ClairCity: Citizen-led air pollution reduction in cities

D7.4 Final City Policy Package – Ljubljana

April 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689289

Document Details

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Creation Date	10/1/2019
Date of Last Revision	10/4/2020
Description	This report provides policy recommendations to Ljubljana City Council based on the overall ClairCity project.

Version History

Version	Updated By	Date	Changes / Comments
V1.0	Stephan Slingerland, Irati Artola, Hans Bolscher, Enda Hayes, Carlo Trozzi (Techne), Vera Rodrigues (UAVR), Kris Vanherle (TML), Joana Soares (NILU), Laura de Vito (UWE)	December 2019	First full report version
V2.0 and V3.0	Stephan Slingerland, Irati Artola, Hans Bolscher, Enda Hayes, Carlo Trozzi (Techne), Vera Rodrigues (UAVR), Kris Vanherle (TML), Joana Soares (NILU), Laura de Vito (UWE)	March 2020	Revised report

V4.0	Stephan Slingerland, Irati Artola	April 2020	Final version, based on comments by Ljubljana city council

Contributions and Acknowledgements

The authors would like to thank the following people for their important contributions used in the preparation of this final document.

Quality Assurance	Hans Bolscher (Trinomics)
Project internal comments	Sabina Popit, Tjaša Tekavčič, Simona Berden (City of Ljubljana), Nadja Zeleznik (REC)

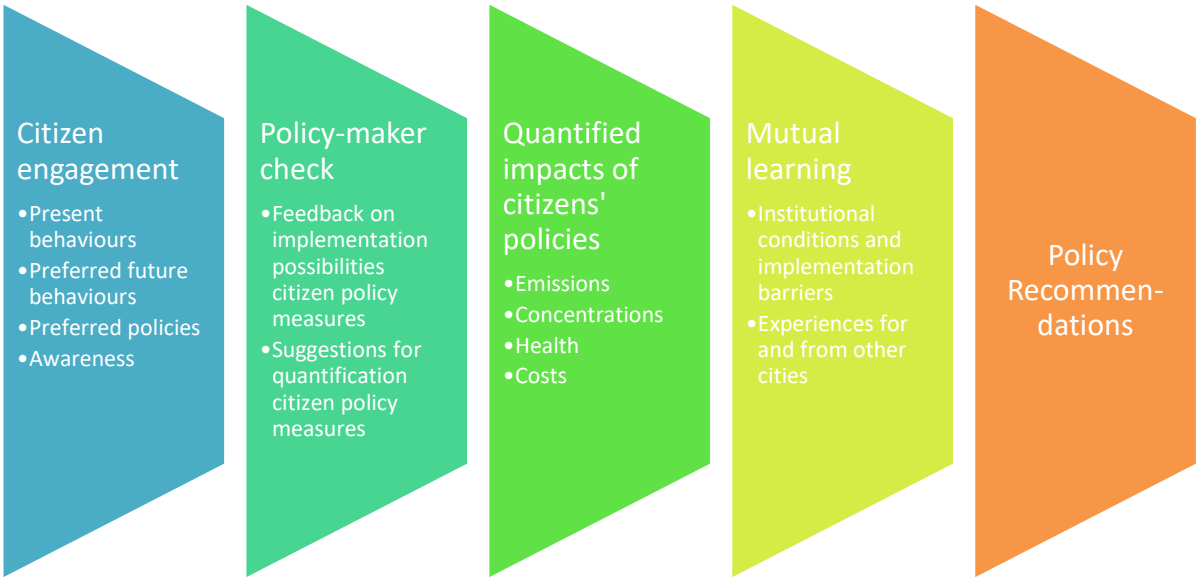
Contents

Executive Summary

ClairCity project and method

The ClairCity Horizon2020 project aims to contribute to citizen-inclusive air quality and carbon policy making in middle-sized European cities. It does so by investigating citizens' current behaviours as well as their preferred future behaviours and policy measures in six European cities[1] through an extensive citizen and stakeholder engagement process. The project also models the possible future impacts of citizens' policy preferences and examines implementation possibilities for these measures in the light of the existing institutional contexts in each city (Figure 0-1). **This report summarises the main policy results for Ljubljana.**

Figure 0-1: The ClairCity policy method in brief



The methodological understanding as developed in the ClairCity project of what citizen-inclusive policy-making is, and what it should and should not comprise, is given in Textbox 0-1.

Textbox 0-1 Citizen-inclusive policy-making according to ClairCity

- Tailor local policies based on detailed knowledge of behavioural practices of citizens;
- Engage with citizens via a diversity of methods, paying particular attention to hearing the voice of 'hard-to-reach' groups;

[1] Bristol, Amsterdam, Sosnowiec, Ljubljana,Aveiro/CIRA region, Genoa/Liguria region

- Ask citizens for their preferred future behaviours and barriers to behavioural changes. Address the perceived barriers of citizens by concrete measures or initiate dialogue with citizens about misconceptions concerning air quality and climate change;
- Ask citizens for their preferred future policies for the city, examine potential impacts of these policies and discuss with stakeholders and policy makers their implementation possibilities;
- Examine and address potential implementation barriers for preferred citizen policy measures beyond citizen perceptions;
- Experiment, and exchange experiences with other cities that are also aiming to implement citizen-inclusive policies;
- Do not confuse citizen-inclusive policies with populist policies. Take full responsibility for democratically implementing popular or unpopular measures considered appropriate, after having been extensively informed about citizens' views and behaviours.

In total, during the period 2017 – 2019 some 250 Ljubljana citizens were reached by the various ClairCity citizen engagement methods (Table 0-1). This is a limited sample, also compared to the other ClairCity cities and it is not fully representative of the Ljubljana population as a whole[2]. Nevertheless, it gives an indication of support for policy measures and intentions for behavioural change of Ljubljana citizens that can be used by policy makers to inform future policies.

Table 0-1: Number of participants in ClairCity citizen engagement methods in Ljubljana

Citizen engagement activity	# of participants engaged
Delphi Process	199
Skylines Game	24
Mutual Learning Workshop	16
Stakeholder Dialogue Workshop (in Delphi process)	26
Policy Workshop*)	12

*) the number of participants of the policy workshop is also included here, despite not being formally part of the citizen and stakeholder engagement process

[2] In Ljubljana, we received 199 responses out of a city population of 280,210. 58% of our respondents were female. In Ljubljana, we have an under-representation of the oldest and youngest categories, with more than two thirds of respondents aged 25-50 compared to 38% in this category in the city as a whole. Our respondents are highly educated, with 65% holding a university education compared to only 24% of the city population. A third of Ljubljana residents have vocational education qualifications, but only 1% of our survey respondents have this. In Slovenia the national or cultural identities of citizens is a politically charged topic due to the histories of Former Yugoslavian populations. As a consequence for ethical reasons we have not used nationality or ethnicity as a demographic identifier for population sampling in Ljubljana.
The majority of respondents were female, making up 68% of the Round 2 respondents. The 37-50 age category were a disproportionate set in our data, at 51% compared to only 24% of the total population. This was at the cost of older people, with only 3% of our Round 2 sample over 65, compared to 15% of the city. The data also represents the highly educated more than the average citizens, with 85% holding some form of higher education certificate, compared to only 31% of the general population.

Conclusions and recommendations for Ljubljana

The main conclusions and recommendations from the ClairCity project for citizen-inclusive policy making in Ljubljana are:

Current air quality and carbon situation in Ljubljana

- **The main air quality issue related to citizens seems PM and biomass burning outside the city, although NO_2 might be also still an issue for the future.**

  Ljubljana has initiated a large number of environmental measures over the last decades, with as most prominent measure the introduction of a large pedestrian zone in the city centre. Particulate matter emissions and resulting concentrations, to a large extent caused by biomass burning outside the city, are noted as a main air quality problem. This holds in particular when comparing concentrations to the much stricter WHO guideline values and more for $PM_{2.5}$ than for PM_{10}. However, ClairCity modelling suggests that also NOx emissions and resulting NO2 concentrations at some hotspots could be an issue when comparing them to legal limit values.

Current behaviours of Ljubljana citizens

- **Current transport behaviour of Ljubljana citizens is already quite environmentally friendly, with shopping as the least environmentally friendly transport activity**

  Of the ClairCity respondents, 42% currently uses only their private car for shopping, compared to 23 and 16% for commuting and leisure. Also, a much smaller number (32%) presently only uses public transport and active travel for shopping, compared to 65% for commuting and 54% for leisure.

Behavioural preferences of Ljubljana citizens for the future

- **Comparing stated intentions of respondents for behavioural change with the policy ambition of the city council to achieve 2/3 active transport, suggests that this could be in line with citizens' intentions for commuting and leisure, but for shopping behaviour achieving the policy target might be more difficult.**

  When asking respondents for their behavioural preferences in the future, 77% indicated preferring to use only public and active transport for commuting in the future, 70% did so for leisure and 60% for shopping transport needs. Equally, of the respondents 4% indicated wanting to use only their private car for commuting, 9% did so for leisure and 20% for shopping.

- **While expansion of district-heating is an option that could contribute to reducing air pollution in the future, the expansion of district-heating does not seem popular with respondents.**

District heating can be an environmentally friendly option for the heating of private homes, provided that the heat is generated for instance from renewables or waste heat from industry. 32% of the ClairCity respondents indicated to be currently connected to the district-heating system, but only 16% wanted to use district-heating in the future.

Policy preferences of Ljubljana citizens for the future

- **Expansion of cycling lanes in streets at the cost of space for motorised traffic seems controversial.**

  Out of the selected most popular policy measures of citizens for their city in the future, the expansion and the scrapping of cycling lanes showed to be almost equally popular with respondents.

- **The impacts of citizen policy measures as compared to a business-as-usual policy scenario for Ljubljana are small due to the nature of the finally selected measures and ambition levels finally selected by policy makers.**

  Policy makers had a relatively large influence on the impacts of the citizen policy measures compared to other ClairCity cities. Firstly, input measures for the policy workshop were limited to transport measures only, giving an indication where current policy priorities in Ljubljana are. Secondly, policy makers in Ljubljana, contrary to many of the other ClairCity cities, selected low or medium ambition levels for many of the measures preferred by citizens.

- **Costs of policy measures are a key concern to Ljubljana policy makers.**

  The main reason for selecting low or medium ambition levels for preferred measures of citizens given by policy makers are the concerns about costs, as the infrastructural measures preferred by citizens would often incur high costs. Impacts of citizen policy preferences

Institutional conditions and barriers for implementation of citizen policies

- **The integration of local policy measures with the region needs attention**

  The urban area of Ljubljana is surrounded by mostly rural areas. Integration of policy measures with those in the region is therefore a key issue, for instance to integrate regional with urban public transport (bus and train) and to address mostly rural biomass burning – next to industrial background emissions - that impact air quality in the city.

- **Civil society and NGOs need to be fostered**

  In Ljubljana, the mayor is in office for many years and was re-elected several times. In this situation, civil society and NGOs indicate that it is sometimes difficult to make their voices heard. Hence, care has to be taken that also citizen inputs given through these channels remain to be considered in policy decisions taken.

The ClairCity Ljubljana Action Plan

For citizen-inclusive city air quality and carbon policies.

- **Address in particular shopping behaviour, next to other transport behaviours**
  Since shopping behaviour from the ClairCity research appears a main area where behavioural change towards public and active transport is difficult for citizens, a specific campaign could be directed at facilitating non-car shopping transport, e.g. by promoting (electrical) transport bikes, public transport rebates provided by shopping centres and increasing parking fees in shopping areas. Also, home delivery by electric vans could be stimulated.

- **Make citizens aware of the advantages of district heating to combine with renewables**
  Increasing awareness of the positive environmental aspects of district heating – if realised with renewables, waste heat from industry or geothermal heat sources – could make citizens easier accept a switch to this heat source.

- **Discuss the impacts of cycling lanes with citizens**
  Increasing the number of cycling lanes seems controversial with Ljubljana citizens, as it will decrease road space for cars. While this is an intended effect in order to stimulate modal shift from private cars to bikes, it could be investigated where specific hotspots are that are particularly controversial and it could be discussed with citizens what are the intended impacts of the cycling lanes and why.

- **Increase measuring and modelling facilities in Ljubljana, for instance by stimulating citizen science measurements**
  Stimulating citizen science measurements of air quality is a cheap way of increasing the number of measuring spots in the city, that simultaneously increases awareness of citizens of live air quality conditions. Several other cities in Europe, including ClairCity cities Amsterdam and Bristol, are already experimenting with such approaches.

- **Integrate policy measures with those in the regions bordering to Ljubljana and disseminate the successes of the Ljubljana approaches**
  Integration of regional and urban public transport could for instance be studied from the Bristol Metrobus system. A systematic study of integration approaches throughout Europe and their applicability to Ljubljana could be made.

- **Show live air quality conditions in the city in order to increase awareness of citizens of the health benefits of clean air**
  ClairCity city Sosnowiec has integrated live air quality information into the public transport timetable information system. Amsterdam is experimenting with an approach that expresses health benefits of clean air in the reduction of number of sigarettes smoked per year. Similar approaches could be applied in Ljubljana, on top of the approaches already applied in the city, such as the ‘Cyanometer’ art sculpture in the city, that gives an indication of air quality in the city in an artistic way.

- **Communicate successes of the 'European approach' in Ljubljana to other cities**
  Ljubljana has been very successful over the last years to attract European projects that contributed to greening the city. Ljubljana also has been 'European Green Capital' in 2016. The lessons and successes of this approach could be communicated more extensively to other cities in order to strengthen mutual relationships, which in turn could be used further to attract new European projects.

- **Investigate success stories of integration of train transport in the overall transport system in other countries and regions**
  Expansion of train transport is a particular area of interest in Ljubljana. Other ClairCity cities already have extensive experience with integration of train and active transport, for instance Amsterdam.

- **Make sure that voices of civil society and opposition remain to be heard and discussed**
  Existing exchanges between policy makers and civil society should be fostered and could from time to time be rechecked if they fulfill their purpose for both sides.

1 The ClairCity project

This chapter provides the context for the ClairCity project (section 1.1) and introduces its objectives (section 1.2). It also gives a reading guide for this report (section 1.3).

1.1 Introduction

In 2015, the Paris climate agreement set the goal to reduce global greenhouse gas emissions to a level keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius[3]. A similar binding agreement for global air quality is lacking, but in 2005 the World Health Organisation formulated guidelines for ambient air quality aiming to improve health and reduce premature death caused by air pollution throughout the world. In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met.[4] Many countries and the European Union have set national air quality targets that are often not as ambitious as the WHO guideline values, but still set a legally binding framework for emission and concentration reductions of air pollutants.

Cities are main contributors to the emissions of greenhouse gases and air pollutants. Recognizing their responsibilities, on top of their legal obligations many cities have set stricter voluntary local goals for emission reductions of greenhouse gases and air pollutants. Improving air quality and reducing carbon emissions as a contribution to the global, national and local targets and ambitions set therefore will be a huge challenge for cities all over the world in the years to come.

Citizens living in these cities do not only cause an important part of these emissions through their daily behaviours, they also can, and have to, contribute to solutions for reducing emissions not only by changing their own behaviour, but also by providing democratic support for policy measures to be implemented that will affect their daily lives. ‘Citizen-inclusive policy making’ is therefore a crucial prerequisite for future air quality and carbon policies in cities to be successful in reducing emissions and reaching targets set on the local, national and global scales.

[3] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[4] https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

1.2 Project objectives

Main objective of the **ClairCity Project**[5] is to contribute to successful, citizen-inclusive[6] air quality and carbon policy making in cities worldwide.

'Citizen-inclusive policy making' in the ClairCity project is defined as

1. Tailoring city air quality and carbon policy measures based on a detailed knowledge of current behavioural practices of citizens;
2. Asking citizens for their preferences regarding own future behavioural changes and taking these preferences into account in policy making;
3. Asking citizens for their preferences regarding future air quality and carbon policy measures in their city and also taking these into account in policy making.

'Citizen-inclusive policy making' within the ClairCity project is seen as competely distinct from 'populistic' policy making. While the latter within the project is seen as an uncritical adoption of the majority voice of citizens on singular policy topics, 'citizen-inclusive policies' to ClairCity means establishing city policies that are as much as possible informed by a detailed and constantly refreshed knowledge of citizens' opinions and behaviours, with the final responsibility for taking – popular and unpopular – policy measures remaining at all times with the democratically elected bodies.

ClairCity aims to contribute to citizen-inclusive policy making by a detailed examination and cross-case comparison of six middle-sized cities throughout Europe. In each of these cities, a comprehensive citizen engagement process is set up consisting of a mix of proven and innovative methods. This carefully designed suite of activities aims to examine current behavioural practices of citizens as well as preferred future behaviours and policy preferences. By carrying out these activities, ClairCity also contributes to awareness of citizens of air quality and carbon policy issues.

The six pilot cities and regions examined in the ClairCity project are:
- Bristol (United Kingdom),
- Amsterdam (Netherlands),
- Ljubljana (Slovenia),
- Sosnowiec (Poland),
- Aveiro / CIRA Region (Portugal) and
- Genua/ Liguria Region (Italy).

[5] The ClairCity project ('Citizen Led Air pollution Reduction in the City') is funded under the EU Horizon2020 programme, grant agreement nr 689289. It started in May 2016 and runs until May 2020. ClairCity website: www.claircity.eu.
[6] The initial subtitle of ClairCity to promote 'citizen-led' policies throughout the project evolved into 'citizen-inclusive' policies, in order to take into account the important role of citizens and stakeholders for informing and co-creating policies, as well as the final responsibility of democratically elected policy makers for deciding on the implementation of these policies.

1.3 This report

This report is the ClairCity "**City Policy Package Report**" for Ljubljana[7]. It provides a summary of the lessons learned for local air quality and carbon policy making in the city. The primary target group of this report are therefore Ljubljana policy makers and politicians. The report can be further of interest to politicians and policy makers in other cities, to national and regional policy makers, to EU policy makers, and last but not least to stakeholders and citizens in Lubljana and elsewhere engaged or interested in improving air quality and reducing carbon emissions in their city.

Chapter 2 of this report discusses the ClairCity citizen engagement methods that were applied and tested in the city. Chapter 3 analyses the current air quality and carbon situation in Ljubljana and looks into current behaviours of citizens that contribute to air pollution and carbon emissions. Chapter 4 examines what behavioural changes Ljubljana citizens envisage for themselves in the future and what preferences they have for policy measures. It also shows what reflections Ljubljana policy makers have on the views of citizens. Chapter 5 quantifies potential consequences of the citizens' preferences in terms of emissions and concentrations of air pollutants and of carbon dioxide, in terms of health and in terms of costs of measures. Chapter 6 discusses specific institutional conditions and barriers for citizen-inclusive policies found in Ljubljana as well as mutual learning possibilities in order to remove these barriers. Finally, chapter 7 gives the main conclusions and policy recommendations that follow from the ClairCity citizen engagement and analysis in Ljubljana.

[7] In the ClairCity project, this report is part of deliverable D7.5 Final Policy Package – Last City.

