Work Package 2

Executive Summary:

D2.6 'Consideration of different scenarios for each city'

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Deliverable aims and objectives

Deliverable 2.6 (D2.6) is an overview of how the four STEP UP cities have tested their sustainable energy strategies to produce more robust, enhanced SEAPs. This was done via the modelling and investigation of alternative scenarios, and an assessment of the impact of these scenarios on cities' CO_2 emissions reduction targets and planned energy actions.

Whilst historically development trends within cities may have been heavily influenced by external factors, the achievability of targets has not always been formally tested. As a result, ambitious CO_2 emissions reduction targets and the actions designed to meet them may have low resilience against external factors without the cities knowing or understanding the impacts of this. To address this, D2.6 seeks to highlight some of the main challenges in achieving cities' CO_2 reduction targets, through an examination of changes to external factors beyond those planned for in city policy projections and an investigation of how a city's economy, social structures, and infrastructure may change in response to this. A key aim of this endeavour has been to introduce the concept of this type of scenario analysis into the city planning cycle, because for a number of the STEP UP cities it is the first time that this approach has been used.

The scenarios examined in D2.6 are plausible, but unexpected, alternative futures, obtained by extrapolating uncertain and potent driving forces. The scenarios are not visions of desired futures, neither do they set out to accurately predict the likelihood of existing forecasts being realised. The cities have examined how these alternative futures may manifest, and as a result this exercise should assist cities in developing strategies and actions that are flexible and able to withstand inherent unpredictability. Used as part of a vision creation process, scenario analysis can provide a view of how various forces can drive the future in different directions. Therefore, the scenario analysis is a way of developing and testing strategies and policies in a range of possible futures.

City approaches

To design alternative scenarios and analyse their impacts, STEP UP partner cities collaborated with various relevant stakeholders, assisting the partners in justifying the choice of external factors to consider and providing indicators as to how these factors may impact on the city. Impacts were

assessed both on achievability of CO_2 emissions reduction targets and implementation of CO_2 emission reduction measures within the Covenant of Mayors sectors.[1] This included, but was not limited to, those actions analysed within deliverable D2.5, 'Inventory and assessment of energy actions'. Each city sought to project the extent of the impacts of the alternative scenarios examined, in both a qualitative and quantitative way.

The PEST analysis[2] method was used within the STEP UP project for the first time. PEST analysis is a widely-used tool for examining the inter-related aspects of the Political, Economic, Socio-cultural and Technological (PEST) environment within which the city is operating; *inter alia* it gives the opportunity to apply a more holistic approach when evaluating the impact of different factors on various sectors.

Whilst the proposed time horizon for this scenario exercise was 15-20 years (i.e. up to 2030 or 2035), cities were given the freedom to choose a different time horizon if this was more appropriate for their individual city context. For example, if a city had pre-existing targets in place only up until 2020, then a shorter time horizon would be more helpful in terms of determining the projected impact of the scenario on the city's targets. As a result, the four cities did not all use the same time horizon for their analysis (see Table 1 below).

As preparatory work, cities began by stating their baseline scenarios, i.e. what their CO_2 emissions, energy consumption and renewable energy contribution within energy supply (where applicable) would be in the selected time horizon under existing city PEST contexts. Cities were also given the opportunity to state other relevant targets, including those reflecting 'smart city' ambitions (such as reduced transport emissions), or nationwide climate or energy goals within which the city's targets sit. In order to describe the PEST contexts in which these existing visions and targets sit, the assumptions used by the cities within deliverable D2.4, 'Visions and targets for each of the partner cities', were re-considered and applied within the PEST framework.

Once the baseline scenario was understood, each city then developed and analysed two or three alternative scenarios. These scenarios were developed by changing one key PEST factor so that it is

[1] The Covenant of Mayors sectors are municipal, residential and tertiary buildings, equipment and facilities, industry, public lighting, transport, local electricity production, local heat/cold production and others.

[2] PEST framework is described in www.mindtools.com/pages/article/newTMC_09.htm

clearly different to the context of the scenario in which the city expects to meet its visions and targets, and then understanding the impact of this change. A focus on economic and socio-cultural factors was suggested by the Work Package leader because these factors are often outside of the city's control, yet have a high impact on the city and its operations. However, cities were given the freedom to look at other PEST factors that were of particular interest or relevance to them, recognising that these may also be difficult to control at the city level.

