POCACITO

european post-carbon cities of tomorrow

INTEGRATED CASE STUDIES ASSESSMENT REPORT

INTELI – INTELIGÊNCIA EM INOVAÇÃO, CENTRO DE INOVAÇÃO

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LIST OF ABBREVIATIONS

GDP	Gross domestic product
GVA	Gross value added
KPI	Key performance indicator
Toe	Tonne of oil equivalent

I INTRODUCTION

In the context of the POCACITO – "Post-carbon Cities of Tomorrow – Foresight for Sustainable Pathways towards liveable, affordable and prospering cities in a world context" project, this document intends to present an Integrated Case Studies Assessment Report, integrated in Task 3.3. – Case Studies Integrated Assessment and Benchmarking of WP3 – Initial Assessment.

In fact, the POCACITO project aims to develop a 2050 roadmap to support the transition of cities to a more sustainable or post-carbon future, through a collaborative research and participatory scenario building.

In order to use an evidence-based approach, 10 European case studies were selected: Barcelona, Copenhagen, Malmö, Istanbul, Lisbon, Litoměřice, Milan-Turin, Rostock and Zagreb. An important step to achieve the project's goal is to produce an integrated assessment of case study cities in order to evaluate and make a comparison of the current situation of these cities as an input into the scenario development.

The data presented in this report was collected by the case study lead partners during the production of their individual assessment reports. Copenhagen was not included in the analysis due to late delivery of the report.

The document is divided in the following parts: approach and methodology; overview of the case study cities; key strategies and projects; integrated case study cities assessment; findings and key challenges; and conclusions.

II APPROACH AND METHODOLOGY

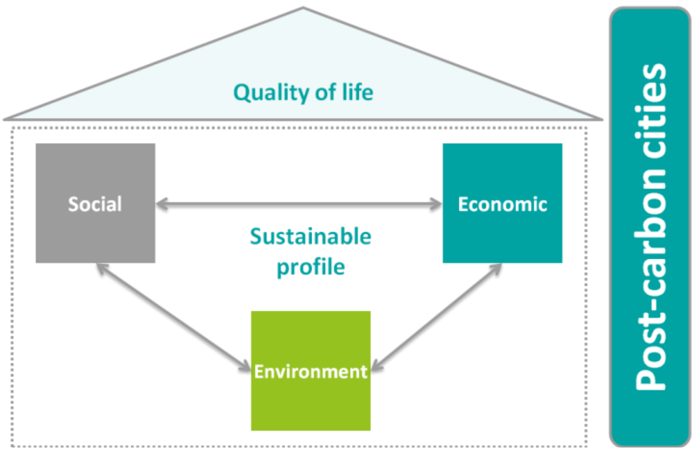
The development of the integrated assessment of the case study cities is based on the Initial Assessment Reports produced by the Case Study Leaders. A set of pre-defined KPI – Key Performance Indicators was used to make possible the comparison among cities.

II.I MODEL AND CONCEPT

'Post-carbon cities' were defined by the POCACITO team as a rupture in the carbon-dependent urban system, which has led to high levels of anthropogenic greenhouse gases, and the establishment of new types of cities that are low-carbon as well as environmentally, socially and economically sustainable. The term 'post-carbon' emphasises the process of transformation, a shift in paradigm, which is necessary to respond to the multiple challenges of climate change, ecosystem degradation, social equity and economic pressures.

Thus, it is assumed that the core components of post-carbon cities are in line with the three pillars of sustainability, comprising environmental, social and economic dimensions. However, cities are complex, adaptive, social-ecological systems (Ecologic Institute, 2014) and cannot be fully understood by examining individual components. For this reason, POCACITO moves away from analysing the three dimensions of sustainability as silos towards a more comprehensive and holistic approach.

Figure 1: Conceptual model

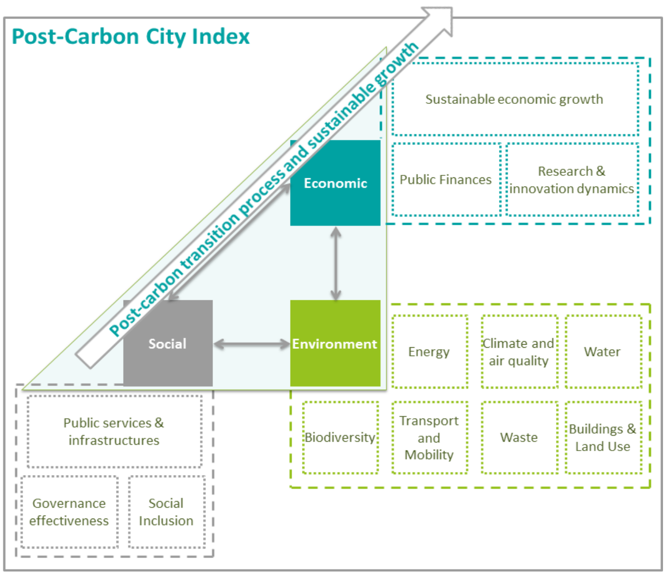


The **social dimension** is concerned about equity both in the current generation and between generations during the transition process to post-carbon cities, which is expected to be smooth for all citizens. The benefits for inhabitants that come out of living in a reduced carbon city are highlighted, showing that these cities are places where it is pleasant to live in and the values of equity and social inclusion are present. Special attention has been given to standards of living related to essential aspects such as education and health (for example, life expectancy and wellbeing). Unemployment rates and poverty are also issues to be addressed on the context of post-carbon cities. Public services and infrastructures that are available for citizens are analysed, as well as aspects of governance and civic society, promoting the positive sense of culture and community.

The **environment dimension** investigates the sustainable profile of the cities and assesses not only the current impacts on the environment, but also during the transition processes, evaluating the environmental resilience of the cities. It is important to continuously adapt the strategies to follow in order to mitigate the negative impacts on the environment during the transition process. The environmental dimension covers the energy sector in general in order to promote not only the final energy efficiency but also the resources depletion associated with energy consumption. Post-carbon cities pay special attention to GHG emission and its contribution to climate change. Some energy intensive sectors are empathised, such as transportation/mobility and the buildings stock. Biodiversity and air quality are critical themes that also belong to this dimension. The concerns regarding waste and water are also evaluated.

The **economic dimension** emphasises the sustainable economic growth based on the wealth of the cities and their inhabitants. It recognises that investments are crucial to promoting post-carbon cities, in particular the ones related to sustainable facilities. The labour market and the life of the companies are taken into account to demonstrate the dynamics of a post-carbon economy in a green economy paradigm. Public finances are also analysed because the cities with a lower level of indebtedness are more prepared to face the challenges during the transition process towards a post-carbon city. This dimension also includes the R&D expenditure because no city can become a post-carbon city without innovation.

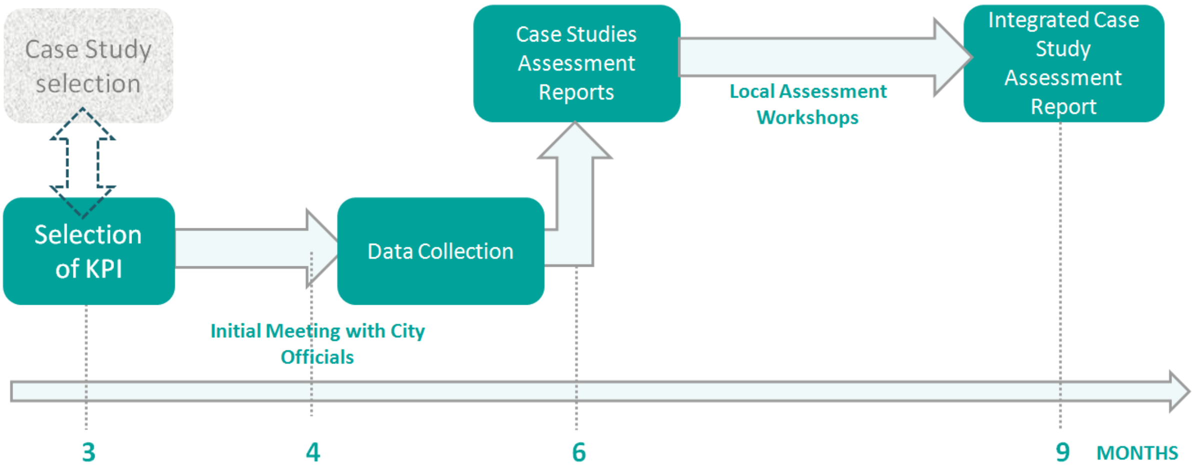
Figure 2: Dimensions and sub-dimensions of the Post-Carbon City Index



For each sub-dimension, a set of indicators has been selected which allows a uniform collection of data, improves the comparison and supports the identification of best practices in each case study city, covering environmental, social and economic aspects (ANNEX I).

The operational model for the production of the integrated case studies assessment report is illustrated in Figure 3.

Figure 3: Methodological approach of the integrated assessment



II.II DATA LIMITATIONS

The integrated assessment report was produced based on the data collected by case study leaders in the initial assessment reports development process.

Data collection rules – Initial assessment reports

The selected methods for data gathering and collection comprise the following two approaches:

- Top-down approach – completion of the indicators list according to a review of main statistical findings, existing relevant strategic and planning documents, and legislation to assure an accurate quantitative data collection;
- Bottom-up approach – discussions with local authorities and other selected stakeholders should be used to complement the collection of quantitative data and enrich the contents of the case study assessment reports.

In general, most of the required data can be retrieved by national/regional statistical offices, government departments, environment and energy agencies, research institutes and non-governmental organisations. The data collection process depends on the availability of high quality and relevant data.

Moreover, all the indicators should be collected for both years 2003 and 2012 in order to compare their evolution throughout this period (sometimes, mainly for some economic and social indicators, time series were required). Whenever data is not available for those years, one should collect the earliest and the most recent years between 2003 and 2012.

The geographical boundaries of the initial assessment of each case study city should be defined by each case study leader, according to the objectives of the work and the limitations of data availability. All indicators should be collected for this geographical level, being privileged the municipality level. If an indicator is not available at this geographical level, then it could be collected for NUT III or NUT II. If the data is only available at the national level, it is considered that it is not representative of the city, so it should be discarded.

The geographical levels selected by case study leaders and data collection limitations are identified in the following tables:

Table 1: Case studies geographical level

CASE STUDY CITY	GEOGRAPHICAL LEVEL
Barcelona	Metropolitan Area and NUT III
Istanbul	Municipality
Lisbon	Municipality
Litoměřice	City
Malmö	Municipality
Milan*	Municipality
Turin*	Municipality
Rostock	City
Zagreb	Municipality

* Milan and Turin were included in the same report.

Table 2: Data collection limitations

CASE STUDY CITY	DATA COLLECTION LIMITATIONS
Barcelona	- Several geographical levels; municipality scale is not representative, only Metropolitan Area and NUT III - Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data) - No data for the following indicators: urban building density; GDP per sectors

CASE STUDY CITY	DATA COLLECTION LIMITATIONS
Istanbul	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data) - Different data sources were used for different years, which can cause comparison problems - No data for the following indicators: budget deficit
Lisbon	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data) - GDP is not calculated at municipality level, which has a negative impact in the calculation of other indicators - No data for the following indicators: carbon emissions by sector; budget deficit
Litoměřice	- Some data was collected for different time periods (unavailability of data) - The city level is not captured in most of the statistical databases - Some data was collected for different geographical scales (unavailability of data) - No data for the following indicators: urban building density; indebtedness level
Malmö	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data) - No data for the following indicators: urban waste recovery; water losses; energy- efficient buildings
Milan	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data)
Turin	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data)

CASE STUDY CITY	DATA COLLECTION LIMITATIONS
Rostock	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data) - No data for the following indicators: energy- efficient buildings
Zagreb	- Some data was collected for different time periods (unavailability of data) - Some data was collected for different geographical scales (unavailability of data)

Because of the referred limitations, the integration of data was difficult. The data was collected for different geographical scales and time periods. Moreover, some data wasn't available. Countries present also different territorial structures. However, all the methodological problems are indicated in the analysis.

III OVERVIEW OF THE CASE STUDY CITIES

III.I TERRITORY

The ten case study cities – Barcelona, Istanbul, Lisbon, Litoměřice, Malmö, Milan, Turin, Copenhagen, Rostock and Zagreb are located in nine different countries: Spain, Turkey, Portugal, Check Republic, Denmark, Sweden, Italy, Germany and Croatia.

Figure 4: Case study cities

The cities present different size and characteristics, which makes the analysis and comparison more interesting.

Figure 5: Geopolitical elements

CASE STUDY CITIES	GEOPOLITICAL ELEMENTS
Barcelona	2nd largest city in Spain, capital of Catalonia 2nd economic centre of Spain, after Madrid Relevant port city Important cultural centre in Europe Touristic destination

CASE STUDY CITIES	GEOPOLITICAL ELEMENTS
Istanbul	Capital city (Turkey), mega city Strategic location: Istanbul extends over 2 continents – Asia and Europe; 4th Pan European Corridor ends in Istanbul Two important ports Cultural, economic and demographic dynamics
Lisbon	Capital city and the largest city in Portugal Westernmost city in Europe, along the Atlantic coast Coastal city and touristic destination Strategic location: relation with Latin America, Africa and Asia, allowing access to 750 million consumers from Europe and Portuguese-speaking countries
Litoměřice	Small city Northern part of Czech Republic 60 km North of the capital Prague
Malmö	3rd largest city in Sweden Southwest coast of Sweden Direct connection to Denmark via the Öresund bridge
Milan	2nd largest city in Italy, after Rome Administrative centre of the Lombardy region Northern part of Italy, midway between Po river and the foothills of the Alps Main industrial and commercial city in Italy Artistic and cultural centre
Turin	4th largest city in Italy Administrative centre of the Piedmont region Western part of the Po river, at the foothills of the Alps 3rd area in Italy in terms of GDP
Rostock	Medium-sized city North-east of Germany by the Baltic sea Geographical region Northern Lowland Can be accessed by highway from Hamburg and Berlin in around 2 hours
Zagreb	Capital city and the largest city in Croatia Northwest of the country, along the Sava river Excellent traffic connection between Central Europe and Adriatic Sea

Istanbul has the biggest territorial area, followed by Zagreb and Malmö. The smallest municipalities are Lisbon and Litoměřice. However, Barcelona is the municipality with higher urban density, followed by Milan and Turin. Less dense municipalities are Rostock and Malmö.