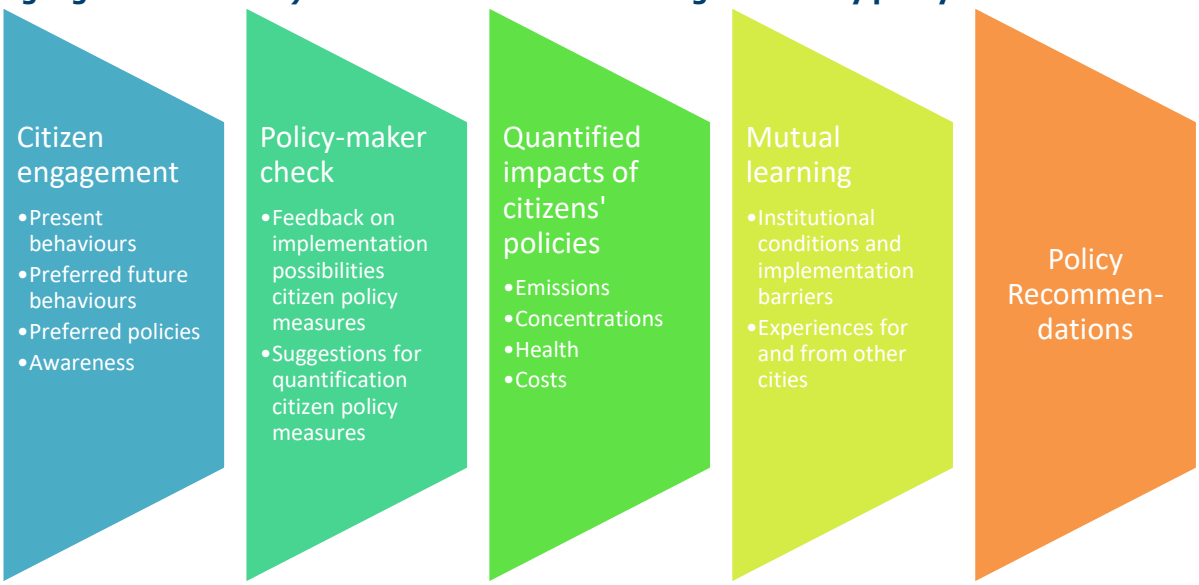
2 ClairCity citizen engagement in Ljubljana

This chapter gives an outline of the ClairCity method of preparing the policy recommendations (section 2.1) and of the citizen engagement activities in Ljubljana (section 2.2). A more detailed overview of the ClairCity project and the positioning of this 'Ljubljana Policy Package' can be found in Annex A. Details of the different ClairCity engagement methods applied in Ljubljana are given in Annex B.

2.1 The ClairCity method and positioning of the Policy Package

Figure 2-1 shows the five-step process in which the policy recommendations for city policy makers in Ljubljana were prepared.

Figure 2-1: ClairCity process including key phases and activities (Policy Package highlighted in red box) and chain of evidence leading to ClairCity policy recommendations



First, in the ClairCity engagement process citizens were consulted in order to examine their present behavioural practices, their preferences for future behaviours and their preferences for future policies. The process by itself contributed to citizen awareness of air quality and carbon issues and policies in the city and also included some activities specifically directed at awareness building.

Second, in a workshop with local and regional policy makers involved in air quality and carbon related policies feedback was obtained on implementation possibilities of the citizen policy preferences. In the workshop, the policy measures that evolved from the engagement process were also more worked out and partly quantified.

Third, from the more detailed citizen policy measures a 'Unified Policy Scenario' was constructed, of which the impacts were modelled regarding emissions and concentrations of air pollutants and greenhouse gases, health and costs to the citizens and city. These impacts

were compared to a business-as-usual scenario with city policy measures implemented and specified in the base year 2015.

Fourth, the specific institutional conditions and barriers for implementation of the citizen measures in Ljubljana were examined, consisting in particular of political framing, financial conditions, multilevel policies and other conditions. These were compared with the experiences in the other ClairCity cities in order to examine what lessons could be learned from and for Ljubljana regarding promising ways for implementation of the citizen measures.

Fifth and finally, detailed policy recommendations for Ljubljana were prepared taking all the steps in the ClairCity process into account.

2.2 Citizen engagement in Ljubljana

Central in the ClairCity project is the engagement process that was specifically designed for the project and rolled out in all six cities. It consists of a suite of existing and proven methods as well as of experimental and innovative methods (Table 2-1).

Table 2-1: ClairCity's citizen engagement activities

		Citizens, general	Citizens, specific target groups[1)]	Other stake-holders[2)]
Policy related	Mutual Learning Workshop	X		X
	Delphi Process	X	X	X
	Skylines Game	X		
Aware-ness related	Secondary schools activities		X	
	Elderly film competition		X	
	ClairCity City Day	X		X
	GreenAnts App	X		

1) Elderly, pupils secondary school
2) NGOs, business, knowledge institutes

Three engagement activities served as key sources to inform the policy workshop and policy recommendations: the Mutual Learning Workshop, the Skylines game for mobile phones and the Delphi-process. In the Mutual Learning Workshop, citizens and other stakeholders (business, NGOs, knowledge institutions) could discuss in the beginning of the engagement process potential policies for the city[8]. In the Skylines game, citizens could decide on policies for their city as if they were holding the position of Mayor of the city[9]. The Delphi process consisted of a three step funneling process, starting with general questionnaires about citizens behaviours and preferences, and ending with 'Stakeholder Dialogue Workshops' to

[8] See ClairCity Report D4.16 Mutual Learning Workshop
[9] See ClairCity Report D4.10 Game User Manual and Data Report

discuss outcomes of the process with stakeholders and to build various citizen scenarios as an input for the policy workshops[10].

In addition, several awareness building activities were carried out in the city to reach specific target groups and to further inform the policy recommendations. These were a film competition for the elderly, classroom discussions with secondary school pupils and a City Day to present ClairCity. An app for the mobile phone that tracks citizens' personal transport behaviour and shows its consequences in terms of concentrations of air pollutants (GreenAnt) still needs to be implemented in the city[11].

In total, during the period 2017 – 2019 some 250 Ljubljana citizens were reached by the various ClairCity citizen engagement methods (Table 2-2). This is a limited sample, also compared to the other ClairCity cities and it is not fully representative of the Ljubljana population as a whole[12]. Nevertheless, it gives an indication of support for policy measures and intentions for behavioural change of Ljubljana citizens that can be used by policy makers to inform future policies.

Table 2-2: Number of participants in ClairCity citizen engagement methods in Ljubljana

Citizen engagement activity	# of participants engaged
Delphi Process	199
Skylines Game	24
Mutual Learning Workshop	16
Stakeholder Dialogue Workshop (in Delphi process)	26
Policy Workshop*)	12

*) the number of participants of the policy workshop is also included here, despite not being formally part of the citizen and stakeholder engagement process

[10] See ClairCity Report D4.4 Delphi Evaluation Report
[11] As of December 2019
[12] In Ljubljana, we received 199 responses out of a city population of 280,210. 58% of our respondents were female. In Ljubljana, we have an under-representation of the oldest and youngest categories, with more than two thirds of respondents aged 25-50 compared to 38% in this category in the city as a whole. Our respondents are highly educated, with 65% holding a university education compared to only 24% of the city population. A third of Ljubljana residents have vocational education qualifications, but only 1% of our survey respondents have this. In Slovenia the national or cultural identities of citizens is a politically charged topic due to the histories of Former Yugoslavian populations. As a consequence for ethical reasons we have not used nationality or ethnicity as a demographic identifier for population sampling in Ljubljana.
The majority of respondents were female, making up 68% of the Round 2 respondents. The 37-50 age category were a disproportionate set in our data, at 51% compared to only 24% of the total population. This was at the cost of older people, with only 3% of our Round 2 sample over 65, compared to 15% of the city. The data also represents the highly educated more than the average citizens, with 85% holding some form of higher education certificate, compared to only 31% of the general population.

3 Current air quality and carbon situation in Ljubljana

This chapter gives an overview of the current air quality and climate situation in Ljubljana based on city data and on ClairCity modelling (section 3.1) and will outline existing policies in these areas in Ljubljana and Slovenia (section 3.2).

3.1 Current concentrations and emissions

In the policy baseline report for Ljubljana[13], it was concluded that:

- One of the most pressing issues in Slovenia is PM_{10} pollution. Slovenia is one of the European countries with the highest levels of PM_{10} pollution and highest levels of PM_{10} emissions per capita and per land area[14]. The reason for it is that in Slovenia, there is a widespread use of wood for domestic heating in outdated boilers and stoves. The contribution of the wood/ biomass stoves to the PM_{10} daily exceedances is about 50%.[15]
- In Ljubljana this also holds, but to a lesser extent. In 2014, the average annual concentration of PM10 particles at the Ljubljana Centre monitoring station fell below the permitted level for the first time. The number of daily exceedances of PM10 emissions is gradually decreasing, even though this number is still above the permitted level.
- For NOx, from 2014 on exceedances of annual mean limit values were not recorded at any Slovenian monitoring station. No exceedances of the one-hour limit value for nitrogen dioxide have been recorded at the Ljubljana Centre monitoring station for several years. The city succeeded in bringing concentrations below the limit value of 40 µg/m3 on an annual level for the first time in 2014[16].
- Regarding greenhouse gases, important reforms in the Slovenian economy led to significant drops in emissions in the 1990s, but since the 2000s, performance in this field has been uneven. While successfully reducing the emissions from the manufacturing, commercial and residential sector, environmental policies were not sufficient to prevent an increase of emissions from the transport sector. As a result, there was an increase in total emissions during the 2000s. In 2009, due to the financial and economic crisis, CO2 emissions fell by over 10%. From 2011 to 2015, GHG emissions in Slovenia have continuously declined.

The city of Ljubljana has been monitoring air quality through continuous measurements since 1968. In 2006 PM10 particle measurements started.However, the findings for Ljubljana are based on only two measuring stations in the city. Modelling can therefore provide additional information next to these direct measurements. The modelling method developed in ClairCity

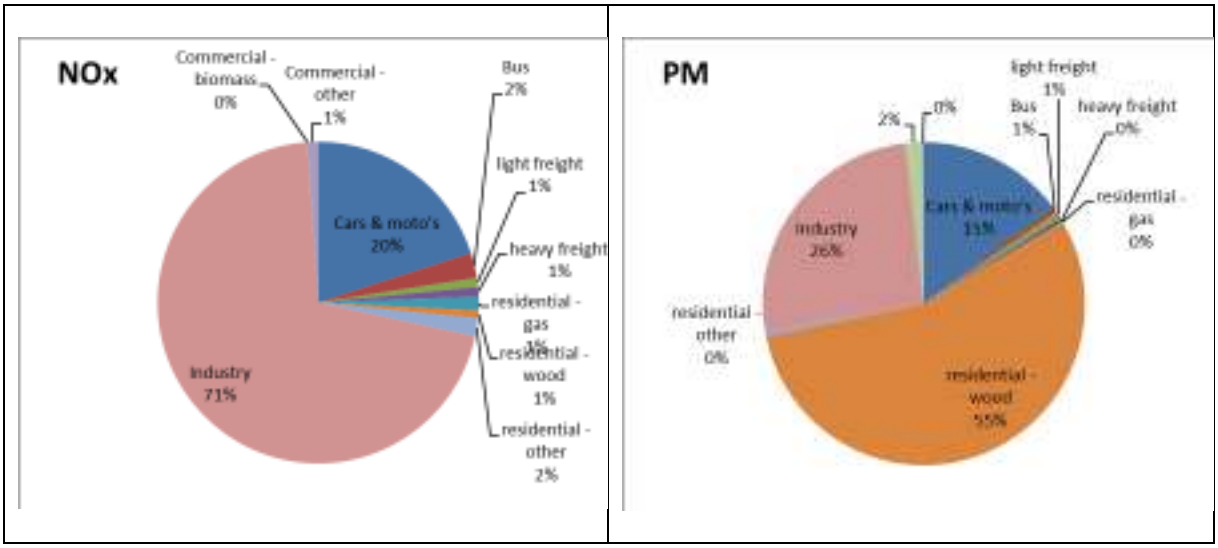
[13] ClairCity report D6.2 Ljubljana – Policy Baseline report, www.claircity.eu
[14] ARSO, Report on air quality in Slovenia, 2015
[15] Interviews with Bostjan Paradiz and Rahela Zabkar, Slovenian Environment Agency (ARSO)
[16] City of Ljubljana, Environment in the City of Ljubljana : European green capital 2016

gives such additional information for NO_x, PM_{10}, $PM_{2.5}$ and CO_2 emissions as well as for NOx and PM concentrations[17]. The outcomes of the ClairCity modelling suggest:

- For NOx emissions, an expansion of measurements to main hotspots of the city might well reveal more exceedances of EU legal limit values than are currently shown;
- Further extending policy ambitions from reaching EU legal limit values to reaching voluntary WHO guideline values would need additional measures in particular for reducing exposure of the Ljubljana population to potentially dangerous exceedances of those values for $PM_{2.5}$.
- Next to industry, resident and road emissions are important target groups for policies to reduce CO_2 emissions in the city, with both contributing almost 50% to total emissions in the city, next to industry and services.

Figure 3-1 shows the emissions of NOx and PM as modelled by ClairCity for the base year 2015. For NOx, industry is by far the dominant source of emissions. However the ClairCity modelling shows that citizens are an important direct source of emissions as well: NOx emissions are caused for 20% by cars and moto's. Citizens play a far larger role in PM emissions: only 26% of these emissions is caused by industry, while 15% of these emissions are caused by cars and moto's and 55% by residential biomass burning.

Figure 3-1 NOx and PM emissions in Ljubljana (Source: ClairCity modelling)



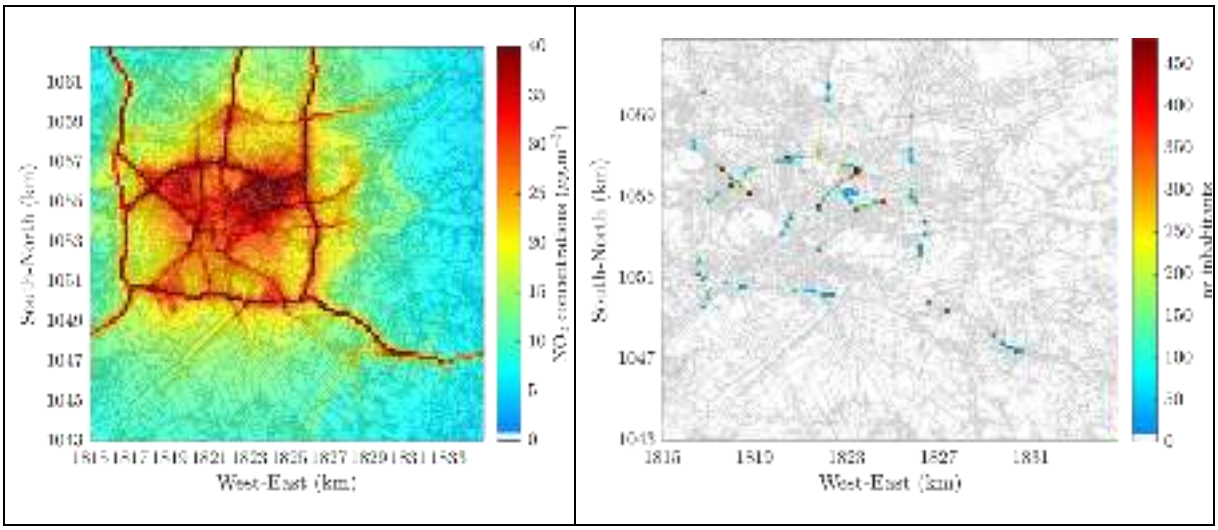
ClairCity also modelled the resulting concentrations of NO_2 and PM based on these emissions. Figure 3-2 a) shows the exceedances of NO_2 limit values in the current situation. The simulation results indicate a peak concentration of 77 $\mu g.m^{-3}$ in one cell of the urban area of Ljubljana, with a contribution for the cell where the maximum is simulated of 81% from the transport sector, 17% from the industrial sector, and 2.3% from the residential and

[17] In the annexes of this report and in the ClairCity modelling methodology report a more detailed background is given to all modelling assumptions. To the ClairCity modelling the disclaimer in Texbox 5-1 applies: it's results cannot be directly compared with national modelling results due to differences in underlying assumptions which are beyond the context of this project.

commercial sector. This concentration is much higher than the current EU annual legal limit value for NO_2 annual concentrations (40 µg.m^{-3}).

According to the modelling, the legal NO_2 limit value is exceeded in 304 grid cells of 200 x 200 metres in Ljubljana closely related to roads[18]. The number of cells with exceedances that have population linked to it that is living permanently there is 170 (Figure 3-2 b). This corresponds with 5% of the population within the area potentially exposed to those concentrations.

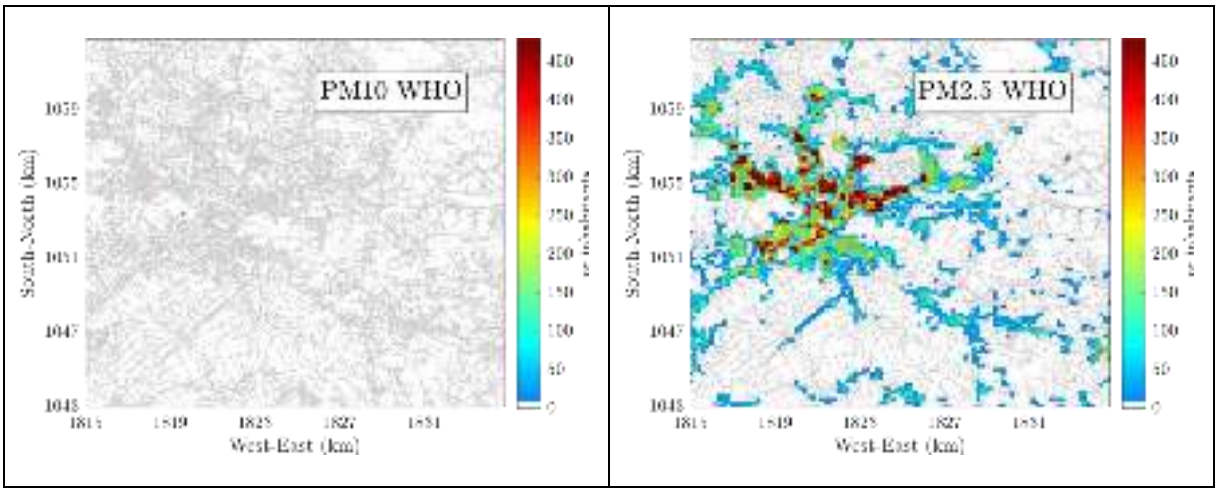
Figure 3-2 NO_2 contour maps for Ljubljana in current situation (reference year 2015): a) annual average of NO_2 concentrations and b) number of inhabitants within the cells exceeding the EU annual limit value of 40 µg.m^{-3}.



The ClairCity modelling indicates that there are no exceedances of PM_{10} and $PM_{2.5}$ EU legal limit concentrations in the Ljubljana area. However, while Ljubljana urban area complies with the EU legal limit values, it does not comply with the stricter (but voluntary) guidelines of the World Health Organization (WHO)[19]. Figure 3-3 indicates two grid cells with inhabitants allocated to those cells exceeding the WHO recommendations for PM_{10}. In total, 147 grid cells were found exceeding these recommendations, but most of these did not have permanently resident population allocated to them[20]. For $PM_{2.5}$, the situation looks less good when comparing exposed population to WHO recommendations for $PM_{2.5}$: the urban area of Ljubljana 100% of the total population are potentially exposed to $PM_{2.5}$ concentrations exceeding the WHO recommendations (Figure 3-3 b).