It should be noted that, as cities were restricted to analysing two or three potential scenarios, the exclusion of one or more PEST factors in this exercise does not necessarily mean that these factors are not considered to be important drivers for the cities. The cities have simply chosen two or three scenarios that they were keen to explore further, with scope for using the scenario analysis to understand the impact of other drivers at a later stage in city planning.

The broad process followed by the partner cities to investigate alternative scenarios included:

- Scenario content design, based on the PEST approach – agreeing one diverging (critical and uncertain) factor to change;
- Defining the impact of this factor on other PEST factors, in order to develop a picture of how the city will look under this change;
- Qualitative analysis of the scenario's impact on overall city targets;
- Qualitative evaluation of the scenario's impact on the Covenant of Mayors sectors and areas of intervention, and within this either i) the specific measures outlined by each city in STEP UP deliverable D2.5, or ii) more general measures that the city might implement.

The cities also gave a rough estimate of the projected extent of the impact of the alternative scenarios analysed, using a five point scale (--, -, 0, +, ++) to indicate whether that particular scenario would make it more or less challenging to meet the city's targets and implement measures in each of the Covenant of Mayors sectors. The extent of each scenario's impact on planned energy actions within each Covenant of Mayors sector was presented as a radar chart, which clearly shows which sectors each scenario is expected to have a significant positive or negative impact on, and which are more robust to the potential changes.

In all four cities the scenario analysis was supplemented by a quantitative evaluation of CO_2 emissions and/or energy consumption in the alternative scenarios compared to the baseline. As this was an additional step to the main requirements of the deliverable, the cities approached this in their own way using modelling tools developed in each city (see Annex 3.3) in order to gain a more in

depth understanding of what the alternative scenarios might mean for each city's ability to meet its targets and implement its planned CO_2 emissions reduction measures.

Key findings

D2.4 illustrates that all partner cities have policies in place to pursue improved energy efficiency, a greater share of renewables in the energy mix and a reduction of CO_2 emissions, particularly in key contributing sectors. However, whilst all four cities have CO_2 emissions reduction targets, energy efficiency and renewable energy targets are less common, with only Gothenburg and Ghent setting targets for all three elements. There are also a number of other city-specific targets, for example Ghent's 2050 climate neutral ambition, Gothenburg's ambition for all district heating to be produced from renewables, waste incineration or industrial waste heat by 2030, or Gothenburg's target for an 80% reduction in road transport emissions by 2030.

There are a number of similarities in terms of the PEST contexts that the four cities are currently operating in, and within which the cities' targets have been set (the baseline scenario). All four cities are experiencing a stable local political situation and support for climate and energy related policies, which is expected to continue. In most cities, economic growth is expected, and employment with it, though less so in Ghent. Population is expected to increase, and consumption with it (though in Gothenburg a move towards more sustainable lifestyles is projected, which should mean that despite an increased population, per capita consumption falls). Education levels amongst the population are also expected to increase, particularly in Riga and Glasgow, which may help citizens to secure better paid jobs, as well as increase understanding of energy and climate issues. In terms of technology, the cities are projecting technological advances and growth of the ICT sector as central to the PEST contexts within which the current visions and targets are expected to be met.

Overall, the partner cities developed, and analysed the impact of, 10 alternative scenarios (Ghent = 3, Gothenburg = 2, Glasgow = 2, Riga = 3; see Table 1 below). The table shows that each city chose a different number, and type of, PEST factor(s) to consider. However, whilst each scenario differed in the detail and projected impacts, there are similar underlying premises across the cities' chosen scenarios that could impact on sustainability and a city's ability to move to a low carbon society. The common drivers that have been considered in multiple cities are:

- Significant changes in the city's population;
- The impact of changes in the fossil fuel price;
- Significant slowdown/stagnation of the city's economic growth;
- Increased fuel poverty resulting from socio-economic changes;

- The importance of national, EU and international climate policies as a means of ensuring positive continuous pressure to execute CO_2 emissions reduction measures; and
- Behaviour change.

