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Horizon 2020

Societal Challenge: Improving the air quality and reducing the carbon footprint of European cities

Project: 690105 – ICARUS

Full project title:

Integrated Climate forcing and Air Pollution Reduction in Urban Systems

D6.1 Blending Future and Smart and Healthy Cities

WP6: Developing pathways to green, smart and healthy cities

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Responsible Author (Partners)	ADDMA			
Responsible Author	A.Gkika		**Email**	gkikatasia@gmail.com,
	Partner	ADDMA	**Phone**	
Other partners (Institution)	AUTH, USTUTT, EUCENTRE, MU, SWISSTPH, UNEXE, ISCIII, JSI, EUC, NCSRD			

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ACRONYMS USED

WP	Work Package
WHO	World Health Organization
EU	European Union
GHG	Greenhouse Gas
GDP	Gross Domestic Product
RES	Renewable Energy Source
GIC	Gross Inland Consumption
EPBD	Energy Performance Building Directives
EED	Energy Efficiency Directives
IT	Information Technology
EEA	European Environment Agency
OECD	Organisation for Economic Co-operation and Development
TEN-T	Trans-European Network of Transport
100RC	100 Resilient Cities
CRF	City Resilience Framework
SME	Small Medium Enterprise
NGO	Non-Governmental Organization

1 Introduction

ICARUS WP6 objective is to develop visions of smart, green and healthy cities through employing a foresight approach - combining participatory workshops, literature review and horizon scanning. Horizon scanning involves consultation with experts, state-of-the-art evidence reviews and web-based horizon scanning to identify new and emerging issues. The main element of these urban visions will be a combination of the use of digital technologies and green city planning to promote and optimize well-being whilst curbing air pollution and mitigating climate change.

There are two agendas currently competing within the same broad space forming the focus of the ICARUS bid – those broadly defined as Future Cities, and Smart Cities. The World Health Organization (WHO) has created a Healthy Cities network focusing on enhancing public health via environmental interventions. These are not mutually exclusive agendas, but each has its own paradigm. Future Cities tends to be populated by architects and planners using a more qualitative set of approaches. Smart Cities on the other hand is technology focused, tending to try to embed sensors within infrastructure or to use citizens as sensors themselves. Healthy Cities promote public health improvements through targeted interventions focusing on improving the quality of the urban environment as a whole. ICARUS strives to blend these agendas together with their respective stakeholders.

ICARUS cities, as all cities around the world, are facing similar challenges (climate change, globalization, urbanization) and are adjusting by adopting holistic and integrated strategies as well as implementing policies that will increase city resilience in all dimensions (social, financial, environmental). All participating cities have developed visions, short or long term, to tackle challenges in an effective and sustainable way in the future years. In the frame of WP6 activities, a two-day participative workshop for "Developing visions for Smart Green and Healthy Cities" with experts and stakeholders of ICARUS cities was held in Madrid on the 20th and 21st of September 2018. The aim of the workshop was to identify the more relevant future trends, and to elaborate future narratives on green and healthy cities from the point of view of key stakeholder and strategic sectors experts. A further participative workshop with stakeholders and experts will be organized in Athens at the end of January 2019 to present and discuss further the initial results of the project.

This deliverable constitutes a report on how cities could develop visions in line with EU key policies and existing EU trends in sectors such as energy, transport etc. that will help them to address challenges and ensure a sustainable urban development for the future.

2 EU Directives and Key Policies to 2020

2.1 EU Key Policies on Energy and Climate Change

The "Europe 2020[1]" is a strategy for sustainable, competitive and secure energy and consist the EU's agenda for smart and inclusive growth for the current decade. The Europe 2020 strategy is used as a reference framework for activities at EU and at national and regional levels. The EU sets three key targets based on climate change and energy sustainability for 2020 [1], the so-called '20-20-20' targets:

- 20% reduction in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewables
- 20% improvement in energy efficiency

EU governments have set national targets to help achieve the overall EU targets. The period until 2020 includes the most sweeping transition due to the targets of the '20-20-20' targets and the decade 2010-2020 sets the ground for future development. EU policies on energy and climate change will result in considerable changes in the energy system relative to past trends.

Energy consumption and energy efficiency trends analysis in the EU for the period 2000-2015[2] reports the effectiveness of the key policies and implemented measures that have been issued to achieve 20-20-20 targets. The results show that EU inland gross energy consumption[3], primary energy consumption[4], and final energy consumption[5] have declined from 2000 by 5.93%, 5.46%, and 4.31% respectively The breakdown into sectors shows that: the largest decline of final energy consumption has been registered in the industry sector (-17.59%); in the residential sector there has been a decrease (-5.51%), the transport sector has registered a slight increase (4.04%), and the tertiary sector has experienced the highest positive growth rate (+16.48%) [1]. Primary and final energy consumption trends for the mentioned period with 2020 EU-28 energy targets are illustrated in Figure 2-1.

On 30 November 2016 the Commission proposed an update to the Energy Efficiency Directive[6], including a new 30% energy efficiency target for 2030 and through the 'Clean Energy For All Europeans' proposals presented a package of measures that are in line with the EC commitment to cut CO_2 emissions by at least 40% by 2030 [2,3,4].

[1] EUROPE 2020 A European strategy for smart, sustainable and inclusive growth, http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

[2] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110326/efficiency_trends_2017__final_lr.pdf

[3] Gross energy consumption, is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration

[4] Primary energy consumption measures the total energy demand of a country. It covers consumption of the energy sector itself, losses during transformation (for example, from oil or gas into electricity) and distribution of energy, and the final consumption by end users. It excludes energy carriers used for non-energy purposes (such as petroleum not used not for combustion but for producing plastics).

[5] Final energy consumption is the total energy consumed by end users, such as households, industry and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself.

[6] https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

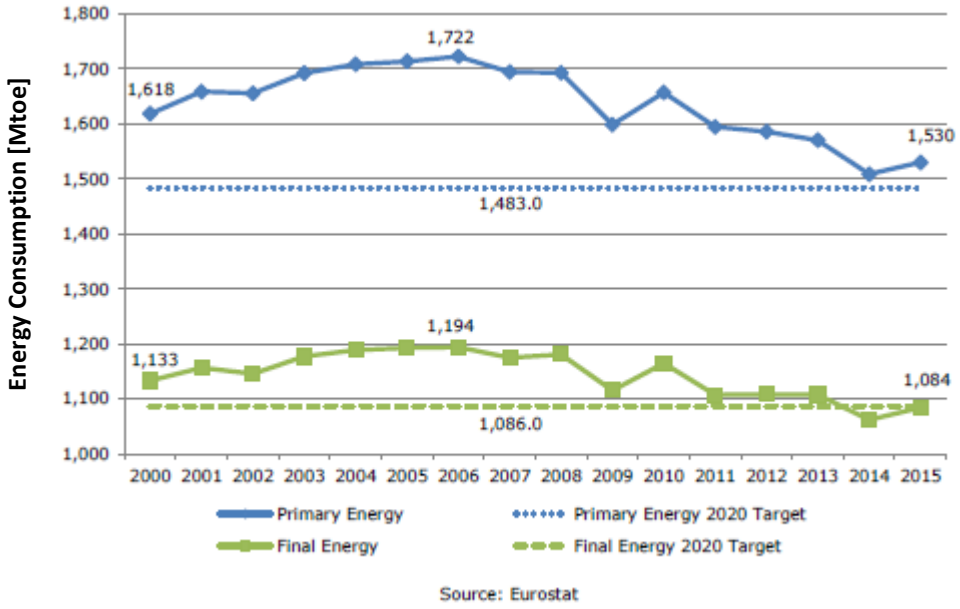

Figure 2-1 Energy consumption trends with 2020 EU-28 energy targets, 2000-2015 [2]

The major conclusions of analysis showed that:

- In 2015 the EU-28 final energy consumption increases by 2.01%, compared to the previous year, by registering a value of 1,084 Mtoe. Despite this increase the final energy consumption remains below the 2020 target (1,086 Mtoe) with a gap of - 0.18%.
- In 2015 primary energy consumption increases by 1.5% compared to the previous year, registering a value of 1,530 Mtoe. This increase interrupts the decreasing trend started in 2010 and the primary energy consumption moves away from the 2020 target (1,483 Mtoe).
- The transport and the tertiary sector have increased their final energy consumption over the analysed period while in the residential and industry sectors the final energy consumption has declined.
- Overall, the current final energy consumption trends show that the financial and economic crisis (which started in 2007 and peaked in 2008) has strongly affected dynamics and growth rates of the different economic sectors and Member States.

Under the Energy Efficiency Directive, all EU countries should establish new national measures to ensure major energy savings for consumers and industry alike. For example, these specific measures and policies could include:

- Energy distributors or retail energy sales companies could achieve energy savings through the implementation of energy efficiency measures.
- Issue measures to achieve the same level of savings through other means, such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs.
- The public sector could purchase energy efficient buildings, products and services.
- Energy consumers should be empowered to better manage consumption.

- National incentives for SMEs to undergo energy audits.
- Large companies will make audits of their energy consumption to help them identify ways to reduce it.
- Monitoring efficiency levels in new energy generation capacities.

At the same time, the 2030 Climate and Energy Framework set three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels).
- At least 27% share for renewable energy.
- At least 27% improvement in energy efficiency.

The framework was adopted by EU leaders in October 2014 [5].

3 EU Energy, Transport and GHG emissions trends to 2030 and 2050

The most updated report[7] on "European energy and transport - Trends to 2030" was the one that included the economic crisis started in autumn 2008 and has taken into consideration many energy efficiency policies. That is the main reason that the updated report showed a very different picture than the previous report[8] on 2007. Summarizing, the baseline 2009 and reference scenarios that were considered imply lower primary energy consumption, therefore higher security of supply compared to previous projections, lower emissions, but considerably higher costs of electricity.

The "EU energy, transport and GHG emissions trends to 2050" report[9] presents the new "EU Reference scenario 2013" and is an update and extension of the previous trend scenarios for development of energy systems taking account of transport and GHG emissions developments, such as the "European energy and transport - Trends to 2030" published in 2003 and its 2005, 2007 and 2009 updates. In the conclusions it is referred that:

- The main characteristic of the future EU energy system is a significant reduction of the carbon intensity of power generation.
- Overall, despite significant economic growth making the EU economy 78% larger in 2050 than it was in 2010, there is a decline of total energy consumption by 8%.
- Regarding GHG emissions, target levels would be even surpassed at the EU level. In 2020 GHG emissions fall by 24% compared to 1990, further decreasing to 32% below the 1990 level in 2030 and by 44% in 2050.
- After having undergone all the structural adjustments to cope with the 2020 targets and policies, total energy system costs grow slower than GDP, leading to decreasing ratio of energy system costs to GDP in the period 2020-50.

Summarizing, the "EU energy, transport and GHG emissions trends to 2050" indicates that the intense deployment of Renewable Energy Source (RES) following notably the investment to achieve the 2020 targets results in sizeable decrease in external energy dependence. In the long run, however, the limited availability of indigenous fossil fuel resources (due to depletion of domestic resources) as well as limited additional biomass imports lead to total net energy imports increasing again (after 2035). This mainly concerns natural gas, which according to the projection will play a crucial role in the context of emission reduction targets and as back-up for variable RES.

3.1 EU Energy trends

3.1.1 Energy consumption

Energy consumption in the EU saw a significant shift from past increasing trend in the period from 2000 to 2006 to a downward trend even before the onset of economic crisis in 2008-2009 [6]. In spite of the gradual recovery from the economic crisis, gross inland consumption (GIC) continually decreases until 2035 and shows a marginal increase thereafter, though still below 2010 level. A decline in GIC suggests a switch from fossil fuel towards renewable energy sources (RES) including hydro, solar and

[7] https://ec.europa.eu/energy/sites/ener/files/documents/trends_to_2030_update_2009.pdf
[8] https://ec.europa.eu/energy/sites/ener/files/documents/trends_to_2030_update_2007.pdf
[9] https://ec.europa.eu/transport/sites/transport/files/media/publications/doc/trends-to-2050-update-2013.pdf

wind (Figure 3-1). The main drivers for this switch is attributed to the implementation of binding targets on RES and energy efficiency policies such as Energy Efficiency Directives (EED), Energy Performance of Building Directives (EPBD), Eco-design Directives, and CO_2 emissions standard for vehicles etc., with fuel consumption declining considerably throughout the projection period [6].However, after 2030, energy consumption is expected to follow a slow increasing trend, probably due to absence of additional policies on energy efficiency. In addition, electrification is projected to show an upward trend (Figure 3-2). This is mainly due to an increasing demand for air conditioning system, electric heat pumps and a persistent increase in the use of electric gadgets in residential settings and IT sectors (Figure 3-3).