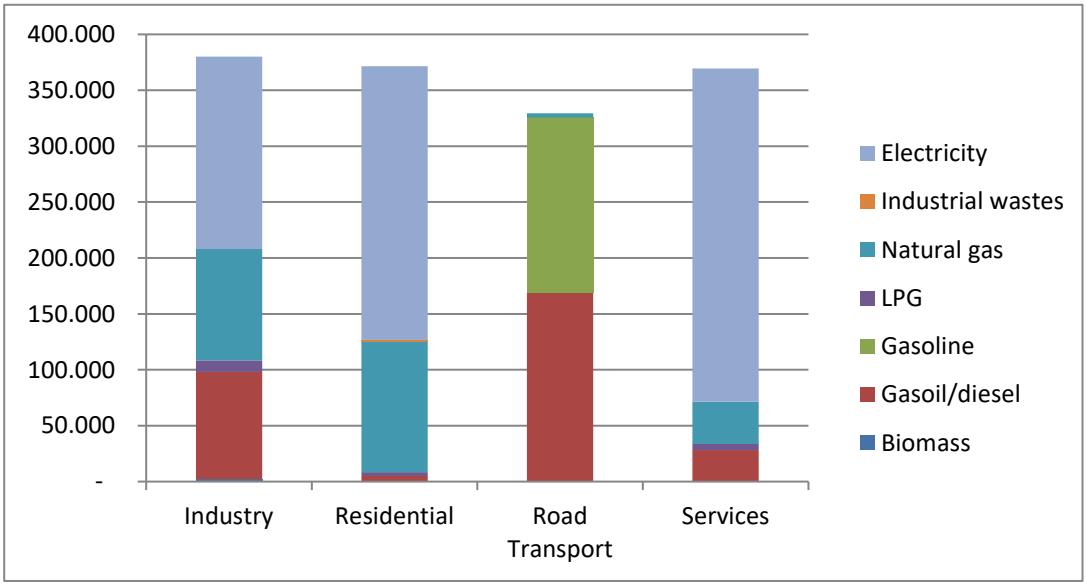
[18] A 'cell' refers to the 200 m x 200m modelling domain that was utilsed by ClairCity
[19] Based on the latest scientific evidence available, WHO has established limit values for PM_{10} and $PM_{2.5}$ that are substantially below current EU and British legal limit values. These values are 20 µg.m^{-3} for PM_{10} (compared to a legal limit value of 40 µg.m^{-3}) and 10 µg.m^{-3} for $PM_{2.5}$ (legal limit value 25 µg.m^{-3} annual mean). See https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
[20] Population data based on Copernicus Urban Atlas, https://land.copernicus.eu/local/urban-atlas

Figure 3-3: Number of inhabitants within the cells exceeding the WHO air quality guideline values: a) of 20 µg.m^{-3} for PM_{10} concentrations, and b) of 10 µg.m^{-3} for $PM_{2.5}$ concentrations.



Regarding greenhouse gas emissions, ClairCity modelling specifies the emissions for 2015. In Figure 3-4 the Carbon Footprint expressed as tonnes CO_2 equivalent on Life Cycle is reported by fuel and sector. The computed indicator takes into consideration the overall life cycle of the energy carrier; this approach includes not only the emissions of the final combustion, but also all emissions of the supply chain; it includes emissions from exploitation, transport and processing (e.g. refinery) steps in addition to the final combustion; this hence includes also emissions that take place outside the location where the fuel is used. The figure shows that the different sectors contribute almost equal to the total carbon footprintof the (lifecycle adjusted) greenhouse gas emissions in Ljubljana. Residential CO_2 emissions (fully citizen-based) and road transport (partly citizen-based) together are responsible for almost half of the CO_2 emissions in Ljubljana.

Figure 3-4: Carbon Footprint expressed as tonnes CO_2-eq on Life Cycle by fuel and sector



3.2 Existing air quality and carbon policies

The ClairCity policy baseline report for Ljubljana concluded regarding existing air quality and carbon policies that

- Main air quality actions are outlined in the Slovenian Action Plan on Clean Air (2014), which is complemented by seven city level air quality plans, including one for Ljubljana. In 2007, Ljubljana adopted the Air Quality Programme (2007-2013), which was later expanded with the Operational programme for the protection of Ambient Air against PM10 Pollution (2009) and an update aiming at the period 2014 - 2020.
- The aim of these plans it to reduce the air pollutant emissions exceeding the permitted levels. The focus is on residential heating and traffic. In particular, the PM10 daily exceedances are addressed in these plans. While in the past it was a long-time perception that industry and traffic were the main contributors to these daily exceedances, the focus of these plans is on addressing the small combustion installations in residential housing as main contributors to winter air pollution.
- Operational plans on a city level include the Sustainable Energy Action Plan (2011–2020) and the Sustainable Mobility Plan (2012- 2020) and 2017 update. The mobility target for 2020 is to divide mobility into thirds: 1/3 public transport, 1/3 non-motorised traffic, 1/3 private vehicle, with an updated version (2017) envisaging that until 2027 two thirds of journeys are going to be completed in a sustainable way – on foot, by bicycle or by public passenger transport and only one third by private cars.
- In 2014, the government adopted the Operational Programme of measures for reducing Greenhouse gas (GHG) emissions until 2020 (OP GHG 2020) .
- The plan includes sectoral and development programmes that target GHG emission reductions. Such programmes are developed in the field of renewable energies, energy efficiency or municipal waste management.

More recently, several updates of air quality and climate policy plans and sectoral mobility and energy plans have been published[21].

[21] Sustainable Urban Mobility Plan of the Ljubljana Urban Region (2018), https://www.rralur.si/sites/default/files/CPS%20LUR%20z%20ovitkom_november2018.pdf, Strategic plan Energetika Ljubljana https://www.energetika-lj.si/sites/www.jhl.si/files/energetika_lj_si/stran/datoteke/strateski_nacrt_jpe_2017-2021_povzetek.pdf, Public transport company strategic plan, https://www.lpp.si/o-druzbi/strateski-nacrt-2, Public parking company strategic plan http://www.lpt.si/zgodovina_podjetja/lpt/uploads/cms/file/STRATESKI%20NACRT%202017-2021.pdf, Update of urban master plan in 2018, https://www.ljubljana.si/sl/moja-ljubljana/urbanizem/obcinski-prostorski-nacrt/, Strategic projects and documentation, https://www.energetika-lj.si/energetika-ljubljana/o-druzbi/strateski-nacrt/strateski-projekti, Energy action plan projects, https://www.ljubljana.si/sl/moja-ljubljana/ljubljana-zate/projekti-mol/energetika-ljubljana and https://www.ljubljana.si/sl/moja-ljubljana/varstvo-okolja/energetska-ucinkovitost/, Energy for the City of the Future – Sustainable Energy Action Plan of the City of Ljubljana (2011-2020), Vision of Ljubljana 2025, Urban Master Plan – Strategic Plan and Impelmenting Plan 2011-2027

4 Citizens' views on cleaner air and carbon policies in Ljubljana

In Ljubljana, the ClairCity Delphi process led to 199 responses out of a city population of 280,210 in 2016. 58% of the respondents were female, with an under-representation of the oldest and youngest age categories: more than two thirds of respondents were aged 25-50, compared to 38% in this category in the city as a whole. The respondents were highly educated, with 65% holding a university education compared to only 24% of the city population.

The ClairCity Delphi sample hence represents only a small and non-representative part of the Ljubljana population, with a response rate lower than in other ClairCity cities. It nevertheless gives some insights into behaviours and visions of the Ljubljana population. The respondents were interviewed for their commuting, shopping, leisure and heating behaviours as well as for their preferences regarding these practices for the future.

4.1 Views of citizens on their own transport and heating behaviour in the future

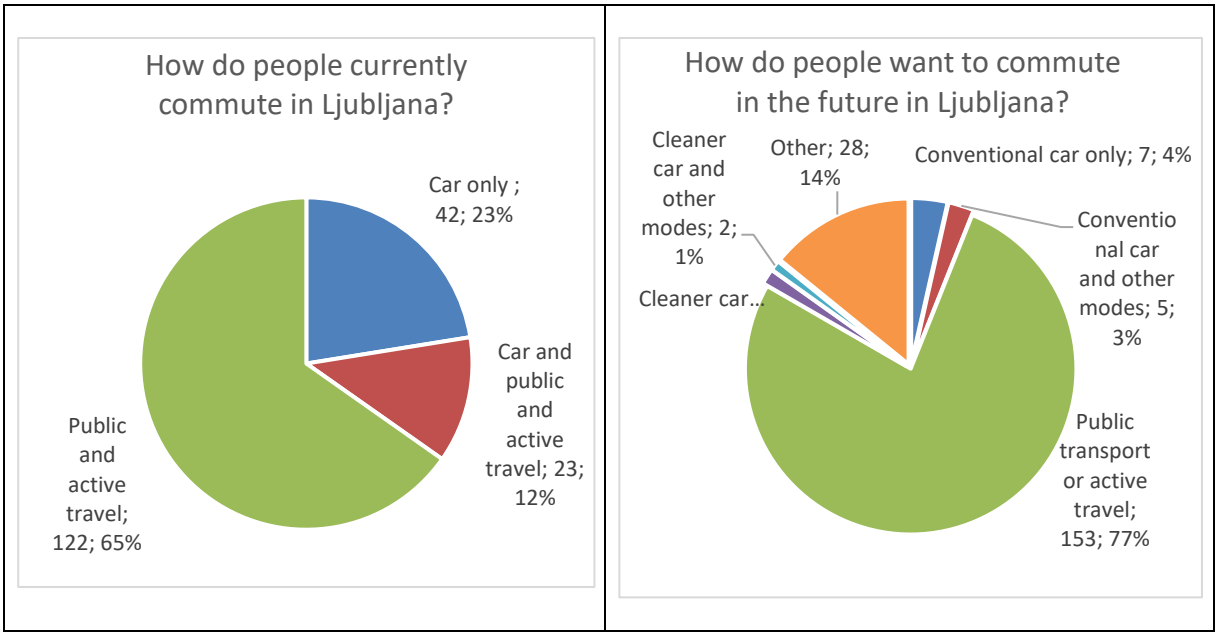
A large part of the interviewed sample of the Ljubljana population already either uses public or active travel for commuting (65%). In the future, the share of public and active travel users will increase to 77%. Remarkable is that hardly any of the commuters expects to use a conventional car in the future (4% conventional car only, and 3% conventional car and other modes of transport). At present, 35% of the commuters still use either car only or car and other modes of transport[22].

31 of the respondents indicated to use a car only at present and want to switch to alternative means of transport in the future. The most frequently indicated reasons that prevented them from doing so already at present were related to negative comments about public transport (20 responses). None of the complaints about public transport from this group mentioned the cost. The majority, 15 respondents, referred to the slowness and the amount of time they wasted if they used it: "too long a trip, less comfort, poor connectivity" and "Public transport is currently 3 to 6 times slower, which is absurd." There were also 7 references to a lack of service or unreliability, for example "bad and irregular connections, uncertainty in the schedule".

Both of the comments about poor infrastructure referred to a lack of cycle paths: "Unregulated bicycle infrastructure" and "risk of life on non-cycling routes; pavement instead of cycling routes…" were their complaints. In terms of "time/distance," comments were short but stated issues like "too much, too far" [to cycle] and "waste of time" [walking rather than driving].

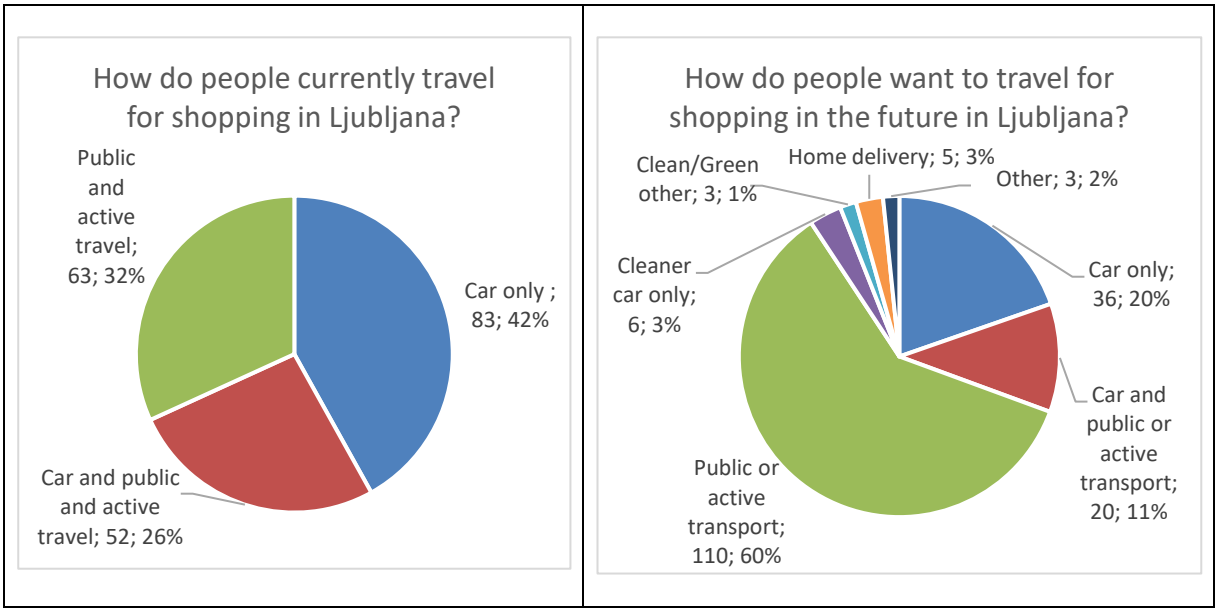
[22] See ClairCity report D4.4 Pilot Cities Delphi evaluation report, www.claircity.eu

Figure 4-1 Current and desired future commuting behaviour in Ljubljana (source: ClairCity Delphi)



For shopping, the percentage of citizens that at present only uses public and active travel is much lower than for commuting (32%, see Figure 4-2). Yet, looking at expressed desire for behavioural change the percentage shift is much higher (from 32 to 60%). Still some 31% of the interviewees either expects to exclusively use a conventional car for shopping or to use it alternated with public and active transport in the future.

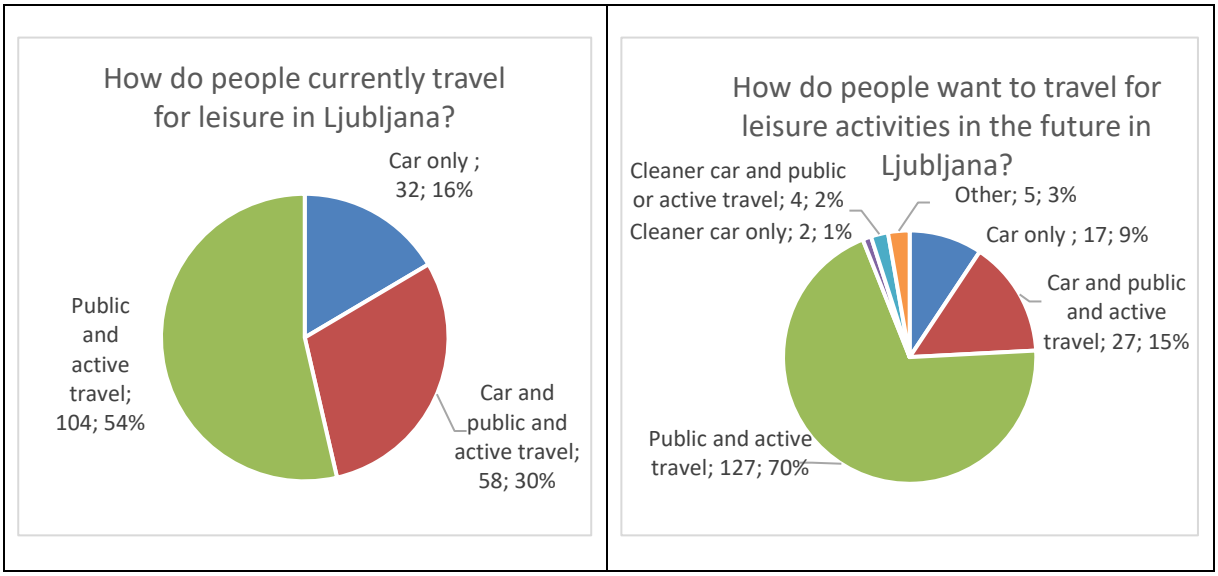
Figure 4-2 Current and desired future shopping behaviour in Ljubljana (source: ClairCity Delphi)



Figures for present and preferred future leisure transport behaviour of Ljubljana citizens are in between those of commuting and shopping behaviour (Figure 4-3). 54% of the respondents indicates to use public and active transport for leisure at present, while 70%

would like to do so in the future. While 46% of the interviewees at present uses the car exclusively or together with public and active travel, in the future still 24% expects to do so.

Figure 4-3 Current and desired future leisure behaviour in Ljubljana (source: ClairCity Delphi)



Gas (40%) and (coal-fired) district heating (32%) are the main sources of energy for home heating in Ljubljana at present. Both sources will be used much less in the future according to indicated future home heating behaviours of the respondents (17 and 16% of interviewees respectively). The majority of respondents (55%) expects to heat their homes with renewables in the future (currently 3%).

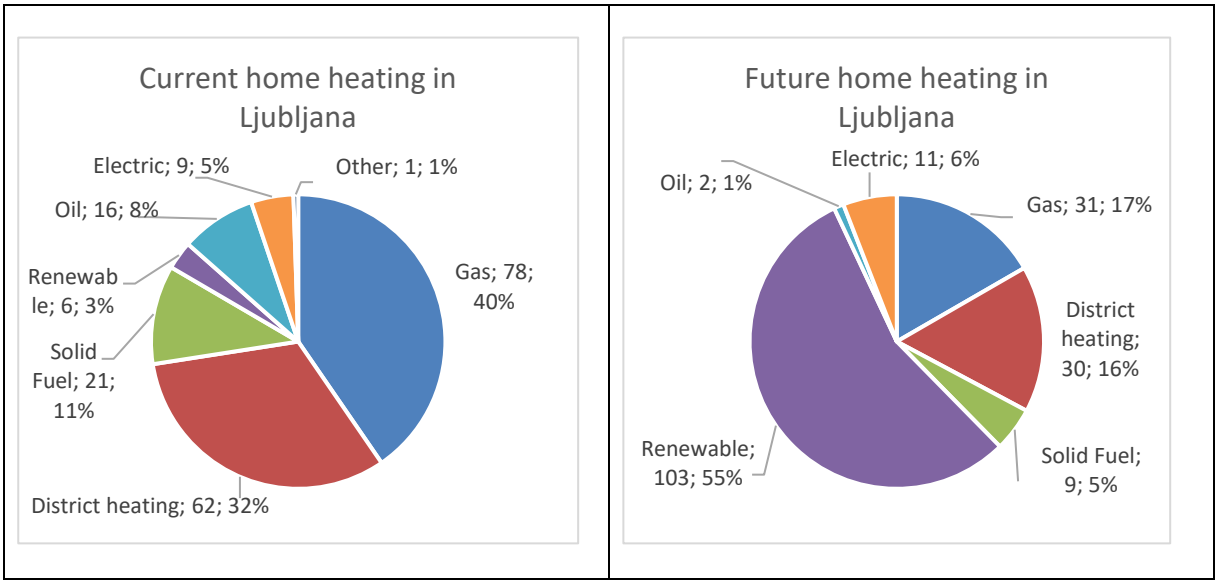
ClairCity explored the reasons why those who were currently using solid fuel heating systems wanted to change or felt they could not (or were not interested) in changing to a less polluting source. 176 respondents answered both their present and future heating choices. It was examined where respondents were moving away from the “polluting” source (solid fuel use, which could include wood, coal or other) to any other heat source.

Overall, the direction of desired change in Ljubljana was found to be moving away from polluting heating sources. The five respondents who wanted to stay using solid fuels included three who gave no reason for their choice. The other two mentioned cost as a reason, with one also stating that they felt it was more environmental: “Solar cells and all modern technology do not pay for their lifetime, it's expensive to maintain, coming from different parts of the world ... it's more environmentally friendly to use biomass from the nearby forest than having the most advanced technology”.

For those who were “looking for positive change”, cost was the most significant reason that they had not already switched away from solid fuel. The “environmental” response related to using wood cleared under forest management practices. The person indicating that they were “happy with current situation” response located their fuel choice in a wider political landscape, stating “Wood is the only source of heat which is independent of global trends and national ideas.” One “Other” coding related to a respondent currently on biomass and

gas, who wanted heat pump and solar. They explained “Just a few years ago we switched to gas heating”.