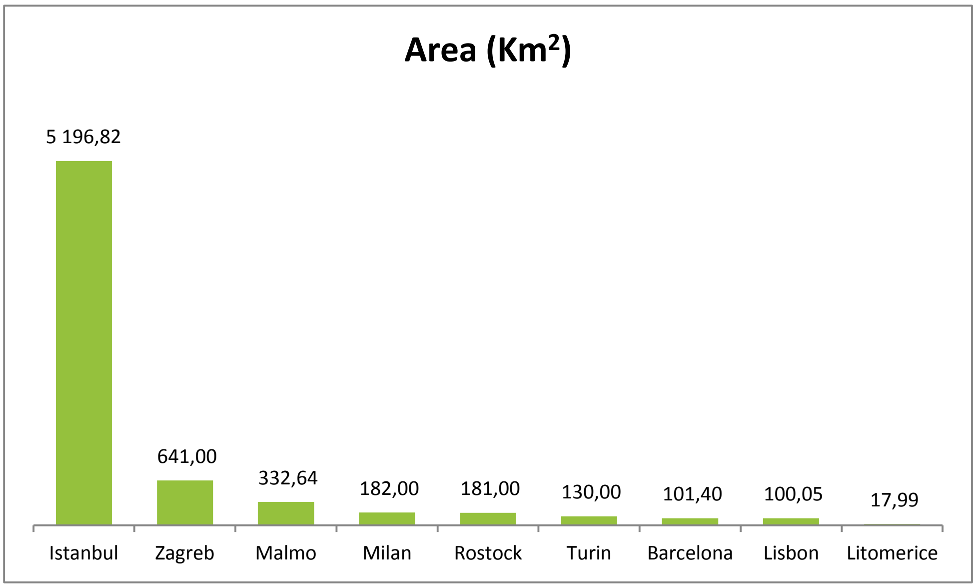


Figure 6: Area (km²), Municipality, 2013

Note: Zagreb and Lisbon: 2011; Istanbul: 2012.

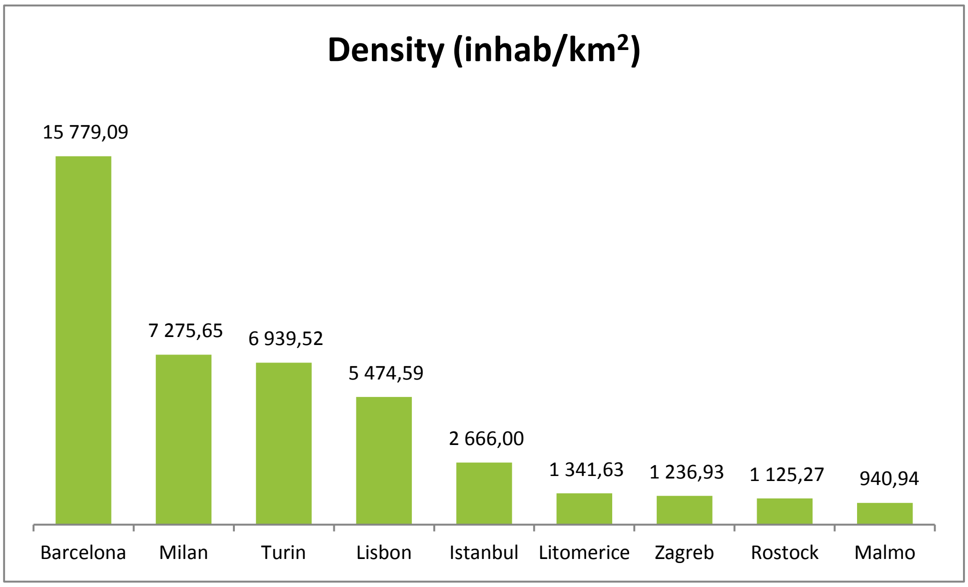


Figure 7: Density (inhab./km²), Municipality, 2013

Note: Zagreb and Lisbon: 2011; Istanbul: 2012.

III.II POPULATION

The number of inhabitants of the case study cities is very diverse: from around 14 million inhabitants of Istanbul to 24,000 of Litoměřice. It is worth of notice that Istanbul is a mega city, ranking 8 out of 78 OECD metropolitan regions in terms of population size and first for population growth since the mid-1990.

Foreign population is increasing in all cities, being Malmö, Barcelona, Milan and Turin the most cosmopolitan and diverse urban areas. Rostock and Litoměřice have only 4% of foreigners in their total population.

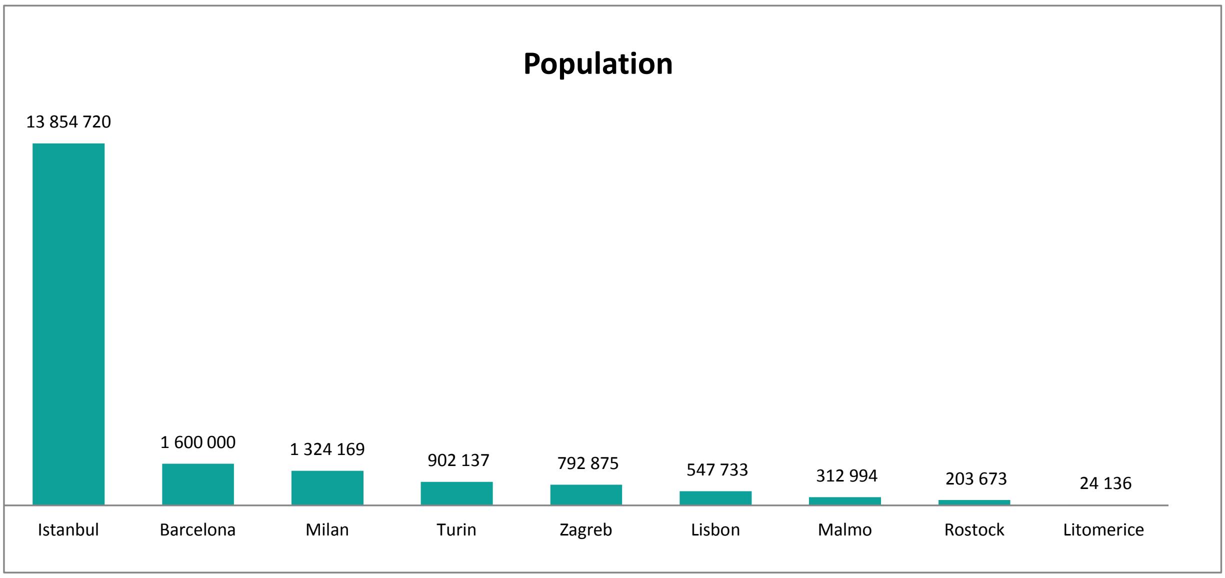


Figure 8: Population, Municipality, 2013

Note: Zagreb and Lisbon: 2011; Istanbul: 2012.

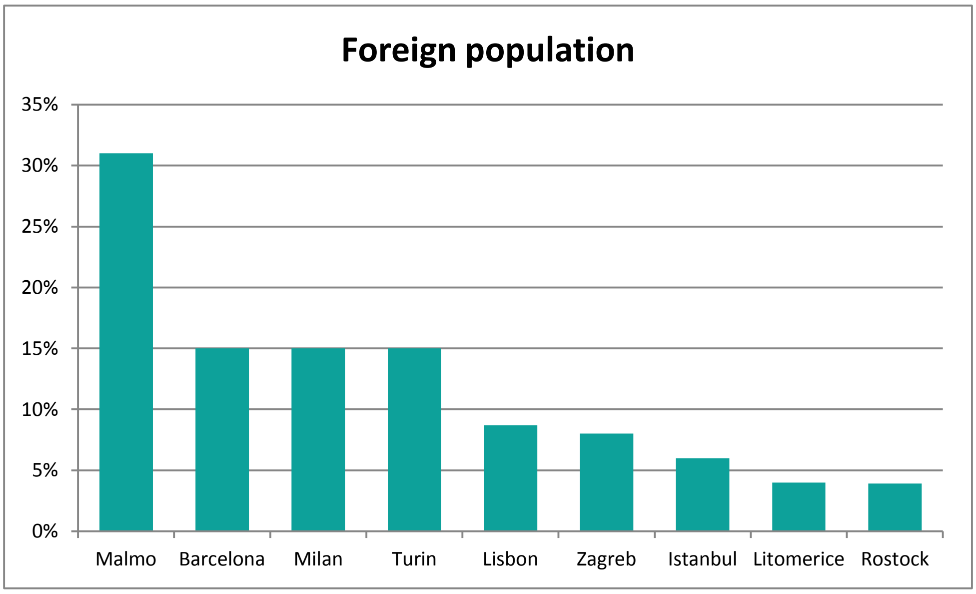


Figure 9: Foreign Population, Municipality, 2013

Note: Zagreb and Lisbon: 2011; Istanbul: 2012.

The age structure of the population of the case study cities is similar, being recognised a trend towards ageing population. This trend is not so visible in Istanbul, with the following distribution of the population: 23% (0-14), 71% (15-64) and 6% (over 65). Malmö is an exception: almost half of the population is under 35 (49%) and 71% of the households consist of single parent or single person households (2013).

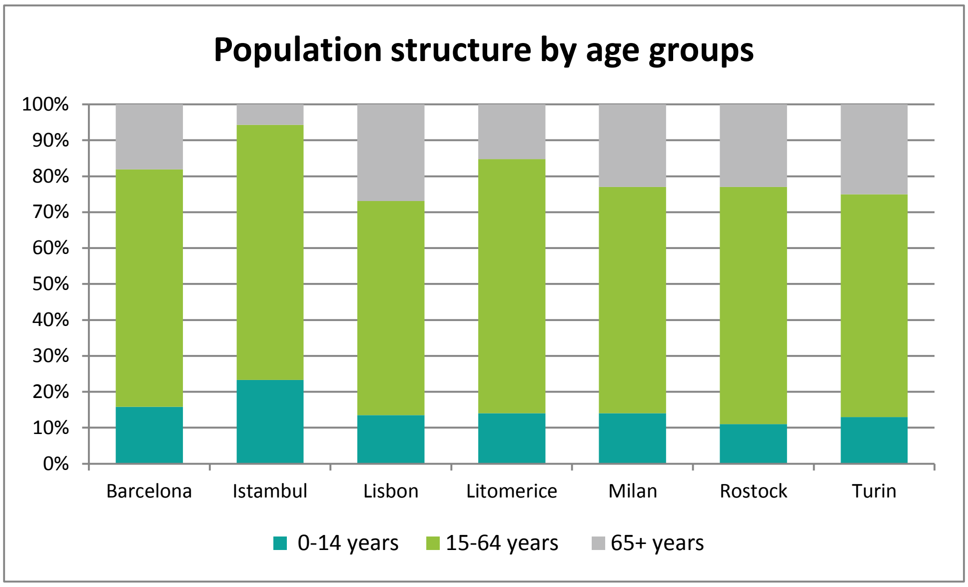


Figure 10: Population structure by age group, Municipality, 2013

Note: Barcelona – Barcelona Metropolitan Area; Lisbon: 2011; Istanbul: 2012; Non comparable data available for Zagreb and Malmö.

IV STRATEGIES AND KEY PROJECTS

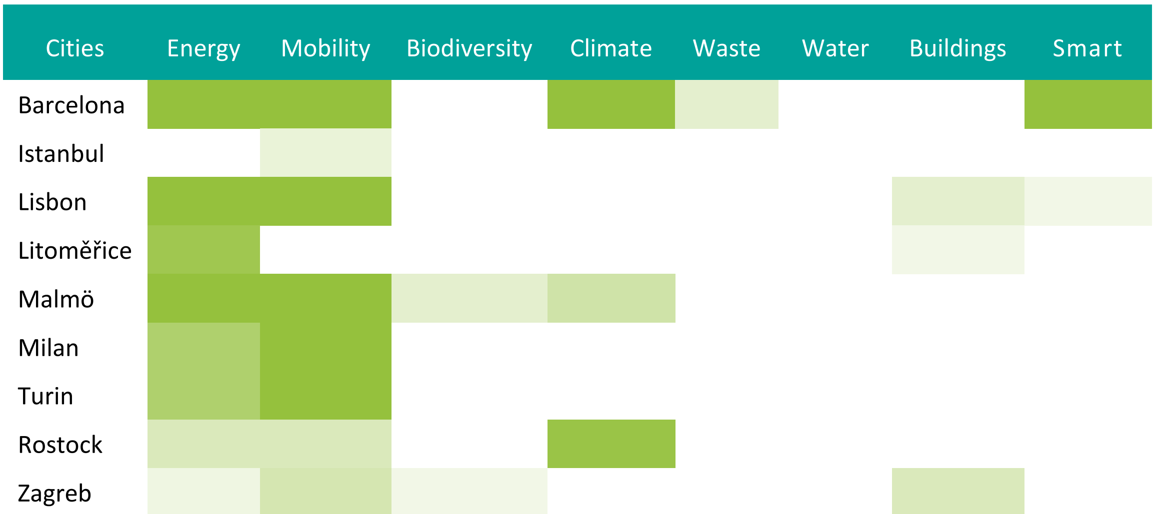
The majority of case study cities have defined some strategies and projects linked to sustainability, with a specific focus on energy and mobility.

Figure 11: Key strategic elements

CASE STUDY CITIES	KEY STRATEGIC ELEMENTS
Barcelona	To become at the forefront of the smart cities movement worldwide Award "European Capital of Innovation" (2014) Energy Improvement Plan of Barcelona (2002) - Strong strategy to reduce CO_2 emissions (energy efficiency and renewable energies) Energy, Climate Change and Environmental Quality Plan; adhesion to the Covenant of Mayors – 20% CO_2 emissions reduction till 2020 Energy Observatory to monitor CO_2 emissions Adaptation Plan to protect city from climate change Majority of strategies defined for Barcelona Metropolitan Area
Istanbul	Improvement in Public Transport and Popularisation of Usage Plan: new metro lines and railways; alternative transport modes; integrated mobility Reduction of carbon emissions in airports
Lisbon	To become a smart city, integrating three strategic areas: sustainability, citizen participation and entrepreneurship; pole for creativity and innovation Atlantic business hub Award "European City of the Year" (2012) and "Entrepreneurship Region of the Year" (2015) Energy-Environmental Strategy; Sustainable Energy Action Plan (Covenant of Mayors) and signature of Mayors Adapt initiative (2013) Integrated Urban Renewal Strategy 2011-2024, with specific focus on energy efficiency Biodiversity strategy 2020
Litoměřice	Strategic development plan for the city 2030 Member of national network of healthy tows and energy cities Energy plan: heating, public lighting, buildings, renewable energy; etc. Plan to build a new geothermal power plant (20 MWh)
Malmö	Comprehensive Plan for Malmö, comprising economic, social and environmental issues Green plan: green areas, parks and recreational areas, biodiversity City Environmental Program Storm Water Strategy Traffic program (2012-2017): sustainable traffic system with focus on soft modes (pedestrian, biking, etc.) Biking plan (2012-2019) and Pedestrian plan (2012-2018) Energy strategy: focus on renewable energy

CASE STUDY CITIES	KEY STRATEGIC ELEMENTS
Milan	Action Plan for Sustainable Energy and Climate (2009-2020) Sustainable Urban Mobility Plan (2012-…)
Turin	Turin Action Plan for Energy (2010-…) Sustainable Urban Mobility Plan (2010-2020)
Rostock	Climate protection concept Communal master plan (2012-2016): reduction of energy demand by 50% by 2050, and CO_2 emissions reduction by 95% compared to 1990 levels
Zagreb	City development strategy 2014-2020 City Spatial Plan Sustainable Energy Action Plan (Covenant of Mayors) - reduction of CO_2 emissions by at least 20% until 2020 Urban regeneration, namely of old industrial areas

Figure 12: Sustainability key projects



Some anchor projects are presented below as good practices that can be adapted and replicated in other cities.

Electric Mobility - Barcelona

The project intends to turn electric vehicles into Barcelona's standard mode of public and private transport for individuals and groups. It integrates the following components:

Electric Taxis: Barcelona will become the leader in the implementation of this type of vehicle in the realm of public transport.