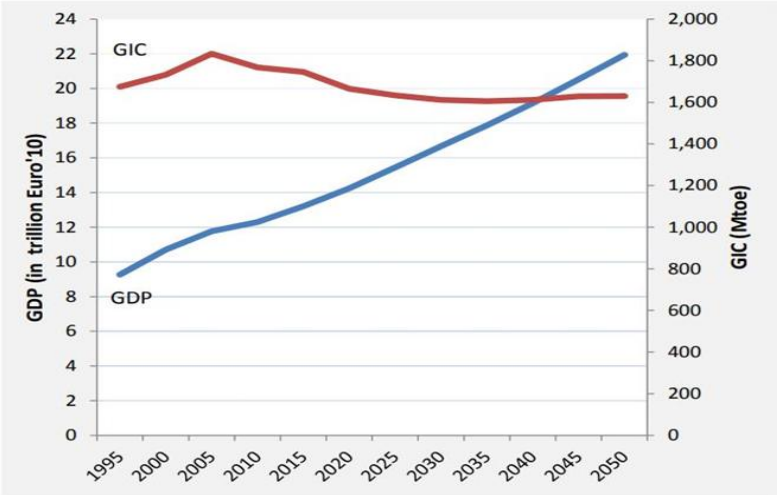

Figure 3-1 Gross Inland Consumption (GIC) in relation to GDP [6]

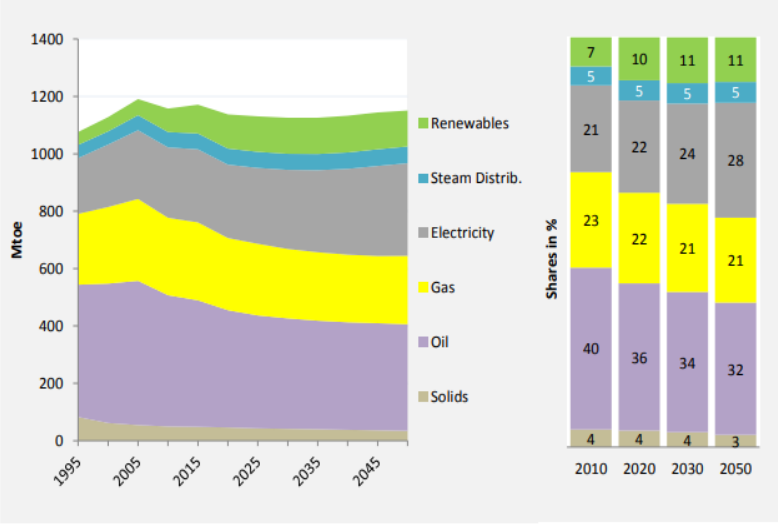

Figure 3-2 Final Energy consumption projections [9]

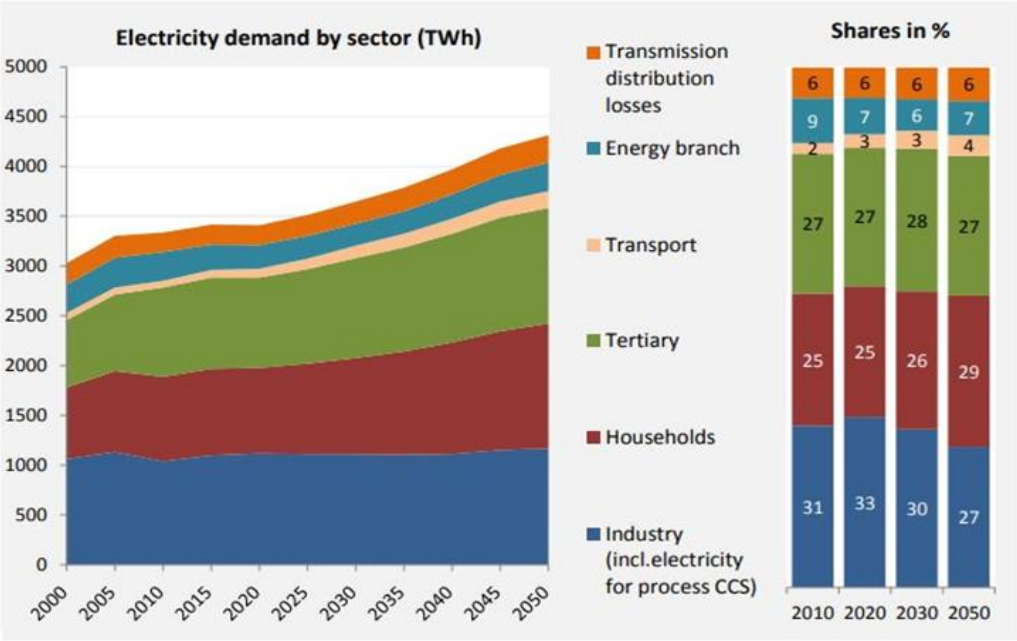

Figure 3-3 Trends in electricity demand by sector [6]

The European Environment Agency (EEA) reported that the EU's gross final energy use obtained from renewable sources had reached 16.7% in 2015 and that EU is on track to meet its 2020 target – that is by 2020, 20% of its energy should come from renewable sources [7]. The share of renewable energy in transport sector was 6.7% in 2015, suggesting an insufficient progress toward achieving an estimated target of a 10% gross final energy use in this sector [7]. A trend analysis by the EUROSTAT showed that GIC of energy in EU remained relatively the same from 2005 to 2008, but decreased significantly by 5.8% in 2009 – plausibly due to financial and economic crisis- before a modest rebound of 1.2% in 2015 among EU-28 GIC [8]. Interesting, the level of GIC reported in 2015 was almost the same level seen in 1990 despite a 33.3 million population increased in EU-28. The GIC of each EU member state depends on a number of factors including the structure of the energy system, the primary energy production and economic development of each Member State. Thus, Germany (19.3), France (15.5%), United Kingdom (11.7%) and Italy (9.6%) accounts for 56.1% of the EU-28 GIC while a half of EU-28 Member State had a lower GIC in 2015 when compared with the 1990 level [8].

In regards to primary energy consumption by fuel, it was reported that increase of about 200 million tonnes of oil equivalent (Mtoe) from 2005 to 2030 will be met by renewables and natural gas, with renewable showing the greatest increase – 90% from today to 2030 [9]. Power generation is projected to show the greatest increase in the use of RES, followed by transport and heating and cooling systems. While solid fuels are expected to exceed their current level by 5% in 2030, following increase in oil and gas prices in certain Member States, fossil fuels is projected to experience a significant decline in 2030 as opposed to the 1990 level [9]. Oil production was reported to have peaked in 1999, but will see a 77% decrease in 2030 when compared with the peak value [9].

3.1.2 Industrial sector

Although it is projected that industrial sector will recover from the economic crisis and will follow an upward trend in the future, energy consumption in this sector will grow at a slower pace than the activity of the sector [6]. Energy efficiency improvements brought about by the use of RES will offset the growth from industrial sector and as a consequence, energy consumption will marginally change over time. The above trends will likely be followed by a decrease in the use of coal and oil (Figure 3-4), favoring RES and to a lesser degree, electricity. The fuel switch is associated with the compulsory emission reduction guidelines that industries should achieve and the increased prices of fossil fuel.

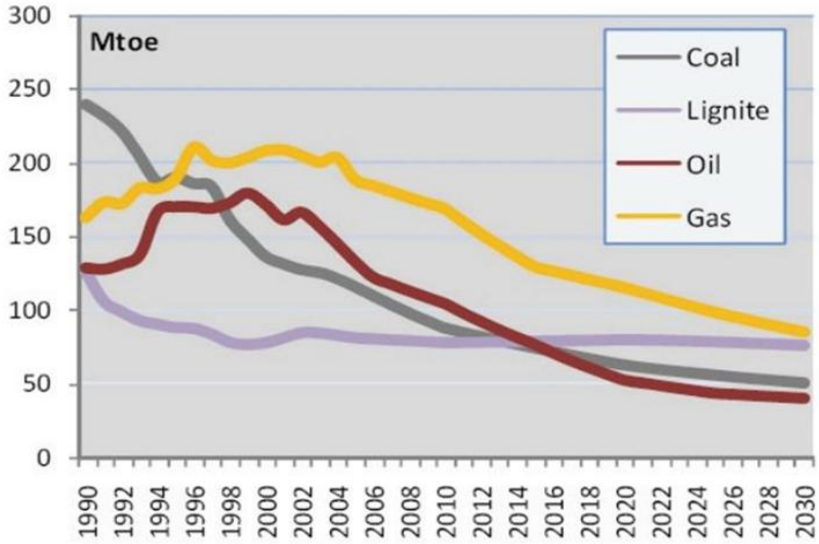

Figure 3-4 Primary indigenous Production of fossil fuels in the EU-27 [9]

3.1.3 Residential sector

Energy demand/consumption in residential sector is expected to plateau or possibly decline in future. After 2015 and beyond, energy demand in residential settings remains lower than the level seen in 2010 (Figure 3-5) [6]. This decline is driven by policies and regulatory provisions (such as EPBD) for the residential sector which centres on energy efficiency savings. As a result, residents will be able to improve their energy efficiency saving via: the use of more efficient smart equipment (for example, electric appliances, heating and cooling appliances, and energy monitoring equipment etc.); the upgrade of energy features of building (thermal integrity of building) and; behaviour change in energy consumption [6]. Additionally, after 2030, the use of oil in residential settings decreases, favoring the use of gas – owning to its relative low price when compared with oil.

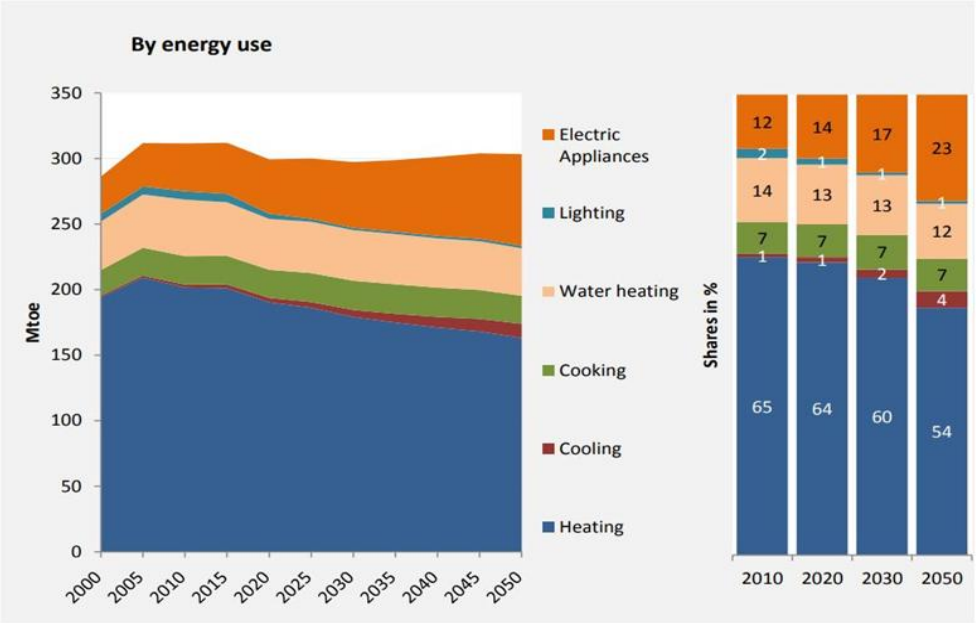

Figure 3-5 Final energy demand in the residential sector [6]

In February 2016, the Commission proposed and EU heating and cooling strategy10 to make heating and cooling more efficient and sustainable, reduce energy imports, cut costs for households and businesses and to deliver the EU's greenhouse gas emission reduction goal (commitment under the COP21Paris agreement).

Buildings (industrial, commercial and residential) are the first consumers in heating and cooling. 45% of energy for heating and cooling in the EU is used in the residential sector, 37% in industry and 18% in services (Figure 3-6).

Two thirds of the EU's buildings were built when energy efficiency requirements were limited or non-existent; most of these will still be standing in 2050. Increasing energy efficiency of the buildings with simple renovations (wall insulation, double glazing and replacement of old appliances) will reduce energy demands for heating and cooling. To achieve the decarbonization goals of the strategy buildings need to beestablished. This would involve building renovation with intensified efforts in energy efficiency and renewable energy, supported by decarbonized electricity and district heating.

Investments in buildings with better environmental performance are projected to enhance economic benefits through increased building value, increased asset value and reduction in operational cost. Although the cost associated with environmental certification of buildings may not change in the future, cost related to environmental improvements are projected to decrease owing to the standardisation of green infrastructure and construction processes over time (21).

Also, cogeneration plants (electricity and heating) could be an effective way to supply energy to remote areas and result in lowering GHG emissions[11].