Figure 4-4 Current and desired future home heating behaviour in Ljubljana (source: ClairCity Delphi)



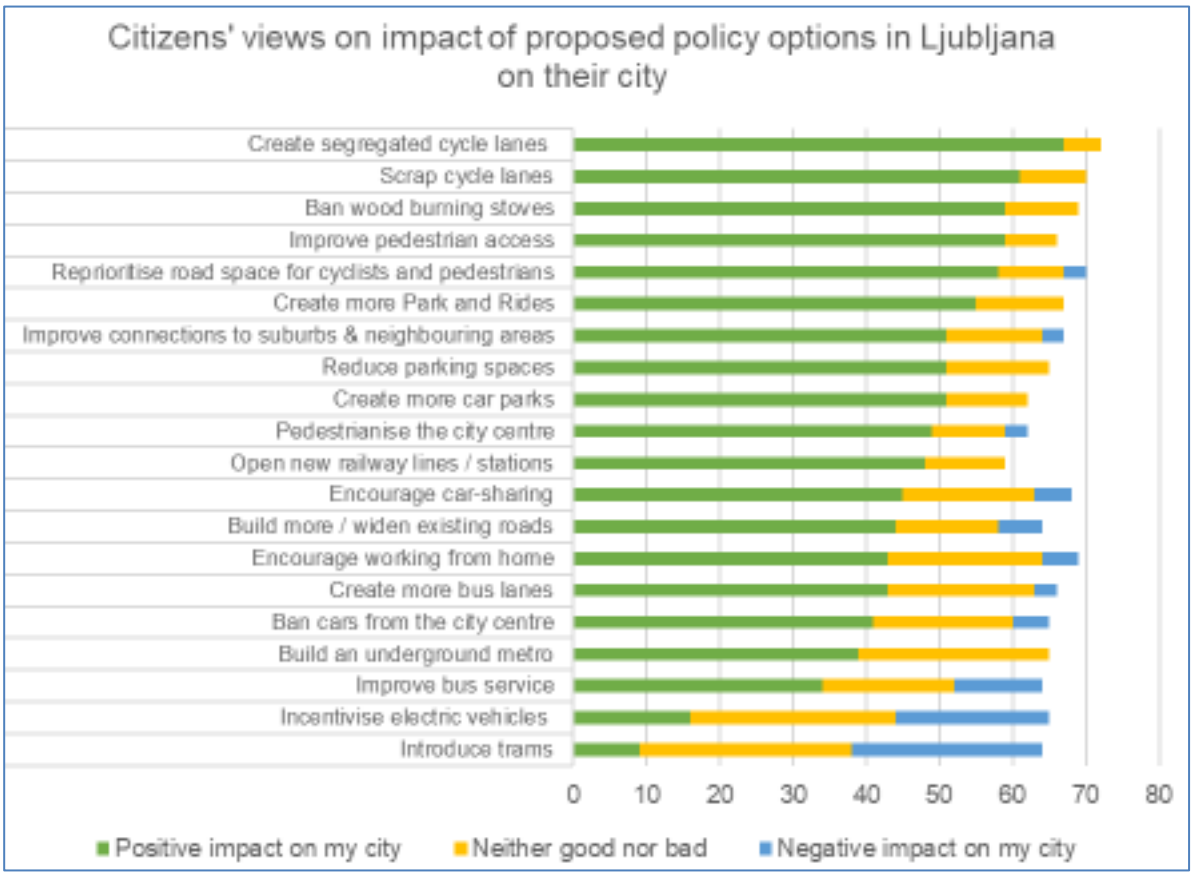
4.2 Views of citizens on future policies in Ljubljana

The ClairCity team also asked Ljubljana citizens for the preferred future air quality and carbon policies in the city (Figure 4-5)[23].

In Ljubljana, among individuals there is strong support for improving connections to suburbs and neighbouring areas and building more, or widening existing, roads. There is also an interest in encouraging car share and for reprioritising road space for cyclists and pedestrians, and creating more bus lanes and segregated cycle lanes. Interestingly others would prefer to scrap the existing cycle lanes. More people would prefer to increase the car parking in the area than want to reduce it, although both options received very few detractors. There is quite a lot of support (and no detractors) for a new underground metro, although less support for improving the bus service, introducing trams or opening new railway lines or stations. There was support for improving pedestrian access but less for further pedestrianisation of the city centre. Encouraging working from home and banning cars from the city centre were the most unpopular options for individuals. Banning wood burning stoves was generally found acceptable.

[23] See ClairCity report D4.4 Pilot Cities Delphi evaluation report, www.claircity.eu

Figure 4-5: Citizens' views on the impact that proposed policy options in Ljubljana would have on their city



Ten of the most popular measures that were indicated by the Ljubljana respondents were used as an input for a 'Stakeholder Dialogue Workshop' in which Ljubljana citizens and other stakeholders could participate. Participants in the workshop had to choose between three different ambition levels for each measure: one level lower than current policy ambitions; one level similar to these ambitions; and, one level higher than the policy ambitions. From their choices, two different coherent scenarios were produced by the ClairCity team, one merging all selected lowest ambition levels by participants (Scenario 'LOW'), and one merging all selected highest ambitions (Scenario 'HIGH'). For the scenarios only transport measures were selected, as transport was considered a more urgent policy problem than energy by the Ljubljana team. The two scenarios were then discussed by policy makers, which could choose either of the two scenario options for each measure and could provide comments and tips for implementation (Table 4-1).

Table 4-1 Overall preferred policy measures of Ljubljana citizens

#	Measure	Low option	High option	Preferred option of policy makers
1	Green fleet for the Ljubljana Passenger Transport (LPP)[24]	Half of the public transport fleet fulfils standard EURO VI by 2025	Low-emission public transport fleet until 2027	Low
2	Higher frequency of buses and inclusion of train transport in city traffic	Increase of public transport for 10% by 2027	Increase of public transport for 100% by 2027	Medium (30 % by 2027)
3	Cheaper public transport	Public transport is made 50% more expensive to finance and co-finance other sustainable transport solutions in the city.	Public transport is made 50% cheaper for all.	Medium
4	New areas for non-motorized traffic (pedestrian and bicycling areas)	Maintaining the current range of pedestrian areas.	Designing new areas with limited access for vehicles and strengthen requirements for access to existing areas.	High
5	New cycling routes and connections	New and modified cycling routes - 10% by 2021.	New and renovated cycling routes - 50% by 2021.	Medium (30 % by 2021)
6	Safe cycling and walking in the city	No increase in the number of dead and injured pedestrians and cyclists until 2027 within the ring road.	0 dead or heavily injured pedestrians and cyclists until 2027 within the ring road.	Medium
7	Independence from the car	Car sharing is left to the market.	Incentives and subsidies for car-free neighbourhoods by 2027.	High
8	E-mobility	Electromobility is left to the market.	Each neighbourhood has a mobility plan and shared ownership of e-vehicles by 2050.	Low
9	Change of parking norms	Parking norms remain the same (1 parking space per 1 new apartment).	Parking norms reduced to 0.5 per new apartment by 2020.	High
10	Regional public passenger transport	Expansion of motorway and AC ring.	Implementation of the Railhub solution by 2027.	High

4.3 Reflections from Ljubljana policy makers

Ljubljana policy makers could react on the outcomes of the citizen scenarios in a policy workshop[25]. This workshop was held on the 21st of June 2019 and was attended by 12 participants (7 male; 5 female) representing Ljubljana City municipal departments and units responsible for energy efficiency, planning, environment, transport, EU cohesion and EU projects, urban institutes on national, regional and city level, representative of Ljubljana public transport. One representative from the Ljubljana City Hall and one ClairCity team member facilitated the session.

For four of the ten measures that were part of the citizen scenarios, policy makers selected the high ambition level, for two a low ambition level was preferred and for four measures a medium ambition level was chosen as a compromise between the lower and higher option (Table 4-1). Measures were a higher ambition level was considered appropriate were increasing pedestrian and cycling areas, incentives for car-free neighbourhoods, less space

[24] Public transport company
[25] See ClairCity report D6.6 Policy Workshops – Last City, www.clairclty.eu

for private car parking and improving regional train transport. Low ambition levels were chosen for greening the public transport fleet and e-mobility.

Main comments made by policy makers in the workshop regarding implementation were:

Public transport

- Public transport is the backbone for the transportation in Ljubljana, but the Slovene rail company is not prepared to take the transport from the regional and even wider area to Ljubljana. As such, smaller buses with higher frequency should be introduced in Ljubljana for within the city travel.
- There is a need to investigate the construction of a metro in Ljubljana.
- There are discrepancies between national and municipal decision makers around transport policies.
- The eligibility criteria for the Eco-fund calls should be adapted so public companies can also apply. This doesn't guarantee lower transport prices as efficiency is not a criteria taken into account for granting subsidies (so the criteria for efficiency should be made mandatory when tendering). Currently, yearly losses of the transport company are covered by the municipality.
- A decrease in the price of transport would not necessarily lead to an increase use of public transport, so the ambition of the chosen measure is medium.
- Another possibility is to have free transport and to pay the compensation subsidies' amount directly to public company. Vulnerable groups, like unemployed and disabled have free transport already.
- The majority of employees are compensated for transport as part of their income and they don't want to exchange the cash money received for access to public transport.
- The population of students is expected to rise radically in the next 5 years. Pressure on regional public passengers' transport may be doubled in the next 5 years. This peak will last for 8-10 years. The city is not ready for that and yet there is no discussion about this challenge at the moment. It should be investigated how current public transport should be adjusted to the future situation and where the bottlenecks are.

Active transport

- New areas for non-motorized traffic should be introduced in particular outside the city center and the frequency of buses would need to be increased.
- The policy of penalties against offenders should be clearly defined and then also implemented.
- An integrated territorial plan has been drafted and includes also new cycling routes. More cycle lanes will lead to more cyclists.
- The largest challenge is how to integrate lanes for bikes with car roads. There is currently also tension between pedestrians and cyclists. The width of the lanes for buses and cars need to be adjusted.
- The law does not follow technology. Modern electric vehicles (like scooters and boards) are supposed to go on the sidewalk and not on bike lanes -according to the

law- whereas they can readh higher speeds than bikes themselves. The legal system should be flexible and should accommodate new technological development.

Private car

- E-mobility is hampered by a lack of electricity charging stations and the high investments needed for those. Elektro Ljubljana just started to charge for the charging of electric vehicles.
- An integral assessment should be performed to understand the impacts of e-mobility on air quality.
- To tackle the problem of massive amounts of delivery vans – coexisting with pedestrians in rush hour- good practices from other cities should be explored (e.g. pickup points and delivery by city carts with manual delivery).
- The commitment is zero deaths the inner ring. That would need to implement a real speed limitation to 50 km/h in the inner ring and 30 km/h in the city centre.
- A roadmap for car-free neighbourhoods should be prepared. If we want neighborhoods without cars, this means that people do not own their cars. Instead there would be car-sharing.
- Developers should allocate money into a fund that helps finance the mobility plan for the neighbourhood. In parallel, an awareness campaign has to be carried out.
- Construction of houses require until today the building of parking places. This will now be changed from municipality spatial plans.
- However, there is uncertainty whether there is enough capacity for daily commuters, now estimated to be about 160.000. This holds even despite the fact that Ljubljana has “park and ride” areas at the main entrances to Ljubljana which are also frequently used.

5 Impacts of implementing citizens' views

This chapter discusses the potential impacts of implementing the citizens' views on future policies on air quality (section 5.1), health (section 5.2), carbon emissions (section 5.3) and on costs (section 5.4). It is based on ClairCity modelling, to which the disclaimer formulated in Textbox 5-1 applies.

Textbox 5-1 Disclaimer ClairCity modelling versus national modelling

> "ClairCity modelling differs from local and national models in the ClairCity countries due to different modelling assumptions and inputs. Although the utmost care has been taken to calibrate the ClairCity models to local conditions, a detailed comparison of ClairCity modelling assumptions to those of local and national models in each country was considered to be outside the scope of this project. Therefore ClairCity modelling outcomes cannot be one-to-one compared with the outcomes of national and local models; they should be regarded as indicative and can deviate from locally measured and modeled concentrations."

The modelled potential impacts are based on a 'Unified Policy Scenario' (UPS) that was prepared by combining citizen preferences for future policy measures with policy maker reflections as expressed in the policy workshop and quantifying them where possible. Main assumptions made for preparing the UPS are given in Annex C. The impacts of the UPS are compared with those of a 'Business-As-Usual' scenario (BAU) that is based on all city policy measures implemented in Ljubljana in the base year 2015[26].

5.1 Impacts on air quality

ClairCity models NO_x, PM_{10} and $PM_{2.5}$ as air pollutants. Measures implemented in the business-as-usual (BAU) scenario starting in 2015 would reduce NO_x emissions to about 80% of 2015 levels in 2025 and to about 65% of the base year value in 2050 (Figure 5-1). The UPS scenario measures as modelled do not lead to a further decrease of NO_x emissions compared to BAU. This is mainly due to the fact that the selected measures and ambition levels are already partly included in the BAU or do result in one combined mode shift effect[27].

Figure 5-1 also shows that PM emissions in the BAU scenario would fall to some 55% in 2025 compared to 2015 and to some 45% compared to the base year in 2050. In the UPS scenario, the PM emissions are only slightly more reduced than in the BAU scenario for the same reasons as mentioned for NOx. Figure 5-1 also shows that for PM-emissions the

[26] Policy changes implemented in Ljubljana since 2015 could not be incorporated in the baseline. This obviously affects the differences between BAU and UPS scenario.

[27] see Table 4-1: measure 1, 'greening of public transport', is already foreseen in BAU, measure 6; 'safe cycling', does not contribute to further emission reductions compared to BAU, neither does the selected ambition level of measure 8, 'leaving e-mobility to the market'. Measures 2,, 3, 4, 5, 6 and 7 together are assumed to result in a mode shift effect to public transport of 30% in 2027. Measure 9, 'change of parking norms' is assumed to contribute a further 50% to the reductions of car use foreseen in BAU, and measure 10 'improving regional transport' is assumed to lead to a reduction in travel time by train with 10%. A slight increase in emissions in UPS compared to BAU can be seen because of a modal shift from active to public transport.

emission reductions achieved by BAU and UPS are limited, mostly due to the large share of industrial emissions on the outskirts of the modelling domain.

In more detail, from Figure 5-1, a steady trend in improving NOx emission in the BAU can be observed. This decreasing trend is less explicit compared to other ClairCity cities, mainly due to the large share of NOx-emissions from industry which are not changing over time. All reduction in the BAU in this case is derived from decreasing transport emissions. Remarkably, the UPS scenario has almost no effect on the NOx emissions and in fact causes a slight increase of NOx emission compared to the BAU. This can be explained as follows: All measures are related to transport, so industrial, residential and commercial emissions will not change compared to the BAU. In the transport emissions, we observe a decrease of car emissions and an increase of emissions from buses. The measures in the UPS to large extent cause a modal shift toward bus. Public transport in this case is made so attractive that it causes a shift from pedestrians to public transport, thus shifting zero-emission transport (walking) to low-emission transport. Overall, the reduction of car NOx emissions is not sufficient to offset the increase in emissions from buses. This is because car emissions are expected to decrease strongly already in the BAU, while no extra measures are taken in the UPS to ensure zero-emission bus transport.

We observe a similar trend for PM-emissions, although reductions are stronger already in the BAU. Key sources are residential solid fuel consumption and the industrial sector. Both improve in the BAU, but no further in the UPS due to lack of specific measures targeting these emissions. Unlike for NOx, PM emissions from transport in total decrease marginally in the UPS compared to the BAU.

Figure 5-1 Trend of PM10 and NOx emissions in the UPS scenario (citizens measures), compared to the BAU scenario (Ljubljana policies as of 2015) (source: ClairCity modelling)

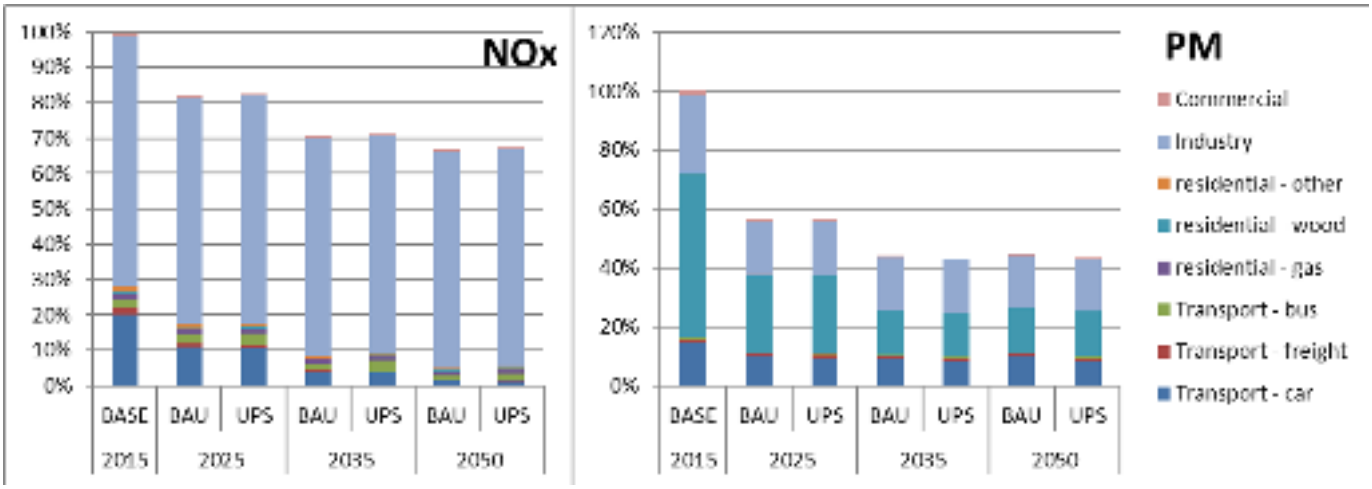
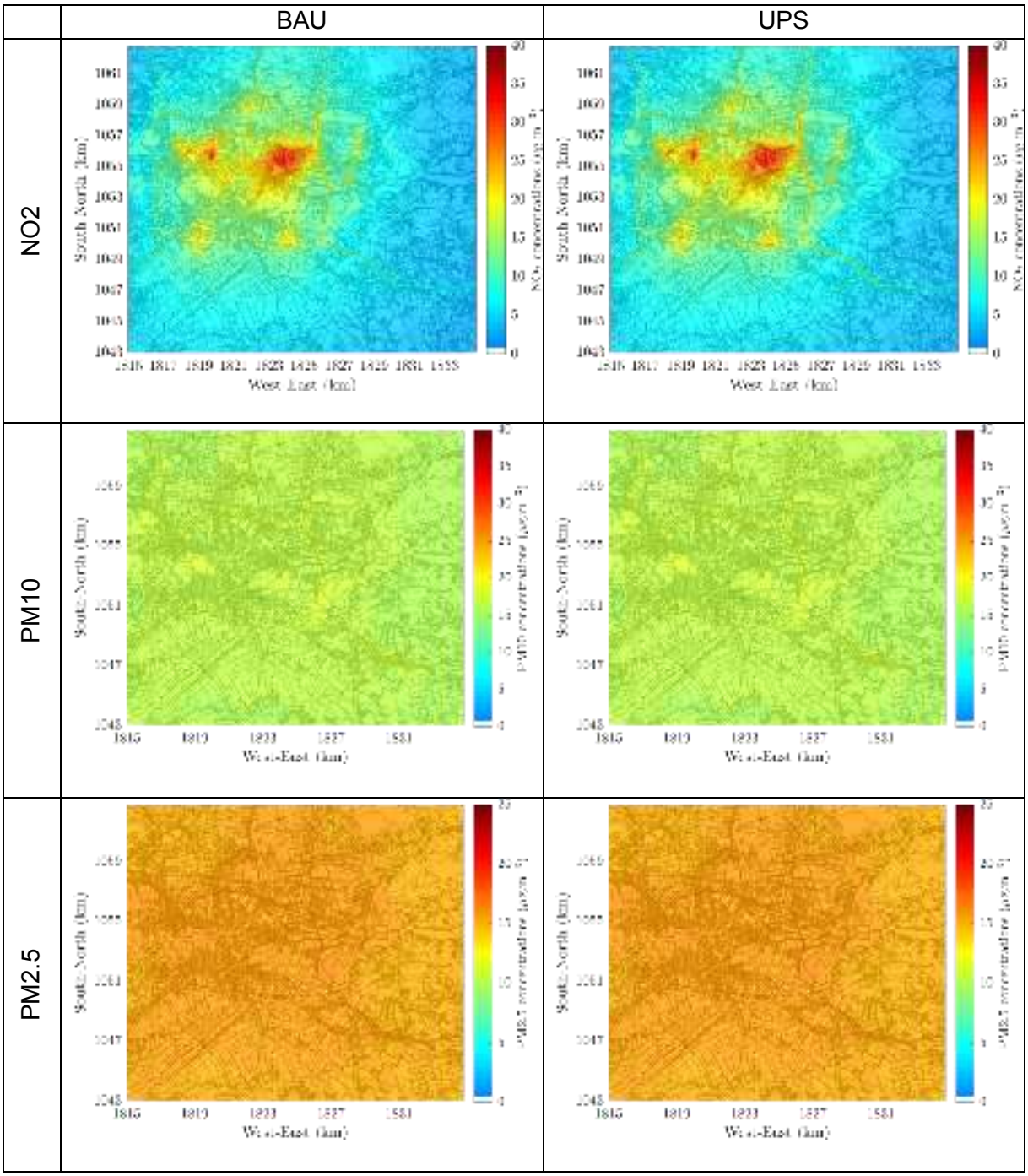


Figure 5-2 gives an overview of modelled NO_2, PM_{10} and $PM_{2.5}$ concentrations in the BAU and UPS scenario in 2050. More detailed concentration modelling results can be found in Annex C. Because of the very limited differences between BAU and UPS emissions, also the reductions in concentrations of air pollutants in the city would be almost equal.