As can be seen in Table 1, meeting the CO_2 emissions reduction target is considered more challenging in 7 out of the 10 alternative scenarios developed by the cities. In 4 of these 7 scenarios, the cities considered that it would still be possible to meet emissions reduction targets, but that it would be more difficult to do so.

Table 1. Summary of the cities' alternative scenario analyses

Alternative scenario	**Time horizon**	**Main PEST factor chosen for building the alternative scenario**	**Impact on the city's ability to meet its CO_2 target** [3]	**Is it still possible to meet the city's CO_2 target?**
Ghent				
Scenario 1: 'Growth in fuel poverty'	2020	**Economic**: Levels of disposable income and income distribution	more challenging '- - '[4]	Yes, efforts in the business and energy production sectors could compensate the negative impact upon the residential sector.
Scenario 2: 'Slowed adoption of innovation'	2020	**Technological**: Uptake of emerging technologies	more challenging '- '	Yes, the increased uptake of Best Available Techniques (BATs) and innovation will be necessary to meet the set target.
Scenario 3: 'High efficiency gains but with social cost'	2020	**Economic**: Unemployment and labour supply	more challenging '- '	Yes, although this scenario is a social catastrophe as it polarises society further, it can safeguard the reduction targets. However, this depends on the % of measures that are still taken up by local companies.
Glasgow				

[3] The impact scale used for this analysis (as set out in Table 7) is as follows:

--	it is **much harder** to achieve the actions than in the baseline scenario
-	it is **harder** to achieve the actions than in the baseline scenario
0	actions in the specific sector are achieved with the **same grade of difficulty as in the baseline scenario**
+	it is **easier** to achieve the actions than in the baseline scenario
++	it is **much easier** to achieve the actions than in the baseline scenario

[4] NB. This is an assessment of the city's CO_2 emissions reductions target and energy consumption target.

Scenario 1: 'Major Boost'	2020	**Socio-cultural**: Population demographics and change (population increase)	more challenging '- '	Yes, it is likely that more funding would be available, there would be stronger economic, social and environmental justification for energy and carbon saving measures, and there would be more support for these measures from stakeholders across the city.
Scenario 2: 'London Calling'	2020	**Socio-cultural**: Population demographics and change (population decrease)	less challenging '+ '	Yes, despite high impacts of de-population and reduced availability of finance for measures, ability to achieve targets is eased as lower number of inhabitants lowers volume of emissions generally.
Gothenburg				
Scenario 1: 'Public indifference'	2030	**Political**: Tax policy, and trade and tariff controls	more challenging '- '	No, lower general climate ambitions have led to weaker climate and energy policy. Emissions are significantly higher than the baseline scenario, but lower than today.
Scenario 2: 'Negative spiral of adverse influences'	2030	**Political**: Tax policy, and trade and tariff controls	more challenging '- -'	No, climate and energy policy development in Sweden and the EU has failed. Climate ambitions in society (nationally and internationally), both politically and socio-culturally, are much lower than expected. Emissions are significantly higher than the baseline scenario and today.
Riga				
Scenario 1: 'Population increase'	2030	**Socio-cultural**: Population demographics and change (population increase)	more challenging '- '	No, only the execution of extensive additional energy efficiency measures in the residential sector and renewable energy deployment in the tertiary and municipal sectors may ensure the CO_2 reduction targets are still met.
Scenario 2: 'Fossil fuel price rise'	2030	**Economic**: Levels of disposable income and income distribution	less challenging '+'	Yes, short-term rapid price rise of fossil fuels would make the government prioritise support for renewable energy and energy efficiency measures and also lead to a change in consumption behaviour.

Scenario 3: 'Slowed economic growth'	2030	**Economic**: Current and projected economic growth, inflation and interest rates	less challenging '+ '	Yes, although climate and energy efficiency measures will be less economically and politically attractive, economic stagnation would depress supply and demand, limiting the volume of emissions.

As can be seen in the table above, in all three of Ghent's alternative scenarios, the meeting of the CO_2 emissions reduction target is projected to be possible. This may in part be due to the City of Ghent's particular approach to the building of their SEAP; by developing a wide set of measures in several sectors, including measures focused on increasing the city's resilience in the face of different potential scenarios, the city has increased its ability to counteract the negative impact of external factors. By considering the relatively short time horizon of 2020 in the scenario analysis, this external impact may be easier to project than it would be over the longer term.