[10] https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v14.pdf
[11] https://ec.europa.eu/energy/en/topics/energy-efficiency/cogeneration-heat-and-power

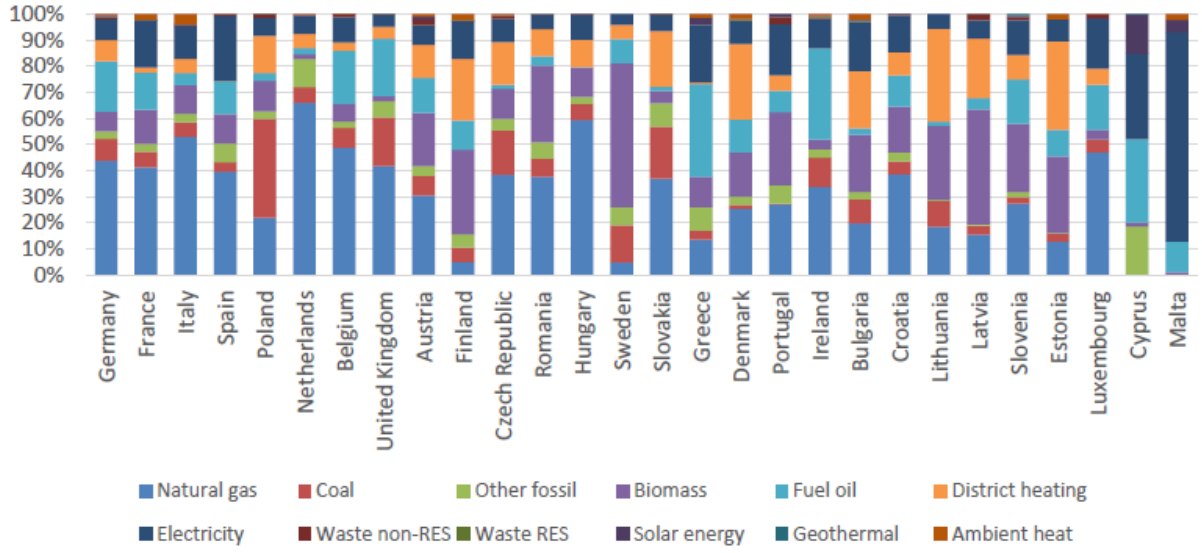

Figure 3-6 Final energy consumption for heating and cooling, 2012 [10]

3.2 EU Transport trends

Transport demand in Europe is significantly higher than in 2000 and this increase is expected to continue. According to estimates from European Commission, passenger transport is projected to rise by more than 50% and freight transport by 80% by 2050 when compared with the level reported in 2013 [11]. This poses a number of challenges to the development of greener, healthier cities. European transport systems depend mainly on oil consumption which not only releases air pollutants into the atmosphere but also greenhouse gases contributing to climate change [11].

3.2.1 Road transport

Frequency of use

Despite growing at lower pace compared to other form of transport (0.6% per annum, p.a.), road transport is projected to retain its dominant role in passenger transport, with private cars alone contributing to about 67% of the total passenger transport activity in 2050 [6]. The slight reduction in the growth rate of private cars is attributed to saturation levels of car ownership in many EU15 Member States, high congestion levels, increase in fossil fuels and the ageing population of EU member States (2). Passenger transport via buses and coaches and powered 2-wheelers would grow at slightly higher rates than private cars by 2050– 0.7% p.a. and 1.1%p.a. respectively [6]. All in all, road transport activity undertaken via buses and coaches, powered 2-wheelers, and private cars would decline from 84% reported in 2010 to 76% in 2050 [6].

In some European countries, the decline in the use of private cars and buses may be associated with age, sex and geographical location. For example, in the UK, the average number of private cars per person decreased by 12% from 1995 to 2013, with major decreases seen among men aged 30 and over, the young and London residents [12]. The number of female drivers, on the other hand, increased within this time frame [12]. There is no clear justification for this trend. However, some plausible explanations exist including falling number of company cars, young people remaining in their parent houses for longer period of time and improved public transport in urban areas. In regards to buses,

there has been a notable decline in its use across the UK. Nevertheless, bus use in London has doubled and the trend is projected to continue owing to a lot of factors – such as population growth, introduction of the smart Oyster card systems (making the use of buses easier and affordable), increased number of buses (which saves passengers time), integration of buses with public transport, and the introduction of congestion charging [12]

One important means of road transport that has received recent attention is cycling. Cities such as Amsterdam and Copenhagen are leading the way, with 28% and 32% respectively, of all inhabitants' trips covered with bicycle [13]. Although, the modal share of cycling in Netherlands has been more or less stable over the past three decades, and this trend will likely remain the same by 2050 and beyond [13]. Given the paucity of strong time-series data, particularly on key cycling indicators including number of trips covered per capital, projection of current cycling trends into the future may be difficult if not impossible [14]. OECD European countries including Denmark, the Netherlands, and the UK with available data showed an increased mode share by 0.2% points per year, though this may be subject to a maximum of 2 percent per year [14].

Driverless cars

The ability of cars to drive partly or fully by itself, with little or no human assistance has been set to the short-term objective of 2020 by the auto industry for its actualization [15]. Presently, more than 90% of road accidents are attributed to human errors and inattention including speeding, distraction and drink-driving [15]. With autonomous driving, road accidents and auto fatalities could be drastically reduced in the future. This was supported with a study that found self-driving cars was 3.2 crashes per million miles compared to average human driving of 4.2 accidents per million miles (European Commission report on "autonomous cars: a big opportunity for European Industry) [15].

Usage model

The way people use cars is changing, with a trend away from car ownership and a rise in the field of shared mobility [12]. It was reported that an average of 89 cars were shared per million citizens in 2011. Two years later, the number rose to 115 cars per million citizens – representing a compounding annual growth of 14% increase p.a. There is also a rise in the use of hired taxis or minicabs, and the trend is projected to continue. In order to respond to the number of cars available for consumer demand, companies, such as Uber, employ the use of location awareness and smartphone connectivity to tackle this challenge [12].

3.2.2 Aviation

Air transport is projected to be the fastest growing modes of passenger transport, rising up by 133% between 2010 and 2050 – about 2.1% p.a. [6]. A possibility for air traffic growth as a result of holiday trips and affordability of flying is anticipated in EU12 with faster growing GDP per capita. However, with EU15, air transport activity is projected to increase at a lower rate owing to weaker growth of GDP per capita [6]. All in all, aviation activity will see an increase in passenger transport from 8% in 2010 to 13% in 2050 – becoming the major means of passenger movement after road transport [6]. While EU directives have facilitated a 90% decrease in measured noise pollution from aviation, the number of people residing within less than 1 km from various airports has increased [6]. Thus, it is expected that many people will report being "highly annoyed" by aviation noise pollution in the future.

3.2.3 Rail

Passenger transport via rail is expected to increase by 79% – 1.5% p.a. – expanding the modal share by 2% (from 8% in 2010 to 10% in 2050) [6]. This increase will most likely be driven by the completion of the TEN-T core network by 2030, which in turn, will lead to a comprehensive network by 2050 [6]. With high speed rail, the increase in regards to volume of passengers is projected to be 2.5% p.a. over the same time period, mainly due to infrastructure expansion and upgrade of existing railway lines.

Taking into account population growth, passenger rail will compete with both road and air transport. In EU15, additional demand of passenger transport will be covered by rail [6]. Furthermore, given the decrease in car use due to increase in fossil fuel prices, economic growth and increased competition that has led to fare choices, part of passenger transport will be shifted to rail.

3.2.4 Freight transport

Freight transport is projected to increase by 57% between 2010 and 2050 – about 1.1%p.a despite showing a decline in activity previous years (lower levels in 2010 as opposed to 2005) due to economic crisis [6]. The completion TEN-T core network by 2030 deadline and the comprehensive network by 2050 is anticipated to offer more transport infrastructure coverage [6]. The highest growth in freight transport would occur in the EU12 – 72% between 2010 and 2050 – due to GDP growth [6].

In regard to the mode of freight transport, rail is projected to show the highest growth in freight transport, increasing its modal share from 16% in 2010 to 18% in 2050 –about 1.5%p.a [6]. This increase will be driven by the completion of the TEN-T core network and comprehensive network. However, road freight traffic is expected to more than double between 2010 and 2050 (growth rate at 1.1%p.a.), leading to a marginal reduction in the modal share of road transport (from 71% in 2010 to 70% in 2050) [6].

3.3 EU Population growth and urbanization

Presently, urban areas in Europe are facing significant challenges. Over 70% of the European population are currently living in urban cities with at least 50,000 inhabitants [16], and the number is expected to increase to 75% or more by 2050 (Figure 3-7) [17] – around three quarters of the population [18]. This will have major implications on the quality of the urban environment and urban health and will continue to impact on urban planning decisions. For example, European countries depend to a certain extent on imports to meet domestic demand for food – such as vegetables, fruits, tea, cocoa and seafood [19]. With population increase in urban areas, more pressure will be mounted on global ecosystems through conversion of natural habitats to agricultural farmland, thereby leading to biodiversity loss [19]. Approximately a third of the global biodiversity has already been lost due to land-use change (for agricultural purposes), infrastructural development, human encroachment of natural habitats as well as climate change and pollution, and further loss is projected to occur – with a 10% decline in terrestrial biodiversity by 2050 [20]. Moreover, European freshwater quality and quantity are impacted upon by direct pressure resulting from climate change and global pollution levels. Water scarcity and drought associated with the negative effects of climate change are expected to increase in southern Europe – a region where 80% of its surface water abstraction has been used for agricultural irrigation [18]. By contrast, flood damage is projected to increase in western and northern Europe [19].

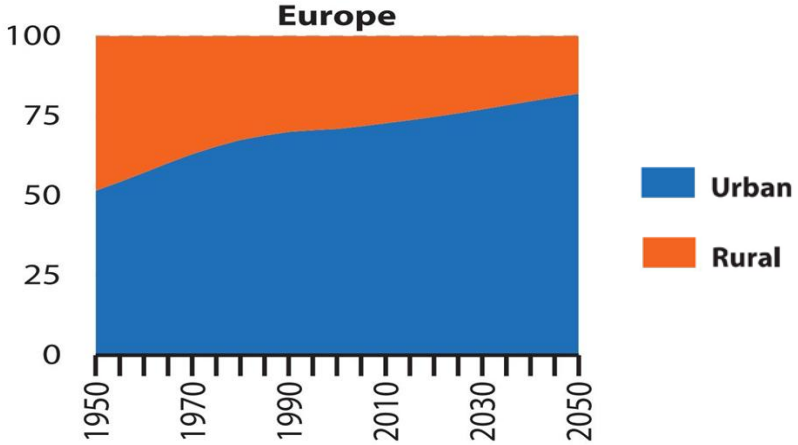

Figure 3-7 Share of urban and rural populations, 1950-2050 (17)

The population share of urban areas (cities, town and suburbs) in the EU-28 is increasing but at a slower rate compared to the increase reported in time part. For example, one percent increase was reported between 1991 and 2011 [16]. However, the population grew twice as fast in capital city from 2002 to 2012, with nearly all capital cities including London, Brussels, and Paris having the highest share of foreign-based residents. Considering the positive net migration and high natural growth particularly in capital city, it is likely that the population of urban cities will continue to grow.

Higher education institutes and jobs in cities attract skilled workers. A 2011 data for metro regions reported that 62% of residents in capital cities are between 20 and 65 years old compared to 61% in other cities and 60% in outside cities. With this in mind, urban planners should consider how to accommodate a growing elderly population in cities. Active ageing in cities can be encouraged by ensuring accessibility of public spaces, transport and smart buildings.

3.4 Urban economic development

Given the highly educated population, cities particularly larger and capital cities in EU tends to produce 68% of GDP, with 62% of jobs and 59% of the total EU population [16]. However, environmental health challenges resulting from climate change and pollution (air, soil and water pollution) will always be at their highest level in cities [16].

EU cities, especially those in the west, EU have good access to market via road, rail, and air. Successful completion of the trans-European transport network will improve access for many cities in eastern EU where rail services are slow and motorways are rarely available [16].

4 Developing green, smart and future city visions

Cities in order to face world's challenges such as urbanization and climate change (higher temperatures, extreme weather conditions, flash floods, poor air quality) need to implement policies and develop long term urban sustainable solutions (by using smart, green and clean technologies) that will increase livability and will improve quality of life. Predictions indicate that by 2050 the two thirds of the world's population will be residing in cities. This continuing urbanization will increase the number of mega-cities around the world. Rapid and unplanned urban growth threatens sustainable development while inadequately managed urban expansion leads to rapid sprawl, pollution, and environmental degradation, together with unsustainable production and consumption patterns. Thus, better urban design to allow sustainable population growth in urban areas and policy making that will ensure the benefits of city life are equitably shared are required for the development of a safe and healthy urban environment.

European cities will have to adopt a holistic model of sustainable urban development. Due to their density, cities offer a huge potential for energy savings and solutions for a more sustainable way of life. A shared vision of the European Cities of tomorrow[12] is that they are places of:

- Advanced social progress
- Democracy, cultural dialogue and diversity
- Ecological and environmental regeneration
- Engines of economic growth

The shared vision of the European model of urban development is one in which all dimensions of sustainable development are taken into account in an integrated way.

When designing a city, a long-term and ambitious vision is highly valuable. It must address the central question that is: what do we want to become, as a city, in 20 or 30 years from now? In the following sections different approaches on how cities could develop their future vision are presented.

4.1 Foresight Approach

This section provides a synthesized description on foresight research and evidence collection; the purpose is its potential use in ICARUS cities governance and long-term policy making.

In the following section an extended abstract from the recent UK research and analysis "Future of Cities" is provided while the approach and findings are presented in a way that they are applicable as guidance for ICARUS cities.