Electric buses: Barcelona is a benchmark for this type of service. The city has the cleanest fleet of buses in Europe. All thanks to the introduction of and support for hybrid and compressed natural-gas-powered vehicles, as well as the installation of anti-pollution filters in diesel vehicles. TMB is also collaborating with the company Siemens on hybridisation designs for buses and minibuses, to cover 100% of the bus routes.

Car sharing using electric vehicles: Barcelona is establishing a new rental model for such vehicles, which will also improve the current system, as users will be able to pick up and drop off the vehicles wherever they wish.

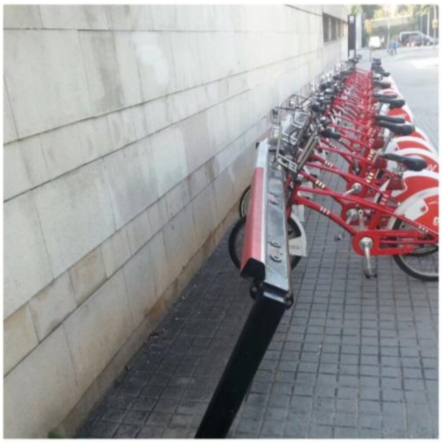
Electric motorbikes: Barcelona already provides 150 recharge points for these vehicles as well as a newly installed electric motorbike station at the IESE Business School, which is currently functioning at full use.

Bicing - Barcelona

The project aims to achieve a safe and efficient means of transport with less impact on the environment.

Bicing was launched in 2007 as a complementary urban transport based on shared bicycle use. It has 420 stations spread round the city and 6,000 bikes.

Bicing is complemented by the BicingApp. This is a simple app that gives access to real-time user information such as bicycle availability and stations. Thanks to Barcelona Contactless technology, users can download the app by merely scanning the QR code or drawing their mobile close to the NFC chips placed in every station.



Sensors for Urban Services - Barcelona

The project brings order to the many municipal information systems and aims to integrate other information systems from the private sector.

Barcelona has been working for the last years in several pilot projects to install sensors in the city and to create platforms that allow the share of information and give it the proper use to citizens, city managers, businesses and professionals. Furthermore, there are different formats of sensors, databases, new applications and designs generated both by public administration and private firms. Barcelona is creating an efficient and smart service delivery platform for citizens and municipal workers. This platform has a common data warehouse where the different sensors systems store their information. This system has been built through a public-private partnership model, developing a normalised model based on well-known standards.

Different pilot projects cover many applications to improve management of urban services. Some examples are sensors in solid waste containers (to report loading data to adjust schedules or routes), street sensors (occupancy of parking spaces and loading areas) for environmental control (air and noise pollution), humidity (for irrigation in public parks) and urban metering (of gas, water or power).

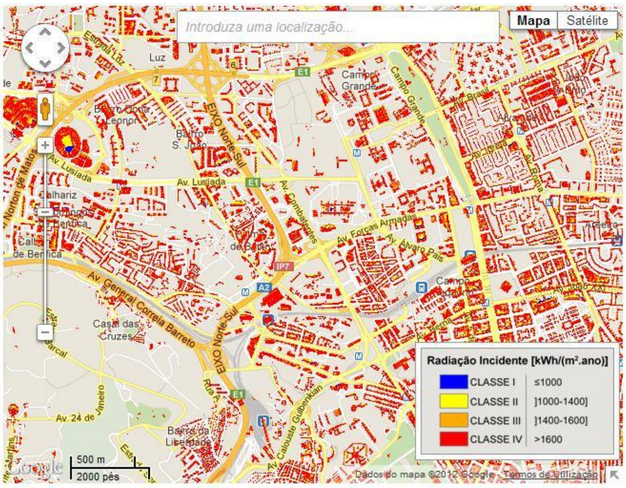
SIIUR - Integral Solution for Urban Infrastructures - Barcelona

The goal of the project is to better satisfy the needs of citizens and institutions, improve energy efficiency and reduce pollution and energy consumption.

SIIUR project is an innovative integration of urban infrastructure and services to manage cities in a more efficient, friendly and intelligent way. The high cost of operation and maintenance of street lighting is not only an economic problem but also an environmental concern. The application of measures such as control of lighting zones, regulation of the hours of lighting, improvements in facilities and an electrical analysis of the position of lamps results in costs savings of up to 40%.

Street lamps in the SIIUR project are equipped with LED technology to reduce cost and pollution. Lamps include sensors that process environmental information and detect presence, temperature, humidity, noise and pollution. These lights are connected to a Street Lighting Cabinet that centralises all communications and services (such as Fibre-optic cabling to the Home, Wi-Fi or Electrical Vehicle recharging stations), and sends the information to a central control centre. This new lighting system is located in Passatge Mas de Roda, with two main objectives: to test new more efficient lighting systems and to integrate technological features to develop a real smart city environment.

Solar Potential Map - Lisbon



The Lisbon Solar Potential Map was promoted by Lisboa E-Nova under the European Project POLIS – “Identification and Mobilisation of Solar Potentials via Local Strategies” (with the following city partners: Paris, Lyon, Munich, Malmö and Victoria). The project aimed at the evaluation of the potential solar installation of solar systems in the built heritage of Lisbon.

Lisbon Solar Potential Map, available online via Google Maps application, covers all the buildings in Lisbon. It allows the identification of the preferable areas to invest in solar technologies and represents an efficient awareness tool, both for local authorities, investors and companies and citizens.

As a result of the project and cooperation between the various European partners, it was possible to identify measures that contribute to the definition of public policy at the level of development of municipal urban planning regulations, as well as new legal and financial mechanisms to encourage the adoption of solar technologies in the urban environment.

Eco-neighbourhood Boavista Ambiente + - Lisbon

The project aims at the reconversion and qualification of public space, implementation of measures to improve the energy performance of buildings and remodelling of some equipment in the social neighbourhood Boavista, including the municipal swimming pool.

Dissemination and awareness actions to the residents of the neighbourhood were also promoted, such as the launching of a challenge posed to 100 families to cooperate in order to enhance domestic savings of electricity, natural gas and water.

Within the Eco-neighbourhoods program supported by regional funds, an additional project is being funded in a neighbourhood in Vila Franca de Xira.

V INTEGRATED CASE STUDIES ASSESSMENT

V.I SOCIAL PERFORMANCE

UNEMPLOYMENT LEVEL BY GENDER

In general, from 2006 to 2012 unemployment rate has increased mostly because of the adverse effects of the economic and financial crisis. In this period, in Barcelona the variation of male's unemployment rate was +239% and the variation of women unemployment rate was +158%. Exceptions are Istanbul, Rostock and Zagreb.

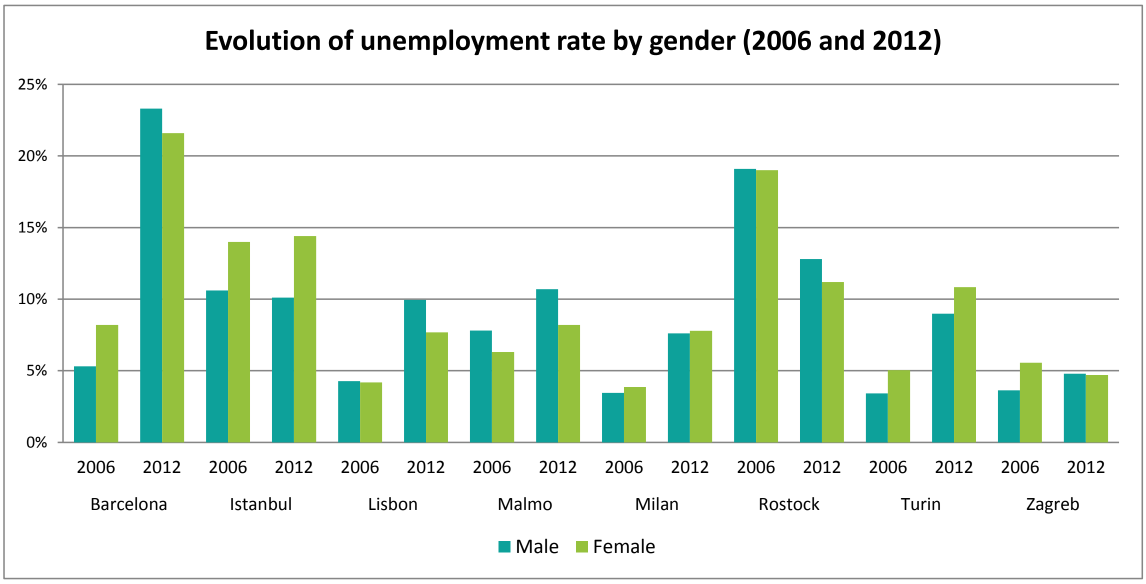


Figure 13: Evolution of unemployment rate by gender, 2006 and 2012

Note: Barcelona, Milan, Turin: NUT III; Istanbul, Lisbon, Rostock: NUT II; Malmö, Zagreb: Municipality; Information for Litoměřice not available.

TERCIARY EDUCATION LEVEL BY GENDER

Tertiary education rate is higher in Zagreb, followed by Malmö, Lisbon and Barcelona. Istanbul reports the lowest tertiary education level.

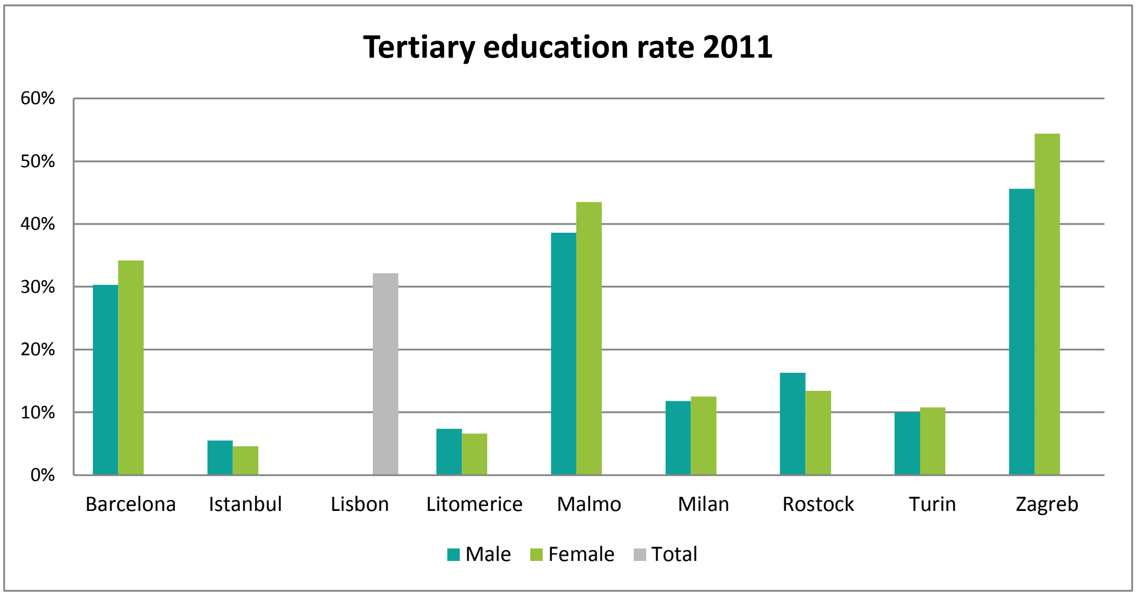


Figure 14: Tertiary education rate by gender, NUT II, 2011

Note: Malmö – Municipality.

POVERTY LEVEL

In 2009, Litoměřice and Zagreb (Croatia) presented the highest poverty rates, followed by Rostock and Barcelona. Istanbul reported a poverty rate of 14.9%.

A sharp increase in the poverty rate happened between 2008 and 2011 while a reversion of this trend can be appreciated from 2011 onwards, being Milan the exception.

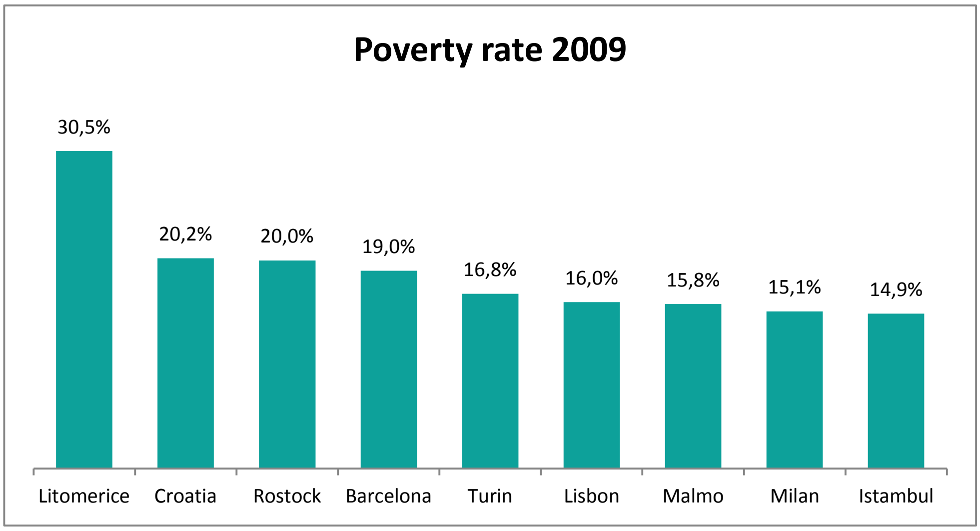


Figure 15: Poverty rate, NUT II, 2009

Note: Litoměřice: 2010; Zagreb – Croatia – NUT I.

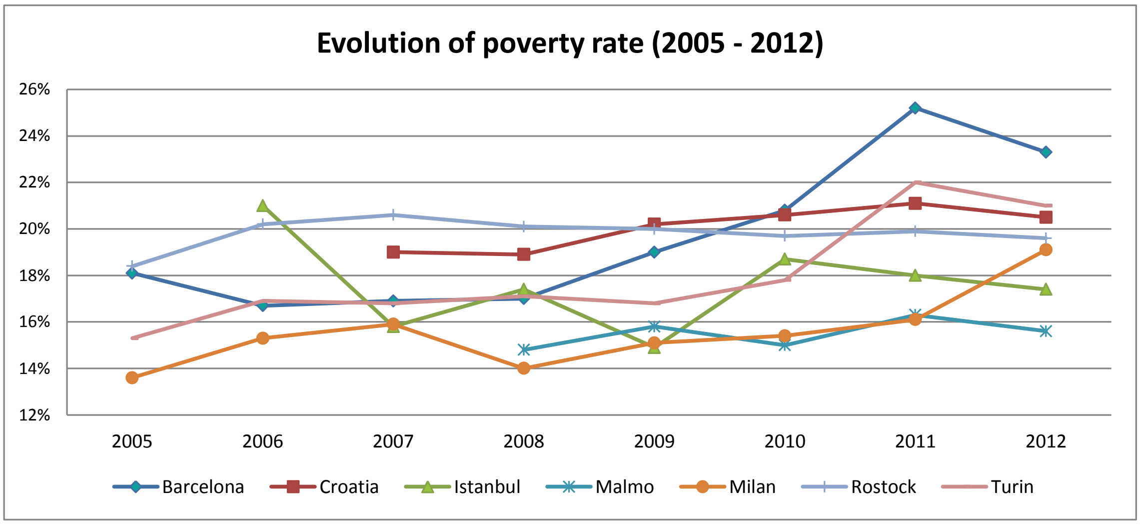


Figure 16: Evolution of poverty rate, NUT II, 2005-2012

Note: Litoměřice: 2010; Zagreb – Croatia: NUT I; Non comparable data for Lisbon and Zagreb.

