Eco-innovations in the urban regeneration projects

Eco-cities

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List of Acronyms

APMCHUD	Asia Pacific Ministerial Conference on Housing and Urban Development
AVAC	automated vacuum collection systems
BAS	building automation system
BEF2030	Built Environment Foresight 2030
BMS	building management system
BREEAM	Building Research Establishment's Environmental Assessment Methodology
BRT	Bus Rapid Transit
CH_4	methane
CO_2	carbon dioxide
CSR	Corporate social responsibility
CT	Communication Technology
CURC	College and University Recycling Coalition
DAE	Digital Agenda for Europe
DEGEST	demography, economy, government, environment, society and technology
DIT	Dublin Institute of Technology
EC	European Commission
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
EIT	The European Institute of Technology
ENOLL	The European Network of Living Labs

EPA	Environmental Protection Agency
EPA	United States Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
EPCs	Energy Performance Certificates
EPIC	European Platform for Intelligent Cities
EU	European Union
FCFCG	Federation of City Farms and Community Gardens
GDP	Gross Domestic Product
GDP	Gross Domestic Product
GHG	greenhouse gas
GIS	geographic information systems
HVAC	Heating, ventilating and air-conditioning
ICT	information and communication technologies
ICT	Information and Communication Technologies
IntelCities	Intelligent Cities
IT	information technology
ITS	intelligent transportation systems
KAB	Keep America Beautiful
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
LEZ	low emission zones
LRT	light rail transit
MPO	Miejska Partyzantka Ogrodnicza
MEF	Major Economies Forum
N20	nitrous oxide
NGOs	non-governmental organisations
NY	New York
O_3	ozone
OECD	Organization for Economic Cooperation and Development
PEEST	policy, economy, environment, society and technology
PERIPHČRIA	Networked Smart Peripheral Cities for Sustainable Lifestyles
PPP	public-private partnership
PRT	private rapid transit

PV	photovoltaic
PWC	PriceWaterhouseCooper
R&D	Research and Development
RFID	radio frequency identification
RICS	Royal Institution of Chartered Surveyors
ROI	return on investment
SMARTiP	Smart Metropolitan Areas Realised Through Innovation & People
SUMP	Sustainable Urban Mobility Plans
TBM	tunnel-boring machines
TDM	travel demand management
UK	United Kingdom
ULI	Urban Land Institute
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
USGBC	US Green Building Council
WEEE	waste electric and electronic equipment

Publisher's note

We're delighted to bring you the book series prepared by the Authors taking part in the "Eco-innovations in cities" Project (POKL.04.03.00-00-249/12-00). The series, which is available free of charge, consists of six books:

- "Eco-cities" by Dominika Brodowicz, Przemysław Pospieszny and Zbigniew Grzymała
- "Green Project Funding" by Hanna Godlewska-Majkowska, Katarzyna Sobiech-Grabka, Paweł Nowakowski
- "Green Urban Regeneration Projects" by Marek Bryx, Jacek Lipiec, Izabela Rudzka
- "Planning and Management in Eco-cities" by Stanislaw Lobejko, Anna Stankowska, Mariusz Zabielski
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- "Making the 21st Century Cities" ed. by Krzysztof Jarosiński.

The Project was designed and prepared by Professor Marek Bryx, Deputy Rector of the Warsaw School of Economics (SGH), and Doctor Dominika Brodowicz. The Project has been carried out within the Priority IV "Tertiary Education and Science", Measure 4.3 "Strengthening the didactic potential of universities in the fields of key importance for the aims of Europe 2020 Strategy". In line with the objectives, the Project is conducted from 1st July 2013 until 31st December 2015.

The main aim of this Project was to create at the Warsaw School of Economics a one-year specialisation entitled "Eco-innovations in the urban regeneration projects". What is more, the Project's aim is to develop the study offer concerning the area of green and socially responsible eco-innovations in cities regeneration. The main objective of this new specialisation is to enhance students' knowledge

about eco-cities, give them sufficient information and discuss case studies on the subject: how contemporary cities should be planned, developed and managed. As most of our communities exist within the urban environment, the provision of eco-innovations is essential for the well-being of society. This unique educational programme for M.A. students provides information on maximising the benefits of making innovative and creative cities to citizens, local authorities, planners, developers, students, researchers and non-government organisations interested in improving the quality of life in cities.

MSc Alina Modrzejewska-Kołakowska – Project Manager
Prof. Anna Szelągowska Ph.D. – Project Methodological Coordinator

Introduction

The challenges lying ahead of the urban areas, specifically cities are formidable. These include growing population, air pollution, congestion, energy efficiency and demand for high quality of living. Although they are varied and can appear as seemingly unrelated, they more often appear on international agendas of the United Nations, European Union and various non-governmental organisations (NGOs) under umbrella of sustainability or more often as green agenda.

This book is an introduction to the dynamically developing and evolving area of green innovations taking place in contemporary cities, with a specific focus on the European and North American examples. It is divided into three interconnected parts, each prepared by a separate author specialising in the areas like communal services, real estate and information technologies. First, authored by doctor Dominika P. Brodowicz focuses on green urban models and challenges facing 21st century cities. Second, developed by IT specialist and doctoral researcher Przemysław Pospieszny presents green transportation and smart technological innovations. Third, compiled by Professor Zbigniew Grzymała relates to European and American legal requirements and strategies towards eco-cities development.

PART I

Typology and ‘components’ of eco-cities

Chapter 1

Typology of green cities

Dominika P. Brodowicz

"*What is a city, but the people*"
Sicinius in Shakespeare's "Corolianus", Act III, Scene I

Introduction

This chapter is a preliminary review of new and emerging concepts of environmentally friendly cites. It includes examples from the European Union (EU) as well as from the United States of America (USA), but not on a comparative basis. There are and will be significant differences between the EU and the USA cities, which are deeply rooted in the spatial planning tradition, space availability (European compact cities versus American sprawl), social issues and tradition (European walkable communities versus American car dependency). Therefore, this chapter includes examples as a lessons learned instead of comparisons.

1.1. Greening of cities

The world is facing an urban future. It has been projected that even more than 65 per cent of the population will be living in cities by 2050[1]. All issues related to their functioning deserve attention of businesses as well as public bodies. It is vital nowadays, when many spatial planners and property investors are searching for 'the next big thing' and when new ideas and trends are transforming cities and influencing their inhabitants' lives. Among the most

[1] UN (2014), *„World's population increasingly urban with more than half living in urban areas"*, http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html, accessed on 14.02.2015.

apparent issues are environmental degradation, uncontrolled urban sprawl and lack of public transportation. All of them could be clustered under the theme of 'eco-movement'. Modern environmental movement is not a unique phenomenon of the 21st century as these issues were already discussed for instance in late 1940 in the USA[2]. Therefore, it cannot be said that there has been a sudden acceleration of green projects. This rather proves that there is more information about such initiatives, especially in electronic media.

Urban areas, especially cities, have always been hubs of business and social activities, and therefore prone to change. Eco trends are a new wave of change enforced by governments, market competition and by non-governmental organisations[3]. More often one can hear about what could be called a 'green city label', aiming to market a city as a place that is eco-friendly, sustainable, liveable, walkable and so on. Sometimes those are only marketing manipulations and greenwashing. In other cases they reflect the actual city policy and changes really taking place there.

Eco-cities are no longer isolated cases; they are slowly becoming a worldwide phenomenon! There are differences between particular cities in terms of specific projects, type of eco-innovations, and in most cases in specific issues like office space, transportation, housing, parks rather than the whole city area. It could be caused by numerous factors including:

- funding available;
- spatial planning; and
- type of the developed land, for instance, brown field or green field development.

From a variety of city and town types only a selection of cases focusing on green and sustainable issues will be discussed further.

1.2. Eco-city

Eco-city (or Ecocity) is a term that became mainstream in recent years, although it was coined around the mid-1970s, and slowly developed throughout the 1980s and 1990s[4]. Those were early attempts to launch a more structured

[2] http://www.pbs.org/wgbh/americanexperience/features/timeline/earthdays/, accessed on 14.02.2015.

[3] For instance Friends of the Earth (see http://www.foei.org); Earthwatch Institute (see http://eu.earthwatch.org); Rainforest Alliance (see http://www.rainforest-alliance.org); and probably the most known all around the world – Greenpeace (http://www.greenpeace.org/international/en/).

[4] Joss, S., Tomozeiu, D., Cowley, R. (2011), "Eco-Cities – a Global Survey 2011. Eco-city profiles", University of Westminester, http://www.westminster.ac.uk/?a=119909, p. 1, accessed on 27.01.2015.

movement clarified after The United Nations Earth Summit (Rio de Janeiro in 1992) and expressed in the Agenda 21[5]. In the context of urban areas, the issues of ecology and social well-being became focal points, mainly due to growing population in cities worldwide and environmental degradation.

In many cases Eco-cities cannot be discussed as something real, because as complete structures and as whole entities they simply do not exist (at least not yet). Instead, there are initiatives in cities including specific neighbourhoods or districts, and in many cases focused on a single aspect rather than multiple areas of transportation, energy and housing. Generally, eco-initiatives in cities can be divided into[6]:

- new developments (built as new cities – in majority of cases Asian and Middle Eastern cities built from scratch;
- expansion of urban areas (common in the US, numerous examples from Europe); or
- retro-fit development (majority of European initiatives).

Discussing the nature of green cities Birch and Wachter[7] distinguished differences between new and existing cities. First can be developed in a way that is limited only by local plans (zoning ordinances) and designed to avoid negative experiences of other cities. In contrast, existing cities need to adapt and mitigate already existing non-green solutions. Looking at American examples of old industrial cities located in the so-called US Rust Belt[8] (Cleveland, Detroit and Pittsburgh)[9], as well as UK industry icons like Liverpool and Portsmouth, significant green areas can be noticed alongside vast brownfields, time-worn sewerage and sanitary systems. Others, like Orlando, Atlanta and Detroit are spread-out and low-density towns, with relatively poor public transportation (relying mostly on automobiles), with little or non-existing parkland, and few mixed-use developments[10]. Therefore, each type of city (cities) will have its own agenda to achieve green (eco) status and improve the well-being of its inhabitants.

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5 Ibid.

6 For examples see: http://www.mecsd.com/sustainable_development/; http://www.urbangreenbluegrids.com/about/historical-importance-and-development-of-parks-and-public-green-grids/; and http://www.fordham-bedford.org/index.php?option=com_content&view=article&id=58&Itemid=66;

7 Birch, E.L. and Wachter, S.M. (2008), "Growing Greener Cities. Urban Sustainability in the Twenty-First Century", Penn Press. pp. 4-6.

8 Also referred as Factory Belt, Manufacturing Belt or Steel Belt.

9 http://geography.about.com/od/urbaneconomicgeography/a/Rust-Belt.htm, accessed on 27.01.2015.

10 In contrast to European compact cities.

To sum up briefly discussion about definitions, it needs to be emphasized that there are numerous attempts to describe eco-cities. Many of them are broad enough to actually describe numerous cities, including Warsaw, a city that is rarely mentioned in global rankings of green cities, which could bring their accuracy into question. This type of dichotomy and a plethora of definitions is a norm whenever quite new or emerging concepts like eco- or green cities appear. For the purpose of this book, Ecocity Builders description is used[11]:

> "*An ecocity is a human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems. The ecocity provides healthy abundance to its inhabitants without consuming more (renewable) resources than it produces, without producing more waste than it can assimilate, and without being toxic either to itself or to the neighbouring ecosystems. Its inhabitants' ecological impact reflects planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice and reasonable equality.*"

1.3. Typology of cities branded around green issues

"*The beginning of wisdom is calling things by their right names.*"
Ancient Chinese proverb

Establishment of typology of green cities is another academic and practical challenge.

Nowadays, under the umbrella of green cities there numerous and varied initiatives hidden. From single projects focused on transportation or communications, to large districts redevelopments to even entire new city development. They differ in size, aim, timeline and expected outcomes. They are labelled for instance as sustainable, smart, zero-net energy districts or cities. Following sections present selected examples of cities branded around green theme.

Sustainable city is conceptually representing harmony between environmental protection, social well-being and safety of citizens, and economic growth[12]. In practice, for the time being there is no such ideal city, but this term is often used as a synonym to eco-city. Examples of this type of city are Copenhagen, Gothenburg, and Freiburg.

[11] Ecocity Builders http://www.ecocitybuilders.org/why-ecocities/ecocity-definition/, accessed on 14.02.2015.

[12] http://www.un.org/en/sustainablefuture/cities, accessed on 15.02.2015.

Smart city label is used broadly and frequently to describe urban areas in which high technology plays an equally important role as buildings (physical capital) to support social and environmental capital leading to sustainable development of the city. In practice, it can be demonstrated by application of energy efficient grids, affordable information technologies (IT) and green transportation to secure urban growth and citizens' well-being[13]. Examples of smart cities are Eindhoven, Vienna, New York

In theory, zero energy city or zero net energy city should be the one, which does not consume more energy than it produces (or potentially can generate), preferably from a renewable source. It is important to notice that, hypothetically, even if the city was using coal to produce energy, being self-sufficient at the same time, and even if it were polluting the air and soil in neighbouring (or even more remote) areas, it could still be officially labelled as a zero energy city, although it practically would do more harm than good[14]. In practice two modern cities Masdar and Dongtan represent the essence what current zero energy look like.

Another type of city has a quadruple label – carbon neutral city, net zero city, zero carbon city or low carbon city. All four terms are used as synonyms to describe cities, which offset (or realistically try to offset) carbon dioxide emissions to achieve a zero net level of emissions. Ideally, it should be an urban area, which produces no greenhouse gases and uses clean/renewable energy. It refers mostly to the areas of transportation and buildings operations, which are the largest sources of carbon dioxide emissions on the global scale[15]. Again Masdar City and Sydney are examples of this kind of cities.

Next type of urban areas are biophilic, which preserve and protect nature in its various forms including fauna and flora, and promote day-to-day contacts of their citizens with the natural environment in their neighbourhoods. There are no specific boundaries for cities to become biophilic. Each place, depending on its geographical location and climate has to find its own way to be more nature-friendly, to encourage urban-nature connections and social understanding of the importance of green areas (spaces) in human life[16]. San Francisco, Oslo and Vitoria Gasteiz could be classified to the group of biophilic cities.

Urban areas where promotion of solar power, energy conservation and smart meters is a priority, in order to encourage sustainable use of energy and reduction of green house emissions are described as solar cities. The policies

[13] http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/, accessed on 15.02.2015.

[14] http://r2cities.eu, accessed on 15.02.2015.

[15] http://www.worldbank.org/en/topic/urbandevelopment/brief/low-carbon-livable-cities, accessed on 15.02.2015

[16] http://biophiliccities.org, accessed on 15.02.2015.

are supported by governmental grants, loans or other incentives for the private sector and local communities. For instance, incentives may encourage purchase and installation of photovoltaic panels on rooftops of buildings like homes, schools and hospitals. Data on solar power projects shows that they are implemented not only in sunny places like Australian cities but even in the UK and Ireland, where advanced technological are applied in order to maximise the efficiency of solar panels[17]. Among commonly recognised solar cities are Adelaide, Buenos Aires, and Dezhou.

Last but not least, are slow cities. Cittaslow was born in the late 1990s in Italy to support the concept of 'ecogastronomy' (European approach to Slow Food as opposed to US Fast Food). The movement (or rather anti-movement) aims to promote healthy lifestyle, with specific emphasis on the culture of food, which is closely related to tourism and social life. It is more about the society and quality of life itself than about the physical structure of the city and buildings[18]. Usually small-sized towns are members of Cittaslow association. For instance Positano (one of the first Cittaslow Italian cities), Perth, Bisztynek, Vizela, Fairfax.

Like most terms describing new and emerging concepts, those presented in the table are fuzzy, in many cases inconsistent and equivocal. Some of them are used as fashionable buzzwords to label the city on the global map of competitors and collaborators, and to create a competitive edge. Next decades will show which of them will become a reality and which will be forgotten.

1.4. City branding

There are numerous city rankings all over the world. Some are made to attract investors and media, others to build a city image among tourists and the society. Public and private entities, such as city authorities, organisations and companies relying on positive image, see a great potential in positioning the cities and urban areas as green, sustainable, zero-carbon, net-carbon, walkable or liveable and so on. It is a part of 'city branding', which usually is a strategy for competing with others[19]. In order to operate and develop cities, organisations need various resources including human, capital and intellectual ones. Places with vibrant, diverse and skilled population receive higher recognition by companies, investors and tourists, which translates into city attractiveness and budgetary income.

[17] http://www.iscicities.org, accessed on 16.02.2015.

[18] http://www.cittaslow.org, accessed on 16.02.2015.

[19] Dinnie K. (2011), "*City branding. Theory and cases*", Palgrave MacMillan, p. 9.

Brands, or so-called city labels, change over time. Cities pursue different campaigns depending on the aim they want to achieve, available budget or challenges they face. Generally, a well-crafted city branding campaign should lead to[20]:

- increased inbound investment;
- higher inbound tourism;
- global recognition and partnerships with other cities, public and private institutions including universities and NGOs; as well as
- civic pride and self-identification with the place.

According to Clark[21], for cities to be attractive and competitive, three tiers are important:

1. Economic factors – innovation/creativity, human capital and connectedness.
2. Socio-political factors – diversity, quality of life, governance.
3. Infrastructural factors – quality and affordability of housing, parks and green spaces, walkability and safety.

Briefly looking at the proposed tiers, it can be automatically noticed that factors mentioned by Clark are (or should be) components of contemporary green cities, from walkability and liveability of the main streets, to improved quality of living and communication. Unfortunately, this does not mean that economically successful cities (Abu Dhabi), or those with large and vibrant population (Mumbai) are green or eco. Therefore, there are numerous issues to be considered by public authorities while developing a city brand strategy. Table 1.1 shows key questions for developing a city brand strategy, which could also be applied while working on green branding.

Table 1.1. Issues to consider while branding a city

Communication
• How do we reach and interact with our audiences in a creative and convincing way? • How do we tell the story of our city with credibility? Brand communications are no longer transmitting messages to a passive audience. Messages cannot be controlled. Consideration must be given to how selected audiences can be reached and invited to participate in a dialogue about the city and its offering. In addition to traditional media channels, there is increasing use of interactive social media for building a city brand. Author's comment – use of electornic media, especially social media, and activity of global corporations can support information spread and boost communication.

[20] Ibid. p. 16.

[21] Clark G. (2007), "*Report to the Economic Development Committee, City of Toronto*", presentation to The City of Toronto, January 24, referred by Dinnie K. (2011), "*City branding, theory and cases*", Palgrave MacMillan, p. 18.

Coherence
• How do we organise programmes and actions to achieve consistency and uniformity in communications? A major part of this stage is to decide who will drive specific initiatives. Consideration must also be given to the big picture, that is, how consistent particular action items and activities are. Author's comment – the chosen strategy and images of the city sent out to the public need to be coherent and well-considered.
Identity
• Who are we? • What do we stand for? The community assesses its shared assets, personality, desirable attributes and so on and selectively emphasizes aspects of the city's identity. The mechanisms and the environment must be conducive to encouraging community participation and support for the brand strategy. Author's comment - very strong emphasis on community's identity and understanding of the place.
Nominated outcomes
• What do we want to achieve? • Who do we want to attract? • How do we measure progress? Integration and consistency of brand essence with the city's development goals. Definition of the segments the city is amining to attract and appeal to. Selection of appropriate measures to monitor progress and assess return on investment. Resident participation in the selection of indicators is vital. Author's comment - again, community engagement and participation is a focal point.

Source: Own elaboration based on Dinnie, K. (2011), "*City branding. Theory and cases*", Palgrave MacMillan, p. 9.

Well-known examples of city branding are New York (NY), London and definitely Paris. The first one is widely recognised as the Big Apple and 'a city that never sleeps', which appeals to its vibrant, opportunistic, and entrepreneurial character. It is also marketed as a city 'close to everyone's heart' – I love NY – a slogan coined in the 1970s as a part of a tourist campaign and continued till today (see Figure 1.1 for visualisation). In terms of green branding NY is ranked as one of the greenest cities in the US, mainly due to its extensive public transportation system and numerous buildings certified in Leadership in Energy and Environmental Design (LEED).

The second city is perceived as a the financial hub of Europe, a melting pot of cultures, languages and art, but with a distinct and noble 'British' character, where tourists eagerly admire the Royal Family, want to see a Shakespeare play and have a pint of beer. As for the 'green standing', London is ranked high for similar reasons as NY – transportation, buildings certified in the Building Research Establishment's Environmental Assessment Methodology (BREEAM) system and walkability. Figure 1.2 below presents one of examples of London label – underground.

Figure 1.1. I love New York logo

Source: Milton Glaser, Creative Commons Attribution.

Figure 1.2. Underground roundel

Source: Edwin, Creative Commons Attribution.

The last of the notable examples is Paris. The city of roofs (more and more often green roofs and also green walls), 'love', cafes, artists, high fashion and monumental tourist attractions including the Louvre Museum, the Eiffel Tower and Montmartre. Nowadays Paris aspires to be more than a favourite tourist destination known for all those wonderful things. It is also a high-density city with an extensive metro system and a strong encouragement for car sharing among Parisians (below Figure 1.3 presenting Autolib' logo from Paris).

Figure 1.3. Bolloré Bluecars recharging at an Autolib' carsharing service kiosk on Rue du Quatre Septembre in Paris

Source: Mariordo (Mario Roberto Durán Ortiz), Creative Commons Attribution.

1.4.1. Eco-branding

In the context of this book, the most relevant and important are so-called green and eco-brands of the cities. They will be discussed on the basis of selected city rankings and projects connected with such issues and trends as new green spaces and roof gardens. Below is a list (in no particular order) of indexes and projects connected with green cities that currently appear in media and academic analyses:

- Siemens Green City Index – link;
  Scientific American – link;
- World Bank Eco2 Cities – link;
- Earth Day Network – link
- Popular Science link; and
  European Commission European Green Capital – link.

1.4.1.1. Siemens Green Cities Index

Looking from the global perspective, one of the interesting initiatives coming from the private sector is Siemens Green Cities Index (actually conducted by the Economist Intelligence Unit and sponsored by Siemens)[22]. It is a project in which over 120 cities from all around the world including Warsaw were ranked. According to authors of the index, cities were chosen on the basis of size and importance. Mostly capital cities and business centres were taken into consideration. As for European cities, factors taken into account were divided into eight to nine categories depending on the region and were a mixture of qualitative and quantitative indicators including CO_2 emissions, energy consumption levels, and buildings operations. The information was compiled from official public sources. This proves how important is adequate and open data reporting on the national level. Countries, which fail to do it, were scored lower than the others.

Overall, Copenhagen was ranked as the greenest among European cities included in Siemens' study[23]. It was also chosen as the European Green Capital 2014 (information about EC Green Cities will be provided in the next paragraph). It gained an advantage over other 29 cities ranked. The authors of the index stressed that forward thinking, municipal and national governance aimed at promoting sustainable development make Copenhagen really stand out among

[22] See http://www.siemens.com/entry/cc/en/greencityindex.htm

[23] Siemens and Economist Intelligence Unit (2009), „European Green City Index. Assessing the environmental impact of Europe's major cities", http://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/report_en.pdf, p. 10, accessed on 12.04.2014.

European cities, although places like Oslo and Stockholm are in many areas equally strong. It is worth mentioning that in Siemens' index Warsaw was ranked 16 out of 30 cities, with a score of 59.04 out of 100 possible, yet there was not a single city with 100 points and the highest score was Copenhagen's 87.31[24].

Among North American cities including US and Canada, the first place was granted to San Francisco[25]. It had a strong standing in all categories starting with waste management and ending with environmental governance. This city's authorities are known for open strategies towards public-private partnership (PPP) aiming to make San Francisco more eco and liveable, providing subsidies for energy efficient solutions in buildings operations, encouraging use of mass transit instead of private cars while commuting to work[26]. It should be remembered that it is a city located in California, a state proclaimed as the greenest state in the entire US. Like in Copenhagen, success of San Francisco lies in sustainable policies enforced by public authorities, public awareness and the will to adopt environmentally friendly behaviours.

1.4.1.2 The European Green Capital Award

The European Green Capital Award was started as an initiative undertaken by 15 cities including Helsinki, Riga, Berlin, Ljubljana, Prague, Vienna, Glasgow and Warsaw in 2006. The aim expressed in the Memorandum of Understanding[27] was to establish an informative and structured body to recognise cities with so-called green vision – following the principles of sustainable development and contributing to the built environment with less greenhouse emissions, promoting walkability and improving the quality of life for citizens. European Commission launched the initiative in 2008 and the first winner was selected in 2010. According to the award committee, the city appointed as the European Green Capital of the year has to have[28]:

- consistent record of achieving high environmental standards;
- on-going and ambitious goals for further environmental improvement and sustainable development; and
- a positive green image which makes it possible to act as a role model to inspire other cities and promote best practices to all other European cities.

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[24] Ibid.

[25] Siemens and Economist Intelligence Unit (2011), „US and Canada Green City Index Assessing the environmental performance of 27 major Canadian and US cities", http://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/report_northamerica_en.pdf, p. 10, accessed on 12.04.2014.

[26] Ibid. pp. 116-119.

[27] See memorandum under this link http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/06/Tallin-Memorandum.pdf)

[28] http://ec.europa.eu/environment/europeangreencapital/about-the-award/index.html, accessed on 15.04.2014.

So far the winning cities were[29]:

- Stockholm in 2010;
- Hamburg in 2011;
- Vitoria-Gastiez in 2012;
- Nantes in 2013;
- Copenhagen in 2014; and
- Bristol was appointed for 2015.

Beside the annual European Green Capital award, the EC[30] initiative became also a centre for all European cities, not only those awarded, to communicate their strategies and projects and also share experiences. At EC website – link – there are numerous pieces of news about the best practices and green projects undertaken by cities including plans for a bike sharing scheme in Dublin, introduction of buses powered by a by-product of food waste in Oslo and Hamburg's announcement to become a 'Car Free City' by 2034[31].

Conclusions

Remember, like most of terms describing new and emerging concepts these discussed in the current chapter are not unequivocal and will be evolving over the next years. Including concepts of ecology, greening of cities and sustainable development.

Be aware that the issues presented in this lesson are not a novelty. For instance, sustainability has been on the political agenda since 1970s, but current challenges of environmental degradation, rapidly growing urban population make them more important than ever in the history of cities.

Therefore, one will hear more about public and private initiatives regarding greening of the urban areas through building walkable districts, improving the public transportation options and implementing energy efficient technologies in buildings.

[29] Ibid.