Figure 5-2 NO_2, PM_{10} and $PM_{2.5}$ concentrations in the BAU and UPS scenario in 2050



Comparing UPS and BAU modelling results with legal limit values and WHO guideline values further shows that:

- **Both BAU and UPS scenarios lead to compliance with EU legal NO_2 limit values as well as WHO guideline values in 2050[28].** In that year, the maximum values correspond

[28] NO2: both values are the same, 40 µg.m-3 annual mean

to respectively 32.9 µg.m $^{-3}$ (BAU) and 33.3 µg.m $^{-3}$ (UPS), both below the EU limit value. However, in earlier years still exceedances of limit values in some grid cells are found. In 2025, in the BAU scenario the maximum NO_2 concentration found equals 53.8 µg.m $^{-3}$. In the UPS scenario, the maximum NO_2 concentration is equal to 55.3 µg.m $^{-3}$ in the same year. The UPS scenario will reduce the maximum NO_2 concentrations by 27.9 and 56.6% respectively in 2025 and 2050, as compared to the base year 2015. BAU reduction values are almost the same: 29.9% in 2025 and 57.2% in 2050.

- **For PM_{10}, the BAU and UPS scenario comply with the EU legal limit values as well as with the WHO guidelines in 2025 and 2050[29].** The maximum values in the UPS scenario correspond to 19.3 µg.m $^{-3}$ in 2025 and to 18.8 µg.m $^{-3}$ in 2050, translating into a 15.6% and 17.5% reduction of the maximum concentration compared to 2015. When comparing the UPS scenario with the BAU scenario, the maximum concentrations will be the same in 2025 and 2050 (maximum concentration of 16.7 µg.m $^{-3}$ in 2025, and 16.5 µg.m $^{-3}$ in 2050). Main reason for the fact that concentrations in 2025 and 2050 are the same, while emissions still decrease (see figure 5-1), are the high background concentrations that overshadow the decrease in emissions.

- **For $PM_{2.5}$, BAU and UPS scenarios comply with EU legal limit values, but even in the UPS scenario there are still significant exceedances of WHO guideline values for $PM_{2.5}$ in 2050[30].** In 2025, the maximum value modelled in a grid cell of the UPS scenario corresponds to 17.1 µg.m $^{-3}$, and to 16.6 µg.m $^{-3}$ in 2050. Compared with the WHO guidelines, all the grid cells will still show exceedances in the UPS scenario in 2050. When comparing the UPS scenario with the BAU scenario, the maximum concentrations will be the same in 2025 and 2050 (maximum concentration of 15.5 µg.m $^{-3}$ in 2025, and 15.4 µg.m $^{-3}$ in 2050).

5.2 Impacts on health

Table 5-3 shows the comparison between the UPS and BAU scenario, assessing the health impact benefits of the emission levels proposed by the scenarios. **The resulting relative health improvements benefit of both scenarios are almost exactly the same, independently of the health impact indicator: number of premature deaths or number of year life lost [31].**

The health benefit from implementing the control measures behind the future emission scenarios is considerable. In 2015, the number of premature deaths as a result of NO_2, PM_{10} and $PM_{2.5}$ is 219, 185, and 169 respectively. The BAU scenario reduces these numbers by 67%, 5%, and 3% in 2050 respectively, and the UPS scenario reduces the impact on health due to exposure to NO_2 in 64%, 5% for PM_{10}, and 3% for $PM_{2.5}$.

[29] PM10: EU legal limit 40 µg.m-3 annual mean, WHO guideline value 20 µg.m-3 annual mean
[30] PM2.5: EU legal limit 25 µg.m-3 annual mean, WHO guideline value 10 µg.m-3 annual mean
[31] See Annex C for the methodology on the health impact assessment and results

The health benefit from the reduction on the emissions is in line with the reduction of concentration levels predicted for Ljubljana. However, for particulate matter the reduction of the number premature deaths and the numbers of years of life lost is much lower than maximum concentration levels reduction. This might point to a lower reduction of concentration levels at sites where population density is higher[32].

Table 5-3 Benchmarking the UPS, low and high emission scenarios in 2025, 2035, and 2050 against the baseline scenario in terms of health indicators (%) related to $PM_{2.5}$, PM_{10} and NO_2 exposure.

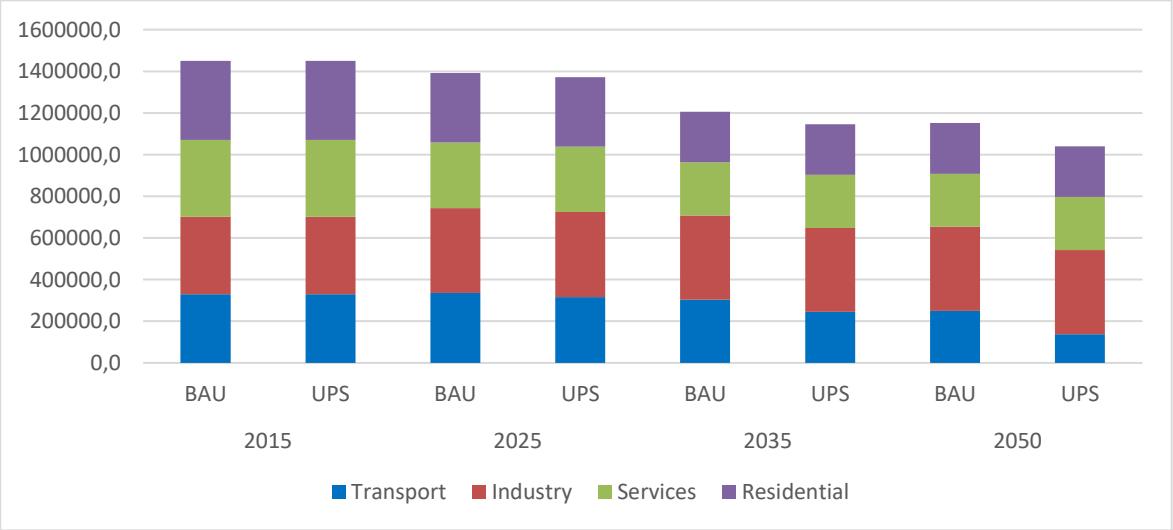
	PM2.5			PM10			NO2		
scenario	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**
BAU	-3	-3	-3	-4	-5	-5	-33	-58	-67
UPS	-3	-3	-3	-4	-5	-5	-31	-54	-64

5.3 Impacts on carbon emissions

Figure 5-4 shows the impacts of UPS measures compared to the BAU scenario in terms of Carbon Footprint.

The figure shows that BAU in 2050 reduces CO2 emissions to about 80% of the level in 2015. In line with the findings in section 5.1 and 5.2, the UPS measures have also a limited impact on CO2 emissions compared to BAU: the UPS measures would reduce the CO2 emissions to some 75% of the 2015 emissions. The reductions are limited to the transport sector, since the UPS measures only refer to this sector.

Figure 5-4 Carbon emissions of UPS scenario compared to BAU (tonnes of CO_2-eq on life cycle)



[32] Also, data of the Copernicus Urban Atlas for Ljubljana that were used for the population calculations are of limited quality. See https://land.copernicus.eu/local/urban-atlas

5.4 Impacts on cost

Table 5-4 gives a qualitative estimate of the cost of the measures in the UPS scenario versus the BAU. More detail on the method applied can also be found in Annex C. We distinguish between estimated monetary costs to citizens, costs for government/city council (no distinction is made between different levels of government) and a net total cost to society, summing up both. On top of that, for an exact calculation of benefits also the indirect benefits of health improvement of citizens (saved public health costs) have to be taken into account. This was beyond the scope of the ClairCity modelling.

In total, net monetary cost effects of the 10 UPS measures vary substantially. Many measures cannot be assessed with the available data. Others, in particular investments in infrastructure, will result in net negative direct effects for society. However, this balance would be more positive if also the indirect health benefits of improved health of citizens would be added.

Table 5-4 Estimated cost impacts of citizen measures that are part of the UPS scenario in Ljubljana

#	Policy measure	Citizens	Government	Society
1	Green transport park for public transport LPP	0	0	0
2	Higher frequency of buses and inclusion of train transport in city traffic	+	-	-
3	Cheaper public transport	+	--	-
4	New areas for non-motorized traffic (pedestrian and bicycling areas)	n/a	n/a	n/a
5	New cycling routes and connections	n/a	n/a	n/a
6	Safe cycling and walking in the city	n/a	n/a	n/a
7	Independence from the car	n/a	n/a	n/a
8	E-mobility	0	0	0
9	Change of parking norms	0	0	0
10	Regional public passenger transport	+	-	-

(+) assumed net positive effect/ benefits for target group; (-) assumed net negative effect / costs for target group; n/a effect of measure cannot be assessed

We can broadly distinguish 2 types of measures: public investment in public transport, either via direct subsidy, increased service frequency or service connectivity and secondly measures that affect infrastructure investment. The former will be beneficial to citizens but will require additional resources for the government, to be generated by taxation. The cost impact of the latter and the infrastructure investment depend on the additionality or shift of the available infrastructure funds.

The assumed cost effects per measure are explained in more detail below:

1. Cleaner buses require extra investment at a cost to the government (-) without a cost effect on citizens (0), leading to an overall net negative cost effect on society (-). However, the level of ambition of this measure (half of busses is EURO VI compliant by

2025) is such that it will likely in full already be achieved in the BAU, thus entailing no additional cost compared to the BAU.

2. A higher frequency of public transport services requires a higher subsidy for buses to be provided by government (-). This measure leads to a cost decrease for citizens as PT becomes an attractive alternative at times and locations currently not the case (+). Yet, this is at a greater expense for the government as incremental model shift to public transport is assumed to require a larger subsidy. The overall societal cost effect is therefore considered to be negative (-).
3. Cheaper public transport requires a higher subsidy for buses to be provided by government (-). This measure leads to a cost decrease for citizens (lower fares) (+), yet at a greater expense for the government as incremental model shift to public transport is assumed to require a larger subsidy. The overall societal cost effect is therefore considered to be negative (-).
4. (and 5,6,7). These are all infrastructure related or “soft” measures, the cost impact of which cannot be assessed without extra information. When assuming a reallocation of the (fixed) investment fund in infrastructure (i.e. from road for cars to infrastructure for walking and cycling), there is no extra cost. When assuming an aggressive investment strategy in new walking/cycling infrastructure, this measure would come at an (extra) cost to the government. Therefore, we did not consider this measure to have a direct measurable cost effect.
8. Incentivize/promote the use of electrical vehicles (EVs) is left to the market. No subsidies or mandatary targets are set. As such we assume no change compared to the BAU.
9. Changing parking norms for new buildings will lead to a gradual change in the available parking spaces. As this involves only new or replacement investemnt in the housing stock, this does not have a measurable cost impact. Investment cost my drop because less space is needed for parking spots, yet this is expected to have a marginal impact on overall project costs. We assume no measurable cost impact for this measure.
10. Finally, a regional hub requires an additional investment and will make public transport (PT) more attractive, inducing a larger subsidies requirment for PT. Investment is borne by government (-), benefits citizens (better connectivity/lower time costs) (+), yet at a greater expense for the government as the investment and the additional model shift to public transport is assumed to require a larger subsidy. The overall societal cost effect is therefore considered to be negative (-).

6 Ljubljana and other ClairCity cities – Mutual learning

In this chapter, main institutional conditions and barriers for implementing citizen policy preferences are discussed (section 6.1). Possible lessons from other ClairCity cities for Ljubljana are outlined in section 6.2 and lessons from Ljubljana for other ClairCity cities in section 6.3.

6.1 Institutional conditions and barriers for citizen-inclusive policies in Ljubljana

Political framing

Zoran Janković is the Mayor of the City of Ljubljana since 2006 as a head of the party Positive Slovenia. He was a former entrepreneur and director of the largest retail organisation of Slovenia. While in the past there have been discussions about alleged corruption cases, this has not withstood his large popularity in the city since his first election[33]. After 2006 he has been reelected in the fisrt round with large majorities four times by the citizens of Ljubljana, lastly in 2018. Janković has initiated policies with strong environmental ambitions which resulted in Ljubljana gaining the title “European Green Capital”[34] in 2016. He also initiated the successful pedestrianisation of the city centre.

Figure 6-1 Ljubljana mayor Zoran Janković

Finance

Ljubljana has been very successful in acquiring European funds for projects, which in turn have a positive effect on the city’s green development. Since 2006, there were more than 1,800 green projects in Ljubljana implemented[35], part of which with European funding. However, the Ljubljana policy makers taking part in the ClairCity policy workshop foresee

[33] https://en.wikipedia.org/wiki/Zoran_Jankovi%C4%87_(politician)
[34] https://ec.europa.eu/environment/europeangreencapital/winning-cities/2016-ljubljana/
[35] Naomi Larsson. “The greenest city mayors take home the fight against climate change”,30 November 2015. Accessed at: https://www.theguardian.com/public-leaders-network/2015/nov/30/green-city-mayors-climate-change-paris-cop21.

limitations of city budgets to invest in new green infrastructures in the future. Therefore they were very cautious not to support the high ambition options of in particular the infrastructural measures that were popular by citizens.

Citizen engagement culture

The City council takes a large effort to engage with citizens regarding environmental issues. Engagement methods vary from websites to events, surveys, public discussions, proposals and a city office for citizens' initiatives[36]. Also, the Mayor has a very specific style of personal engagement with citizens, engaging in direct discussions with them and inviting them to air their personal experiences and grievances at bi-weekly open doors meetings. However, the long-term popularity of the Mayor also runs the risk that oppositional voices are less heard. According to some NGOs, formal and legal requirements of citizen involvement are generally followed, but often only in a relatively late stage of policymaking where major decisions have already been taken. Informal contacts to policymakers are therefore a key method of making citizen opinions heard in Ljubljana, with the risk to create a 'closed system', in which opinions that are not expressed within the inner circle of informal policy discussions are not heard[37].

Links with other governance levels and stakeholders

The Ljubljana urban region has a dominant position in Slovenia as an economic and governance hub. Where Ljubljana seems to take the lead in environmental policy making, the surrounding more rural regions seem less progressive. Integration of Ljubljana policy making therefore seems a major precondition for successful further development of environmental policies, in particular as biomass burning in the surrounding areas seems to contribute substantially to air pollution in the city. The integration of regional transport with urban or city's public transport is an important precondition for further modal shift towards public transport of commuters and others entering the city from elsewhere.

6.2 Lessons from other ClairCity cities for Ljubljana

Two general lessons from the other ClairCity cities that could be relevant for Ljubljana are fostering civil society and opposition, and contributing to citizen awareness of the relationship between air quality and health. Furthermore, the examined ClairCity cities could provide several successful implementation examples in the areas of public transport, car and active transport and energy.

Fostering civil society and opposition

In Poland as well as in the Netherlands, NGOs have contributed substantially to overcoming barriers to further development of national and local air quality and climate legislation and

[36] See the Claircity Ljubljana policy baseline report D6.2, www.claircity.eu
[37] See the Claircity Ljubljana policy baseline report D6.2, www.claircity.eu

policies, the latter in particular in Sosnowiec[38]. The specific cases of these NGOs could stimulate Ljubljana to maintain an even stronger relationship with its own NGOs and opposition and thereby find new incentives for furthergoing policies - even more so as the long term dominance of one political party and mayor could run the risk of funneled policy making.

Public awareness of air quality and health

The air pollution indication system that was integrated in the electronic information panels of public transport in Sosnowiec could also be an asset for Ljubljana and all other ClairCity cities when trying to increase citizen awareness of air pollution in the city and its relation to health. This could add to the efforts already undertaken by Ljubljana in this direction, such as daily updated online information on current air quality in the city on various websites and the Ljubljana magazine.

Public transport

Train transport and integration of regional and urban transport seem a remaining vulnerable spot in Ljubljana. The expansion of the national transport infrastructure is a national competence that does not always seem to be synchronised with local developments. So far, the investments in the rail system for instance have been very limited compared to the massive expansion of the road infrastructure in the past decades.

Car and active transport

In ClairCity many citizens expressed to be in favour of expanding the number of cycling lanes in city roads, but there were also many citizens against this measure, as the cycling lanes will reduce the accessibility of roads for cars. Judging from these ambivalent opinions of citizens on the integration of new cycling lanes with private car transport, Ljubljana might take benefit from the experiences in other ClairCity cities where such integration of cycling with car transport already has taken place, notably Amsterdam.

Energy

Further expansion of the urban district heating system and reduction of biomass burning are two measures that could contribute to local air quality and carbon policies in Ljubljana. ClairCity cities Bristol and Amsterdam are also considering substantial expansion of their urban district heating systems. Likewise, the Aveiro region faces similar problems with regional biomass burning as Ljubljana. Mutual exchange of success stories and lessons learned therefore could possibly benefit Ljubljana as well as the other ClairCity cities.

[38] Alarm Smogovy, with a local branch also in Sosnowiec, with its protests against the bad air quality and smog in Polish cities has been a main reason for the implementation of new regional and national air quality legislation in Poland. The NGO is also involved in local action in Sosnowiec. In the Netherlands, the Dutch NGO Urgenda has forced national government by a court case to stick to implementation of its own climate goals set.

6.3 Lessons from Ljubljana for other cities

Pedestrian zone

The pedestrian or ecological zone in Ljubljana is a particularly successful measure, which is supported by most citizens. Other ClairCity cities could learn from the stepwise process of implementation of this zone. It was introduced in 2007 and expanded over various years with an accompanying package of supportive measures such as a free bikesharing system (from 2011), electrical taxi-like transport free of charge within the pedestrian zone, improved public transport and the construction of underground car parks. The pedestrian zone combines a reduction of air pollution and carbon emissions with improved living conditions in the city centre and with making the city more attractive to tourists. The latter in turn is very beneficial for the economic development of the city.