AVERAGE LIFE EXPECTANCY

In 2011, average life expectancy was higher in Milan, Barcelona and Turin (83 years old), followed by Malmö (81.7). Litoměřice (76), Istanbul (77.8) and Zagreb (78.1) reported lower average life expectancy. The difference between the best and the worst performer is expressive (7 years). However, between 2004 and 2011 average life expectancy has grown in all case study cities.

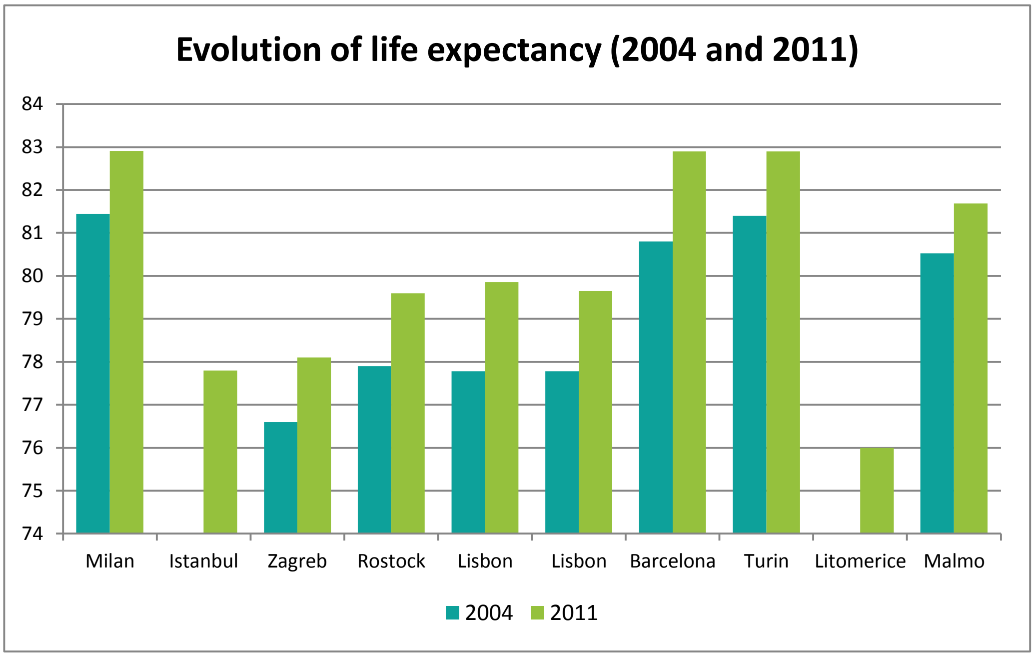


Figure 17: Evolution of average life expectancy, 2004 and 2011

GREEN SPACE AVAILABILITY

Malmö and Rostock present a high percentage of green space over total urban area, compared with the other case study cities.

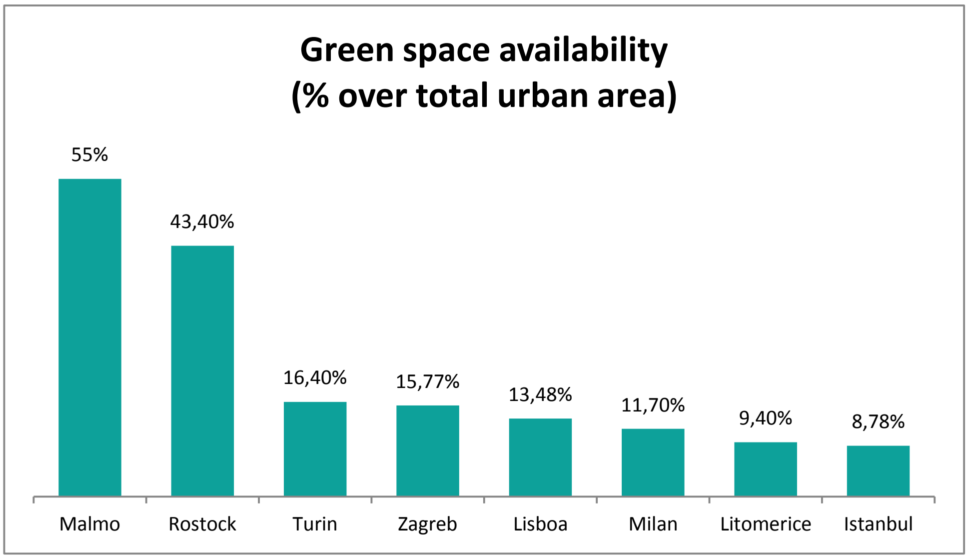


Figure 18: Percentage of green space over total urban area, Municipality, 2009

Note: Rostock – 2012; Litoměřice – 2013; Lisbon – 2014; Non comparable data for Barcelona.

MONITORING SYSTEM FOR EMISSIONS REDUCTIONS

Barcelona, Malmö, Milan, Rostock, Turin and Zagreb have a monitoring system for emissions reduction.

Every municipality in the district of Barcelona calculates the emissions based on a common methodology, grounded on data from energy consumption in housing, transport and industry. The district of Barcelona has also introduced a further level of emissions monitoring by including emissions dependent on the water cycle and waste management, areas in which municipalities have direct influence. The monitoring system for emissions reduction in Turin has been implemented by the Province since 2000, and it has been enhanced since the adoption of SEAP in 2010. Malmö municipality has a target of 40% emissions reduction until 2030 compared to 1990. This is monitored and reported on a yearly basis in order to indicate whether the target will be fulfilled by 2030.

Rostock has developed and concluded a carbon neutrality plan “Masterplan 100% Climate Protection” at city level, with the goals to reduce CO_2 emissions by 95% and energy consumption by 50% by 2050. Based on this plan, the climate department of the city is responsible for monitoring and providing the indicators and data structure for data collection of CO_2 and energy consumption in the future. In Zagreb, there are currently six monitoring systems in the city territory for tracking emissions and air quality.

V.II ECONOMIC PERFORMANCE

LEVEL OF WEALTH

Milan and Malmö have the highest level of GDP per capita among the case study cities. This position is followed by Rostock, Turin and Barcelona. Lisbon presents an expressive decrease in the level of wealth between 2007 and 2010.

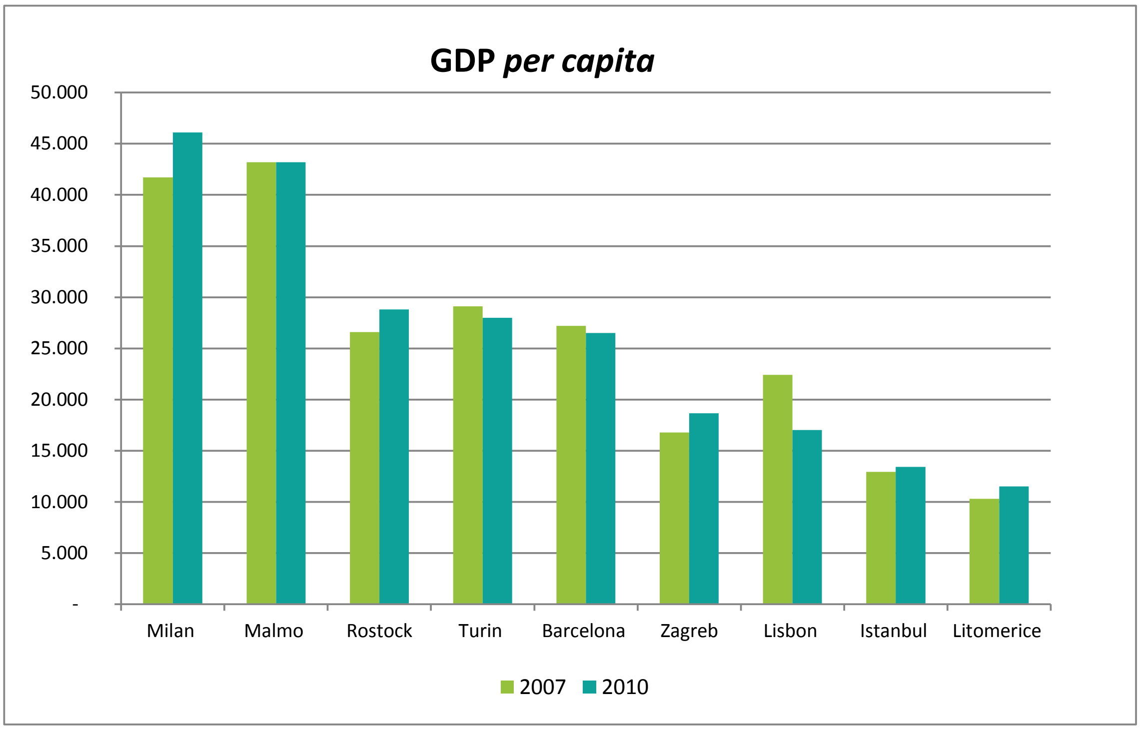


Figure 19: Evolution of GDP per capita, NUT III, 2007 and 2010

Note: Istanbul, Lisbon – NUT II; Rostock, Zagreb – Municipality.

EMPLOYMENT BY SECTORS

The profile of case study cities in terms of employment per sectors is similar. A higher and growing employment in the services sector is the common trend. Istanbul reports a higher importance of the industry sector when compared with the other cities.

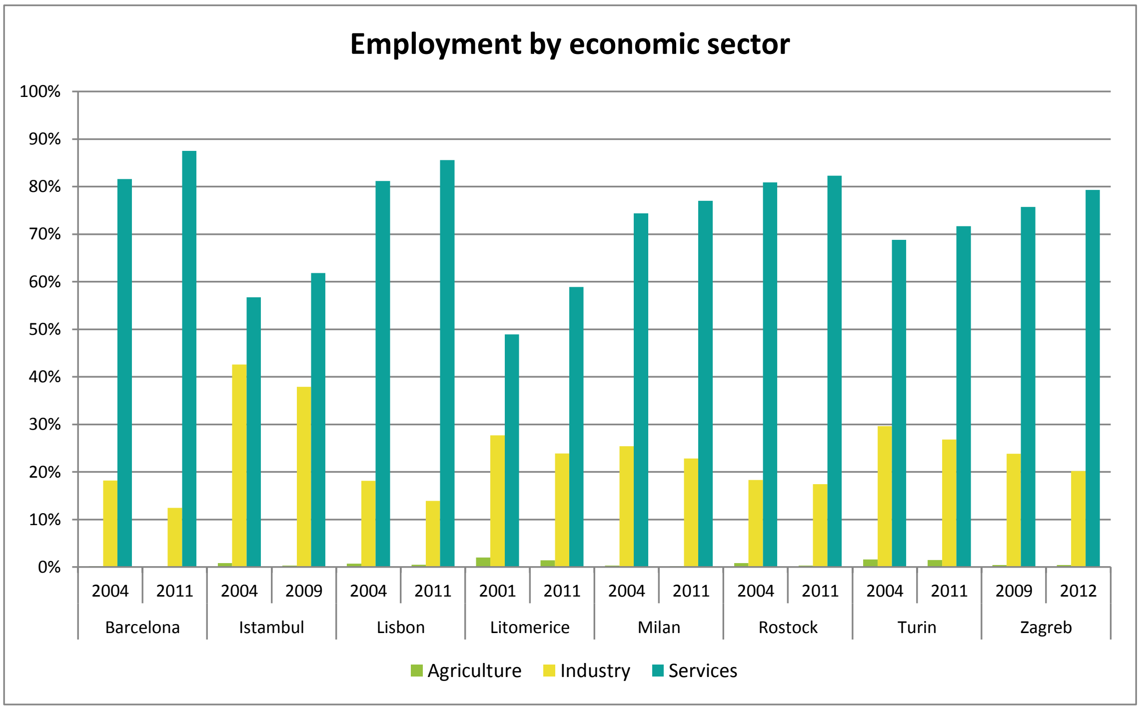


Figure 20: Employment by economic sectors

Note: Istanbul – NUT II; Rostock, Zagreb, Barcelona – Municipality; Milan, Turin, Lisbon – NUT III.

INDEBTEDNESS LEVEL

The debt level in percentage of GDP is only relevant in Istanbul (31.7%). However, this value decreased to 13.4% in 2011 and 9.5% in 2012.

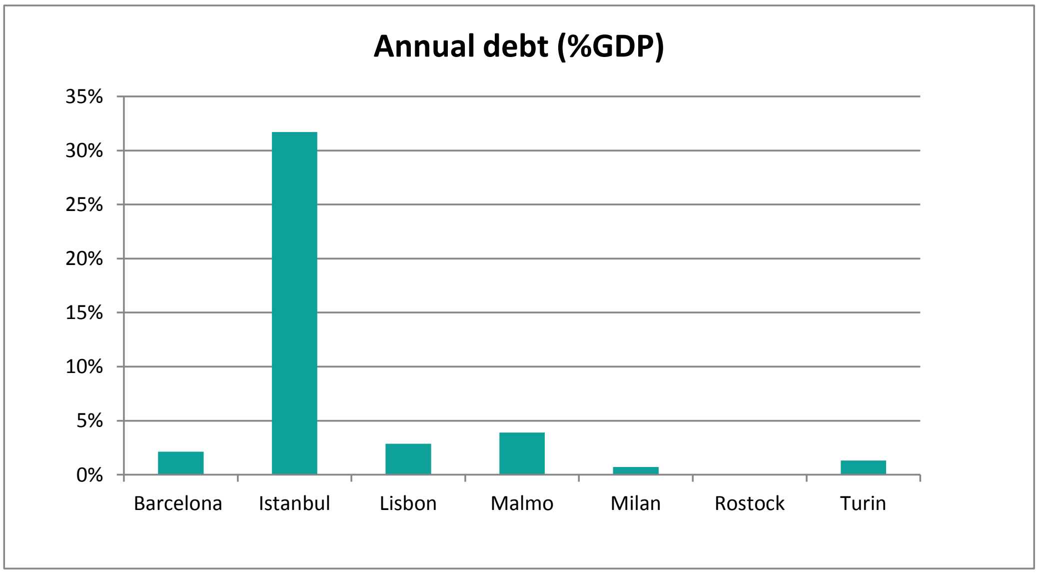


Figure 21: Debt level (% GDP), 2010

R&D INTENSITY

Malmö (3.2%) and Lisbon (2.48%) are the best performers in term of R&D expenditure as a percentage of GDP, followed by Rostock and Turin. The worst performer is Litoměřice (0.28%).