Two of Riga's alternative scenarios ('Fossil fuel price rise' and 'Slowed economic growth') and one of Glasgow's alternative scenarios ('London Calling') forecast that CO_2 emissions reduction will be less challenging due to the direct impact of these scenarios on energy demand. However, they all have a negative outlook for the long-term implementation of CO_2 emissions reduction measures; ultimately it is likely that in these scenarios climate policy implementation becomes a lower priority and the cities may face difficulties in securing financial resources for the implementation of measures to reduce CO_2 emissions.

Riga and Glasgow's first scenarios, both relating to population growth, have similar impacts in terms of making it more challenging for the cities to meet their CO_2 emissions reduction targets. However, whereas Glasgow expects that the city's targets can still be meet, Riga projects that in their population growth scenario it would not be possibly to meet the city's target without the implementation of additional mitigation measures that would counteract the additional CO_2 emissions in this scenario. However, it is worth noting the different time horizons used by the two cities – in Glasgow the focus is on 2020, and under this time horizon Riga does still expect to be able to meet its targets in this scenario. It is only when considering the longer timeframe of 2030 that Riga's target becomes impossible to meet with the existing set of measures.

In both Gothenburg's alternative scenarios, the city does not expect it to be possible to meet its targets in 2030. In scenario 1 ('Public indifference') there are lower general climate ambitions which have led to weaker climate and energy policy. As a result, emissions are expected to be significantly higher than the baseline scenario, but lower than today. In scenario 2 ('Negative spiral of adverse

influences'), where climate and energy policy has failed and climate ambitions are much lower than expected, emissions are significantly higher than the baseline scenario and today.

Besides meeting the CO_2 emissions reduction targets, all the cities have visions focussing on equity. The alternative scenarios also considered factors that may cause a decrease in equality, and the potential impact of this decrease on the city's overall strategic development; specifically on energy consumption and CO_2 emissions reduction. The analysis provides a useful insight into how to safeguard the meeting of CO_2 emissions reduction targets, in addition to upholding the Europe 2020 strategy goals, in relation to employment, R&D, education, fuel poverty and social exclusion.

Challenges and learning points

Overall the cities have found that the method adopted in D2.6 was useful for assessing the potential qualitative, and in some cases quantitative, impact of unplanned external factors upon the execution of CO_2 emissions reduction measures. This has helped the cities to evaluate the robustness of their SEAPs, and this in turn may help them to identify mitigating measures that could be adopted in order to increase the resilience of their SEAPs. The PEST analysis approach, used for the first time within the STEP UP project in D2.6, has also been recognised as a useful way to identify and analyse critical factors that affect a city and the way it operates.

Each city identified a number of learning points from this exercise, which should be considered by STEP UP cities and other cities when they come to develop and revise CO_2 emissions reduction targets and measures in the future.

These are set out in detail in the conclusions, and relate to the following aspects:

- **The scenario analysis approach**, including the selection of factors to consider and the difficulty of making comparisons between cities;
- **The timing of the deliverable**, including how scenario analysis fits into the SEAP development process;
- **The power and influence of a city authority**, including recognising where a city does or does not have control and acting accordingly;
- **Monitoring current and potential socio-economic changes**, to identify trends that may impact on SEAP targets and respond appropriately;
- **Surprising results**, and the value of developing an in-depth understanding of a scenario in order to develop a more comprehensive picture of the threats, challenges and opportunities it presents; and

- **Data availability and the challenge of quantitative analysis**, for example where research on existing trends is lacking and assumptions are difficult to justify, and the need for quantitative modelling tools to address this.

