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

D5.2 – Two databases of a) policies and b) measures towards integrated win-win solutions on the urban scale

WP5 Integrated assessment for short to medium term policies and measures

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1 INTRODUCTION

1.1 Background

Air pollution and climate change are two major environmental concerns worldwide. Many cities in Europe and globally are affected by air pollution and are at the same time major contributors to the emissions of air pollutants and greenhouse gases (GHG). Effective city, national, EU level policies and measures to reduce emissions will have to consider the interest of citizens for clean air and will simultaneously have to rely on the feasibility of interventions of achieving these very goals.

Notwithstanding the air quality improvements within European Member States in recent decades, a significant proportion of Europe's population lives in cities where exceedances of air quality standards occur particularly regarding particulate matter (PM), nitrogen dioxides (NO_2) and ozone (O_3). This situation is deemed to have a major adverse impact on human health. The analysis of emissions data show that urban areas are responsible for almost 70% of European CO_2 emissions with urban transport accounting for 70% of the air pollutants and 40% of the GHG emission of European road transport.

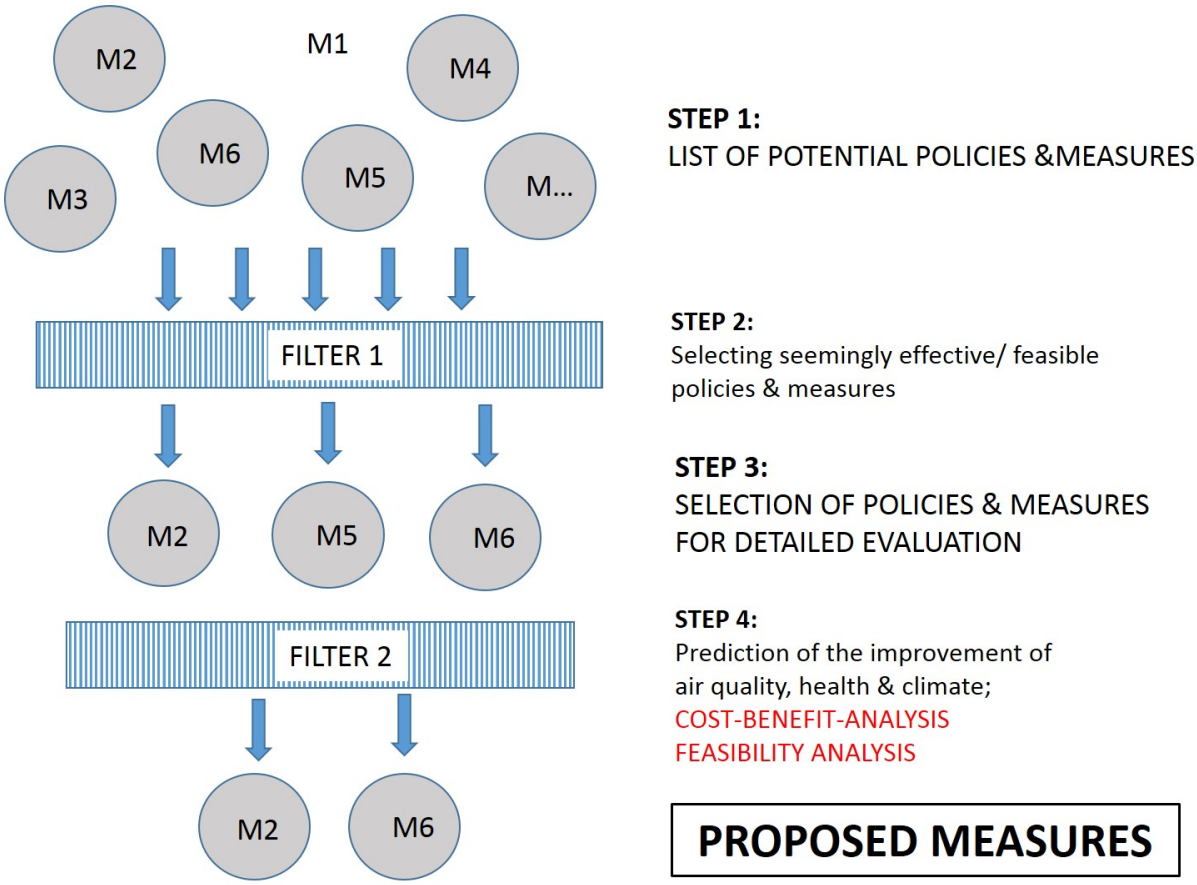
Despite the clear interconnections between Carbon Footprint (CFP), air quality (AQ) and GHG, the policies to control emissions and to improve air quality are still considered separately arriving often to contradictory results. ICARUS aims at developing an integrated approach to address simultaneously the needs for reductions in air pollution levels of cities and to identify the appropriate policies[1] as well as the optimal combination of technical and non-technical measures with co-benefits in air quality and climate change mitigation. Feasibility and applicability of both at ICARUS cities is of key consideration.

1.2 Description of policy/measure selection and evaluation process

The work presented in this report is a first step towards this goal and it presents the inventory of air pollution reduction policies and measures for each participating city (**Error! Reference source not found.**). In this phase over 720 potential policies and measures have been identified in relation to the incentives of the EU, national and municipal authorities, transport and energy providers. Within the *step 2*, a selection of approximately 10 policies/measures per city (97 altogether) was made based on the pre-defined criteria (described in detail in chapter 3); the application of *filter 1* thus resulted in a

[1] In ICARUS policies are defined as the use of eco-political instruments (command and control policies, taxes, etc.) to enforce environmental protection by public authorities, while the induced measures are reactions of lower level administrative bodies/operators of emission sources when confronted with policies. The term policies refers to urban policies as well as regional/EU wide policies, as long as the latter have a considerable effect on air pollution in cities. The measures analysed will include technical (i.e. measures that change emission factors such as use of filters, change of technical process with same output) and non-technical measures that change behaviour/decisions, for example, the use of bicycle instead of a private car.

selection of approximately measures per city that will undergo further evaluation in the following steps – *3, 4*. The focus is on energy consumption/supply and transport policies, as these are the two areas that have the most direct impact on both air quality and climate change. The detailed list of selected measures is included in Appendix 1.



Further steps will provide the answers whether the measures and policies identified actually have the potential of being implemented in a particular city along with the prediction of improvement (air quality, climate, health) and at what total societal costs. The latter include political and economic justification among the parties expected to be involved in the implementation, as well as changes in the urbanisation of the cities, reconstruction of the existing and construction of the new infrastructure, changes in transport of goods, energy provision and savings, agricultural changes, etc. The implementation of new plans will require citizen engagement and participation, which will eventually disclose which sets of measures will be perceived as good, and will be evaluated as the most effective/feasible and eventually acceptable for the society. Similarly, consideration of changes in other activities/sectors in the city, for example industry, energy supply/consumption, and other services towards lower pollution will constitute alternative policies/strategies for long-term health improvements. The comparative evaluation of alternatives will allow identification of the most appropriate strategies/options for a particular city which will then be a subject of integrated modelling that would lead towards the applicability of win-win solutions in the 9 ICARUS cities followed by the 892 cities in EU with over 50.000 inhabitants, and finally for the entire EU.

1.2.1 Organisation of the report

The report is organised in a following manner – after the introductory chapter (1), chapter 2 contains the description of international and EU policies regarding the air pollution and climate change, focusing on guidelines from WHO and EC directives with special focus on practical applications of the latter – for example Air Quality Plans and EU initiated and funded research projects. Chapter 3 gives insight on the potential abatement options (policies, measures) for the ICARUS cities and their selection for future evaluation, while chapter 4 provides the concluding remarks and guidelines for the future work within the WP5.

2 OVERVIEW OF POLICIES REGARDING AIR POLLUTION AND CLIMATE CHANGE

2.1 Overview of international/EU policies

For the air quality and climate change, a number of relevant international agreements, policies and frameworks exist that affect national and city level policies. On a global level, the United Nations Economic Commission for Europe's (UNECE) **Convention on Long-Range Transboundary Air Pollution (CLRTAP)** and the **World Health Organisation's (WHO) Guidelines** are seen as the important mobilising frameworks; the latter playing an important role in influencing national policies through a set of published guidelines for several air pollutants:

- **For transport:** prioritising rapid urban transit, walking and cycling networks in cities as well as rail inter-urban freight and passenger travel; shifting to cleaner heavy-duty diesel vehicles and low-emissions vehicles and fuels, including fuels with reduced Sulphur content; shifting to clean modes of power generation (for electric transit and vehicles);
- **For urban planning:** improving the energy efficiency of buildings and making cities more compact, and thus energy efficient;
- **For industry:** clean technologies that reduce industrial smokestack emissions; improved management of urban and agricultural waste, including capture of methane gas emitted from waste sites as an alternative to incineration (for use as biogas);
- **For power generation:** increased use of low-emissions fuels and renewable combustion-free power sources (like solar, wind or hydropower); co-generation of heat and power; and distributed energy generation (e.g. mini-grids and rooftop solar power generation);
- **For municipal and agricultural waste management:** strategies for waste reduction, waste separation, recycling and reuse or waste reprocessing; as well as improved methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste. Where incineration is unavoidable, then combustion technologies with strict emission controls are critical.

Many EU Member States are still falling short of agreed air quality standards, and the air pollution guidelines of the UN World Health Organization are generally not being met. Namely, a majority of Member States are currently subject to infringement proceedings for non-compliance with PM_{10} obligations, and a large number of them report exceedances of the annual average NO_2 limit value. In this framework the European Commission is currently reviewing the air quality legislation aiming at updating health and environmental standards, establishing new actions to reduce emissions for meeting interim objectives taking into consideration costs and benefits of these actions (EC, 2013).

While the Clean Air Policy Package adopted by the EC in 2013 has brought significant reductions in concentrations of harmful pollutants such as particulate matter, sulphur dioxide (the main cause of acid rain), lead, nitrogen oxides, carbon monoxide and benzene, major problems remain. Fine particulates and ozone, in particular, continue to present significant health risks since their limits are regularly exceeded. EU air quality standards and targets are breached in many regions and cities, and

public health suffers accordingly, with rising costs to health care and the economy (EC, 2013).. The total external health-related costs to society from air pollution are estimated to be in the range of €330-940 billion per year. The situation is especially severe in urban areas, which are now home to a majority of Europeans.

In the following a brief overview is provided regarding adopted and implemented policies in the EU in the past 3 decades in terms of reducing air-pollution and related health impacts:

A new **Clean Air Programme for Europe (2013)** where the importance of measures at national, regional and city level was stressed in order to further help cut air pollution, with a focus on improving air quality in cities, supporting research and innovation, and promoting international cooperation. The majority of such measures are likely to be non-technical; they encourage behavioural change, modal shifts in transport choices, or use fiscal measures to encourage the use of cleaner technologies to ensure that existing targets are met in the short term, and new air quality objectives for the period up to 2030.

- Framework Directive 96/62/EC on ambient air quality assessment and management and in accordance with the **Air Quality Directive (2008/50/EC)** sets ambient air quality concentration limits and target values for several substances. These were introduced in the context of an overall trend for significant declines in EU emissions over the last 10-20 years. This was particularly the case for SO_2 levels, but PM_{10} and NO_2 levels are declining much more slowly, and this is part of what the Directive was introduced to address. The Ambient Air Quality Directive air quality concentration limits and target values are generally less strict than the WHO guidelines (Table 1). In order to achieve these concentration levels, for air quality related emissions the **National Emissions Ceiling Directive (2001/81/EC)**, agreed in 2001 and amended in 2009 and 2016, sets national emission ceilings (NECs) for the EU Member States. Rules were also set for measuring air quality by the **Directive 2004/107/EC on Reference methods, data validation and location of sampling points for the assessment of ambient air quality**, which was adapted in 2005 and 2015.

Table 1: Air Quality Emission Standards comparison for selected main air pollutants: WHO and EU standards (maximum number of annual exceedances in brackets)

Pollutant	WHO[2]	EU[3]
PM_{10}	20 µg/m^3 annual mean 50 µg/m^3 24-hour mean	40 µg/m^3 annual mean 50 µg/m^3 24-hour mean (35)
$PM_{2.5}$	10 µg/m^3 annual mean 25 µg/m^3 24-hour mean	25 µg/m^3 annual mean
NO_2	40 µg/m^3 annual mean	40 µg/m^3 annual mean

[2] http://www.who.int/mediacentre/factsheets/fs313/en/

[3] http://ec.europa.eu/environment/air/quality/standards.htm

	200 µg/m^3 1-hour mean	200 µg/m^3 1-hour mean (18)
SO_2	20 µg/m^3 24-hour mean	125 µg/m^3 24-hour mean (3) 350 µg/m^3 1-hour mean (24)

In addition to these directives, there exist a variety of regulations and directives in the fields of energy and transport relevant for regulation of sources of air pollution. These are for instance the **Large Combustion Plants Directive (2001/80/EC)** and the **Regulation on light passenger and commercial vehicles (459/2012)** setting the so-called 'Euro-6' emission standards for cars.

Table 2 gives an overview of relevant EU and other international legislation concerning air quality.

Table 2: Legislation in Europe regulating emissions and ambient concentrations of air pollutants (European Environmental Agency (2016) Air quality in Europe — 2016 report, Copenhagen)

Policies \ Pollutants		PM	O_3	NO_2, NO_X NH_3	SO_2, SO_X	CO	Heavy metal	BaP, PAH	VOCs
Directives regulating ambient air quality	2008/50/EC (EU, 2008)	PM	O_3	NO_2, NO_X	SO_2	CO	Pb		Benzene
	2004/107/EC (EU, 2004)						As, Cd, Hg, Ni	BaP	
Directives regulating emissions of air pollutants	(EU) 2015/2193 (EU, 2015)	PM		NO_X	SO_2				
	2001/81/EC (EU, 2001)	(a)	(b)	NO_X, NH_3	SO_2				NMVOC
	2010/75/EU (EU, 2010a)	PM	(b)	NO_X, NH_3	SO_2	CO	Cd, Tl, Hg, Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V		VOC
	European standards on road vehicle emissions (c)	PM	(b)	NO_X		CO			VOC, NMVOC
	2012/46/EU (EU, 2012)	PM		NO_X		CO			HC
	94/63/EC (EU, 1994)	(a)	(b)						VOC
	2009/126/EC (EU, 2009c)	(a)	(b)						VOC

	1999/13/EC (EU, 1999a)	(a)	(b)						VOC
	91/676/EEC (EU, 1991)			NH_3					
Directives regulating fuel quality	1999/32/EC (EU, 1999b)	(a)			S				
	2003/17/EC (EU, 2003)	(a)	(b)		S		Pb	PAH	Benzene, VOC
International conventions	MARPOL 73/78 (IMO, 1978)	PM	(b)	NO_X	SO_X				VOC
	CLRTAP (UNECE, 1979)	PM (a)	(b)	NO_2, NH_3	SO_2	CO	Cd, Hg, Pb	BaP	NMVOC

Notes:

(a) Directives and conventions limiting emissions of PM precursors, such as SO_2, NO_X, NH_3 and VOCs, indirectly aim to reduce PM ambient air concentrations.

(b) Directives and conventions limiting emissions of O_3 precursors, such as NO_X, VOCs and CO, indirectly aim to reduce troposphere O_3 concentrations.

(c) http://ec.europa.eu/environment/air/transport/road.htm.

- The current framework for international climate policies is based on the 2015 Paris Climate Agreement (http://unfccc.int/paris_agreement/items/9485.php). It was signed by 195 countries and sets out a long-term goal of keeping the increase in global average temperature to below 2°C related to pre-industrial levels. The agreement also expresses the ambition to limit the increase to 1.5°C, since this would significantly reduce both the risks and the impacts of climate change.

The European Union has long been active in promoting ambitious climate policies – the latest was adopted in 2014 and consists of the following main targets:

- 40% cuts in greenhouse gas emissions based on 1990 levels;
- 27% share for renewable energy; and,
- 27% improvement in energy efficiency.

- Key policy objectives of the **7th Environment Action Programme to 2020** are aimed at:
  - protecting, conserving and enhancing the Union's natural capital;
  - turning the Union into a resource-efficient, green, and competitive low carbon economy;
  - safeguarding the Union's citizens from environment-related pressures and risks to health and wellbeing;
  - maximising the benefits of the Union's environment legislation by improving implementation;
  - increasing knowledge about the environment and widen the evidence base for policy;
  - making the Union's cities more sustainable;
  - helping the Union address international environmental and climate challenges more effectively.

2.2 Practical examples of policy implementations

In the following sub-sections we focus on the most significant EU efforts for reducing air pollution i.e. the introduction of the Air Quality Plans (AQP) and the initiatives for more efficient transport in urban areas and related measures.

2.2.1 Air quality plans

AQP serve as the strategy to reduce the negative effects, particularly in cities where the majority of the world population lives; it is to define air quality improvement policies. In this sense, the Member States (MS) are obligated to establish AQP for their zones/agglomerations (Costa et al, 2014, Silveira et al., 2016). AQP based emission abatement measures have to be designed and implemented in accordance to the Framework Directive 96/62/EC on ambient air quality assessment and management and in accordance with the Air Quality Directive (EC, 2008) whenever exceedances of air quality limit values are recorded (Miranda et al. 2015). The integrated assessment of the various improvement options - emission abatement measures, in relation to their economic and technical feasibility and to their effects on the environment and human health, are considered.

AQP are usually formulated following the two approaches: scenario analysis and optimization approach. Scenario analysis approach starts with the identification of control strategy measures as a result of poor air quality results. The proposed abatement measures and policies must be transformed into emission reductions and their impacts on the air quality, quantified using modelling tools. Policy implications, technical feasibility, resulting costs and environmental and health impacts are evaluated, but rarely within an organised stakeholder/citizen engagement process. In case an optimization approach is used the cycle is fully closed and costs and benefits are integrated towards the optimization of the measures taking into account cost–efficiency aspects (Miranda et al, 2015, Silveira et al, 2016).

Parameters mostly addressed by the AQP are particulate matter (PM_{10}), ozone (O_3), nitrogen oxides (NO/NO_2) and Sulphur dioxide (SO_2). The main source of PM_{10} and NO_2 pollution can be attributed to road traffic, followed by industry, commercial and residential sources. SO_2 pollution is primarily associated with industrial activity.

Within the AQP the following specific areas of interest can be distinguished (Miranda et al. 2014):

- Costs for implementation (equipment and maintenance) of abatement measures;
- Effectiveness of the measures in reducing emissions is assumed to be proportional to benefits on the air quality (using only monitoring indicators);
- Impact on air quality of designed measures based on modelling (validation with reference observed values);
- Air quality impacts on the human health or air quality impacts on both human health and environment.

The definition of effective abatement measures can benefit from source apportionment to identify the geographic origin of pollutants and the contribution of sources responsible for the air pollution exceedances. Thus, AQP abatement measures have been focused on the most relevant pollution

sources (Miranda et al. 2014). Abatement measures (technical and non–technical), are used and evaluated aiming to quantify their reduction efficiency and costs of their implementation and operation. Technical measures are the so–called "end–of–pipe–technologies" and they neither modify the driving forces of emissions nor change the structural composition of systems or activities, but are applied to reduce emissions before being released in the atmosphere. Non–technical measures reduce anthropogenic driving forces and can be related to people's behavioural changes (e.g. environmental education and awareness, car sharing, cycling, walking etc.) or to technologies that, reducing the energy demand, abate the fuel consumption (e.g. the use of high efficiency boilers or building thermal insulating coats).

