2050 CliMobCity: demonstrations summary

Approach to estimate effects of policies to reduce CO_2e emissions

The first step in the approach was to have the cities choose a planning period, clarify the CO_2e reduction aims for that period, and define measure packages and policies that expectantly reduce the CO_2e emissions from mobility in magnitudes responding to the aims. The cities opted for different aims and planning periods, varying from specific reduction levels in 2030 to climate-neutrality in 2050. The envisaged measures were ones in the field of transport/mobility, technology and land use.

In a series of follow-up steps, the effects of these measure packages/policies were estimated.

First, how will the mobility change in the future, also taking account of demographical, economic and social backgrounds and current strategic measure packages/policies, as documented in municipal planning and other documents? These reference futures are the '***Business as usual' (BAU) scenarios***.

The proposed measure packages were – combined with the BAU background developments – included in alternative scenarios, dubbed as ***CliMobCity scenarios***.

The cities then predicted the future mobility of persons, goods and vehicles by applying their transport and mobility models – in the BAU as well as in the CliMobCity scenarios. The prediction was once in the while accompanied by additional analysis efforts.
Then, for all these scenarios the impacts of the mobility changes for future CO_2e emissions were estimated. The project also reflected on whether there are indications that the future mobility leads to traffic flow problems or can't be absorbed in spatial terms.

The output of the predictions is described along a set of ***mobility indicators***. Some of them focus on central mobility changes that need to be present in order to reduce CO_2e emissions of mobility, like reducing the average distance of trips, or shifting to more sustainable modes. Other indicators are transport times, spatial distribution of trips, and traffic volumes. By comparing these indicators for the various scenarios, mobility developments could be described.

The ultimate indicator for the carbon footprint of the mobility is the change of fossil fuel vehicle-kms per mode and type of infrastructure. Therefore, not only the change of mobility needs to be known, but also of the types of propulsion systems used in the vehicle fleet, and the expected over time developments therein. One important aspect is the proliferation of non-fossil fuel vehicles within the fleet ('penetration rate'), including the share of electric vehicles. The estimations on these developments vary widely, different (country tuned) ***powertrain scenarios*** are applied.

This all relates to another important aspect which is the way electric energy – to be used in electrified cars, busses, vans, trams, metros, trains and small electric vehicle – is generated. This can be done from renewable or 'green' sources (such as water, wind and solar power), from fossil fuels (coal, gas, oil) or from other sources (including nuclear energy). The shares of these energy sources are represented in the '***energy mix***', which differs from country to country and for which expectations on future developments vary widely. Therefore, two ***energy mix scenarios*** have been adopted from literature and applied.

By combining the results of the mobility model analysis for the BAU and CliMobCity scenarios with the powertrain and energy mix scenarios, sets of estimations of future CO_2e emissions could be calculated.

The project is fully aware of the complexity of the approach and the multitude of results. Still, the overviews give profound insight in the contribution of different measures and different assumptions on the estimated CO_2emission reduction. Combined, the results also clearly show the (significant) bandwidth between the higher and lower estimations, giving a well-elaborated explanation for the uncertainties involved.

As can be seen below, the estimated overall emission reductions do not match - by a smaller or wider margin – with the targets set by the municipalities.
Therefore, some additional analysis has been conducted.
Specifically for Bydgoscz some explorative measures in the fields of land use planning and car-free zones have been analysed in the so-called '***plus scenarios***'. For all cities also a further analysis of potential but still realistic emission reduction approaches has been done. Referring to the terminology in the applied emission calculation model, this is referred to as the '***lever analysis***'.

CO_2e emission estimations

Following the above described approach, below the intermediate and overall results of the CO_2e emission estimations will be discussed in generic terms.

With respect to the socio-economic development it is very relevant to notice that in Plymouth, Leipzig and Thessaloniki a population growth of between approx. 2-13% is expected – in itself increasing the number of trips, travel distance and most likely also CO_2e emissions. Next to that, exogenous developments (related to economic development and or example car ownership) are also expected to result in more car trips and more car kilometres driven (Plymouth +22% between 2015-2034), even if the population size itself does not grow (Bydgoszcz, with an expected increase in car kilometres of about 30-40% between 2021 and 2050).
Trying to reduce CO_2e emissions can in that sense be seen as a kind of an uphill battle.