[30] Link to ECG secretariat information on YouTube http://www.youtube.com/user/EGCwebteam

[31] http://ec.europa.eu/environment/europeangreencapital/index_en.html, accessed on 15.04.2014.

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Chapter 2

Trends affecting the 21st century cities

Dominika P. Brodowicz

Introduction

Chapter 2 is dedicated to challenges experienced by 21st century cities and built environment in general, as well as examples of analysis, ways of presenting and responding to these challenges based on global, industry and regional perspective.

2.1. Cities and challenges

Cities around the world are growing and the number of inhabitants living in urban areas is increasing significantly. It happens for numerous reasons, but the most important are employment opportunities and quality of life offered by cities and towns. Some of newcomers from rural areas succeed, others do not and leave the city or live in poor urban areas like slums or ghettos. This situation often occurs in South American (Rio de Janeiro) and Asian (Mumbai) cities, and more seldom in economically challenged American cities (like Detroit). Lower standard of living resulting in overpopulation and lack of fixed income is not the only challenge that contemporary cities are facing. Other significant problems are lack of social and affordable housing, congestion and numerous issues related to environmental degradation like air and water supply pollution, waste and greenhouse emissions. Cities face numerous challenges closely linked with the lack of sustainability (on all three levels) and ecological deprivation (the issue of global warming is left out from this discussion due to the on-going dispute among scientists, see ex Greenpeace member and founder link, against National Geographic's information link).

2.2. Academic approach

Project background

"The Built Environment Foresight 2030: Sustainable Development Imperative" (further referred to as BEF 2030) is a research project conducted by the Futures Academy at Dublin Institute of Technology (DIT) in cooperation with the Royal Institution of Chartered Surveyors (UK), King Sturge International Real Estate Consultants (UK) and supported by ULI European Sustainable Development Council, Salford University, Hong Kong University, Purdue University, and De Paul University[32]. It addressed the following question[33]:

> "*What are the major forces of change affecting the built environment in general, and the real estate industry in particular, and how should the global real estate community prepare itself now to address the sustainable development imperative*?"

It was focused on three major spheres of influence and activity of real estate companies – Europe, Asia-Pacific and North America and on the major trends and issues driving the change and forcing the property industry to follow the sustainability path towards the year 2030 (20-year span is characteristic of projects based on Futures Research methodologies like Foresight).

Methodology applied in the BEF 2030 study

Methodology applied in the project was based on the Futures Research and comprised 'Prospective Through Scenarios'[34] methodology including various Futures methods and was supported by over 100 experts from the real estate field. For instance, environmental scanning was used for identification of trends. In general, environmental scanning is a research method, which could be applied in the process of identification, monitoring and evaluation of issues and trends in the external environment of the investigated phenomena. As a research method it is recognised in the literature of Futures Studies and strategic management as horizon scanning or industry analysis. In the research

[32] Market version of this report is available at http://www.sobe.salford.ac.uk/about-us/news/?a=11867

[33] Ratcliffe J., O'Brien G., and Brodowicz D. (2009), "*Built Environment Foresight 2030: Sustainable Development Imperative*", The Futures Academy, DIT, p. 5.

[34] 'Prospective Through Scenarios' is: "(...) the capability of organisations to perceive creatively what is going on in their environments, to think imaginatively through what this means for them, and then demonstrate the readiness to act decisively upon this new knowledge." The Futures Academy http://www.thefuturesacademy.ie/node/88, accessed on 3.03.2014.

process it can perform various functions from identification of events and trends in the external environment to explaining the relationships between them and clustering those, which are likely to have the most impact upon the subject under investigation[35]. There are various tools for conducting the process of environmental scanning, for instance PEEST (including policy, economy, environment, society and technology), and DEGEST (demography, economy, government, environment, society and technology) used in the BEF 2030 study[36].

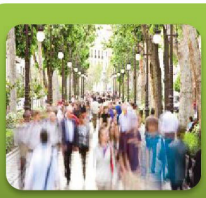
Outcomes of BEF 2030

For the purpose of this book only results of European and North American scanning will be discussed. Like in other large studies, the research team was aware that various forces from the demographic, economic, environmental, governmental, social and technology fields were involved. Trends were chosen based on the highest degree of certainty and likelihood to impact decisions of real estate professionals towards 2030. In some cases categories overlapped. For instance, some trends could be assigned to both government and economy. This proves their importance and interrelations in the macro-environment. Although some of the trends chosen by experts taking part in the study may seem obvious, they could not be that easy to introduce to national agendas and followed by market practitioners. Most of the 'green movement' would have to be enforced by law and supported by grants and subsidies available at both national and local levels. Figure 2.1 and 2.2 the most significant trends regarding sustainability in city planning towards 2030 discussed in the European strand of the project.

[35] Lenz, R.T. and Engledow, J.L. (1986), "*Environmental analysis and strategic decision-making: a field study of selected 'leading-edge' corporations*", Strategic Management Journal, Vol. 7 No. 1, pp. 69-89.

[36] Ratcliffe, J., O'Brien, G., and Brodowicz, D. (2009), "*Built Environment Foresight 2030: Sustainable Development Imperative*", The Futures Academy, DIT, p. 5.

Figure 2.1. Major European city planning trends identified in BEF 2030 study



Demography

- Increased density in city areas urges the need for smart and optimal use of urban land, while sprawl is often not an option.
- In response to the needs of ageing populations, local authorities will be forced to reshape and adjust neighbourhoods to elderly citizens' needs.

Economy

- Urban areas offering jobs and affordable housing opportunities will experience significant economic challenges caused by overpopulation, for instance covering the costs of waste management, popularisation of green energy use.

Governance

- Local governments will be more focused on sustainable urban development including greening of the urban space and refurbishment of public buildings to meet eco standards due to availability of EU funding.

Environment

- 'Green projects' and nothing else will be approved by the city authorities.
- Efficiency in waste and sewage management will be required in every metropolis due to high density living and natural environment degradation.

Society

- Security of buildings and neighbourhoods will be a crucial issue including physical security against natural disasters and virtual protection measures against cyber crimes.

Technology

- Growing number of 'smart houses', 'smart neighbourhoods' in the 21st century city.

Source: Own elaboration based on Ratcliffe, J., O'Brien, G., and Brodowicz, D. (2009), "*Built Environment Foresight 2030: Sustainable Development Imperative*", The Futures Academy, DIT, pp. 74-79.

In the North American strand of the project the most significant trends regarding sustainability include public transportation challenge and lower density.

Figure 2.2. Major North American city planning trends identified in BEF 2030 study

Demography

- Coastal gateway-cities will continue to grow (sun-belt cities will be the most populated).
- Increased density will require fewer car-dependent transportation options. City planners will have to rethink the shape of communities and make them pedestrian- and bike-friendly.

Economy

- US cities are facing an Era of Green Management. Many ideas coming from Canada and the West Coast.
- Lower-cost cities usually attract investment and new residents, but sustainability has a high price tag. City planners will need to search for optimal balance between price and quality through legislative and tax support.

Governance

- Coastal city planning strongly influenced by the possibility of natural disasters like floods and hurricanes. Therefore, subsidies for in-home shelters and higher standards of new developments will be enforced.

Environment

- Cities will experience waves of environmental colonialism. Heartland cities are threatened by water shortages and temperature increase. Massive population influx to the coasts will require redevelopment of brown fields, and preservation of green spaces.

Society

- More decision-making power to neighbourhood groups instead of state authorities.
- Debate on low-density communities versus increased-density areas and high-rise buildings will not only be about economic gain, but also about social well-being and liveability.

Technology

- Public transportation is weak in many urban areas except for a few major cities. Transport consultancy based on advanced technology and renewable energy will become a profitable sector.
- Commuter trains like in Denver and Chicago will be introduced to provide mass transportation in major regions.

Source: Ibid. pp. 143-153.

As presented above, both European and North American trends towards 2030 are not only complex, but also interconnected and in many cases similar for urban areas in both spheres.

2.3. Industry approach

Project background

Emerging Trends in Real Estate is an on-going initiative of Urban Land Institute (ULI) and PriceWaterhouseCooper (PWC)[37]. It includes reports on American, European and Asian markets and a global overview. The aim of this type of industry publications is to present experts' opinions based not only on hard data, but also on their experience and predictions regarding investment and transactions level for the next months. In the case of 2013 publications series, one can see a burst of optimism regarding return on investment (ROI) and, what is more important in the context of this work, numerous references to sustainability and green development[38].

Methodological process of data collection

Every year, all trends report series by PwC and ULI are based on the opinions of hundreds of property market professionals gathered during interviews or through surveys. Contributors usually represent a broad range of sectors including investment, development, brokerage and consultancy.

Outcomes

Both European and American reports cover numerous issues regarding investment, purchase and sale transactions, prospects for further development and growth of markets in the region. Green issues are mentioned on several occasions throughout the reports proving that there is an interest in those topics and that the awareness is growing.

To summarise European 2013 report[39], green issues are appearing on property professionals' agendas more and more often. This happens not only

[37] For examples of reports see http://uli.org/research/centers-initiatives/center-for-capital-markets/emerging-trends-in-real-estate/.

[38] http://uli.org/emerging-trends/emerging-trends-in-real-estate-2013/, accessed 03.03.2014.

[39] http://www.pwc.com/en_GX/gx/asset-management/emerging-trends-real-estate/assets/pwc-emerging-trends-in-real-estate-2013-europe.pdf, accessed on 1.03.2014.

because of the commitment towards eco-solutions, but due to the market demand, as they are also driven by consumers and stakeholders. Companies more often consider how to reduce carbon footprints of their products and operations, and basically all their operations take place on their premises. This leads to increased interest in energy efficient buildings and redevelopment strategies. Also, the role of governments has been recognised, since without law enforcement and tax incentives green revolution will not succeed. Investors looking at business plans calculate how their endeavours will perform in the market when completed and whether they will get their money back. Greening of properties and adding sustainable solutions are actually among the reasonable solutions. Specialists taking part in the PwC and ULI study also emphasized the connection and influence of buildings on their neighbourhoods and communities around them. Some cities, like Copenhagen or specific districts of London, are already ahead of the game with refurbishing properties to meet the green standards and specialists monitoring the European market have noticed it.

In the American 2013 report[40] most of the references to sustainability concerned LEED certification of commercial buildings, mainly offices. Another important issue tackled in last year's edition was compactness of spaces and buildings, which is a strong reverse trend towards traditional planning and development patterns in the US, where city sprawl and large-scale developments are dominant. According to experts contributing to the report, businesses seek smaller spaces to reduce renting costs. It becomes possible not only through 'squeezing employees' into smaller spaces but mostly due to a change in work philosophy – flexible hours, work on call, work from home, 24-hour accessible buildings, flexible office layouts.

For majority of experts contributing to the 2013 report, green buildings were of moderate importance, but still there were numerous issues heavily related to this area. One of them was the cost of buildings operations, including electricity usage and waste management. Therefore, LEED-rated projects were often mentioned throughout the document. Other important features of green properties included access to natural lighting, connectivity and transportation options, and air quality.

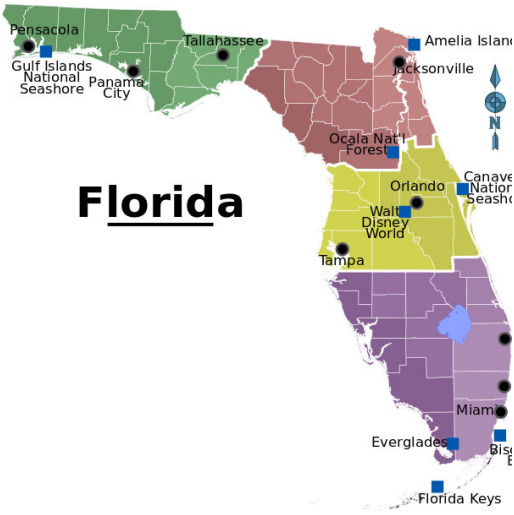
[40] http://uli.org/wp-content/uploads/ULI-Documents/Emerging-Trends-in-Real-Estate-US-2013.pdf, accessed on 3.03.2014.

2.4. Regional approach

Project background

The project was initiated almost five years ago by South Florida and Treasure Coast Regional Planning Councils and its aim was to develop a Regional Prosperity Plan for Southeast Florida. It concerned an area over stretched 200 miles across seven counties and over 100 municipalities and looked at the potential for development over the next 50 years. The groundwork for the project was a notion that universal trends like demographics, international trade, wireless communication and education strongly influence the region and shape its future. Project authors aimed to develop tools and encourage cooperation across the counties to address the arising issues and respond to challenges lying ahead for the region at least in common and overarching areas of transportation, climate and environment. The main results of Seven50 were presented at the conference organised in January 2014 in Fort Lauderdale[41]. Southeast Florida counties taking part in the project were Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie and Indian River. Figure 2.3 presents these counties in light purple colour.

Figure 2.3. Regions of Florida with Cities. Map showing Florida's travel regions, subregions, cities, and major destinations



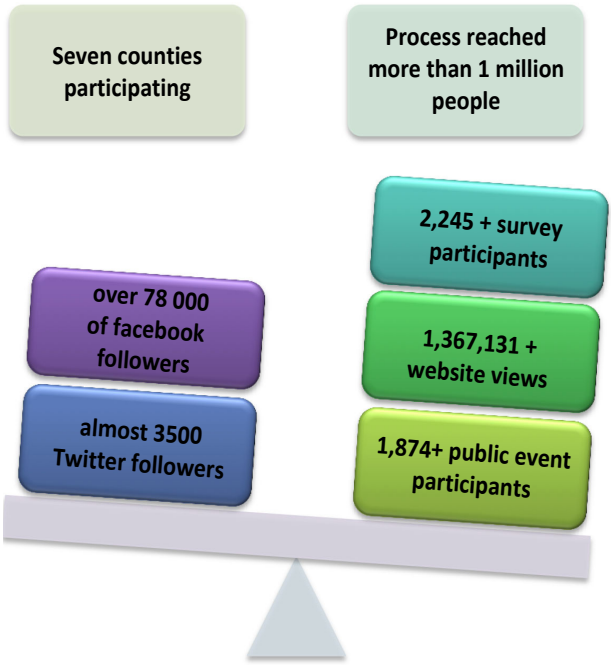
Source: User: (WT-shared) LtPowers, :commons:Image:Map of Florida highlighting Alachua County.svg, Creative Commons Attribution.

[41] Information about the project is available on-line http://seven50.org/seven50-se-florida-prosperity-plan-draft-report/.

Methodology used to collect data for the project

The process was focused on six areas – education; workforce and economic development; development patterns including housing, transportation and healthy communities; community assets and culture, environment; natural resources and agriculture; climate and energy resilience; inclusive regional leadership and opportunity. Information was gathered during workshops, summits and meetings, and also through surveys. Very important was a broad application of electronic social media including Twitter and a project website. A consulting team led by Dover, Kohl and Partners was hired to enhance public participation and cooperation of local societies with community leaders, experts and public representatives. According to the authors of the project, „the public process to develop Seven50 was the largest of its kind conducted in the region[42]." Figure 2.4 below presents a summary of public outreach of the project from between 2010-2013.

Figure 2.4. Public outreach of the project



Source: Own elaboration based on http://seven50report.org/home-page/public-engagement, accessed 1.02.2014.

[42] Seven50 report, http://seven50.org/seven50-se-florida-prosperity-plan-draft-report, accessed on 20.01.2014, p. 32.

Outcomes regarding sustainability and green issues in the Southeast Florida Region

The report and data presented on the interactive and constantly updated website cover a broad range of issues regarding the preferred future and obstacles to development of the Southeast Florida Region. As mentioned before, there were six major areas of interest of which three are the most relevant to eco theme: housing, transportation and healthy communities; environment, natural resources and agriculture; climate and energy resilience. Some of priorities and proposed actions cross the areas and are strongly interconnected, for instance, Everglades' restoration, weather resilience, water and energy security.

In the area focused on development patterns including housing, transportation and communities' well-being, the general priorities were to[43]:

- provide more transportation options;
- enhance physical infrastructure;
- provide more housing and workplace choices;
- plan more transit-oriented developments;
- enhance public-private cooperation;
- protect and enhance the unique character of communities in the region;
- explore sustainable transportation funding and alternative financing; and
- leverage natural assets to connect the region.

As a result of an on-going discussion several actions were proposed. To mention, but a few[44]:

1. In housing – mixed-use, social and affordable housing and more apartments instead of expensive houses
2. In transportation – interstate commuter rail transport, local bus networks, electric and hybrid cars, shared vehicles and bicycle networks.
3. In healthy communities topic – more sidewalks, new urban parks and support of fresh and healthy food industry in the area.

Another area discussed in Seven50 report was environment, natural resources and agriculture. General priorities in the area of environment, natural resources and agriculture were to[45]:

- secure access to fresh water;

[43] Seven 50 Report http://seven50.org/wp-content/uploads/2013/11/Seven50_011414_sm.pdf, pp. 81-93, accessed on 1.02.2014.

[44] Ibid. accessed on 2.02.2014.

[45] Ibid. pp. 103-114, accessed on 2.02.2014.

- prioritise redevelopment opportunities over new projects;
- enhance independence, quality, access and security of food supply;
- ensure resilient and sustainable coastal development;
- mitigate damage and ensure proper freshwater flows to the Everglades and other main water reservoirs;
- put more stress on ecosystem restoration; and
- support Everglades restoration.

Examples of proposed actions included development of living shorelines; farmlink programs; community-supported agriculture; redevelopment and cleaning of brownfields; promotion of on-site energy generation by solar and wind panels.

Floridians also touched the issue of climate and energy resilience in the report and discussed how to[46]:

- ensure water supply: identify at-risk natural resources and minimise saltwater intrusion;
- engage and educate the public to create a new policy regarding climate change;
- utilise adaptive planning for natural systems;
- reflect the goals of conservation, energy efficiency and sustainable infrastructure in policy making;
- protect agricultural assets;
- ensure a sustainable and cost-effective energy supply in the region;
- prioritise weather risk and emergency management; and
- focus on the region's coastal islands as frontline barriers for the mainland.

According to project participants it is possible to enhance resilience in the region by adaptation actions including mangrove replenishment; flood control gates, beach restoration and higher seawalls. As well as through mitigation steps like investment in electric vehicle charging stations, wider use of sustainable building materials, renewable energy technologies and energy-efficient design.

[46] Ibid. pp. 115-128, accessed on 2.02.2014.

Conclusions

Contemporary cities and urban areas face challenges including overpopulation, environmental depravation and energy security. However, it is important to notice that cities are not vulnerable.

There are numerous formal bodies and stakeholders involved in shaping strategies accurate to current challenges. Examples discussed in this chapter prove that there is awareness and will to act among academics (knowledge and research), local governments (political power) and corporations (resources, products and services).

Challenges and emerging trends can be tracked, monitored and used not only as a part of reactive, but most importantly as proactive strategies both for city managers and companies.

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Ratcliffe, J., O'Brien, G., and Brodowicz, D., (2009), "Built Environment Foresight 2030: Sustainable Development Imperative", The Futures Academy, DIT, reports available at http://www.sobe.salford.ac.uk/about-us/news/?a=11867 and http://www.thefuturesacademy.ie/node/113.

Seven 50 Organisation, (2014), "Seven50 Southeast Florida Prosperity Plan", report available at http://seven50.org/seven50-se-florida-prosperity-plan-draft-report/, accessed 03.03.2014.

The Futures Academy, (2004), "The Futures Academy Compendium", document available at http://www.thefuturesacademy.ie/node/88, accessed on 3.03.2014.

ULI and PwC, (2013), "Emerging Trends in Real Estate 2013" and "Emerging Trends in Real Estate 2013 Europe", both reports available at http://uli.org/research/centers-initiatives/center-for-capital-markets/publications-resources/.

Web references (all websites last accessed on 20.02.2014)

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Seven50 report, http://seven50.org/seven50-se-florida-prosperity-plan-draft-report, p. 32.

Chapter 3

Public participation and social engagement in greening the cities

Dominika P. Brodowicz

Introduction

This chapter presents top-down and bottom-up approach towards public participation and social engagement in investment projects taking place in cities. Both of them contribute significantly to building communication and understanding of goals of public or private investors and needs of stakeholders influenced by the plans at the initial stage of the project, whether it is a new road, shopping centre, residential or office building.

3.1. Top-bottom approach to participation and engagement of the society

Nowadays, public participation is one of the key factors of successful city projects and it is required by law; therefore, it could be classified as a top-bottom initiative. It could be described as: a two-way communication and collaboration process whereby a public or private organisation consults with stakeholders such as clients, other organisations, local communities, as well as interested or affected individuals before making a decision[47]. In the case of cities this concerns consultations regarding development/redevelopment plans for a district, location of a new building or its part etc. The basic thought behind

[47] International Association for Public Participation (2007), IAP2 Core Values, available on-line: http://www.iap2.org/

this concept is that those who might be affected by a specific project have the right to be heard and express their opinion about it.

According to United States Environmental Protection Agency (EPA) public participation could be[48]:

"*any process that directly engages the public in decision-making and gives full consideration to public input in making that decision. Public participation is a process, not a single event. It consists of a series of activities and actions by a sponsor agency over the full lifespan of a project to both inform the public and obtain input from them. Public participation affords stakeholders (those that have an interest or stake in an issue, such as individuals, interest groups, communities) the opportunity to influence decisions that affect their lives.*"

In general, the process should be beneficial for both the sponsor agency (private investor, public body such as city authorities) and the public (community, society, individual participants). EPA distinguished two main benefits[49]:

1. Sponsor agencies make better and more easily implementable decisions that reflect public interests and values and are better understood by the public.
2. Communities develop long-term capacity to solve and manage challenging social issues, often overcoming long-standing differences and misunderstandings.

To provide such positive outcomes and perspectives for the success of the consulted project the process requires[50]:

- leadership – it is important to appoint a person or a team representing a public body or a private investor with good reputation and acknowledge the person as an expert in the field, who would commit to the process and co-ordinate.
- clarity – aims, objectives and time-line of the process should be specified at the planning stage.
- communication – information sharing and exchange is one of the most important issues in the process.

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48 http://www2.epa.gov/international-cooperation/public-participation-guide-introduction-public-participation, accessed 17.02.2015.

49 http://www2.epa.gov/international-cooperation/public-participation-guide-introduction-public-participation, accessed 17.02.2015.

50 World Bank (1999), "*Public Consultation in the EA Process: A Strategic Approach*", Washington, D.C., pp. 6-9. Frewer, G. and Rowe, L.J. (2000), „*Public Participation Methods: A Framework for Evaluation, Science, Technology & Human Values*", Winter 2000, pp. 3-29.

Consultation process should be based on interaction and mutual understanding of goals and interests of parties involved in it. There are three main approaches towards conducting the process[51]:

1. Notification – one-way process for communicating the information in which the public has actually a passive role. It is usually based on distribution of brochures and newsletters or advertisements in media.
2. Consultation – an active way of conducting the process in the form of seminars, focus group discussion and surveys.
3. Participation – actual involvement of stakeholders in creating policies, and influencing decision-makers in order to enhance 'ownership' of ideas and mutual support through their presence in advisory bodies and discussions.

Figure 3.1. Rotunda

Source: Licensed under CC BY-SA 3.0 via Wikimedia Commons – http://commons.wikimedia.org/wiki/File:Rotunda.JPG#mediaviewer/File:Rotunda.JPG.

There are hundreds of examples of public participation processes all around the world. One of them is the recently completed Rotunda 2013 project (see Figure 3.1 for a visualisation of Rotunda building) regarding redevelopment of a building owned by PKO Bank Polski in Warsaw city centre. The aim of the

[51] On the basis of Iwińska K. (2010), "*Konsultacje społeczne w demokracji środowiskowej*", "*Zielona Akademia*" – Studium podyplomowe "*Ekologia – etyka – technika*", Collegium Civitas, Klub Myśli Społecznej Inicjatywy, and Brodowicz, D. (2014) "*Public participation in the process of the regeneration*" in *„The European Standard for Vocational Training in Urban Regeneration*", ed. M. Bryx, Oficyna Wydawnicza SGH, Warszawa 2014, pp. 36-40.

consultations was to engage Warsaw residents and others interested in the discussion about the needs, visions and ideas for redevelopment of the Rotunda building as a space designed not only for the bank's financial services, but also for culture, as well as ideas for the rest of the area situated in the heart of the city, which is already a popular meeting place. A Unit for Social Innovation and Research – Shipyard managed the entire process. Consultants used numerous methods to engage potential participants to take part in the process – panel discussions with experts, an on-line survey, workshops and on-line interviews. As a result, over 10,000 people took part in consultations, which proves that redevelopment of Rotunda is important not only for the property owner.

3.2. Bottom-up approach to participation and engagement of the society

Public participation in the investment process does not always equal consultations that are enforced and required by the law. Examples from countries like Sweden, Ireland, UK and the US prove that community engagement and self-organisation within the neighbourhoods also play an important role in city greening and enhancing liveability of places. Rubin[52] sees huge potential in urban citizens movements for enhancing rewards for communities in both social and environmental dimensions. Most of people actively taking part in consultations with city authorities/investors or trying to do something on their own tend to care for the environment, aesthetics and general well-being. It brings rewards to citizens and also tangible results for the community environment. For instance, it could be a new green square or a park, cleaned waterfront or reservoir, biking and running trails. Active community could also become a partner for city authorities in the planning process and consultations and can make its needs more vocal and visible for decision-makers. It also contributes to development of social bonds, local culture and protection of heritage. Selected examples of community initiatives and engagement are presented in section 3.2.1 and 3.2.2.

3.2.1. Water – Friends of the Chicago River

Water – Friends of the Chicago River[53] established in 1979, it is an organisation focused on ecological health of the river by improving the quality

[52] Rubin, V (2008), "*The Roots of the Urban Greening Movement*" in Birch, E.L. and Wachter, S.M. ed. (2008), "*Growing greener cities. Urban Sustainability in the Twenty-First Century*", Pen Press, pp. 187-206.

[53] http://www.chicagoriver.org/about-us, accessed on 15.03.2014.

of water, cleaning and organising the waterfront, and protecting the wildlife in the area. Through protecting the river and its natural inhabitants, the organisation aims to encourage leisure activities in the river area and community revitalization. Projects and on-going activities include among others restoration of the river (activities such as removing non-native plants, collecting native seeds, monitoring projects); forthcoming Horn Park project aiming to repair the inaccessible and eroding riverbank in the area covering 12 acres; Chicago River Day, which is an annual event bringing together volunteers to clean up the river bank, restore walkable trails along the river and install native plants. The organisation also tends to involve business into projects and encourages paid use of its facilities, like picnics for corporate partners not only for financial gains but also to attach companies to the image of river supporters and to boost interest of their employees in leisure activities on the Chicago River.