The largest diversity of abatement measures can be associated to road traffic: technical measures, traffic management, public transport, traffic restrictions, road construction, speed reduction, street cleaning and others. Technical measures are closely related to technological improvements to reduce emissions (introduction of electric and hybrid vehicles). Traffic management options are mainly taken to reduce the traffic in urban centres and to regulate the circulation and parking conditions. Within the public transport category, the use of buses, trains, car sharing, bicycles or even walking is promoted. Traffic restrictions in certain zones can be introduced (e.g. EURO norms, fuel type, time of day and during the most polluted days). Other traffic related pollution options include the preparation and implementation of mobility plans (CIVITAS initiative, CH4LLENGE project).

The economic analysis as a part of the measure implementation process allows for an identification of alternatives/measures to improve the air quality, comparing their consequences or effects against their costs. These external costs (externalities) generated from air pollutants are related to the social welfare and economy, and can include both negative economic effects (damages) and positive economic effects (benefits, also described as avoided external costs) on the environment and health (EC, 2005). If benefits exceed the costs, the policy or measure is more effective and beneficial for improving air quality. The comparison of measures is examined through cost–effectiveness and cost–benefit analyses which, ideally, can prove an important decision-making parameter (Miranda et al, 2015, 2016, Carnevale C. et al., 2014, Schucht S, 2015, Mizsey P., 2009).

Air quality plans and associated assessment approaches present a useful reference for the ICARUS work process. Integrated assessment jointly addresses the environmental and health impacts of the mitigation measures, as well as their implementation costs and the economic quantification of damages/benefits. However, it must be pointed out that ICARUS has set to take the assessment one step further by introducing a detailed exposure assessment which is often lacking in the reviewed cases. Namely, the population exposure is addressed as static (e.g. population density, distance from the pollution sources etc.) without considering the variations in exposure such as geo-temporal parameters (Nieuwenhuijsen et al., 2015).

2.2.2 EU research projects focused on air pollution

An overview of selected EU projects is provided below which have presented a greater potential in terms of implementation of air quality related policies and measures to be referenced during the ICARUS lifetime and execution.

APPRAISAL – Air Pollution Policies for Assessment of Integrated Strategies At regional and Local scales, 7FP (APPRAISAL 2013 a,b)

The project objectives relevant to this review are to perform an overall review of the AQ and health assessment methodologies, to analyse the limitations of the currently available assessment methods, and to evaluate the possibility of implementing integrated assessment modelling tools. The Guidance on integrated air quality and health assessment systems which was developed and tested in seven cities/regions (Alsace region, Antwerp, Athens, Emilia Romagna, Helsinki, Northern Portugal, Warsaw agglomeration) builds on DPSIR approach (Driver/ Pressure/ State/ Impact/Response). The analysis shows that drivers and to a somewhat lesser degree the pressures and state were well treated and elaborated, while in none of the cases the health impact was considered with high level of detail and also the choice of abatement measures is mostly based on expert judgment. The approaches and tools for identifying air pollution, e.g. emission standards and factors from road traffic and industry combined with air dispersion modelling are well covered, however their transposition towards policy development for health impact reduction is scarce.

In the frame of the project an Integrated Assessment framework has been designed, classifying (in broad terms) two possible decision pathways:

- Scenario analysis. Expert judgment or Source Apportionment is used to identify potential emission reduction measures, which are tested through a “scenario analysis” modelling methodology. This approach has the advantage of simplicity but does not guarantee that cost-effective measures are selected. An evaluation of costs and impacts can only be performed "ex-post".
- Optimization. This approach uses optimization to identify cost-effective measures to improve air quality. During this optimization process, abatement costs and impacts are continuously compared until the least cost set of measures is found, to achieve a given air quality target.

The experience gained may be applied in ICARUS, however, the APPRAISAL showed lesser integral assessment potential in the studied areas than is expected in ICARUS. More emphasis is given on emission and immission/pollution part than on exposure and health impact assessment in the studied urban areas and regions; policies and measures for AQ and public health improvements are not included in the impact assessment.

CH4LLENGE project

The project served as a basis for developing a Sustainable Urban Mobility Plan (SUMP) for the cities of Brno, Ljubljana, Madrid, Milan. Generally, a number of physical and organisational measures are considered in the framework of a particular SUMP, e.g. land-use changes to support public transport, light rail systems, flexible working hours, integrated ticketing, new rails stations and lines, clean vehicles, pedestrian zones, low emission zones, speed reduction. Different tools are applied in an assessment exercise with regard to traffic calming strategies and reduction of congestion in the urban centres and their influence on air quality, e.g., KonSULT option generation tool (Brno), Infras/IWW (Ljubljana), Inventario de Emisiones y el Balance Energético (Madrid), AMAT (Milan) – scenario generation and analysis of demands, spatial and temporal distribution in transport.

The SUMP approach is conceptually similar to the ICARUS approach, with the exemption that emissions, AQ concentrations, and exposures are integrated more or less implicitly in the SUMP measures, while the ICARUS deals with these components explicitly and analytically. SUMP is concentrated on the approval and implementation of the measures and policies in transportation, while the ICARUS provides modelling results related to different air pollution sources as a basis for approval by the cities.

CIVITAS Policy Recommendations for EU Sustainable Mobility Concepts (Based on CIVITAS Experience, ISBN-978-80-86502-77-9, 2015)

The publication presents the main findings arising from the evaluation of the CIVITAS Plus Collaborative Projects (CPs), which ran from 2008-2012. It seeks to identify factors that can boost the effectiveness and consistency of future strategies, thereby securing greater sustainability in urban mobility patterns. Policy makers are provided with contemporary facts for debating purposes, and a number of conclusions and recommendations based on lessons learnt from CIVITAS Plus are put forward. The evaluation results lend support to a number of recommendations, which are structured according to the most relevant policy aspects. Some policy measures seem to be more established in their practical implementation, while others still require further and more in-depth technical and scientific investigation. Walking and cycling measures, or measures supporting public transport, for example, are encountered widely, while measures linked to clean fuels and vehicles or to ITS are less prevalent. Other measures need to be adapted to new mobility models and lifestyles, or they provide a new perspective on urban mobility services, as has been the case with carpooling and car-sharing.

The CIVITAS Policy Recommendations are to be considered and applied in WP6 of the ICARUS. The CIVITAS experience is invaluable in terms of developing EU Sustainable Mobility Concepts and concrete SUMPs.

NACLIM, 7FP, 2012-2017

The project was aimed to better understand the effects of the North Atlantic and Arctic oceans on global climate change. Climate change is predicted to cause more frequent and higher intensity extreme weather events, such as heat waves. Within the project the scientists also tried to understand the phenomenon of more frequent and higher intensity extreme weather events, such as heat waves and in particular the urban heat island effect, so that the end-users (such as European cities) can prepare for this better. Three cities have been selected for demonstration: Almada (Portugal), Antwerp (Belgium), and Berlin (Germany).

ICARUS is expected to apply knowledge developed in NACLIME in the following areas:

- downscaling of the spatially coarse resolution CMIP5 climate predictions to the urban scale,
- applying the urban climate model to obtain climate information at the urban scale from the CMIP5 forecast experiments,
- investigating the relation between heat waves and the urban-rural temperature increment (urban heat island effect),
- coupling the high-resolution urban climate prediction fields to relevant socio-economic data, focusing on the health,
- combining predicted urban climate fields with spatially explicit vulnerability maps (population density and typology, housing quality, age structure) in order to produce heat risk maps.

CLIMSAVE, 7FP, 2010-2013

CLIMSAVE was a pan-European project that developed an interactive web-based tool that allows stakeholders to assess climate change impacts and vulnerabilities for a range of sectors, including agriculture, forests, biodiversity, coasts, water resources and urban development. The linking of models for the different sectors enables stakeholders to see how their interactions could affect European landscape changes. The tool also enables stakeholders to explore adaptation strategies for reducing climate change vulnerability, discovering where, when and under what circumstances such actions may help. It highlights the cost-effectiveness and cross-sectoral benefits and conflicts of different adaptation options and enables uncertainties to be investigated to better inform the development of robust policy responses. Outputs from the linked models are translated into ecosystem services. Project results are summarised in Policy Briefs for Europe and Scotland, respectively. Both are valuable inputs for building on in ICARUS regarding impacts to/from agriculture, forestry, and urban systems. Environmental services are linked to wellbeing to express impact to humans, however health impact has been treated only indirectly, e.g. by number of people flooded due to extreme weather events. Cost-effectiveness module of the CLIMASAVE Platform, on the other hand could be useful for comparative assessment of measures and policy options in ICARUS cities.

AIRCLIM – Air Pollution and Climate Secretariat, http://www.airclim.org

The mayors of nine EU capitals have asked the EU institutions to adopt tougher mandatory legislation to minimise air pollution from cars, including a new Euro 7 “technologically neutral” standard for vehicles, and that all vehicle sales be “zero emissions” in the coming two decades.

In a letter dated 25 October 2017, the mayors of Paris, Rome, Amsterdam, Madrid, Copenhagen, Brussels, Helsinki, Vienna and Sofia wrote to the European Commission, the Council and the European Parliament, saying that they need “new tools” to cut air pollution and CO2 emissions from public transport fleets and private vehicles. They argue that zero-emission cars, vans and buses are the future solution for cities to provide clean, energy-efficient and affordable transport for their citizens, and call among other things for the introduction of mandatory sales targets for electric vehicles and a Euro 7 emissions limit that would be technologically neutral. The orientation of the nine EU capitals towards radical emission reduction from transport will be taken into consideration in ICARUS, particularly in the work of WPs 5 and 6.

MAPLIA - Moving from Air Pollution to Local Integrated Assessment, National Project (Portugal), 2013-2015, http://projeto-maplia.web.ua.pt/project/

Integrated assessment models for air quality planning (encompassing health impact assessment) like RAINS and GAINS models are not designed for and are not detailed enough to support the decision-makers at the sub-national scale (both sector-based or geographically), particularly in urban areas where a major share of the European population lives and where health impacts are more pertinent. Integrated assessment in terms of local air quality compliance, should therefore build on a bottom-up approach which links decision making, air quality (often non-linear) dynamics, source identification and consequent health impacts in a customised but consistent way to suit each local situation. This is the rationale of the MAPLIA project: to analyse the feasibility of an impact assessment bottom-up

approach for air quality planning, tailored to the local features, for which the policies defined at European or country level constitute an overarching policy constraint.

Publications (peers and others) based on this research are valuable reference points for ICARUS, since they demonstrate an integrated approach combining the effects of several emission abatement measures on air quality, impacts on human health, and associated implementation costs, which enable an effective cost–benefit analysis and an added value to the decision-making process. Basic steps and tools for integrating health into air quality assessment (health indicators, exposure-response functions) are described.

INVENTORY AND EFFECTIVENESS OF MEASURES TO IMPROVE AIR QUALITY – German Federal Environment Ministry (Umwelt Bundesamt), 2015

The inventory contains a description and analysis of 242 air quality plans (AQPs) and action plans published in Germany up to 30.11.2012. These plans offer an extensive overview of the current situation in Germany regarding air quality, different methods of assessment and proposed measures to improve air quality. The analysis of source apportionments shows that more and more plans compiled due to NO2-exceedances include source apportionments (77 % spatial and 69 % pollution sources). For PM10 the fraction of spatial source apportionments has been over 80 % for many years. Apportionments with respect to pollution sources have risen continuously to a current figure of 57 %. The approach of the APPRAISAL project for reviewing and consolidating methods to address and assess the impact of local or regional AQPs and their health implications has been applied for eleven air quality plans. Due to various reasons the analysis of evidence of effectiveness made for Germany clearly shows that it is inherently difficult to determine the isolated effect of a measure or a policy – e.g. measurement data are not enough, so continuous modelling was described as an extended evaluation method. In this relation a need of further research with respect to quality assured evaluation methods that provide comparable results is emphasized. These issues have been considered and are dealt with in ICARUS.

2.2.3 EU policy recommendations regarding the sustainable urban mobility

The list of sustainable urban transport related policies (*adopted from Civitas PLUS project – »Cleaner and better transport in cities«, http://civitas.eu/ as one of the leading initiatives in the field of sustainable transport within the EU*) and their associated impacts on the air quality along with fuel consumption and GHG emissions reduction are presented in

Table 3.

Table 3: CIVITAS Plus policy measure impacts on air quality

Policy thematic category	Policy measure categories	Impact on air quality
Fuel alternatives and clean-fuel vehicles	Vehicle modification or replacement	Positive
	Alternative fuels	Positive
Collective passenger transport	Information, ticketing and tariffs	Positive
	Accessibility, infrastructure and network	Positive
	PT fleet management	Positive
Demand management strategies	Parking and park-and-ride	Positive
	Regulative measures (access and LTZs)	Positive
	Pricing (road charging, rewarding mechanisms and R&D)	Positive
	Cycling infrastructure enhancements	Positive
Mobility management	Mobility services	Neutral
	Mobility plans	Positive
	Mobility marketing	Neutral
	Eco-driving	Positive
Safety and security	Pedestrians and cyclists	Neutral
	Public transport	Neutral
	Traffic management	Neutral
Car-independent lifestyles	Car-sharing	Neutral
	Carpooling	Positive
	Cycling services (bike-sharing, integration cycles and buses)	Positive
City logistics	New distribution schemes	Positive
	Access restrictions and control	Positive
	Freight partnership schemes and driver support	Positive
Transport telematics	Traffic management and control	Positive
	PT fleet management	Positive
	Parking guidance systems	Positive

As presented above, the air quality is a dimension where almost all policy measures implemented have yielded positive results. This applies, for example, to clean vehicles whose increased deployment, combined with greater use of alternative fuels, has resulted in significant reductions in pollutant emissions.

Policy measures targeting collective passenger transport have also resulted in significant improvements, while other important gains in this domain have been attained through the implementation of demand management strategies, such as park -and- ride, LTZs and access restrictions.

Further environmental advances have been achieved through policy measures that have encouraged cycling as a modal choice, either by improving cycling infrastructure or increasing the availability of bike-sharing systems and their integration with collective passenger transport.

Logistics and freight distribution and transport telematics are further groups of policy measures that have shown significant eco-friendly potential. In most cases, the impact of these measures has been small, though up-scaling might help to maximise their potential benefits.

The assessment of environmental indicators has proved to be problematic only when evaluating the impact of those measures aimed at changing travel behaviour, such as mobility management measures (mobility plans, mobility services etc.) and car-independent lifestyle measures (car-sharing and carpooling).

There are several factors combine to determine transport behaviour and choice of transport modes. These factors evolve over time, and both influence and reflect significant changes in lifestyles and working patterns, as well as profound demographic shifts and their subsequent impact on mobility behaviour. Changes in mobility behaviour will largely shape the emergence of new mobility needs and requirements, while generating a need for adequate and accessible policies that offer equal mobility opportunities to all citizens. The shift of needs in terms of tackling the mobility issues over the past 2 decades is presented in the Table 4**Error! Reference source not found.** and Figure 1 (adopted from CIVITAS initiative, http://civitas.eu/).

Table 4: Comparison of thematic categories from CIVITAS I, II and Plus programmes

CIVITAS I 2002-2006	CIVITAS II 2005-2009	CIVITAS Plus 2008-2012
Clean private and public fleets	Clean vehicles and alternative fuels	Alternative fuels and clean vehicles, energy-efficient vehicles (Clean fuels and vehicles)
Stimulation of PT modes	Stimulation of PT modes	High quality energy-efficient collective passenger transport (Collective passenger transport)
Integrated pricing strategies	Integrated pricing strategies	/

Access restriction	Access management	Demand management strategies based on economic (dis-)incentives (Demand management strategies)
Innovative soft measures	Innovative soft measures	Mobility management, communication and education (Mobility management)
/	/	Safety and security
New forms of vehicle use and ownership	New forms of vehicle use and ownership	Mobility services for energy-efficient vehicle use (Car-independent lifestyles)
New concepts of goods distribution	New concepts of goods distribution	Energy-efficient freight distribution (Urban freight logistics)
Integration of traffic management systems	Telematics	Innovative transport telematics systems (Transport telematics)

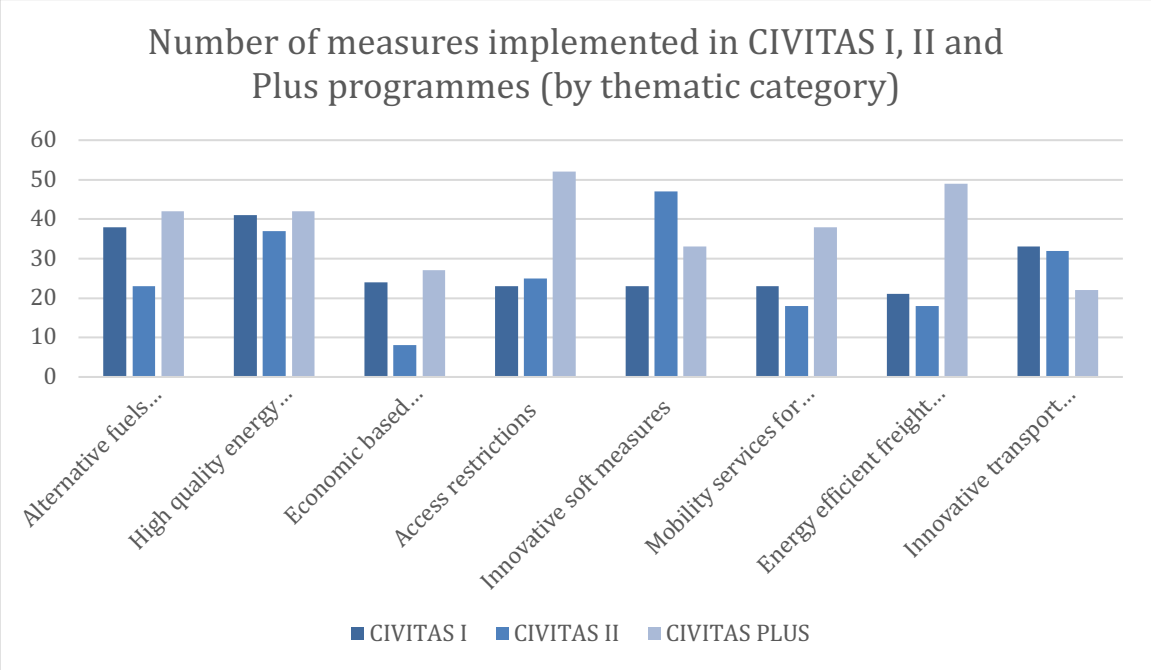


Figure 1: Number of measures implemented by thematic policy categories

While thematic content remained mostly constant over the first two CIVITAS editions, CIVITAS PLUS placed a greater emphasis on the issue of energy saving which is still relevant to this day (and for the implementation of measures within the ICARUS framework). Energy saving spans over all eight policy categories, including in particular: clean vehicles and alternative fuels, energy-efficient collective transport, car-independent lifestyles, and efficient goods distribution.

In the period 2002-2006, measures largely focused on the development and improvement of public transport, as well as on the promotion of clean vehicles. In the period 2005-2009, most measures concentrated on the development of innovative soft measures aimed at managing transport demand

through the introduction of integrated planning strategies. The period between 2008-2012 includes a large share of measures relating to access restrictions and energy efficient freight distribution.

The data presented point to a declining trend for Intelligent Transport System (ITS) measures, shares of which have diminished over time. Public transport, however, remains the main focus of intervention in most cities aiming towards sustainable urban transport, including the smaller ones.

The experience from sustainable transport initiatives confirmed the effectiveness of many of the policy measures implemented, while at the same time highlighting the need for future research. Some policy measures seem to be more established in their practical implementation, while others still require further and more in-depth technical and scientific investigation. Walking and cycling measures, or measures supporting public transport, for example, are encountered widely, while measures linked to clean fuels and vehicles or to ITS are less prevalent. Other measures need to be adapted to new mobility models and lifestyles, or they provide a new perspective on urban mobility services, as has been the case with carpooling and car-sharing. The development of strategic planning tools and paying close attention to participation, sharing and acceptance of policies implemented are not only of paramount importance, but are prerequisites for successful policy implementation.