Key recommendations

A number of key recommendations have been identified as a result of this analysis, which would benefit the STEP UP cities as well as other cities developing and analysing the robustness of their SEAPs. These are:

- **Increase the SEAP's robustness through scenario analysis:** If a SEAP is more aspirational than achievable, then it is unlikely to have the desired impact. Therefore, cities should propose realistic targets and measures, then evaluate their robustness before they are finalised, using a scenario analysis approach. Considering the constancy of measures against potential changes in the city's context can supplement common assessment criteria for CO_2 emissions reduction measures, such as impacts and costs. Conducting some kind of scenario analysis may be beneficial prior, or in parallel, to the development of each iteration of a SEAP, and would be best co-ordinated by the body responsible for SEAP implementation in the city to ensure that the findings are taken on board. As a result of this exercise, it may be necessary to adapt the proposed SEAP measures to design an improved solution given the challenges and opportunities identified in the analysis.
- **Create a European-wide library of scenarios**: In order to inspire cities to conduct scenario analyses, and assist them with the approach, a library of scenarios could be established, managed by an independent reputable body such as the Covenant of Mayors. This would enable cities to review scenarios created by other cities, the changing factors within them, their impacts and proposed mitigation measures when targets are at risk, and to build the learnings from these into their own scenario analysis. Cities could also add their own scenarios to the library, to share their own experiences and findings. This is a practical approach because it would provide an easy-to-adopt framework, help to build familiarity with the scenario analysis exercise, and would facilitate knowledge exchange between cities. Within this, cities should also look to see if there are existing national level scenarios within their country that might be applicable at, or adaptable to, the city level, to be built into a city's scenario analysis.
- **Develop a 'blueprint' of potential mitigating solutions that could be deployed for particular scenarios:** This could form part of the scenarios library suggested above. For example, where population increase/decrease changes are considered by multiple cities, it

may be possible for common solutions to be examined, especially where the considered causes and impacts of these changes are similar. These solutions could act as contingency measures in cases where the impact of unknown external factors means that a city's target could no longer be met, or would be much more difficult to meet, using the original SEAP actions. These would need to filter through to other city strategies and policies, ensuring robustness across key sectors.

- **Conduct quantitative analysis where possible:** In-depth scenario analysis should be carried out with specific contextual changes and their impacts quantified where possible to develop deeper understanding. This could help increase understanding of scenarios and their impacts, and potentially help avoid 'surprising' results.
- **Visualise scenario impacts using a mapping tool such as GIS:** This could help cities to understand better how the impacts of a particular scenario are likely to be felt across the city, and therefore target mitigation measures to particular geographical areas. For example, a scenario which has a significant impact on residential buildings is likely to have an impact on areas surrounding a city centre, and less so on the city centre itself, as this is where the majority of houses and apartments tend to be found.
- **Link to wider city, national and international strategies and policies:** Constructing alternative scenarios in-line with wider city strategic documents should help to gather relevant data and ensure the analysis is useful for city decision-makers. Feedback should also be provided to national and international objectives, such as suggested modifications to national climate policy, to ensure that these policies are also robust to potential socio-economic changes on the local, national and international scale. In addition, mitigation measures should be developed with a focus on the smart city concept, ensuring that they take an integrated approach with wider cross-sector benefits.
- **Implement monitoring as standard:** A clear plan should be set in all cities for how to monitor, acquire and analyse data for the well-timed identification and further assessment of the impact of external factors, as well as the development of approaches to address them. Key Performance Indicators (KPIs) could be tied to specific scenario settings, allowing cities to pursue key lines of enquiry and better identify which stakeholders are important to engage with for access to data, and which are central to addressing potential scenarios.
- **Involve and engage a wide range of stakeholders in defining and developing alternative scenarios:** This should be built in to the scenario analysis process, and may be of particular value in the process of gathering and interpreting data as it may offer mutual benefits for the city and other stakeholders. For example, improved information exchange on city

planning may assist an energy provider in long-term energy security decision-making, as opposed to working solely with short-term planning approvals.

- **Align scenario time horizons with national or European CO_2 emissions reduction targets:** Longer time horizons up to 2030 may be better aligned with other European cities, making it easier for them to learn from the outcomes of the STEP UP project and produce comparable results. In the longer-term the view may be aligned with the EU roadmap for moving to a competitive low-carbon economy by 2050.

Going forward, this analysis supports cities in the on-going process of enhanced SEAP development (deliverable D2.7) by indicating potential issues and helping cities understand how the resilience of their SEAPs can be augmented. It also supports the selection of pipeline projects for further development, which is being carried out in Work Package 3. The approaches taken by the partner cities to analyse scenarios will also be used in Work Packages 4 and 5, to share learning and experiences from STEP UP with the wider learning network, and potentially for those cities who are interested to use the approaches documented here for their own scenario analyses.