3.2.2. Waste – Keep America Beautiful (KAB)

The best way to explain what KAB is and why it was created is to quote the organisation itself[54]:

"Long before being 'green' was fashionable, Keep America Beautiful formed in 1953 when a group of corporate and civic leaders met in New York City to discuss a revolutionary idea – bringing the public and private sectors together to develop and promote a national cleanliness ethic."

KAB was formulated over six decades ago and with a combined effort of New Yorkers and companies it contributed to raising the ecological awareness and encouraged pursuit of higher quality of living in the urban areas throughout the country. Projects managed in cooperation with KAB members and supporters are for intense Game Day Challenge. It is a project for higher education institutions, such like universities and colleges to encourage waste reduction at football games. Last year's edition was conducted in partnership with the College and University Recycling Coalition (CURC) and RecycleMania. The amount of waste is tracked and this data is used to rank the schools. Universities in Poland could have a similar competition, for instance during 'Juvenalia' celebration). Similar to the academic competition, yet larger in scale is Great American Cleanup. Over 20 000 communities[55] are involved in this initiative annually through creating and executing programs that aim to deliver a positive impact on green environment mainly in the urban areas through improvement of recreation areas, park protection and planting trees, cleaning waterways, waste recycling and educating communities about eco-living.

[54] http://www.kab.org/site/PageServer?pagename=index, accessed on 15.03.2014.

[55] http://www.kab.org/site/PageServer?pagename=gac_the_program, accessed on 15.03.2014.

3.2.3. Green space – guerrilla gardening and city farming

Next two examples come from the UK and show two ways of approaching the issue of greening the neighbourhoods and promoting healthy living. The first one is Federation of City Farms and Community Gardens (FCFCG). A charity, which supports and promotes over 1000 locally managed gardens, farms and other green areas enhancing well-being in communities not only in the urban environment, but also in isolated rural areas.[56] It aims to encourage partnerships between private and public bodies to deliver projects on farming and gardening. The practical actions provided by the FCFCG to communities involve site visits, training opportunities, representation of members to public bodies to raise the profile of the projects and support bidding for grants and other types of financial support. An outline of projects already carried out would include numerous examples from London alone.[57] There are also dozens and even hundreds of small and large-scale initiatives from Wales, Scotland and Northern Ireland. Projects include school farms and gardens, community orchards and farms with livestock and rare breeds offering a wide range of facilities, like picnic areas, sustainable/green building on site, community space for hire and recycling. According to FCFCG on-line information[58] there were 17 farms or gardens with green building on site including Hackney City Farm (East London) and Surrey Docks Farm (also London).

Another type or rather way of enforcing urban gardening and farming through community activities engagement is guerrilla gardening. Simply, it is gardening on land to which gardeners do not hold any legal rights to utilise. Usually it happens without any permission, on an abandoned urban site. Self-proclaimed urban gardeners raise plants and trees in such a space and cultivate it. Since most of this type of actions is considered as illegal, many actions take place at night and in secrecy to avoid legal action against those who conduct them. According to various sources[59] this type of green activism was initiated in 1970s in New York by group called Green Guerrillas. The group focused on neglected areas with abandoned buildings and no green space around. Its actions were supported by local stores and local people in the frame of The Bowery Houston Farm and Garden. Since then the idea to green urban space spread around the world. It became a part of social movement in countries like the UK, Canada and the US.

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56 https://www.farmgarden.org.uk/about-us, accessed on 17.03.2014.

57 http://www.farmgarden.org.uk/farms-gardens/your-region/london, accessed on 18.03.2014.

58 https://www.farmgarden.org.uk, accessed on 18.03.2014.

59 http://www.greenguerillas.org/history; http://www.ecotippingpoints.org/our-stories/indepth/usa-new-york-community-garden-urban-renewal.html, accessed on 18.03.2014.

Some of actions classified as Guerrilla Gardening do not concern overnight planting on someone's private yet deprived property. It could be planting seeds around people's own home. This type of actions, especially in counties where both private and public property ownership is strong, like in the US, could be penalised despite the good will of the 'gardener'. Figure 3.2 presents example of Guerrilla gardening on a Los Angeles street.

Figure 3.2. Guerrilla Gardening in front of Flying Pigeon LA

Source: Umberto Brayj [CC BY 2.0, http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons.

In Poland there are also many environmentally engaged groups in cities from greening of neighbourhoods with plants and rearranging the backyards to those who postulate more walk able areas and bike roots. To mention, but a few Miejska Partyzantka Ogrodnicza (MPO) in Warsaw (link); Warszawska Masa Krytyczna (link); Poznańska Masa Krytyczna (link); Zielone Mazowsze (link); and certainly Greenpeace Polska (link).

Conclusions

Public participation (in practice consultations) is a process required by law at the initial stage of the project in many countries, especially in the EU. It should be a the two-way communication and collaboration process by which public or private organisation consults with stakeholders, like clients, other organisations, and mostly with local communities planned investment in order to inform them about it and gather their opinions.

It is treated as a top-bottom approach and the main concept of public participation is based on the belief that those who could be affected by planned actions have a right to take part in the decision-making process and present their opinions. Apart from consultations required by law, important initiatives come actually from the community engagement.

Most of them could be classified as a bottom-up approach, when a single citizens or entire communities communicate with city municipalities and private investors regarding the specific project, propose changes and inform about their needs. For instance, to add to the investment plans a green area, clubs for children etc. It is also important to remember that nowadays in the EU and US local communities can be very active and practically shape their own neighbourhoods like in cases discussed in this chapter.

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Chapter 4

Green buildings and certification

Dominika P. Brodowicz

Introduction

The last chapter of Part I is focused on green buildings, their features and positive impact on the environment and users. It also presents voluntary and mandatory certification schemes in the EU and the US and energy certificates, and examples of characteristic buildings certified under each scheme.

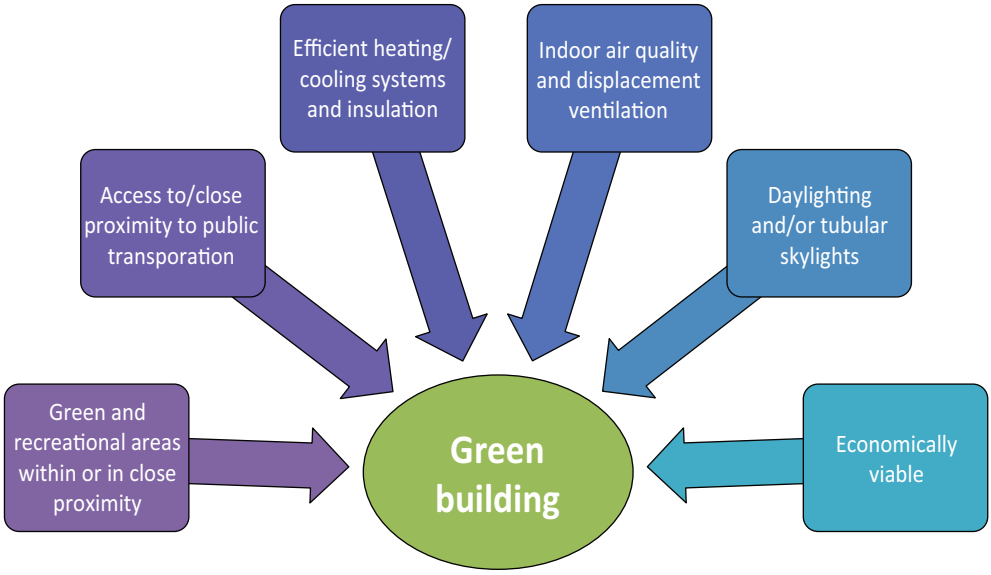
4.1. Green buildings

Green buildings reflect current trends towards sustainability and mitigation of environmental impact in the urban areas and property market. This can concern any type of property including public building, office, school and warehouse incorporating resource-efficient solutions in construction, renovation, operation and demolition phases of the life-cycle. It is often described as a cradle-to-cradle design. In practice green buildings complement traditional design based on technology and economy with sustainability and solicitude about energy efficiency and environmental quality. According to US Green Building Council (USGBC)[60], green buildings are more environmental friendly and reflect social responsibility trend by (see also Figure 4.1):

- efficient use of energy, water, and other resources (e.g. smart meters, zone air conditioning, clean energy-powered heating/cooling systems);
- protection of health and wellbeing of users (for instance access to daylight, superior air quality, noise control); and
- reduction of waste and pollution (e.g. reuse of grey water, green and brown roofs).

[60] http://www.usgbc.org/leed, accessed on 4.05.2014.

Figure 4.1. Selected green building features



Source: Own elaboration based on USGBC http://www.usgbc.org/projects and EAI http://www.eai.in/club/category/green_buildings, accessed on 4.05.2014.

4.2. Certification

Across the globe there are hundreds of different types of green certification systems. They are used as 'property labels' and information about sustainable features applied in buildings and their operations, and even more often about the socially and environmentally responsible procedures used at the construction sites. Certificates like LEED and BREEAM are exploit by investors, property owners and agencies to market their property projects as environmentally friendly, with tested and approved green technologies applied in buildings, and to set benchmarks higher than national regulations. For companies renting such a space it means reduction of operating costs, higher working environment for their employees and possible positive additional to their corporate socially responsible policies (CSR policies).

4.2.1 BREEAM

Historically, first in the world environmental assessment method was BREEAM. According to BRE[61] more than 250,000 buildings are already with

[61] http://www.breeam.org/about.jsp?id=66, accessed on 5.09.2014.

certified BREEAM assessment ratings and more than a million registered for assessment since it was first in 1990. These are for instance office buildings and homes. UK's BREEAM was established to set standards for sustainable design, construction and operations of properties far before than any other system, including American LEED. It uses a wide range of categories and criteria enabling to define buildings' energy performance, waste and water management, CO_2 emissions level, quality of indoor environment and many other ecological indicators.

Certified property can be assigned to one of five categories. Depending on the number of points granted to the project, they can be certified as the lowest Pass, through Good, Very Good, Excellent, or as the highest Outstanding[62]. Generally, schemes correspond with geographical division, or rather with countries where BREEAM was adapted as a certification method. These are: UK; Germany; Netherlands; Norway; Spain; Sweden; Austria; and International[63] (for example used in Poland). Each of national systems corresponds with local situation and standards such climate and building regulations. International scheme includes universal assessment methods that concern all stages of a building's lifecycle from new constructions, to homes and industrial assets, as well as refurbished properties.

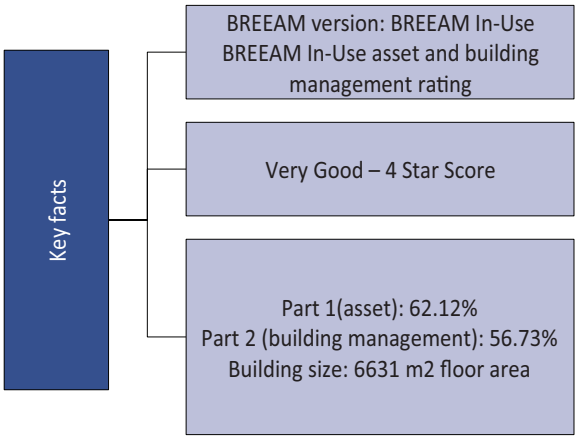
Among thousands of buildings already certified quite interesting examples is 10-12 Downing Street building complex. It includes the locale of British Prime Ministers and is 300-year-old grade 1 listed. The building was awarded BREEAM In-Use asset and building management rating: Very Good, but still is going through refurbishment programme since 2013. Greening of Downing Street reflects British efforts towards promoting sustainable solutions and remarks from BREEAM assessment were used to set redevelopment strategy. Already introduced eco-innovations in the property included building management system with utility monitoring (data displayed on the No 10 website), waste heat recovery from IT equipment to heat hot water and rainwater harvesting for garden irrigation[64]. Figure 4.2 presents major facts about BREEAM results for this building.

[62] http://www.usgbc.org/leed#certification, accessed on 5.09.2014.

[63] http://www.usgbc.org/organizations, accessed on 5.09.2014.

[64] http://www.breeam.org/page.jsp?id=581, accessed on 4.09.2014.

Figure 4.2. BREEAM Downing Street



Source: Own elaboration based on http://www.breeam.org/page.jsp?id=581, accessed on 4.09.2014.

BREEAM certifies educational establishments, which is used as a part of a long-term strategy of information and convincing young generation about the importance of sustainability actually through their own experience of studying in green buildings. This year in BREEAM Education category was given to the university project – Energy Technologies Building, University of Nottingham certified as BREEAM Excellent[65]. It is a low carbon building used as Research & Development laboratory in sustainable energy technologies. Among numerous green solutions applied in this property are low energy lift, heat recovery ventilation with earth tube supply, and green and brown roofs with many features increasing its ergonomics and comfort of users. Figure 4.3 includes main features of this property.

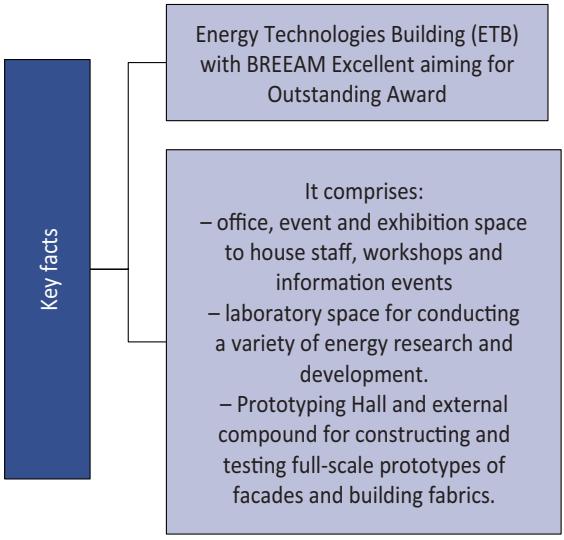
BREEAM certification system is more often used in Poland, especially in the commercial real estate market, where investors and potential tenants represent international corporations and similarly for financial and accounting standards, also prefer to invest and occupy buildings with recognised 'label' proving their high environmental standard and efficiency in water, energy and waste management[66]. For instance, Lumen and Skylight buildings in Warsaw City Center, Le Palais also in Warsaw, as well as Katowice Business Point[67].

[65] http://www.alumni.nottingham.ac.uk/NetCommunity/Alumni-News/Alumni-Latest-news-18/03/14, accessed on 4.09.2014.

[66] Brodowicz, D. (2014), "*Odpowiedzialne inwestowanie na rynku nieruchomości w Polsce – bariery i możliwości dla inwestorów*", Oficyna Wydawnicza SGH, Warszawa, pp. 70-71.

[67] Buildings from Polish portal Baza biur, http://www.bazabiur.pl, accessed on 10.09.2014.

Figure 4.3. Energy Technologies Building



Source: Own elaboration based on http://www.nottingham.ac.uk/energy/alce/whatweoffer/energy-techbuilding.aspx, accessed on 5.09.2014.

4.2.2. LEED

According to USGBC "LEED is a green building certification program that recognizes best-in-class building strategies and practices"[68] and one of the most frequently used in many countries around the globe. It can be used to certify different types of properties, from office buildings to private homes. To be LEED certified, property projects have to earn points in designated credit categories, e.g. sustainable sites, water efficiency, indoor environmental quality, innovation in design. There are five rating systems corresponding with the project type[69]:

- building design and construction (can be applied to properties that are being newly constructed or going through a major renovation including schools, retail, hospitality and warehouses);
- interior design and construction (used for certification of projects that are a complete interior fit-out, like retail, hospitality and commercial interiors);
- building operations and maintenance (employed in scoring of existing properties that undergo improvement work, little to no construction. Among them are data centres, retail and schools);

[68] http://www.usgbc.org/leed, accessed on 10.09.2014.

[69] http://www.usgbc.org/leed#rating, accessed on 10.09.2014.

- neighbourhood development (applied for new land development undertakings or redevelopments with residential, non-residential or mix uses. Projects can be at any stage, from planning to construction); and
- homes (used for assessment of all types of housing from single family homes, to low-rise and mid-rise multi-family.

Each of five systems consists of a combination of credit categories and prerequisites buildings have to fulfil to obtain a certificate. Starting from 'integrative process' category, which describes the necessity to create diverse projects teams during the pre-design stage of the project and is not credited, yet used as a prerequisite. Going through credited category of location and transportation, to materials and resources used in the construction process, to issues of water efficiency, energy performance and sustainability of sites, and innovative approach to design and building operations. All these components and many more are taken under the consideration and are quantified in order to certify the property. Depending on the number of points buildings can be certified as Platinum (80+ points); Gold 60-79 points; Silver (50-59 points). The lowest number of points that building has to score to be certified is 40. All properties with 39 or less points cannot be LEED certified[70].

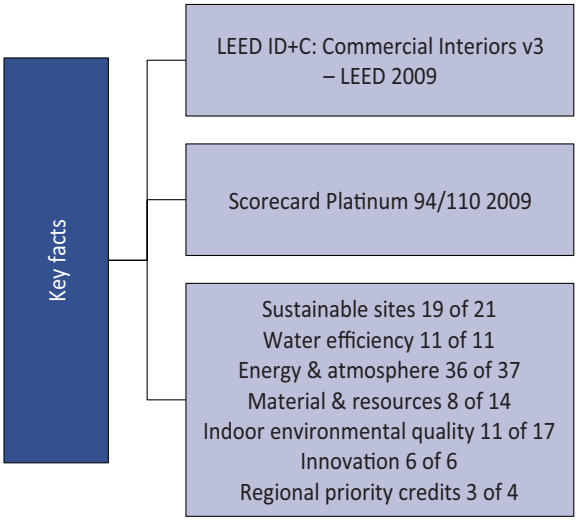
One of the examples of LEED certified building is USGBC Headquarters in the Golden Triangle Business Improvement District in Washington D.C[71]. It achieved Platinum level (LEED ID+C: Commercial Interiors v3 – LEED 2009). New premises of organisation were designed as a benchmark to prove benefits of operating in the green building. Architects used natural light, flexibility of space and reduction of energy consumption as main features of the new premises. Offices of USGBC are situated on the fifth and sixth floors of a ten-story building, the rest is also occupied and certified under LEED for Existing Buildings: Operations & Maintenance rating system. See Figure 4.4 below for information about scores.

Other interesting example of Platinum rate office is Skanska New York Office in iconic Empire State Building. It was certified in the LEED ID+C: Commercial Interiors v2 – LEED 2.0. in 2009. The office is located on the 32nd floor of the building constructed already during the Great Depression in the 20th century. Main features of renovated interiors are access to day-lightning in all four directions, which in many American offices organised as small workstations is not a standard. Main guidelines were economic design, environmental responsibility and sustainability of sites and refurbishment process. See Figure 4.5 for key fact about Skanska Office.

[70] Ibid. accessed on 10.09.2014.

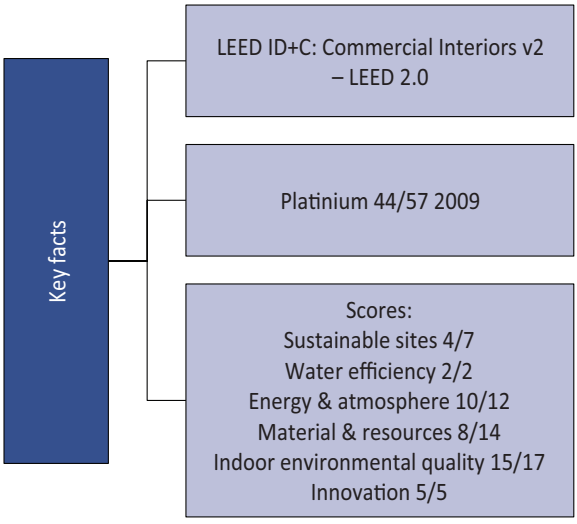
[71] http://www.usgbc.org/projects/usgbc-headquarters, accessed on 10.09.2014.

Figure 4.4. USGBC Headquarters



Source: Own elaboration based on http://www.usgbc.org/projects/usgbc-headquarters?view=stories, accessed on 14.09.2014.

Figure 4.5. Skanska Office



Source: Own elaboration based on http://www.usgbc.org/projects/skanska-new-york-office, accessed on 14.09.2014.

In Poland there are numerous commercial buildings certified in LEED system. According to portal Architekuta.info the first LEED Silver building in Poland was BorgWarner office building in Jasionka near Rzeszów. The main features of this space are access to daylight for all workstations, relatively low water consumption and technological innovations. Other examples of LEED certified buildings are Deloitte House in Warsaw developed by Skanska Property Poland; and Business Garden II also in Warsaw with Vastint Poland as a developer, which is a part of Inter IKEA Property Division.[72]

4.2.3. Energy performance of buildings in the EU

In the European context discussion about green buildings would not be complete without mentioning The Energy Performance of Buildings Directive (EPBD) (Directive 2002/91/EC, recasted in Directive 2010/31/EU) and Energy Performance Certificates (EPCs)[73]. First inspections in buildings in the EU focused on air condition systems, boilers and energy performance stated in January 2006, although Member States were able to apply for an additional period of three years for implementing mandatory energy labelling for new and existing building and units (e.g. apartments). Poland implemented EPBD principles in 2007 and 2008. The Parliament approved change to the Constitution on September 19th 2007, and together with Ministerial Ordinances published in year later, in November 2008, EPBD was constituted into the national law and certification started in 2009.

Certificates are awarded by qualified and independent assessors by using a standard calculation methodology, although EPBD provides a framework and Member States are obliged to detail the mechanisms according to the specifics of the regions, like geographical features of the area, legal context, available subsides and characteristics of local real estate market (see Figure 4.6).

Energy performance indicators have to be available already while advertising buildings for rent or sale, therefore for the public not only for buyers and tenants. EPCs are required whenever building is built, sold or rented. Generally all new or designated for the market transition properties should be certified, from commercial offices to public use buildings, but there are exemptions from this requirement[74]. For example places of worship, temporary buildings planned to be used for less than two years and some listed buildings (depending on local decisions and use) do not have to be certified.

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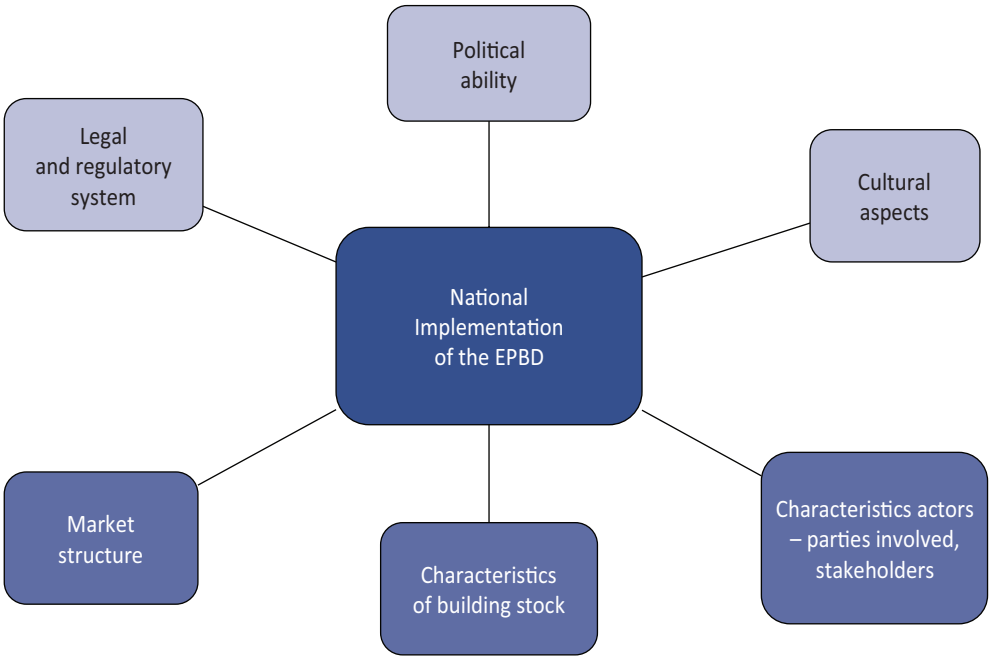
72 http://www.bazabiur.pl, accessed on 15.09.2014.

73 http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm, accessed on 15.09.2014.

74 http://ec.europa.eu/energy/efficiency/eed/eed_en.htm, accessed on 15.09.2014.

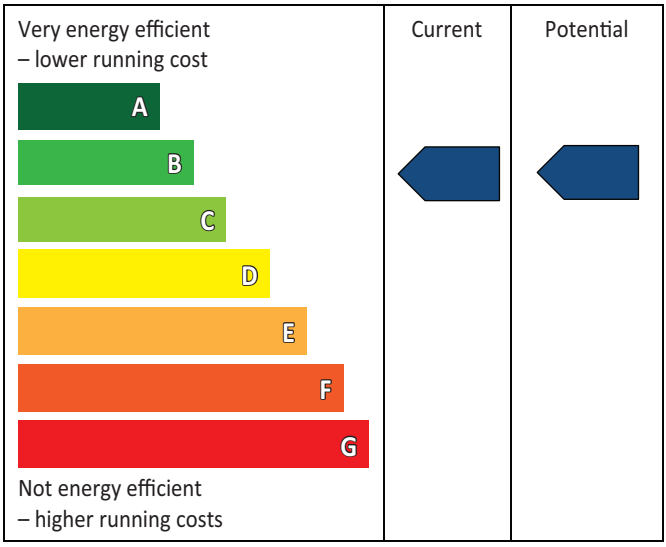
Figure 4.6. Factors influencing national implementation of the EPBD



Source: Own elaboration based on http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm, accessed on 14.09.2014.

EPCs have to include data regarding energy needs/consumption of a building, which makes possible to compare and assess energy performance of properties. It is important to note that EPCs include recommendations for cost-effective options to improve the rating of the building to reduce energy demand and operating costs. EPCs should included information about a property's energy use and typical energy costs, as well as recommendations about how to reduce energy use and operational costs. In general, ratings are based on a letter scale with A (very efficient) to G (very inefficient). See the scale below Figure 4.7.

Figure 4.7. General EPCs scheme with indication of current and potential performance



Source: Own elaboration based on http://www.get-direct.com/residential-energy-performance-certificate--epc-for-northern-ireland-129-p.asp, accessed on 15.09.2014.

Conclusions

Era of buildings certification was commenced in yearly 1990w with the introduction of the BREEAM tool in the UK. Since then, gradually other countries followed with their voluntary schemes, including the US (LEED), Australia (Green Star) and Japan (CASBEE), and mandatory EPCs for the EU Member Countries.