It is evident that EU legislation and EU-provided funds can have an influence on the implementation of policies and measures towards win-win solutions on the urban scale. City, regional and national governments might be involved in a number of ways; through national/regional/municipal legislation and administrative procedures; through setting goals and preparing policies on how to reach these goals; and by providing finances for investment in transport and energy related infrastructure and the operation of related services. Table 5 illustrates how and in which ways different authorities can contribute to the implementation of policy measures.

Table 5: Stakeholder involvement

Level	Roles
Local, regional authorities	• Key role in the implementation of transport and energy supply and consumption policies/ measures at city level • Involve stakeholders and promoting a culture of sustainability • Planning processes and integration of urban policies • Monitor progress of implementation and providing feedback on the planning process
National government	• Legislation and harmonising rules and regulations (e.g. ITS) • Promote and fostering new approaches, methods and evaluation tools for innovation in the transport sector • Funding selection and prioritisation • Strategic decisions concerning the use of national and European financial resources and opportunities

European Union	• Promote EU-wide best practises • Promote integrated approaches to planning • Promote ex-ante and ex-post evaluation methods and tools • Promote innovation (e.g. Horizon 2020 research programme) • Harmonisation of rules and regulations • Focused financing according to urban and metropolitan areas, critical areas, vulnerable historical sites and environmental areas

It should also be noted that the challenges referred to in this chapter - that cities will have to cope with in the short and mid-term period - will play in shaping the attractiveness and quality of life (including health and wellbeing) of European cities require decision makers at different levels to consider the following objectives:

- Develop policy packages of integrated measures aimed at achieving common and shared objectives, such as improvement in air-quality levels and reduced CO_2 emissions;
- Intervene in major populated cities, where air pollution impacts pose critical threats to the health of Europeans. These negative impacts will become more evident over time. Densely populated areas have an innate tendency towards innovation and also provide the best grounds for testing new measures;
- Make a commitment to develop policy actions in cooperation with local entities and representatives in order to bring real results in changing mobility patterns and energy consumption habits. Most importantly, plans and measures should be developed and implemented that can have long-lasting, far-reaching positive impacts.

3 ICARUS CITY-SPECIFIC POLICIES AND MEASURES

Within the analysis of city specific abatement options, over 720 policies/measures have been considered. The complete list of a) policies and b) measures for each ICARUS city is presented in Appendix 1. The shortened list of policies/measures for each city (97 altogether), selected for a detailed analysis and evaluation are presented in this section. The criteria for the selection consisted of (1) compliance of both AQ limit values and WHO health-based guidelines, (2) reduction in long-lived GHG and short-lived climate pollutant (SLCP) emissions and (3) changes in sequestration (i.e. CO2), as well as the following criteria/questions focused on the effectiveness, efficiency, acceptability:

- Is the measure expected to have high air pollution/GHG reduction potential? (is the measure transferable/scalable to the city level; e.g. from house/street level?)
- Are there any impact assessments available, i.e. an estimation of the effect either on greenhouse gas emissions or air pollutants or both?
- How high is the rate of implementation/ chance for implementation in respective cities?
- Societal relevance? Is the measure currently in discussion in the media/research/municipality or in the pipeline?
- Is the measure quantifiable? What information is needed for quantification? (might be particularly important for non-technical measures; for example, expected behavioural changes)
- Is necessary information for the modelling available (city experiences regarding the effect of non-technical measures, changes in transport modes based on literature)
- Is information regarding the costs of the measure available? (at different levels: emission source operator, state, individuals)
- Is the measure likely to be interesting for other cities (transferability)?
- Have other ICARUS cities had the experiences with the policy/measure?
- Are there any measures that are obviously not effective/acceptable/relevant in the city and should thus be omitted?
- Who has the authority for measure implementation? City or municipality?

The acceptability and feasibility of the measures will be thoroughly discussed after the first assessment of costs and benefits (CBA), which could serve as an additional filter in the selection of measures which will undergo the final CBA and feasibility analysis in tasks T5.3 and T5.4. This approach aims avoiding the exclusion of measures that might have a high pollution reduction potential, but are not yet considered by the authorities or because of their unpopularity. The first estimate of the reduction potential has been taken from impact assessments of local air pollution plans and energy or climate concepts. However, these plans exclusively focus on the emissions of NO_x, PM_{10}/$PM_{2.5}$ and CO_2. The integrated impact assessment performed in ICARUS will also take the effect on other air pollutants and greenhouse gases into account. The city emission inventories of ICARUS WP2 show that the road traffic sector has a particularly high impact on the overall emissions. Therefore, various transport-related measures are selected as primary for further analysis. The second most important sector, especially for PM_{10} emissions, is the small and medium combustion plant sector. Households also account for a considerable amount of cities CO_2 emissions, which is why energetic renovation of buildings and changes in the heating technologies is given further attention.

Further developments in the future are expected regarding the prevention of waste generation, and especially recycling and recovery of energy, which will result in changes of emission inventories of both air pollutants and greenhouse gases.

3.1 ATHENS

3.1.1 City specific facts & figures

The City of Athens dominates the Metropolitan Athens area with a population of 664,000 habitants (2011) within its administrative limits, and a land area of 38.96 km^2. Athens Municipality consists of 7 administrative City Districts.

The Population growth in the Municipality of Athens has been reduced in the decade 2001-2011, contrary to the increase that was presented in the previous decade 1991-2001, according to the Census performed by the Hellenic Statistical Authority.

Within the Attica region an extended air pollutant measurement network operates under the supervision of the Ministry of the Environment, Energy and Climate Change. Four (no. 1,2,8-urban traffic and no. 3-suburban industrial) out of the 14 air pollutant monitoring stations *are located within the boundaries of Athens Municipality* (Figure 3 right). The air pollutants are measured at different time intervals and correspond to CO, NO, NO_2, O_3, SO_2, PM_{10}, $PM_{2.5}$, C_6H_6 and heavy metals. The air pollution levels are recorded in daily and annual reports that are available on-line through the official website of the Ministry.

The City of Athens has adhered to Mayors' initiatives, such as the Compact and the Covenant of Mayors, to actively join global efforts to mitigate climate change and reduce greenhouse gas emissions in the City. The measures that will be implemented are outlined in the *Climate Change Mitigation and Adaptation Action Plan* that was compiled with the support of the C40 Cities Network and is also included in Athens Resilience Strategy[1]. The *Climate Change Mitigation Action Plan* focuses on actions that aim at reducing energy consumption in the city, while the *Adaptation Action Plan* focuses on actions to improve the Municipality's capacity to respond to rising urban temperatures and make the city resilient in climate changes. As a first step, the City of Athens *developed a greenhouse gas emissions inventory* using the GPC protocol of the C40 Cities Network. The Municipality of Athens will take measures resulting in a reduction of 28% in GHG emissions in residential sector and 42% in commercial and municipal sectors. The overall reduction target of the GHGs is 40%, until 2030.

3.1.2 Measures and policies selection

Following the criteria given above the policies and measures selected for further analysis/evaluation include:

TRANSPORT

[1] http://www.100resilientcities.org/strategies/athens/

- Low Carbon Vehicles - Fleet renewal according to new European emission standards – "greening" the car fleet
- Public buses replacement with electric buses (or CNG buses) – Alternative transport fuel (biodiesel)
- Transformation of Athens inner ring into "green" ring (Low emission zone)

BUILDINGS AND HOUSEHOLDS

- Replacement of oil central heating system with natural gas central heating system in residencies
- Saving Energy at home, renewable energy sources in households
- Zero energy buildings: 10% in private households; municipal buildings 1. January 2019, private households 2021
- Energy upgrade in municipal buildings
- Energy upgrade in commercial and residential buildings
- Municipal lighting network upgrade

3.2 BRNO

3.2.1 City specific facts & figures

Brno is situated in the centre of Europe and is the second biggest city in the Czech Republic with almost 400.000 inhabitants. It is the centre of the fourth largest region in the country – the South Moravian Region.

The city is situated at the crossroad of European multimodal corridors which belong to the TEN – T network. The location of the city enables very favourable accessibility (important motorways and railroads go through the city). There are regular flights taking off and landing on at the international airport in Brno.

Brno is situated in the basin of Svratka and Svitava rivers. It is surrounded by a picturesque countryside, located between the Bohemian-Moravian Highlands and Protected Landscape Area Moravian Karst in the north and the Southern Moravian lowlands with its vineyards in the south.

The city of Brno is important as the second largest centre of education in Czech Republic. The number of students per inhabitants is the highest in the Czech Republic. There is over the 80 000 students at many famous universities (e.g. Masaryk University Brno, Brno University of Technology).

Brno is internationally known as a centre of fairs, with the Brno Exhibition Centre as one of the modern landmarks. In 2006 the exhibitions were visited by over 1 million visitors. Lately Brno supports strongly the development of science – especially medical science and technical education – by building Technological Parks and university campuses.

Brno is the centre of the economy in the South Moravian Region. Key strengths of the city are the good transport location in the European multimodal corridors, a highly educated and motivated labour force and a well-developed business support infrastructure.

During the preparation of the new development areas the city is putting an accent on the provision of a sustainable urban transport system to avoid the unequal increase of private car use and freight traffic.

Important is to ensure adequate PT service in such growth areas, specifically by extending the tram system and a trolley bus lines. The areas within the Industrial Zone "Černovická terasa" for example are connected with a railway line. More new industrial zones are planned next to the railway lines. The railway is an important transport provision for the daily commuters to these areas, while it does not play any role for freight transport. The railway is an important part of the Integrated Public Transport System of the South Moravian Region.

Thanks to its historical development the public transport system in the City of Brno is very well developed. The tram plays an important role in this system. The radial system of tramlines connects the commuter belts around the city with the centre. On 13 tramlines (the length of the network is 171 km) operate 318 vehicles, which transport 191 000 000 passengers per year. Another important element is the system of trolleybuses. The length of the network served by 11 lines is 94 km, 143 vehicles transport 45.000.000 passengers per year. These low pollutant systems of PT – tram and trolley bus – are the backbone of the PT system in the city centre. The additional system of the conventional buses serves the fringe areas of the city. The length of the network is 549 km, 300 vehicles are operating on 49 lines, transporting nearly 104 000 000 passengers per year.

The emission inventory of ICARUS WP2 has shown that road traffic is the major contributor to PM_{10}, $PM_{2.5}$ and NO_x emissions, accounting for 60-65% of the total emissions. Given that the city of Brno is exceeding the European limits for these pollutants, most of the investigated measures will belong to this sector.

Moreover, in case of PM_{10} and $PM_{2.5}$, small combustion plants from residential sector represents the second most important sector, accounting for about 30% of their emissions, and therefore some measures related to this sector will also be considered.

3.2.2 Measures and policies selection

For the City of Brno, there exists high interest about assessing the consequences of stricter parking legislations on the concentrations of particles. Therefore, this measure, which has a high potential for realization but which will be challenging to assess quantitatively will be considered. The aim of such regulation is to reduce the usage of personal cars (both residential and non-residential) and increase the usage of the public transportation. This goes together with the parking navigation system and the building of the P+R parking system, which should be capable of accommodating up to 20,000 cars from outside. A feasibility study for low emission zone in Brno has already been prepared and given the low impacts on the air quality, is not anymore considered by the City Council, even though it is still present in the Mid-term strategy for improving air quality in the Czech Republic. Therefore, this measure was not considered. Overall, the reduction of cars in the city of Brno are planned to be achieved also by the promotion of cycling and walking activities and increased usage of public transport.

The policies and measures to be considered are the following:

TRANSPORT:

- Stricter parking legislations
- Promoting low carbon vehicles
- Enhancing cycling and pedestrian activities
- Reduction of the vehicles in the city centre (city toll system)
- Promotion of the integrated public transportation within whole metropolitan area

BUILDINGS AND HOUSEHOLDS:

- Switch of combustion techniques in residential and municipal buildings: Replacement of solid fuel boilers by gas boilers, district heating and electricity (heat pumps)
- Promotion of district heating
- Promotion of insulation and renovation

ENERGY SUPPLY:

- Increasing the utilization of the energy related to the waste

3.3 BASEL

3.3.1 City specific facts & figures

Basel lies at the heart of the three-country-triangle where Switzerland, France and Germany meet. Cross-border relations have always been a part of life here. Basel collaborates closely with its neighbors on all sides of the borders on issues such as transport, environment, education and culture.

Basel has an excellent transport infrastructure – especially where public transport, bicycles and pedestrians are concerned. Cars are not really essential in Basel. Most places can be conveniently reached by other means of transport. More than half of Basel's households do not have a private car. Basel‘s extensive public transport system takes you everywhere in the city and the surrounding region.

Basel is also an excellent town for cyclists. Thanks to short distances and an extensive network of bicycle lanes, the inhabitants of Basel use the bikes for a large part of their transport needs.

Basel’s mostly car-free centre of town (implemented as of 2014), comprehensive 30 km/h zones in residential areas and over 60 shared zones (i.e. traffic-calmed zones where pedestrians have right of way) allow visitors to enjoy and explore the city safely on foot.

The Canton manages traffic in Basel on the basis of sound urban planning and environmental principles. Harmonious and fair coexistence of all traffic participants and unobstructed access are relevant factors in this context.

3.3.2 Measures and policies selection

The policies and measures to be considered are the following:

TRANSPORT

- Taxi holders get 10'000 CHF when buying an electric car
- Change public busses to electric
- Implementation of the program "Sustainable mobility Basel City"
- which includes various activities and measures into an overall framework.
- Law to reduce traffic (except motorways) by 10% until 2020

ENERGY SUPPLY

- Heating and hot water (oil, gas): In case of replacement obligation to switch to a renewable system (heat pump, district heating, etc.)

3.4 LJUBLJANA

3.4.1 City specific facts & figures

As the capital of Slovenia and the country's largest city (276 000 inhabitants), Ljubljana is a strong centre of economic and cultural activities for the wider region. Over 47.000 students, a wide range of companies and research facilities, many important national institutions, diplomatic services, and cultural facilities make it a vibrant and diverse city.

The historic city centre at the side of Ljubljanica River is the focus of urban life. The manifold activities in the area and the related movements of people and goods make urban transport a key variable for the economic success and the liveability of the city and the entire region. Ljubljana has a strong commitment to work towards a more sustainable urban transport system, which is also demonstrated through its participation in the projects CIVITAS MOBILIS and ELAN, CHAMP, Bike2Work, CH4LLENGE, EVIDENCE etc. as well as through the achievements such as European green capital award for 2016 and two European Mobility Week awards.

Ljubljana is a transport node at the intersection of two corridors in the trans-European transport network. Over the last 15 years there has been a constant growth in urban and regional car (and cargo) traffic. Transport in the city is causing air (NO_X, CO, CO_2, and PM_{10}) and noise pollution, because commuter streams heavily rely on the private car use. These traffic streams are the origin of congestion during peak hours, which significantly contribute to the present traffic situation in Ljubljana in general – average speed in the city centre ranges between 10 and 18 km/h. Therefore, among multiple measures towards improving the situation the aim of reducing car use and changing the modal split in favour of modes that are less harmful for the environment, such as public transport (by improving its quality, speed, safety and image), cycling and walking is a top priority. Awareness, acceptance and citizen participation to take part in processes leading to better traffic situation are also key elements of the future endeavors.

3.4.2 Measures and policies selection

Following the common selection criteria, the following policies and measures have been selected for further analysis. The attention is mainly on the main pollution parameters, i.e. NOx, CO, CO_2 and PM10 which are related primarily to transport and household/building heating and energy use.

TRANSPORT

- Implementation an integrated transport strategy (SUMP)

Increased share of walking; In the heart of the city, a pedestrian-friendly network of streets will be arranged to all the city's attractions and important institutions. The ban or restriction of motor traffic along with the renovation of streets and markets. Residents of neighborhoods will get safe paths to parks, schools, homes for the elderly, kindergartens, shops, day centres and public transport stations.

Increased share of bicycle use;

An uninterrupted bicycle network of main and connecting routes will be established, connecting the most frequented pedestrian areas.

In addition, the city will provide sufficient cycling stands and covered bike storage facilities for secure bicycle storage, especially in the area of the passenger centre of the new railway and bus station, around the main traffic generators (employer companies) in the city and at the P & R car parks.

Increased share of public transport use;

Bus routes will be extended to neighboring municipalities, while working migrants will be given the opportunity to park their car in one of the P & R facilities on the outskirts of the municipality, from where they will reach the city centre quickly and easily during the traffic congestion.

On three avenues with heavy traffic congestion, a faster travel time for LPP buses from passenger cars will be ensured with PT priority an intersections and dedicated bus lanes.

Decreased use of personal cars:

Alternative parking policy; Street parking spaces will be intended primarily for residents. To this end, the municipality will gradually introduce parking zones in densely populated neighborhoods and quarters, in which street parking spaces will be payable and limited to two hours. This measure will limit the possibility of parking for daily migrants in residential areas. Daily migrants will be provided with parking spaces at P & R facilities at the outskirts of the city and in public garage houses);

Ten largest employers in the city will prepare and implement their transport mobility plans with the aim of achieving the municipality goals of modal split (1/3 personal cars, 1/3 public transport, 1/3 cycling, walking);

- Prohibition of heavy freight vehicles on the northern Ljubljana bypass
- Renovation of public passenger transport vehicle fleet (CNG, hybrid buses), utility vehicle fleet and city administration vehicle fleet

- Promotion of electromobility

HOSEHOLD HEATING/ENERGY SUPPLY

- Increased utilization and expansion of district heating systems
- Increase in connecting facilities to the gas network
- Further encouragement of the replacement of existing combustion units with more appropriate means
- Advice for efficient use of domestic heating

OTHER

- Reduction of fireworks use in the area of the municipality

3.5 MADRID

3.5.1 City specific facts & figures

Madrid is southern Europe's most, and the continent's third-most, populated metropolis. Around 3.23 million people live in the city (5294.5 inhabitants per km²) and over 6.5 million live in its metropolitan area.

The city is known for its wide avenues and four major ring roads that are linked by a radial road network. But Madrid is also famous for its powerful public transport system: a 293-km subway network and nine commuter train lines with 89 stations that connect the metropolitan area to the city, in which there are 13 great transport interchanges. The urban bus network, with 200 lines travelling on routes totaling around 775 km, reaches areas the subway does not. The 1 560 electric bikes of the public bicycle system and car-sharing services provide further transport flexibility.

Forty-three per cent of the city's overall space is intended for pedestrians; 42 per cent of citizens use public transport, 29 per cent walk and 29 per cent use private vehicles. In spite of the already positive modal split, the Madrid SUMP intends to further discourage the use of private cars in favour of PT and active modes in order to reduce negative impacts of car traffic and improve citizens' quality of life.

The Plan suggests 95 specific measures oriented to reach (by 2020) close to a six per cent reduction of traffic in the city in favour of pedestrian mobility, bicycle use and public transport.

Introducing a smart Regulated Parking Service (SER), improving of the cycle path network, creating alternative methods of car-parking and bus-only lanes, and introducing technological solutions to control access to traffic in loading and unloading areas are among the most prominent measures.

The SUMP will increase comfort for citizens and improve their quality of life by reducing car use. Madrid estimates that implementing the measures of the Plan will result in 3.2 million fewer kilometres being travelled by car per day, which corresponds to a reduction of 135 000 tons of CO2, 400 tons of NOx and 26 tons of PM2.5.

Madrid predicts that in 2020 it will need to accommodate around 130 000 extra journeys a day (a rise of 3.5 per cent). The Plan will allow this to be absorbed by sustainable ways of transport to prevent additional congestion in the city.

Measures to discourage private vehicle use and promote other ways to travel are expected to increase the share of public transport from 42 to 45 per cent. Active mobility, such as walking and cycling, will rise from 29 to 32 per cent. The use of private vehicles would consequently fall from 29 per cent of current daily journeys to 23 per cent.