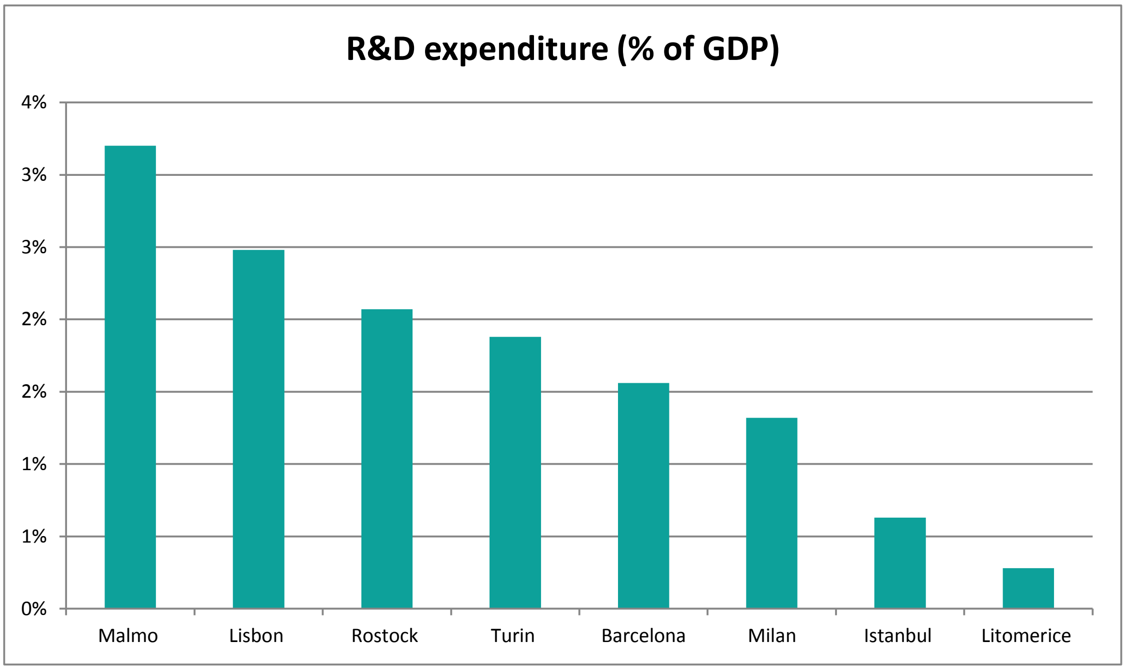


Figure 22: R&D expenditure as % of GDP, NUT II, 2011

Note: Malmö, Lisbon – NUT III; Lisbon – 2010.

V.III ENVIRONMENTAL PERFORMANCE

ECOSYSTEM PROTECTED AREAS

Litoměřice reports 92.1% of ecosystem protected areas as a percentage of total surface area, followed by Barcelona (28%).

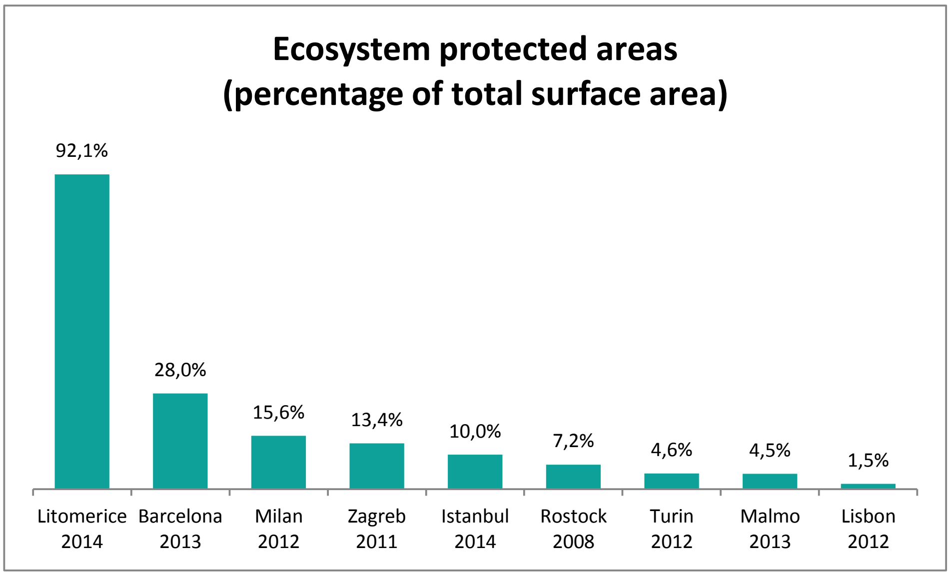


Figure 23: Ecosystem protected area (% total surface area), Municipality

Note: Milan – NUT II; Barcelona – Barcelona Metropolitan Area.

ENERGY INTENSITY

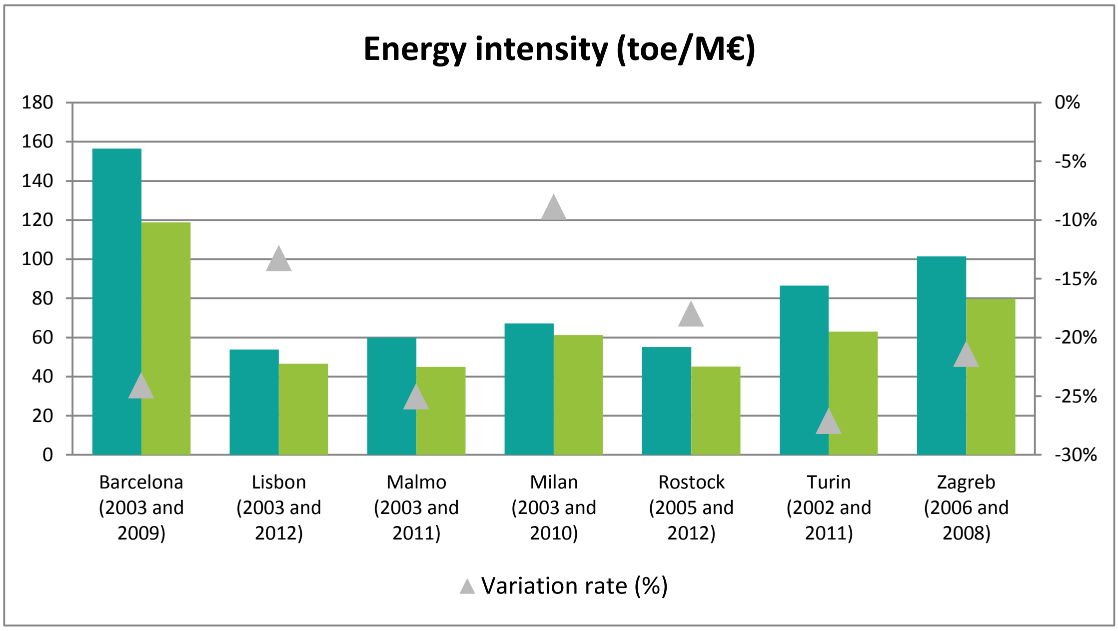


Figure 24: Energy intensity (toe/M€)

Note: Barcelona – NUT II; Lisbon, Milan, Turin – NUT III; Malmö, Rostock, Zagreb – Municipality.

Energy intensity is higher in Barcelona, followed by Zagreb and Turin. The general decrease in energy intensity is a trend in all case study cities.

ENERGY CONSUMPTION BY SECTOR

The profile of case study cities in terms of energy consumption by sectors is very diverse. In Milan, services present higher energy consumption in comparison with the other sectors. In Lisbon and Barcelona the higher energy consumer is the transport sector. In Turin and Malmö the residential sector dominates. With a different sectors classification, in Rostock industry, services and agriculture lead in terms of energy consumption, while in Zagreb are the residential and commercial sectors.