Some of these systems are used as endorsement labels and mostly for the commercial market use like LEED, other like EPCs are applied as comparison tools enabling identification of best and worst performing buildings in the European scale and creating recommendations for refurbishments. Generally, both contribute heavily to the improvement of the quality of property stock, energy performance and sustainability of urban areas through lowering negative impact on the environment.

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US Green Building Council, http://www.usgbc.org.

PART II

High-technologies in cities operations

Chapter 5

Green Urban Technologies

Przemyslaw Pospieszny

Introduction

First chapter of Part II is dedicated to green technologies. Green urbanism cannot be based solely on compact planning, green landscape and walkable cities. The success of future cities depends on how they can use the existing resources and capacity in a sustainable way. In order to achieve real efficiency and decrease ecological footprint of urban areas, modern information, communication and clean environmental technology need to be applied. The use of technology is widespread from parking sensors, traffic management to solar panels and zero-efficiency buildings. It covers every aspect of city landscape like utilities, buildings and transportation. The aim of this chapter is to present different technological solutions with application areas that contribute to creation of a green city.

5.1. From green urban technologies to smart cities

5.1.1. Green technologies

The environmental concerns like climate change and resource depletion, as well as population growth, urbanisation and congestion, force cities to adapt to the new challenges in order to be able to achieve sustainable growth in the next decades. Changes in urban planning approach (e.g. compacting) and radical reduction in pollution (e.g. restricting car traffic) may significantly affect citizens' quality of life and appear unprofitable, or even lead to bankruptcy of the city. Therefore, in recent years we can observe an increasing trend of

applying technologies that could serve as a 'bridge' between current inefficient, polluted and congested cities, and green cities of the future.

Ecologically oriented urbanism is not a new term as it was developed more than 30 years ago, but it hardly included any green technology solutions, and this was caused by innovation processes focused on other aspects of human life. However, recent advances in computer science, sensors, networking and clean solutions facilitated implementation of new technologies in order to cope with challenges that cities are nowadays facing. The solutions that are at our disposal allow cities to gather real-time information about city performance through numerous sensors and present it in a form that is easy to understand. Based on acquired information, city leaders are able to make decisions that lead to resource savings, e.g. predict traffic flow, water pipe leaks or outages of power grids. In addition, green technology enables generation of energy from renewable sources, electricity-fuelled public transportation and recycling of waste. The main advantage is that it leverages the existing infrastructure, optimizing it under the green banner rather than building a new one, which can be much more expensive in land-depleted and congested cities. Therefore, in order to transform cities into green ones, it is essential for them to utilize green technologies and become smart in terms of resource and capacity use.

The concept of 'green technology' is relatively new. It is considered to be an application of the environmental science and technology for the development and application of products, equipment and systems to conserve the natural resources and the environment, as well as to minimize or mitigate the negative impacts on the environment from human activities[75]. It is often referred to as environmental technology, sustainable technology or clean technology. Green technology, in simple words, is an application of environmental science and knowledge in order to conserve the environment and reduce man's impact on it. The term is also used to describe green energy generation from renewable sources (clean energy), such as wind turbines, bioreactors or solar panels. Green technology methods, techniques and materials are constantly evolving in order to achieve better efficiency and environmental friendliness.

Green technology is an umbrella term under which following three major concepts can be distinguished:

- Environmental or Clean Technology;
- Information Technology (IT); and
- Communication Technology (CT).

[75] Show K. (2010), „*Green Technology*", Department of Environmental Engineering.

The first one refers to a range of materials and technologies that are supposed to generate power from renewable sources, utilize natural resources or reduce harmful impact on the environment. The term refers mostly to energy, water and waste management. Information technology with regard to green urbanism is considered as a range of computer-based hardware and software solutions, with emphasis on sensing technologies that optimise city performance. The last one, communication technologies, often used in conjunction with IT under the term 'Information and Communication Technologies' (ICT), comprises technologies responsible for transfer of data – information and knowledge vital for decision-making. They facilitate IT software data analysis (even in real time), forecasting and extraction of meaningful knowledge for users (e.g. decision-makers, inhabitants).

Those three technologies complement one another and combining them is essential for an efficient green city paradigm. They enable transformation and creation of a new eco city that features not only green landscape but also management of its resources in an intelligent, smart way. In recent decade, the 'Smart City' concept emerged and is becoming increasingly popular due to availability of 21st century advanced ICT technologies for improved city management, optimisation of resource utilization and enhancement of city competitiveness. The essence of the smart city idea revolves around the need to coordinate and integrate technologies that have hitherto been developed separately from one another but have clear synergies in their operations and need to be combined in order to take advantage of new opportunities that will improve the quality of life[76]. It provides a potential solution to the issue of balancing environmental concerns with economic development and quality of life. Therefore, the concept is in the process of implementation in every major megacity, from Barcelona to San Francisco.

5.1.2. Smart cities

The 'Smart City' term is often treated as a marketing brand by both cities and companies, therefore the definition is very fuzzy and differs depending on the purpose of its use. In principle, the concept combines information and communication technologies with social and environmental capital. The addition of the last two aspects differentiates it from digital and intelligent cities. The main emphasis is put on ICT but human, social and environmental-relations issues are also key factors responsible for urban sustainable growth. Social inclusion enables access by low-income citizens to modern urban

[76] Batty M., et. al. (2012), „*Smart cities of the future*", The European Physical Journal Special Topics 214.

technology and limits situations, where ICT can be used only by those educated and wealthy. However, reducing social inequality must be combined with proper education since the concept requires urban citizens to be technology-literate. Sustainable city growth would not be possible without environmental concerns and linking it closely to local economic development in order to balance growth-enhancing enablers with eco-friendless.

Table 5.1. Dimensions of smart city

Dimension	Description	Technology
Smart Living (quality of life)	Housing, provision of basic services, education, health, safety and security, culture and tourism, lifestyle, urban farming	• Ubiquitous connectivity: anytime/anyplace access to networks; • Education web services: increase access, improve quality, reduce costs; • Health care data analytics: provide rapid diagnostics, preventive care with better cost-effectiveness.
Smart Economy (competitiveness)	Green technologies and jobs, innovative local industry and businesses, green jobs, small and medium-sized enterprises	• Cloud computing: data storage and processing as online service; • Open standards: service-oriented architecture for interoperable hardware and software systems; • Collaboration platforms: unified communications platforms bringing technologies/ sectors/ people together.
Smart Energy (efficiency)	Renewable energy resources, energy efficiency, smart grids, smart meters, fuel cells, energy storages	• Smart meters: real-time access to energy consumption and costs • Smart grids: greater efficiency in power distribution, monitoring, and maintenance • Real-time data analytics: power quality and energy conservation monitoring
Smart Transport (connectivity)	Environment-friendly modes of transport like public transport, public transport, bicycling walking, alternative fuel vehicles, reduction of congestion, provision of logistics information	• Radio-frequency identification: easier access encouraging the use of public transport; • Sensor networks: real-time based congestion charging; • Real-time traffic information systems: making travelling more efficient.
Smart Environment (sustainability)	Reduction of greenhouse gas (GHG) emissions, green and open spaces, green buildings, efficient use of natural resources, water management, waste management, disaster risk management	• Real-time information: anticipate and respond actively to emergencies; • Digitally controlled devices: real-time control of buildings and infrastructure; • Geospatial platforms: easier, faster, and cheaper abilities to use data on a map or aerial image.

Smart People (knowledge)	Local human and social resources, universities, schools, business community, adolescents, minor and ethnical groups, bottom-up engagements, social integration, social cohesion	• Social networks: enabling community activities; • Anytime/anyplace devices: designed for accessing services from the cloud via Wi-Fi network; • Open data access: supporting development of new applications.
Smart Governance (participation)	Communication mechanism between local government and residents, e-government, open data, data centres, transparency, community consultation	• E-government: better access to services and more transparency; • Urban operational centres: advanced real-time data analytics for fact-based decisions; • Data analytics: efficient municipal services delivery, cost control, or consolidated billing.

Source: Own elaboration based on Lindfield M., Steinberg F. (2012), "*Green Cities*", Asian Development Bank, Urban Development Series.

The aim of smart city concept is to address mentioned above features through ICT technologies in intelligent way ultimately to improve quality of life. They should be applied in conjunction and across several dimensions to generate greater impact. For example combination of traffic optimisation and energy efficient buildings can substantially reduce local air pollution.

Smart approach to city management and intensive use of ICT technology is not only related to automation of processes and services, but above all it allows decision-makers and citizens to understand the city performance. Once acquired, complete information can be extracted and analysed in order to improve efficiency and quality of life in real time. Increased rapid flow of information brings about economic advance, facilitates adequate allocation of resources and decreases prices of goods. For example, cost savings achieved through implementation of LED street lamps enables allocation of city expenditures for improvement of public school facilities. Although it needs to be mentioned that in many cases implementation of ICT solutions can be expensive, savings often exceed the costs, which makes modern technology useful for urban purposes, if implemented with inhabitants' support.

Due to tangible benefits in cost and resource savings, as well as traffic and air pollution improvement, the ICT and environmental technologies under the smart city banner are within the scope of interest of policymakers, city managers and industry. The UN, Organization for Economic Cooperation and Development (OECD) and EU perceive the concept as tools that will support attempts to reduce greenhouse gas emissions to the limits defined under the EU Horizon 2020 strategy. For that purpose the European Innovation Partnership on Smart

Cities and Communities (EIP-SCC) partnership was established to connect cities, industry and inhabitants with the common goal of improving urban life and achieving smart growth through integrated green and sustainable technology solutions.

For more information about EU approach to smart cities please refer to:

- EIP-SCC Operational Implementation Plan – link
- EU Smart Cities websites with resources – link 1, link 2

The smart city idea has been implemented recently in almost every major metropolis worldwide. Cities combine ICT technologies with more 'traditional' green technologies like zero-emission buildings, environment-friendly transport, optimised energy, water and waste systems to increase efficiency and reduce negative impact on the environment. There is no single widely accepted smart city index, like for green cities, and rankings differ depending on subjective views of reviewers. However, in almost every comparison the top 10 includes megacities like Vienna, Barcelona, Paris, London or New York, as well-known for being green. Nevertheless, due to benefits of green technology application the concept is also very popular with medium-sized cities that often are playgrounds for new ideas.

Please see following rankings of smart cities:

- Fast Company: The Top 10 Smart Cities On The Planet – link
- European smart city ranking – mid size cities – link

Obviously the smart city idea would not succeed without modern environmental and ICT technologies designed by public sector for urban needs. The key players in terms of delivering green and sustainable solutions for cities are:

- Information Technologies – IBM 'Smarter Cities' – link
- Communication Technologies – Cisco 'Smart Connected Communities' – link
- Environmental Technologies – Siemens 'Sustainable Cities' – link

5.1.3. Urban analytics – sensors, open data and knowledge discovery

The main aspect of smart cities is their reference to knowledge, its extraction and use in an intelligent way in order to optimize city performance and stimulate sustainable growth. In recent years, with advancing digitalisation and implementation of IT solutions within urban areas, cities have been collecting vast amounts of data on their day-to-day operations. Water usage, energy

consumption or traffic flow are just examples of information gathered. It is collected by numerous sensors placed in different urban environments – water sensors in pipes, traffic cameras or energy meters. The data is stored in various historic databases distributed across departments and organisations, with a very narrow purpose of use (e.g. periodic reporting). In order to cope with new challenges that cities are facing, there is a need for real-time synthetized performance information gathered 'on the fly' from sensors and presented to city managers via dashboards and consoles to facilitate making efficient decisions on resource usage. For example, thanks to information collected from water pipe sensors, leaks can be identified in advance and sewerage crew can be sent to prevent further pipe damage. This contributes to water and money savings, citizens' satisfaction and creation of proactive city image rather than reactive one.

Urban Analytics focuses on data-driven analyses of economic activity, urban perception, human behaviour, mobility patterns, and resource consumption to inform the city design process[77]. Nowadays, the ICT industry provides cities with real-time analytic solutions which support them in understanding how the city functions, help make proper decisions and predict future trends. It consists mostly of following main components that interfere and complement one another:

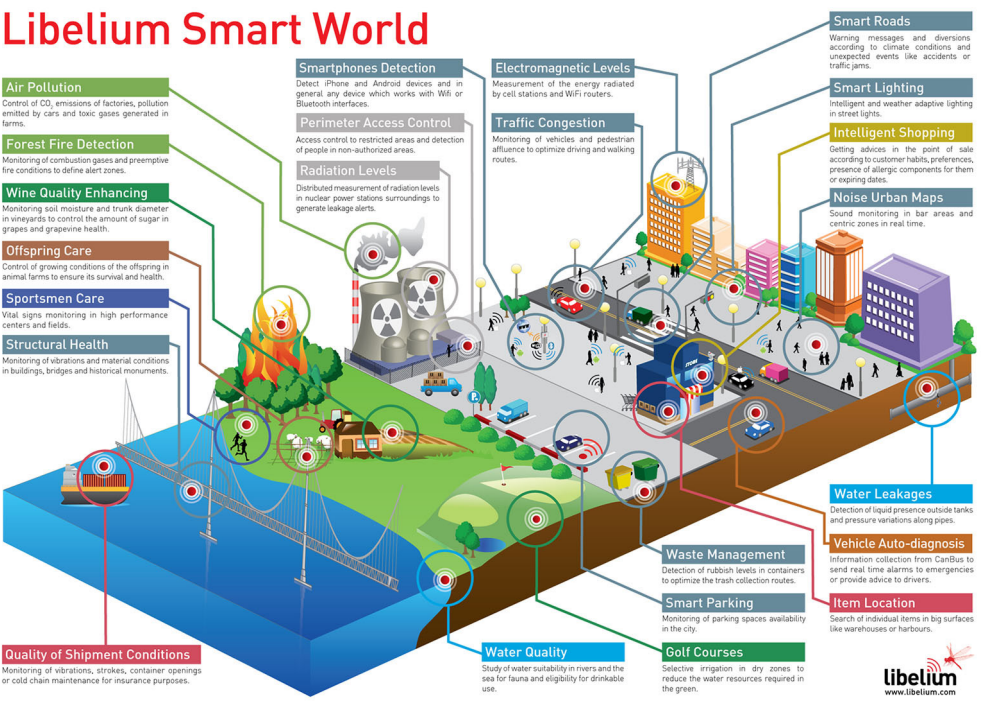
- sensors – collection of data;
- databases – information storage (big data, open data);
- analytical software – discovering knowledge, trends and predictions, urban simulations;
- visualisation tools – reports, dashboards and management consoles, operation centres, GIS; and
- communication infrastructure – mobility and integration (optical fiber, WI-FI, WiMax, mobile broadband).

5.1.3.1. Urban sensors and open data

Urban sensors are digitally instrumented devices built to measure city environment. They are used to collect and monitor in real time different aspects of urban life by distributed network of sensors throughout the urban area.

[77] MIT, http://cities.media.mit.edu/research/urban-analysis, accessed on 31.01.2015.

Figure 5.1 Urban smart sensors (*Libelium Smart World*)



Source: http://www.libelium.com/libelium-smart-world-infographic-smart-cities-internet-of-things.

They can measure environmental conditions like air pollution, weather, water levels and seismic activity. The data collected can be used for imposing traffic restrictions, resilience management or for educational and information purposes, educating environmentally-aware inhabitants. For example, Amsterdam and San Francisco, with cooperation of Cisco, established 'Urban Ecomap' portal that tracks the amount of greenhouse gas emissions produced by various neighbourhoods (link).

Consumption of utilities like energy, water and waste can be monitored for resource savings. Sensors can gather information about current consumption of energy, water, gas and alert about any anomalies observed, e.g. abnormal consumption, leakage or low quality. Those placed in trash containers may detect rubbish levels and optimize the collection process. Data gathered may be used as well for predictions of future resource demand. For supplemental case studies regarding flooding prevention and citizens' eco-awareness increased by implementation of smart meters please refer to following websites:

- HBR blog: Smart water management (link)
- Fast Company: Smart Meters Reveal Lack Of Business Intelligence (link)

Regarding buildings, both commercial and public, we need to mention that the idea of an automated or smart building led to the introduction of numerous sensors like lighting control, energy meters, water flow, air humidity and temperature gauges. Based on collected information the building is adjusting its use of resources in order to preserve them and become more efficient, e.g. switch on dim lights and limited air-conditioning function if it detects that nobody is present on the building's floor. For instance, a smart thermostat called Nest can learn from inhabitants' daily routines and automatically adjust building temperature accordingly (for additional information see: link). Moreover smart building can also automatically inform technicians about any anomalies or faults detected.

As for transportation, sensors and camera networks can monitor vehicle flow and adjust traffic lights in a dynamic way by restricting traffic in order to reduce traffic jams and deal with congestion. Moreover, small 'metal dots' at parking spaces can measure availability of parking slots directing drivers to the nearest ones saving fuel and reducing pollution. Public transportation can be monitored in real time by acquiring data from vehicles about their location (GPS) or malfunctions. The information captured can be further used to update inhabitants on possible delays, traffic jams and time travel durations, for example via dashboards located at bus/tram stops.

The future of urban sensors is connected with citizens' smartphones. Currently by means of GPS, mobile Internet, accelerometers and gyroscopes they are capable of gathering vast amounts of urban data. The most sophisticated but commonly known example is Google Traffic. Based on techniques called 'crowdsourcing' and Google Maps application installed on our smartphone, we are able to combine information collected from thousands of mobile phones to determine traffic flow in a given area, even with the GPS disabled (additional information at: link). It is achieved by mobile Internet position proximity identification and Wi-Fi networks available during our trip (if the Wi-Fi sensor is turned on), which Google collected using their Street View car. The information is available to the public on the Google Maps portal, marking in colours current traffic, accidents or closed roads. Moreover, based on this information, Google Navigation system can adjust the route in order to make it more efficient.

Being aware of smartphone sensing possibilities, cities are trying to use them to extend their network of 'traditional' measuring devices. For example, City of Boston's 'Street Bump' application collects data on how smooth a user's ride is by using the device's GPS and an accelerometer. Any bump discovered is uploaded onto the city's servers and analysed in order to identify road potholes to be fixed. In many countries in Europe (the UK, Belgium, Germany) cities are

collaborating in a similar way with communities through the FixMyStreet portal and mobile applications. Inhabitants can report potholes, broken streetlights and other road problems. In the US the portal is known as CitySourced. In the nearest future we can expect rapid growth of sensing mobile applications since smartphone companies are prototyping with additional sensors like temperature, humidity and air quality to be included into our small mobile pocket computer. For additional information please see the following case study on how researchers from California are measuring air pollution using smartphones (link).

In order to extract useful knowledge from various sensors it is necessary to store it, if possible, in integrated databases (data warehouses) or integrate data sets (sources) on-the-fly for real time analysis. The last concept is known as 'big data' and emerges from users' demand to access information from multiple sources without any delays, in order to be able to react in a fast manner to the dynamically changing environment. There is also a need for online collaboration with city communities; therefore, some information has to be available to inhabitants. Open data allows them to access a certain pool of data, use it for their purposes and then upload their information back onto the city servers. The activity is usually performed through cloud computing, e.g. Geographic Information Systems (GIS) city web portals. Cities also encourage mobile software developers to build their own applications based on city data available via on-line databases. For example, New York City challenges them by BigApps annual competition. In 2013 the best 'cleanweb' category award was granted to an application that, in simple words, educates people about benefits of solar power and financing options for installing solar panels, and indicates incentives that you could receive by shifting to it.

5.1.3.2. Analytic tools and visualisation

The information stored, preferably in integrated data warehouses, can be analysed in order to discover patterns or make predictions that could be used to optimize city performance. Based on historic information statistical, mathematical and artificial intelligence models called 'data mining' are applied to find similarities (trends) or anomalies within data like increased consumption of energy in certain areas or citizens riding patterns to better tailor public transportation. It can also be used for such purposes like identification of garbage losses, and streetlight failures. Application of predictive analytics goes even beyond just identifying commonalities. They are very powerful in the field of forecasting, e.g. future resource consumption, public transportation malfunctions, traffic congestion or even environmental disasters. For instance

Miami-Dade County uses IBM predictive analytics for public water management and identification of leaks, with savings estimated to be around 1million dollars (link). City of Chicago is in the process of establishing predictive tools based on open source solution with cooperation of academic researchers (link). The extension of predictive analytics is urban simulation that relies on constructing and applying advanced models to simulate different scenarios of urban systems.

The real-time information gathered from sensors combined with discovered trends and predictions can be visualised by means of numerous techniques depending on the purpose and desired recipients. City decision-makers, instead of raw data, require pre-processed information delivered via operations centres or dashboards served in a way that is easy to understand. Almost every city that aspires to become a smart city implements city control centre screen-based consoles composed of gauges and charts. Information combined from different sources is displayed to help departments and agencies to manage city performance, enhance its efficiency in a real-time manner and to identify potential future risks that may occur. Dashboards can also serve as an educational tool for citizens by improving green awareness. For example eight UK cities implemented city dashboard portals for their communities, where such information as current air pollution, bike sharing indicator or even happiness level is presented (link). The new emerging trend is connected with street dashboards. They are being installed on bus stops, subway stations or other accessible places where inhabitants can learn about current city performance for instance on their way to work. Moreover, they are placed on buildings indicating their energy, water consumption, and overall green performance (Green Building Monitors).

Another powerful urban analytical tool and foremost visualisation technique is GIS. Stored geotagged data captured by sensors can be queried and displayed by users on interactive maps, globes and charts. The biggest advantage of GIS is visualisation of data in a way that is easy to interpret geographically, therefore it is widely used from urban planners to regular inhabitants. For example, it helps understand neighbourhood characteristics, display polluted areas or those with water quality issues. For more information and case studies please refer to the following article from ESRI-GIS a software company: link.

Finally, it needs to be mentioned that all the above would not be possible without advances in fast Internet connectivity. Nowadays, data flow between components of urban ICT solutions is enormous and can be calculated in petabytes (1 petabyte = 1024 terabytes). This substantial bandwidth is operated by such networking technologies as WiMax and LTE for wireless communication (with sensors) and optical fibres where possible.

5.2. Efficient districts

Urban analytics are considered as a top-down insight into city performance – from the city management perspective. Knowledge gained during the analysis process might be further used to make decisions about optimising city districts and reducing their environmental impact through green technologies (combination of ICT and environmental ones).

In recent years buildings, streets and transportation are subject to ecological innovations that can be observed in every city, from roof solar panels to electric charging stations. Initiatives like green buildings, zero-net energy, low energy, passive houses or LEED certification wouldn't be possible without advances in modern green technologies. All the above terms and trends have one purpose in common – reducing overall impact on the environment and human health by using renewable resources (e.g. solar, wind), plants (e.g. roof gardens for rainwater preservation) and optimisation of building processes. Green technologies support those aims by providing tools for efficient energy use, reduction of pollution or waste and improved management. Although the approaches and technologies for green buildings and streets should be used in synergy to achieve greater efficiency, the following main groups can be distinguished:

1. Energy efficiency – renewable energy, smart grid, efficient HVAC, smart lighting;
2. Water efficiency – harvesting rain and greywater, storage, reuse, conservation and smart grid;
3. Waste reduction – smart waste collection and recycling;
4. Smart buildings – building management systems, transformable buildings;
5. Smart transportation – intelligent transportation systems, smart traffic management, and modern way-finding.

Please see 'The Crystal in London' – one of the world's greenest buildings (BREEAM and Platinum LEED certified) – link.

5.2.1. Energy management

The green urbanism relies heavily on use of renewable energy. Residential, commercial or other buildings have a capability to harvest and store it in many ways. Obviously, the technologies cannot be deployed in every city due to climate differences but should be tailored for a particular urban area.

Solar energy can be transformed into electricity by means of photovoltaic cells (PV) that use thin sheets of silicon. They are commonly implemented as roof solar panels or solar power plants (like Ivanahin in Mojave Desert, California, see: link). Sunlight can also be captured through active and passive systems. The first one uses a fluid such as water to absorb the heat. It has been achieved by roof collectors and pumps that distribute heat around the building. The passive solar system, in turn, is connected with the very design of the building with no engagement of special equipment. It involves south orientation, efficiency of materials to store 'thermal mass' and natural distribution of heat or cool air. Effective passive techniques can be exemplified by a Trombe wall that consists of a glass external layer and a dark-coloured, high-heat-capacity internal wall. Those two layers are separated with a layer of air of isolation.

Solar energy is also widely used for heating systems. Collectors (evacuated tubes or flat plates) harvest heat from the sun and use it to heat up water that is stored in cylinders decreasing energy needed for heating water by means of conventional methods (e.g. electricity, gas). Alternatively, geothermal water can be used for this purpose if easily accessible.

Another approach for generating energy are wind turbines that are integrated into roofs of buildings and can transform renewable energy into electric one. Nevertheless, so far successful implementations have been rare. For example, the Strata building (see picture below), considered as one of the unattractive buildings in London, utilizes its turbines very seldom. Low popularity of wind building technology and failure of its implementation is caused by numerous factors like generation of significant noise and vibration by turbines and wind turbulence swirling around tall buildings. Therefore, it's more effective in suburban wind turbine plants where wind is more streamlined. In fact, new advances go in the direction of numerous small, silent and adjustable turbines that do not require tall towers and can be placed on almost every type of building, rotating panels (link) or even flying turbines (link).

Excess of harvested energy can be stored within the building using batteries or, more conveniently, 'sold' through a smart grid. The term refers to application of digital technology to supply electricity to consumers via two-way digital communication. The main characteristics of the system are[78]:

- Load Handling – the sum/total of the power grid load is not stable and it varies over time. If heavy load is indicated, a smart grid system can advise consumers to temporarily minimize energy consumption.

[78] http://www.techopedia.com/definition/692/smart-grid, accessed on 31.01.2015.

Figure 5.2. The Strata Tower, London

Source: Loz Pycock, "Strata Tower From Top of Rockingham Street" May 15, 2011 via Flickr, Creative Commons Attribution.

- Demand Response Support – provides users with an automated way to reduce their electricity bills by guiding them to use low-priority electronic devices when rates are lower.
- Decentralization of Power Generation – a distributed or decentralized grid system allows the individual user to generate renewable power on site and sell it back to the grid.