4.1.1 Abstract from the research and analysis "Future of Cities"

The Foresight project Future of Cities13 is a part of the projects, commissioned by the UK Government Office for Science, aims at exploring long-term development of UK cities by 2065. It deals with questions how UK cities work today and how they will need to evolve in the future to meet the challenges and opportunities that the coming decades will pose. A number of publications[14] in

[12] http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citiesoftomorrow_final.pdf
[13] https://www.gov.uk/government/collections/foresight-projects in 2014
[14] http://www.ids.ac.uk/idsorganisation/foresight

different forms are available as a result of the project. The following selected topics are abstracted from the above mentioned publications.

Science and evidence, in the broadest sense, are key to developing a better understanding of what makes successful cities both 'liveable' and engines of economic growth. New technologies and innovative design will have a key role to play but predicting the future is simply not possible. To help cities, and the people that live in them, be more resilient and dynamic, policy makers will need to be able to think in a structured way about different possible futures, some more desirable than others.

To support city policy makers, the Foresight project has developed a peer-reviewed, interdisciplinary evidence base. Understanding the past is a key to thinking about the future, so this evidence base looked backwards as well as forwards. The academic evidence has been enhanced by a series of seminars and interactive workshops which drew on the locally based expertise of those who make decisions in our cities today. This approach to evidence gathering has been critical to understanding the individuality of UK cities, as well as the commonalities. Understanding the interaction between the local and national, and how national policy impacts differently across the UK and across cities, is critical when thinking about how cities are designed, developed and delivered.

At the same time, and in parallel with the Foresight Future of Cities project, a vast and diverse body of research and policy development work was produced by think tanks, universities, research institutes and commissions. This work was aimed at influencing possible future directions for UK urban policy and city development. There is no lack of ideas about the future of cities. The extensive expertise and understanding of UK cities, and what might ensure they are prosperous, healthy places in future is impressive, as well as encouraging. Building a clear framework for cities to succeed and prosper has been, and should continue to be, a collaborative process.

All cities are unique, and this diversity means that there is no 'one' future of cities or model pathway to follow: those concerned with the future of a given city, or system of cities, will have to forge their own paths and do their own future thinking. Whilst predicting the future is impossible, the current phase of dynamic urbanisation and re-urbanisation means that it is certain that it will be substantially different from now.

City Foresight is the science of thinking about the future of cities and it may offer leaders a chance to set a new and distinctive direction for their areas, while engaging creatively with partners and citizens, including young people. Evidence for the *Foresight for Cities* report indicates that futures thinking can encourage an emotional engagement that may motivate people to become more involved with civic matters – such as finding opportunities for new social enterprises to deliver public services, or organising crowdsourced funding for environmental projects. This in turn may engender civic pride, rebuild trust in municipal leadership, and increase electoral turnout. Figure 4-1 below indicates groups engaged in city foresight.

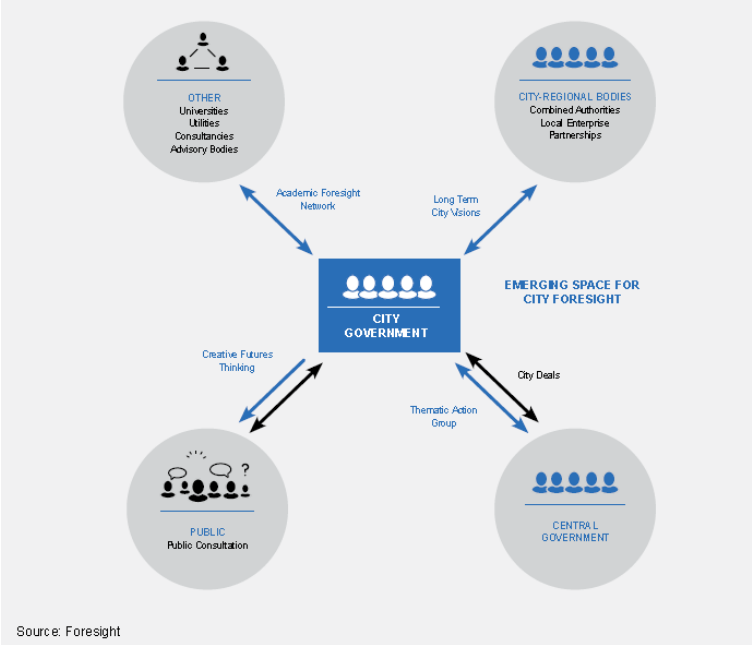

Figure 4-1 City Foresight groups' engagement (source: Foresight)

Project Focus: a long-term view on the future of UK cities in 2040 and 2065

In this context, the Foresight project has made a distinctive and specific contribution to the UK cities agenda by taking a longer term view of the future of cities. From a policy maker perspective, this is crucial as they need be able to navigate complex decisions, in a constantly changing environment, which will have impacts over a long timeframe. These decisions typically transcend sectors and areas of service delivery. For example, we are still living with the health impacts of the decision to promote car-oriented design in cities almost 50 years ago, and our cities are still adjusting to de-industrialisation processes that started in the 1960s.

To make effective decisions, policy makers need robust evidence about cities. The Foresight Future of Cities project combined traditional evidence gathering with expert insights from city officials, practitioners and decision makers. These were gathered through seminars and interactive workshops held in over 25 cities across the UK.

The academic, peer-reviewed papers, as well as shorter essays and the outputs of seminars and workshops, were published throughout the project. This extensive output can be found at https://www.gov.uk/government/collections/future-of-cities. But as cities constantly change and evolve so does the evidence base. Enhanced understanding and insights are being developed all the time and new solutions proposed. Therefore, even the best evidence gathered will only be a snapshot in time, quickly superseded by the next project or report. In this constantly shifting, fast-paced environment, the Foresight project identified that decision makers also needed methods for analysing new evidence as well as tools to help them consider the long run impacts of the decisions they take today.

Project Impact: methods and tools for decision making

As a result, the project focused significant attention on interactive workshops which used easily replicable methods and tools to draw practical conclusions about the future of cities at a national, local

and sectoral level. To support this and refine these methods, the project established the 'City Visions Network'. Over 25 cities joined, alongside national government officials, academics, urban designers, practitioners, business representatives and third sector organisations to provide unique perspectives and insights as well as understand commonalities about cities. Six cities led the way by running their own Foresight projects and in the later stages of the project, Milton Keynes Council launched their 2050 Futures Commission, drawing on the expertise of the network, as well as the Foresight project team. Detail of this city-level work can be found in the accompanying Foresight for Cities report.

As this work progressed it was clear that a high degree of collaboration and integration is required in most of the important issues affecting the UK's internal development. Central and local government will need to forge new and agile ways of working together to help tackle both local and national challenges. Inspired by the Cabinet Office's work to open up national policy making, the Foresight project conducted a place-based open policy making experiment.

The starting point was the repeated concern cited in our seminars and workshops that too many of the UK's graduates appear to gravitate to London, at the expense of other UK regions. The project reviewed the evidence, noted the important policy developments already in train, and then considered what practical innovations might be mounted to tackle the issues involved. This experiment brought together six cities, with their universities and central government departments, in an action group focused on working out how more UK city-regions could be attractive to graduate talent. The details of this work are contained in another accompanying report, *Future of Cities: Graduate Mobility and Productivity.*

Towards the end of the project, whilst the evidence base the project had gathered was extensive, it was apparent that there were still gaps in our understanding of cities. The project held an interactive workshop with all of the academic experts it had consulted over the last three years, as well as leaders from the major urban research initiatives within the Research Councils, to develop an agenda for future urban research, *The Science of Cities: Future Research Priorities*. The report examines what science can offer to understanding the future of cities, and in what direction research could most usefully be focused in future.

The Foresight project approach could benefit ICARUS cities and act as guideline on how to establish their long term visions as it offers practical lessons for implementing and managing a city foresight process that is aimed primarily at local government official's partners.

Summarizing, cities are constantly changing and the future of the cities cannot be easily predicted. But as cities grow there is an urgent need for strategic urban development and urban policy. A narrative-based approach of the foresight project could include the following steps:

- Understand the past through collecting science and academic evidence (analyzing trends) and identify where new or emerging science can inform policy
- Give this evidence to policy-makers to help them make policies that are more resilient to the future
- Use open policy-making techniques to explore issues identified for the city (e.g. graduate mobility)
- Encourage collaboration between national government and key local actors including local government, universities and employers to meet national challenges
- Establish bodies of research and policy development that will influence possible future directions for urban policy and city development.

5 ICARUS Methodological approaches on long-term visions

This section aims at providing methodological approaches on how to incorporate ideas of green, smart and healthy cities into one future vision in the longer-term, preferably by 2050.

5.1 Madrid methodology on developing the Air Quality Plan

A dynamic collaborative process that combined multiple qualitative techniques [22 -25], such as: literature review, semi-structured interviews to add expert views, and participatory workshops was implemented by Madrid in order to develop its Air Quality Plan.

The dynamic collaborative process proposed was characterised by: (i) a bottom-up process, in which experts (mainly practitioners from different sectors and policy-makers) could determine future visions on green and healthy; (ii) a dynamic implementation of the collaborative process, which evolved from preliminary literature reviews, semi-structure interviews with experts to specific participatory workshops focused mainly on policy-makers; (iii) a learning process, where participants could meet face-to-face, promoting transparency in mutual discussions, so that refinement of collective views could take place.

The methodological process was structured into four sequential phases (Figure 5-1): (i) Literature review to identify future trends on green and healthy cities; (ii) Semi-structured interviews to add experts' views; (iii) A face-to-face workshop to elaborate longer-term narratives; (iv) Selection of the final future narrative by using multi-criteria analysis.

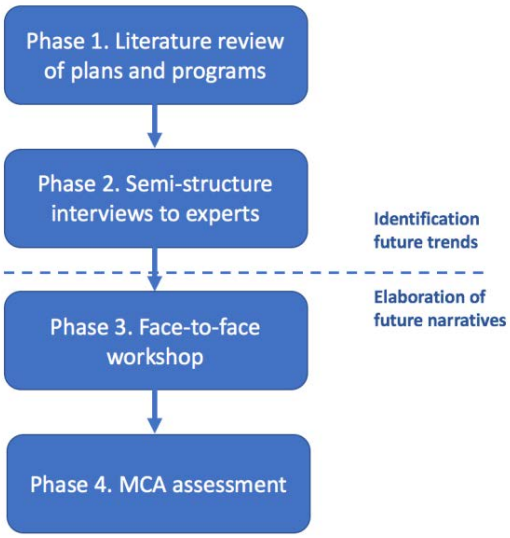

Figure 5-1 Dynamic methodological process structure

Phase 1: Literature review on future trends on green and healthy cities

The research team carried out a comprehensive review of a wider range of future trends associated to green and healthy cities (e.g. role of autonomous vehicle, urban compactness, etc.).

This review was based on academic articles and experiences across the world. Future trends were codified to be further analysed and used in subsequent methodological phases. Special attention was paid to existing plans and programs for each case study (e.g. city plan, air quality plans, infrastructures

plans, etc.). This would help to determine business-as-usual projection, as well as identify future trends which could be both plausible and reliable.

Phase 2: Semi-structured interviews to add future views

The future trends identified during the methodological phase 1 are the basis for the second methodological step. The obtained results were used for elaborating the general structure of the semi-structured interviews. That meant that semi-structured interviews should be focused on those future trends more frequently appeared during the literature review for each case study.

Methodologically, semi-structured interviews provide an open scenario building process, where the interviewer (the research team) has a series of general questions, as well as having some latitude to ask more detailed questions in response to what are seen as significant replies. Both local experts and representatives from citizens should be interviewed. Local visions will be added to the existing ones from phase 1, providing a more customised identification of futures trends for each case study. A total of 5-10 participants should be interviewed, including the wider range of professionals involved in city planning and public health issues, as well as representatives from citizens.

Each semi-structured interview consisted of a set of open questions according to the following structure: "What type of future do you desire in terms of… (incorporate here future drivers identified in the previous methodological phase. For example: (i) modal shift and travel behaviour; (iii) technological changes; (iv) accessibility and planning, etc.) for the city of Madrid by 2050?"

When necessary, these four questions were followed up with clarifying questions of why and when, as well as other clarifying words such as: e.g. biofuels; e-working; reaching daily destinations; etc. Each interview session was designed to take about 45 minutes, and they were recorded so that detailed analysis was possible later.

At the end of the semi-structured interview, participants were encouraged to add any other remarks they consider relevant for the city future.

The interviews in Madrid were conducted in May 2018. A total of 26 local experts and representatives from citizens, including NGOs, were invited to participate in the ICARUS interviews phase in the city of Madrid. Sixteen people took part in semi-structured interviews including key stakeholders, air quality and sustainable mobility experts, NGOs, citizens associations, automotive industry.

