

Horizon 2020

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



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Full project title:

Integrated Climate forcing and Air pollution Reduction in Urban Systems

MS18: Preliminary report on the list of options for partner cities, groups of cities and the EU

WP 5: Integrated assessment for short to medium term policies and measures

Lead beneficiary: USTUTT



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Introduction

The list of options for partner cities, groups of cities and the EU is the first step in ICARUS work package 5 and presents the possible options (policy/measure combinations) for reducing air pollution and the carbon footprint in cities. To set up the list of options the experience and knowledge of the ICARUS participating cities which are all very active in developing and implementing policies for climate change mitigation and air pollutions reduction have been leveraged. Furthermore a literature research has been conducted to explore the strategies and plans of institutions such as the European Commission, national authorities and transport and energy providers (e.g. ERTICO and CONCAWE).

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. Furthermore, short term measures that can be implemented in the immediate future and medium-term measures that include changes of infrastructure or a certain time for market penetration and are thus fully effective only after 2020 have been distinguished. For these two categories possible options in addition to the measures already used in the baseline scenario have been systematically collected.

Specific options for ICARUS partner cities

During the first phase of measure collection in WP5 over 720 potential policies and measures have been identified in relation to the incentives of the EU, national and municipal authorities as well as transport and energy providers. Phase 1 was followed by a selection of approximately 10 policies and measures per city (99 altogether) which was made based on predefined selection criteria.

The criteria 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?

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

Athens

TRANSPORT

- 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

Brno

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

Basel

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.)

Ljubljana

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

HOUSEHOLD 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

Madrid

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



Milan

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)

Stuttgart

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)

Thessaloniki

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 CO₂ 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



For each of the 9 partner cities the evaluation of option feasibility will be made through comprehensive process evaluation in Task 5.4. 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 5.3 and 5.4. This approach aims at avoiding the exclusion of measures that might have a high pollution reduction potential, but which 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, PM₁₀/PM_{2.5} and CO₂. 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 PM₁₀ emissions, is the small and medium combustion plant sector. Households also account for a considerable amount of cities CO₂ emissions, which is why energetic renovation of buildings and changes in the heating technologies is given further attention.

Options for groups of cities and the EU

Additionally to the experiences of the ICARUS participating cities, a literature research has been conducted to explore the strategies and plans of institutions such as the European Commission, national authorities and transport and energy providers (e.g. ERTICO and CONCAWE). Results of the literature review as well as city specific measure have been combined to derive options for urban clusters.

Overview of international/EU policies

For 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 PM₁₀ obligations, and a large number of them report exceedances of the annual average NO₂ 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 SO₂ levels, but PM₁₀ and NO₂ 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 ¹	EU ²
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 200 µg/m ³ 1-hour mean	40 µg/m ³ annual 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.

Errore. L'origine riferimento non è stata trovata. 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)

Pollutants		PM	O ₃	NO ₂ , NO _x , NH ₃	SO ₂ , SO _x	CO	Heavy metals	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				NM VOC
	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, NM VOC
	2012/46/EU (EU, 2012)	PM		NO _x		CO			HC
94/63/EC (EU, 1994)	(a)	(b)						VOC	

¹ <http://www.who.int/mediacentre/factsheets/fs313/en/>

² <http://ec.europa.eu/environment/air/quality/standards.htm>



Policies		Pollutants							
		PM	O ₃	NO ₂ , NO _x , NH ₃	SO ₂ , SO _x	CO	Heavy metals	BaP, PAH	VOCs
	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	NMVOG

Notes:

- (a) Directives and conventions limiting emissions of PM precursors, such as SO₂, NO_x, NH₃ and VOCs, indirectly aim to reduce PM ambient air concentrations.
- (b) Directives and conventions limiting emissions of O₃ precursors, such as NO_x, VOCs and CO, indirectly aim to reduce troposphere O₃ 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;
 - maximise the benefits of the Union's environment legislation by improving implementation;
 - increase 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.