Please see Smart Grid iconographic: link

A smart grid increases efficiency of electricity use by analysing consumer consumption in real time, forecasting demand and providing enough power to sustain city operations (smart power generation). By providing information to customers it increases their awareness in such a way that they can cut costs by

planning their household activities. For example, instead of turning the dishwasher on during the day tariff, it can be switched on at night time. The biggest advantage of a smart grid is the possibility to sell locally generated energy. For example, customers owning solar panels can sell excess of harvested power back to the grid and receive credits on their electricity accounts. Nevertheless, the most widely-recognised aspect of smart grids is smart meters that replaced the analogue ones, both sensing and measuring customer's electric power and enabling all above-mentioned functionalities. Most of cities and countries in the EU and the US are at an early stage of their implementation. It mostly consists in implementing smart meters and enforcing necessary regulations. The leaders in Europe are Sweden, Finland, Germany and Italy. Due to Horizon 2020, all member states are obliged to make a substantial progress in smart grid implementation till 2020.

Heating, ventilating and air-conditioning (HVAC) account for approx. 40% of total electricity used, especially those installed in commercial buildings. Therefore, in order to reduce energy needed to sustain district operations, it is vital to employ energy efficient HVAC systems, like energy star or ISO 16813:2006 certificates. Buildings should benefit from renewable energy collected, for example from active and passive systems for natural ventilation and heating. Electricity harvested by solar panels and wind turbines should fully power the HVAC that will enable green self-sufficiency of buildings. Furthermore, geothermal systems should be used for heating and cooling that pumps heat or cold air (depending on the season of the year) or hot water from the ground. If resources appear unavailable or depleted, due to e.g. cloudy weather or increased demand for heating, natural gas should be used. Apart from the above, intelligent HVAC management systems should be smart – using sensors, zones and thermostats adjusting the temperature of the building depending on occupancy and people's requirements.

Another substantial energy consumer is lighting in buildings and streets. In pursuit for efficiency in this aspect the term 'smart lighting' was established. It refers mostly to use of natural light, energy-saving bulbs and systems that control lighting. Intelligent systems, based on sensor-collected information about daylight and occupancy can adjust cost-saving LED lighting to environmental conditions. In buildings, smart lighting is usually combined with HVAC and monitoring in order to create a smart comprehensive management system. Motion detection sensors can identify an empty room or zone and turn off the lights, which can even halve the energy use. Ambient light sensors are able to adjust brightness of lighting depending on sunlight availability. Moreover, by means of electrofluidic cells and series of open-air 'ducts', sunlight can be

directed to shady places providing additional light (for additional information please refer to: link).

Smart lighting is also successfully applied for streets and is considered as one of key elements of smart cities. It is based on exactly the same principles as described above. Sensors can adjust streetlights depending on traffic and sunlight availability (no need to program them). Moreover, they can be controlled remotely from the city operations centre (for case study please refer to: link).

5.2.2. Water management

Water is the most essential resource on our planet and also the biggest challenge in forthcoming decades. Due to depletion of fresh water and increased demand from rising urban populations, cities apply various modern technologies and approaches for efficient water management. Special emphasis should be put onto buildings since they account for almost 40% of water consumption[79]. Moreover, the water sector is a major energy user since activities like water pumping and treatment are very energy-consuming. Therefore, new technologies for harvesting and storing water are constantly being developed and applied in order to turn cities into areas that are self-efficient and effective in managing water resources.

The key elements for understanding water management are terms used for naming types of water. LEED standard identifies 4 of them– potable, grey, black and process. The first one means drinkable tap water suitable for consumption but used for flushing toilets or landscape irrigation as well. Both grey and black water is wastewater; the difference is that the first one is generated by washing, laundry or kitchen sinks whereas the other is a result of discharge from toilettes, containing human waste. Process water covers a wide range of water used for industrial operations like heating or cooling.

In order to minimise usage of fresh water from supply network, rainwater and snow-water can be harvested using collectors located on roofs of the buildings. The most sustainable and widely used solution is green roofs that consist of multilayer vegetation structure including plants, soil, membrane and drainage. Acting like sponges, they are able to collect water and filter it. Moreover, eco-roofs isolate the building, which decreases energy consumption for its heating/cooling and adds beauty to urban landscape. There is already a large number of green roofs located all over the world, especially in Chicago (see map of Chicago green roofs: link) but majority of them are used for storm water

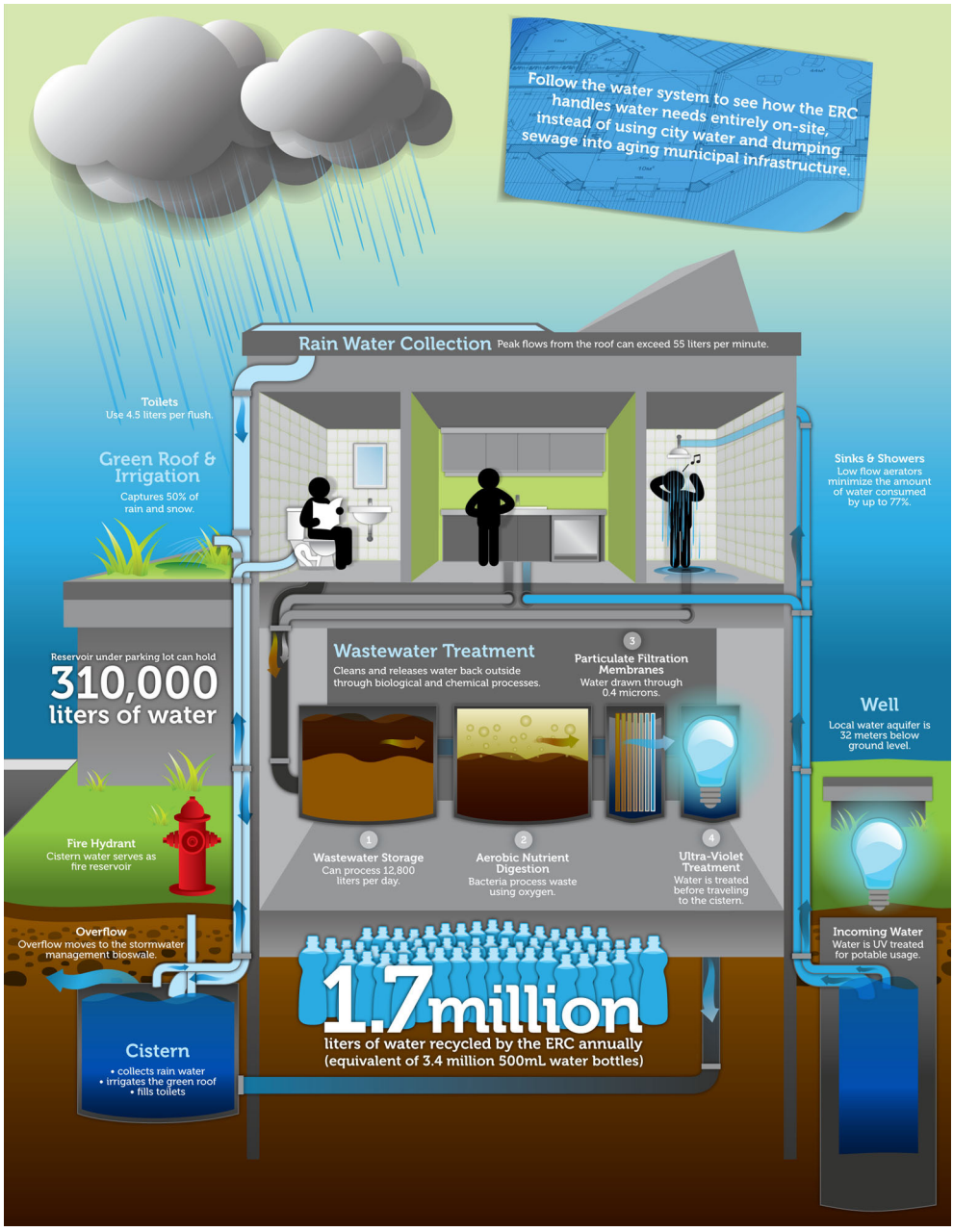
[79] United Nations Environment Programme: http://www.unep.org/sbci/AboutSBCI/Background.asp, accessed on 31.01.2015.

management – to mitigate runoff impact on sewage instead of draining for storage. Another solution for collecting rainwater is disconnected downspouts – drains used to store rather than to sewer.

In many countries, due to dry climate and drained natural fresh water reservoirs, it is not possible to harvest large volumes of water for urban areas from rivers, lakes or rainwater. Therefore, in many regions, desalination of salt water became a necessity, especially considering that about 96% of earth's water is found in seas and oceans. There are two types of salt and minerals removal from saline water: vacuum distillation and reverse osmosis. The first one, to simplify, consists in boiling salt water and the second one is based on a set of membranes that desalinate water. Although reverse osmosis process is less costly than distillation, both consume a high amount of energy. Therefore, they are used only when other alternatives, like ground water, are not available. Recent research focuses on decreasing energy consumption by cogeneration – a system where a power station simultaneously generates electricity and useful heat required for desalination process, e.g. nuclear power plants in Kazakhstan. A more sustainable and green solution is application of renewable energy like wind turbines and solar panels for feeding the process (link).

Both collected rainwater and greywater diverted from the plumbing system can be stored in dedicated fiberglass or polyethylene tanks and barrels located within the building or under the ground for reuse. It can serve as replacement for potable water for such purposes as flushing toilets, landscape irrigation and for building operation systems, e.g. cooling, HVAC. Reuse of water is regulated by country policies due to the possibility of its bacterial contamination. The process itself is an emerging trend and in the coming years we will observe numerous incentives put in place in order to encourage its usage and installations of systems designed for this purpose within both private and public buildings. Prior to storage or reuse, rainwater and greywater needs to go through water treatment process in order to remove unwanted chemicals, bacteria, viruses and other undesirable contaminants. Recycling of black water is usually limited by high cost and complex process due to human waste pollution. The purification process is based on different techniques and methods, like filtration, distillation or biological processes depending on water type and purpose of reuse. The most common approaches include multiple filtration, microbial digestion, chemical and ultraviolet (UV) treatment. It needs to be mentioned that some of them actually create unhealthy by-products that need to be utilized, especially blackwater treatment.

Figure 5.3. Earth Rangers Centre for Sustainable Technology Building in Ontario, Canada



Source: Earth Rangers Centre, "Water Conservation", Creative Commons Attribution.

Apart from collecting and reusing water, its conservation plays a significant role. Obviously, the most effective approach to restricting usage is water pricing and education, but there are also numerous technological solutions for preventing extensive water flow. The most widely used are listed below:

- low-flow shower heads;
- low flush, dual flush, waterless and composting toilets;
- automatic and aerator faucets;
- waterless carwashes; and
- efficient irrigation systems.

Application of those techniques alone may reduce overall water consumption by up to 40%. For example, a shower using a low-flow head uses up to 23 litres of water every 4 minutes. To compare, a standard one uses 53-76 litres per 4 minutes. The other way of conserving water is use of Energy Star appliances that are designed for efficiency. As for outdoor water, use of smart irrigation systems can save large amounts of water during hot seasons when two thirds of water is consumed for that purpose. Modern systems can automatically adjust the irrigation schedule to the current conditions using soil moisture, rain, wind and sun sensors, and download weather forecasts via Internet.

Like electric grids, water distribution networks are evolving into smart ones in order to improve efficiency of the grid. It consists of smart meters for data collection, two-way transfer of data over the GSM network or public Wi-Fi to the central system and analytic tools for information extraction. The main aim of a smart water grid is to automate the meter-reading process and enable real-time analytics for water consumption, leaks and fraud detection. In addition, modern Information Technology software (e.g. IBM SPSS Modeler: link) allows complex data modelling to be performed in order to identify trends and forecast future consumption. This enables change of mindset in the municipalities, from reactive to proactive one and, as a result, saving large amounts of precious liquid. Improved water distribution networks require less energy to transport water and therefore reduce operating costs. Moreover, thanks to gathered geospatial data, the solution enables real-time control over infrastructure, including pipes, water pumps, filtration equipment and other elements. Ultimately, following a 'smart' path allows cities to establish goals more accurately and plan future investments.

From consumers' perspective, a smart grid allows citizens to access their water usage data via a web portal or by directly connecting to the meter using a tablet or another Wi-Fi-equipped device, thus increasing their awareness and enhancing the green mind-set. Based on information presented to them, they can be informed which of their activities consume the most water.

To date, smart water grid implementations are mostly limited to pilot programs, like in the United Kingdom or the Netherlands, which aim to establish a multi-utility smart metering system, which means one integrated metering system for electricity, water and gas (for more information see: link). In the future, deployments of the grids may be extended by water quality monitoring sensors that determine whether the network works properly, like it was performed in Valencia, Spain (link).

5.2.3. Waste management

Every day cities generate enormous amounts of waste, but only a part of it is recycled and diverted from landfills. For example, New York, with population around 8.5m, in 2013 generated more than 14m tonnes of waste and only about half of it is recycled[80]. In order to decrease impact of unwanted products of our activity on the environment and inhabitants' health, many cities, like San Francisco, launched 'zero waste' initiatives that aim to send zero-discards to landfills or high-temperature destruction. In order to achieve it they implement new smart technologies for efficient collection, recycling, reuse and reclaim of solid waste.

In recent years pay-as-you-throw programs are being rolled out in many cities. The concept is based on a similar idea as electricity or water consumption – citizens pay only for trash they dispose. It is measured by the number of pre-paid trash bags used or waste weight. Further innovations include real-time assessment of disposed amount of waste by collection banks based on swipe cards to open the container and volume or weight sensors. The information about waste they have thrown away and current amount of the bill that they will have to pay is accessible for people through web portals on almost real-time basis. There are also attempts to utilise Radio Frequency Identification (RFID) chips for charging, sorting and tracking waste (link).

Waste collection process can be optimized by installing sensors in containers that will send information via public Wi-Fi or GSM network when they are full or emit odours above certain threshold. Such smart systems are already deployed for example in Finland – see promotional movie from service provider: link. A more efficient waste pickup system contributes to reducing truck air and noise pollution. Where possible, automated vacuum collection systems (AVAC) can be installed to transport sorted waste at high speed (around 70 kph) via underground pneumatic pipes to a central collection station located up to 2km away where it will be compacted and taken to treatment facilities. The solution

[80] http://www.nyc.gov/html/planyc2030/html/theplan/solid-waste.shtml, accessed on 31.01.2015.

has already been implemented on a small scale in various districts in New York, Seville, Copenhagen, Olympic villages in Paris and London suburbs.

Before recycling and reclaiming, waste has to be sorted. New modern recovery facilities are equipped with optical and X-ray separation systems that automatically sort a range of different types of waste (e.g. glass, paper, batteries). Those innovations substantially improve the recycling process as they facilitate sorting more than twice as much waste compared to traditional manual techniques.

Recyclable materials like glass, paper, metal, plastic, textiles and electronics (waste electric and electronic equipment – WEEE) can be recovered and processed in recycling factories for new product manufacturing. Due to increase in WEEE each year and depletion of rare earth elements like lithium, neodymium and europium much effort is put into advances in recycling solutions like hydrometallurgical processes for lithium. Trash that cannot be put into recovery process can be turned into energy using the combustion process instead of being sent to landfills. For example, contaminated wood or plastic can be converted into solid fuel source able to replace fossil fuels like coal. Furthermore, used cooking oil from food processing industry can be turned into biofuel. The gas generated by landfills can be captured and turned into energy instead of polluting the atmosphere and increasing GHG emissions. Modern sophisticated facilities can turn waste into alternative energy that can be used for heat or electricity generation.

Another method of generating energy from waste that receives increasing attention is anaerobic digestion. The process consists in series of biological processes where microorganisms break down biodegradable material in the absence of oxygen. The resulting biogas can be used for generating thermal energy, electricity, biofuel, natural gas, and even hydrogen. Anaerobic digestion is especially popular in countries like Sweden, Germany or the UK thanks to management of biowaste – see UK Biogas Plant Map: link.

In the future, in zero-waste cities, produced waste will be used for supplying electricity, heating homes or even powering cars. This will reduce our footprint on the environment and create green communities for next generations.

5.2.4. Smart buildings and management systems

The term smart home has been around for a couple of years, but in practice there have been very few implementations due to high cost of custom installations required. According to World Business Council for Sustainable

Development, buildings consume on average 40%[81] of energy worldwide. For urban areas that struggle with pollution and high rate of resource consumption, it is smart buildings that are the path to follow. The concept is based on enhanced environmental and economic performance of office and commercial complexes featuring effective resource management and emphasis on renewable energy use. It combines sustainable energy, water and waste management techniques (mentioned before in this chapter) with ICT system, known as Building Management System (BMS) or Building Automation System (BAS), in place to monitor, control and optimize them.

The main functions of smart buildings include:

- sensing;
- monitoring;
- analytics; and
- control & feedback.

Through numerous sensors like smart meters (energy and water flow), HVAC (temperature, humidity and airflow) and occupancy (motion detection, swipe cards, video, parking spaces) data about different performance aspects of a building can be gathered. Based on that, it can adapt to current conditions in real time, for example dim lights if people are not detected by motion detection sensors, parking sensors or video surveillance. In addition, data obtained can be used for modelling – identifying patterns and predicting future trends. This feature can be used for energy consumption estimates and balancing supply with demand. Excess of power harvested by solar panels can be accumulated in energy storage systems that can be also used for providing a charging infrastructure for electric vehicles.

In order to perform constant measurements and rapid response to changes in the condition of buildings, BMS was designed. It consists of ICT technologies that integrate distributed hardware, software and network interfaces into one 'organism'. BMS serves as an umbrella for all subsystems designed for different purposes (e.g. lighting, solar panels, parking) that make occupants productive (e.g. illumination, thermal comfort, air quality, physical security, sanitation, and many more) at the lowest cost and environmental impact on the lifecycle of the building[82]. A BMS that is optimized it terms of green function and sustainability can significantly:

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[81] World Business Council for Sustainable Development: http://www.wbcsd.org/work-program/sector-projects/buildings/eeb-manifesto.aspx, accessed on 31.01.2015.

[82] What is a Smart Building?: http://www.institutebe.com/smart-grid-smart-building/What-is-a-Smart-Building.aspx, accessed on 31.01.2015.

- reduce energy consumption;
- lower GHG emission;
- limits building material wear and tear;
- provide more sustainable environment for building occupants;
- increase occupants safety;
- provide up to date building performance information and enable further predictions; and
- decrease time and cost of building repairs (malfunction alarms).

After introduction of smart grids, buildings can be integrated with the network and fully benefit from it. Thanks to two-way interaction, information about current and future demand can be exchanged in order to adjust the supply. Additionally, information gathered about not only electricity but also water consumption, temperature, heating etc. can be available for people to improve their green awareness. This can be achieved via easy-to-understand dashboards located on web portals, touch screens in main building arteries, or even outside the building (link). In the future, due to mankind increasing demand for information, we can expect district street screens or information kiosks displaying indicators of city performance, like pollution, energy, water and waste management.

Modern technology allows us to create personalized and transformable urban building interiors– depending on demand, space can be converted to meet users' needs– see 'CityHome Changing Places Group' from MIT: link.

5.2.5. Smart transportation

In contemporary congested cities where road density is already at a high level and where space for new development is limited, it is not possible to expand the existing network of streets indefinitely. To deal with increasing number of cars and demand for public transportation, municipalities turned to smart or intelligent transportation systems (ITS) that are designed to use ICT technologies to optimize existing infrastructure in space and time to better manage and accommodate further growth. The core environmental transportation technologies are presented in the Green Urban Transportation chapter. This section aims mainly to provide supplemental information regarding ICT technologies used for increasing efficiency and environmental impact of transportation on cities.

Although the concept of ITS has been around for more than decade and has been deployed for various purposes like traffic light management, due to recent

advances in modern ICT technologies there is a trend of integrating numerous subsystems into one under the 'smart transportation' banner. The aim of it is to create multimodal, well-coordinated traffic management, foster efficient allocation & use of limited space, and enable real-time information for users. Smart technologies involving ITS significantly contribute to reduction in fuel consumption, decrease in pollution and congestion, better resource utilization and safety of urban areas. In simple words, the idea behind smart transportation is the same as for smart cities or buildings – data from multiple sensors is gathered, analysed and used for taking, preferably automatically, appropriate actions in order to effectively manage city transportation.

The core functionality of smart transportation is traffic management– keeping traffic flow smooth. This can be achieved by applying sensors like induction coils, cameras and data analysis techniques such as artificial intelligence that can learn from previous cases and dynamically adapt to new conditions. Based on information gathered, following improvements are possible:

- traffic signalling can be adjusted for traffic jams prevention,
- traffic can be redirected to avoid accidents and congested places using e.g. overhead LED roadway messaging signs,
- traffic speed limits can be adjusted for increasing vehicle volume, or
- additional hard shoulders can be opened to maintain flow.

In general, intelligent traffic flow technologies and techniques contribute substantially to reducing fuel consumption and emissions. Please see the short video on Stockholm congestion charging implemented using license plate recognition software (link).

In the field of public transportation there are numerous ways of applying ICT technologies for improved sustainable service. Thanks to GPS tracking, buses, trams or trains can be followed and themselves provide information about current location, city traffic and possible delays. The information gatherer can be used for real-time optimisation and dynamic scheduling, for example by sending additional buses to the most popular routes. Moreover, the integrated system covers different transportation modes; therefore, whenever one is delayed the other's schedule can be adjusted in order to maintain expected service. Apart from data on location, the vehicles can also automatically send information via GSM network or public Wi-Fi to the transportation management system about performance of main components like battery charging level.

Collected information about location of buses, trams or trains can be also presented to inhabitants via LED displays located at stops showing current

location of the public transport vehicle, estimated arrival time, to inform about any delays and provide other crucial information like weather forecast. If possible, the stops can be self-efficient in terms of energy supply by employing solar panels. In addition, for inhabitants' convenience they can be equipped with heating, cooling systems, electric bike recharging stations or even book libraries. Moreover, passengers using public transportation should have free access to public Wi-Fi (like in Barcelona with 430 hotspots) and have a chance to use smart ticketing – a smart chip card for all modes.

Please see following link for an example of smart bus stop in Paris, France: link.

As for private passenger cars, the emphasis is on electric cars, deploying rapid charging infrastructure. The future trend that may popularise EV is wireless power transmission, where vehicles will draw their power from the road by means of electromagnetic induction (link). There is also extensive research undertaken in the field of driverless cars that would eliminate human reaction times and therefore decrease traffic jams (e.g. BMW, Google). Due to complexity of the solution we can expect first implementation to be adapted to motorways. Smart solutions can be applied to roads as well – dynamic weather information or lighting, like Smart Highway project (link). In the field of mobile applications traffic rerouting is becoming increasingly popular. Apps like Greenway (link) or Waze (link) can calculate the best route for a smooth drive, fuel savings and CO_2 reduction using information gathered from users working together. Nevertheless, nowadays the most popular trend in passenger vehicles that contributes to decreased number of cars on roads is car-sharing programs like Car2go, Zipcar, Getaround or Car-pooling.

ICT technology is also applied for cyclists and pedestrians. Bike sharing programs in some cities like Copenhagen and San Francisco are entering the 4^{th} generation: bikes equipped with tablets, GPS tracking and electric engines. The technology advances reach even walkable districts with solar charging stations and Wi-Fi hotspots providing renewable energy for inhabitants.

Figure 5.4. Strawberry Tree (solar charger for mobile devices) in Belgrad, Serbia

Source: Renewablesfuture, "Strawberry Tree Black in Tašmajdan Park in Belgrade", Creative Commons Attribution.

Way-finding is also optimized for efficient travel and propagation of walking. Interactive LED displays, kiosks equipped with touch screens and mobile applications are replacing traditional metal signs. They are capable of presenting gathered and analysed data from sensors about such aspects of city life as available parking space, traffic condition, noise, pollution, public transportation or the way to the nearest restaurant or pub. With technology advances and popularization (e.g. Google glasses) in the coming years we will observe increased deployments of such interactive information services in urban areas – see movie about 'Urbanflow' system in Helsinki (link).

Conclusions

Certainly today's cities that want to follow the eco-cities path cannot develop sustainably without implementation of smart and green technologies. Modern advances in ICT allow municipalities to effectively and intelligently manage given resources with limited impact on environment. Moreover green technologies enable generation of energy from renewable sources and conserve it in the smart way.

For years urban areas were neglected from technology application perspective. Air pollution, congestion and urbanisation force municipalities to reach for new more effective methods that will help them to grow sustainable for benefit of current and new generations. Therefore in coming years we will observe increasing use of green technologies within urban areas under 'smart' banner.

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Chapter 6

Green Urban Transportation

Przemyslaw Pospieszny

Introduction

Chapter 6 is dedicated to various aspects of transportation and connectivity within urban areas. Transport is one of the most important aspects for city inhabitants across the world. It is mainly based on fossil fuel and generates around a quarter of total greenhouse emissions, which makes it the heaviest-emitting sector after energy. Majority (around 85%) of emissions are generated by road transport, including private passenger vehicles, vans, buses and trucks.

Climate change, pollution and traffic congestion are becoming the most important problems affecting every city nowadays. If we take into consideration that approximately 55% of the world population live in cities and the percentage is growing, the problem appears even more substantial. Therefore, sustainable and green transport became one of the most important aspects for policymakers addressed by the United Nations in Agenda 21 and by the European Union in Horizon 2020. The EU allocated 6.5 billion euros for resource-efficient transport in 2014-2020.

The aim of this chapter is to provide an overview of green and sustainable transportation forms. The module starts with an explanation of challenges involving the current transportation system and then lists potential opportunities. Next sections present knowledge about green transportation solutions implemented in various EU and US cities, including future trends.

6.1. Challenges and opportunities

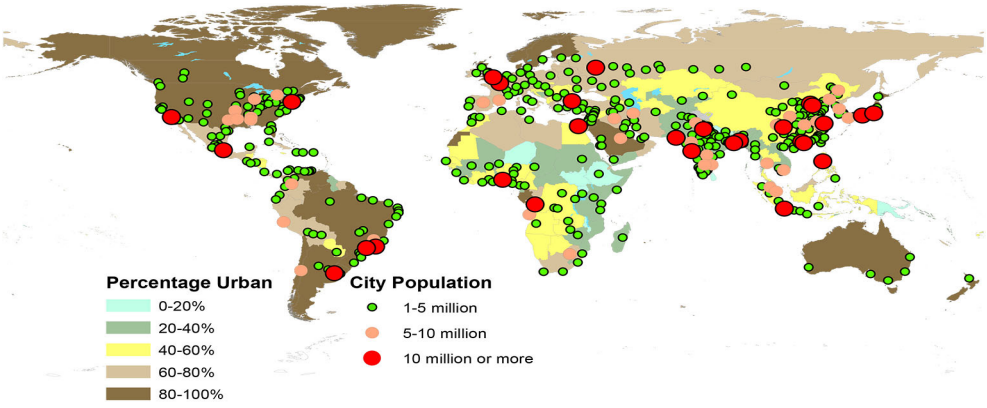
Transport is one of the most important topics on green agendas not only because of its environmental impact on greenhouse gas emissions but also due to possible expansion of limits that the current transportation system has reached. Climate change, pollution, population growth, congestion or pollution are some of the reasons, which force the transport industries and governments to review current situation and adopt to the new reality under the green banner. In recent years, increasing public expenditure has been allocated to transportation to stimulate advances in green vehicles and technologies in order to deal with those problems. The challenges, which the transportation system faces, can be grouped into following three areas:

1. Urbanization, congestion and demand for transport.
2. Climate change, pollution and health.
3. Resource consumption.

6.1.1. Urbanisation, congestion and transport demand

According to UN World Prospects[83], urbanization of the world is increasing rapidly. In 1990 only 13% of the world's population lived in cities, in 1950 it was 27% and in 2011 – 52% (77% for developed countries, including the EU and the US). It is estimated that if the current trend continues until 2030, 59% of people worldwide and 80% in developed countries will be living in cities at that time.