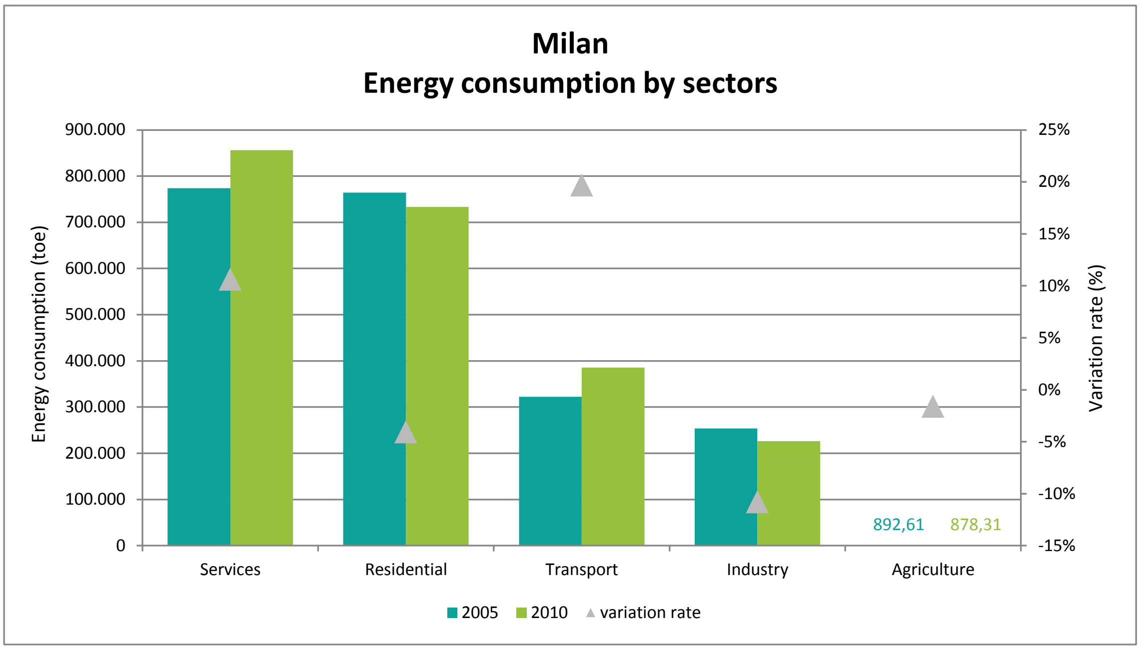


Figure 25: MILAN - Energy consumption by sectors

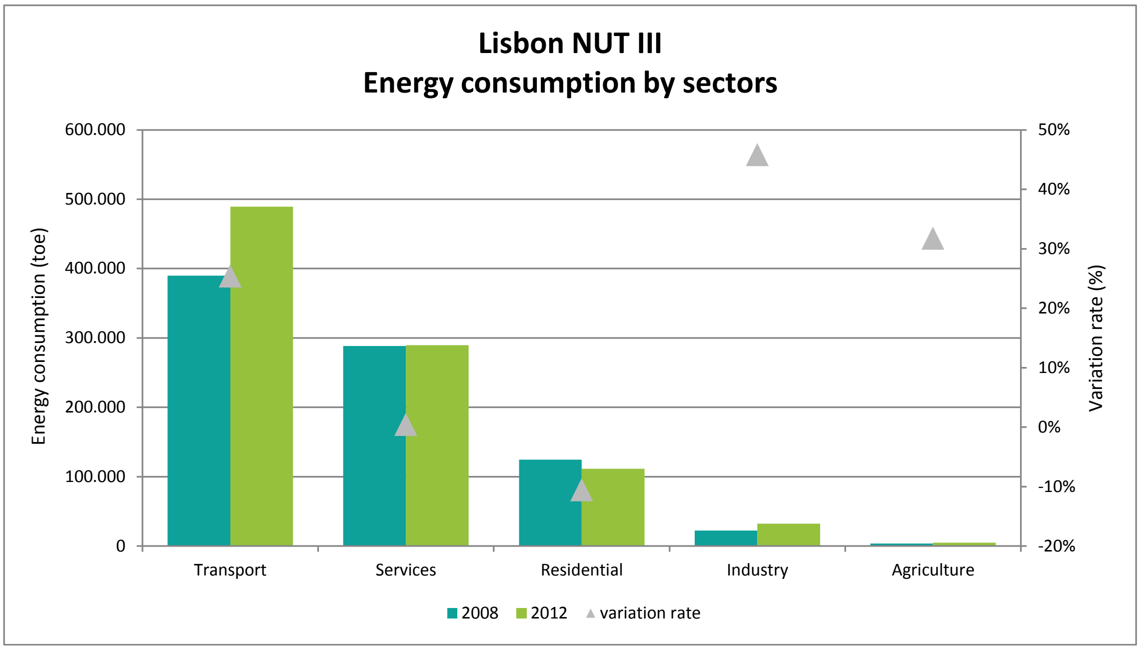


Figure 26: LISBON - Energy consumption by sectors

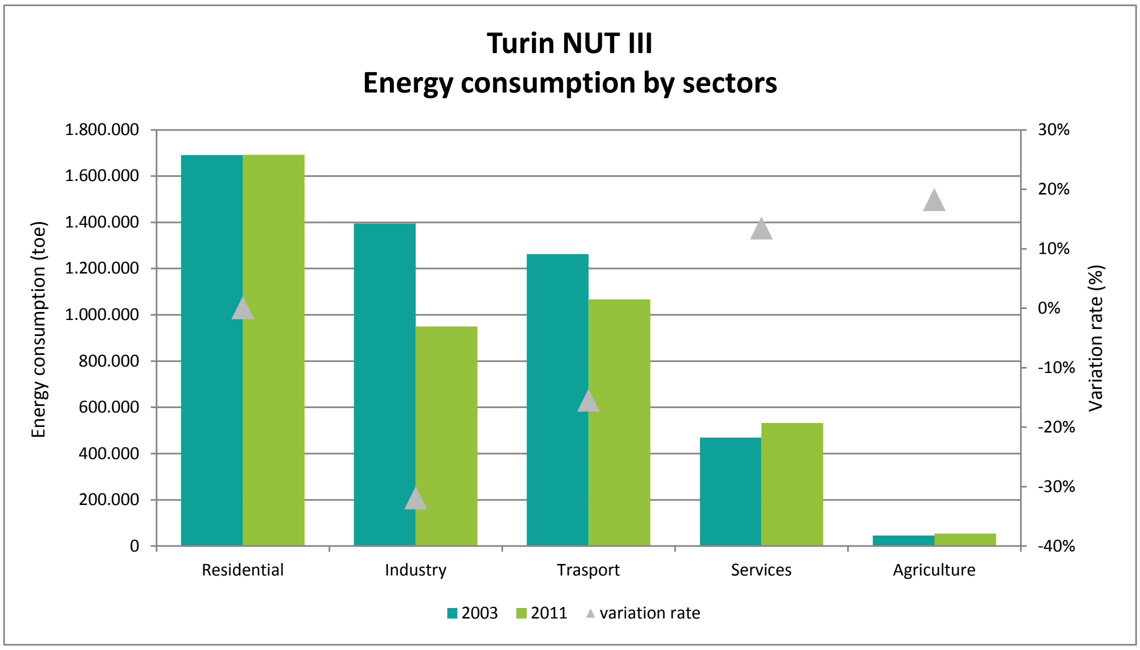


Figure 27: TURIN - Energy consumption by sectors

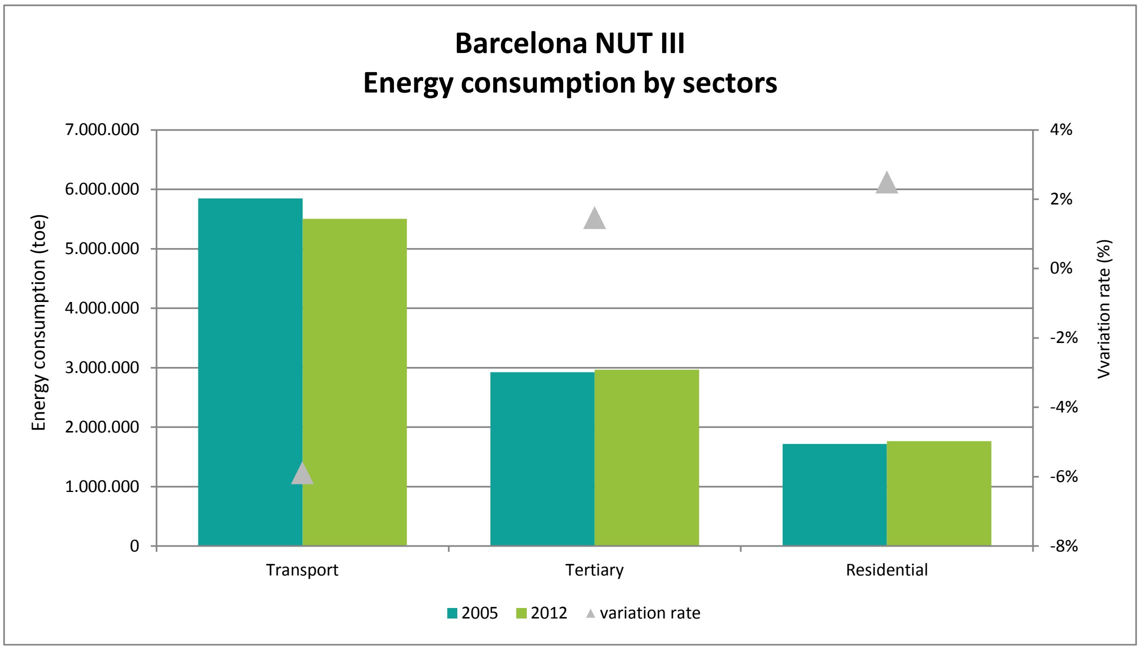


Figure 28: BARCELONA - Energy consumption by sectors

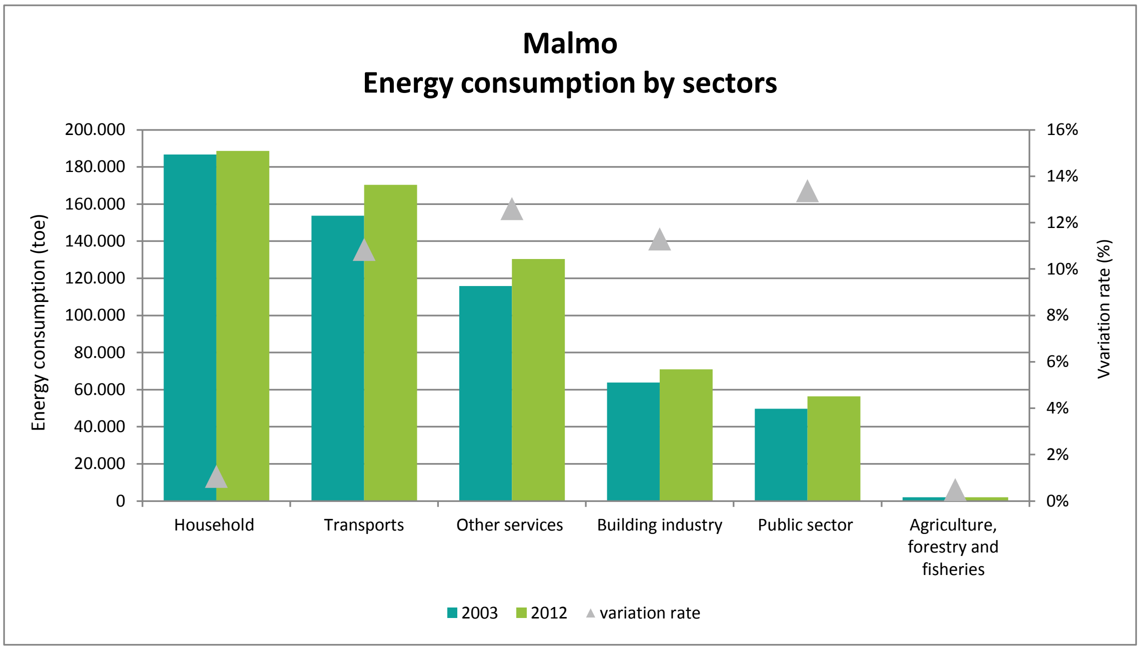


Figure 29: MALMÖ - Energy consumption by sectors

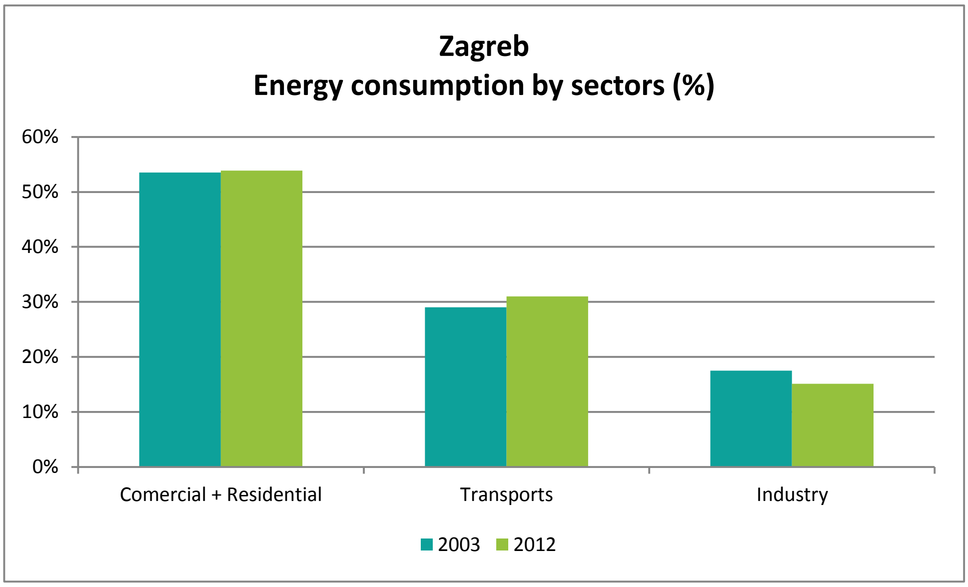


Figure 30: ZAGREB - Energy consumption by sectors

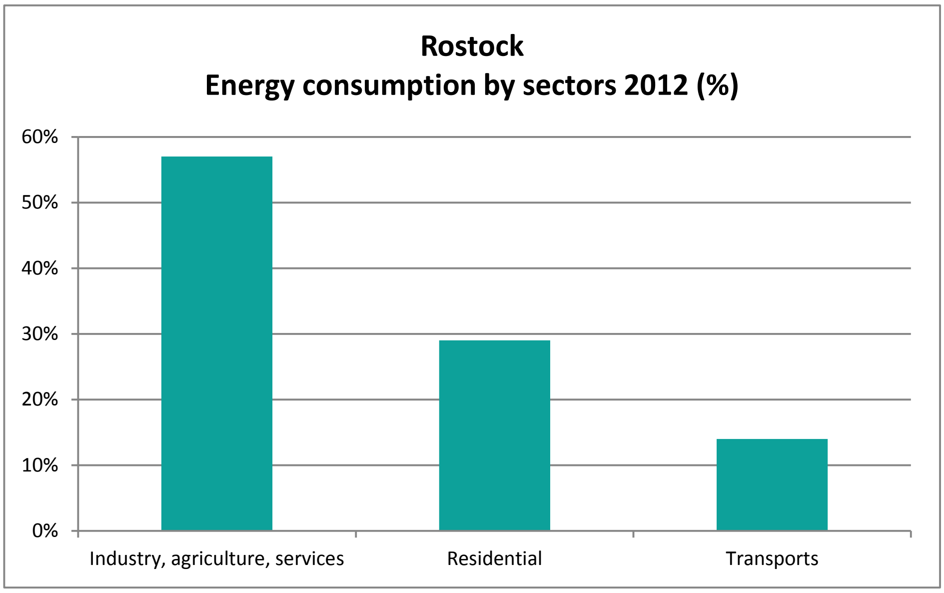


Figure 31: ROSTOCK - Energy consumption by sectors

CARBON EMISSIONS INTENSITY

Carbon emissions intensity is higher in Barcelona. The general decrease in carbon emission intensity is a trend in all case study cities.

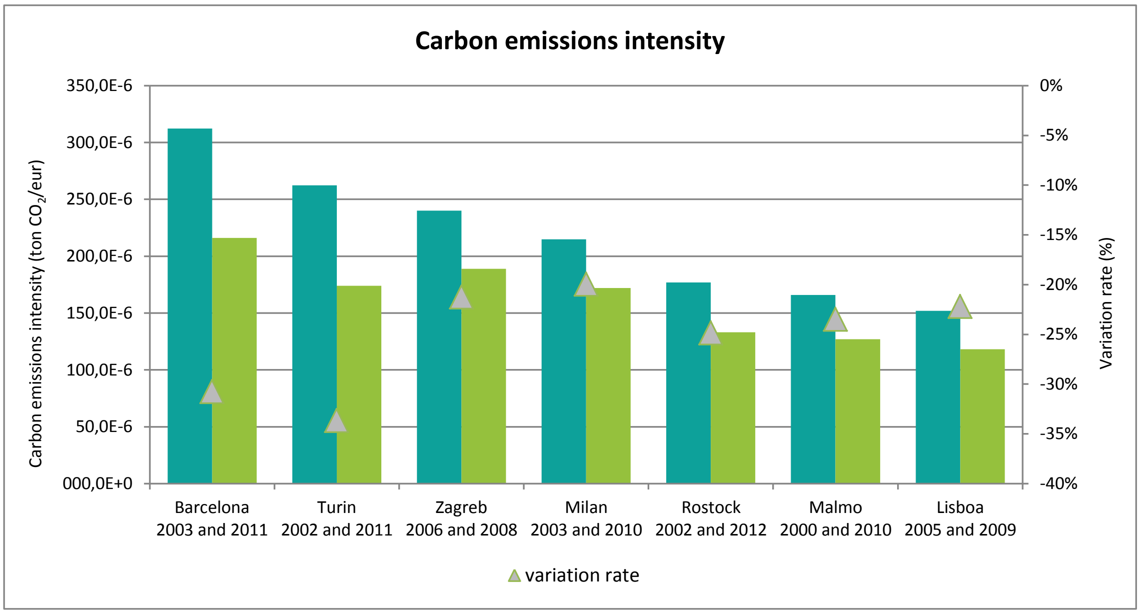


Figure 32: Carbon emissions intensity

Note: Lisbon, Milan, Turin – NUT III; Barcelona – NUT II; Malmö, Rostock, Zagreb – Municipality.

CARBON EMISSIONS BY SECTOR

The profile of case study cities in terms of carbon emissions by sectors is very diverse. In Milan and Turin, services and residential sectors present higher carbon emissions in comparison with the other sectors. In Malmö road transport dominates. With a different classification, in Barcelona energy production lead in terms of carbon emissions, while in Litoměřice and Istanbul is the residential sector. Finally, in Zagreb industry sector is the higher producer of carbon emissions.