Options for urban clusters derived from ICARUS city specific measures

Based on the collected city-specific policy interventions and the literature research of international and EU policies, common measures have been identified whose effect will be analysed in urban clusters across the EU. EU cities will be clustered based on parameters such as size, number of inhabitants, emissions per sector, meteorological parameters like average wind speed and classes, country, availability of natural gas network. For each cluster, an option feasibility analysis will be performed. Table 3 shows possible options for urban clusters.

Table 3 Options for urban clusters

Sector	Policy thematic category	Standardized measure for urban clusters (policy intervention)
(Residential) buildings and households	Enhanced energy conscious behavior	Energy conscious use of appliances Energy conscious use of domestic heating
	Increase of building renovation and efficient design	Energetic renovation of residential buildings Energy efficient design of new buildings
	Environment friendly heating technologies	Switch to gas boilers Switch to solar heating Switch to heat pumps Switch to district heating Switch to biomass burning Switch to modern systems
	Efficiency improvement of appliances	Use of CFL and LED lamps Use of air conditioners with new inverter technology Use of energy efficient appliances
Tertiary and municipal	Enhanced energy conscious behavior	Energy conscious use of appliances
	Increase of building renovation and efficient design	Energetic renovation of municipal buildings/properties Energetic renovation of tertiary buildings Installation of green roofs
	Environment friendly heating technologies	Switch to modern systems Switch to gas boilers
	Efficiency improvement of appliances	Use of CFL and LED lamps in municipal lighting systems Use of energy efficient appliances
	Other energy related investments	Penetration of PVs in municipal buildings
Transport	Car-independent lifestyles	Introduction of new underground railway/metro lines Expansion of bus lanes network Improving cycle networks Pedestrian friendly networks Price reductions in public transport Increased use of car sharing Increased use of park and ride Integrated public transportation system Renovation of public transport fleet (electrified/hybrid/CNG buses, taxis)
	Alternative fuels and	Penetration of electric vehicles



Sector	Policy thematic category	Standardized measure for urban clusters (policy intervention)
	driving technologies (e-mobility, hybrids, CNG, LPG)	Penetration of hybrid vehicles Penetration of CNG Penetration of LPG Renovation of public transport fleet (electrified/hybrid/CNG buses, taxis)
	Increase of vehicles with high emission standard	Withdrawal of old cars
	Retrofitting of old cars	Hardware update of diesel EURO 5 Software update of diesel EURO 5
	Efficient logistics	Efficient urban logistics
	Sustainable mobility plans	Implementation of company mobility plans Sustainable mobility plan for city
	Demand and traffic management strategies	Low emission zone City toll/congestion charge Parking regulations Traffic reduction Redesign of traffic routes
	Freight transport regulations and logistics	Prohibition of heavy freight vehicles Restrictions for commercial vehicles
	Enhanced environmental conscious behavior in traffic	Eco-driving
	Efficiency improvement of appliances	Use of LED lamps in municipal street lighting systems
Energy supply	Promotion of district heating	Expansion of district heating networks
	Switch to less carbon-intensive fuels	Switch from coal to gas power plants
	Efficiency improvements in existing energy production plants	Improvement of efficiency in energy production
Industry	Use of fuel alternatives	Use of refuse derived fuel
Waste management	Eco-friendly waste management with citizens participation	Eco-friendly waste management with citizens participation
	MSW incineration and energy recovery	MSW incineration and energy recovery
Other	Regeneration of neighborhoods	Regeneration and rehabilitation of neighborhoods
	Climate change adaption	Bioclimatic renovation of public areas Re-naturalization measures
	Reduction of other emission sources	Reduction of fireworks



Future work

Possible options for partner cities, groups of cities and the EU have been identified and through a preliminary screening city specific measures have been chosen for further analysis. The measure and policy collection has been based on the experience and knowledge of the ICARUS participating cities and a literature research concerning strategies and plans of institution such as the European Commission and national authorities.

Further steps will provide the answers whether the measures and policies identified 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 comparative evaluation of alternatives will allow the 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.

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