3.5.2 Measures and policies selection

TRANSPORT

- Zero emission Central Area
- Redesign the main traffic distribution routes and periphery-center connection
- Prioritization of pedestrian mobility
- Improvement and expansion of the bicycle network and mobility
- Parking regulation according to air quality criteria
- Reserved infrastructure for public transport
- Public-private collaboration in order to innovate and make urban logistics processes more efficient
- Sustainable work mobility plan

CROSS-CUTTING

- Regeneration of rehabilitation of neighborhoods

BUILDINGS/HOUSEHOLDS/LAND USE

- Development of the Madrid + Natural program, to increase urban resilience towards climate change, with interventions in buildings, neighborhoods and the renaturalisation of the Manzanares River

3.6 MILAN

3.6.1 City specific facts & figures

Milan is the second-most populated Italian city, with 1.35 million people in the city (about 7400 habitants per km²) and about 3.2 million in its metropolitan area (about 2 000 habitants per km²).

Every day 850 000 people enter Milan and 270 000 exit the city – resulting in a total of 5.3 million trips per day. Inside the city, 37 per cent of trips are made by car (car ownership is 0.52 cars per inhabitant) or motorcycle and 57 per cent use public transport (PT), but the share of car trips rises to 62 per cent when the exchange trips between the city and the external areas are considered.

The PT transport network consists of four underground lines and 154 surface lines for a total of 1 286 km, producing about 120 million vehicle km/year. The problems of Milan's mobility and transport system are the increase in private transport demand due to the functional separation between the city centre and the hinterland; the lack of planning of goods transport and logistics activities; road congestion; and inefficient allocation of public space.

The Milan "Urban Sustainable Mobility Plan" (PUMS) arose from the decision of the City Council Committee to update the Milan PUM (Urban Mobility Plan) and carry out a VAS (Strategic Environmental Evaluation). In addition to the consultation process envisaged by the VAS, the PUMS has been developed through a participation process which has involved public authorities (the Municipality, the Mobility Agency, PT operators), stakeholders (professional associations, local associations, companies, residents' associations) and citizens, who contributed to the identification of agreed strategies and actions of the plan.

The participation process consisted of an information campaign (to inform the public on the process for the development of the plan and its main themes), thematic meetings with authorities, stakeholders and citizens, and the publication on the municipality's and mobility agency's website of the presentations held during the meetings and their minutes and reports.

Thanks to a deep analysis of the current situation and trends as well as the consultation process, four mobility strategies were identified:

- a shared mobility governance with coordinated strategies and tools;
- urban accessibility using PT;
- urban space as common good;
- passenger and freight mobility demand management.
- The goals of PUMS include:

Mobility

- The PT modal share is expected to grow up to 63 per cent inside the city, while car share is expected to decrease by 24 percentage points.
- The cycling network, which currently accounts for 9 per cent of the urban road network, will cover 25 per cent.
- The average trip time is expected to decrease by 8.3 per cent (by 9.5 per cent inside the city) and road congestion, measured according to suitable network indicators, by 10 per cent.
- The PT service offer (seat-km) is expected to increase by 20 per cent and PT commercial speed by 17.5 per cent.

Environmental quality

- Air-polluting emissions are expected to decrease by 10 to 17 per cent (in particular CO, NO_x and PM_{10} by 14, 10 and 14 per cent respectively), while greenhouse gas emissions by 13 to 15 per cent (in particular, CO_2 by 15 per cent).
- Energy consumption is expected to decrease by 12 per cent.

Human health and safety

- Citizens' average exposure to air pollutants is expected to decrease by 13 per cent.
- As for citizens' average exposure to acoustic pollution, 37.4 per cent of the population will experience a decrease in noise levels, 14.1 per cent an increase, and the remainder will experience no changes.
- The number of road accidents is expected to decrease by 75 per cent between 2013 (about 10000 accidents/year) and 2024 (about 2 500 accidents/year).

3.6.2 Measures and policies selection

Following the common criteria already described for other ICARUS cities eleven measures have been selected for the city of Milan. We have focused our attention mainly on three sectors: transport, building and households, energy supply. In fact, we know from the emission inventory that a large part of air pollutants and greenhouse gases are coming from those sources. We want to consider in our analysis the tertiary sector as well due to the high number of commercial buildings and shops in Milan, known as "the city of fashion".

For transport, we take into account the use of private cars related to congestion charge/banning for the city centre (the so-called "Area C") new regulations which are coming into force like banning of diesel cars, new rules for commercial vehicles into municipal boundary. Public transport is under a deep renewal regarding fleet buses and underground in these years: it has just started a policy for the substitution of the entire bus fleet with vehicles fueled by electricity and natural gas and works are in progress to finalize a new underground line (MM4). Bike sharing system is increasing year by year and we would like to estimate its impact in terms of emissions prevented.

Due to the high population the policies related to private buildings in terms of improvement of energy efficiency, including actions that inform and train citizens and workers towards energy saving were also selected for further analysis. The Municipality of Milan approved a new building code in 2014 therefore new residential flats have to respect this new regulation.

Regarding energy supply, small combustion plants in households account for large amount of emissions, therefore changes in the heating technologies (from heating oil to natural gas) will be analysed. The large combustion plants of local energy operator could be improved in terms of energy efficiency and a new system of district heating is under development. The city of Milan is paying attention to renewable energy sources as photovoltaic solar power for building uses, with a policy of incentives and subsides for citizens.

Finally, the same analysis applied to private buildings (energy supply and efficiency) will be performed specifically for commercial buildings.

TRANSPORT

- Road transport
  - "Area C", which combine a congestion charge scheme with the banning of the most polluting vehicles in the city centre
  - Low Emission Zone to ban/regulate heavy duty vehicles/ commercial vehicles / diesel cars access into municipal boundary (including potential changes of vehicles fleet composition)
- Public transport
  - Conversion of the entire public buses freight to natural gas fuel or electricity (started March 2018)
  - Development of the new underground line (MM4) (+ additional development of public transport over the BaU scenario)
- Cycling
  - Improvement of public bike sharing system and cycle routes. (this policy will include Information/Education/Training for development of bike use)

BUILDINGS AND HOUSEHOLDS

- Private buildings
  - Improvement of energy efficiency in existing and new residential flats (together with the new Building Code 2014)
- Public buildings
  - Improvement of energy efficiency in existing municipal buildings with energy saving in end-uses (this policy will include Information/Education/Training for employees of the Municipality)

ENERGY SUPPLY

- Electricity and heat supply and Energy distribution
  - Boiler fuel switch (from heating oil to natural gas) in private and public buildings
  - Improvement of efficiency in electric energy production of A2A plants (local energy operator) and development of district heating (A2A)
- Renewable energy sources
  - Photovoltaic solar power for building uses

TERTIARY

- Commercial buildings
  - Improvement of energy efficiency in existing and new commercial buildings (this policy will include Information/Education/Training of workers about energy saving)

3.7 STUTTGART

3.7.1 City specific facts & figures

The state capital Stuttgart extends over the area of 207 km² and forms with about 610,000 inhabitants the upper centre of an administrative region (Region Stuttgart) with a total of 2.7 million inhabitants. The population density of Stuttgart is about 2,95 inhabitants per km² and is thus higher than in most other major German cities. The metropolitan region of Stuttgart goes far beyond the administrative boundaries of the Regional Association and has a radius of about 40-50 km with about 5.2 million inhabitants.

Stuttgart's climate is marked by its position in the wide Neckar basin, shielded by the Black Forest in the West, the Swabian Alb in the South, the Schurwald in the East and the Stromberg and Heuchelberg region in the Northwest. The centre of Stuttgart is located in a Keuper sink (about 240 m above sea level), which is almost completely surrounded by mountains with a height up to 500 m and of which the only opening is at the Northeast of the city. The maximum height difference to be overcome is about 350 m.

The city of Stuttgart is administratively divided into 23 city districts. Due to the topographical conditions and their traffic situation they have been subject to different developments. The districts in the north of the city are predominantly industrial, whereas the districts in the Neckar Valley are traditional wine and fruit cultivation areas. The Neckar harbour with its commercial areas forms the cityscape in the east of Stuttgart. The more agriculturally oriented areas in the south are undergoing a dynamic growth and urbanization process. This is particularly shown in the developments at the airport and the new trade fair. Here is the traffic intersection between air traffic, highway, federal highways and in the future also the railway. This is not just a transfer hub, but also the "gate" to Stuttgart.

The inner city was developed in the 60s after the planning philosophy of car-friendly city traffic axes with high separation effect like the Hauptstätter Straße / Konrad Adenauer Straße (B14) and the Theodor Heuss Straße / Friedrichstraße (B27). From the 70s it was followed by the expansion of the light rail and the realization of the pedestrian zones. Public transport in Stuttgart includes 16 light rail lines, 56 bus lines and 6 S-Bahn lines well developed and secured with a total of 1,162 km of tracks. 897 stops provide a good transport service in the state capital. Since the beginning of the 90s, the expansion of cycling is taking place in Stuttgart (also in a relation to a nationwide cycling network). The cycling network has been expanded from 54 km to 180 km in the last 20 years. The essential components of the cycling network next to the bike paths include the network 30 km/h zone, hinterland and forest paths, one-way streets opened in the opposite direction for cyclists, bicycle reserved strips, as well as protective strips on major roads.

The city faces severe air pollution problems due to industrial, transport and domestic heating sectors which are worsened by unfavorable topographic characteristic. Result of its sheltered position in the Neckar valley and the surrounding mountains is a low wind speed and frequent lulls. Thus, due to the topographic and climatic characteristics Stuttgart is predestined for high air pollutant concentrations.

3.7.2 Measures and policies selection

The measure selection has been discussed with the ICARUS partners of the University of Stuttgart (USTUTT) and the environmental department of the city of Stuttgart (CSTUTT). Measures have been

chosen in accordance with the above mentioned selection criteria taking into account both emission reduction potential and current relevance. The first estimate of the reduction potential has been taken from impact assessments of local air pollution plans and energy or climate concepts for the city of Stuttgart. The emission inventory of ICARUS WP2 shows that the road traffic sector has a particularly high impact on the overall emissions in Stuttgart (>50 % of PM_{10}, NO_x emissions). Therefore, diverse transport-related measures have been selected for detailed analysis. The second most important sector, especially for PM_{10} emissions (30 % of total city emissions), is the small and medium combustion plant sector. Households also account for more than 30 % of the city's CO_2 emissions, which is why energetic renovation of buildings and changes in the heating technologies form the second main focus.

Since emission limits of NO_x (in Stuttgart also PM_{10}) are exceeded in many urban areas in Germany, various measures to meet the legal limits are highly discussed in media and politics. A ban on and retrofitting of older diesel cars depending on the emission standards and free public transport are currently in discussion as measures for highly polluted urban areas and are therefore chosen for the evaluation. The city toll for passenger cars is a rather unpopular measure, but shows a high reduction potential due to the expected decrease of individual transport. Therefore, the effect of this measure will also be analysed in detail. In contrast to the overall vehicle fleet, cities can directly influence the composition of the municipal fleet. Thus, a shift towards low emission vehicles (biofuels/electricity/natural gas) will be modelled not only for private cars but also for the municipal fleet. The increase of the energetic renovation rate of municipal and private buildings aims at reducing the energy consumption of the buildings and is discussed in the climate action plan as well as the energy concept of the city. A replacement of biomass fired small combustion plants with gas installations will also be analysed, since Stuttgart faces high PM_{10} concentrations in the city area; especially during heating periods. Further measures for heating in the households and buildings sector like promotion of district heating, exchange of heating pumps a.s.o. can also be included in the assessment. Finally, the local energy provider (ENBW) intends to modernize the power plant located in Stuttgart comprising a switch from coal to natural gas.

In accordance with the above mentioned selection criteria, the considered policies and measures are:

TRANSPORT

- Promotion of public transport
    - Cheaper (-10% to - 50%) or free public transport in highly polluted urban areas
- Low emission zone and vehicle bans
    - Light blue badge (retrofitted and already registered vehicles EURO 5, 6a, b, c)
    - Dark blue badge (EURO 6d temp, 6d)
- Retrofitting of cars
    - Retrofitting of PC/LDVs diesel EURO 5 (alternative: incl. EURO 6)
        - Hardware update: SCR system (AdBlue)
        - Software update
- Demand management strategies
    - City toll for passenger cars
        - 2-5€
- Promotion of green vehicles: E-cars, hybrid vehicles

- Municipal fleet: Replacement of taxis/buses with e-taxis/buses (municipal fleet towards low emission vehicles)
- Private cars

BUILDINGS AND HOUSEHOLDS

- Promotion of insulation and (energetic) renovation
  - of municipal buildings (EnEV 2016)
  - of private buildings (provision of services like contracting and consulting and subsidies → increase of renovation rate; following EnEV 2016)
- Switch of combustion techniques/ heating technologies
  - Promotion of gas boilers (replacement of biomass boilers (e.g. wood pellet boilers, automatic wood boilers) with gas boilers)
  - Promotion of district and local heating
  - Change of inefficient heating pumps with more efficient pumps in private buildings

ENERGY SUPPLY

- Promotion of natural gas
  - Switch from coal to natural gas at the ENBW power station Gaisburg, modernisation in 2020)

3.8 THESSALONIKI

3.8.1 City specific facts & figures

Thessaloniki is located on the Thermaic Gulf, at the northwest corner of the Aegean Sea. It is bounded on the west by the delta of the Axios/Vardar. The municipality of Thessaloniki, the historical center, had a population of 325,182 in 2011, while the Thessaloniki Urban Area had a population of 788,952 and the Thessaloniki Metropolitan Area had 1,012,297 inhabitants in 2011.

Thessaloniki is Greece's second major economic, industrial, commercial and political centre; it is a major transportation hub for Greece and southeastern Europe, notably through the Port of Thessaloniki.

There are 2.2 million passengers' daily trips taking place by all travel modes and PT share is approximated to 27% (OMPEP, 2000). Thessaloniki's PT system is expected to be enhanced with an underground metro line as early as mid-2017. The Urban Transport Organization of Thessaloniki (UTOT (OASTH)) is until today the sole PT operator in the area. The company holds a concession contract with the Greek Government allowing for exclusive right of operations. The PT system is composed by a total of 78 urban and suburban bus routes operated by a fleet of 621 various size vehicles. In 2011, 43 million vehicle-kms were executed and almost 180 million boarding were counted. The system is characterized by a low fare box recovery ratio and the state subsidy covered 68% of total 2011 expenses (OASTH, 2012). Improvement of delivered quality and rationalization of resources' allocation are regarded as necessary and effective actions for both attracting more users and reducing costs.

According to, the latest "General Study of Transport and Traffic for the Urban Area and the surroundings of Thessaloniki" (Ministry of Competitiveness, Infrastructure, Transport and Networks/ Organisation of Planning and Environmental Protection of Thessaloniki, Thessaloniki, 1999), nearly 25% out of 2.4 million motorized and non-motorized daily passenger travel have one or both ends of the journey to the city center. ThePTA conducted a Socio-Economic Study of the expansion of the Thessaloniki Metro to Kalamaria and the development of a Traffic Model (December 2011) where it was estimated that the car share reaches 55% in 2010 compared to 44% in 1999.

To overcome the city's mobility issues a SUMP (Sustainable Urban Transport Plan) was produced. The PTA (Thessaloniki Public Transport Authority) benefited from its participation as a partner in the Attractive Urban Public Transport for Accessible Cities (ATTAC) project of the SEE programme. The mobilisation and commitment from a wide range of stakeholders (including central government ministries, regional authorities, municipalities, trade unions, passenger and cycling associations, transport institutes and the university) and an emphasis on the better use of public transport were key elements of the planning process. The final SUMP consisted of 12 measures to be implemented and monitored, and enhancements to the SUMP methodology including integrated pricing and financing, travel behaviour research and specific attention to mobility planning for tourist destinations.

Stakeholders have been very positive towards the plan's vision, approach and measures, helped by the fact that most authorities are represented on ThePTA's Board. ThePTA created this SUMP with limited financial resources by using the SUMP guidelines and actively involving stakeholders - making Thessaloniki one of the first cities in Greece with a plan drafted according to these guidelines.

3.8.2 Measures and policies selection

Following the adopted criteria, the policies and measures for further analysis for Thessaloniki metropolitan area include:

TRANSPORT

- Road transport
  - Trainings and information and sensitization events for the promotion of:
    - Eco-driving: Targeted campaigns on training the citizens in eco-driving practices are foreseen. Campaigns will be implemented by the Municipalities of the Thessaloniki Regional Unit.
    - Clean-fuel technologies and energy efficiency in vehicles: Shifting to cleaner energy practices in Transport is important to the City of Thessaloniki. The Municipalities of the Thessaloniki Regional Unit will organize events for sensitizing and informing the citizens on the modern vehicles fuel technologies (hybrid, electric and clean-fuel vehicles), their advantages and impact on fuel consumption and CO_2 emissions saving.
    - Using public transport: The Municipalities of the Thessaloniki Regional Unit will organize information events and establish mobility information desks for the promotion of public transport. The implementation of the measure is expected to be a joined effort of the Municipalities, the Metropolitan Authority and Thessaloniki Public Transport Authority (ThePTA).

        - Cycling and walking: Individual information events promote cycling and walking in the city.
    - Provision of incentives (e.g. reduction or zeroing of circulation taxes, lower parking fees etc.) for replacing high emission vehicles with ones of modern technology and lower emissions (including hybrid, e-vehicles and clean-fuel vehicles). Inform citizens on the benefits, including incentives, of replacing high emission vehicles with "green" ones.
- Stationary energy consumption - Municipal lighting
    - Integrated medium and large scale interventions in Municipal lighting systems and conversion to LED lamps in Municipal lighting.
- Public transport
    - Measures related to the introduction and use of Metro.

BUILDINGS AND HOUSEHOLDS

- Energetic renovation
    - of municipal and federal buildings, introduction of green roofs.
    - of private buildings (subsidies for energy efficient building renovation)
- Heating technologies
    - Energy efficient heating systems /Promotion of natural gas heating in households (subsidies and incentives for promotion of natural gas, energy efficient appliances and solar thermal energy systems)
- Energy conscious behaviour
    - Information-sensitization-educational actions on efficient energy use targeting the citizens and users of the tertiary buildings.
- Energy efficient appliances
    - Information-sensitization-promotion actions on the use of CLF and LED lamps and energy efficient appliances / Replacement of old ACs with new inverter technology

ENERGY SUPPLY

- Renewable Energy Sources
    - Construction of photovoltaics in school units and municipal buildings.

INDUSTRY

- Cement Industry
    - Increase the use of Refuse Derived Fuel (RDF) in cement industry.

WASTE

- Waste management
    - Promoting eco-friendly waste management with citizens' participation

- Incineration of MSW

3.9 Summary on policy/measure selection

The chosen city-specific policies and measures can be traced back to universal objectives and strategies that are common among all ICARUS cities and related to EU policies as discussed in Chapter 2. They are addressed by various city specific policies and measures as presented in the policy and measure database in Appendix 1. The chosen policies and measures for further detailed consideration cover a wide range of emission source sectors, namely:

- Buildings and households
- Transport
- Energy supply
- Industry
- Waste
- Land use
- Tertiary
- Cross-cutting
- Other

Table 6 shows the derived common policy thematic categories (in the database referred to as »policy«) and examples for related measures that have been chosen for the evaluation (in the database referred to as »measure description (policy intervention)«). The sector buildings and households (and tertiary) mainly includes measures focusing on insulation and renovation of private and municipal buildings, a switch to environmental friendly combustion technologies and the promotion of energy conscious behaviour. Policies related to transportation address a variety of different objectives such as car-independent lifestyles, fuel alternatives and clean fuel vehicles, demand management strategies and the promotion of public transportation. The energy supply sector comprises policies regarding the promotion of renewable energies, efficiency improvements of power plants and the expansion of district heating including co-generation plants. Policies related to the greening of the urban area due to the implementation of green roofs or roadside greenery are summarized in the sector land use. Chosen policies in the waste sector target the prevention of waste generation. The cross-cutting sector includes various measures regarding smart city strategies and general concepts like energy saving behaviour.