On the other side, notably Thessaloniki but Leipzig as well, have already approved or even implemented significant measures to achieve modal shift, already included in their Business as Usual scenarios. In Thessaloniki the inauguration of the metro system and other measures let car trips decline by 14%. Of all trips in the metropolitan areas with at least one end of the trip in the municipality the share of public transport is expected to pass the share of car mobility, reaching a level of almost 40%. Also in Leipzig the increase of public transport share is substantial and also accompanied by a significant growth of the bicycle share, while car shares decline in corresponding amounts.

In the CliMobCity scenarios almost generally a decline of car trips can be expected as compared to the base year, also in Plymouth and Bydgoszcz. The decline of car vehicle-kms is typically smaller than of car trips, due to modal shift taking place more in the central areas of the city or some rebound effects emerging.
Freight transport vehicle-kms, certainly of HGVs in Bydgoszcz, Plymouth and Thessaloniki, show large growth rates, also in the CliMobCity scenarios.

Bydgoszcz has explored the impacts of another line of development, namely the relocation of one third of the population of a large peripheral area to more central city parts in combination with a frequency increase and other quality improvement of public transport in the central area. Along most indicators for climate-friendly mobility this CliMobCity scenario scored more positive than an alternative CliMobCity scenario, in which the spatial pattern is hardly changed, while the public transport is more expanded. An important difference between both scenarios is also that in the first one road capacity is reduced, due to which there are less rebound effects following modal shift from road to other modes. Finding an affective combination of push and pull measures appears to be very important.

The subsequent emission calculations show a broad range in results, related to the differences in mobility changes as well as to the differences in country-specific technology and energy mixes. The range runs from about +10% to -20% in comparison to the base year, taking into account the changes of types of vehicle propulsion and energy mix for electricity production in the base and prediction year. If energy provision becomes green the reduction rates rise to about -20% to -30%. Additional measures let the reduction rates move up.

This result must be relativized by a few, however important remarks. One is that (inter)national fiscal measures encouraging modal shift or the shift to post-fossil fuel vehicles or other innovation have not or only indirectly (via municipal measures) been addressed. Another remark is that the mobility effects of certain types of measures which currently stand in the centre of many strategic municipal plans, have – due to lack of research and empirical results – not been quantified, although they are expected to deliver more sustainable mobility; measures like the implementation of mobility hubs, development of micro-mobility and market penetration of shared vehicle services.

Furthermore trucks and vans have less vehicle-kms than cars, but have a relatively large share in CO_2e emissions. The partner cities, as far as they address freight transport, have already concluded that innovative concepts in this field should be the object of further explorations.

Last but not least, the change of mobility perceptions of people and organisations on the long term, being the result of changing understanding of new urgent matters, like climate change, is hardly incorporated in the project's work. Lifestyles can't remain the same in the climate-friendly future, but the transport models assume the lifestyle per demographic and social segment of the population to be constant; not because of lack of willingness, but because of missing knowledge. Bydgoszcz has – in a sensitivity-like approach – changed some parameters to simulate changing mobility preferences. Although such approach is still to be validated by future research, it certainly is relevant for long-term transitions like that to climate-friendly mobility.

Nevertheless, the project gives reason to reflect on more and other types of measures, perhaps more effective combinations of push and pull and behavioural and technological measures, all directed towards the question how can fossil fuel (road) vehicle-kms significantly be reduced and – in favour of the accessibility of compact city which has shorter average distances and therefor consumes less energy and emits less CO_2e – how can the share of active travel and public transport and of multimodal chains with much active travel and public transport be increased. And also in all cases, the order of magnitude of the analysed reduction shows the enormous relevance of national and even European and international policies and measures for climate-mitigation on the regional or municipal level.