Figure 6.1. Percentage of urban population and agglomerations by size class in 2014



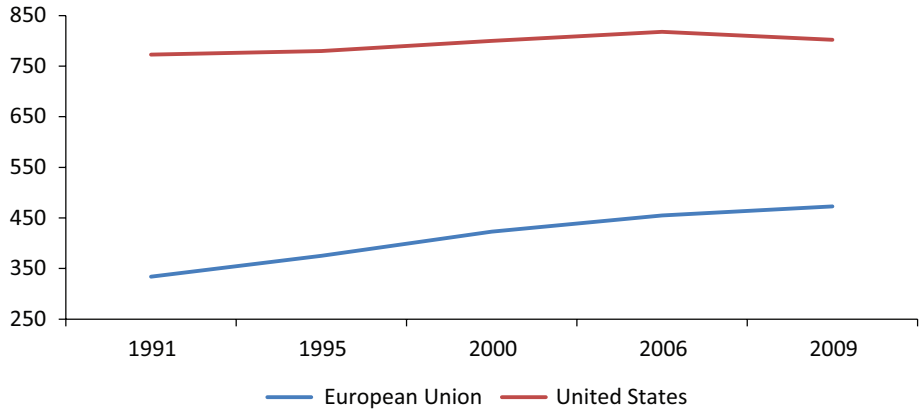
Source: http://esa.un.org/unpd/wup/Maps/CityDistribution/CityPopulation/CityPop.aspx, accessed on 31.01.2015.

[83] For the report please refer to: http://esa.un.org/unup/pdf/WUP2011_Highlights.pdf, accessed on 31.01.2015.

The above-mentioned trend of global urbanization contributed to appearance of megacities with increasing demand for public and private transportation. In addition, as a result of suburbanization, a network of highways and commuter rail systems for fast connectivity had to be incorporated into cities. However, despite public transportation in place, like buses, trams and subways, cars are the most preferred form of transportation for any inhabitant due to door-to-door transit.

Due to increasing demand for transportation and limited possibility of expanding the road infrastructure (scarcity of land) the number of vehicles moving each day within any city has reached the level where it is not possible to travel effectively due to traffic congestion. Expanding the road network in order to deal with the traffic congestion problem is only a temporary solution. Developers mostly build new residential and commercial estates where new roads are built or existing ones are expanded by adding lanes. This, in a few years, results in the same congestion problems and in many cases cities reach their limits of expansion due to scarcity of land and real estate price increase. The described paradox ultimately leads to the conclusion that adding lanes or roads is not financially feasible and cities need to put an emphasis on alternative forms of green transportation to cope with congestion which is considered as one of the factors decreasing a city's productivity and, in general, it costs Europe about 1% of Gross Domestic Product (GDP) every year. Moreover, expanding the road network always happens at the expense of green spaces; therefore, it is not an environmentally sustainable option.

Figure 6.2. EU-27 and United States – Number of cars per 1 000 inhabitants



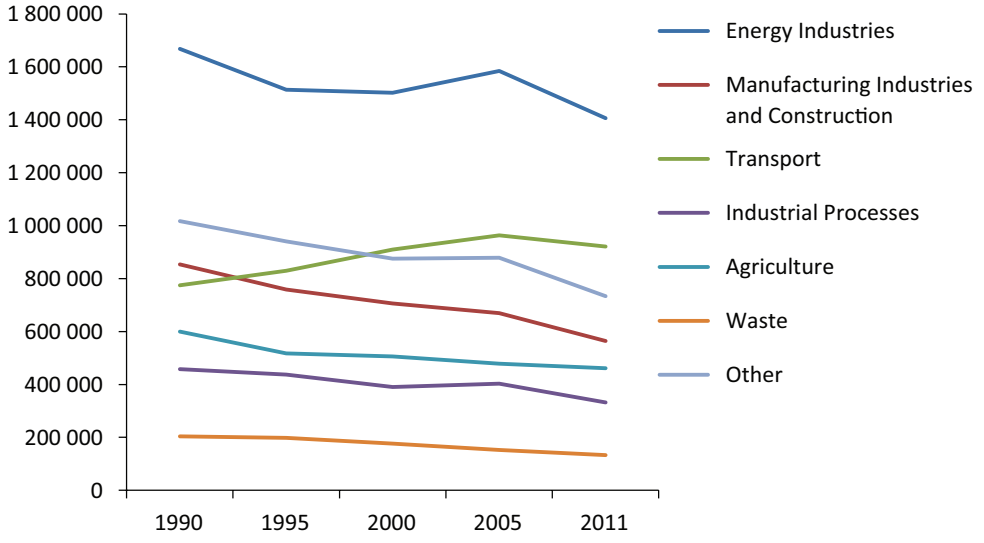
Source: Own elaboration based on Eurostat (Code: tsdpc340), The World Bank Data.

6.1.2. Climate change, pollution and health

In recent years we have been observing changes in the world's climate. Scientists consider pollution as one of the factors contributing to worldwide average temperature change, glacier and arctic sea ice melting and sea level increase. The biggest emitter of GHG is China (around 23% of the total) and USA (19%). Approximately 13%[84] of GHG emitted yearly comes from the European Union but the share of the EU is decreasing each year, whereas that of emerging economies is increasing.

Transport's contribution to overall GHG emissions is estimated to be 13% worldwide. It differs depending on the region. For example, in 2011 in the US, which mostly relies on petrol, it amounted to 33%, in contrast to 20% in the EU. Although each year since 1990 the share of the industry has been shrinking thanks to modern green technologies in use, emissions generated by transport are rapidly increasing due to urbanisation and higher demand for transportation.

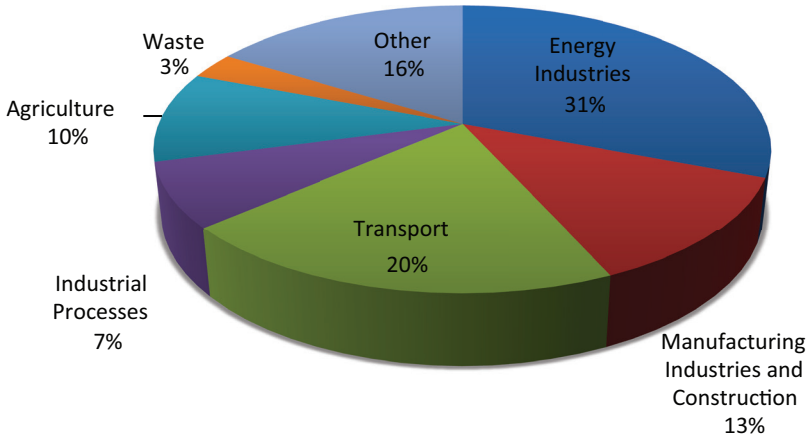
Figure 6.3. EU-27 Greenhouse gas emissions by sector 1 000 tonnes of CO_2 equivalent



Source: Own elaboration based on Eurostat (Code: tsdcc210).

[84] http://www.epa.gov/climatechange/ghgemissions/global.html, accessed on 31.01.2015.

Figure 6.4. EU-27 Greenhouse gas emissions by sector 1 000 tonnes of CO_2 equivalent in 2011



Source: Own elaboration based on Eurostat (Code: tsdcc210).

Urban transport activity is increasingly motorized – it is based on private cars and buses. Moreover, the number of vehicles is increasing rapidly and it is estimated that the trend will continue. Therefore, in terms of pollution, each year we can observe higher share of transportation in overall sector pollution breakdown, especially CO_2. Around 95% of total GHG emitted by transport is CO_2, which accounts for around 26% of total carbon dioxide emissions in the EU and 3.5% of total global CO_2 emissions. Other highly toxic gases generated during fuel combustion are methane (CH_4), nitrous oxide (N_2O) and ozone (O_3).

The gases emitted by transport contribute to poor local air quality and smog; furthermore, they pose environmental and health risks. CO_2 emissions do not impact urban air quality directly, although they contribute to GHG, but methane, nitrogen oxides and volatile organic compounds are highly toxic and lead to such disorders as cardiovascular, pulmonary and respiratory disease (e.g. asthma) and various allergies. It is estimated that in the US air pollution causes 200,000 premature deaths each year. Moreover, noise generated by road traffic contributes greatly to diminishing citizens' quality of life, impacting both physical and psychological aspects. In the European Union about 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB(A), and 20% is exposed to levels exceeding 65 dB(A), which is considered as harmful. It results in hearing problems, development of mental dysfunctions and increased stress. In addition, noise impacts cognitive abilities and causes sleeping disorders.

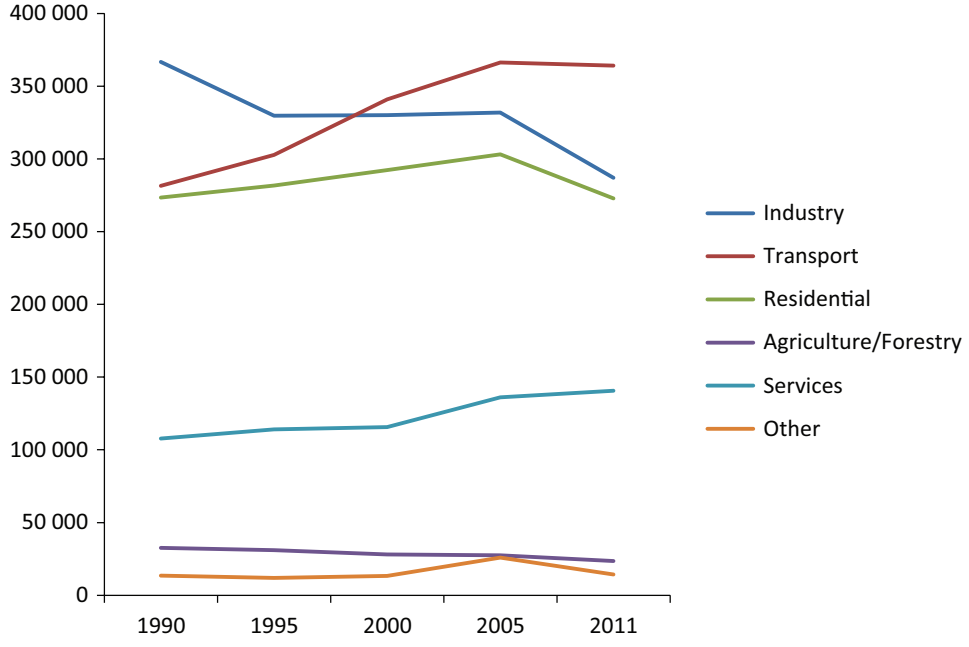
The problems caused by poor air quality and noise in urban areas have been widely recognized by policymakers due to decreasing quality of life and impact on GDP (influencing health care expenditure).

Recently a range of pollutants have been targeted by EU Directives to limit health-damaging harmful gas concentrations in urban areas. The Commission prepared a substantial budget (Horizon 2020) for 2014-2020 to carry out studies that investigate additional policies and technologies needed to achieve 20% emissions reduction by 2020 (from 1990 levels). Moreover, the Commission is proposing to set the ambitious goal of cutting carbon emissions in transport by 60% by 2050.

6.1.3. Resources consumption

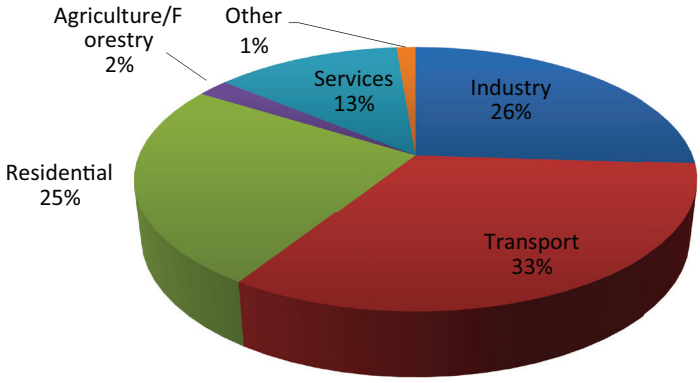
Around 30% of total energy produced worldwide is used by transportation of people and goods. It is the fastest-growing consumer of energy and producer of greenhouse gases. Although energy consumption and GHG are separate issues, they are discussed together in the context of green transport, since emissions result from energy consumption.

Figure 6.5. EU-27 energy consumption, by sector, 1 000 tonnes of oil equivalent



Source: Own elaboration based on Eurostat (Code: tsdpc320).

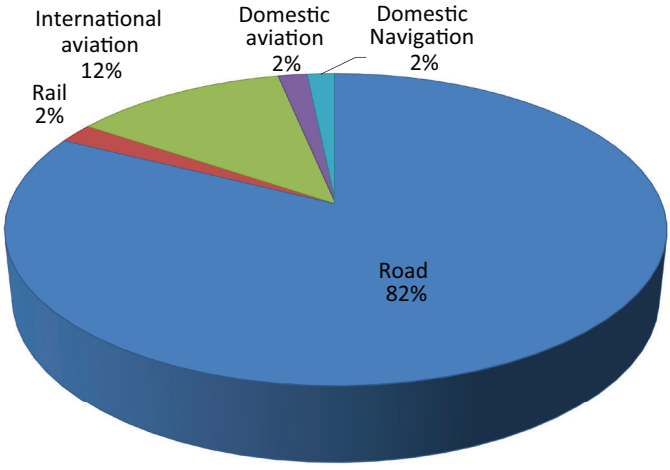
Figure 6.6. EU-27 energy consumption, by sector, in %, 2011



Source: Own elaboration based on Eurostat (Code: tsdpc320).

In European Union transport accounts for around 33% of energy consumption. While consumption in other sectors like industry or housing is decreasing, transportation shows an upward trend in this matter, in spite of advanced technology and modern fuel processing techniques. This is mostly caused by increasing demand for transportation and lack of investment in alternative transportation.

Figure 6.7. Energy consumption by transportation type



Source: Own elaboration based on Eurostat (Code: tsdcc320).

As illustrated above, 82% of energy is consumed by road transport, 12% by domestic aviation and only 2% by rail. In comparison to 1990 it increased by 26% for road transportation and 84% for aviation. In effect, it became recently part of EU Emissions Trading System. Railway's fuel consumption decreased by 10%, which resulted from expansion of electrified lines that have been replacing diesel fuel usage. In contrast, the US consumes more then twice as much energy for transportation than the EU. However, the breakdown into transport types is almost the same as in the EU.

The EU transportation energy consumption is almost in 98%[85] dependent on petroleum products, although share of these fuels is stabilizing and even slightly decreasing. This is mostly caused by fast decrease in motor gasoline, increased usage of biofuels and increasing popularity of electric vehicles. Transport consumes more than a half of global liquid fossil fuels and is expected to generate almost all of the increase in oil consumption in the next 20 years.

For additional information regarding world's dependency on oil please see the TED Talk – Richard Sears 'Planning for the end of oil': link.

It needs to be mentioned that fuel resources are depleted each year and ultimately in the future we will observe increase in their price due to higher demand and shrinking supply. Moreover, despite advances in transport technology and fuel formulas, which have resulted in a substantial decrease in emissions from certain pollutants (e.g. industry), transportation energy consumption and emissions increase each year and in around 95% depend on fossil fuel. Due to the above deficiencies combined with urban congestion and pollution generated by transportation industry, each year city councils and governments invest large amounts of money in research into alternative engines and technologies in order to reduce dependence on oil. In recent years electric/hybrid cars, low-emission engines, intensive development of public transport, bicycle-friendly and walkable areas are just examples of transportation initiatives undertaken by every major city worldwide. Technology improvements, proper policies in place and changes in citizens' habits may contribute to substantial decrease in fuel consumption.

Nevertheless, there are economic trade-offs incorporated into implementation of green solutions. For example, reduction of transportation emissions takes place at the expense of road users who pay increased fees and taxpayers who pay higher tax rates. Therefore, it is important to encourage citizens to become green by means of various incentives, education, improvements in public transportation as well as bike – & walk – friendly local urban design.

[85] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Transport_energy_consumption_and_emissions, , accessed on 31.01.2015.

The Directive on Renewable Energy (Directive 2009/28/EC) sets ambitious targets for all EU Member States. By 2020 the transport sector will be expected to account for 10% of renewable energy. It should be achieved by investment in alternative renewable energy sources under Horizon 2020 Programme and also by[86]:

- Optimising transport demand, e.g. avoiding or reducing trips through integration of land use and transportation planning, as well as localised production and consumption;
- Obtaining a more suitable modal split – shifting to more environmentally-efficient modes such as public and non-motorised transport for passengers, as well as to rail;
- Using the best available technologies, e.g. improving vehicle and fuel technology to reduce the negative social and environmental effects for each kilometre travelled.

6.2. Green transportation

Transportation in cities contributes to both developmental and environmental concerns that pose a challenge for governments and urban decision-makers. There are both economic and environmental costs linked to the decisions which municipal officials make concerning the provision of city transport. Traffic congestion in many metropolitan areas today is not only costly for businesses and inhabitants but also implies a heavy burden on the environment in terms of air pollution and greenhouse gas emissions. Increasing demand for transportation and land scarcity force cities to launch road construction programmes that are likely to find sufficient space or land to build roads and highways. Moreover, in residential areas there is often a problem of noise pollution from traffic. A city landscape that is broken down by roads and highways and covered by dense traffic poses a problem for inhabitants wishing to reach their destination on foot or by bike[87].

Therefore, in contemporary urban areas, struggling with climate change, pollution, congestion and resource depletion, it is crucial for urban transportation to participate in green, sustainable initiatives, as transport services are being considered as the main contributor to the urban issues. This situation affects

[86] Urban Environment Good Practice & Benchmarking Report: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2013/02/MDR0763Rp00026_Good-Practice-Report-2015_F01_light.pdf, accessed on 31.01.2015.

[87] Ling O. (2005), "*Sustainability and Cities: Concept and Assessment*", World Scientific Publishing Company, p. 151-152.

every citizen directly and indirectly through e.g. traffic jams, air quality, health and prices of oil. Furthermore, demand for transportation services is increasing each year due to development of megacities and population increase. To handle this problem, numerous actions have been taken recently to turn urban transportation into a greener and more sustainable sector.

So far there is no single agreed definition of green transportation, as it is considered to be a relatively new term. Therefore, those related to sustainability are being used by reason of similarity. There is still an on-going discussion among researchers, policymakers and industry about which factors, strategies, approaches and benefits are considered as green.

Green transport as a term was coined to describe green, sustainable development and is used mostly to describe modes of transport that are consistent with the green strategy. Nevertheless, it is often overused, as a greenwash marketing technique for products that are not proven to make any positive contribution to environmental sustainability. There are many definitions of sustainable transport, but you can hardly find any related to green mobility. In general, it is considered as a category of sustainable transport that uses human power, public transportation, smart and renewable energy in order to move from point A to B. Here is a more formal definition of sustainable transport presented OECD[88]:

> *"Transportation that does not endanger public health or ecosystems and meets mobility needs consistent with (a) use of renewable resources at below their rates of regeneration and (b) use of non-renewable resources at below the rates of development of renewable substitutes."*

Additionally EU Council of Ministers of Transport defines green sustainable urban mobility as that[89]:

- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise;
- allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;

[88] OECD Proceedings (1997), "*Towards Sustainable Transportation*", p. 12.

[89] Rahman A. and van Grol R. (2005), „*SUMMA*" final publishable report v.2.0.

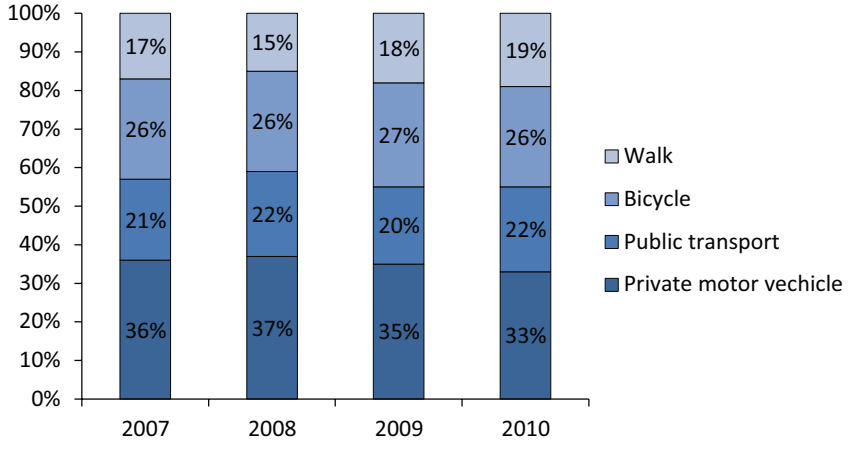
- is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.

All approaches follow the same direction, along the path towards a new economic model that is based on ecologically compatible use of resources, economic efficiency and improvement in urban quality of life. Transport is considered 'green' when it supports environmental sustainability, i.e. protection of the global climate, ecosystems, public health and natural resources. It also supports the other two pillars of sustainability – economic and social[90].

Traditional urban transportation focuses on improvement in mobility as well as providing access to work, education, goods and services. Thanks to new modern technologies this goal can be achieved together with reduction of environmental impact. The aim of green transportation, apart from reducing greenhouse gas emissions, air pollution, congestion and noise, is to decrease poverty and support economic growth. It can be achieved by applying new low-emission vehicle technologies in conjunction with efficient public transportation system and smart urban planning for pedestrians and bicycles.

Transportation in Copenhagen, which was chosen for European Green Capital of 2014, has one of the greenest systems. Public transport, walking and cycling, considered as green mobility, accounts for almost 70% of transport. The use of private vehicles decreases each year despite population increase.

Figure 6.8. Modal split of transportation used in Copenhagen in years 2007-2010

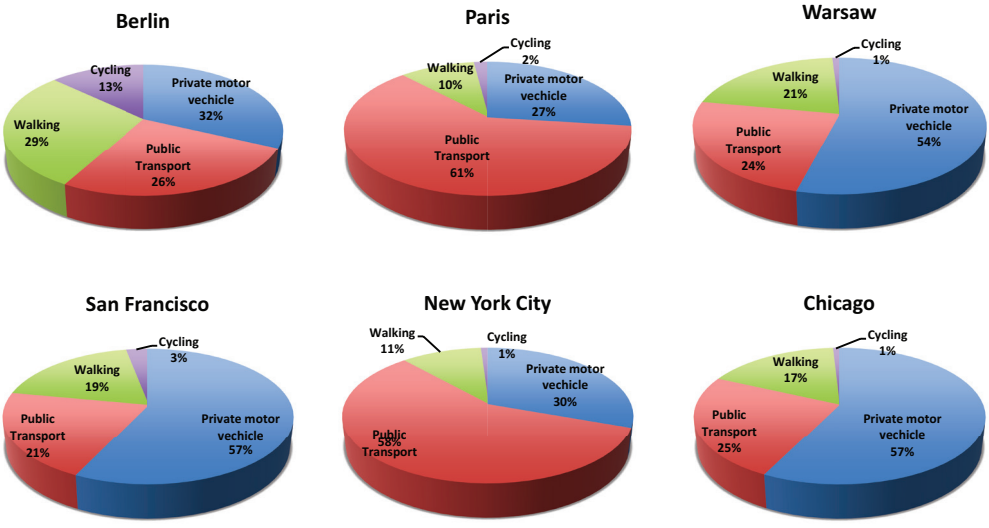


Source: Own elaboration based on http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2012/07/Section-2-Local-transport_Copenhagen.pdf, accessed on 31.01.2015.

[90] Bongardt D., Schaltenberg P. (2013), "*Transport in a Green Economy*", Transport Policy Advisory Services, p.1.

The chart below compares the use of different transportation modes in six EU and US cities in order to present the diversity of mobility trends. Berlin, Paris and Warsaw, ranked by Siemens Green City Index[91] respectively 8, 10 and 16, are mostly based on public transport, walking and biking. In contrast, the US cities (San Francisco-1, New York-3, Chicago-11), which are known for high motorisation, private vehicles are the most often chosen form of transportation, with the exception of New York, due to high congestion and public transport availability. While comparing top-ranking green European and US cities, Copenhagen and San Francisco, it can be noticed that the major difference is biking in the first city (26% vs 9%).

Figure 6.9. Modal split of transportation used in six urban areas in 2011



Source: Own elaboration based on http://sootfreecities.eu, http://www.epomm.eu, http://www.lta.gov.sg/ltaacademy/doc/J11Nov-p60PassengerTransportModeShares.pdf, accessed on 31.01.2015.

The next sections present different approaches to green urban transportation which, when used in conjunction, may contribute to development of eco-cities:

- public transportation;
- personal vehicles;
- bike-friendly cities;
- walkable cities.

[91] Siemens Green City Index: http://www.siemens.com/entry/cc/en/greencityindex.htm, accessed on 31.01.2015.

6.3. Public transportation

Today public transport is an integrated part of every urban area and there can hardly be found any city functioning well without it. It enables inhabitants' access to work, home, education, health services and leisure activities. In addition, it provides better social inclusion for the whole population, regardless of income or location. Public transport becomes commonly used, especially in congested metropolises, as the preferred choice of transportation regardless of wealth or purpose of journey.

Public transport is more efficient compared to private transport in terms of energy usage, road space, cost of vehicle production and pollution. Therefore, it is considered as a sustainable and green solution. For example, on average public transport consumes almost 4 times less energy per passage than private vehicles. Moreover, due to congestion, a journey from home to work by car uses almost 20 times more urban space than the same journey made by public transportation (bus or tram). The ratio is even higher if the underground system is taken into account. If all citizens decided to travel to work by car the amount of urban space needed for parking would equal the workspace.

Figure 6.10. Amount of space required to transport 60 of people by bicycle, car and bus

Credit: Press-Office City of Münster, Germany.