Table 6: Common policies and policy measure examples

Sector	Policy thematic category	Policy measure examples
Buildings and households	Promotion of insulation and renovation (indirect)	Provision of services for energetic renovation of private buildings: - Information services - Subsidies - Energy performance contracting - Energy consulting

Sector	Policy thematic category	Policy measure examples
	Energy efficient renovation (direct)	Energetic renovation of municipal and federal buildings/properties like: - Schools - Hospitals - Residential buildings blocks
	Energy efficiency interventions	- Subsidies for replacement of old appliances with more efficient ones in households - Information-sensitization-promotion actions on the use of CLF and LED lamps in residential buildings - Better thermal insulation materials on the building walls - Installation of new more efficient heating systems
	Promotion of energy saving behaviour	- Advice on reduction of inner temperature in buildings - Advice for users for efficient domestic heating - Information-sensitization-educational actions on efficient energy use targeting the citizens
	Switch of combustion techniques	- Bans and financial incentives for replacement of solid fuel boilers or biomass boilers - Subsidies for introduction of gas boilers, district heating, electricity (heat pumps) combined with solar thermal
Transport	Fuel alternatives and clean fuel vehicles/ Promotion of green vehicles	Conversion of public buses to natural gas/ bio-diesel fuels Use of bio-fuels (bio-diesel) in municipal and state vehicles Promotion of hybrid, LPG, natural gas technologies for private car owner: - Lower parking fees and taxes - Informing and training citizens Provision of incentives for replacement of older cars with modem technology ones Active measures for fleet renewal
	Demand management strategies	- Parking standards - Low emission zones: blue zone, green zone - Law to reduce traffic

Sector	Policy thematic category	Policy measure examples
		- City toll system - Bans on specific vehicle types, technologies or emission standards
	Mobility management	- Sustainable Urban Mobility Plan (e.g. Basel) - Transport Mobility Plans of enterprises
	Speed limits	- Implementing speed limits on specific roads
	Car-independent lifestyles	- Public bike sharing - Car sharing services - Car pooling services - Construction of pedestrian friendly networks - Sensitization events on the use of bicycles and walking in cities
	Road cleaning	- Street washing during night time
	Transport telematics	- Demand responsive transport services
	Promotion of e-mobility	- Grants for buying an electric car - Municipal e-car fleets
	Retrofitting of cars	- Retrofitting of PC/LDVs diesel EURO 5 - DPF installation on diesel commercial vehicle
	Promotion of public transport	Free/subsidized public transports Improving the public transport services: - Introduction of a new metro line (higher frequency) - Improving the public transport network - P+R facilities Dedicated lanes for public buses circulation
	Promotion of eco-driving	- Training events for citizens - Training the drivers of municipal and state vehicles in eco-driving
	Energy efficient appliances in Transport	- Conversion to LED lamps in municipal lighting
Energy supply	Promotion of renewable energies (photovoltaics, wind power, ...)	- Photovoltaic projects on municipal properties (e.g. school units, municipal buildings, municipal land) - Subsidies, regulations for private building owners - Information campaigns

Sector	Policy thematic category	Policy measure examples
	Improvement of efficiency in energy production	- Improvement of efficiency in electric energy production of A2A plants
	Promotion of district heating	- Expansion and increase of the density of the long-distance heating network - Increasing the connection to the district heating network - Offering district heating services for citizens
	Energetic utilization of waste	- Construction of waste to energy plants - Incineration power plants
	Promotion of natural gas	- Switch from coal to gas at power plants - Improving the connection to the natural gas network
Industry	Shift in fuel use	- Use of refuse-derived fuels in cement industry
Waste	Prevention of waste generation	- Concepts for waste avoidance
Tertiary	Promotion of insulation and renovation	- Efficiency improvements in commercial buildings
	Promotion energy savings behaviour	- Changing the behaviour of employees and workers due to information campaigns
Land use	Conservation agriculture	- Crop rotations
	Increase of public urban green areas (tree planting)	- Tree planting - Green roofs
Cross-cutting	Promotion of energy saving behaviour	- Information/education campaigns for citizens
	Smart concepts	- Smart city concepts

Sector	Policy thematic category	Policy measure examples
Other	Reduction of other emission sources	- Reduction of fireworks in the city center

Despite the variety of addressed sectors, Table 6 highlights the importance of the energy consumption/supply in the buildings and household sector and the transport sector. The following section therefore presents examples of common policies and measures related to these sectors. Further details as well as a description of policies and measures related to other sectors can be taken from Appendix 1.

3.10 Practical features of selected energy savings and transport policies/measures

Promotion of insulation and renovation of private buildings

Various city specific measures are related to the policy for promotion of insulation and renovation in the building sector. Local climate change mitigation plans and energy concepts in multiple ICARUS cities include actions that aim at reducing energy consumption at the city level due a higher standard of energy efficiency in private and municipal buildings. The cities have only indirect influence on the renovation of private buildings, therefore numerous energy consulting services (e.g. Stuttgart) and financial incentives (e.g. income related subsidies, interest-free loans, contracting concepts in Athens, Thessaloniki and Stuttgart) are offered to citizens in order to carry out major interventions for improving their houses' energy efficiency (insulation of walls, facades, roofs; modernization of windows). The programs either set concrete objectives such as improving the energy performance of the household by at least one energy class (Athens, Thessaloniki) or general objectives such as an increase in the renovation rate for the whole city (Stuttgart).

Specific measures in the ICARUS cities supporting the general policy are:

- Provision of subsidies for energy efficient building renovation
- Provision of services regarding energy renovation
- Energy performance contracting or energy consulting for private building owners
- Communication campaigns for energy efficiency
- Energy savings funding programs focusing on energy renovation for private building owners

Energy efficient renovation in municipal buildings and properties

The measure is related to the policy for energy efficient renovation and targets the municipal properties. In contrast to private buildings, cities are directly responsible for the maintenance of municipal buildings (school buildings, hospitals etc.). Most of them lack adequate thermal insulation resulting in high energy demands. Cities have implemented and will continue to implement energy retrofits and soft energy-saving actions within their building stock to improve efficiency and reduce

energy costs. The measure also contributes to the diffusion of best practices and innovative solutions within the city.

Replacement of oil heating system with natural gas heating systems

The measure targets private buildings and specifically households and is related to the policy for a switch in combustion techniques in the building sector and the promotion of natural gas in the energy supply sector. The measure aims at increasing the use of natural gas for heating in residential buildings and the expansion of the natural gas heating system by the natural gas supplier. Currently diesel is the dominant choice of fuel used for heating demands in residential buildings in many ICARUS cities. City specific measures include cooperation between cities and the natural gas suppliers and aim at awareness raising activities in order to steer the households towards the use of natural gas heating systems. Apart from awareness raising activities, the cities provide subsidies and incentives for the installation of natural gas systems (switch of combustion techniques).

Information and educational actions on efficient energy use

Various measures are related to the policy for promoting energy saving behaviour and target the increase of citizens' awareness regarding their energy use. The measures foresee various information-sensitization-educational events on efficient energy use that are organized on a Municipality level. The events provide guidelines for selecting energy efficient heating systems, lighting lamps and electrical appliances, and for introducing RES in households, as well as advice on energy saving in homes. The establishment of local energy forums in Municipality level are also included. The expected responses are an increased awareness among the citizens and advanced energy conscious behaviour.

Installation of photovoltaics on public and municipal land/buildings.

The measure is related to the policy promoting renewable energies (RES). It implements the installation of photovoltaics on municipal land and buildings in order to increase the energy production from RES. Apart from energy production and CO_2 emission savings the measure aims at raising the public awareness of renewable energy sources. Incentive measures of new building regulation could promote a further development of investments in this field.

Retrofitting of Diesel PC/LDV Euro 5

The retrofitting of diesel passenger cars/LDVs, EURO 5, is a technical measure that is related to the policy targeting the retrofitting of older cars. The hardware update includes the installation of an additional selective catalytic reduction system (SCR) for AdBlue injection. The SCR system aims at reducing the emitted NOx due to chemical transformation processes. The heating and dosage of the urea (AdBlue) lead to increased energy consumption by the vehicle. The time horizon of the measure is not completely definable since the possibility of a widespread market launch is still questionable. Furthermore, its technical implementation in all vehicle types (engine sizes) is still under discussion.

City toll for passenger cars

The city toll is a non-technical measure that aims at reducing traffic congestion and therefore relates to demand management strategies. A charge has to be paid by motorized vehicles (passenger cars) when entering the highly congested areas of a city and for each crossing of the toll cordon (goods

traffic and local inhabitants excluded). The exit of the area is free. The expected response is a decrease of trips by private cars and an increase of trips by public transport, cycling and walking, and ride sharing. The measure can be accompanied by a ban on most polluting vehicles in the city center like a low emission zone.

Low emission zone

The low emission zone is a non-technical measure and relates to demand management strategies. It describes an area where highly polluting vehicles are restricted from entering based on their European emission standard. The ban can address different vehicle types like heavy duty vehicles, commercial vehicles or diesel cars. The potential for the emission reduction decreases with the introduction year as the fraction of the vehicle fleet that is going to be banned decreases due to fleet modernization.

Development of bicycle travel

Measures aiming at the promotion of bicycle travel are related to the policy car-independent lifestyle. City-specific measures can comprise an extension of the bicycle path network, improvement in the connection among existing paths, the use of new bike-sharing systems and incentives for the purchase of bicycles.

4 FUTURE WORK

The policies and measures selection presented in this report represent the first key steps towards the main goal of ICARUS – to identify feasible, cost-effective abatement options for reducing air pollution, climate change, and carbon footprint in the European cities. The two lists – one for policies, and one for measures - serve as the ground for the following activities including the estimation of health and climate impacts of the selected policies/measures (Task 5.2), monetary evaluation of the changes and related cost-benefit analysis (Task 5.3), and finally the synthetic evaluation of the feasibility of strategies/options at the city level (Task 5.4). This will later converge into the development of the pathways to green, smart and healthy cities, which is the ultimate goal of the ICARUS project.

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APPENDIX 1 – Two databases of a) policies and b) measures towards integrated win-win solutions on the urban scale

The two databases of a) policies and b) measures towards integrated win-win solutions on the urban scale have been added to this deliverable in the electronic version (.xls datasheet) which allows for a more efficient presentation of the data due to form and design of the tables.

Common policies/measures as well as technical and non-technical measures are collected and described. To collect possible options in addition to the measures already used in the initial selection, the experiences and knowledge of the ICARUS participating cities has been considered.

The following text presents a summary on the design and contents of the data tables in the xls. spreadsheets.

Database a) Policies

Database a) presents policies and relates them to more specific city measures described in detail in database b). It contains further information regarding the policy implementation like an assessment of stakeholders and eco-political instruments. The way from policies to measures and finally to expected outcomes (responses) reflects first estimations and existing experiences of the cities and will be improved during the course of the project based on results of the agent based modeling in ICARUS WP4, WP5.

The database is represented by the first part of the excel sheet and marked in blue.

Table A1: Structure of database a) Policies

Database a) policies	Column	Description	Example
Policy description	Sector	Sector, which will be affected by the respective policy/measure; e.g. Buildings and households, Energy supply, Industry, Transport, Land use, Tertiary, General/Cross-cutting	Transport
	Subsector	Finer description of the respective sector; e.g. Sector transport can be divided into Road transport, Public transport, Railways, Aviation, …	Road transport
	Policy	Overarching strategies and objectives of specific measures (Promotion of public transport, car independent lifestyles, demand management strategies)	Car-independent lifestyles
	Policy group (eco political instrument)	E.g. financial (tolls, subsidies), command and control, information/education/training	Subsidies

Database b) Measures

Database b) is divided into two parts: 1) presents the list of analysed measures and contains a description of measure (marked in purple), 2) relates to the features and the estimation of the

abatement potential (based on existing literature) and information regarding the costs of the respective measure (marked with orange).

Table A2: Structure of database b) 1.Identification and description of measures

Database b) 1. Identification and description of measures	Column	Description	Example
Measure description	Measure description (policy intervention)	Concrete measure or policy intervention, that aims to contribute to the related policy or general aim (there is usually more than one measure for each respective policy)	Implementation of a job ticket (some companies and authorities subsidise a ticket for local public transport for the employees with 10 to 30%)
	Body/organization	Body or organization that implemented/ has to implement the measure, measures can be implemented at different levels and by different bodies, e.g. city, power plant operator, energy supplier, transport company	Transport company (subsidies from companies and authorities)
	Expected output of the measure (responses)	Expected impact of measure or intervention (at least one level lower than the measure body/ organization, driven by actions at the individual level)	Switch from car to public transport: increase of trips by public transport, other modes will be reduced respectively
Stakeholder management and implementation	Implementation status	E.g. implemented, intended, tested but not feasible	Implemented
	Time scale for possible implementation	E.g. short-term, medium-term, long-term (if not already implemented)	-
	Assessment of feasibility	First estimation of the feasibility or important issues that need to be considered regarding the implementation	Feasible, depends on the interest of stakeholders/ local companies and authorities
	Assessment of view of institutional actors	Which institutional actors are involved?	Public transport company, companies, authorities
	Assessment of view of stakeholders	Are there any further stakeholders that are involved or need to be involved?	
	Assessment of public acceptance	First assessment of public acceptance	High acceptance and support by the public

	Other factors relevant to implementation/ lessons learned		
	Barriers	First estimation of potential barriers	
	Drivers	First estimation of potential drivers	

Table A3: Structure of database b2. Description of features, abatement potential and costs

Database b): 2. Description of features, abatement potential and costs	**Column**	**Description**	**Example**
Features	Synergies/ interactions with other objectives	Shows possible interactions between different sectors like energy generation and transport or households	Electricity consumption (for railways)
	Category (technical – non technical)	Explains whether it is a technical measure or a non technical measure. Technical measures are the so–called "end–of–pipe–technologies" and they neither modify the driving forces of emissions nor change the structural composition of systems or activities, but are applied to reduce emissions before being released in the atmosphere (technical measures are e.g. the introduction of a new filter system and therefore basically change emission factors. Non–technical measures reduce anthropogenic driving forces and can be related to people's behavioural changes (e.g. environmental education and awareness, car sharing, cycling, walking etc.) or to technologies that, reducing the energy demand, abate the fuel consumption (e.g. the use of high efficiency boilers or building thermal insulating coats). Non technical measures change the activities of the activity-emission factor databases, e.g. energy consumption per fuel type).	Non technical
	Spatial scale (urban, non-urban, local)	Provides the spatial extent of the measure (Is the measure applicable in urban systems, on highways, at a regional level, whole EU, ...?)	Urban, regional
Activity emission factor database and emission modeling	Affected sector in WP2 database	Estimation, which emission source sector(s) will be affected	Road transport (NFR09 1A3b), Railways (NFR091A3c)

	Change in activities or emission factors	Explains whether the measure changes activties (AC) or emisssion factors (EF) or both (refers to the activity emission factor databases of WP2)	AC
	Abatement potential	Provides the potential impact of a measure (based on a literature research)	
	Abatement target/ description	Describes the impact of the measure on reducing emissions or concentrations/immissions, …	
	Assumptions for calculation	Describes relevant assumptions and input data	
	Reference for abatement potential	Reference where information about the impact of the measure is evaluated and given	
	Changes in life cycle emission expected?	Is an effect on life cycle emissions expected? E.g. are relevant up- and down stream proccesses affected?	Increased demand for public transport means (additional busses, railways)
Costs	Costs (investment)	Provides the costs for the acquisition of the necessary equipment for the implementation of a measure	
	Costs (running)	Provides the running costs of the measure	
	Reference for costs		

The final part of the excel sheet contains the comments regarding the measures.

Comments	Comments	Important remarks and information concerning the measure	Example
	Contact for measure	Provides the information about who to contact for further information about the measure	
	Further literature for measure description	Other references where the measure is described in more detail	
	Chosen for evaluation in ICARUS?		yes

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs												Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions							Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ I nteractions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Athens	**Buildings and households**	Non residential buildings (municipal buildings)	Energy efficient renovation	Subsidies	**Saving energy at buildings/ Energy renovations in school buildings and other municipal buildings, installation of green roofs, use of natural gas.**	City of Athens,	Reduce GHG emissions	implemented and will be expanded	medium-term		Related departments of Athens municipality					National Energy Efficiency Action Plan		non-technical	local	Small combuston Plants/ Domestic	AC		Reduction in GHG emissions		1,2							yes
Athens	**Buildings and households**	Residential and non residential buildings	Promotion of energy saving behaviour	Information/ campiagns	**The City of Athens will promote through informative campaigns national funding programs regarding energy savings.**	Ministry of Energy of Energy and the Environment	Increase citizens awaireness		short-term							National Energy Efficiency Action Plan	CRES	non-technical	local	Small combuston Plants/ D omestic	AC		Reduction in GHG emissions		1,2	no						yes
Athens	**Buildings and households**	Residential buildings	Heating technologies	Subsidies	Choosing **natural gas over diesel for heating demands** could save up to 20% in total energy consumption in the residential sector of Athens.	Ministry of Energy of Energy and the Environment	Emission reduction	implemented and will be expanded	medium-term							National Energy Efficiency Action Plan	energy generation	non-technical	Regional	Small combuston Plants/ Domestic	AC		Reduction in GHG emissions		1,2	yes						yes
Athens	**Buildings and households**	Residential buildings	Promotion of insulation and renovation	Legislation	**The City of Athens will support in any possible way the conversion of 10% of the existing residential sector to nearly zero-energy-buildings until 2030.**	City of Athens	Promote nearly zero-energy buildings, emission reduction	to be implemented	medium-term							National Energy Efficiency Action Plan		non-technical	urban	Small combuston Plants/ Domestic	AC		Reduction in GHG emissions		1,2							yes
Athens	**Energy supply**	Decentralized plants	Promotion of renewable energies	Infrastructure	**Installation of PVs in school buildings**	City of Athens	promote renewable energy sources, reduce energy costs, reduce emissions	implemented and intended	short/ medium-term									Technical	urban	energy	EF		Reduce emissions			yes						yes
Athens	**Transport**	Public transport (metro, bus)	Fuel alternatives and clean-fuel vehicles	Public transport/ Infrastructure	Establishment of two **electric bus lines**; connecting city districts with other historic landmarks of the city center.	Athens Transportation Company, City of Athens	Promotion of clean-fuel vehicles in public transportation, decrease of private transport; mileage of public transport systems increase	intended	medium-term		Athens Urban Transport Organisation S.A. (OASA S.A.)						electricity consumption	non-technical	Regional	Road transport	AC		Reduce emissions	Urban buses replacement with electric buses (or CNG buses) – Alternative transport fuel (biodiesel)	K.M.Fameli, V.D.Assimakopoulos, Development of a road transport emission inventory for Greece and the Greater Athens Area: Effects of important parameters (2015)	yes					K.M.Fameli, V.D. Assimakopoulos, The new open Flexible Emission Inventory for Greece and the Greater Athens Area (FEI-GREGAA): Account of pollutant sources and their importance from 2006 to 2012	yes