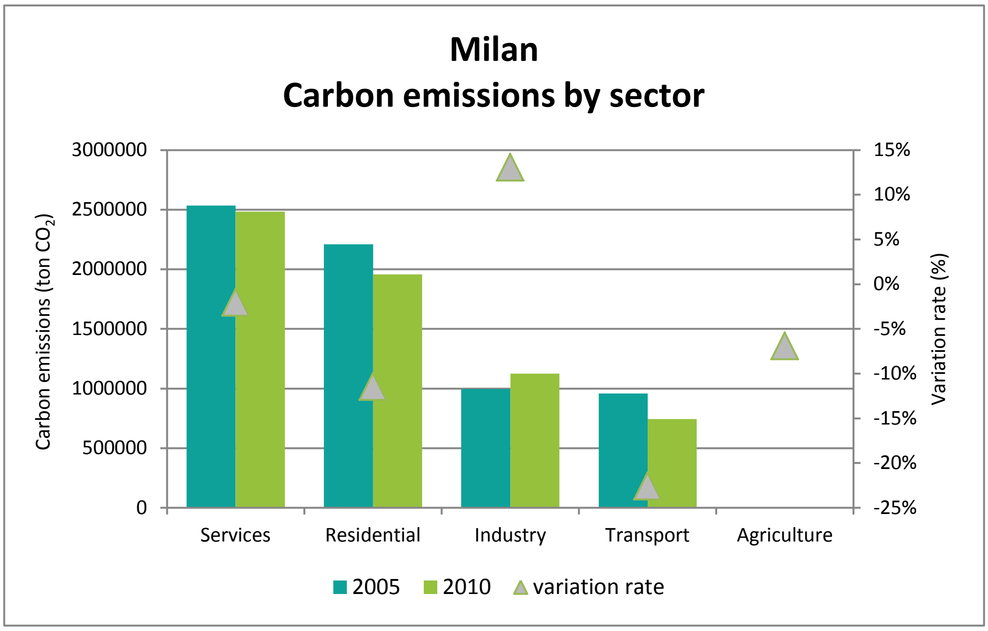


Figure 33: MILAN - Carbon emissions by sector, 2005 and 2010

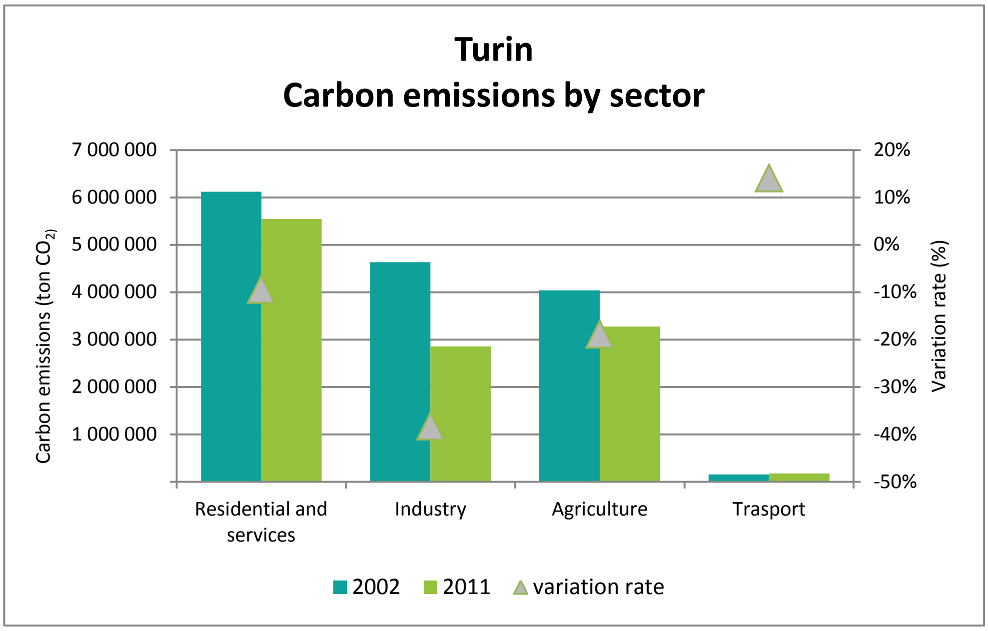


Figure 34: TURIN - Carbon emissions by sector, NUT III, 2002 and 2011

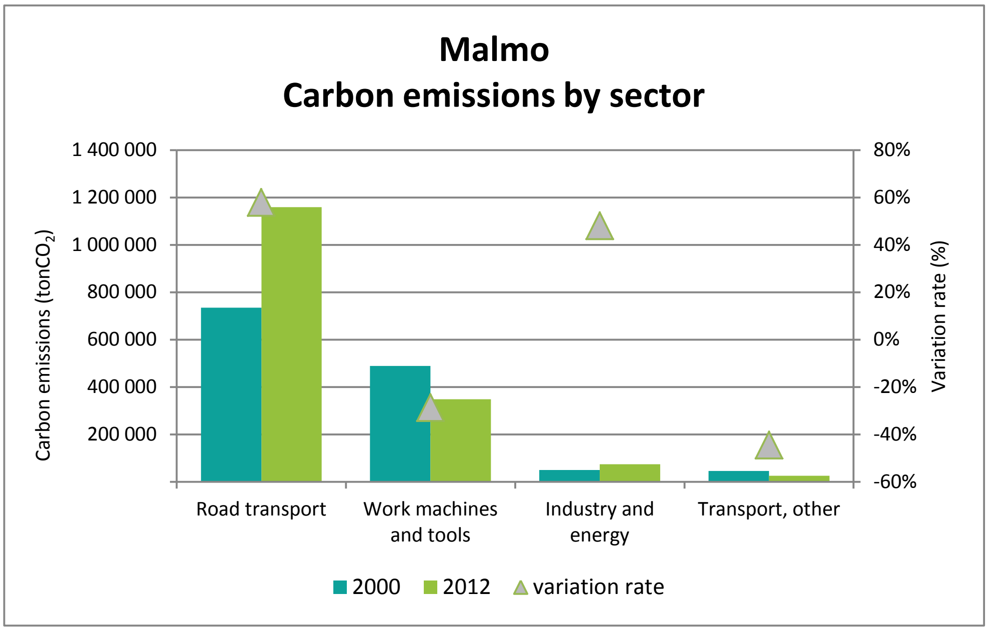


Figure 35: MALMÖ - Carbon emissions by sector, 2000 and 2012

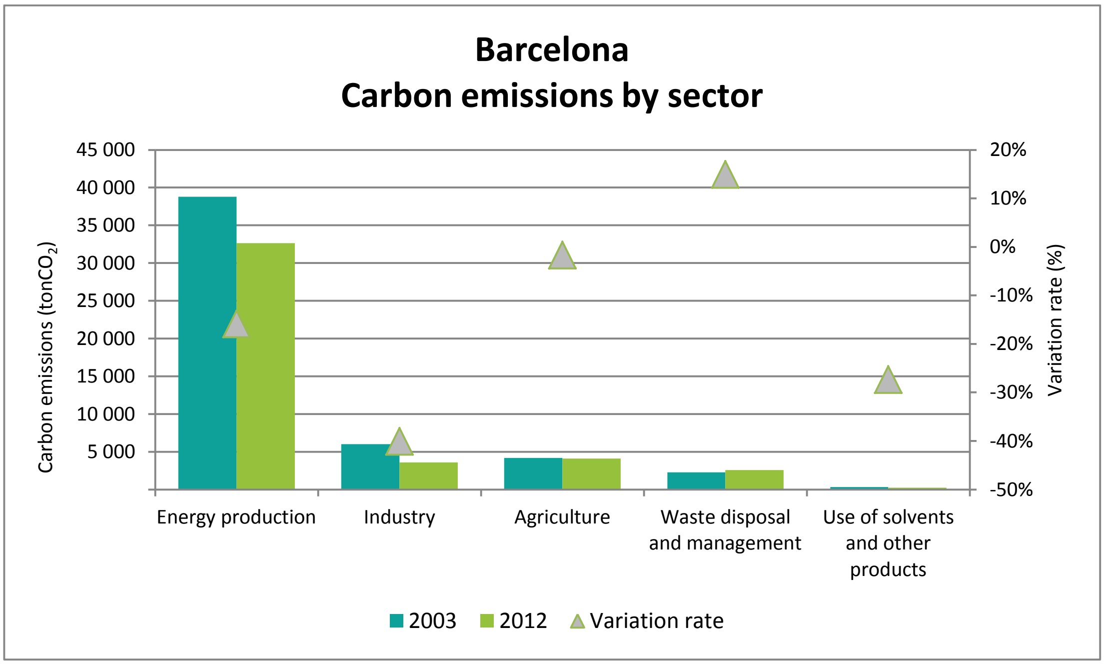


Figure 36: BARCELONA - Carbon emissions by sector, 2003 and 2012

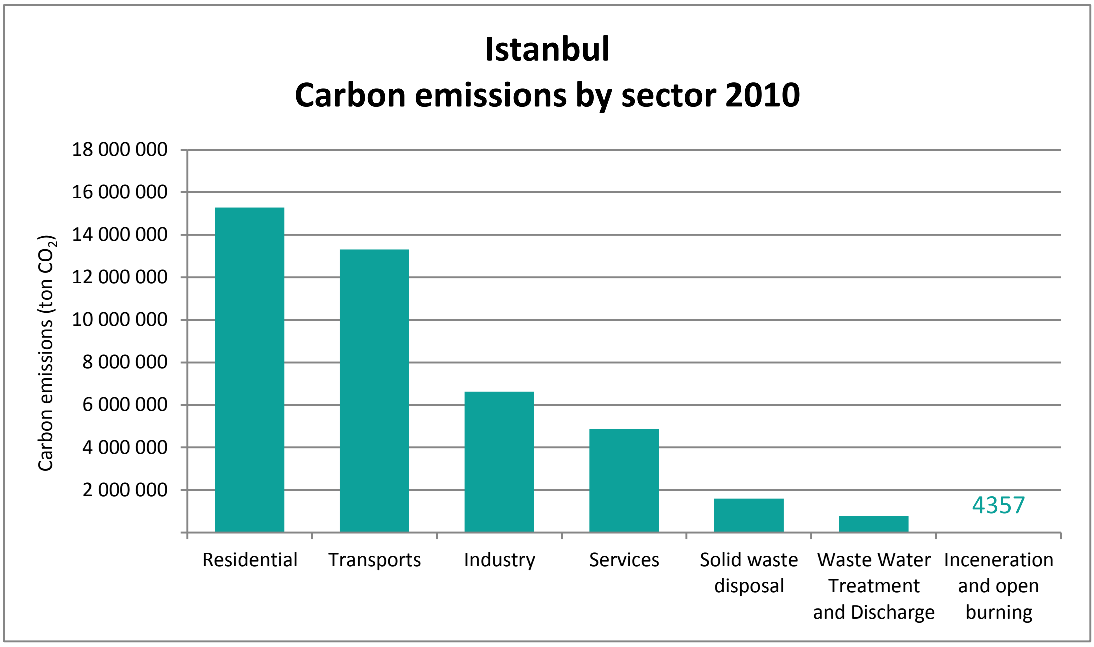


Figure 37: ISTANBUL - Carbon emissions by sector, 2010

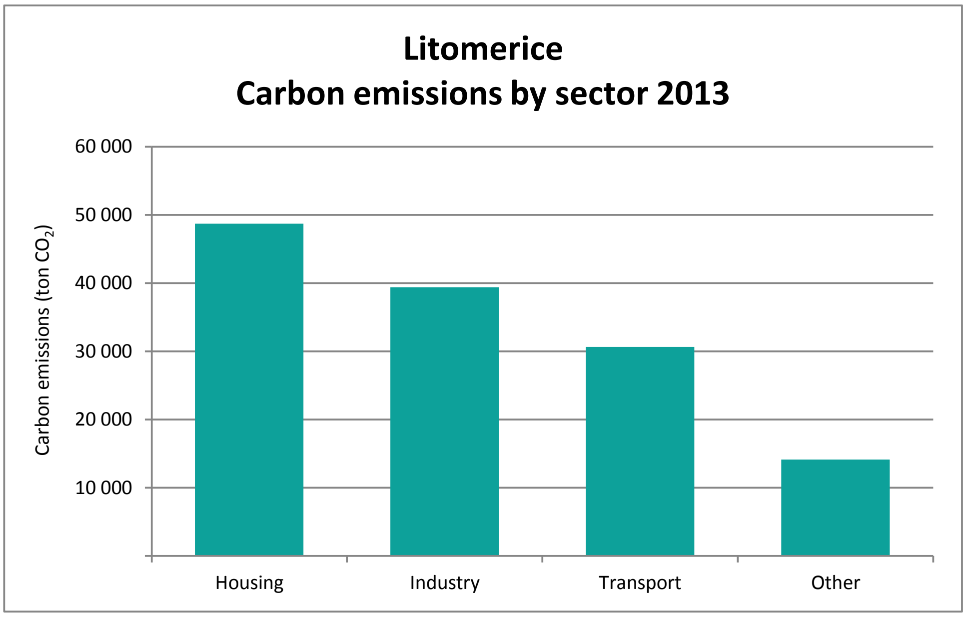


Figure 38: LITOMĚŘICE - Carbon emissions by sector, 2013

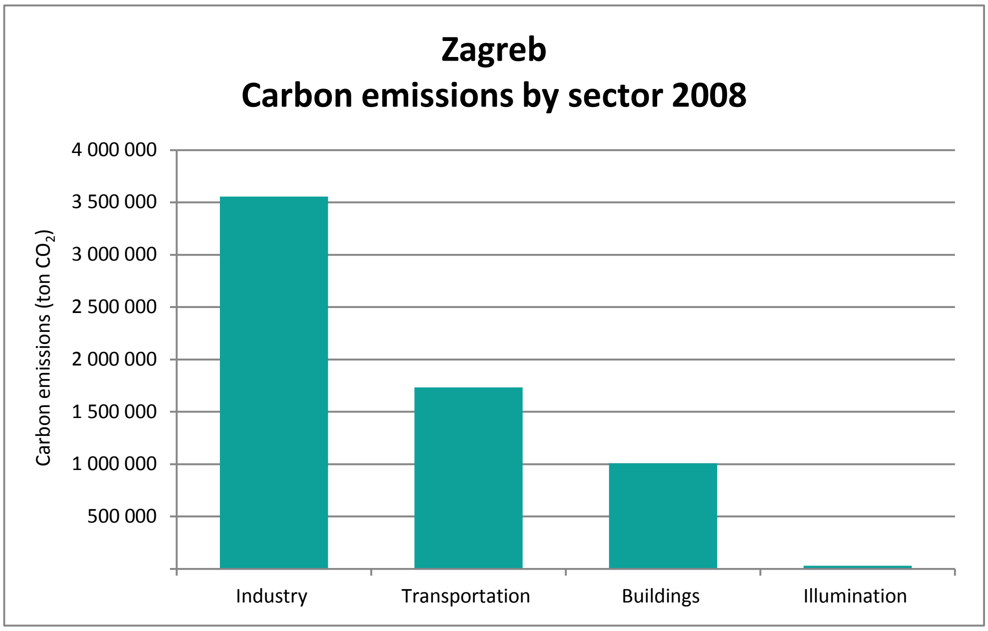


Figure 39: ZABREB - Carbon emissions by sector, 2008

SUSTAINABLE TRANSPORTATION

The share of sustainable transportation (public transports, walk, and bike) in total modal share is higher in Istanbul, followed by Litoměřice. Malmö and Rostock residents use bicycle as an alternative transportation mode.

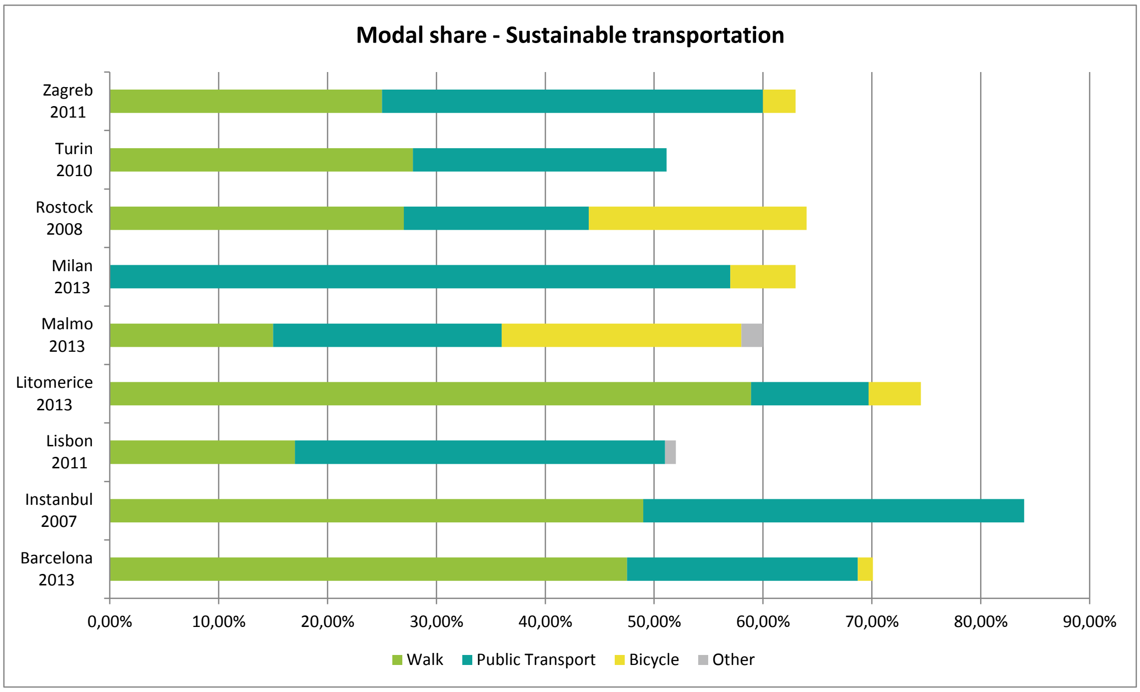


Figure 40: Sustainable transportation

URBAN WASTE GENERATION

Urban waste production was higher in Turin and Milan in 2007. In 2011, Lisbon reported the highest urban waste generation. However, the decrease in the amount of this indicator is the general trend, with exception of Lisbon and Istanbul.