Notable is also the start of the pedestrian zone in Ljubljana, where the Mayor took creative action in order to test and overcome initial public resistance to the zone. When several streets in the centre once were closed for sewage works, the mayor initiated that the streets remained closed slightly longer than strictly necessary in order to see what public resistance would result[39]. When it turned out that public resistance was managable, a permanent closure of some of the streets was ordered as a start of the pedestrian zone in Ljubljana. Indeed, now an overwhelming majority of the population supports the pedestrian zone that was gradually implemented and expanded over several decades.

Figure 6-2 Ljubljana pedestrian zone

[39] See the Claircity Ljubljana policy baseline report D6.2, www.claircity.eu

Transport regulation

The pedestrian zone measures were complemented by a city ring, introduction of yellow lanes reserved for public transport on main entry roads, regulation of junctions so that pedestrians and cyclists have priority and a reorganisation of roads into one-way traffic zones and 30 km/h zones. Further, the public transportation system was equiped with an electronic payment system (Urbana smart card), the munical public fleet became all electric or gas, public transport routes were optimised and transport on demand was introduced.

7 Citizen-inclusive air quality and carbon policies in Ljubljana: Conclusions and recommendations

The ClairCity project has set up an innovative citizen engagement process and verified implementation possibilities of policy desires of citizens with that of stakeholders and policy makers. The project has also modelled the likely consequences of the consolidated citizen scenario for air quality and carbon emissions.

In this chapter we draw the main conclusions and propose recommendations to Ljubljana policy makers. These have to be understood within two main limitations of the ClairCity project:

− Despite the large and varied number of engagement methods, the sample of respondents in Ljubljana is not fully representative for the whole city population.

− ClairCity modelling assumptions do not fully correspond with those of local modelling. The quantitative outcomes of modelling the citizen policy measures in terms of emissions, concentrations and health cannot be directly compared with those of local models.

Despite these limitations, however, the ClairCity project gives an overall indication of how Ljubljana citizen behavioural practices and anticipated future behaviours might affect policy making. The project also gives a view on what citizens in Ljubljana think of future policies and what might be the consequences of implementing these views, callibrated by policy maker comments, into actual policies.

7.1 Conclusions

7.1.1 Current city policies in Ljubljana

- **The main air quality issue related to citizens seems PM and biomass burning outside the city, although NO_2 might be also still an issue for the future.**

  Ljubljana has been continuous measuring air pollution in the city for over 45 years. The city has initiated and strenghened large number of environmental measures over the last decades, with as most prominent measure the introduction of a large pedestrian zone in the city centre. Particulate matter emissions and resulting concentrations, to a large extent caused by biomass burning outside the city, are noted as a main air quality problem. This holds in particular when comparing concentrations to the much stricter WHO guideline values and more for $PM_{2.5}$ than for PM_{10}. However, ClairCity modelling suggests that also NOx emissions and resulting NO2 concentrations at some hotspots could be an issue when comparing them to legal limit values.

7.1.2 Current behaviour of citizens in Ljubljana

- **Current transport behaviour of Ljubljana citizens is already quite environmentally friendly, with shopping as the least environmentally friendly transport activity**

  Of the ClairCity respondents, 42% currently uses only their private car for shopping, compared to 23 and 16% for commuting and leisure. Also, a much smaller number (32%) presently only uses public transport and active travel for shopping, compared to 65% for commuting and 54% for leisure.

7.1.3 Behavioural preferences of Ljubljana citizens for the future

- **Comparing stated intentions of respondents for behavioural change with the policy ambition of the city council to achieve 2/3 active transport, suggests that this could be in line with citizens' intentions for commuting and leisure, but for shopping behaviour achieving the policy target might be more difficult.**

  When asking respondents for their behavioural preferences in the future, 77% indicated preferring to use only public and active transport for commuting in the future, 70% did so for leisure and 60% for shopping transport needs. Equally, of the respondents 4% indicated wanting to use only their private car for commuting, 9% did so for leisure and 20% for shopping.

- **While expansion of district-heating is an option that could contribute to reducing air pollution in the future, the expansion of district-heating does not seem popular with respondents.**

  District heating can be an environmentally friendly option for the heating of private homes, provided that the heat is generated for instance from renewables or waste heat from industry. 32% of the ClairCity respondents indicated to be currently connected to the district-heating system, but only 16% wanted to use district-heating in the future.

7.1.4 Policy preferences of Ljubljana citizens for the future

- **Expansion of cycling lanes in streets at the cost of space for motorised traffic seems controversial.**

  Out of the selected most popular policy measures of citizens for their city in the future, the expansion and the scrapping of cycling lanes showed to be almost equally popular with respondents.

- **The impacts of citizen policy measures as compared to a business-as-usual policy scenario for Ljubljana are small due to the nature of the finally selected measures and ambition levels finally selected by policy makers.**

  Policy makers had a relatively large influence on the impacts of the citizen policy measures compared to other ClairCity cities. Firstly, input measures for the policy

workshop were limited to transport measures only, giving an indication where current policy priorities in Ljubljana are. Secondly, policy makers in Ljubljana, contrary to many of the other ClairCity cities, selected low or medium ambition levels for many of the measures preferred by citizens.

- **Costs of policy measures are a key concern to Ljubljana policy makers.**

  The main reason for selecting low or medium ambition levels for preferred measures of citizens given by policy makers are the concerns about costs, as the infrastructural measures preferred by citizens would often incur high costs.

7.1.5 Institutional conditions and barriers for implementation of citizen policies

- **The integration of local policy measures with the region needs attention**

  The urban area of Ljubljana is surrounded by mostly rural areas. Integration of policy measures with those in the region is therefore a key issue, for instance to integrate regional with urban public transport (bus and train) and to address mostly rural biomass burning – next to industrial background emissions - that impact air quality in the city.

- **Civil society and NGOs need to be fostered**

  In Ljubljana, the mayor is in office for many years and was re-elected several times. In this situation, civil society and NGOs indicate that it is sometimes difficult to make their voices heard. Hence, care has to be taken that also citizen inputs given through these channels remain to be considered in policy decisions taken.

7.2 Recommendations

Based on the conclusions of the Amsterdam ClairCity analysis several recommendations for more citizen-inclusive policy making can be given:

7.2.1 Tailoring policies to current behaviours and to preferred future behaviours of citizens

- **Address in particular shopping behaviour, next to other transport behaviours**

  Since shopping behaviour from the ClairCity research appears a main area where behavioural change towards public and active transport is difficult for citizens, a specific campaign could be directed at facilitating non-car shopping transport, e.g. by promoting (electrical) transport bikes, public transport rebates provided by shopping centres and increasing parking fees in shopping areas. Also, home delivery by electric vans could be stimulated.

Figure 7-1 Supermarket home delivery service by electrical bike in the Netherlands (De Stentor - F. Schinkel, 2018)

- **Make citizens aware of the advantages of district heating to combine with renewables**

Increasing awareness of the positive environmental aspects of district heating – if realised with renewables, waste heat from industry or geothermal heat sources – could make citizens easier accept a switch to this heat source.

- **Discuss the impacts of cycling lanes with citizens**

Increasing the number of cycling lanes seems controversial with Ljubljana citizens, as it will decrease road space for cars. While this is an intended effect in order to stimulate modal shift from private cars to bikes, it could be investigated where specific hotspots are that are particularly controversial and it could be discussed with citizens what are the intended impacts of the cycling lanes and why.

7.2.2 Addressing institutional barriers and mutual learning

- **Increase measuring and modelling facilities in Ljubljana, for instance by stimulating citizen science measurements**

Stimulating citizen science measurements of air quality is a cheap way of increasing the number of measuring spots in the city, that simultaneously increases awareness of citizens of live air quality conditions. Several other cities in Europe, including ClairCity cities Amsterdam and Bristol, are already experimenting with such approaches.

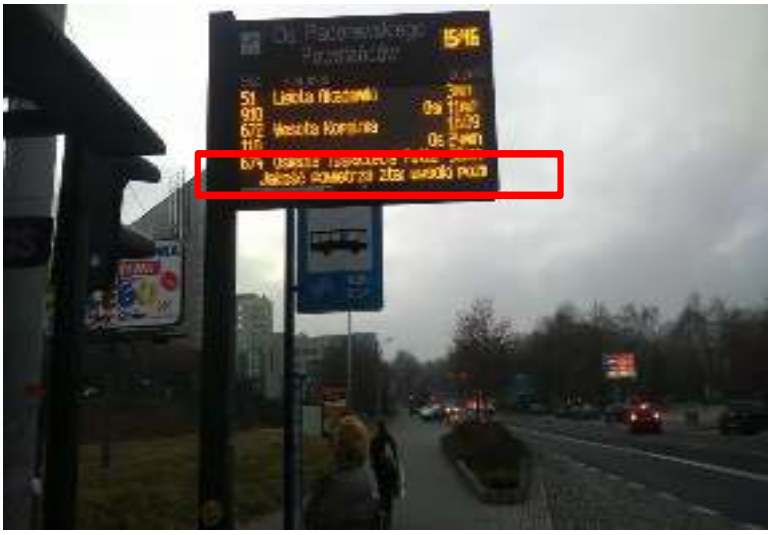
- **Integrate policy measures with those in the regions bordering to Ljubljana and disseminate the successes of the Ljubljana approaches**

Integration of regional and urban public transport could for instance be studied from the Bristol Metrobus system. A systematic study of integration approaches throughout Europe and their applicability to Ljubljana could be made.

- **Show live air quality conditions in the city in order to increase awareness of citizens of the health benefits of clean air**

ClairCity city Sosnowiec has integrated live air quality information into the public transport timetable information system. Amsterdam is experimenting with an approach that expresses health benefits of clean air in the reduction of number of sigarettes smoked per year. Similar approaches could be applied in Ljubljana, on top of the approaches already applied in the city, such as the 'Cyanometer' art sculpture in the city, that gives an indication of air quality in the city in an artistic way.

Figure 7-2 Live air quality information in ClairCity city Sosnowiec



- **Communicate successes of the 'European approach' in Ljubljana to other cities**

Ljubljana has been very successful over the last years to attract European projects that contributed to greening the city. Ljubljana also has been 'European Green Capital' in 2016. The lessons and successes of this approach could be communicated more extensively to other cities in order to strengthen mutual relationships, which in turn could be used further to attract new European projects.

- **Investigate success stories of integration of train transport in the overall transport system in other countries and regions**

Expansion of train transport is a particular area of interest in Ljubljana. Other ClairCity cities already have extensive experience with integration of train and active transport, for instance Amsterdam.

- **Make sure that voices of civil society and opposition remain to be heard and discussed**

Existing exchanges between policy makers and civil society should be fostered and could from time to time be rechecked if they fulfill their purpose for both sides.

Annex A. The ClairCity project in detail

This annex explains in more detail the ClairCity process and the positioning of this 'Ljubljana policy package report'.

The ClairCity project consists of three phases and seven work packages (Figure A-1):

Phase 1: Establish the Baseline Evidence

The primary aim of Phase 1 is to understand and quantify the baseline status of air quality, carbon emissions and related public health in our cities. Phase 1 is achieved with the following main activities:

1. **Benchmarking behaviour**: Understanding the local demographic data and establishing the citizen practice-activity data to feed into the air quality models.
2. **Quantify the baseline**: Quantification of the baseline air quality emissions and concentrations, carbon emissions and public health impacts in a city.
3. **Assessment of Policy**: Collation and analysis of current policies (local, regional, national and EU) that influence the city.

Phase 2: Citizen and Stakeholder Engagement & Co-creation of Scenarios

Phase 2 has three key aims: (1) understand citizens' current behaviours, practices and activities, (2) enable citizens and stakeholder to co-create and visualise their low carbon, clean air, future city and (3) raise awareness of the environmental challenges and their solutions. Phase 2 utilised evidence from Phase 1 to help frame and inform the engagement activities. Phase 2 is achieved with the following main activities:

Citizen and stakeholder engagement & co-creation

1. The ClairCity Delphi method uses citizens as local experts to generated qualitative evidence of their entrenched behaviours and what enabling interventions would allow them to act and behave differently in future (WP4).
2. The Mutual Learning Workshop brings citizens and stakeholders together to debate the challenges facing the city and co-create policy interventions for cleaner, healthier futures (WP4).
3. The ClairCity Skylines Game 'crowd-sources' the public perceptions and public acceptability of difference policy interventions (WP4)
4. Citizens and stakeholders come together in a Stakeholder Dialogue Workshop to review and debate the Delphi, Mutual Learning Workshop and ClairCity Skylines evidence and co-create scenarios for a low carbon, clean air, health futures (WP4 and WP7).
5. The scenarios generated in the Stakeholder Dialogue Workshop go through a rapid quantification step (WP5) and are then returned to the local citizens/stakeholders to discuss in a Policy Workshop (WP6) and to agree a single Unified Policy Scenario (WP7).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689289

Public Engagement & Awareness: Additional awareness raising activities are also implemented across the project in each city (WP4). These include:

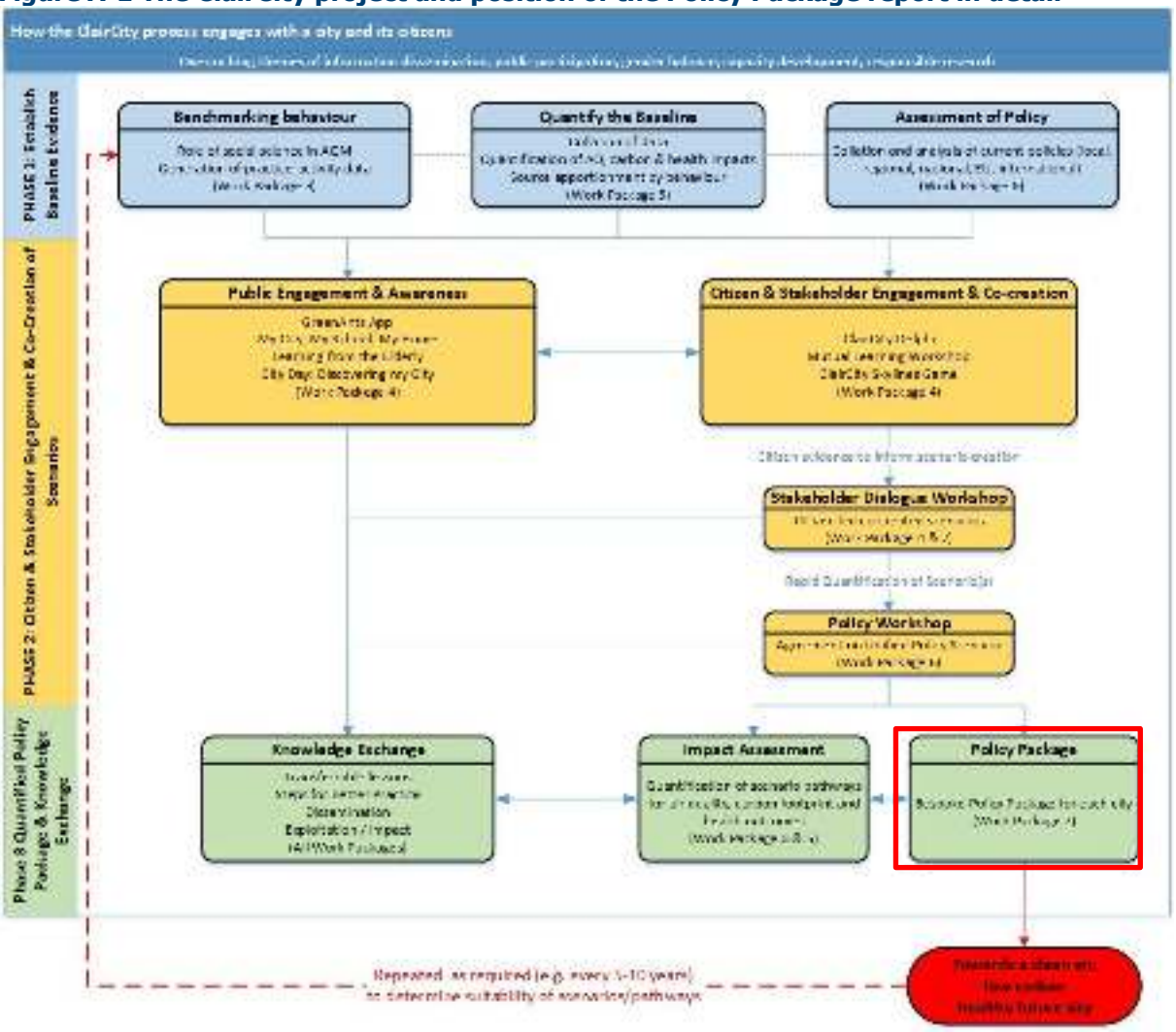
6. The GreenAnt App which allows citizens to become a citizen scientist and monitoring their transport activities, emission generation and exposure using mobile GPS data.
7. The School Competition: My City, My School, My Home engages young people in the air quality, carbon and public health debate utilising an online platform for the students to select the interventions that influence their housing, transport and use of resources in order to be able to design tools for change towards smart consumption, reduced emissions and healthy lifestyles.
8. Learning from the elderly filming activity engages the older, potentially vulnerable, community to talk about the changes in their city, their personal mobility and the steps they take to minimise their exposure to air pollution.
9. The City Day: Discovering my City helps disseminate the final project results and provide healthy and smart tips to promote non-motorised mobility of citizens by highlighting availability and benefits of walking and cycling routes in the city.

Phase 3: Quantified Policy Package & Knowledge Exchange

The primary aim of the final Phase 3 is to collate the evidence and lessons learned from Phase1 and Phase 2 to generate a quantified, bespoke, citizen-led and citizen-inclusive policy package for each city. Phase 3 is achieved with the following main activities:

1. **Knowledge Exchange**: Collation of transferrable lessons and steps for better practice based on the experiences of the ClairCity project to inform other environmental and public health practitioners (WP3, WP4, WP5, WP7).
2. **Impact Assessment**: Rapid quantification of the scenarios generated in the Stakeholder Dialogue Workshop (WP4) and detailed impact assessment of the final Unified Policy Scenario generated in the Policy Workshop (WP6). This quantification includes an assessment of the source apportionment by behaviour or purpose; air quality emissions and concentrations, carbon emissions, air pollution related health impact and interventions cost analysis (WP5).
3. **Policy Package**: Development of a bespoke Policy Package for each city drawing together the findings from across the whole project (WP7).

Figure A-1 The ClairCity project and position of the Policy Package report in detail



Annex B. The ClairCity citizen engagement process

The citizen engagement process developed by ClairCity consisted of policy focused activities and of awareness raising directed activities. In annex B-1 the former are discussed in some more detail, in annex B-2 the latter. For an even more comprehensive overview and analysis in addition the more detailed ClairCity reports on each activity can be consulted.

B.1 Policy related engagement activities

Three main engagement activities directly informed the policy workshop and the policy recommendations: the Mutual Learning Workshop, the Delphi process and the Skylines game.

Mutual Learning Workshop (MLW)

The MLW in Ljubljana was attended by 16 participants. The attendees were asked to imagine how Ljubljana would look in 2050, including any changes they expect to see.