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs												Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions						Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Athens	**Transport**	Road Transport	Fuel alternatives and clean-fuel vehicles	Information/ Education/ Training	**Promote new technology vehicles**	Ministry of Energy of Energy and the Environment	promotion of environmental friendly vehicles, improve air quality	implemented	short/ medium-term								energy generation	technical	regional	Road transport	AC,EF		Reduce emissions	Fleet renewal of PC according to new European emission standards	E.A.Nanaki, C.J.Koroneos, G.A.Xydis, D. Rovas, Comparative environmental assessment of Athens urban buses – Diesel, CNG and biofuel powered	yes						yes
Athens	**Transport**	Stationary Energy consumption	Energy efficient appliances	Infrastructure	Interventions in **Municipal lighting systems and conversion to LED lamps in Municipal lighting network**	City of Athens	Reduce energy consumption, emission reduction, cost savings	to be implemented	short-term		Related departments of Athens Municipality					Reducing Greenhouse Gas Emissions in the City of Athens		Technical	urban	enegry	EF		Reduction in GHG emissions		2	yes						yes
Athens	**Waste management**	Waste management	Promoting eco-friendly waste management with citizens participation	Information/ education/ technological measures	**Waste is pre-treated and pre-sorted into biodegradable and non-biodegradable material for further anaerobic digestion and composting. Residues end in landfill. Plastic, paper and ferrous material are recycled.**	Municipalities in the Attica Region	Change in waste management streams, reduction of waste sent to landfill, recycling 50% up to 2020	Intented	Short-term		Related departments of Municipalities				Citizens awarenes s, financial situation	Regional Planning of Attiki for Waste Management (ACMAR)	Reduction of CO2 emissions, reduction of toxic compounds released in the environment	Technical and non-technical	Urban	Waste	AC	CO2 emissions savings: 414 Kt CO2/ a in Municipality of Athens	Reductions of CO2 emissions by 414 kt / y compared to the reference case (2012) by 2020	Reduction of waste going to landfill by 50%, life cycle analysis of emissions	Sarigiannis DA, Handakas EJ, Karakitsios SP, Antonakopoulou MP, Gotti A. Life cycle analysis for urban waste treatment optimization. Environmental Division 2014 - Core Programming Area at the 2014 AIChE Annual Meeting, 2014, pp. 16-23.	yes						yes
Athens	**Waste management**	Waste management	Promoting MSW incineration and energy recovery	Technological measures	**Waste without any pre-treatment or pre-sorting goes directly for combustion to the incinerator for electricity production**	Municipalities in the Attica Region	Change in waste management streams, reduction of waste sent to landfill, incineration 50% up to 2020	Intented	Short-term		Related departments of Municipalities				Financial situation	Regional Planning of Attiki for Waste Management (ACMAR)	Reduction of MSW volume, energy production, CO2 emission reduction	Technical	Urban	Waste	AC	Energy and CO2 emissions savings: 1473 GWh/ a; 124.9 Kt CO2/ a in Municipality of Athens	Reductions of CO2 emissions by 124.9 kt compared to the reference case (2012) by 2020	Reduction of waste going to landfill by 50%, life cycle analysis of emissions	Sarigiannis DA, Handakas EJ, Karakitsios SP, Antonakopoulou MP, Gotti A. Life cycle analysis for urban waste treatment optimization. Environmental Division 2014 - Core Programming Area at the 2014 AIChE Annual Meeting, 2014, pp. 16-23.	yes						yes
Basel	**Buildings and households**	Residential and non residential buildings	Heating technologies	Regulations	Heating and hot water (oil, gas): In case of replacement obligation to **switch to a renewable system (heat pump, district heating, etc.)**	City	reduction of emissions	implemented	medium-term	feasible							electricity consumption	technical	regional	Small combustion 1A4	AC	CO2 emissions savings: 285'000 t CO2/ a (34% of the total CO2 emissions).	Fossil free heating and hot water.	Different scenarios possible: 1. all gas/ oil-fired heatings are replaced with district heating (80% renewable), 2. all gas/ oil-fired						4	Yes

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs													Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions							Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
																								heatings are replaced with a mix of heat-pumps, geothermal and solar energy										
Basel	**Transport**	All transport modes	Mobility Management	Urban planning and traffic managment	Implementation of the program **"Sustainable mobility Basel City"** which includes various activities and measures into an overall framework.	City	increase the proportion of environmental friendly mobility.	implemented									modal shift	non-technical	regional	Road Transport	AC	No calculations available	Reduce emissions and traffic load	Cargo bikes replace urban freight traffic by car (replace 10% of current LDV's).							10	Yes
Basel	**Transport**	Public transport (metro, bus)	Promotion of e-mobility	Regulations	**Change public busses to electric**	Region	reduction of air pollution	in discussion	short-term	debated							electricity production, fleet composition change	technical	regional	Road Transport	EF	No literature/ calculations available	Reduce emissions	All public busses are replaced by fully electric busses. No changes will occur in the traffic load.	-		-					Yes
Basel	**Transport**	Road transport	Promotion of e-mobility	Subsidies	**Taxi holders get 10'000 CHF when buying an electric car**	City	increase e-mobility	implemented	short-term	feasible					recharching network not sufficient		electricity consumtion, fleet composition change	non-technical	regional	Road Transport	EF	No literature/ calculations available	Reduce emissions	All taxis are replaced by fully electric cars. No changes will occur in the traffic load.	-		8500 Euro per taxi	-	9			Yes
Basel	**Transport**	Road transport	Demand management strategies	Regulations	Law to **reduce traffic** (except motorways) by 10% until 2020	City	traffic reduction	intended		disputed			public voted for this in 2010		industry/ commerce is lobbying against it		public transport	non-technical	regional	Road Transport	AC	No calculations available	Reduce emissions and traffic load	Traffic (without motorways) is reduced by 10%.								Yes
Brno	**Buildings and households**	Non residential buildings (municipal buildings)	Promotion of insulation and renovation	Subsidies	Reduce energy consumption by insulating the building, windows replacement and regulation of the heating system; **The Green Savings Programme**	City	• 1% decrease of CO2 emissions • Reduction of energy for heating 6.3 PJ for the whole Czech Republic (Brno has 3.6% of the Czech population) • Increase of the production of heat from renewable resources by 3.7 PJ for the whole Czech Republic • Reduction of the dust particle emissions by 2.2 million kilograms for the whole Czech Republic	implemented			The State Environmental Fund of the Czech Republic		High acceptance and support by the public				indoor air pollution, reduction of energy/ fuel consumption for heating	technical	local	1 A 4 c i	AC, EF		reduction of CO2 and particles emission		1		6800000		Budget official reported by the Ministry of Environment for the whole Czech Republic (http:// verejne-budovy.zelenausporam.cz/ cz/ aktuality/ 170-milionu-na-energeticky-usporne-renovace-verejnych-budov/)	measure DB2	1	Yes
Brno	**Buildings and households**	Residential and non residential buildings	Heating technologies	Subsidies	**Replacement of solid fuel boilers by gas boilers, district heating, electricity (heat pumps) combined with solar thermal**. 700 boilers were replaced in the 1. call of the Operational Programme Environment in Priority Axis 2 - Improving air quality in human settlements. In the	Building owners	Replacement of coal fired boilers by heat pumps, natural gas boilers and biomas boilers	implemented		Assessment of feasibility for each call is prepared by the South Moravian Region	the South Moravian Region, City		High acceptance and support by the public			High shares of subsidies to motivate people to buy a new boiler	Promotion of insulation and renovation. Boiler replacement is often done with the insulation of building. GHG emission	technical	regional	1 A 4 b i	AC (fuels), EF	up to 25000 of old coal fired boilers	reduction of PM10, PM2.5, SO2, NOx, VOC, B(a)P, GHGs and CO2 emissions, emission reduction per boiler is on average: PM10: 53.1 kg/ y, PM2.5: 51.5 kg/ y, SO2: 16.9 kg/ y, NOX -3.9 kg/ y, VOC 133.5 kg/ y, B(a)P 30.1 g/ y, CO2: 5.4 t/ y		1		2500 euros per boiler invested by the city (rough approximation)	0	Evaluation of the first call in all regions in the Czech Republic was done by ENVIROS	measure DB1	1, https:// www.kr-jihomoravsky.cz/ Default.aspx?PubID=346840&TypeID=2	Yes

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs												Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions							Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
					2. call 800 boilers is expected for replacement												s increase.														
Brno	**Buildings and households**	Residential and non residential buildings	Heating technologies	Subsidies	Creating conditions for reducing fossil fuel consumption by **connecting to district heating system**	Power plant operator, energy supplier	Decrease of fossil fuel consumption	considered	long-term			Teplárny Brno, SAKO Brno,			Low heat price from coal/ biomass and relatively high price from district heating systém		waste management heat supply	technical	local	1 A 1 a	EF, AC		reduction of the PM10, PM2.5 and Nox emission from household heating		1					measure DB3	1	Yes
Brno	**Buildings and households**	Residential buildings	Promotion of insulation and renovation	Subsidies	Reduce energy consumption by insulating the building, windows replacement and regulation of the heating system (**The Green Savings Programme**)	Building owners	• 1% decrease of CO2 emissions • Reduction of energy for heating 6.3 PJ for the whole Czech Republic (Brno has 3.6% of the Czech population) • Increase of the production of heat from renewable resources by 3.7 PJ for the whole Czech Republic • Reduction of the dust particle emissions by 2.2 million kilograms for the whole Czech Republic	implemented			the South Moravian Region, The State Environmental Fund of the Czech Republic		High acceptance and support by the public				indoor air pollution, reduction of energy/ fuel consumption for heating	technical	regional	1 A 4 b i	AC, EF		reduction of CO2 emission		1		35080000	0	Costs based on list of the beneficients http://www.zelenausporam.cz/soubor-ke-stazeni/17/5186-zu_prehled_prijemcu_podpory_12_2016.pdf	measure DB1	1, http://www.zelenausporam.cz/soubor-ke-stazeni/17/5186-zu_prehled_prijemcu_podpory_12_2016.pdf	Yes
Brno	**Transport**	Cycling/ Walking	Car-independent lifestyles	Mobility management; command and control	**Improving cycle networks**	City, bikesharing companies	Changes in the usage of bikes from 2 % in 2015 to 12 % in 2050, increase the current share of use to 0.4%	a. Measure is already adopted		3 – fairly difficult to implement measure	•Cooperation with municipal transport departments •Road Maintenance organization	•City Districts •Cycling association •Car Clubs	Usually in urban environment	n/ a				technical	local	Road transport	AC		Reduction of emission from road traffic (PM, Nox)		3					One measure for lines 10-15	3	Yes
Brno	**Transport**	Public transport (metro, bus)	Promotion of public transport	Information/ Education/ Training	Promotion of the **integrated public transportation within whole metropolitan area**		Change of ratio of passengers in trains/ cars. Increase of train passengers by > 52%	b. Measure is being considered	long-term			South Moravian Region, Train providers						non-technical	regional	Road transport	AC		Emission reduction of road traffic		6						6	Yes
Brno	**Transport**	Road transport	Promotion of green vehicles	Information/ Education/ Training; subsidies	**Promoting low carbon vehicles**	City	Reduction of primary emissions due to the traffic sector	b. Measure is being considered		2 – fairly easy to implement measure	•Cooperation with municipal transport departments, environmental departments •Organizations promoting healthy lifestyle •PT operators	•NGOs •Cycling association •Pedestrian associations •Environmental organisation •Organizations dealing with road safety and security	•High impact on the public	n/ a				non-technical	regional	Road transport	EF, AC		Emission reduction of road traffic		3					chapter 5.1.2	3	Yes

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs												Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions							Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ I nteractions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Brno	**Transport**	Road transport	Demand management strategies	Regulations	**Parking standards**	City, private companies	Reduction of both external-city vehicles and intra-city vehicles mobility in the city of Brno. This effects mainly individual car transport.	b. Measure is being considered	medium-term	3 – fairly difficult to implement measure	•Cooperation with municipal transport departments, planning departments •Road Maintenance organization	•Car clubs •City districts •Organizations dealing with road safety and security •Cycling association	•Citizens have to include in the discussion since the parking itself is very sensitive topic •If the benefits of the measure will be explain comprehensibly and clearly the acceptance by the public could increase	•It is rather unclear if the residential parking will be implemented in the one wave fro whole city, or step-by-step	Public opinion, Dissemination of the system to the public			non-technical	local	Road transport	AC	In Prague there was a reduction of 30-40 % of the parking cars in some area.	Emission reduction of road traffic		9						9	Yes
Brno	**Transport**	Road transport	Demand management strategies	Financial incentives	**City toll system**, Reduction of the vehicles in the city centre	All cars	Changes in the usage of individual cars from 39 % in 2015 to 20 % in 2050	Measure is not considered presently	short-term			City of Brno, BKOM, Police						technical	urban		AC				6						6	Yes
Brno	**Waste management**	Waste management	Promoting MSW incineration and energy recovery	Technological measures	Incineration of waste at the power plant	Incineration power plant SAKO Brno	Increase heat supply to the district heating grid from 1 PJ to 1,3 PJ	considered	medium-term		City	SAKO Brno, Heating plant Teplárny Brno, a.s.					Reduction of the heating from Energy sector	technical	local	1 A 1 a	AC		Reduction of energy from other sources		3					table 19, page 47	3	Yes
Ljubljana	**Buildings and households**	Residential and non residential buildings	Heating technologies	Subsidies	**Increase in connecting facilities to the gas network**	City of Ljubljana	reduction of emissions	Intended for implementation	medium term	Feasible								Technical	Urban		AC				1,2,5,6,7,8				1,2,8			YES
Ljubljana	**Buildings and households**	Residential and non residential buildings	Heating technologies	Subsidies; Information/ Education/ Training	**Further encouragement of the replacement of existing combustion units with more appropriate means**	City of Ljubljana	reduction of emissions	Intended for implementation	Short term	Feasible								Technical	Urban		AC				1,2,5,6,7,8		9.200.000		1,2,8			YES
Ljubljana	**Buildings and households**	Residential buildings	Promotion of energy saving behaviour	Information/ Education/ Training	**Advice for users for efficient use of domestic heating**	City of Ljubljana	Efficient energy use, reduction of emissions	Intended for implementation	Short term	Feasible								Non-technical	Urban		AC				1,2,5,6,7,8				1,2,8			YES
Ljubljana	**Energy supply**	Energy distribution	Promotion of district heating	Subsidies; Information/ Education/ Training	**Increased utilization and expansion of district heating systems**	City of Ljubljana	Efficient energy use, reduction of emissions	Intended for implementation	medium term	Feasible								Technical	Urban		AC				1,2,5,6,7,8		2.800.000		1,2,8			YES
Ljubljana	**Other**	Other emission sources	Reduction of fireworks	Command and control	**Reduction of fireworks use in the area of the municipality**	City of Ljubljana	Reduction of fireworks use in the area of the municipality - reduction in PM10 pollution	Intended for implementation	medium term	depends on the interest of stakeholders															1,2,5,6,7,8				1,2,8			YES
Ljubljana	**Transport**	All transport modes	Mobility Management	Mobility management; command and control	Ten largest employers in the city will prepare and implement their **transport mobility plans** with the aim of achieving the municipality goals of modal split	Large companies - employers	Decreased use of personal cars	Not implemented	medium term	Feasible								Non-technical	Urban		AC			To decrease car based pollution by 20%		1,3,4,8		50.000		3,4			YES
Ljubljana	**Transport**	Cycling/ Walking	Car-independent lifestyles	Command and control	In the heart of the city, a **pedestrian-friendly network** of streets will be arranged to all the city's attractions and important institutions.	City of Ljubljana	Increased share of walking	Partially implemented	Short term	Feasible			High acceptance by stakeholders/ public					Technical	Urban		AC	Increase of pedestrian ares by 10 %.			1,3,4,8				3,4			YES
Ljubljana	**Transport**	Cycling/ Walking	Car-independent lifestyles	Command and control	The **ban or restriction of motor traffic** along with the renovation of streets and markets.	City of Ljubljana	Increased share of walking	Partially implemented	Short term	Feasible								Non-technical	Urban		AC				1,3,4,8				3,4			YES

CITY	Database a): Policies				Database b) 1. Identification and description of measures												Database b) 2. Description of features, abatement potential and costs												Comments		
	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions						Costs					
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Ljubljana	**Transport**	Cycling/ Walking	Car-independent lifestyles	Subsidies; Information/ Education/ Training	provide an **uninterrupted bicycle network** of main and connecting routes will be established, connecting the most frequented pedestrian areas.	City of Ljubljana		Partially implemented	medium term	depends on the interest of stakeholders			High acceptance by stakeholders/ public					Technical	Urban		AC	increase of cycling rate, based on the number of journeys (by 10%)			1,3,4,8				3,4			YES
Ljubljana	**Transport**	Public transport (metro, bus)	Fuel alternatives and clean fuel vehicles	Public transport	**Hybrid and CNG bus implementation - renovation of PT fleet**	PT company/ City of Ljubljana	Cut fuel consumption costs by 20%	Partially implemented	medium term	Feasible				•bus technology has a potential to be replicated in other Slovene cities •further study on hybrid technologies •necessary insight into LPP's decision-making process/ system	•Change of LPP budget •Technical issues with hybrid buses	•Strategic decision towards environmental friendly vehicles •High social acceptance			Technical	Urban		AC	Cut fuel consumption costs by 20% in the high quality mobility corridor	Reduction of emissions by 3% (overall PT network)		1,3,4,8		30.000.000		3,4	•reduction in external costs •Hydraulic hybrid buses perform best when disabling hybrid technology •CNG bus showed lowest pollution		YES
Ljubljana	**Transport**	Public transport (metro, bus)	Promotion of public transport	Infrastructure	Integrated **high-quality mobility corridor**; On three avenues with heavy traffic congestion, a faster travel time for **LPP buses** from passenger cars will be ensured with PT priority an intersections and dedicated bus lanes.	City of Ljubljana	Decrease in: •fuel consumption •emissions •time travel	Partially implemented	medium term	Feasible		acceptance of dedicated bus lanes	acceptance of dedicated bus lanes	•Positive results for implementation of yellow lanes on broadened road profile •Increase in support for sustainable transport (gain a change in ideology concerning the transport related issues) •feasibility study for the implementation of the proposed project should be made •negative media viewpoint	•P+R in flood •Lack of transport strategies within the city administration •Spatial constraints in the southern part of the corridor(not enough space for lines) •Lengthy administrative processes (adopting spatial planning documents/ permissions)	•Indirect requests for traffic reduction measures (from outside partners) •Political and public support		Technical	Urban		AC	Increase in PT journejy by 10% (by 2020) and 30% (by 2027); 16% PT use in modal split	5% fuel consumption reduction for private cars during the morning and afternoon peaks; 5% PM10, NOx pollution reduction for private cars during the morning and afternoon peaks		1,3,4,8		10.000.000		3,4			YES
Ljubljana	**Transport**	Public transport (metro, bus)	Promotion of public transport	Infrastructure	**Bus routes** will be extended to neighboring municipalities	PT company/ City of Ljubljana	Decreased use of personal cars; Increased share of public transport use;	Partially implemented	Short term	Feasible								Technical	Regional		AC				1,3,4,8				3,4			YES
Ljubljana	**Transport**	Public transport (metro, bus)	Promotion of public transport	Mobility management; command and control	**P & R** facilities on the outskirts of the municipality	PT company/ City of Ljubljana	Decreased use of personal cars; Increased share of public transport use;	Partially implemented	medium term	Feasible								Technical	Regional		AC		To dectrease car based pollution by 20%		1,3,4,8		11.000.000		3,4			YES
Ljubljana	**Transport**	Road transport	Demand management strategies	Mobility management; command and control	**Alternative parking policy**; Street parking spaces will be intended primarily for residents.	City of Ljubljana	Decreased use of personal cars	Partially implemented	Short term	Feasible								Technical	Urban		AC		To decrease car based pollution by 20%		1,3,4,8				3,4			YES
Ljubljana	**Transport**	Road transport	Demand management strategies	command and control	**Prohibition of heavy freight vehicles** on the northern Ljubljana bypass	National; City of Ljubljana	Reduced pollution	Not implemented	medium term	depends on the interest of stakeholders								Non-technical	Regional		AC				1,3,4,8				3,4			YES