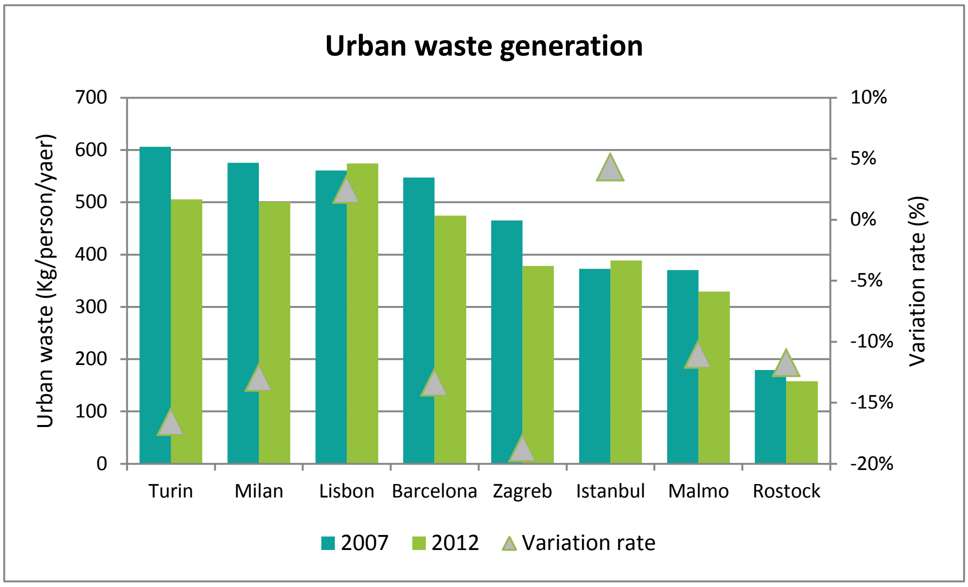


Figure 41: Urban waste generation, 2007 and 2012

Note: Zagreb – 2008-2011; Rostock – 2006-2012.

URBAN WASTE RECOVERY

Urban waste recovery is higher in Rostock, Turin, Milan and Barcelona, being Lisbon, Zagreb and Istanbul the worst performers. The trend is towards the increase of urban waste recovery, with the exception of Lisbon.

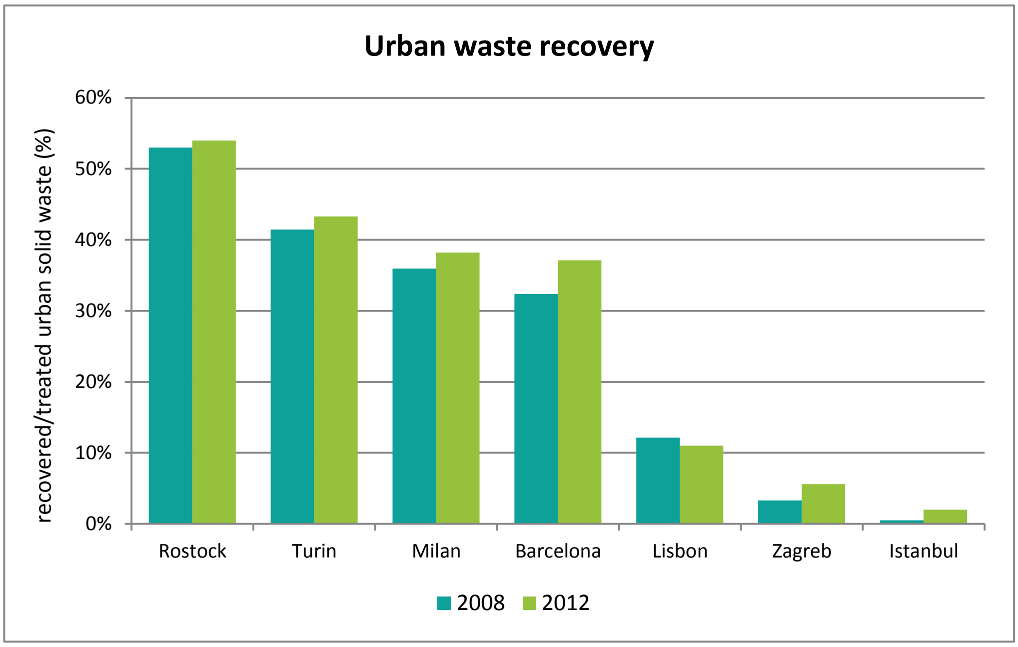


Figure 42: Urban waste recovery, 2008 and 2012

Note: Zagreb – 2009-2011; Rostock – 2009-2013.

WATER LOSSES

Water losses are bigger in Istanbul and Turin, being Lisbon and Rostock the best performers.

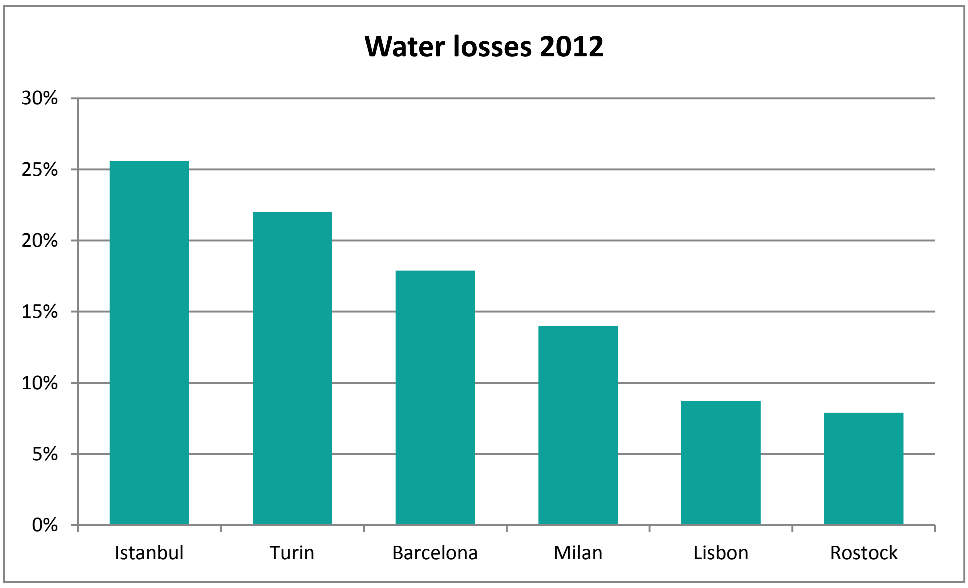


Figure 43: Water losses, 2012

Note: Barcelona – 2013

URBAN BUILDING DENSITY

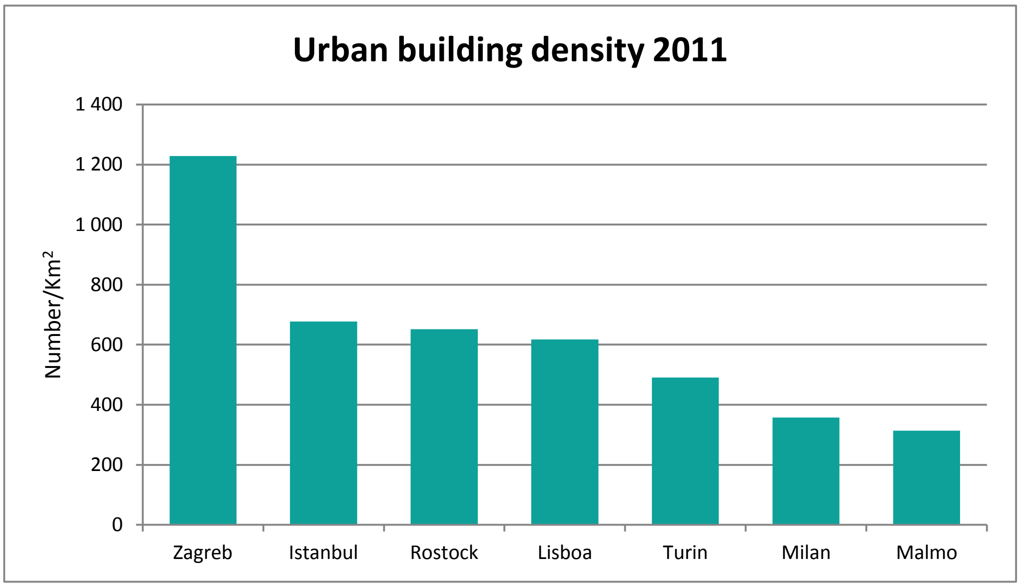


Figure 44: Urban building density, 2011

Note: Malmö – 2010.

Urban buildings density is higher in Zagreb. The other case study cities report a similar urban density, being Malmö the less dense city.

VI KEY FINDINGS AND CHALLENGES

In the following table, key strengths and challenges are described per case study city.

Figure 45: Key strengths and challenges

CITIES	STRENGTHS	CHALLENGES
Barcelona	At the forefront of smart cities movement Several strategies which are impacting carbon emissions Sustainability strategies are being implemented: transports, green space, waste and water management Strong role of AMB as a coordinating body Influx of young immigrants	Increased share of the population at risk of exclusion and poverty Increased level of unemployment Need to find a balance between the need to maintain it as a tourist centre, while keeping its local character Growing level of municipal indebtedness
Istanbul	Initial stage of development towards a post-carbon city Investments in public transportation Improvement of social performance Increase in level of wealth and economic attraction	Population increase and growing urbanisation Sprawl of the city towards peripheries caused by growing population Air and environmental pollution; stress on natural protection areas and forests Environmental performance as the weakest dimension and most underestimated by city
Lisbon	Several strategies and plans are being implemented in the area of mobility and energy, but still with medium impact Reduction of pollutants and carbon emissions Expressive reduction of water losses Improvement of public finances	Loss of population in the city centre and aging people Increase in unemployment and poverty levels Use of car as the privileged mode of transportation Need to improve performance in waste management and recovery Need to invest in buildings renovation
Litoměřice	One of pioneer cities in Czech Republic aiming at energy efficiency and renewable energy production Ambition to become an energy self-sufficient city Emphasis on the geothermal power plant project	Small city that is from large extent influenced by the development of higher territorial units Dependence on the availability of external financial resources
Malmö	Ambitious energy strategy Sustainable transportation is on the right track Innovative city with a positive trend in GDP per capita Young and multicultural city	Economic inequity in the city Segregated city with evidence of social unrest (high immigration numbers) No protocol to calculate the carbon footprint of the city

CITIES	STRENGTHS	CHALLENGES
Milan	Leading city in economic and social areas Innovative city	Advantage compared to Italian cities in terms of environmental standards, but behind European average standards Need to invest in the shift towards a zero-carbon paradigm and to increase civil awareness Poor air quality, high pollution Aged building stock
Turin	Innovative city Relevant share of green areas	Increase in unemployment and decrease in GDP (due to strong specialisation) High percentage of people in risk of poverty Poor air quality, high pollution Stock of debt is high
Rostock	Important measures to reduce environmental footprint Improvement of air quality, waste and water management and sustainable mobility	Weak infrastructure and social challenges regarding poverty and unemployment in the region Weak financial situation
Zagreb	Growing number of citizens and transition groups paving the way towards a post-carbon paradigm (bottom-up approach) Participation in major EU and global initiatives aiming at CO_2 reduction	Lack of strategic planning Need of social participation in the transition towards a post-carbon city Critical success factors: social – unemployment and poverty; environment – public transportation and municipal waste management; economic – GDP per capita, business survival and social entrepreneurship

On an empirical basis, we can identify three clusters of cities with different stages of development in the transition towards a post-carbon city:

At the forefront of the transition towards a post carbon city:

Malmö

Barcelona

Intermediate stage of development in the transition towards a post-carbon city:

Lisbon

Milan

Turin

Rostock

Initial stage of development towards a post carbon city:

Istanbul

Litoměřice

Zagreb

VII CONCLUSIONS

The evaluation and comparison of the pre-defined Key Performance Indicators in the case study cities suggest that there is a global trend towards a post-carbon paradigm. However, cities present different development stages.

Barcelona is at the forefront of the smart cities movement. Several strategies towards a post-carbon city are being implemented by the Metropolitan Area, namely in the areas of energy, mobility, water and waste management, and biodiversity. The use of smart technologies to achieve this objective is a reality. However, unemployment and poverty are weaknesses that have been enhanced by the economic and financial crisis.

Malmö is a frontrunner in the transition towards a post-carbon city. An ambitious energy strategy is being implemented with positive impacts in carbon emissions and energy consumption. It is a young and multicultural city with reasonable economic and social performance.

Lisbon is in an intermediate stage of development in the transition towards a post-carbon city. Several strategies and projects have been launched in the areas of energy, mobility, and biodiversity but still with limited impacts. Due to economic and financial crisis, unemployment and risk of poverty are increasing.

Milan is in an intermediate stage of development in the transition towards a post-carbon city. It is a leading city in economic terms but the investment in environmental issues is comparatively lower. One of the major urban problems is pollution and poor air quality.

Turin is in an intermediate stage of development in the transition towards a post-carbon city. It is an innovative city, but it is being affected by unemployment and poverty due to strong specialisation. One of the major urban problems is pollution and poor air quality.

Rostock is in an intermediate stage of development in the transition towards a post-carbon paradigm. Important measures were adopted to reduce the environmental footprint of the city, namely in the areas of air quality, waste and water management and sustainable mobility with positive impacts.

Istanbul is in an initial stage of development towards a post-carbon city. Environmental performance is the weakest dimension and most underestimated by the city. The main problems are growing urbanisation, urban sprawl, pollution, and stress in natural protection areas. However, Istanbul is improving in economic and social terms, being a dynamic and vibrant city.

Zagreb is in an initial stage of development in the transition towards a post-carbon city. Some grassroots movements are in place, but strategic planning is weak. It is worth of notice the high qualification of the population, in comparison with other case study cities.

Litoměřice is in an initial stage of development in the transition towards a post-carbon city. It is a small city that is influenced by the development of higher territorial units. To become an energy self-sufficient city is the ambition, mostly based on the geothermal power plant future project.

Cities were generally affected by the economic and financial crisis, with negative consequences on unemployment and poverty.

However, case study cities are very different in terms of population size and economic, social and cultural dynamics, which makes the comparison difficult. Moreover, the majority of cities had problems on data collection; thus, the development of urban information systems is a recommendation for all case study cities.

VIII ANNEX

List of key performance indicators

DIMENSION	SUB-DIMENSION	INDICATOR	UNIT	YEAR
SOCIAL	Social Inclusion	Variation rate of unemployment level by gender	Percentage	
		Variation rate of poverty level	Percentage	
		Variation rate of tertiary education level by gender	Percentage	
		Variation rate of average life expectancy	Average Nº	
	Public services and Infrastructures	Variation rate of green space availability	Percentage	
	Governance effectiveness	Existence of monitoring system for emissions reductions	Yes/No Description	
ENVIRONMENT	Biodiversity	Variation rate of ecosystem protected areas	Percentage	
	Energy	Energy intensity variation rate	Toe/euro Toe	
		Variation rate of energy consumption by sectors	Percentage	
	Climate and Air Quality	Variation rate of carbon emissions intensity	Ton CO2/euro Ton CO2	
		Variation rate of carbon emissions by sector	Ton CO2	
		Exceedance rate of air quality limit values	Nº	
	Transport and mobility	Variation share of sustainable transportation	Percentage	
	Waste	Variation rate of urban waste generation	Kg/person/year	
		Variation rate of urban waste recovery	Percentage	

DIMENSION	SUB-DIMENSION	INDICATOR	UNIT	YEAR
	Water	Water losses variation rate	m3/person/year	
	Buildings and Land Use	Energy-efficient buildings variation rate	Percentage	
		Urban building density variation rate	Nº/ km2	
ECONOMY	Sustainable economic growth	Level of wealth variation rate		
		Variation rate of GDP by sectors	Percentage	
		Employment by sectors variation rate	Percentage	
		Business survival variation rate	Percentage	
	Public Finances	Budget deficit variation rate	Percentage of city's GDP	
		Indebtedness level variation rate	Percentage of city's GDP	
	Research & Innovation dynamics	R&D intensity variation rate	Percentage	