The list of participant is provided below:

1. Deputy Director of Traffic Control and Taxi Service Department, Madrid City Council.
2. Deputy Director of Sustainability Department, Madrid City Council.
3. Head of Air Quality Service, Sustainability Department, Madrid City Council.
4. Head of Environmental Health Department, Madrid City Council.
5. Head of Studies and Planning Department, Madrid Regional Transport Consortium.
6. Coordinator of Environment Department, Madrid Regional Transport Consortium.
7. Expert consultant in mobility, Municipal Transport Company of Madrid.
8. Researcher on air quality modelling, Technical University of Madrid.
9. Expert consultant in sustainable urbanism and mobility, Gea21.
10. Product Manager of Mercedes-Benz. Spain.
11. Director of Institutional Relations and Communication of the PSA Group for Spain and Portugal
12. Representative of *enbicipormadrid.es* cycling citizen association.
13. President of the Regional Federation of Neighbourhood Associations of Madrid.

14.Coordinator of environmentalist NGO, Ecologists in Action.
15.Air Quality responsible of environmentalist NGO, Ecologists in Action.
16.Spokesperson of environmentalist NGO, Ecologists in Action.

Responses in Madrid were processed following a systematic approach of coding, resulting in 331 different codes. Such codes were grouped in several rounds. On the one hand, codes related to urban form were systematically studied and compared (Figure 5-2). Responses highlighted the desire of the stakeholders in promoting Madrid as a compact, highly diverse, and green city. On the other hand, codes related to transportation and urban mobility were also analyzed and systematically compared (Figure 5-3). The obtained results showed how stakeholders preferred an increase in the electrification process of vehicles, followed by an increase in the public transport systems, and by an increase in the mobility-sharing platforms.

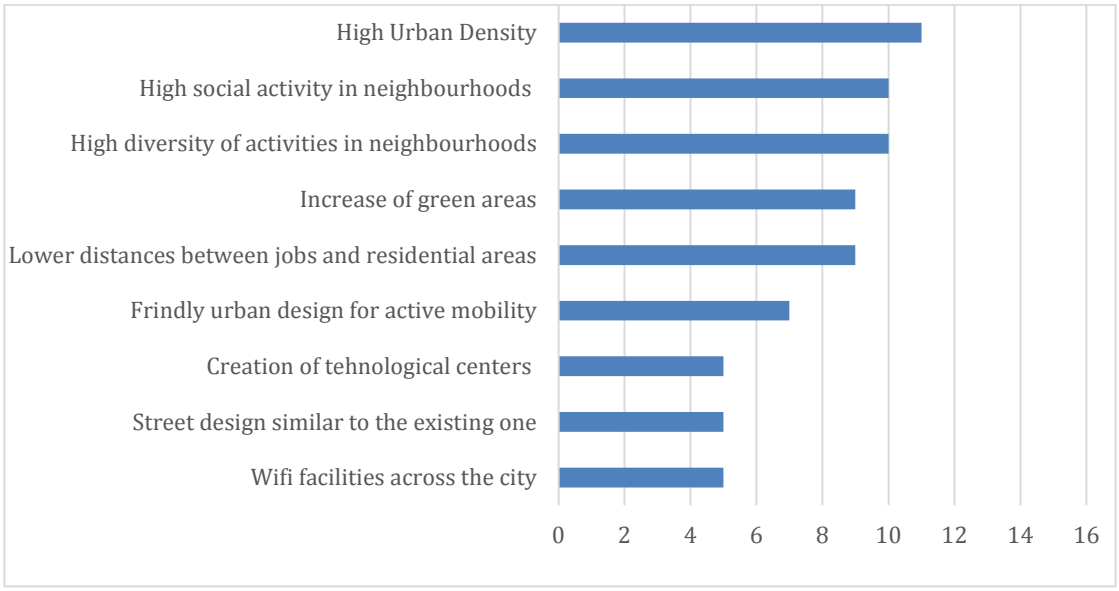

Figure 5-2 Urban form factors during Madrid responses

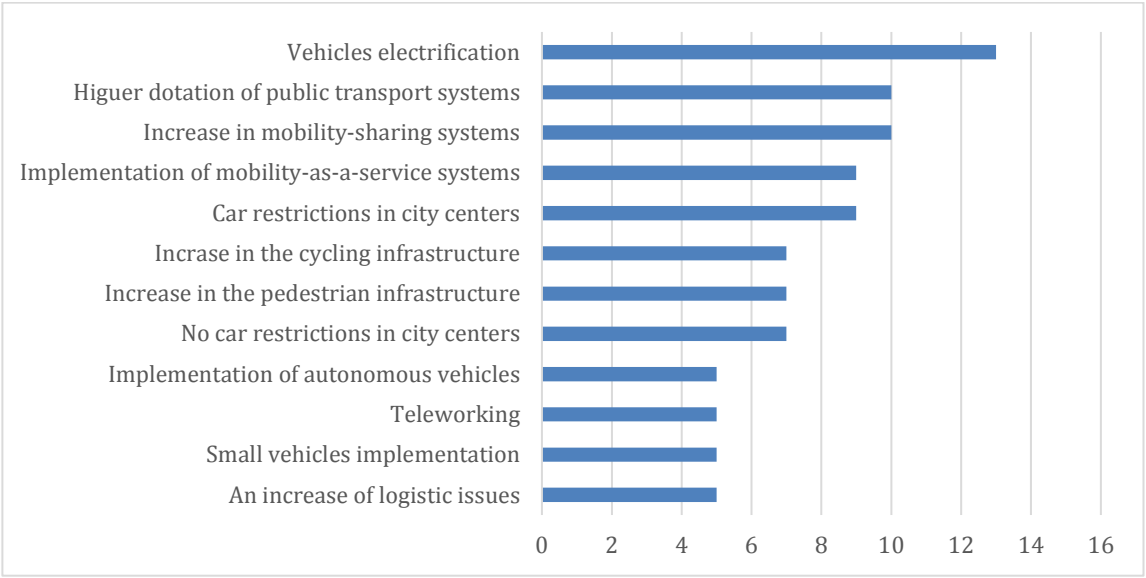

Figure 5-3 Transportation factors during Madrid responses

Phase 3: A face-to-face workshop to elaborate future narratives

Phase 3 was initiated through a workshop where local policy-makers were involved

The workshop entitled "*Participatory workshop: Towards a better sustainable and healthy city. Design of future scenarios for Madrid*" (face to face workshop) was held in Madrid hosted by the ISCIII, on 12th June 2018 (Figure 5-4). The aim of the workshop was: (1) to identify the two more relevant future trends that can led future narrative descriptions; (2) to elaborate future narratives on green and healthy cities for each case study; and (3) selection of the final future narrative by using multi-criteria analysis.
A total of 18 people from strategic sectors were identified, personally contacted and invited to the event. Several participants attended the workshop, representing the key stakeholders, air quality and public health experts, NGOs and citizens associations. List of the participants, according to their work organization are listed below:

1. Head of Air Quality Service, Sustainability Department, Madrid City Council.
2. Head of Environmental Health Department, Madrid City Council.
3. Specialist of the Energy and Climate Change Department, Madrid City Council
4. Researcher on air quality modelling, Technical University of Madrid.
5. Researcher on public health, Carlos III Health Institute
6. Coordinator of environmentalist NGO, Ecologists in Action.
7. Air Quality responsible of environmentalist NGO, Ecologists in Action.
8. Spokesperson of environmentalist NGO, Ecologists in Action
9. President of the Regional Federation of Neighbourhood Associations of Madrid


Figure 5-4 Madrid Participatory workshop

During the first part of this participatory workshop, the results obtained during the methodological phases 1 and 2 were shown to local policy-makers. This actually was a list of future trends on green and healthy cities customised for each particular case study. Workshop's participants were encouraged to rank those future trends, selecting the two more relevant for the future of green and healthy cities in the longer term. During the second part of the workshop, four narratives on future visions were elaborated by participants by using the two future trends identified in the first part of the workshop. To do that, a cross-axis methodology was used (Lyon and Davidson, 2016) (Figure 5-5).

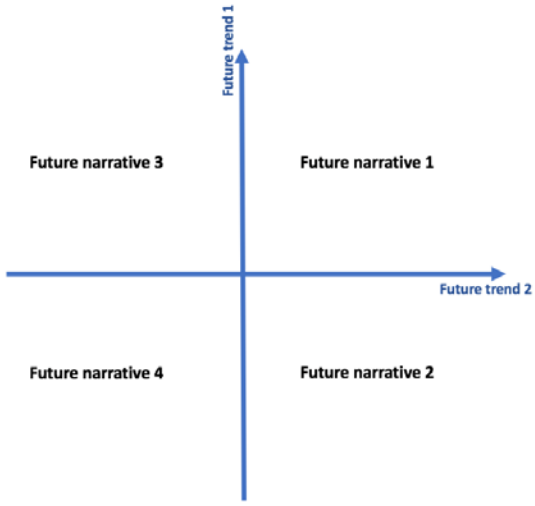

Figure 5-5 Cross-axis scheme to elaborate future narratives on green and healthy cities

The four future visions for the city that were finally obtained in the participatory workshop are presented in the cross-axis scheme in Figure 5-6 and include the following:
(i) "The car paradise", based on a situation where private car will predominate and the multifunctional level of the city will be very high; (ii) "The long distance city", for those situations in which the multifunctional level of the city will be very low and private vehicles will predominate; (iii) "The public transport paradise" for the situation in which public transport will predominate, but large distances should be covered due to the low multifunctional level of the city; (iv) "The slow city" for that situation in which public transport will predominate and the multifunctional level of the city will be very high. During the workshop the comments were recorded and the narratives for the four visions were finally elaborated.

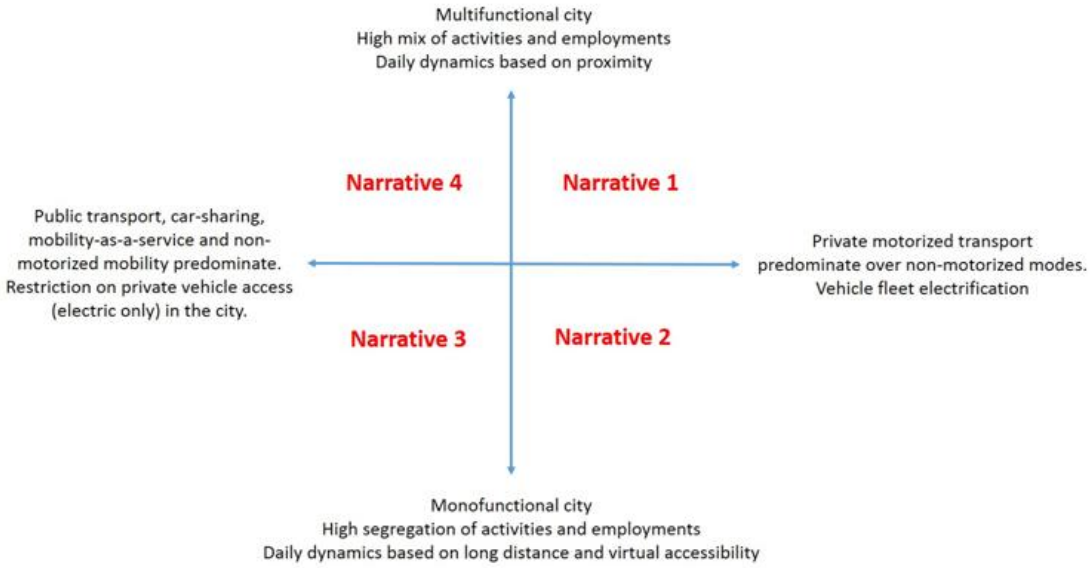

Figure 5-6 Cross-axis used to elaborate future narratives on green and healthy cities for Madrid case study during the Participatory workshop

Phase 4: Selection of the final future narrative by using multi-criteria analysis

Multi-criteria Analysis (MCA) was then used to select the final future vision between the four narratives elaborated during the previous methodological phases. The same local policy-makers that participated in the face-to-face workshop were asked to participate in the MCA questionnaire. Questions were based on the analysis which narratives generate more positive impacts for environment, economics, and society.

The Analytic Hierarchy Process (AHP) developed by Saaty (1987) [26] was used in Madrid case. The AHP method has been widely used in the transport field to rank transport alternatives in complex decision-making processes. It is useful to elicit individual preferences that are then aggregated into a collective decision. It is used to derive ratio scales from both discrete and continuous paired comparisons of sustainability impact categories. These comparisons were taken from a nine-point scale, which reflects the relative strength of preferences and feelings of policy-makers on the likelihood that specific impacts from each category can be generated by the four narratives. During the process, four pair-wise matrices (environmental, social, economic, and global matrix) were obtained for each future narrative and transformed into priority vectors. The combination of priority vectors provided weights to rank the impacts expected to be generated by each narrative. The narrative with the highest weight will be finally selected.

The preliminary results of the Madrid case study (Table 5-1) showed how the narrative called "the slow city" was seen as the most convenient for the city of Madrid, as well as the most desired between the stakeholders involved.