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Ljubljana	**Transport**	Road transport	Promotion of e-mobility	Subsidies; Information/ Education/ Training	**Promotion of electromobility**; establishment of a car sharing network	City of Ljubljana	Decreased use of personal cars	Intended for implementation	Short term	depends on the interest of stakeholders								Technical	Urban		AC				1,3,4,8				3,4			YES
Madrid	**Cross-cutting**	Resilience and adaptation strategies	Low emissions and energy efficiency urban management	Urban planning	**Regeneration and rehabilitation of neighborhoods**	Madrid City Council		Intended and still in progress	short-term (2017-2018)									technical	urban	Energy consumption	AC, EF		Primary energy and GHG emission savings in Madrid								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Land-use**	Resilience and adaptation strategies	Climate change adaption	Urban planning	**Development of the Madrid + Natural program, to increase urban resilience towards climate change, with interventions in buildings, neighborhoods and the re– naturalization of the Manzanares River**	Madrid City Council	Climate change adaptation	Intended and still in progress	long-term (2017-2030)																		The A Plan's budget for the period 2017-2020 is 543.9 million euro.				Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	All transport modes	Mobility Management	Information/ Education/ Training	**Sustainable work mobility plans**	Madrid City Council		Intended and still in progress	short-term (2017-2018)									non-technical	urban	Road transport	AC, EF		Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Cycling/ Walking	Car-independent lifestyles	Mobility management; command and control	**Prioritization of pedestrian mobility**	Madrid City Council		Intended and still in progress	short-term (2017-2018)														Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Cycling/ Walking	Car-independent lifestyles	Infrastructure	**Improvement and expansion of the bicycle network and mobility**	Madrid City Council		Intended and still in progress	short-term (2017-2020)																						Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Public transport (metro, bus)	Promotion of public transport	Infrastructure	**Reserved infrastructure for public transport**	Madrid City Council		Intended and still in progress	short-term (2017-2019)									non-technical	urban	Road transport	AC		Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Road transport	Sustainable mobility	Regulation / ban	**Zero Emissions Central Area**	Madrid City Council	• 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.	Intended and still in progress	short-term (2017-2018)										non-technical	urban	Road transport	AC	• Reduce NOx emissions by 23%, PM10 by 8% and PM2.5 by 9% in the whole city area by 2020, compared with 2012 levels. • 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.	Emission reduction of road traffic				The A Plan's budget for the period 2017-2020 is 543.9 million euro.				Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES

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Madrid	**Transport**	Road transport	Traffic management and optimization	Infrastructure	**Redesign the main traffic distribution routes and periphery-center connection**	Madrid City Council		Intended and still in progress	short-term (2017-2019)									non-technical	urban	Road transport	AC		Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Road transport	Traffic management and optimization	Regulation	**Parking regulation according to air quality criteria**	Madrid City Council		Intended and still in progress	short-term (2017-2018)									non-technical	urban	Road transport	AC		Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Madrid	**Transport**	Road transport	Traffic management and optimization	Information/ Education/ Training	**Public-private collaboration in order to innovate and make urban logistics processes more efficient**	Madrid City Council		Intended and still in progress	short-term (2017-2018)									technical	urban	Road transport	EF		Emission reduction of road traffic								Plan A: Air Quality and Climate Change Plan of the City of Madrid	YES
Milan	**Buildings and households**	Residential and non residential buildings	Heating technologies	Technological measures	**Fuel switch from fuel oil to natural gas** in heating plants is already taking place in Milan, also as an effect of incentives provided by the Local Administration		fuel switch of heating plants will continue with a higher replacement rate than the BaU rate, under effect of regulations, incentives and financial aids that the Local Administration will further enforce to sustain plant renovation	implemented and still in progress	short-term, mid-term (2020)		Provision of incentives to replace and renovate heating plants		Communication activities and counselling to citizens within the "Sustainable Energy Point", to diffuse information on incentives to renovate heating plants and current laws	Evaluate if a ban on installation of new fuel-oil heating plants should be introduced in the new building regulation			Buildings heating (district heating)	Technical	urban	Energy industries	AC	54 ktonCO2/ year	· improvement of air quality; Primary energy and CO2 emission savings; Average abatement cost: -396 €/ tCO2	CO2 emission reduction by 2020 is estimated from fuel switching of plants that would serve for heating 6 million m2 of built surfaces, additional over the BaU scenario.		Yes					Comune Milano - Sustainable Energy and Climate Action Plan 2009, POCACITO	YES
Milan	**Energy supply**	Decentralized plants	Promotion of renewable energies	Financial incentives	several **photovoltaic projects** have recently been started up (i.e. ATM's depot in Precotto, renovation of the "School for Tourism" building). Incentive measures of new building regulation could promote a further development of investments in this field, based on projects that have already been planned up to now.	Municipality of Milan	emission reduction has been estimated assuming that 300,000 m² photovoltaic panels will be built by 2020 (+300% in comparison to 2005), equivalent to 39 MWp of power and 85 GWh/ year of annual electricity production, which will enable to avoid the consumption of grid electricity.	implemented and still in progress	short-term, mid-term (2020)	Assessment of suitable areas for the installation of photovoltaic systems	Simplification of administrative procedures and legislative framework pertaining to the installation of photovoltaic systems	Development of photovoltaic programs on specific typologies of buildings (i.e. schools)					longer term security for local power supply; Infrastructure change, building heating		local	Energy Savings	AC	26 ktCO2/ year	improvement of air quality	emission reduction has been estimated assuming that 300,000 m² photovoltaic panels will be built by 2020 (+300% in comparison to 2005), equivalent to 39 MWp of power and 85 GWh/ year				191 €/ tCO2			Comune Milano - Sustainable Energy and Climate Action Plan 2009, POCACITO	YES
Milan	**Transport**	Road transport	Demand management strategies	Urban planning and traffic managment. Ban / regulations. Charging zone	**'Area C', which combine a Congestion Charge scheme with the banning of the most polluting vehicles in the city centre.**, By January 16th 2012 Milan Municipality implemented a new private traffic restriction scheme called 'Area C' ('C' stands for 'Congestion Charge'), which combine a Road Pricing Scheme with the banning of most polluting vehicles in the central part of	Municipality of Milan	Mobility Results: •Reduction - 36.723 (first 24 months compared with 2011 Ecopass, the previous pollution charge Scheme) •Less Traffic: - 28 % Less Road accidents: - 23.8% (-26.3 % with injured injured; out of Area C: 10 Area C: 10 – 11 % - 2012 compared compared with 2011) •Increase of public transport speed during peak hours: +6,9% for buses and +4,1% for tram •Decrease in parking occupation -10%	implemented and still in progress					A survey carried out in April 2013 analyzing the perception of the citizens of Milan stated that 58% of residents expressed favorable views of 'Area C' measure.			fuel consumption; - reduced traffic congestion; - reduction in the number of on-road parked vehicles - reduced noise pollution	technical	urban	Road Transport and Railways	AC	Total PM10 - 18% ; Exhaust PM10 -10%; Ammonia - 42%; Nitrogen Oxides -18%; Carbon Dioxide - 35%; Less Airborne Black Carbon (BC) concentrations: -52% (Summer, at kerbside) and - 28% (Winter, residential site).	Less Traffic - 30,2% (reduction of daily entrance - 39.864 vehicles, compared with 2011 Ecopass, the previous pollution charge scheme); Less Road accidents - 23.8%; Less occupation of on-street parking - 10% (with a gain in public space availability); Increase of public transport speed (during peak hours: +9,3% for buses and +5,4% for tram); Less pollutant vehicles: - -49% (-2.400 pollutant		Area C	yes				All the Area C LTZ incomes have been reinvested in projects for Sustainable Mobility such as the strengthening of public transport and the development of the bike-sharing system.	PUMS, PRIA, PAES	YES

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					the city. The area subject to the congestion charge is bounded by the ring road called 'Cerchia dei Bastioni' (Bastioni ring) and corresponds to an area of 8.2 km2, approximately 4.5% of the whole territory of the Municipality of Milan. To enter the 'Area C' LTZ a ticket is required for Euro 4-6 diesel cars and for Euro 1-6 gasoline powered cars. Inside the 'Area C' LTZ the circulation is forbidden to Euro 0 gasoline cars, Euro 0-3 diesel cars; after December 31, 2016 the access will be forbidden also to Euro 4 diesel cars. Furthermore inside Area C LTZ heavy duty vehicles longer than 7.5 meters can't access. Only electric, hybrid, LPG and natural gas, bi-fuel powered vehicles are allowed to enter Area C without charge in the first years of the measure (until December 31, 2016). Motorcycles and mopeds are exempted from payment. Exemption is also provided for those vehicles transporting people with disabilities, subjected to life-saving treatments or for those who must go the first aid. Vehicles for public transport services, vehicles for public utility services, tour buses, taxi, 'Euro 3' diesel vehicles belonging to residents and vehicles for the transportation of goods for public utilities and for the residences can access free. 'Area C' LTZ is operating on workdays from 07:30 am to 07:30 pm; on Thursday		(+10% public spaces available) Environmental Results: •Less pollutant vehicles: - 49% (-2.400 pollutant vehicles entering every day the Area C) More cleaner vehicles + 6,1 % (from 9,6% to 16,6% of the total vehicles) •Less emissions of pollutants: Total PM10 Total PM10 -18% ; Exhaust PM10 Exhaust PM10 -10%; Ammonia -42%; Nitrogen Oxides -18%; Carbon Dioxide -35% •Less Black Carbon (BC): -52% (Sept) and –32% (Oct) of BC concentration inside Area C compared to the outside Area C stations.																	vehicles entering every day the Area C); More cleaner vehicles + 6,1 % (from 9,6% to 16,6% of the total vehicles);											

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					the operating time is 7:30 am - 6:00 pm.																											
Stuttgart	**Buildings and households**	Non residential buildings (municipal buildings)	Energy efficient renovation	Information/ Education/ Training	**Energetic renovation of municipal and federal buildings/ properties**	City of Stuttgart	Energetic renovation of schools, hospitals, bathhouses,…	implemented and intended	short-term	2 – fairly easy to implement measure	supportive	supportive	•High acceptance and support by the public	to be assessed during the project	to be assessed during the project	to be assessed during the project	indoor air pollution, reduction of energy/ fuel consumption for heating	technical	urban, non-urban	Energy consumption	AC	energetic renovation of municipal properties ca. 221,6 GWh/ a; 52587,1 t CO2/ a in Stuttgart, energetic renovation of federal properties 126.2 GWh/ a in Stuttgart, for comparison: total primary energy consumption of municipal buildings in Stuttgart is 740 GWh/ a	Primary energy and CO2 emission savings in Stuttgart	pending request	5	yes, renovation materials	to be assessed during the project	to be assessed during the project	unknown	5, Measure: "Sanierung städtischer Liegenschaften", measure 34	5,11	yes
Stuttgart	**Buildings and households**	Residential buildings	Promotion of insulation and renovation	Information/ Education/ Training	Provision of services regarding **energetic renovation** like energy performance contracting or energy consulting for **private buildings**	City of Stuttgart	Energetic renovation of private buildings (insulation of walls, facades, roofs; modernisation of windows)	in progress	short-term	2 – fairly easy to implement measure	supported	Energy consulting agency	•High acceptance and support by the public, but unclear how many building owners decide for renovatition due to the contracting and consulting services	to be assessed during the project	to be assessed during the project	to be assessed during the project	indoor air pollution, reduction of energy/ fuel consumption for heating	non technical	urban, non-urban	Energy consumption	AC	45-55%, 100 kWh/ m² / a (12); ca. 40 GWh/ a in Stuttgart (0.9% of the total final energy consumption in the household sector; 1.3% of energy for heating) (5)	reduction of heating and cooling energy demand of a non-renovated household, primary energy and CO2 emission savings in Stuttgart	Increase of the renovation rate of residential buildings (1%/ a to 2%/ a); 66% heating energy savings per household(year after renovation	12	yes, renovation materials	to be assessed during the project	to be assessed during the project	unknown	11 Measure: "Altbaumoderniserung"; different measures can be found in the "Energiekonzept", e.g. 29 contracting for private energetic renovation 9.3 GWh/ a, 32 energetic renovation in renovation quarters 4.1 GWh/ a	11,12	yes
Stuttgart	**Buildings and households**	Residential buildings	Heating technologies	Information/ Education/ Training	Promotion of **gas boilers (replacement of biomass boilers with gas boilers)**	City of Stuttgart, Ministry	Replacement of biomass fired small combustion plants (e.g. wood pellet boilers, automatic wood boilers) with gas installations	implemented and intended	short-term	2 – fairly easy to implement measure	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	GHG emissions increase	non technical	urban, non-urban	Energy consumption, small combustion plants	AC (fuels), EF	emissions of incomplete combustion (PM, CO and VOC) can be reduced by more than 60%	emissions	assumed replacing rate 5 %/ a	8		to be assessed during the project	to be assessed during the project	unknown		8	yes
Stuttgart	**Buildings and households**	Residential buildings	Heating technologies	Financial or market based instruments, Subsidies, Information/ Education/ Training	Switch to **renewable heat supply in residential sector** (e. g. solar heating, biomass boilers, heat pumps)	City of Stuttgart, Ministry	Private building owners exchange their heating technology	in progress	short-term, medium-term	2 – fairly easy to implement measure / 3 – fairly difficult to implement measure	to be assessed during the project	to be assessed during the project	to be assessed during the project	feasibility depends on the direct and indirect influence of the authorities to motivate the private building owners	to be assessed during the project	to be assessed during the project	Land use (biomass use); biomass combustion: air pollutants	non technical	urban, non-urban	Small combustion plants	AC	cf. sub measures in long measure list	Emission reduction	unkown	cf. sub measures in long measure list	yes, electricity consumption/ production	to be assessed during the project	to be assessed during the project	unknown	includes several sub measures	18	yes

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Stuttgart	**Buildings and households**	Residential buildings (private buildings)	Promotion of insulation and renovation	Subsidies	Municipal subsidies for **energy efficient building renovation (private buildings)**	City of Stuttgart	Energetic renovation of private buildings (insulation of walls, facades, roofs; modernisation of windows)	in progress	short-term	2 – fairly easy to implement measure	supported	supported	•High acceptance and support by the public, but unclear how many building owners decide for renovatition due to the contracting and consulting services	to be assessed during the project	to be assessed during the project	to be assessed during the project	indoor air pollution, reduction of energy/ fuel consumption for heating	non technical	urban, non-urban	Energy consumption	AC	45-55%, 100 kWh/ m^2/ a (12), 154,4 GWh/ a; 36480,0 t CO2/ a in Stuttgart (4% of the total final enrgy consumption in the household sector; 5% of energy for heating) (5)	reduction of heating and cooling energy demand, primary energy and CO2 emission savings in Stuttgart	Increase of the renovation rate of residential buildings (1%/ a to 2%/ a); 66% heating energy savings per household(year after renovation	12, 5	yes, renovation materials	to be assessed during the project	to be assessed during the project	unknown	total energy consumption of households in Stuttgart is 4.300GWh/ a (2013)	5	yes
Stuttgart	**Energy supply**	Energy distribution	Promotion of district heating	Financial or market based instruments	**Expansion and increase of the density of the long-distance heating network** including heat storage systems (district heating)	Local energy provider	More households will be connected to district heating	in progress	short-term, medium-term	3 – fairly difficult to implement measure / 2 – fairly easy to implement measure	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	Infrastructure change, building heating	non-technical	urban	Energy consumption	AC	50,0 GWh/ a; 6000,0 t CO2/ a, for comparison: primary energy consumption in Stuttgart is 20.000 Gwh/ a	Primary energy and CO2 emission savings in Stuttgart	unknown	5	yes	to be assessed during the project	to be assessed during the project	unknown	5, Measure 79: "Ausbau und Verdichtung des Wärmenetzes unter Einbeziehung von Wärmespeichern"	5,12	yes
Stuttgart	**Energy supply**	Power plants	Promotion of natural gas	Technological measures	Switch from coal to natural gas at the **ENBW power station Gaisburg, modenisation** (in 2020)	Operating company	Modernisation of the power plant	intended	short-term	2 – fairly easy to implement measure	positive	positive	positive, a lot of information campaigns	none	none	none	Enrgy use of the residential and commercial sectors	non technical	urban (local)	Energy industries (LCP)	AC	20% reduction of primary energy (260 GWh/ a, 140.000t CO_2, for comparison: primary energy consumption in Stuttgart is 20.000 Gwh/ a)	Primary energy and CO2 savings in Stuttgart in 2020	constant district heat production, base load operation of gas engines (cogeneration plant)	5, p.48	yes, fuel transport	not yet known	not yet known	unknown	modernization has already started	5, https:// www.enbw.com/ unternehmen/ konzern/ energieerzeugung/ neubau-und-projekte/ heizkraftwerk-stuttgart-gaisburg/	yes
Stuttgart	**Transport**	Public transport (metro, bus)	Promotion of public transport	Financial incentives	**Cheaper (or free) public transport** (e.g. -10, -25%, -50%)	Local public transport company (City of Stuttgart)	increase of trips by public transport, other modes will be reduced respectively	in discussion (at national level by environmental agency)	short-term	3 – fairly difficult to implement measure	•Transport Departments •Public Transport Operators •Coordinator of Regional Public Transport •Railway Authority	•City districts •NGOs •Cycling association •Pedestrian associations •Environmental organization •Association of citizens with disabilities • - to completed these sings with information	•High acceptance and support by the public – this measure improve the quality of the provided PT service	to be assessed during the project	to be assessed during the project	to be assessed during the project	electricity production (public transport)	non-technical	urban	Road Transport and Railways	AC	unknown	Change the behaviour and reduction of road traffic emissions	unknown	none	yes, electricity consumption/ production	to be assessed during the project	to be assessed during the project	unknown			yes
Stuttgart	**Transport**	Road transport	Retrofitting of cars	Regulations	**Retrofitting of cars:** Retrofitting of PC/ LDVs diesel EURO 5 (alternative: incl. EURO 6) a) Hardware update: SCR system (AdBlue) b) Software update	Ministry of Infrastructure and Transport	Retrofitting with a filter system (90% of car owners), software update	in discussion	short-term, medium-term	3 – fairly difficult to implement measure	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	none	technical	urban, non-urban	Road Transport	EF	to be assessed during the project	Emission reduction of road traffic, changing the fleet composition	Potential for retrofitting among EURO 5 diesel, PC/ LDV cars: 95% (21) - NOx reduction of diesel Euro 5 inside cities: 50-70% (A22) o Cold Start: 44-61% less NOx emissions in city traffic o Hot driving emissions: up to 70% reduction - NOx reduction of diesel Euro 5 outside of	21, 22	yes, AdBlue production	to be assessed during the project	to be assessed during the project	unknown		20, 21, 22	yes

