumatic refuse collection

Envac Stationary pneumatic waste collection and transport system, Wembley, London respectively Hammarby Sjöstad, Stockholm www.envac.se. Photo Vanessa Sternbeck

Stationary pneumatic waste collection means that waste is transported underground in pipes to a collection station, where it is compacted in closed containers. Different waste chutes/inlets and different collection containers are used for separate waste fractions. When all waste has been collected from the first chute, the air inlet valve closes and the air inlet valve of the next branch is opened. In the collection station the waste is steered to the right way through keeping only one valve open at the time. A computer located in the collection station controls and manages the collection process.

5.7.2. Waste collection examples

Wate maintance facilities in Palm de Mallorca; Stockholm; Stockholm; Stockholm; Eskilstuna, Sweden and Amsterdam.

5.8. Information & Communication Technologies

*- the concept of the **smart city** has been introduced as a framework and to highlight the growing importance of Information and Communication Technologies (ICTs), social and environmental capital in profiling the competitiveness of cities.*

5.8.1. The Royal Seaport smart grid project

A first step has been to make the core ICT infrastructure of the area smarter, focusing initially on energy. Ericsson is leading the ICT aspect of the development of the Stockholm Royal Seaport's Urban Smart Grid project, which in turn is being managed by the energy company Fortum.

Smart grids use ICT to gather and act on information about the behaviour of suppliers and consumers using the grid. This information can then be used to improve the efficiency, reliability and sustainability of electricity production and consumption in the grid.

5.9. Administrative methodologies

*- example; **integrated planning methodology** comprises both physical planning and infrastructure planning, and an environmental programme, dialogue with users, purchasers, authorities and the public procurement and also laws, ordinances and standards.*

5.9.1. BREEAM Comuinities

BREEAM®

BREEAM Communities is a certify-standard that helps developers, urban planners and design teams achieve sustainable designs and plans for new communities. It covers economic, social and environmental sustainability – assessing issues like housing provision, transport networks, community facilities, and economic impact. It makes sure that sustainability is considered at the very early stages of design where site-wide solutions can have a big impact. The BREEAM Communities is sustainability standard at the master planning scale useful for developers, local government and design teams and is described as a 'framework' and a 'dialogue tool' that facilitates discussion between the professions and organisations involved in planning new communities. Rather than a simple checklist, BREEAM Communities provides a process that is aligned to the practice and timing of planning new communities. www.breeam.org/communities

5.9.2. Haute Qualité Environnementale

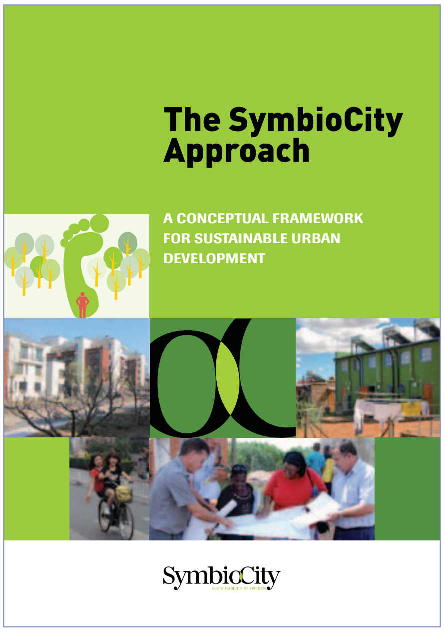
HQE ASSOCIATION RECONNUE D'UTILITÉ PUBLIQUE

The Haute Qualité Environnementale or HQE (High Quality Environmental standard) is a standard for green building in France, based on the principles of sustainable development first set out at the 1992 Earth Summit. The standard is controlled by the Paris based Association pour la Haute Qualité Environnementale (ASSOHQE).

In June 2009, it was announced that the CSTB (Centre Scientifique et Technique du Batiment) and its subsidiary CertiVéA had signed a memorandum of understanding to work together with the global arm of the United Kingdom's Building Research Establishment (BRE) to develop a pan-European building environmental assessment method. The BRE developed and markets (BREEAM (the BRE Environmental Assessment Method), which has similarities to the French HQE.

5.9.3. The SymbioCity Approach

The Swedish Association of Local Authorities and Regions/SKL has developed the **SymbioCity Approach** – a conceptual framework for sustainable urban planning and development. According to The SymbioCity Approach will a **cyclical and iterative working procedure** following the SymbioCity approach urban and planning review processes take place:



1. Define and the process.

2. Diagnose of current situation.

3. Specify objectives, indicators and targets.

4. Develop alternative proposals

5. Analyse impacts.

6. Develop a strategy for implementation and follow-up.

5.10. Smart living

- lifestyle/smart living - among many things; involves knowledge, information and communication - it must be easy to act correctly. To actively influence people to make smart choices, we need information, knowledge and feedback.

Sorting waste baskets in Seoul; Duyun, China; Palma de Mallorca; Toronto; Medellin and Istanbul.

5.10.1. Fair trade

Fair trade needs to be mentioned as an important movement to enable sustainable development and empowerment of disadvantaged producers & workers in developing countries through certification. www.fairtrade.net/ The **Cradle to Cradle** Products Innovation Institute is a non-profit organisation created to bring about a large-scale transformation in the way products are made. www.c2ccertified.org

Street market in Chongqing.

5.10.2. Human Rights

World Human Rights Cities Forum 2013 was hosted by Gwangju Metropolitan City and The theme 'Sustainable Human Rights City for All ' was chosen to highlight the importance of effective institution-building to make human rights city sustainable and relevant to the needs of ordinary citizens and inhabitants.

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