Table 5-1 Rank and weight of the impacts expected generated by each narrative

Environmental Factor	Weight	**Societal Factor**	Weight	**Economic Factor**	Weight
The slow city	0.66	The slow city	0.57	The slow city	0.54
The car paradise	0.16	The car paradise	0.28	The car paradise	0.24
The PT paradise	0.13	The PT paradise	0.10	The PT paradise	0.14
The long distance city	0.05	The long distance city	0.05	The long distance city	0.08

Finally the phases 1, 2 and 3 of Madrid case study were presented and discussed during the ICARUS Madrid workshop, 20th and 21st of September 2018.

5.2 Developing city vision through cities networks – *Athens, Thessaloniki and Milan Resilience Strategies*

International and global cities networks are dedicated to assist cities around the world to overcome the challenges of the 21st century by developing holistic strategies and setting targets aligned with existing policy frameworks. Cities must advocate for a long-term vision and set ambitious goals that guarantee resources (in the present and the future), citizen and stakeholders' engagement, relevant urban planning and solutions to the environmental challenges. Therefore, it is important for the cities to define local and specific short-term objectives and actions that will contribute to improve urban strategic planning, and, in the end, to achieve the longer-term vision.

Cities networks provide cities with tools and resources necessary to develop a roadmap to achieve future goals that set in their visions. Through networking cities can exchange knowledge on how to face challenges and share best practices and strategies with one another.

The 100RC network defines urban resilience as "the capacity of individuals, institutions, businesses and systems within a city to adapt, survive and thrive no matter what kind of chronic stresses and acute shocks they experience." 100RC supports the adoption and incorporation of a view of resilience that includes not just the shocks – earthquakes, fires, floods, etc. – but also the stresses that weaken the fabric of a city on a day to day or cyclical basis. By approaching cities in a systemic way and by focusing on both shocks and stresses, the resilience approach can prepare urban centers for a wide range of challenges both known and unknown, as well as become better in both good times and bad.

Within the context of the 100 Resilient Cities methodology, the city resilience journey begins with a diagnostic assessment that delineates its own significant challenges: its shocks and stresses. The 100RC provides an innovative model for the local authority to develop a holistic city strategy in collaboration with local academic institutions, the nonprofit sector, private stakeholders, citizens, and communities of the city. The City Resilience Framework (CRF - Figure 5-7) is a lens through which the complexity of cities and the numerous factors that contribute to a city's resilience can be understood. The CRF describes the essential systems of a city in terms of four dimensions: Health & Wellbeing; Economy & Society; Infrastructure & Environment; and Leadership & Strategy. Each dimension contains three "drivers," which reflect the actions cities can take to improve their resilience.

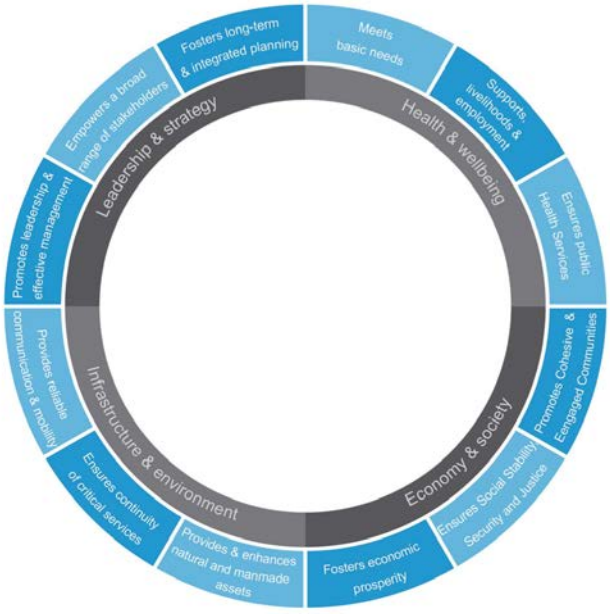

Figure 5-7 100 Resilient Cities - City Resilience Framework (CRF) (source: https://100resilientcities.org/resources/)

It is a useful tool to help cities explore the strengths and weaknesses of its systems. The CRF identifies 7 characteristics that various city systems need:

- Reflective, using past experience to inform future decisions
- Resourceful, recognizing alternative ways to use resources

- Inclusive, prioritize broad consultation to create a sense of shared ownership in decision making
- Integrated, bring together a range of distinct systems and institutions
- Robust, well-conceived, constructed, and managed systems
- Redundant, spare capacity purposefully created to accommodate disruption
- Flexible, willingness and ability to adopt alternative strategies in response to changing circumstances

In 2014, through a competitive process, the City of Athens and the City of Thessaloniki were selected to join the 100 Resilient Cities (100RC – *Pioneered by the Rockefeller Foundation*) network. Both Cities engaged in an intense and participatory process in order to draft and implement a holistic, robust and realistic strategy that supports and enhances the resilience of the city for the upcoming decades. Milan is also member of the 100RC and is currently developing its Resilience Strategy.

Athens Resilience Strategy

In order to further address challenges that undermine both the physical environment as well as the citizens' quality of life, the City of Athens also turned to partnerships and collaborations with international city networks, such as *100 Resilient Cities* and *C40 Cities Climate Leadership Group,* consolidating methods and resources, developing capacities and knowledge. As a result, in June 2017 the City of Athens Office for Resilience and Sustainability launched an up-to-date, comprehensive and integrated action plan, under the title *Redefining the City: Resilience Strategy for Athens 2030*[15], which is also aligned with the city's operational and strategic plans.

The Resilience Strategy for Athens 2030 was created in collaboration with city staff and elected officials, central government authorities, academics, nonprofits, entrepreneurs, and a large variety of citizens and community groups. Over a period of 18 months, more than 140 organizations and 900 citizens participated in many workshops, conferences or public events. Athens initiated and co-hosted international meetings with fellow cities; international and local experts worked together trying to get a better grasp of the challenges the city faces.

The Athens Resilience Strategy aims towards a city that is open, green, proactive and vibrant, setting forth concrete actions that address issues of maintenance, safety, efficiency and accountability, crisis preparedness and management. It presents a series of distinct yet connected actions with a clear vision of how the city can best cope with the increasing interdependence of shocks and stresses. This can be reached though eco social policies that elevate the role of local government and give it its rightful place as an important player in economic development, social welfare, environmental adaptation and technological innovation.

Meanwhile, also in 2014, the City of Athens (an active member of the C40 cities network since 2008) requested from C40 a technical on-the-ground support to help the city develop a Climate Action Plan for reducing greenhouse gas emissions and adapt to climate change. At the same time, equal importance has been given to adaptation; the climate adaptation action plan is used for increasing the city's resilience to climate risks, improving the quality of life and ensuring a sustainable future for the next generations.

[15] https://www.100resilientcities.org/strategies/athens/

The City of Athens is one of the very first cities that successfully combined and consolidated the methods, guidance and resources of the two international networks/policy organizations, integrating its Climate Change Adaptation and Mitigation Action plan within a robust, horizontal and forward-looking Resilience Strategy that addresses all city systems in ways that confer multiple benefits. As mentioned before, an essential part of this whole process involved engaging effectively a wide range of stakeholders from the public and private to the third sector and the academic community. This has been a bottom up process.

Thessaloniki Resilience Strategy

Thessaloniki, as mentioned, was selected in 2014 as part of the second cohort of cities to join the 100 Resilient Cities (100RC) network. Thessaloniki is a city in transformation with a long history and multi-culture that has experienced significant shocks and stresses during the recent past, a devastating fire and a major earthquake, but it has responded with resilience. *Resilient Thessaloniki: A Strategy for 2030*[16] was officially launched in March 2017.

To prepare the strategy, the Department of Urban Resilience followed a two-phase process. In Phase I, an initial resilience assessment was conducted and discovery areas were identified. In Phase II, these were explored further, alongside diagnostic and analytical activities that led to the final development of the resilience strategy.

The Resilience Strategy is based on eight city values (Social Cohesion, Local Identity & Heritage, Environmental Management, Health & Wellbeing, Youth Empowerment, Multi-stakeholder Engagement, Technology Adaptation, Economic Prosperity), which represent the city's identity and guide how will plan for the future. The values cut across four main goals that together form the basis of the strategy. These goals are broken down into 30 objectives and more than 100 actions, each with multiple benefits for the resilience of our city and population. Actions include policies, projects, and initiatives (existing and new) that connect goals and city values, from youth participation to clean power for mobility; from waste management to co-ownership of public space and risk reduction. The City of Thessaloniki joined forces with the Metropolitan Development Agency of Thessaloniki to create a strategy that delivers both local and metropolitan scale solutions.

More than 40 organizations and 2000 citizens participated in the city's resilience dialogue, ensuring the strategy aligns with and complements other strategic initiatives in the local, regional, national and international domain, including the city's 5 year Operational Plan 2020 and European Strategy for 2020.

Building Resilience into Milan's 2030 City Plan

Milan is currently developing its Resilience Strategy following the 100RC resilience journey. Milan is a financial, cultural, commercial and industrial center. The city has already identified the shock and stresses (environmental degradation, lack of affordable housing and riot/civil unrest) that have to deal with and build resilience. The city is also working to address challenges from climate change, including severe weather events such as heat waves, which pose worrisome health problems and drive energy consumption. Given its geographic position, Milan is also at high risk of various types of flooding. Officials have been working with regional agencies to mitigate flood risk in Milan, and coordinate more effective responses to emergencies. By 2030, Milan will be a city increasingly connected to its larger metropolitan area as well as the globe. At the same time, it will be a city with a local focus, with special attention given to the main squares and transport nodes that are central to the growing youth

[16] https://www.100resilientcities.org/wp-content/uploads/2017/07/Thessaloniki_Resilience_Strategy_PDF.pdf

population and the city's middle class. The city will be even more innovative and inclusive. A green and resilient Milan will require the same quality of urban space for the city center as for the suburbs; the city's 88 neighborhoods characterized by a strong local identity. By overcoming the physical, social, economic distances between the city and its periphery, growth will be inclusive, extended to all neighborhoods, and will engender improved quality of life for all residents.

6 Establishing long term visions in ICARUS cities

6.1 Evaluating long-term visions in ICARUS cities

The present status in the ICARUS cities on establishing long-term visions and related implementation of changes is provided below. Based on this information one can examine, which city has policies that would enable it to convert the vision into reality within a realistic timeframe.

Athens

Resilience Strategy for Athens 2030 was launched in June 2017 following the methodology of the 100 Resilient Cities – pioneered by the Rockefeller Foundation.

Name of concept or plan (year)	City Vision
Athens Resilience Strategy for 2030	By 2030 Athens strives to be a responsive, embracing and inspirational city that is proud, green and citizen led. We nurture creativity and innovation, creating prototypes of belonging, bridging history and progress. Athens is a city that listens and speaks with the world. Athens wants to be: - **An open city:** The City of Athens will achieve effective and efficient governance and manage to communicate and collaborate better with its residents by fostering data driven policy making and accountability. - **A green city:** We need nature in Athens. The city of the future will meet our human need for proximity to nature and be able to withstand climate change and environmental challenges. - **A proactive city:** Athens will streamline and up-scale its best "survival" skills, and through planning and communication, it will create trustworthy and a safe environment for its people. - **A vibrant city:** Athens will nurture and develop its assets in order to promote well-being, creativity, entrepreneurship and a new, inclusive, and exciting identity.
Athens Climate Change Action Plan (up to 2030)	The target set is to reduce by 40% the greenhouse gas emissions (compared to 2014) by 2030. - Residential sector; national energy saving programs; use of natural gas; dedicated campaigns to raise citizens' environmental awareness, (28% reduction) - Commercial and Municipal sector; energy upgrade of municipal buildings and public lighting; installation of PV; use of RES; promote nZEB (41% reduction) - Transport; upgrading municipal fleet, promote eco-driving, SUMP (41% reduction). - Solid Waste; organic waste diversion from landfills (100% reduction) - Manufacturing Industries and Industrial processes (21% reduction)

Basel

A prominent plan focused on energy and climate change aspects is the "Vision: 2000-Watt-Gesellschaft", a vision developed by Swiss Federal Institute of Technology in Zurich. The aim is to reduce primary energy output to an average of 2000 Watt per person by 2050. Basel adapted this vision as the first pilot region in 2001.

The most recent policy is the energy concept which was approved by the cantonal parliament in 2017. It only focuses on CO2 reduction and does not include mobility. The goal is to reduce CO2 emissions to 1tonne per person by 2050 and increase the percentage of renewable energy to 90% of the total energy. Short- and medium-term measures were implemented with the concept.

Name of concept or plan (year)	City Vision
Energy Concept 2050	The primary objectives of the plan are: - Limit CO2 emissions to 1t CO2 per year and person, increase renewable energy to 90% of the total energy by 2050 - Maintain electricity 100% renewable

Brno

The city of Brno has been working on its own vision, called Brno2050, since 2016 to now. The city of Brno has realized that a long-term strategy, targeting at 2050, is needed to formulate the general directions of city development for the following years. The Brno Vision and Strategy 2050 was approved by the city Council in December 2017. Once the strategy was finalized, more specific mid-term strategies were developed until 2025, based on the 2050 visions.