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	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions							Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ I nteractions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
																								cities: 90% (22), new NOx EF (50 mg/ km) below EURO 6 limit value (80 mg/ km) (22) - 5% higher fuel consumption (22) à 5% higher EF for combustion related emissions of CO2, EFs for regulated pollutants remain constant since the change of complex combustion processes and engine control due to the increased consumption is not assessable										
Stuttgart	**Transport**	Road transport	Promotion of green vehicles	Subsidies	Promotion of **green vehicles: E-cars, hybrid vehicles a)municipal fleet, b)private cars**	Ministry of Infrastructure and Transport, City of Stuttgart	Change of the fleet composition of private trasportation: Replacement of high emission vehicles with ones of modern technology and lower emissions.	implemented and intended	short-term, medium-term	2 – fairly easy to implement measure	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	to be assessed during the project	electricity production	non-technical	urban, non-urban	Road Transport	AC, EF	promotion of private e-mobility (e.g. decree of parking prices): emission reduction NO2: 1%, PM10: 0%; e-mobility in vehicle fleets: NO2: 2-4%, PM10: 0%	Emission reduction of road traffic within the city area compared to a base year	unknown	1	yes, electricity consumption/ production	to be assessed during the project	to be assessed during the project	unknown	to specify	2, 8	yes
Stuttgart	**Transport**	Road transport	Demand management strategies	Regulation	**Low emissions zones: blue badge** (all-season; entry only for diesel cars with at least Euro 6 and gasoline cars with at least Euro 3) a) light blue badge b) dark blue badge	City of Stuttgart?	replacement of high emission vehicles and fleet penetration with moden technology cars, no significant traffic relocation to non-urban road network due to early announcement and discussion of the measure	in discussion	short-term	3 – fairly difficult to implement measure	•Cooperation with planning authorities – local municipalities, region •Road Maintenance organization	•City districts, shop owner, owners of the properties – to discuss and explain the necessity of this measure •PT operators, car clubs •Association of citizens with disabilities - to completed these sings with information	•As for any restrictive measure it is necessary to explain why it will be implemented, what are the benefits; •Information campaign has to take place – with the clear explanation of the tariffs, detours, etc.	to be assessed during the project	to be assessed during the project	to be assessed during the project	electricity production (public transport), modal shift, fleet composition change	non-technical	urban	Road Transport	AC	NOx: -40% - -46%, PM10: -4% for the whole city area, Nox: -54% - -63%, PM10: -4% - -6% in the inner city region (basin), Nox: -51% - -60%, PM10: -5% - -6% at the measuring station 'Am Neckartor'	Emission reduction of road traffic at different spatial scales (selected road, inner city center, …) compared to a basic case (reference year 2019)	base year 2019, assumption for 2019: 80% of the PCs meet the requirements of the blue badge, 20% are exceptions from the ban (35. BImSchV), traffic volume/ load remains stable	1	no	to be assessed during the project	to be assessed during the project	unknown	Implementation of a new badge (blue badge) is still in a discussion. This has to be introduced by the Federal Government.	2	yes

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	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Stuttgart	**Transport**	Road transport	Demand management strategies	Financial incentives	**City toll** is a non-technical measure that aims at reducing traffic congestion. A charge has to be paid by motorized vehicles (passenger cars) when entering the highly congested areas of a city and for each crossing of the toll cordon (goods traffic and local inhabitants excluded). The exit of the area is free. The toll is considered to be independent from the time of the day and the vehicle technology. The charge for entering the basin in Stuttgart is assumed to be a) 2€ or b) 5€.	City of Stuttgart (see assessment of feasibility)	Decrease of trips by car, increase of trips by public transport, cycling and walking, ride sharing; park&ride at the city borders due to avoidance of entering the city area with the passenger car	cancelled (but still discussedl)	short-term	There is currently no legal framework for the introduction of a city toll. There are still numerous open questions regarding tax law design and legislative competence of federation and states. Basically, the road is free for common utilization. The introduction of a city toll therefore requires a legal basis, whereby a state authorization would not be sufficient. A city toll for federal highways expressly opposes § 7 para. 1 sentence 4 FSTRG, according to which the levying of fees for the common use needs a separate legal regulation. 4 – very difficult to implement measure Due to the lack of legal basis, the city toll can not currently be included as a measure in the clean air plan since will be an implementation in accordance with § 47 para. 6 BImSchG would not be possible.	politicians have reservations due to low public acceptance	ADAC (automobile club in Germany) negative	public acceotance is rather low --> ; in Stockholm referendum in 2006 51,3% pro city toll	no lessons from Stuttgart; other cities: http://urbanaccessregulations.eu/urban-road-charging-schemes/overview-of-urban-road-charging-schemes	to be assessed during the project	to be assessed during the project	electricity production (public transport)	non-technical	urban	Road (PC, Bus), Rail (metro&tram)	AC	NOx: -7%, PM10: -7% in the whole city area, NOx: -28%, PM10: -29% in the inner city region (basin), NOx: -34%, PM10: -35% at the measuring station 'Am Neckartor'	Emission reduction of road traffic at different spatial scales (selected road, inner city center, …) compared to a base year	5€/ entry, exit is free; modal shift: trips by PC -7%, walking: +2%, cycling +0.25%, public transport: +4%, ride sharing: +0.25%; vehicle fleet composition remains unchanged; vehicle kilometres in the Stuttgart basin decrease by about 35%, within the larger city area by about 8%	1	An increase of trips by public transport (metro and tram) leads to a higher electricity consumption so that an effect on emissions due to electridcity generatio outside of the city boundaries can be expected	examples for London, Milan, and Stockholm in references	2-5€ for each entry; examples for London, Milan and Stockholm in references	Transek (2006), Cost-benefit analysis of the Stockholm Trial, http://www.stockholmsforsoket.se/upload/Sammanfattningar/English/Cost-benefit%20analysis%20of%20the%20Stockholm%20Trial%20v2.pdf; Leape, J. (2006), The London Congestion Charge, Journal of Economic Perspectives. Volume 20, Number 4—Fall 2006—Pages 157–176, https://ac.els-cdn.com/S2213624X1400011X/1-s2.0-S2213624X1400011X-main.pdf?_tid=70ec991f8-a638-4c8e-a25a-68d6d393016a&acdnat=1522312659_9be4c296dfb6fa7cd13561e1d6bcb819	please see also measure "Area C" in Milan	2, http://urbanaccessregulations.eu/urban-road-charging-schemes/overview-of-urban-road-charging-schemes	yes
Thessaloniki	**Buildings and households**	Non residential buildings (municipal buildings)	Promotion of insulation and renovation	Technological measures	**Energy renovation of municipal buildings/ properties (schools, public buildings, swimming pools,etc.), bioclimatic renovation of public open areas and implementation of green roofs in public buildings**	Municipalities of the Thessaloniki Regional Unit	Energy and CO2 emission savings in municipal buildings/ properties, Improvement of thermal comfort conditions in urban environment, Reduction of air pollution	Implemented and intended	short-term						Capital funding	New Regulation of Energy Efficiency of Buildings, Funding programs for renovation of public areas and promotion of green roofs	air-quality, reduction of energy/ fuel consumption for heating, microclimate.	technical		Energy consumption	AC and EF	Energy savings: 42.81 GWh/ a; CO2 emissions savings: 24850 t CO2/ a. For comparison: total final energy consumption of municipal buildings/ facilities in Thessaloniki Regional Unit is 173.78 GWh/ a	Energy and CO2 emission savings, improvement of thermal comfort conditions in urban environment, positive effect of green roofs on air pollution	The respective measures include: a) energy efficiency measures on 830 municipal buildings/ facilities, b) 24 large-scale green roofs to be implemented in public buildings, c) 2 public areas to be improved in terms of their microclimate, d) 4 athletic open areas to be renovated	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13		59.345.655,00 €		1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	The implementation of the measure is expected to be completed by the year 2020	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	Yes

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	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions						Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Thessaloniki	**Buildings and households**	Residential and non residential buildings	Promotion of energy saving behaviour	Information/ Education/ Training	**Information-sensitization-educational actions on efficient energy use targeting the citizens and users of the tertiary buildings.**	Municipalities of the Thessaloniki Regional Unit	Energy conscious behaviour	In progress	long-term								electricity production, buildings modernisation	non-technical		Energy consumptions/ Small Combustion Plants	AC	Energy savings: 198.43 GWh/ a; CO2 emissions savings: 87633 t CO2/ a. For comparison: total final energy consumption of residential buildings is 4220.95 GWh/ a and of tertiary buildings is 1327.51 GWh/ a.	Energy and CO2 emission savings	The measure is expected to reach a 3% reduction of the total final energy consumption of residential buildings.	1, 2, 4, 5, 7, 8, 10, 11		513.500,00 €		1, 2, 4, 5, 7, 8, 10, 11	The implementation of the measure is expected to be completed by the year 2020	1, 2, 4, 5, 7, 8, 10, 11	Yes
Thessaloniki	**Buildings and households**	Residential buildings (private buildings)	Promotion of insulation and renovation	Subsidies	**Subsidies for energy efficient building renovation**	Ministry	Energy renovation of private buildings (insulation of walls, facades, roofs; modernisation of windows)	Implemented and intended	short-term						Capital funding	New Regulation of Energy Efficiency of Buildings	air-quality, reduction of energy/ fuel consumption for heating and cooling	non technical		Energy consumption	AC	31% per building, Energy savings: 423 GWh/ a; CO2 emissions savings: 165923 t CO2/ a	Reduction of heating and cooling energy consumptions / Energy and CO2 emission savings	121340 households are estimated to be renovated until 2020.	1, 2, 4, 5, 7, 9, 12		206.010.000,00 €		1, 2, 4, 5, 7, 9, 12		1, 2, 4, 5, 7, 9, 12	Yes
Thessaloniki	**Buildings and households**	Residential buildings (private buildings)	Heating technologies	Subsidies	**Subsidies and incentives for switching combustion techniques / promotion of natural gas / Promotion of energy efficient appliances and solar thermal energy.**	Ministry	Replacement of heating oil boilers with natural gas heating systems and of heating oil boilers with new ones (energy efficient) in households. Energy consumption decreases. Energy and CO2 emission savings in households.	Implemented and intended	long-term						Capital funding	New Regulation of Energy Performance of Buildings, Funding programs for residencies, Maturity of the national market of solar systems	air-quality, energy consumptions	technical		Energy consumption, small combustion plants	AC (fuels), EF (boilers)	Energy savings: 235.28 GWh/ a; CO2 emissions savings: 169864 t CO2/ a; average heating energy savings in residential sector: 17%, in tertiary sector: 21%. For comparison: total final energy consumption of households is 4420.95 GWh/ a.	Energy and CO2 emission savings / Solar thermal energy production	The change in emission factors is due to the use of other fuels (gas or pellets/ woodchips instead of heating oil) --> change in emissions follows the relation of other fuel-emission factor to heating oil-emission factor. Up to the year 2020 at least 69450 households and commercial/ office buildings will proceed to the replacement of their heating oil boiler and heating fuel type and at least 8000 households will proceed to the utilization of solar thermal energy to produce domestic hot water.	2, 4, 5, 7					The implementation of the measure is expected to be completed by the year 2020. Gas-emission factor is 24% lower compared to the heating oil-emission factor.	2, 4, 5, 7	Yes
Thessaloniki	**Buildings and households**	Residential buildings (private buildings)	Energy efficiency interventions	Information/ Education/ Training	**Information-sensitization-promotion actions on the use of CLF and LED lamps and energy efficient appliances / Replacement of old ACs with new inverter technology**	Municipalities of the Thessaloniki Regional Unit	Inform citizens on energy efficient appliances and decrease energy consumption	In progress	long-term							Eco-Labelling of all new energy appliances and ACs	Electricity consumption	non-technical	urban	Energy consumption	AC	Energy savings: 84.98 GWh/ a; CO2 emissions savings: 95643 t CO2/ a	Energy and CO2 emission savings	The measure is expected to reach a 17% reduction of the total electricity consumption.	2, 4, 5, 7					The implementation of the measure is expected to be completed by the year 2020	2, 4, 5, 7	Yes

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	Policy description				Measure description			Stakeholder management and implementation									Features			Activity emission factor database (WP2) and modeling of emissions						Costs					
	Sector	Subsector	POLICY	Policy group (Ecopolitical instrument)	Measure name and description (policy intervention)	Body/ organisation	Expected output of the measure (responses)	Implementation status in your city or EU wide (implemented, intended, tested but not feasible)	Time scale for possible implementation (short-term; medium-term; long-term)	Assessment of feasibility	Assessment of view of institutional actors	Assessment of view of stakeholders	Assessment of public acceptance	Other factors relevant to implementation and lessons learned, further development	Barriers	Drivers	Synergies/ Interactions with other objectives			Affected sector in WP2 database	Change in activities (AC) or emission factors (EF) in WP2 database	Abatement potential (based on literature)	Abatement target/ description (e.g. emissions, concentrations, …)	Assumptions for calculation	Reference for abatement potential	Changes in life cycle emissions expected?	Costs (investment) in €	Costs (running) in €/ unit	Reference for costs	Comments	Further literature for measure description	Chosen for evaluation in ICARUS?
Thessaloniki	**Energy supply**	Decentralized plants	Promotion of renewable energies		Installation of photovoltaics on public and municipal land/ buildings	Municipalities of the Thessaloniki Regional Unit	Energy production and CO2 emission savings in Metropolitan area; Raising public awareness through demostration projects	Implemented and Intended	medium-term, long-term		Departments of Technical Services of the Municipalities				Capital funding	Net metering program for grid-connected renewables	Weather depending, electricity production, buildings modernisation	technical	urban, non-urban	Energy consumption	AC	Energy production from renewable resources: 10.87 GWh/ a; CO2 emissions savings: 12661 t CO2/ a	Energy production and CO2 emission savings	Up to the year 2020, school units and municipal buildings will proceed to the installation of photovoltaic systems (a total of 7.92 MWp of electrical power will be installed).	1, 2, 4, 5, 7, 8, 12, 13		8.794.290,00 €		All refs	The implementation of the measures are generally expected to be completed by the year 2020. The measure is also expected to raise public awareness.	1, 2, 4, 5, 7, 8, 12, 13	Yes
Thessaloniki	**Industry**	Cement industry	Fuel alternatives	Corporate Social Responsibility (CSR)	**Increase the use of Refuse Derived Fuel (RDF) in cement industry.**	Cement industries	CO2 emission savings, Reduction in the use of non-RES for energy production in cement industry, Improvement of CSR of cement industry	intended	short-term, medium-term		Related departments of cement industry					Financial crisis, Energy costs (e.g. the hike in heating oil taxation), Environmental concerns (CSR)	Energy production, fuel energy consumption, air-quality	technical	urban, non-urban	Industry	AC, EF	CO2 emissions savings: 0.1–0.5 kg/ kg of cement produced compared with currentproduction techniques using fossil fuels.	CO2 emission savings by reducing the use of non-RES for energy production and		16		2.750.000,00 €		17	Investment costs represent the mean value of the available respective systems in the market.		Yes
Thessaloniki	**Transport**	Public transport (metro, bus)	Promotion of public transport	Infrastructure	**Introduction of a metrostation in the city of Thessaloniki**	Ministry of Infrastructure and Transport, Municipalities of the Metropolitan area	Change of the traffic flow in selected areas of the city; Overall, reductions in traffic flow ranged between 20% and 50%, affecting for the most part roads close to the metro line	Intended	short-term	The feasibility of the measure has been studied within the project URGENCHE and the results are published						Reduction of CO2 emissions	Reduction of traffic congestion, reduction of CO2 emissions, improving public transport	technical	urban	Road Transport	AC	Energy savings: 540 GWh/ a; CO2 emissions savings: 344000 t CO2/ a	Reduction of traffic emissions of 20% compared to the reference case (2011) by 2020	Reduction of traffic flow by 20% compared to the reference case (2011) by 2020	14		1.400.000.000,00 €		15		14, 3	Yes
Thessaloniki	**Transport**	Road transport	Promotion of eco-driving, green vehicles, public trasport and cycling and walking	Information/ Education/ Training	**Training the citizens** in eco-driving, information and sensitization events on clean-fuel technologies and energy efficiency in vehicles, on the use of bicycles and walikng in cities	Municipalities of the Thessaloniki Regional Unit, Metropolitan Authority, Thessaloniki Public Transport Authority (ThePTA)	Replacement of high emission vehicles and fleet penetration with modern technology cars, energy saving and reduction of traffic emissions, increase the use of public transport (including the Metro after its completion), increase of trips by bicycle and walking, raise of public awareness.	Implemented and intended	long-term		Various actors within the competent Authorities				Initial Funding	The operation of the Metro after 2020	Air-quality	non-technical	urban, non-urban	Road Transport	AC	Energy savings: 732.33 GWh/ a; CO2 emissions savings: 196000 t CO2/ a	Reduction of traffic emissions and energy saving of 26% compared to the reference case (2011) by 2020 (eco-driving/ green vehicles by 24% , cycling and walking by 1%, public trasport by 25% of total energy consumption in private and commercial transport).	No changes will occur in the traffic load and the daily movements of the vehicles.	1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13		793.650,00 €		1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13		1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13	Yes

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Thessaloniki	**Transport**	Road transport	Promotion of green vehicles	Incentives, Information/ Education/ Training	**Provision of incentives (reduction or zeroing of circulation taxes and lower parking fees) for replacing high emission vehicles with ones of modern technology and lower emissions** (including hybrid, e-vehicles and clean-fuel vehicles). Inform citizens on the benefits, including incentives, of replacing high emission vehicles with "green" ones.	Ministry of Infrastructure and Transport, Municipalities of the Thessaloniki Regional Unit	Change of the fleet composition of private trasportation: Replacement of high emission vehicles with ones of modern technology and lower emissions.	Implemented and intended	long-term								fuel energy consumption, electricity consumption, air-quality	non-technical	urban, non-urban, motorway	Road Transport	AC	Energy savings: 25.83 GWh/a; CO2 emissions savings: 24268 t CO2/a	Emission reduction of road traffic by changing the fleet composition.	80% of the vehicles put into circulation before 1999 and 40% of the vehicles that circulated before 2004 (reference year is 2010) will be replaced by the year 2020. This means that 43% of the total private fleet (private fleet corresponds to 83% and commercial fleet to the rest 17%) will be replaced by 2020. The calculations refer only to the private fleet. No changes will occur in the traffic load and the daily movements of the vehicles.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13		14.456.315,00 €		1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13		1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	Yes
Thessaloniki	**Transport**	Stationary Energy consumption	Energy efficient appliances	Technological measures	Integrated medium and large scale interventions in **Municipal lighting systems and conversion to LED lamps** in Municipal lighting.	Municipalities of the Thessaloniki Regional Unit	Energy consumption decreases	Implemented	long-term		Departments of Technical Services of the Municipalities				Capital funding		Electricity consumption	technical	urban	Energy consumption	AC	Energy savings: 22.66 GWh/a; CO2 emissions savings: 26967 t CO2/a	Energy and CO2 emission savings		1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13		16.530.366,00 €		1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	The cost is expected to be depreciated in 3-4 years.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	Yes
Thessaloniki	**Waste management**	Waste management	Promoting eco-friendly waste management with citizens participation	Information/ education/ technological measures	**Waste is pre-treated and pre-sorted into biodegradable and non-biodegradable material for further anaerobic digestion and composting. Residues end in landfill. Plastic, paper and ferrous material are recycled.**	Municipalities of the Thessaloniki Regional Unit	Change in waste management streams, reduction of waste sent to landfill, recycling, an. Digestion and composting 50% up to 2020	Intented	Short-term						Citizens awareness, financial situation	Regional Planning of Central Macedonia for Waste Management	Reduction of CO2 emissions, reduction of toxic compounds released in the environment	Technical and non-technical	Urban	Waste	AC	CO2 emissions savings: 132000 t CO2/ a	Reductions of CO2 emissions by 132000 t compared to the reference case (2012) by 2020	Reduction of waste going to landfill by 50%, life cycle analysis of emissions	18						Yes
Thessaloniki	**Waste management**	Waste management	Promoting MSW incineration and energy recovery	Technological measures	**Waste without any pre-treatment or pre-sorting goes directly for combustion to the incinerator for electricity production**	Municipalities of the Thessaloniki Regional Unit	Change in waste management streams, reduction of waste sent to landfill, incineration 50% up to 2020	Intented	Short-term						Financial situation	Regional Planning of Central Macedonia for Waste Management	Reduction of MSW volume, energy production, CO2 emission reduction	Technical	Urban	Waste	AC	Energy savings: 146 GWh/ a; CO2 emissions savings: 44900 t CO2/a	Reductions of CO2 emissions by 44900 t compared to the reference case (2012) by 2020	Reduction of waste going to landfill by 50%, life cycle analysis of emissions	18						Yes

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