In many congested cities, especially in Europe, public transport creates around 1.2 million jobs. In represents around 1% of EU's GDP. Increased usage of public transport provides more green workplaces locally and reduces countries' dependency on fossil fuel. Diversity of public transit services is a major element of developing a green transport system. The demand for travel

from inhabitants varies based on their income, purpose and distance to travel. Therefore, transport systems providing only one type of transportation cannot meet all citizens' needs or serve all purposes and may not be sufficient. A balanced public transport system consisting of buses, trams, rapid railways and the underground should be put in place in order to meet the transportation demand. It should serve all citizens including commuters, low-income citizens and disabled people and be environmentally green – i.e. use technology that produces low gas emissions (preferably none), require little urban space and emits low noise or none.

In order to match the inhabitants' demand and align with green sustainable strategy, cities have made large efforts to improve the public transport system in order to attract more passengers. It is performed in two ways, through:

- incentives, low fares or even making it free, or
- congestion charges, traffic restrictions.

See following article regarding free public transportation service in Estonia, Tallin: link.

In White Paper Roadmap to a Single European Transport Area released in March 2011, the European Commission has proposed that all major cities should follow a strategy involving such aspects as pricing schemes or efficient public transport services to reduce congestion and emissions. The cities' strategies should be developed as Sustainable Urban Mobility Plans (SUMP) in accordance with EU guidelines defined in Urban Mobility Package. The Commission considers taking mandatory approach for development of SUMP in all cities with more than 100 thousand inhabitants (for more information about mobility plans please see following: Sustainable Urban Mobility Plans (link); Guidelines for developing SUMP (link).

6.3.1. Bus transit

6.3.1.1 Green buses

Buses are one of the biggest polluters and fuel consumers in the field of public transport. However, if we take into account the number of passengers they carry, they are more 'green' than private vehicles. In order to decrease exhaust gas emissions, the bus industry offers cities numerous technologies. Over the past decade many cities invested in bio gas/diesel-fuelled buses but the environmental outcome is insufficient since the pollution generated by them doesn't decrease as expected. In addition, the cost of purchase and

maintenance is higher than that of diesel-fuelled vehicles. Therefore, cities that aim for efficiency, cost savings and sustainability, shifted their interests into propane gas and diesel-electric hybrid buses. Such technologies bring substantial benefits for urban air quality. Offered by manufacturers, hybrid and propane-fuelled buses can reduce $C0_2$ emissions by up to 40% compared to conventional buses and significantly decrease fuel cost.

Nevertheless, the future of green bus transit belongs to electric buses that generate no exhaust gas, are almost noiseless and decrease dependency on fossil resources. They can be traced back to the 19th century when trolleybuses were invented but due to overhead wires required to operate them and limited mobility were they were replaced with conventional buses. In spite of that they remained in usage in Eastern Europe and China, and are even regaining popularity due to being equipped with batteries. Cities like San Francisco, Vancouver or Landskrona (Sweden, supplied by Polish Solaris company) recently launched their trolleybus systems.

Figure 6.11. A Trolleybus in Reading in 1966

Source: Alan Murray-Rust, "A double-deck trolleybus in Reading, England, 1966", Creative Commons Attribution.

Electric buses are definitely a green and sustainable form of transportation. Nevertheless, they have substantial drawbacks that prevent them from wide usage. Firstly, there is high upfront cost of purchase compared to conventional buses. Secondly, they have limited range due to battery capacity and it varies depending on speed, traffic and busload. Another factor is charging – it takes

approximately 4-6 hours to fully charge the batteries. Therefore, in order to increase their usage, new technologies are being explored to increase battery capacity and develop rapid charging stations. For example, in Milton Keynes (UK) implemented inductive charging plates at terminus stations. A similar approach was taken in Vienna and their microbuses are charged through tram overhead power stations located at end stations. The city of Geneva is testing wireless charging stations implemented on bus stops. In addition, solar panels on bus roofs are being considered in order to provide additional energy for heating or air-conditioning systems. Taking the above into consideration it can bestatedthatthankstotechnologicaladvanceselectricbuseswillbecomeacommon part of urban landscape in the nearest future.

Figure 6.12. Bus charging in Vienna

Source: Andrew Nash, "Vienna Electric Bus April 2013", Creative Commons Attribution.

6.3.1.2. Bus Rapid Transit (BRT)

Combining the idea of electric buses with the BRT concept allows cities not only to improve air quality but also to cope with congestion and create a more green and sustainable transportation system. BRT combines quality of light rail (e.g. trams) and flexibility of bus service. There is no single definition of BRT, although it is considered as a general improvement to the existing bus system, which aims to convert it into a rubber-tired light rail transit. Since it provides benefits of both of them, it is recognized as one of the most effective and innovative transportation options in many urban areas.

The main aim of Bus Rapid Transit is to minimize travel time and maximize the number of passengers. It is achieved by bus-priority in traffic flow though integrating exclusive bus lanes into existing roads (low-end BRT) or, in the most advanced implementations, mimicking light rail system (high-end BRT).

Table 6.1. Differences between high-end and low-end BRT

	High-end BRT	Low-end BRT
Running ways	Exclusive transit-ways, dedicated bus lanes, some grade separation	Mixed traffic
Stations/Stops	Enhance shelters to large temperature-controlled transit centres	Stops, sometimes with shelter, seating, lighting, and passenger information
Service design	Frequent services, integrated local and express services, timed transfers	More traditional service designs
Fare Collection	Off-vehicle collections, smart cards, multi-door loading	More traditional fare media
Technology	Automated vehicle location (AVL), passenger information systems, traffic signal preferences, vehicle docking/ guidance systems	More limited technological applications

Source: Cervero R., (2013), "*Bus Rapid Transit (BRT): An Efficient and Competitive Mode of Public Transport*", Berkley University of California, Institute of Urban and Regional Development, p. 2.

From the above table it can be concluded that the exact features of BRT are vague and not clearly defined. One of the fundamental requirements of a BRT system is the use of rubber-tired buses designed for rapid transit. In addition, the degree of segregation from regular traffic is the primary parameter in designing BRT. It can be achieved by[92]:

- Busway alignment: median-location of a busway (the most effective) or bus-only corridor that minimizes conflicts with turning vehicles and other potential obstructions;
- Dedicated right-of-way: physical segregation and full enforcement;
- Off-board fare collection: barrier-controlled turnstiles that verify off-board ticket payment;
- Intersection treatments: turn prohibitions across busway and sign priorities; or
- Platform-level boarding: elimination of steps and shrinkage of gaps between vehicles and platforms through bus guidance, raised platforms, and boarding bridges.

[92] Cervero R., (2013), "*Bus Rapid Transit (BRT): An Efficient and Competitive Mode of Public Transport*", Berkley University of California, Institute of Urban and Regional Development, p.p. 3.

According to the Institute for Transportation and Development Policy (go.itdp.org), the most effective BRT systems in the world are located in Bogota, Columbia and Guangzhou, China. However, their systems can arguably be considered as green or sustainable due to dependency on fuel-propelled buses. Europe and the US mostly implemented low-end BRT with dedicated bus lanes. As BRT popularity is increasing, more and more cities are interested in implementing it or are in the process of deploying green technologies (e.g. Barcelona: link, San Francisco: link). In addition, it is preferred over light rail because of relatively lower cost of implementation.

6.3.2. Rail transit

Currently urban rail transit is experiencing its renaissance due to environmental friendliness, speed of transit, affordability and energy efficiency. In the 1960s numerous trams and other rail systems mostly in Western Europe (e.g. the UK, France, Spain) and the US were replaced with buses and private vehicles, considered as the modern forms of transportation. With increasing pollution, congestion, fuel price increases as well as strict environmental, safety and quality-oriented regulations, in the 1990s cities found urban rail system attractive again, as it could replace or supplement the existing transportation systems and facilitate creation of multimodal, spatial transportation framework. Above all, it is clean, green, based on electric energy with almost no GHG footprint, and it can transport passengers in a fast and reliable manner. It helps eliminate cars from congested roadways and ultimately reduce carbon emissions. Urban rail transit is an umbrella term for all sorts of local rail modes that provide passage service within cities and connecting them with suburban areas. It consists primarily of:

- Light rail,
- Metro, and
- Trams.

The above-mentioned forms of transportation often overlap and are implemented in conjunction. For example, metro in city centres goes under the ground but in less urbanized areas it takes the form of light rail (Paris, London, New York). Although in some cases light rail is wrongly considered as metro (e.g. in Minneapolis, Shanghai) and trams as light rail.

In general, light rail transit (LRT) is a rapid transit service using passenger rail cars on ground-fixed rails, mostly separated from other traffic and electrically propelled. The main aim of LRT is to connect suburban areas with city centres, covering long distances in a rapid manner. The stations are located rather far

away from each over. The term LTR was invented in contrast to heavy rail, which is a competing alternative for the same relatively long corridors, but LTR is a local form of transportation with more closely spaced stops. The longest light rail systems are located in Melbourne (Australia) and in Europe (Vienna, Berlin). In the US, one of the oldest and longest systems is located in Chicago ('L'). It combines light rail, metro and tram functions, operating in the city centre on elevated rails. The future of LTR belongs to elevated monorail and magnetic levitation.

Figure 6.13. Chicago 'L' light rail

Source: Kelly Martin, "Chicago-Loop-SEcorner", Creative Commons Attribution.

Metro, also called subway or underground, is an alternation of light rail. Like LTR, it is a rapid means of transit that operates on rails, stations are located at long distances from each other, but it runs under the ground. It originated in 1863 in London, firstly powered by steam engines, later, at the end of 19th century, propelled by electricity. Up to current days London and New York metro are the largest underground rapid rail systems in the world. Metro in general is regarded as the best form of urban transportation due to its ability to rapidly transport a large number of passengers with little use of land. The downside of its implementation is the cost. It is estimated that it is 5 times higher than for light rail. In addition, extensive time of implementation, although reduced by appearance of tunnel-boring machines (TBM), plays a significant role and in many cities decision-makers choose to implement hybrid forms – underground in the most congested areas, ground in others, or even in extreme cases it takes the form of ground light rail.

Trams (street cars) are also considered as rapid means of transportation, since a majority of rail tracks are separated from other forms of urban transit. Thus they can operate in a fast manner in spite of traffic and congestion in city centres. In contrast to light rail and metro, tram stops are located at close distances from one another. They have the same function as buses and cars but are more environment-friendly – propelled by electric motors, which each year become more effective and consume less power. Moreover, they are cheaper to run and maintain than buses, but what prevents them from wide usage is the high upfront cost necessary to implement the infrastructure (although substantially lower than for metro). Nevertheless, after being abandoned in the 1960s and replaced with buses, since the 1990s urban trams have been experiencing rebirth. Cities realised that is the most sustainable and green form of transit within city centres. Therefore, old lines are modernised and new ones are constructed, equipped with efficient electric vehicles. Moreover, even tram tracks are modernised to become greener, through for example implementation of vegetation systems (see picture below) that reduce noise and dust levels (e.g. Barcelona, Berlin, Frankfurt). The largest tram systems are located in Central and Eastern Europe's cities – Berlin, Vienna, Warsaw and Sankt Petersburg. In Western countries that withdrew from this form of transportation 50 years ago, the concept is gaining new attention and the number of lines is growing. Trams have all the features to become a 'flagship' means of green urban transportation.

Figure 6.14. Green tram tracks in Nantes

Source: Matanya, "Green spaces along the tracks", Creative Commons Attribution.

In order to meet all inhabitants' demand, an urban agglomeration should not rely on one mode of public transport but rather implement a hybrid form that will be environment-friendly to benefit current inhabitants and future generations. The system preferably has to be based on electricity and fuel-propelled buses should be replaced by trams, electric bus rapid transit or metro. For suburban areas that depend mostly on cars, light rail should be modernised or constructed in order to serve as a means of really fast transportation. It will allow people to abandon private vehicles and save their time by moving them in a fast and efficient manner. Moreover, the approach should be combined with other strategies like park & ride.

Many European cities are at an advanced stage of implementing such a hybrid green approach (e.g. Berlin). Others are in the process of developing it, for instance Warsaw, where tram and suburban rail is relatively efficient but metro is being expanded. Paris is currently expanding their tramway network that 20 years ago hardly existed. Similar decisions are made in the largest US agglomerations, where metro and light rail is mostly sufficiently deployed for rapid transit (New York, Boston, San Francisco) but for close urban transit they still rely on buses or private vehicles. They are in the process of developing bus rail transit systems and tramway network. Nevertheless, the future may belong to monorail and private rapid transit (PRT) systems (link).

6.4. Personal vehicles

People often visualise green urban transportation as a city full of electric cars, which truly are not generating pollution and noise but still are not a complete solution to urban transportation issues (e.g. congestion). Therefore, in order to reduce usage of private vehicles and create car-free districts, various incentives and restrictions are being introduced in order to lower the number of cars travelling and shift inhabitants' transit habits into public transportation, like car sharing/pooling, car restrictions and road pricing.

Private vehicles are considered as the most comfortable form of urban transportation. They allow door-to-door transit and are used especially by commuters. Cities, in spite of their best efforts, will never meet all transit demand or persuade people to drop cars in favour of trams, buses or rail. Therefore, in the last 10 years many cities and governments have encouraged people to switch to electric cars that first of all significantly contribute to reduction in local air pollution and decrease city dependence on oil. It is being done in numerous ways, for example by subsidising electric car purchases,

developing a network of charging stations (similar to fuel stations), dedicating car parking spaces or allowing electric cars to take exclusive road lanes (e.g. bus lanes). On one hand, cities are promoting them by launching electric car rental systems, similar to bike rentals, which are operating in numerous cities like Berlin, Paris and Miami (i.e. Car2go, Autolib). On the other hand, governments discourage people from using ineffective, polluting fossil-based cars through aggressive emissions restrictions standards, taxes and insurance fees.

Unfortunately, technology limitations and lack of infrastructure still prevent electric cars from wide usage. The batteries can last for shorter distances than fuel-propelled cars. Therefore, people are afraid of running out of power in the middle of their travel. In addition, there are still very few charging stations and the process of charging is time-consuming, despite bust charge and other technologies offered by car manufacturers. Moreover, the battery lifecycle is limited and there is still the unsolved problem of large quantities of electro-chemicals when the cells are utilised.

Figure 6.15. Car2go in Amsterdam

Source: Ludovic Hirlimann, "Electric car charging Amsterdam", Creative Commons Attribution.

Nevertheless, sales of electric and hybrid cars are improving each year despite the high upfront cost – higher than for conventional cars, even with government incentives. The reason for this is mainly excessive cost of batteries. Tesla company, the leader and pioneer in the electric car sector, decided to

mount laptop batteries, which are cheaper than traditional ones, in their cars in order to lower the vehicle cost. Because of all limitations of electric batteries (charging, lifecycle and utilisation) and insufficient research progress in this area, in the next years we will still observe applications of interim solutions such as hybrid and propane gas-propelled cars that bring us closer to limiting air pollution. The future of private vehicles, apart from electric cars, may belong to hydrogen fuel cell or even steam-propelled cars (compressed air). Extensive research is undertaken in those areas as well.

Non-fossil-powered cars that help to reduce urban air pollution do not solve the congestion problem. Therefore, cities are encouraging inhabitants, especially commuters, to share their cars (car-sharing programs) to remove single-person vehicle occupancy on roads. They offer web-portals for finding the best-matching companion and money incentives for them to travel together (see Miami-Dade car-sharing programme: link.

Moreover, cities, especially in the US, where dependency on car transit is one of the highest in the world, implement separate express road lanes for car-sharing vehicles with +2 passengers occupancy called HOV (High Occupancy Vehicle). Certain communities went even further. Getaround, a San Francisco-based company, encourages inhabitants to share their private cars with other individuals. The company operates in the US west coast's major cities and so far more than 10,000 vehicles signed up. Studies suggest that one-shared car may take up to 14 others off the road (snowball effect)[93].

In European 'packed' cities, where suburbs are not as developed as in the US, the emphasis in discouraging people from usage of private vehicles is put on road traffic restrictions and pricing (e.g. congestion pricing). The first one is achieved by means of strategies such as single way traffic, speed limits, aggressive parking space limitations and car-free zones. Restricted vehicle traffic is the ultimate goal of green cities – creation of pedestrian, bicycle and public transport-friendly cities. On a small scale it can be observed in almost every European city's old town. Some urban areas even extended it to the whole city centre, mostly historic districts, like Freiburg, Venice and Sienna.

Another approach to reducing traffic and limiting the number of car users travelling in cities is congestion pricing and low emission zones (LEZ). For example, London implemented congestion pricing in 2003 by charging a fee for driving private vehicles in its central area during weekdays. In addition, in 2008 they implemented (LEZ) within city centre to improve local air quality. To drive

[93] TED (2013), *„City 2.0: The Habitat of the Future and How to Get There"*, TED Books, p.161-184.

within the Greater London without paying a daily charge, the vehicles must meet certain emissions standards in terms of gas emitted from the exhausts.

LEZ was introduced in 2008 to encourage the most polluting heavy diesel-fuelled vehicles driving in the capital to become cleaner. The LEZ covers most of Greater London. To drive within it without paying a daily charge, these vehicles must meet certain emissions standards that limit the amount of particulate matter (a type of pollution) coming from their exhausts (for additional information regarding LEZ see LEZ zones in EU (link); and Paris approach to congestion problem (link).

Development of car-free cities cannot be achieved by a single action. Therefore, numerous cities implemented travel demand management (TDM) strategies that cover traffic restrictions, incentives and initiatives like car-free days, which result in better traffic, pollution decrease and improvement in health of inhabitants. For more about principles of TDM please refer to: link.

6.5. Bike friendly cities

Car-free cities cannot be accomplished without replacing cars with other forms of transportation, especially for short– to medium-distance trips. Since the 1960s the number of cycle trips decreased rapidly due to car popularity, affordability, and improvements in public transit. In the past decade, however, bicycles have made an impressive comeback. Although modal share of bike trips is growing each year, it still constitutes about half of the level from the 1940-50s. The reasons for increasing bike popularity include above all: relatively low price, promotion of healthy lifestyle and the growing trend of eco-friendliness. Studies show that people are eager to cycle even in light rain, cold temperatures and in snow. Cycling does not generate any pollution, depending on human power, takes less space than cars and the production process is fairly sustainable (consumes small amounts of resources). Therefore, cycling is considered as the greenest form of transportation for short – to medium-distance trips.

Figure 6.16. Bike counter in Copenhagen

Source: James Cridland, "Cycle counter", Creative Commons Attribution.

Cycling seems to be a global trend not limited to hipsters and youngsters travelling from point A to B. Each year you can find more and more bikers in the streets, e.g. professionals pedalling to work, retired people doing shopping or whole families spending their free time actively. This biking trend could not be achieved without strong promotion from city councils and governments, which have a great deal in doing so. According to research conducted by City of Copenhagen in Denmark[94], every kilometre cycled brings savings of approximately 23 eurocents to the city. It is due to lower road surface usage (average bike weight is 1% of that of a car) or fewer public transport passengers. Furthermore, healthy citizens means less public expenditure on health care. As for urban air, in Copenhagen annual CO_2 reduction achieved due to increase in biking is estimated to be at the level of 90 thousand tonnes of pollution, compared to driving the same distance by car. To compare, 74 thousand acres of forest would be needed in order to sequester such amount of carbon.

So how can cities promote the green form of transportation that biking undoubtedly is and create a bike-friendly city? The most important aspect is infrastructure. Cyclists should travel on separate painted lanes, ideally located outside of the vehicle traffic. The lanes should cover the whole urban area and

[94] http://www.cycleluxembourg.lu/2013/10/18/cycling-as-a-key-to-creating-more-livable-cities-copenhagenize-style/, accessed on 31.01.2015.

be smart – include turn lanes, bike boxes on junctions to gather ahead of traffic and avoid bus stops (pass right). Another important factor is availability of parking spots. They should be located in front of almost every building, equipped with supporting racks and covered (roofed) or even located under the ground.

Figure 6.17. Biceberg is an automated underground bicyle parking system in Zaragoza, storage for 46 bicycles

Source: Jezhotwells, "Biceberg", Creative Commons Attribution.

It needs to be emphasized, that an effective urban biking system requires integration with public transport in order to fully benefit from it. It can be accomplished by mounting bike racks on buses, bike transport-adapted light rail cars and incentives such as free public transportation for bikers.

Another approach to promoting bike-friendly cities is through bike-sharing systems (link), which are really booming nowadays. From 2007 to 2013 the number of bike systems went up almost ninefold (to around 550) using over 500,000 bikes. Bike systems are implemented in every major city worldwide. For example, in Poland there are 7 systems, with another 7 to be implemented in the next couple of years. They provide affordable access to bikes for short urban distance travels and are an alternative for private vehicles, public transport or walking. The biggest advantage of the system for citizens is that there is no ownership required and no upfront cost of bike purchasing. Bike sharing systems often fill the transportation gap in car-free areas or connect people with public transport ('last mile'). For example Paris program called Velib consists of 20,000 bicycles that are available 24 hours a day. It has 1,800 bicycle stations that are located every 300 meters, covering almost entire city centre.

The future of bike sharing belongs to its 4th generation that is in the process of development and only few cities (bike-friendly leaders) are in the process of implementing certain elements of it, like Copenhagen or San Francisco. The 4th generation brings improved efficiency, sustainability and usability by improving distribution of bikes (pattern recognition and analysis), faster and cheaper installation of stations, solar-powered stations, GPS tracking and pedal assistance (electric bikes). For example, Copenhagen is in the process of implementing a bike system with GPS-enabled Android tablets. They will provide navigation for travellers; enable scheduling trains for commuters or checking availability of bikes and docks in the neighbourhood. This will also allow better bike tracking and data collection in order to adjust service to the demand. On the other hand San Francisco, known for its hilly area, is introducing electric bikes that will give less physically able people a possibility to participate in bike sharing.

Expansion of bike infrastructure, integration with public transport and development of bike sharing definitely contribute to establishing a bike-friendly environment and green city creation (see Livable Copenhagen The Design of a Bicycle City: link). Nevertheless, to make the approach complete, it should be also accompanied with proper safety education, bike traffic regulations and policy restrictions like mandatory helmets. Currently very little is being done in this field but if increase in bike popularity continues, we will definitely observe higher interest in this issue, which may lead even to introducing bike registration plates.

The most bike-friendly city is obviously Amsterdam (the cycling capital of the world), but Copenhagen is very close. In the US, among the major cities, the leaders are Portland and Chicago. Bike-friendliness is measured through 'Copenhagenize index' and a set of criteria (see: link). The City of Copenhagen's Bicycle Strategy 2011-2025: link.

6.6. Walkable cities

A walkable city is another attempt to create green a car-free city. In general, the concept derives from one of the most natural human activities, which is walking. For centuries it connected people socially and allowed them to conduct daily activities. However, industrial revolution, rail and motor vehicle propagation, as well as development of mass transportation, facilitated longer-distance travel and walking was simply not feasible. Due to development of transportation, city area changed significantly and became larger, spreading

into suburban areas. In addition, every family wanted to have a car that was treated as a 'must have' product, defined their socio-economic status, almost equal to ownership of a TV set or a refrigerator. The most visible spread of urban areas happened in the USA where travelling without a car is impossible even today and public transportation is almost non-existent. Moreover, majority of city centres within the US, with the exception of cities like New York, Boston, Chicago, San Francisco look abandoned and hardly any pedestrian can be found. See TED Talk 'Walkable city' by Jeff Speck: link.

Recently, the idea of walking is being revived, mainly because of healthy lifestyle promotion. Although the concept has been around for years in European countries where in car-free areas, mostly historic old towns, walking is the only possibility. Nevertheless, nowadays people are consciously choosing walking over car or public transport, for example on the way from work or shopping. This green habit is spreading relatively fast and cities, along with their bike-friendly approach, should enable people to walk freely, even long distances, in order to create pedestrian cities or at least districts. This obviously, from the green city perspective, will remove cars from the streets, reduce congestion and noise, remove traffic jams and improve urban air pollution.

What exactly is a walkable city? There is no single definition in place but it is perceived as a pedestrian-friendly city with a combination of physical elements that allows pedestrians to travel from point A to point B (e.g. walkways, escalators) and perceived ones (e.g. safety, comfort). It involves special city planning with mixed urban development and proximity of places like shops, schools, work and recreation areas in order to meet all everyday needs. The desired destinations should be located within the walking distance – preferably up to 1 km. The key characteristics of walkable cities include a recognisable centre or focal point like main street, shopping centre, town centre, compact and mixed-use development, pedestrian-centric design, and walking accessibility to work, services and opportunities for social interaction.

Walkability of a city or a district is a core element of its liveability. It has a positive impact on local economy because pedestrians are customers of local restaurants, cafes and shops. Moreover, vital urban areas increase value of properties and the general perception of the city is improved. It also increases social capital of neighbourhoods – helps establish social ties and connections. Greetings and quick spontaneous conversations improve relations and encourage a sense of trust. But above all, walkability improves health of the inhabitants since it does not generate any air pollution (decreases risk of respiratory diseases or allergies) and through involvement in physical activity helps to keep inhabitants fit. Modern intense exercise serves as a safeguard against cancer, depression, cardiovascular disease and others. Therefore, modification of the city

environment is so important to make the walking experience enjoyable and help shift citizens' habits from inactive to more active lifestyles, which may result in green and happy societies.

In order to achieve it, cities need to change their urban design approach and implement comprehensive plans that would include such elements as:

- promotion of a culture of walking through events and other celebrations;
- pedestrian urban planning, improvements in existing sidewalks (e.g. wider with obstacle removal, light priority); and
- expansion of pedestrian car-free zones.

Stockholm – the wakable city plan: link.

Additionally, pedestrian networks should be fully integrated, with a way-finding system in place that can take the form of websites, mobile city map applications, city map signs or electronic map systems with the route-finding function. Travelators and escalators can be implemented for long distance walking. Moreover, greenery (e.g. trees, parks) needs to be integrated into city landscape to encourage people to walk (link).

A majority of walkable cities in the world, just like those featuring green urban transport, are located in Europe (e.g. London, Paris, Barcelona). However, in the US there are at least three cities which stand out in their pedestrian-friendliness, mostly due to compact city centres and high congestion – New York, Boston and San Francisco. The best US example of walkable districts are university campuses, where car traffic is banned and people travel either on foot, by skateboards (recent trend) or electric golf carts and buses for long distances. On the other hand, some complexes may be wrongly considered as pedestrian – and environment-friendly, especially Silicon Valley ones like Google headquarters (Googleplex in Mountain View, USA), where employee transportation is based on fuel-propelled shuttle buses that are far from being either green or sustainable.