The participants defined the Priority actions and measures:

By 2020

- Promotion of adopted strategies – policy measure: closing of the roads for individual transport for several days,
- Vegetation of riparian area - measure: continuous and round cycling routes
- Improvement of quality of living - measure: more green elements in the traffic streets, more stations for bicycle, promotion of sustainable mobility

By 2030

Ljubljana city for all generation - measure: increase of green spaces and green infrastructure with multifunctional role

Sustainable mobility - measure: relieve of Zois street for traffic

Burn calories not gas - measure: spread of inner pedestrian ring, car sharing

By 2050

Strategy for implementation of adopted strategies - measure: the center of city is free of cars, the delivery is arranged

Modern, innovative city - measures: Complete electrification of public transport, hyper mobility, bicycle is the engine for development, work from home, reduction of needs

Main barriers identified were:

- To establish the final vision of the area of interest,
- to increase the traffic free zone to the wider area,
- to establish the sharing space which is in use on very busy area of Ljubljana,
- to increase the number of Bicycle (the bicycle) stations,
- to introduce the transport on the Ljubljanica river regular stations,
- to replace all public transport with electric buses and cars,
- to increase the number of vehicles for older and other in need (Kavalir type of individual transportation linking the public transportation).
- in addition, city would need to work on restoration of green areas, including new water elements (fountains and drinking water areas).

- another systematic solution for cleaner air is a complete public heating system which is currently not available.

Delphi Process

The Delphi process in Ljubljana consisted of two survey rounds followed by a Stakeholder Dialogue Workshop.

In Ljubljana, 199 responses were received out of a city population of 280,210 . 58% of the respondents were female. There was an under-representation of the oldest and youngest categories, with more than two thirds of respondents aged 25-50 compared to 38% in this category in the city as a whole. The respondents are highly educated, with 65% holding a university education compared to only 24% of the city population. A third of Ljubljana residents have vocational education qualifications, but only 1% of our survey respondents have this. In Slovenia the national or cultural identities of citizens is a politically charged topic due to the histories of Former Yugoslavian populations. As a consequence for ethical reasons we nationality nor ethnicity were used as a demographic identifier for population sampling in Ljubljana.

The majority of respondents were female, making up 68% of the Round 2 respondents. The 37-50 age category were a disproportionate set in the data, at 51% compared to only 24% of the total population. This was at the cost of older people, with only 3% of the Round 2 sample over 65, compared to 15% of the city. The data also represents the highly educated more than the average citizens, with 85% holding some form of higher education certificate, compared to only 31% of the general population.

The Stakeholder Dialogue Workshop (SDW) was organized in Ljubljana on the 18th of April 2019 as part of WP4 - Citizens and Stakeholder Engagement, Task 4.1: Citizen Delphi Engagement. The event was entitled as »SKUPAJ Z VAMI ZA ŠE ČISTEJŠI ZRAK V LJUBLJANI« (in translation “Together with you for cleaner air in Ljubljana”). The aim of the SDW was to synthesize the evidence streams from the ClairCity process such as the Delphi, Mutual Learning Workshop and Game to allow city stakeholders to generate a number of potential future scenarios for a low carbon, clean air pathways in the short-medium and long term to 2050. The event was organised on the premises of Ljubljana municipality City Hall.

Figure B-1 Ljubljana Stakeholder Dialogue Workshop

The SDW was attended by 26 participants, with 2 persons from academia, 8 from authorities, 1 city councilor, 5 from SME, 4 from NGOs 2 from citizens community biro and 4 from media. The attendees were having background from geography, architecture, health, medicine, economy, landscape and urbanists, security, physics and chemistry.

The SDW was divided in several parts, first covering the ongoing projects relevant for the city and presenting some of the recent national and international projects. The second part was devoted to moderated discussions between the representative of the municipality bodies and participants. Third part was focused on the interactive workshop in which participants discussed the policy measures and ambitions which would be in a short, medium and long term implemented in the city. The policy measures were discussed in relation to the public transport, walking and cycling and car use, the policies were evaluated based on the ambition of participants to achieve. Also, the interdependences of measures were taken into account by understanding of the impacts which the implementation of measures can bring and economics behind. The event finished with the guided cycling tour in which the vice mayor of Ljubljana presented some of the challenges and solutions for improvement of cycling in Ljubljana.

Skylines game

ClairCity Skylines is a ‘serious game’, designed to capture citizen decision making about issues in their city, where players travel between areas representing a city’s environment, economy and its citizen’s health & satisfaction, and at the same time gatheringa ideas for low carbon, clean air, healthy future policies before 2050 (Figure B-2).

Bristol was the first of the six partner cities to to be included in the game, and launched in April 2018. An updated, localised version of ClairCity Skylines was launched in Amsterdam following a significant database upgrade in November 2018 based on the findings of the Bristol pilot. The upgrade allowed the final 4 cities/regions to launch simultaneously in Ljubljana, Sosnowiec, Aveiro and Liguria in January 2019, with primary data capture closing at the end of March 2019. The game includes English, Dutch, Slovenian, Polish, Italian and Portuguese localisations for game text, UI and the policy database.

The total number of players in Ljubljana was 24, as compared to 949 in Sosnowiec, 836 in Bristol, 371 in Amsterdam, 243 in Aveiro, 66 in Liguria and 307 in other cities.

Figure B-2 Logo of the Ljubjana version of the Skylines game

Figure B-3 Total number of Skylines players per city

Location	Number of users	Percentage
Sosnowiec	949	33.9
Bristol	836	29.9
Amsterdam	371	13.3
Other	307	11.0
Aveiro	243	8.7
Liguria	66	2.4
Ljubljana	24	0.9
No response	4	0.1

B.2 Awareness related engagement activities

Three activities in the ClairCity engagement process were mainly awareness related: the secondary school activities directed at young people, the film competition for the elderly and the city day.

Reason for the focus on young people and the elderly is that ClairCity builds on the WHO Policy Framework and the European Commission's Clean Air Policy Package that promote public health by paying special attention to more vulnerable groups, such as children and senior citizens. The aim is to empower these citizens to better understand the specific challenges and opportunities that their city currently offers and to engage them into moving towards reduced air pollutant emissions and carbon footprints. The project has therefore collected their perceptions and ideas on sustainable lifestyles and a 'better quality of life' within their city in the future.

Young people

The Ljubljana project team tested and launched the Slovenian version of the school software and contacted four schools (age 11-13 years old). However, finalisation of this activity was delayed due to the 2020 Corona crisis. Therefore information on the activity could not be included in this report.

Elderly

In Ljubljana, three videos were prepared by elderly. The topics of the videos were the following:

- cycling and walking across the city: video shows the alternative mobility options in the city
- health benefit of non-motorised transportation: video explains the preventive aspects of healthy mobility
- sustainable mobility in the city: video shows the alternative possibilities for mobility and promote cycling and walking in broader sense

The videos were promoted via the project website and social media to receive feedback on the content and format of the short video. All videos received positive feedback by the followers and the project team.

The videos were uploaded to the ClairCity project website, Facebook, YouTube and linked to the city website.

The videos were uploaded to the ClairCity project website, Facebook, YouTube and linked to the city website.

Link to the project website: http://www.claircity.eu/take-action/communities/

Link to YouTube:
https://www.youtube.com/watch?v=_wsvEfxLmFs

https://www.youtube.com/watch?v=d8Fuw9vO4TQ

One of the most interesting topics of the films is the cycling access in Ljubljana for the citizens. The self-service bicycle rental system BicikeLJ was set up in May 2011 and since then the city has recorded over six million bike rentals. The last station was incorporated into the system on 3rd June, on World Bicycle Day, it was set up in front of the Mercator retail store on Celovška Cesta 163.

In addition to this, Ljubljana was ranked as one of the most bicycle friendly cities in 2019. The ClairCity project filming activity promoted cycling and walking to increase the sustainable mobility in the city. Interesting to learn that the Copenhagen Index is the most comprehensive and holistic ranking bicycle friendly cities on earth. The Index's smallest city, Ljubljana was described as a breeze to visit: green, liveable, bike-friendly.

City Day

The City Day was organised on 21st September 2019 during the 'mobility week'. The agenda of the mobility week focused on several activities to promote sustainable lifestyles, the active travel, the improvement of the actions of the city social networks. The City Day fits to the agenda of the 'mobility week' with raising awareness of environmental challenges and their solutions through proactive dissemination of the project outcomes. The ClairCity project goals and outcomes on the citizens led air pollution reduction options were disseminated during the city day for a few hundred participants.

Annex C. Ljubljana citizen engagement impacts: scenarios and modelling

C.1 Overview of modelling activities

To understand the impact of the policies the citizens put forward, we assessed the impact of policies on emissions, air quality, health and costs in three steps:

1. Step 1: Reproduce the air quality situation as it is currently, in a modelling environment ("baseline"): First, estimate total emissions from different sources, in line with statistics (by sector, by time of day, link with behaviour); Second, model the air quality and validate the modeling ouput with with observations; Third, assess exposure and health impact with common indicators.

2. Step 2: Estimate future emissions in a scenario with existing policy measures and model the resulting air quality. This business-as-usual scenario (BAU Scenario) aims to capture the changes in air quality if no further measures are taken, only accounting for changes in the emissions due to policy measures made in the past and expected technological and/or behavioural changes.

3. Step 3: Estimate future emissions in a scenario with additional policy measures as aimed for by Ljubljana citizens and commented by Ljubljana policy makers (Unified Policy Scenario, or short UPS Scenario). We follow the same route, from estimating the impact of the measures on emissions, to air quality and health impact.

The three steps are explained in more detail in section C.2. Section C.3 gives further results from the behavioural modelling / source apportionment approach carried out with the data in order to relate air quality emissions and concentrations to citizens' behavioural activities.

C.2 Results

The results of the modelling exercise consist of three parts:

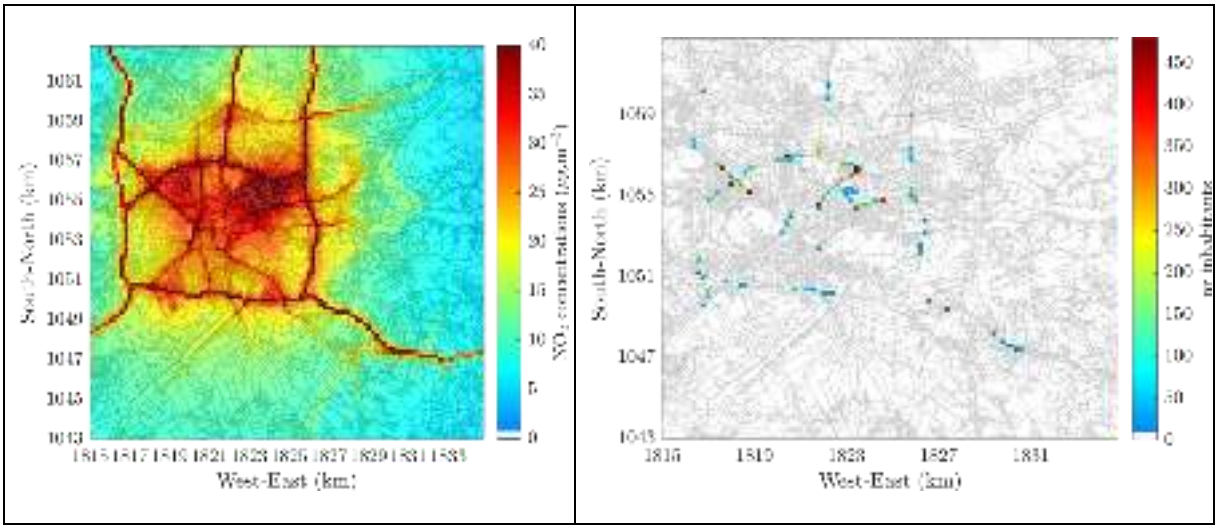
- Results for the situation as it is (baseline)
- Expected future without future action (BAU)
- Future with additional policy action (UPS)

C.2.1 Air quality for the baseline

The second-generation Gaussian model URBAIR was setup and run at an urban scale for the computational domain over the urban area of Ljubljana. The baseline simulations were performed for the full-year using the meteorological vertical profiles from the WRF-CAMx system and the emissions available on the ClairCity emissions database. Background concentrations were added to the URBAIR model results. For that purpose, it was established a single value to apply to each grid cell. This value is the average concentration from the transboundary transport obtained from the WRF-CAMx results using the source apportionment tool. In addition, the simulation results together with the added background concentrations were calibrated against the measurements[40] through the adjustment procedure. For NO_2 concentrations, a slope of 1.7 obtained from the linear regression is applied as a correction factor over all the domain. In case of particulate matter, PM10 and PM2.5 concentrations the slope obtained from the linear regression is equal to 0.7 for PM10 and 0.4 for PM2.5 concentrations.

Figure C-1 a) shows the resulting NO_2 annual average concentrations. Figure C-1 b) points out the population potentially exposed to NO_2 concentrations above the EU legal limit value of 40 $\mu g.m^{-3}$.

Figure C-1 NO_2 contour maps: a) annual average of NO_2 concentrations and b) number of inhabitants within the cells exceeding the EU annual limit value of 40 $\mu g.m^{-3}$ in 2015

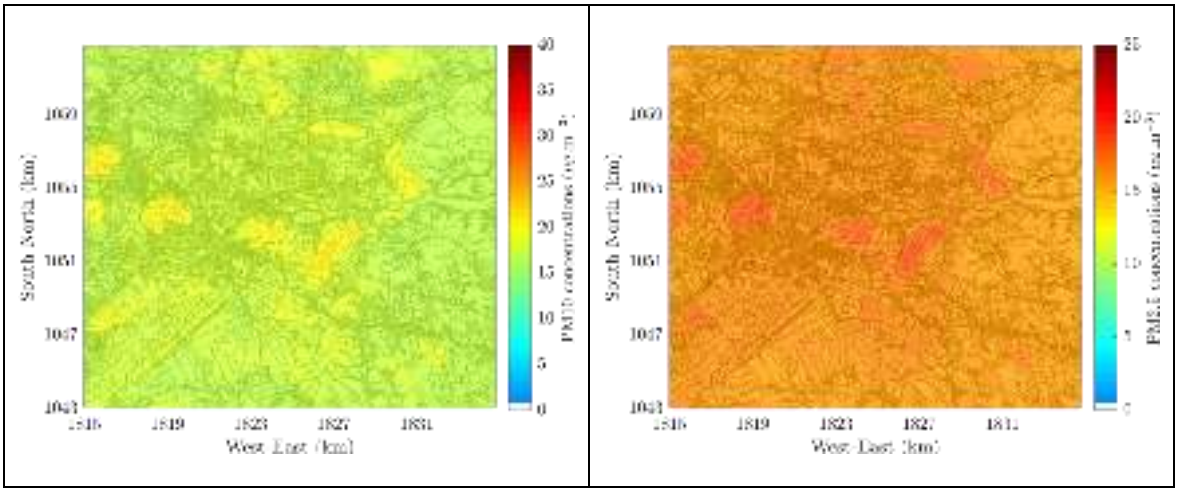


The simulation results indicate a maximum concentration of 76.8 $\mu g.m^{-3}$ over the urban area of Ljubljana, with several hot-spots linked to road traffic patterns. The EU annual legal limit value for NO_2 annual concentrations is exceeded in 304 cells, out of which 170 with permanently resident population allocated to them. This corresponds to around 5% of the total population within the urban area potentially exposed to those concentrations.

[40] The NO_2 observations available for 2015 include measurements from 3 continuous measurements from the Polish monitoring network: 1 road traffic site, and 2 urban background sites. Similarly, the PM10 observations available include measurements from the same 3 continuous sites. PM2.5 observations are only available for the road traffic site.

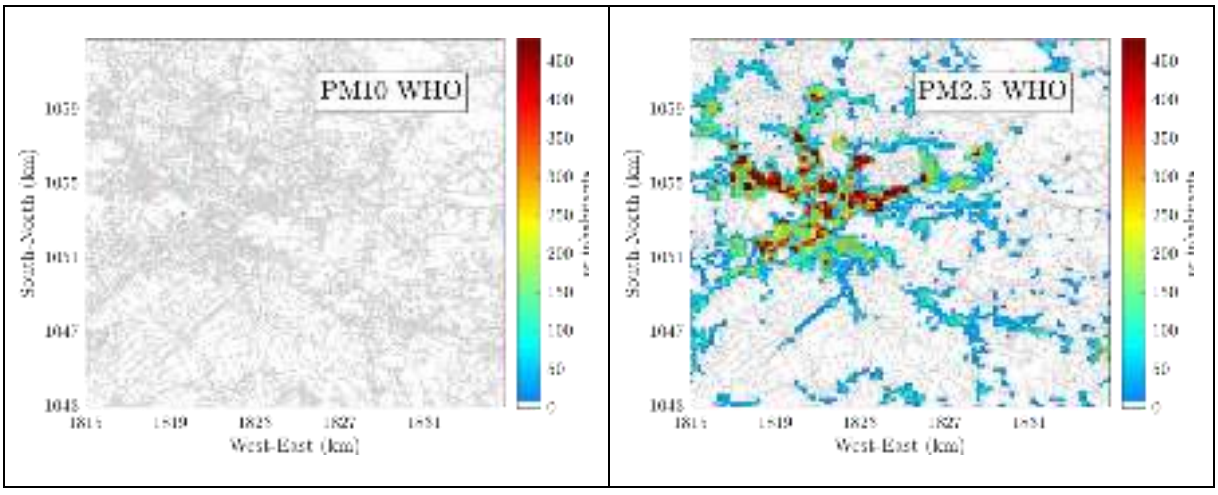
Figure C-2 presents the PM_{10} annual average concentrations (Figure C-2 a)) and the $PM_{2.5}$ annual average concentrations (Figure C-2 b)).

Figure C-2 (a) PM_{10} annual average concentrations and (b) $PM_{2.5}$ annual average concentrations in 2015



The maximum value of PM_{10} concentrations is equal to 22.7 µg.m^{-3}, which is simulated over the urban area of Ljubljana with several hot-spots related with the residential and commercial emission sector, with a contribution of 96.5% to the average concentrations simulated over the whole urban area. The simulated maximum concentration of $PM_{2.5}$ equals 19.5 µg.m^{-3}. The PM concentration contour maps point out no exceedances to the EU legal limit values for PM_{10} and $PM_{2.5}$, equal to 40 µg.m^{-3} and 25 µg.m^{-3}. However, despite the compliance of the EU legal limit values, both the annual PM_{10} and $PM_{2.5}$ concentrations indicate exceedances of the WHO guideline values. In the urban area of Ljubljana 100% of the total population are potentially exposed to $PM_{2.5}$ concentrations exceeding the WHO recommendations.

Figure C-3 Number of inhabitants within the cells exceeding the WHO air quality guideline values: a) of 20 µg.m^{-3} for PM_{10} concentrations, and b) of 10 µg.m^{-3} for $PM_{2.5}$ concentrations in 2015



Assessment of health impacts for the baseline

The health benefits related to air pollution were illustrated by calculating health impact indicators for different air pollutants (NO_2, PM_{10}, and $PM_{2.5}$): the number of premature deaths and years of life lost (YLL). Premature mortality is a standard measure of the burden of the population's health, as it is expected that most deaths are preventable before a person reaches an expected age. YLL is defined as the years of potential life lost due to premature deaths. Since YLL takes into account the age at which deaths occur, relative to life expectancy, higher weight is given to deaths at a younger age than at an older age (de Leeuw and Horálek, 2016). Mortality indicators are not the only indicators available for the burden of disease related to air quality but are certainly the ones with higher external costs to society (OECD, 2016).

The burden of disease associated with ambient air pollution is estimated by relating air concentrations to health outcomes. Gridded annual averages were used as input to quantify the relative risk in a population, based on concentration-response functions (CRF). CRFs reflect the effect of a pollutant on a health outcome, e.g., NO_2 on mortality from cardiopulmonary diseases, typically expressed as the increase in incidence or prevalence per unit increase in concentration. Table C-1 describes the risk ratios, the mortality causes, age interval, and concentration threshold consider when calculating the health outcomes for each air pollutant. The threshold concentration is the concentration level below which no health effects are expected.