In 2016, the city of Brno created a new department specifically dedicated to develop future plan (Vision 2050) for Brno. This department is also responsible of so-called "smart city" development. A team consisting of various city departments was responsible of the evaluation of the Vision 2050 (namely Department of city data, Department for cooperation, Department for strategic planning and Department for Integrated territorial investment (Brno metropolitan strategy). Several meetings with different city stakeholders were held while a working group so called „City ecosystem" has been established, representing all possible actors in Brno (Science partners, Business alliance, Non-governmental organizations, Smart city community, Managing members and National and European Governmental level).

Name of concept or plan (year)	City Vision
Brno Vision and Strategy 2050	The Brno vision is structured in 3 pillars (with 25 subsections and each of the subsection has about of 10 indicators): - Quality of life - Resources - Government

Name of concept or plan (year)	City Vision
	The indicators included the life expectancy, the share of citizens confident with the council, the number of bilingual schools, water quality, percent of the people exposed to noise and the annual average air concentration of different pollutants.
Environment (2050)	- Improve the air quality to achieve the legal limits - Increase the use of public transport and reducing the use of motorized vehicles - Decrease emissions of air pollutants and GHGs in relation to the transport sector - Decrease anthropogenic emissions due to domestic heating

Roskilde (Denmark)

The long-term vision for Denmark is a 100% renewable energy (RE) supply by the year 2050. The capital of Denmark, Copenhagen, will play a key role during this transition for two key reasons: firstly, Copenhagen is the home of 10% of the population of Denmark, so actions made in Copenhagen have a major impact on the overall national progress, and secondly, the implementation of new technologies will require actions at a local/municipal level. In addition, different parts of the country will have different roles to achieve this goal.

Roskilde municipality is part of the Copenhagen Metropolitan area and therefore is in line with energy targets and the goals set at the "Regional growth and development strategy" of the Capital Region of Denmark below reported.

The Mathiesen *et al.* (2015)[17] study supports that converting to 100% RE is economically viable in Denmark, but some key technological changes will be required at the national level.

Name of concept or plan (year)	City Vision
Copenhagen Energy Vision 2050	The City of Copenhagen has a strategy to be CO_2-neutral in 2025. - Copenhagen energy vision 2050 is a sustainable vision for bringing the capital to 100% renewable energy. The pathway to achieve this target will include:Implementation of heat savings in buildings for energy demand reduction and investments in heat supply and distribution infrastructure. - Implementation of renewable energy sources, such as wind power, photovoltaic, solar thermal and geothermal energy. - Integration of the energy sectors by implementing smart energy technologies such as flexible CHP plants (Combined Heat and Power plants), large-scale heat pumps for district heating, and electrification of the transport sector.

[17] Mathiesen, B. V., Lund, R. S., Connolly, D., Ridjan, I., & Nielsen, S. (2015). Copenhagen Energy Vision: A sustainable vision for bringing a Capital to 100% renewable energy. Department of Development and Planning, Aalborg University.

Name of concept or plan (year)	City Vision
	- Changes to different transport modes, stabilisation of the transport demand, and implementation of electricity and sustainable alternatives to fossil fuels.
Denmark's energy plan 2050	The governmental target in Denmark is to have a 100% renewable energy supply at the country level in 2050. The pathway to achieve this target is structured with intermediate goals. **2020:** 40% CO2 emission reductions compared to 2006 **2030:** No coal in the energy system and no oil in the heat supply **2035:** 100% renewable energy in the electricity and heating sector **2050:** 100% renewable energy (incl. industry and transport)
Regional growth and Development Strategy of Capital Region of Denmark[18]	In 2020, Greater Copenhagen will be an international hub for investment and knowledge, in line with the most successful metropolises in Europe. The Capital Region of Denmark's regional growth and development strategy is based on an ambitious political vision of creating a green and innovative metropolis with high growth and quality of life, to be achieved through targeted investment within two frameworks that support the strategic growth areas: - Efficient and sustainable mobility, including cohesiveness in the region and green progress - Highly-skilled workforce and internationalisation, including qualified skilled workers and attracting international talent and four strategic growth areas. And four strategic growth areas: - Health and welfare technology growth, including increased public-private cooperation in research and innovation - Green growth, including conversion of the energy and transport system and green job creation - Creative growth, including attracting more tourists and professionalisation of the creative industries - Smart growth: including regional broadband and mobile phone coverage and sharing economy as a driver of growth.
Transport (2025-2050)	- 20% reduction in travel time on selected priority routes by 2025 - 40% reduction in noise and air pollution from the transport sector by 2025 - Fossil-free transport sector by 2050 - 35% increase in access to public transport to and from Copenhagen Airport by 2025 - Significantly improved international connections by 2025

[18] Regional Growth and Development Strategy, Greater Copenhagen, https://www.regionh.dk/miljoe/en-groennere-region/Documents/Regional%20Growth%20and%20Development%20Strategy.pdf

Name of concept or plan (year)	City Vision
Technology growth (2025)	- 5% average annual increase in private productivity in the capital region by 2025 - 5% annual increase in the number of patents issued in the health sector by 2025 - Increased access to testing facilities via a single, well-established portal at the region's hospitals and similar treatment facilities; the effect of their use assessed in an analysis of public-private partnerships - 40 new leading international researchers work and live in the region, combined with a 5% increase in post-doctorate researcher positions by 2025 - 3% annual increase in external funding from public and private sources by 2025 - 10% increase in employment in the health sector by 2025
Green growth (2025-2050)	- Fossil-free electricity and heating by 2035 - Fossil-free transport sector by 2050 - Capital region widely recognised internationally as being climate prepared by 2025 - Capital region resource efficient with at least 80% of its waste recycled by 2035 - 80% of ground-water resources safeguarded by 2025 against contamination from high risk areas, thus protecting the quality of drinking water - 8% annual growth in the green business and cleantech sector by 2025 - 2.5% annual increase in light railway passengers by 2025, in addition to 1% annual increase in related job creation by 2025
Smart growth (2025)	- 10 new large-scale solutions for patients involving core health sector tasks in the health service by 2025 - Annually increasing number of companies using intelligent urban solutions by 2025

Ljubljana

Ljubljana has no official foresight analysis. However, there are topical long-term considerations and documents available, for example a strategy on comprehensive traffic arrangements and strategic spatial plan. The traffic strategy is in the consultation phase at the moment; comments, critique, and proposals are invited by the city administration, while the spatial plan guides future urbanisation towards vital, green, and clean city, see www.ljubljana.si.

At national level a Vision of Slovenia 2050 has been recently published. . This vision presents general desires and aspirations as seen by the current government.

Name of concept or plan (year)	City Vision
Vision of Slovenia 2050[19]	In harmony with our environment and our era, we have achieved a balanced, highquality standard of living. By learning throughout our lives, we are well-equipped to take on the biggest challenges. We are innovative and translate ideas into actions. We create positive relationships based on trust and are building a society of solidarity and tolerance. With confidence, we open Slovenia to partners willing to cooperate. We are proud that our cultural uniqueness makes a difference around the world. In the Slovenia of 2050, we create new success stories. As active citizens and critical thinkers, we contribute to the shaping of society. With its unique development model, Slovenia is just the right size to foster flourishing innovation. By learning for and through life, we gain new knowledge and skills and increase our resilience to face new challenges. Creative individuals are at ease in the nexus of the institutional, social, and technological innovations of our innovative society. These innovations help us find solutions for pressing social challenges, such as the rapidly ageing population, inequality, and poverty. The relaxed and understanding living environment attracts successful individuals and enterprises to Slovenia. Their attention is first caught by excellent products and services, and then by high-quality scientific research and creative solutions. The vital generation of 2050 has left behind the divisions of the past. Today, mutual trust is of much greater importance and value. We also have trust in transparent and responsible public institutions. People respect their accessibility and user-friendliness, but first and foremost, their smooth and swift procedures. Excellently supported by an efficient legal system, we waste no time and energy in unproductive disputes. Rules are rules – they apply equally to all. We responsibly honour all intergenerational commitments. We respect the values of solidarity, security, tolerance, cooperation, and peace. In 2050, Slovenians are a happy people. Our everyday life validates the global prosperity rankings that put Slovenia in a top position. We have a high quality of life: we live better, healthier, and longer. Societal and environmental responsibility matter. We respect nature and manage natural resources in a sensible manner. Digital excellence and the circular economy drive our economic development and create new employment opportunities. We have made it – because we are bold, enterprising, and responsible. We highly value our time and devote it to things that bring joy to our lives. The greatest wealth of this country is its people. Ours is an inclusive and dynamic society. Our identity and culture foster cooperation in creating synergies and facing challenges. The Slovene language is a precious asset, and our unique culture is a great inspiration. Through determination, we have risen to prominence in global affairs. Owing to our geographic situation, connections and

[19] www.slovenija2050.si

Name of concept or plan (year)	City Vision
	infrastructure, we are part of a broader international context. In it, we assert ourselves with confidence, adaptability, and perseverance. In exchanges with their homeland, Slovenians living abroad add value to our global network. Slovenia's voice, reputation, and visibility reach far beyond its borders.

Madrid

Madrid is developing the *Air Quality and Climate Change Plan*[20] *(Plan A)* that was approved in 2017. Measures are structured in different action programs: (1) sustainable mobility, (2) urban regeneration, (3) climate change adaptation, and (4) public awareness and collaboration with other administrations. The *Plan A* also includes an impact analysis, as well as a monitoring and an evaluation plan. Two horizons have been considered in the timeframe: (1) short-term horizon, 2020 for the achievement of the air quality objectives required by the regulations, and (2) long-term horizon, 2030 for the energy transition and consolidation of the low emissions city model.

Name of concept or plan (year)	City Vision
Air Quality and Climate Change Plan (2030)	The specific objectives of the Air Quality and Climate Change plan are: - Implement air quality legislation at European and national level. - Achieve particulate matter air quality levels according to the World Health Organization guideline values. - Reduce GHG emissions of Madrid by at least 40% by 2030, compared with 1990 levels. - Fulfill the commitment to reduce 50% of GHG emissions caused by urban mobility in 2030, compared to 2012. - Develop an adaptation strategy to the effects of climate change, reducing urban vulnerability to the risks associated with global warming.

Milan

In 2050 in the city of Milan densification tendencies will be most significant for central zones, but will involve, to some extent, all areas that are urbanized at present, except areas under environmental protection. The 2050 post-carbon vision for Milan sees a city that is dense, spacious, green and rich in biodiversity, suitable for pedestrians, and uses carbon-free transport. The energy sources are renewable, with energy-efficient technologies employed. In Milan, people are sensitive to environmental issues and use accessible services with a low carbon footprint. The city has experienced

[20] https://www.madrid.es/UnidadesDescentralizadas/Sostenibilidad/CalidadAire/Ficheros/PlanAire&CC_Eng.pdf

a general change in direction from previous patterns of carbon-intensive consumption and emissions. Milan has a green economy, with continuously improving economic, environmental, and social well-being. This success has been achieved by setting short-term goals – once one is achieved, the next goal is set, to limit costs and maintain momentum. The municipality of Milan, in November 2017, has pledged to develop and begin implementing more ambitious climate action plans to deliver emissions neutral and climate resilient cities by 2050. These plans will ensure the city deliver on their share of emissions reductions required to realize the ambition of the Paris Agreement. In concrete terms, these climate action plans, developed with the support of *C40 Cities*, will help cut their emissions steeply over the next decade, and reach net-zero emissions by 2050. The plans will also demonstrate how city will adapt and improve its resilience to climate-related crises and extreme weather events. Finally, the plans will detail the wider social, environmental and economic benefits for all citizens, of taking climate action. The six primary sectors identified in the 2050 vision for Milan include social issues, mobility and transport, land use, environment, energy, and innovation and technology.

- **Social:** Due to the increase of immigration, the poverty level will increase to a very high 21%. Participative city society will become an active actor in dealing different social and environmental goal.
- **Mobility and transport:** In 2050 all public transport will be electric (or similarly low-emission) and 50% of private transport is fossil fueled. Milan will become the "City of sharing": different services will be accessible even through alternative or complementary forms of private transport.
- **Land use:** In 2050 Milan will become a very dense, spacious, and highly populated city. Despite the increase of human pressure the city will have an increase of the permeable surfaces in order to increase the land capability to absorb more quantity of rain.
- **Environment:** Milano is affected by floods and heat waves and in 2050 the scenario will be even worse. For this reason, the Mayor Giuseppe Sala and his team, is running different front-line initiative. Together with others European Cities, Milan has signed in July 2018 an open letter united their voices in support of the European Commission's mission to develop an European strategy for long-term greenhouse gas reduction in accordance with the Paris Agreement.
- **Energy:** The projected per capita GHG emissions for 2050 are low by current standards, but the current gaps in actions result in total emissions of 1.9 million tCO_2eq per year. The main cause of this is the inadequate supply of local renewable energy and a reliance on national grid supplied electricity (a large portion of which is still projected to be based on fossil fuels in 2050).
- **Innovation and Technology:** At different level technology systems and networks will be integrated to effectively support all aspects of daily life. Promote telecommuting, access to services, and reduce the need to travel these are just some the aspect of the future impacts for Milano in 2050.