Conclusions

In order to develop green cities and decrease impact of urban areas on our environment agglomerations should rely more on public transportation. This should be achieved by numerous incentives, restrictions and wide offer of transportation modes that meet all inhabitants' demand. The system preferably should be based on electricity – fuel-propelled buses should be replaced by trams, electric bus rapid transit or metro. For suburban areas that depend mostly on

cars, light rail should be modernised or constructed in order to serve as a means of really fast transportation. It will allow people to abandon private vehicles and save their time by moving them in a fast and efficient manner. Moreover, the approach should be combined with other strategies like park & ride.

For short distance trips urban areas should become walk and bike friendly. This requires changes in urban design approach, compact districts with shops and restaurants, and infrastructure in place to support it (i.e. bike and car rentals).

Combination of mentioned in this chapter forms of green transportation and various strategies can definitely contribute to development of eco, environmental friendly and liveable urban areas that will be beneficial for current inhabitants and future generations. Although it needs to be mentioned that for each city the implementation strategies and transportation modes should be tailored in order to meet specific cultural features and fulfil all citizens' demands.

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PART III

European and American legal requirements and strategies towards green cities development

Chapter 7

Fundamental plot – a reason for introduction of Europe 2020 Strategy

Zbigniew Grzymała

Introduction

The global economic crisis over the last years severely affected European economy. The European Union GDP in 2009 dropped by 4%, the industrial production decreased to the level of the 1990s and unemployment rate reached 10%. Twenty years of fiscal consolidation have been wiped out during two years of the crisis leaving public finances with deficits at 7% of GDP on average and debt levels at over 80%. The situation of the financial system is still fragile and the road to economic recovery uncertain as businesses and families encounter difficulties with borrowing, spending and investing.[95]

Europe will need to overcome its weaknesses in order to embrace the challenges of the rapidly changing world:

- The growing competition from developed and emerging economies such as China or India puts pressure on some sectors of EU economy. On the other hand, as these countries develop, new markets will open up for European companies.
- Europe will continue to seek global solutions to bring about an efficient and sustainable financial system around the world. The imbalances and artificial growth caused by speculative behaviour and stimulated by the availability of easy credit, short-sightedness and excessive risk-taking in financial markets will need to be addressed.

[95] Communication from the Commission Europe 2020. (2010), "*A strategy for smart, sustainable and inclusive growth*". Brussels, 3.3.2010,, p. 7. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC2020, accessed on 25.02.2015.

- The EU will continue its pursuit of a worldwide solution to the problems of climate change and resource challenges while implementing the agreed climate and energy strategy across the territory of the Union.[96]

European Union faces three challenging scenario. In the best case scenario, we address collectively the immediate challenge of the recovery and the long-term challenges (globalisation, pressure on resources, ageing) in order to make up for the recent years of crisis, regain competitiveness and increase productivity ("sustainable recovery"). Europe is able to make a full return to earlier growth path and raise its potential to go beyond. The second scenario is a permanent loss in wealth and a sluggish growth rate ("sluggish recovery") as a result of slow and uncoordinated reforms. Europe will have suffered a permanent loss I wealth and start growing again from this eroded basis. The third and the worst scenario is growing unemployment, social distress, and an overall decline on the world scene ("lost decade"). Europe will have suffered a permanent loss I wealth and potential for future growth. [97]

7.1. The main goals of the Strategy

The EU2020 growth strategy aims at a smart, sustainable and inclusive growth. Five main objectives of the strategy revolve around employment, innovation, climate/energy, education and poverty reduction:

1. Employment (75% of the 20-64 year old people to be employed by 2020, especially women, young, older and low-skilled people and legal migrants);
2. Research and Development[98] (3% of the EU's GDP to be invested in R&D);
3. Climate change and energy sustainability:
   a. 20% reduction of the greenhouse gas emissions (up to 30%, if the conditions are right) compared to 1990 levels[99];

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96 Ibid.pp. 7-8.

97 Communication from the Commission Europe 2020. A strategy for smart, sustainable and inclusive growth. Brussels, 3.3.2010, COM (2010) 2020 final p. 8-9. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52010DC2020, accessed on 25.02.2015.

98 Systematic activity combining both basic and applied research, and aimed at discovering solutions to problems or creating new goods and knowledge. R&D may result in ownership of intellectual property such as patents. In accounting for R&D costs, the development costs may be carried forward but the basic and applied research costs are often written-off as incurred. Read more: http://www.businessdictionary.com/definition/research-and-development-R-D.html#ixzz2v9jtpvDT

99 The European Council of 10-11 December 2009 concluded that as part of a global and comprehensive agreement for the period beyond 2012, the EU reiterates its conditional offer to move to a 30% reduction by 2020 compared to

b. 20% of energy to be used from renewables;
c. 20% increase in energy efficiency;

4. Education:
   a. reducing school drop-out rates below 10%);
   b. at least 40% of 30-34-year-olds to complete third level education.
5. Fighting poverty and social exclusion:
6. The number of Europeans living below the national poverty lines should be reduced by 25%, lifting over 20 million people out of poverty[100].

7.2. Flagship initiatives

Flagship initiatives corresponding to the 5 goals of Europe 2020 Strategy are as follows:

1. Digital Agenda for Europe

Its main objective is to create a digital market based on fast internet and interoperable applications in order to reboot Europe's economy and help its citizens and businesses to get the most out of digital technologies. Initiated in May 2010, DAE describes 101 actions contained in seven priority areas.[101] The review of those priorities, published on 18th December 2012, refers to 7 key areas for continual efforts to stimulate growth and jobs creation in Europe:

- Creating a new and stable broadband regulatory environment.
- Establishing new public digital service infrastructures through connecting Europe Facility loans.
- Launching Grand Coalition on Digital Skills and Jobs.
- Proposing EU cyber-security strategy and Directive.
- Updating EU's Copyright Framework.
- Accelerating cloud computing through public sector buying power.
- Launching new electronics industrial strategy – an "Airbus of Chips".

The original Digital Agenda approach is still valid, and the implementation of the 101 actions remains a priority. The new key transformative actions build on what has been achieved so far, complementing the original solutions. Progress in the implementation of the Agenda is evaluated in the annual Digital Agenda Scoreboard.

1990 levels, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

100 The national poverty line is defined as 60% of the median disposable income in each Member State.

101 See the original document of the DAE on EUR-Lex, the European Union law website.

Carrying out this updated Digital Agenda would raise European GDP by 5%, or 1500€ per person in 2020, by boosting digital skills in the labour force, increasing investment in Information and Communication Technologies, enabling public sector innovation, and reforming the framework conditions for the internet economy.

2. Innovation Union
   - R&D and innovation policy to concentrate on major challenges for the society like climate changes, energy and resource efficiency, health and demographic issues;
   - Every link in the innovation chain, from 'blue sky' research to commercialisation to be strengthened.

3. Youth on the move
   - Improving all levels of education and training;
   - Enhancing the international attractiveness of European universities;
   - Helping students and trainees study in the foreign countries;
   - Equipping young people better to enter the job market.

4. 'Resource efficient Europe' to help disengage economic growth from the use of resources, increase the use of renewable energy sources, stimulate the shift towards a low carbon economy, modernise the transportation sector and foster energy efficiency;

5. 'An industrial policy for the globalisation era' to improve the business environment, and to promote the development of a strong industrial base prepared for global competition;

6. 'An agenda for new skills and jobs' to modernise job markets and engage people in labour by developing their skills throughout their lives;

7. 'European platform against poverty' to deliver social and territorial cohesion so that the benefits of growth and jobs are widely shared and people experiencing poverty are given opportunity to live in dignity.

Conclusions

European Union faces a moment of transformation. The crisis has erased years of economic and social progress and revealed structural weaknesses in Europe's economy. In the meantime, the long-term challenges of the rapidly changing world – globalization, pressure on resources, ageing – intensify. In these challenging conditions we can succeed only if we act collectively, as

a Union. Therefore, Europe needs a strategy to help itself emerge from the crisis and transform the EU into a smart, sustainable and inclusive economy. Europe 2020 sets forth three priority targets:

- Smart growth: more innovative economy based on knowledge, research and development.
- Sustainable growth: greener and more competitive economy, promoting more resource efficient solutions.
- Inclusive growth: a high-employment economy ensuring social and territorial cohesion and poverty reduction.

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Chapter 8

European and American strategies towards green cities development

Zbigniew Grzymała

Introduction

European strategies towards green cities development are based on Europe 2020 Strategy for smart, sustainable and inclusive growth. The US approach to green cities is comparable to European perspective. One of the main differences is that in the US more emphasis is placed on costs.

The EU has introduced many initiatives and funding streams to promote one or more elements of creating smarter and more sustainable cities. These refer to a number of technical, administrative and social actions that have been affected by, and themselves seek to affect a variety of actors (private, public, community and academic) indispensable for researching, creating and carrying out the initiatives. There has been a notable focus on some networks that bring together, fund and activate different communities of interest in Smart and Sustainable City Agenda.[102]

American green cities strategies concern mainly separated states or cities. Macro strategies on the government level are very vague. On the other hand, various American organisations including nongovernment organisations serve as a specific link between different levels of government. For example, based on Energy tactics and strategies,[103] American cities and counties can use low-cost

[102] JESSICA for Smart and Sustainable Cities, HORIZONTAL STUDY – Final Report, JESSICA , Joint European Support for Sustainable Investment in City Areas, European Investment Bank, 11 December 2012, p. 24.

[103] Thomas Jensen, Viewpoint: Taking action toward sustainability – Energy tactics and strategies for tough times, Science Applications International Corporation (SAIC) http://americancityandcounty.com/commentary/sustainability-energy-efficiency-20110329, accessed on 26.02.2015.

tactics and strategies to build and maintain momentum in their energy efficiency programs. There are different organisations focused on green changes in US. One of them is EPA – United States Environmental Protection Agency. Its principal task is to enforce many of the environmental regulations and statutes in the United States. There are cases, however, where its authority needs to be refined or explained through developing policies and writing guidance.

8.1. Europe 2020 Strategy

The Europe 2020 Strategy is built on European priorities of Smart Growth, Sustainable Growth, Inclusive Growth and Economic Governance[104]. While each of these components aims to improve the overall economic, social and environmental wellbeing of the EU, in rural as well as urban areas, in agriculture as well as in the manufacturing, construction and service sectors, the smart cities agenda has the potential to provide a catalyst to all components of the Strategy. The main goals of Europe 2020 Strategy appear as a reminder in Table2.1. The first column refers to Europe 2020 targets, the second one describes Europe 2020 Flagship Initiatives, and the third one points out corresponding Smart and Sustainable Cities Contribution.

Table 8.1. List of key EU initiatives related to Europe 2020 targets

Europe 2020 Targets	Europe 2020 Flagship Initiatives	Smart and Sustainable Cities Contribution
R&D / innovation: 3% of the EU's GDP (public and private combined) to be invested in R&D/ innovation.	Digital Era for Europe has seven goals: • A new Single Market for online services to deliver the benefits of the digital era • Improve ICT standard-setting and interoperability • Enhance trust and security • Increase Europeans' access to fast and ultra-fast internet • Boost cutting-edge research and innovation in ICT • Empower all Europeans with digital skills and accessible online services. Unleash the potential of ICT to benefit society. Industrial policy for the globalisation era has ten key actions including: • European transport, energy and communication infrastructure and services will be upgraded to serve industry more efficiently, taking better account of today's changing competitive environment	The smart cities agenda can be used to focus businesses and public authorities on the opportunity to extract more value from their existing infrastructure and capital, via research and innovation. Creating new products and services will generate more efficient growth to address social and environmental challenges.

[104] http://ec.europa.eu/europe2020/index_en.htm, accessed on 26.02.2015.

	• Sector-specific innovation performance will be addressed through actions in sectors such as advanced manufacturing technologies, construction, bio-fuels and road and rail transport, particularly in view of improving resource efficiency • The challenges of energy-intensive industries will be addressed through actions to improve framework conditions and support innovation	
Climate change / energy Greenhouse gas emissions 20% (or even 30%, if the conditions **are** right) lower than 1990, 20% of energy from renewables, 20% increase in energy efficiency.	Resource Efficient Europe, has a number of key components: • Outline what the EU needs to do to create a low-carbon economy by 2050, cutting greenhouse gas emissions by 80-95% • Analyse how the EU can create an energy system by 2050 which is low-carbon, resource-efficient, secure and competitive • Present a vision for a low-carbon, resource-efficient, secure and competitive transport system by 2050 that removes all obstacles to the internal market for transport, promotes clean technologies and modernises transport networks • Define medium and long-term objectives and means for achieving them with the main aim to disengage economic growth from resource use and its environmental impact.	Creating smarter grids, powered by more renewable energy, with smart technologies supporting and rewarding people for energy saving behaviour, can do more to reduce energy use and tackle climate change than any one **of** these initiatives alone.
Employment: 75% of the 20-64 year olds to be employed.	A new agenda for jobs and skills, has four key components: • Making labour markets function better through further reform • Equipping people with the right skills for employment, including creating an 'EU skills panorama' to help people better see which skills are most needed now and in the future • Improving job quality and working conditions • Creating jobs.	Smart city developments will create a range of new jobs across all industries, due to the demand for new products and services (Siemens expects EUR 40 billion of green revenue by 2014 and IBM's smarter planet solutions revenues are growing faster than the rest of their business). Smart cities make the best use of scarce resources, making them more productive and competitive.
Education: Reducing school dropout rates below 10%, at least 40% of 30-34- year-olds completing third level education.	Youth on the Move is a comprehensive package of policy initiatives on education and employment for young people in Europe, which aims to improve young people's education and employability, to reduce high youth unemployment and to increase the youth-employment rate by: • Making education and training more relevant to young people's needs • Encouraging more of them to take advantage of EU grants to study or train in another country • Encouraging EU countries to take measures simplifying the transition from education to work.	New methods of teaching and training, at home, school and at the workplace, will make education a more compelling proposition and encourage people to learn, study and update their skills.

Poverty / social exclusion: Lifting over 20 million people out of poverty.	European Platform Against Poverty: • Better access to work, education, social security and essential services (healthcare, housing, etc.) • Better use of EU funds to overcome discrimination and support social inclusion • Smart solutions in post-crisis Europe with more efficient social support	Smart cities can use virtual networks to create and sustain social networks and inclusion. Providing people with better access to information aids in eliminating poverty and reveals opportunities for individual success. The energy efficient refurbishment of existing homes can reduce energy bills and diminish poverty.

Source: JESSICA for Smart and Sustainable Cities, pp. 22-23, accessed on 26.02.2015.

8.2. EU Initiatives

8.2.1. Smart Citizens and Smart Government

One of the platforms for the debate on Smart Citizens and Smart Government is the European Network of Living Labs (ENOLL)[105]. It combines a variety of vital projects across the European Union which aim to research and design innovative solutions to smart cities. Let us look at a few older examples of ENOLL projects:

- Smart Metropolitan Areas Realised Through Innovation & People (SMARTiP)[106] project that promotes transforming public services by empowering 'smart citizens' who are capable of using and co-producing innovative Internet-enabled services within emerging 'smart' cities. The project was created to supply the technical pilots to enhance people's engagement in creating content and applications for smart products and services, as well as being more involved users of the developing Internet-enabled services in 'smart' cities.
- European Platform for Intelligent Cities (EPIC)[107] was introduced to help increase the uptake of new citizen-generated services throughout Europe by integrating business expertise with the practical knowledge of the ENOLL in order to aid cities transition to web based service and cloud computing. The network effects achieved through cloud computing can stimulate synergetic interactions between technology, service providers, small and medium sized enterprises, city administrators and city dwellers.

[105] http://www.openlivinglabs.eu/news/enoll-strategic-project-involvement, accessed on 26.02.2015.

[106] http://www.smart-ip.eu/, accessed on 26.02.2015.

[107] http://ec.europa.eu/information_society/activities/livinglabs/docs/epic_v6_pub.pdf, accessed on 25.03.2015.

- Networked Smart Peripheral Cities for Sustainable Lifestyles (PERIPHÈRIA)[108] explored the application of the living labs knowledge on the local level such as street, square, lecture hall, park or museum. For example, a pilot project in Athens was created to develop the Smart Square Arena as the space for public debate in order to test various ways that Smart Citizens can contribute to the conception of eco-policies.

There is, of course, a number of other EU projects on this subject besides ENOLL. EXPGOV[109], for example, was introduced to understand the ICT-enabled governance models at the city level and to explore ways of producing changes in the governance processes of cities through ICT. The Interreg IVB North Sea Region Smart Cities[110] project, on the other hand, created a network of government and academic partners aiming to provide the innovative e-Government strategies for public service delivery and promote the best practice in the field of e-services. The other very similar project called IntelCities (Intelligent Cities) was established to combine advanced knowledge and experience of electronic government, planning systems and citizen participation from around Europe.[111]

8.2.2. Smart Cities

The European Smart Cities Project[112] ranks 70 selected medium-sized European cities under the categories of Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living and Smart Governance. The purpose of the ranking is to help cities identify their strengths and to explore the perspectives for their development. A similar project mentioned earlier is the Smart Cities Project[113] introduced in the North Sea Region, seeking to create an innovation network between governments and academic leaders. Another project called European Initiative on Smart Cities[114] outlines a roadmap for the cities and regions wishing to reduce their greenhouse gas emissions up to 40% by 2020, through increased take up of energy efficient and low carbon technologies.

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108 http://www.peripheria.eu/, accessed on 25.03.2015.

109 http://is.jrc.ec.europa.eu/pages/EAP/EXPGOV.html, accessed on 26.03.2015.

110 http://www.smartcities.info/aim, accessed on 27.03.2014.

111 JESSICA for Smart and Sustainable Cities, HORIZONTAL STUDY – Final Report, JESSICA , Joint European Support for Sustainable Investment in City Areas, European Investment Bank, 11 December 2012, pp. 24-25.

112 http://www.smart-cities.eu/index2.html, accessed on 27.03.2015.

113 http://www.smartcities.info/aim, accessed on 27.03.2015.

114 http://setis.ec.europa.eu/about-setis/technology-roadmap/european-initiative-on-smart-cities, accessed on 27.03.2015.

One of the most recent EU initiatives is Smart Cities and Communities[115] initiative that focuses on collaborative projects assembling academics, governments and industry around energy-focused themes. Some of those themes, including sustainable planning at the city level, large scale systems for urban area heating and cooling, and partnerships delivering near zero energy refurbishment of buildings.

Last but not the least is the Green and Connected Cities initiative set in motion by the Association of Information and Communication for Sustainable Development. It is a group of private and public bodies including cities, businesses, institutions, associations and researchers seeking to combine information technology and sustainable development to respond to the social and environmental challenges facing European cities.

The main objectives of the initiative are to:[116]

- Design and implement through the ICT new local innovative and carbon effective ecosystems;
- Create places for networking and connected innovative activities;
- Explore the subject of work to home transportation;
- Work on the free and sustainable mobility.

8.2.3. Smart Energy and Climate Change

The European Technology Platform for Electricity Networks of the Future[117] (Smart Grids ETP) began its work in 2005 and its goal is to formulate and promote a vision for the development of European electricity networks looking towards 2020 and beyond. Its broad objectives are to build and maintain a shared vision and maintain a high level overview of developments, opportunities and threats across the sector.

As such the Smart Grids ETP can be seen as the strategic coordinating forum, sitting above the Smart Energy Networks[118], an R&D programme that focuses on the two core components of a sustainable pan-European energy infrastructure, gas and electricity, with a focus on three main themes:

- Interactive distribution energy networks – researching the ways in which the grid can function while energy is often created at homes, streets and communities, and not only in power stations;

115 http://ec.europa.eu/energy/technology/initiatives/smart_cities_en.htm, accessed on 29.03.2015.

116 http://www.greenandconnectedcities.eu/en-1/the-cluster-green-connected-cities/what-do-we-do-exactly/, accessed on 29.03.2015.

117 http://www.smartgrids.eu/, accessed on 29.03.2015.

118 http://cordis.europa.eu/fp7/energy/about-smart_en.html, accessed on 29.03.2015.

- Pan-European energy networks – examining the possibility to create a single grid to support the proper functioning of electricity and gas market, increase security of supply and balance the loads between the EU countries.
- Cross cutting issues and technologies that will often require lateral technical and non-technical solutions.

The European Institute of Technology (EIT) created three Knowledge Innovation Communities (KIC's), including the KIC InnoEnergy[119] seeking to introduce innovative products and services within the framework of the future energy infrastructure (for example: clean coal or renewable energy). The Climate KIC[120], on the other hand, aims to attract and develop future climate entrepreneurs and create platforms connecting and supporting the climate entrepreneurs' community.

8.2.4. Smart Regions

The Smart Specialisation Platform was initiated by the European Commission through the Joint Research Centre[121]. Its mission is to help European regions use their full potential and become competitive on a world scene. Smart Specialisation promotes efficient use of public investments in countries and regions in order to focus deficient human and financial resources on a few globally competitive areas.[122] In addition, it provides guidance, technical support, analysis and training on smart specialisation.[123]

8.3. American strategies

The recent fiscal crisis and limited growth hinder US government investments in energy efficiency and sustainability programmes. Nevertheless many counties are implementing economic programmes to continue progress toward their environmental goals. Cities and rural areas are capable of using low-cost tactics and strategies to build and maintain momentum in their energy efficiency programmes. Those strategies, however, are not working

119 http://www.kic-innoenergy.com/, accessed on 28.03.2015.

120 http://www.climate-kic.org/about/, accessed on 28.03.2015.

121 The European Commission's in-house science service, accessed on 28.03.2015.

122 http://ipts.jrc.ec.europa.eu/activities/research-and-innovation/s3platform.cfm, accessed on 28.03.2015.

123 JESSICA for Smart and Sustainable Cities, HORIZONTAL STUDY – Final Report, JESSICA , Joint European Support for Sustainable Investment in City Areas, European Investment Bank, 11 December 2012, pp. 26-27.

very well, as Richard Register noted. His general guidance for those who want to change things include:

1. Starting with the land use foundations of the city and then building up the detailed eco-cities features.
2. Creating eco-city zoning map, the list of technologies, businesses, and jobs for building and maintaining the eco-city, and then gathering people to animate it.
3. Moving steadily toward the pedestrian compact city.
4. Taking small steps at first before moving on to bigger things.
5. Making commitments that one can keep and those only.
6. Being flexible about eco-city changes.[124]

8.3.1. Pass green building codes

Very important step toward improving the energy efficiency is to meet climate and energy goals. Passing new building codes which would exceed current state ones is one of undertakings which could help to set a new energy efficiency standards. But this step is rather expensive. Local governments should think over such a movement.

U.S. Environmental Protection Agency and the California Air Resources Board made a decision that the country's goal is to significantly reduce overall greenhouse gas consumption of 80 %. There are also suggestions that building energy use must radically drop to 2050 year up to 40% of 2005's level of consumption in order to achieve the above goal. There is around 200 communities which have actually passed such codes during last five years. Many kinds of procedures and actions may be used by cities and counties in order to successfully implement green building codes. All of them should be introduced at a minimal expense and should include a game of different permitting and enforcement actions. Energy efficiency requirements for builders and property owners are also desired but are more expensive and the assumption is that their additional costs will quickly recover in energy savings.[125]

[124] Compare: Richard Register, Ecocities. Rebuilding Cities In Balance with Nature, New Society Publisher, Printing In Canada, February 2012, pp. 311-313.

[125] Based on Thomas Jensen, Viewpoint: Taking action toward sustainability – Energy tactics and strategies for tough times, Science Applications International Corporation.(SAIC) http://americancityandcounty.com/commentary/sustainability-energy-efficiency-20110329.

8.3.2. Cost-effectively finance energy efficiency

When developing energy efficiency programmes all local governments face financing problems. Currently there are many possibilities to overcome these financial issues but difficulties still exist. It become a real challenge to afford all costs of implementing efficient energy. Among new ideas of how to afford financing we local governments experiment with eg. self-financing, including revolving funds, third-party financing or even so called performance contracts offered by energy service companies. Local governments are forced to look for new sources of financing due to limits on credit and the potential negative effect on credit ratings. That's why local governments tap utility programs that allow them to borrow funds at very low or zero interest. In California, for example, local government does it through ratepayer-funded or through on-bill financing programs.[126]

Quite popular become revolving funds used to establish financially self-sustaining energy offices and to finance many energy projects. Results are in many cases amazing. In 2007 San Jose set up a revolving fund of $200,000 and gained a utility rebate funds by installing a traffic signal LED. Thois solutions allowed the city's energy office to retain money. Energy bill savings brought to the city in the first two years great savings and allowed to collect this way a capital for future energy efficiency projects. Up to now that solution has generated close to $200,000 and the forecasts suggest that the sum will double soon. This movement and solutions are supported and caused by the city's American Recovery and Reinvestment Act (ARRA) Energy Efficiency as well as by Conservation Block Grant Funds for additional retrofit projects.[127]

Sometimes some local banks are also interested in supplementing cities' own funds. Departments accept loans at 5 percent interest provided by energy offices. But there is a condition – the loan must be paid back within five years. This way, the departments retain, after the payback period, all of the savings over the life of the equipment.Tax-based financing of energy efficiency or solar projects of small businesses and residences still face the reluctance of the federal home mortgage agencies. Property Assessed Clean Energy (PACE) loans puts a crimp on such solutions and ideas. Despite that local governments seem to be strong and consequent in implementing pilot innovative financing approaches to support and facilitate an introduction of new solutions in

[126] Based on: Thomas Jensen, Viewpoint: Taking action toward sustainability – Energy tactics and strategies for tough times, Science Applications International Corporation. (SAIC) http://americancityandcounty.com/commentary/sustainability-energy-efficiency-20110329

[127] Ibidem

financing energy consumption's savings and in supporting retrofits. Counties and cities have already developed a model programme presenting and giving a good example of how to finance retrofits. This model programme is being used currently in Seattle, USA. This programme is named "Clean Energy Works". This programme shows new options in looking at ways and sources of payments for energy efficiency improvements. According to the rules used in this method homeowners repay the investments through 20-year loans through their utility bills. That approach has its backgrounds in banks settlements. That solution gives another option for local governments or homeowners to deal with the problem of how to finance energy efficiency investments. The proposed type of on-bill financing approach seems to be a good model and may appear helpful in fulfilling the task of efficient decrease of energy consumption and implementation of new energy efficiency standards.[128]

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[128] Based on: Thomas Jensen, Viewpoint: Taking action toward sustainability – Energy tactics and strategies for tough times, Science Applications International Corporation.(SAIC) http://americancityandcounty.com/commentary/sustainability-energy-efficiency-20110329, accessed on 27.03.2015.

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