Table C-1 Risk ratios (RR) for mortality

Pollutant	Value [per 10 µg/m3]	Type	Reference
PM2.5	RR 1.062 (95 % CI 1.040-1.083) No threshold	All-cause (natural) mortality in ages above 30 (ICD-10 codes A00-R99).	WHO 2013a
PM10	RR 1.04 (95% CI, 1-1.09) No threshold		Beelen et al., 2014
NO2	RR 1.055 (95 % CI 1.031-1.08%) Threshold: 10 µg/m^3		WHO 2013a

Premature deaths can be estimated at the grid-cell level by multiplying the population attributable fraction (PAF), the crude death rate (CDR), and the total population for every cell. PAF is defined as the reduction in population mortality if exposure to a risk factor was reduced to an ideal exposure scenario (e.g., concentrations equal to zero). PAF can be calculated from the relative risk, assuming an exponential behaviour. CDRs were calculated based on natural all-cause mortality in 2015 (WHO, 20019, ICD codes A00-R99) and country level population (UN, 2019a), broken down by age and sex. Here it is assumed that CDR is constant across the country's population. YLL is calculated at the grid cell level by multiplying premature deaths with life expectancy by age and sex. Life expectancy data is based on data published by the UN (2019b).The expected burden of disease attributable to air pollution in a specific area can finally be estimated by summing over all grid cells in the area of interest for the indicator of interest.

The results for the baseline scenario indicate there has been 219, 185, and 169 premature deaths atributed to NO_2, PM_{10} and $PM_{2.5}$ polution levels in Ljublijana in 2015, respectively. For the same pollutants, 2306, 1950, and 1781 years of potential life lost were estimated for Ljublijana in 2015.

C.2.2 BAU

BAU impacts on air quality

The reductions of the NO_x emissions in the BAU scenario will lead to significant reductions of the NO_2 concentrations. Figure C-4 presents as example the NO_2 annual average concentrations considering the impacts of BAU scenarios for 2025 and 2050. The maximum NO_2 concentration will be equal to 53.8 $\mu g.m^{-3}$ in 2025 and to 32.9 $\mu g.m^{-3}$ in 2050, corresponding to an overall reduction of the maximum concentration of 39% (from 2025 to 2050). In the BAU scenario, the NO_2 concentrations will still exceed in 2025 the EU limits and WHO guidelines.

Figure C-4 NO_2 annual average concentrations for the BAU scenarios: a) 2025 and b) 2050.

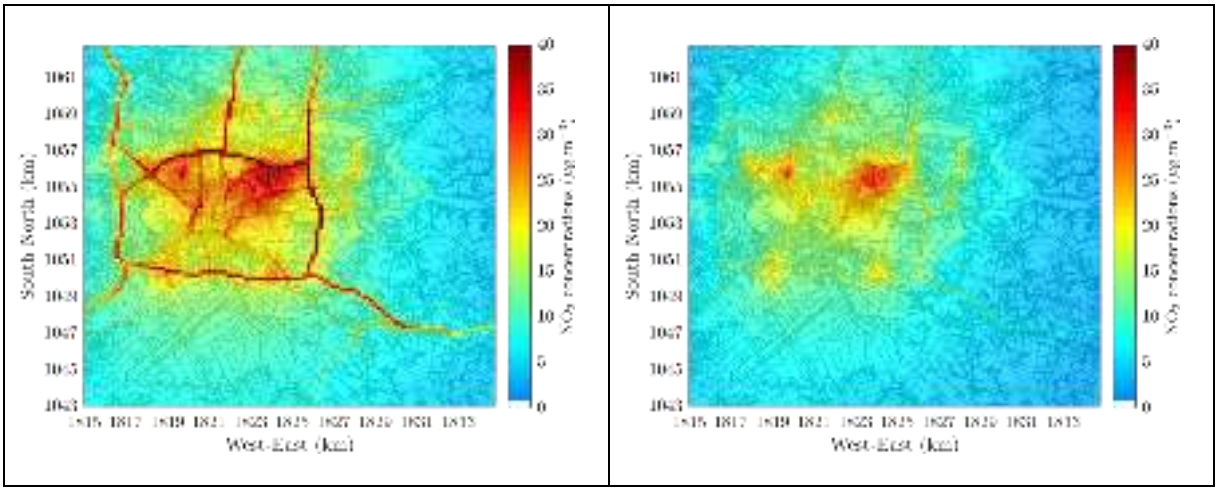
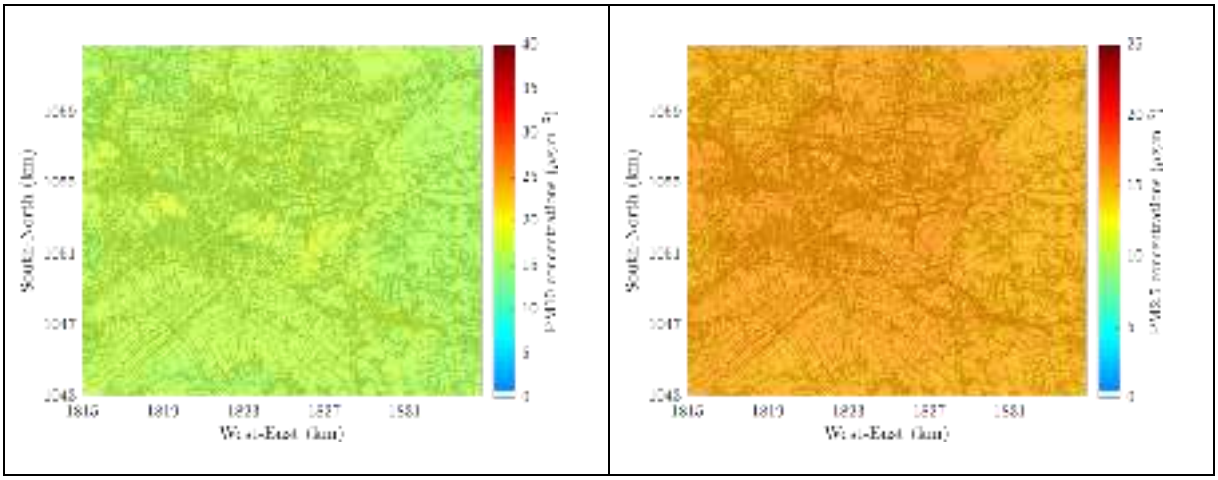


Figure C-5 (a) presents the PM_{10} annual average concentrations for 2050 and (b) the $PM_{2.5}$ annual average concentrations for the same year. The simulated maximum values of PM_{10} concentrations range from 19.3 to 18.8 $\mu g.m^{-3}$ between 2025 and 2050, while the simulated maximum concentration of $PM_{2.5}$ vary from 17.1 to 16.6 $\mu g.m^{-3}$. Therefore, the BAU scenarios will lead to the reduction of PM_{10} concentrations showing compliance with EU limit values and with the WHO guideline values already in 2025. The BAU scenarios will lead to the reduction of $PM_{2.5}$ concentrations showing compliance with EU limit values in 2025. However, for the WHO guideline values all grid cells will still exceed this limit in 2050.

Figure C-5 Particulate matter annual average concentrations for the BAU scenario in 2050. a) PM_{10} and b) $PM_{2.5}$ concentrations.



BAU impacts on health

The results for the BAU scenario indicate there has been 146, 177, and 164 premature deaths and 1542, 1868, and 1731 years of life lost atributed to NO_2, PM_{10} and $PM_{2.5}$ polution levels in Ljublijana in 2025 respectively. Estimations for 2035 indicate that 92, 176, and 163 premature deaths and 970, 1851, and 1720 years of life lost atributed to NO_2, PM_{10} and $PM_{2.5}$ polution levels,respectively, and 72, 176, and 163 premature deaths and 754, 1854, and 1721 years of life lost atributed to NO_2, PM_{10} and $PM_{2.5}$ polution levels in 2050.

C.2.3 UPS

UPS impacts on air quality

The very small reductions of the NO_x emissions in the UPS scenario comparing with the BAU scenarios will lead to an neglectable increase of the NO_2 concentrations (in the UPS when compared to the BAU scenarios). Figure C-6 shows for example the NO_2 annual average concentrations considering the impacts of UPS scenarios for 2025 and 2050. In 2025 the maximum NO_2 concentration will be equal to 55.3 $\mu g.m^{-3}$ and in 2050 equal to 33.3 $\mu g.m^{-3}$. Comparing UPS and BAU scenario in 2050, the maximum concentrations will be at 56.6 and 57.2% compared to 2015.

Figure C-6 NO_2 annual average concentrations for the UPS scenarios: a) 2025 and b) 2050.

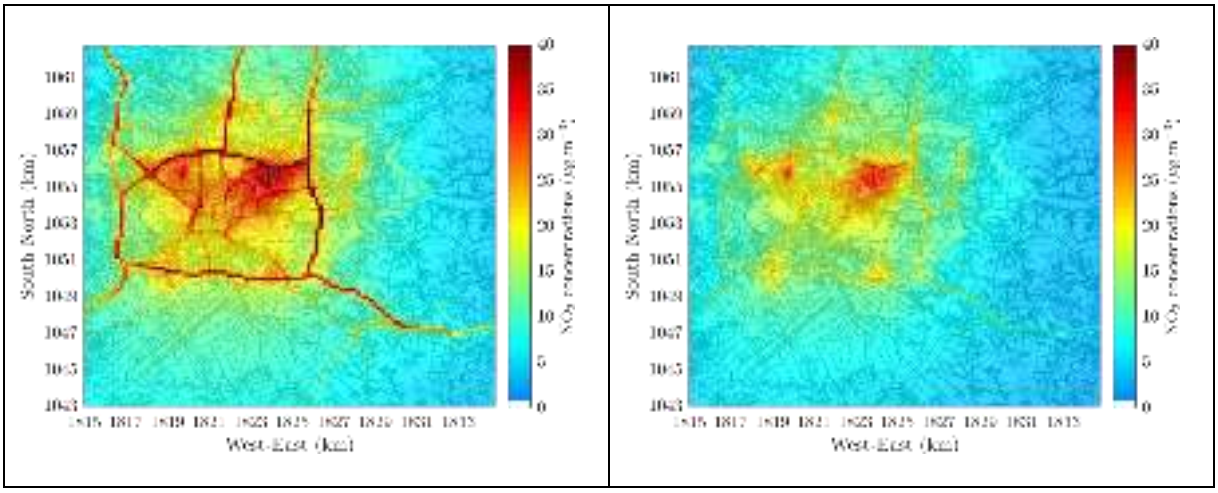


Figure C-7 presents the UPS PM_{10} annual average concentrations (a) in 2025 and (b) in 2050. For PM_{10}, in 2025 the maximum value corresponds to 19.3 $\mu g.m^{-3}$ and 18.8 $\mu g.m^{-3}$ in 2050. This means that there are any exceedances, neither to the EU limit value, nor to the WHO guidelines. Compared to the BAU scenario, the UPS scenario will not further reduce the maximum concentrations.

Figure C-7 PM10 annual average concentrations for the UPS scenario: a) in 2025 and b) in 2050.

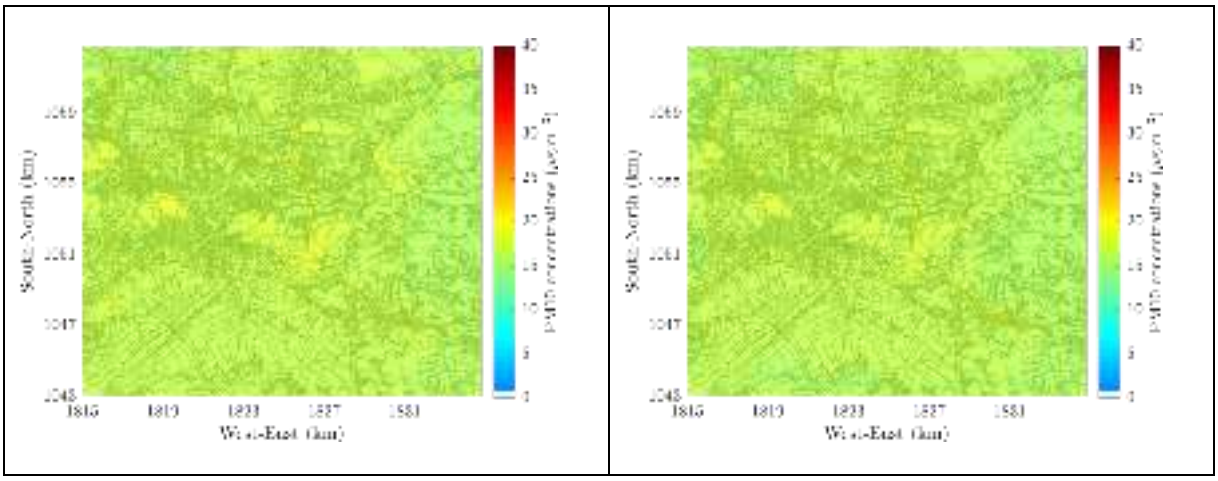
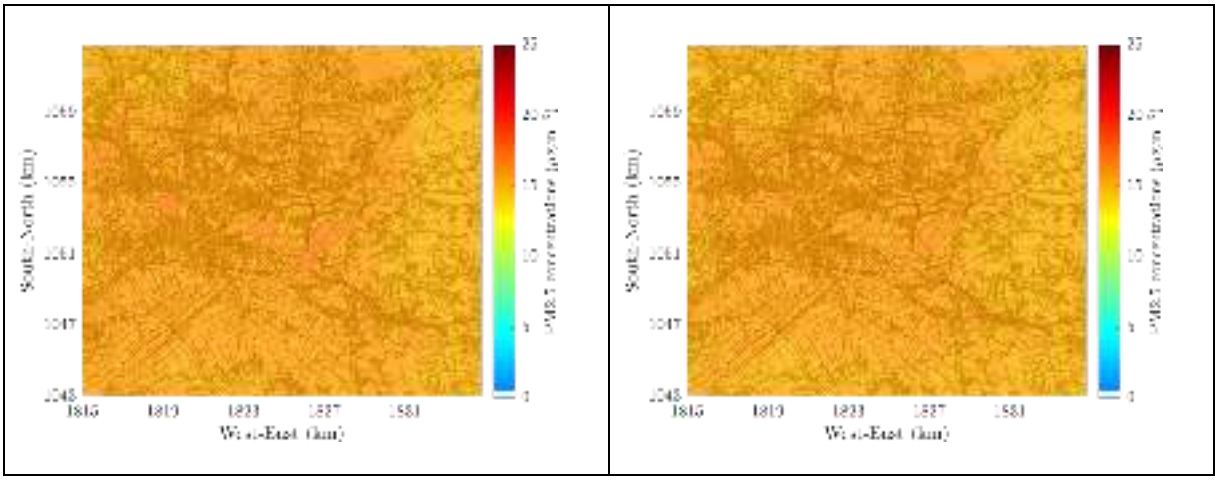


Figure C-8 presents the $PM_{2.5}$ annual average concentrations in the UPS scenario (a) in 2025 and (b) in 2050. For $PM_{2.5}$, in 2025 the maximum value corresponds to 17.1 $\mu g.m^{-3}$ and 16.6 $\mu g.m^{-3}$ in 2050, translating into no further reduction of the maximum concentration compared to BAU. Based on the WHO guidelines in 2025 and 2050 all the grid cells will be exceeding these recommendations.

Figure C-8 PM2.5 annual average concentrations for the UPS scenario: a) in 2025 and b) in 2050.



UPS impacts on health

The results for low, high and final UPS scenarios for 2025, 2035 and 2050 are presented in Table C-2 for premature deaths, and Table B-II for years of life lost.

Table C-2 Number of remature deaths related to PM2.5, PM10 and NO2 exposure for the UPS, low and high emission scenarios in 2025, 2035, and 2050.

	PM2.5			PM10			NO2		
scenario	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**
UPS	164	163	163	177	176	176	151	100	78

Table C-3 Number of years of life lost related to PM2.5, PM10 and NO2 exposure for the UPS, low and high emission scenarios in 2025, 2035, and 2050.

	PM2.5			PM10			NO2		
scenario	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**	**2025**	**2035**	**2050**
UPS	1731	1720	1722	1868	1852	1855	1590	1057	821

UPS impacts on costs

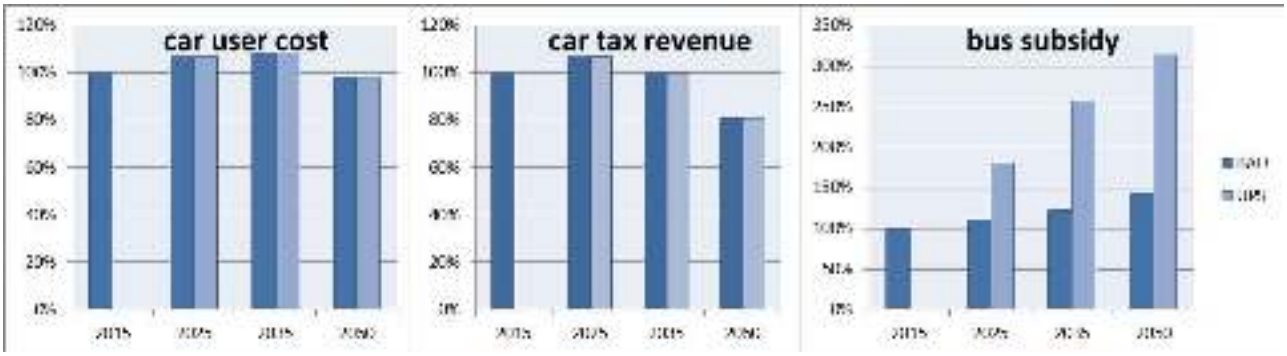
For the assessment of costs, we used 3 indicators:

1. The car user cost: to what extend does the cost to drive a car changes relatively over time in the BAU as well as under influence of the scenario's
2. The government tax revenue from car transport, combing fuel excises, registration taxes as well as any levy's (e.g. cordon charge)
3. The government expenditure on public transport, i.e. bus subsidies

The indicators on tax revenue or subsidy expenditure do not distinguish between different types of government (local, regional, national). With these indicators, we assessed qualitatively the likely costs of measures for citizens, government and society at large. Costs for society were assumed to be the net sum of citizen and government costs. The cost

estimations must be order-of-magnitude estimations only, as the real costs until 2050 will depend on many variables that were not included in the ClairCity modelling. Figure B-13 gives an overview of these order of magnitude costs of the UPS scenario compared to the BAU scenario.

Figure C-9 trends of user cost (left), government tax revenue (mid) and bus subsidy (right) in all scenario's



Car user cost

The car private user cost is expected to increase slightly and then decrease in the BAU. Slovenia is expected to only slowly adopt EV's and fleet turn-over rate is relatively low. As such, it will not benefit immediately from the lower car user cost associated with more fuel-efficient cars (fuel savings offset the higher purchase cost) as well as the uptake of electric vehicles (EVs) that are becoming ever cheaper in the future. The savings of (more) fuel efficient vehicles and EV's only manifests itself from 2035 onwards.

Given that there are no measures that affect the car fleet in the UPS, we observe the same in the UPS compared to BAU.

Car tax revenues

We assume no changes compared to the current situation, so tax revenues follow suit with the user cost. This relates to excise fuel duty and other taxations. The drop in 2050 is due to low-taxed EV's entering the market in large volumes after 2035

Bus subsidies

Bus subsidy follow increasing demand in the BAU. The increase is modest of 10% in 2025, 22% in 2035 and 42% in 2050. However, due to several measures to promote public transport in the UPS, this will lead to higher subsidy levels in the UPS. The massive modal shift in the UPS (mainly by facilitating public transport and reducing the accessibility of car) will lead to huge increase in bus subsidy costs. We estimate that up to a factor 2.5 in 2035, and 3 in 2050, additional subsidy compared to the base year would be needed for public transport to satisfy demand at the lower ticket cost in the UPS. This is likely to be unsustainable from a public spending perspective.