Name of concept or plan (year)	City Vision [27-32]
Milan's 2030 Plan	(1) To increase accessibility through massive investments in public transport: the construction of the new M4 metro line (connecting travelers from Linate airport

	to the city center in less than 15 minutes), the extension of other metro lines beyond the city boundaries, and the strengthening of the railway belt, in addition to the development of high speed trains and of the regional railway service. (2) Six areas in Milan's periphery, accessible to all and placed on strategic axes, will additionally be developed with the intent of attracting international investment and serving as centers of economic opportunity. (3) The new city plan provides for the reduction of land consumption by 4% – made possible by a unique approach corralling over 3 million square meters previously zoned for agricultural use or new construction. 20 new parks larger than 1 hectare, additional 65 hectares of green space. (4) Several initiatives for overcoming barriers between the inner and outer city, to favor safety, cohesion, and social inclusion, building off of widespread services which are designed in particular for young people, the elderly, and the most fragile sections of the population. (5) Diffuse regeneration of the urban fabric will be encouraged in specific areas, thus increasing urban quality, enhancing the functional mix and services, and overall facilitating the economic, social, and cultural development of the city's most vulnerable sectors.
Environment (2030)	With the adhesion to the new Covenant of Mayors, Milan will be committed to reduce its CO_2 emissions at least by 40% by 2030.
Innovation and Technology (2030 - 2050)	At different level technology systems and networks will be integrated to effectively support all aspects of daily life. Promote telecommuting, access to services, and reduce the need to travel. The municipality is working on defining new sectoral targets, towards zero-emission transport, net-zero buildings, 100% renewable energy, and zero waste, that will bring big benefits to its residents, including clean air, green jobs, more efficient housing.
Energy (buildings) (2030 - 2050)	New buildings will not consume fossil fuels and they will include facilities to park soft mobility vehicles. In additional to that many buildings will be able to produce energy feed it back into the system through the smart grid. In the city will be developed new technologically innovative applications that will support co-generation (heat and electricity produced from same energy source) network to use excess heat from industry to heat residential/commercial properties through the district heating/cooling network.
Mobility and transport (2030 – 2050)	In 2050 all public transport will be electric (or similarly low-emission) and 50% of private transport is fossil fueled. Milan will become the "City of sharing": different services will be accessible even through alternative or complementary forms of private transport. A more widespread network of public transport will be developed with the goal to include extension of the circular lines to connect outlying areas, to enhance rail service and to make Milan accessible and usable without a car. In order to raise levels of security, pedestrian areas and

	environmental islands will be created in the periphery of the city, especially to link the center to surrounding suburbs. In 2050 the goal is to have a pedestrian-friendly city with shared spaces. Mayor of Milan ensures that major areas of the city are zero emission by 2030, by signing the *C40 Fossil-Fuel-Free Streets Declaration* (in October 2017).

Stuttgart

The local plans that have been developed to address air pollution control and climate change in the city of Stuttgart mostly deal with short-term measures and policies with a time horizon until 2020 or until 2030. An exception is the energy concept (rough vision for 2050) and the project MASTERPLAN 100% Klimaschutz (100% climate protection). The project MASTERPLAN 100% not only shows the longest time horizon but also includes a strategic roadmap for an almost climate-neutral Stuttgart city until 2050 (95% greenhouse gas reduction in 2050 compared to 1990). It covers measures and policies on short-, mid-, and long-term implementation scales aiming to fulfil either a conservative trend or a more ambitious master plan scenario for 2050.

However, even the ambitious city scenario and related long-term developments show rather a relatively moderate trend development of urban activities than a visionary redesign of the city. General trends like increasing digitalization and electrification are taken into account, but for example the implementation of autonomous vehicles is not considered. The vision of a green Stuttgart should therefore include the integrated aspect of the traffic development and mobility plans regarding air pollution and greenhouse gas mitigation along with the long-term and inter-sectoral approach of the energy concepts (energy concept, MASTERLAN 100%). An ambitious vision for a future green and healthy Stuttgart addressing air pollution, climate change and human health at the same time does not yet exist.

Name of concept or plan (year)	City Vision
Masterplan 100% (Klimaschutz 100%) (2017)	Masterplan 100% climate protection is visioning a climate-neutral city Stuttgart by 2050 with a target of 95% greenhouse gas reduction compared to 1990 while halving energy consumption. The main objective is to have an energy supply without fossil fuels like coal and oil with an extensively use of renewable energy. In addition, a part of the vision is a traffic system strongly marked by electro mobility and a large expansion of foot- and bike-traffic. Within the next years of the project, measures will be developed and implemented.

Thessaloniki

The *Resilient Thessaloniki: A Strategy for 2030* was officially launched in March 2017. The Resilience Strategy is based on eight city values (Social Cohesion, Local Identity & Heritage, Environmental

Management, Health & Wellbeing, Youth Empowerment, Multi-stakeholder Engagement, Technology Adaptation, Economic Prosperity), which represent the city's identity and guide how the city will plan for the future. The City of Thessaloniki joined forces with the Metropolitan Development Agency of Thessaloniki to create a strategy that delivers both local and metropolitan scale solutions.

The Thessaloniki SUMP has been developed in the context of the ATTAC multi-national project (South-East Europe Programme) and covers the whole metropolitan area which includes 9 Municipalities.

Name of concept or plan (year)	City Vision
Resilient Thessaloniki: A Strategy for 2030	The strategy is based on eight city values that cut across four main goals (broken down into 30 objectives and more than 100 actions): - **Shape a thriving and sustainable city:** design and deliver urban and mobility systems that serve people with efficiency, environmental integrity, and strategic use of resources. - **Co-create an inclusive city:** invest in human talent, including skills, leadership, and entrepreneurship; align education and training to career paths; expand the role of boroughs as social labs; empower citizens and community-led projects; make the city welcoming to new residents; and enable cocreation in open and public spaces. - **Build a dynamic urban economy and responsive city:** develop an urban economy policy agenda which recognizes and supports existing and prospective local economic cluster activities and zones. Initiate new cross sector partnerships and update governance approaches to allow the city to respond more effectively to the needs of its citizens and a changing world through financial resilience, metropolitan collaboration, capital investment, and risk reduction management plans. - **Re-discover the city's relationship with the sea**: Integrate the economic and urban development of Thermaikos Bay by investing in the cultural and natural capital of the Bay for improved city life, restoring the ecosystem, monitoring environmental resilience, and designing a new governance system for managing these activities.
Thessaloniki Sustainable Urban Mobility Plan (SUMP)	The following common vision has been elaborated and adopted: *"The metropolitan area of Thessaloniki deserves a modern and sustainable transport system that connects people to the city. The connection to the city is not limited to providing convenient, fast, secure and affordable travel, but extends to ensuring quality in the natural, built and social environment. Urban transport is a product of collaboration between all stakeholders associated with the city towards a single system of urban and suburban transport & travel linking citizens and areas by means that support the economy, the environment and the quality of life"* The main objectives of the SUMP are: - To limit or even ban the use of the car in the urban area and particularly in the city center

Name of concept or plan (year)	City Vision
	- Enhancing the use of public transport by creating new or utilizing existing infrastructure - To encourage the use of other environmentally friendly modes of transport (bicycle, pedestrian) through creation of appropriate infrastructure and measures taken - Gradually change the mentality of moving in the city through various measures and campaigns - To reduced or even zero greenhouse gas emissions for private transport

6.2 Developing pathways to green, smart and healthy cities

In terms of developing pathways to green, smart and healthy cities, the following changes in the ICARUS cities will be explored for the purpose of evaluating their existing plans, orientation, and determination about long-term changes:

- **Urban planning**: this involves changing the role of residential, commerce, recreation, industry, transport areas. Trends like reduction of sales area, as more goods are bought via the internet, or increase in living space per person and more housing meeting the needs of the elderly would be considered;
- **Building development**: this would include better building insulation, mechanical ventilation, decentralized energy and/ or food production, e.g. integration of photovoltaics together with storage devices;
- **Transport planning**: shift to self-driven interconnected electric cars, modal coupling with public transport and bicycle use;
- **Improving energy and resource efficiency**: the most important driver towards green cities might be the improvement of energy and resource efficiency. Potential technical improvements will be analyzed, e.g. less energy use for transport technologies, information and entertainment, industrial processes; the development of efficient electricity and heat storage systems, efficient decentralized waste management, recycling and energy recovery systems supporting the cyclical economy. Furthermore we will analyze behavioural changes, e.g. virtual instead of real travel (for leisure and business), less meat consumption or new methods to grow meat more efficiently.
- **Urban digitization**: City data (use of sensors to collect data from parking and transportation, to trash collection, air quality, tree identity, irrigation etc.) should be available for the citizens and service apps should enable easier access to information that belongs in the public realm. Technological innovations could make public services more efficient, could benefit the city itself (in cutting costs) and improve the quality of life for the citizens (e.g. information updates at bus stops, air quality index, reliable services). Fostering data driven policy making help the city promote its transparency and become more accountable to its residents as well as achieve efficient and effective governance.

In terms of the approach and integrative evaluation method ICARUS is looking at 50 and more years into the future, so the generation of a detailed technology driven scenarios is not possible. Instead scenarios making assumptions with exploration of the improvement, i.e. the reduction of emissions

and then the reduction of health and climate impact is to be made. Thus identification of areas, where a change is most efficient/important could be identified.

For the transition pathway, a number of considerations are important:

1) **Research and development**: Which key technologies have to be further developed, as they are necessary for the visionary concept? Which development goals should be set?
2) **Continuous renovation/renewal**: What would be the necessary renovation or renewal rate (e.g. for buildings)? What would be technical/environmental requirements to be met for renovations and replacements (e.g. using technical venting systems)?
3) **Revolutionary change** (e.g. allowing only self-driving cars from a certain date on): What are the problems occurring in the transition phase?
4) **Behavioural changes**: Which behavioural changes would be necessary to support the transition?
5) **Energy and resource efficiency**: Which rate of improving energy and resource efficiency would be useful or necessary to enable the transition?
6) **Smart technologies:** how urban digitization could be achieved and what kind of smart technologies would be needed to support the transition into a smart city (e.g. the use of digital technologies and IoT to improve municipal processes for the benefit of residents)?

The analysis would be made for the ICARUS participating cities and long term visionary scenarios, guided by the participatory workshops with stakeholders and experts, will be presented in Deliverable 6.2.

7 Stakeholder Engagement Workshops

At the very beginning of the project, originating the strong role of community and city partners the 1st Stakeholder Engagement Event was organized in Athens on 3rd November 2016, hosted by Europe Direct. Around 50 national/regional/local stakeholders, policy makers & regulatory bodies, representatives from engineering & medical sector, industry & SMEs, academic and scientific community, NGOs, international organizations attended the workshop, while a wide dissemination approach was adopted by inviting an extensive list of local media and the press.

The agenda of the 1st Stakeholder Engagement Event included an introduction to the ICARUS methodological framework, open discussion and introduction with stakeholders, routes to stakeholder engagement through various communication and dissemination channels, integration of the ICARUS methodology into local/regional/national action plans and policy framework as well as reference to and connection with the Resilient Cities concept. The event aimed to exchange views and expertise with stakeholders and the community, initiating *win-win* strategies, designing policy solutions and promoting research activity that will contribute to reduce air pollution and mitigate climate change in urban systems.

During the workshop the ICARUS methodology was discussed and the several conceptual steps encompassing the framework were illustrated and discussed with the audience. During and after the stakeholder engagement meetings we have obtained feedback regarding the applicability and relevance of the exposed ICARUS approach in local urban realities. In particular in Athens the urban resilience plan was used as a flagship case for the project since Athens is one of the 100 resilient cities global network and the developments with regard to resilience would reflect options that would be applicable in other urban realities across the EU as well. The ICARUS methodology was updated to reflect the difficulties and explore the resilience solutions described in the Athens resilience plan by way of example for incorporating urban resilience considerations when addressing the development and evaluation of win-win solutions targeting urban air quality and climate change mitigation.

Figure 7-1 ICARUS 1st Stakeholder Engagement Workshop

The second participative two-day workshop for "Developing visions for Smart Green and Healthy Cities" with experts and stakeholders of ICARUS cities was held in Madrid on the 20th and 21st of September 2018. The aim of the workshop was to identify the more relevant future trends, and to elaborate future narratives on green, smart and healthy cities from the point of view of key stakeholder and strategic sectors experts. Several stakeholders of ICARUS cities participated in the workshop and had the opportunity to share and exchange views and ideas on developing long term city visions from a green and healthy perspective.

Figure 7-2 ICARUS 2nd Stakeholder Engagement Workshop in Madrid

The workshop process was structured into two phases: (1) first day (20th Sept), experts were encouraged to list future change factors and select the more relevant for the future of green smart and healthy cities in the longer term; and (2) second day (21st Sept), experts idea-sharing session and discussed with stakeholders from ICARUS cities.

An additional participative workshop with stakeholders and experts will be organized in Athens at the end of January 2019 to present and discuss further the initial results of the project.

Figure 7-3 ICARUS community and stakeholders attending the 2nd Stakeholder Engagement Workshop in Madrid

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