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One Planet Mobility – Transforming Cities towards low-carbon mobility



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1. Introduction

Climate change is the emblem of the global sustainability challenge. Only a global effort will prevent a dangerous scale of anthropogenic climate change, which is likely to increasingly compromise the livelihood of the vulnerable poor, and to cause distress for inhabitants of richer countries. Inhabitants of rich cities are the prime culprits of GHG emissions, but are also vulnerable to extreme climate events. At the same time, cities are a major policy and action arena, where the transition towards a low-carbon life-style can be first realized. Technological options will not suffice, but the way of life needs to change, reducing the carbon footprint while improving or maintaining a high quality of life.

European cities have emulated the American model of the automobile city, dampened by dense historical structure, but are still confronted with stark sustainability challenges. The automobile society is characterized by an unseen degree of mobile flexibility, but also with a distinct pattern of urban sprawl, air pollution, noise and social exclusion. And while the efficiency regulation of the European Union is ambitious, more efficient cars and electric cars alone will not be enough to rapidly reduce greenhouse gas emissions.

On the flipside of this, city governments are increasingly committed to becoming leaders in sustainability. This is to large extent because tackling the biggest environmental challenges of our times – like climate change – offer cities unique opportunities to simultaneously tackle some of the fundamental root problems that negatively affect or threaten to affect so many aspects of urban life.

Transport can have negative impact on local economies in many ways: through rising oil prices, growing obesity, high levels of noise and accidents, growing stress and poor community relationships as a consequence of car- but not people-friendly urban spaces. Turning these problems into opportunities and creating urban spaces that increase quality of life for people, with low noise, accident and stress levels and thriving community relationships can go hand in hand with finding transformative solutions for some of biggest global threats of our times like climate change and the loss of biodiversity.

Cities offer huge opportunities to achieve policy changes and changes in life styles that ultimately can achieve a large reduction in environmental impact. Local governments in most countries have huge powers over the way cities are developed, over policies on urban planning, land use, and transport infrastructures. It is also a context where the various actors that can achieve change – policy makers, business and people on the ground – are most likely to know each other personally, which increases opportunities for meaningful collaboration and innovation. If on the national and global level, policy makers are likely to be personally detached from the changes they decide and the effect it has on ordinary people, this is less likely to happen in the city context. Citizen participation and engaged municipal governance

has the potential to realize a low-carbon way of living that is adapted to the local qualities.

A range of initiatives exists to reduce the environmental impact of urban transport. Including a range of best practice and benchmarking processes. However, the UNFCC, NGOs and scientific bodies such as IPCC have reported that there is a lack of comprehensive data on the links between climate change and transport, as well as a paucity of local or regional action to establish long-term strategies that are ecologically sustainable and develop scenarios on how to best achieve these targets. Here, we want to contribute to closing this gap by exploring low-carbon transport scenarious for European cities.

2. Objectives of the One Planet Mobility European Cities project

When exploring opportunities to make a significant impact towards systemic change in the transport field, WWF came to the conclusion that it was the right moment to build strong partnerships for change in cities to catalyze transformative solutions for sustainable transport that benefit people, the environment and local economies.

This project therefore brought together a small number of European cities (Barcelona, Malmö, Freiburg and Sofia) that showed commitment to lead the way towards a new mobility paradigm that is compatible with global environmental limits and with the expectation of a high quality of life for its citizens.

Research Phase: The first aim of the project was therefore to uniquely link local transport policy with the global environmental limits (with a focus on carbon emissions as the most important environmental impact from transport) and develop scenarios and comprehenive strategies for sustainable urban transport.

Implementation Phase: The second aim was to build groups of core stakeholders (change agents from local government, business and civil society) in each city who would start exploring how the scenarios can be put into practice and start developing projects for change.

This report is the final report about the research phase focussed on the exploration of possible transitions towards low-carbon and sustainable mobility in European cities. Because this endeavour concerns all inhabitants of the cities alike, and because the endeavour can become reality only by the cities' stakeholders, a strong participatory approach constitutes the basis of all scenarios.

A small group of ambitious pioneer cities worked together with the OPM Cities project team from the TU Berlin – Rainer Mühlhoff, Felix Creutzig and Julia Römer – complemented by Michael Narberhaus from WWF UK, to put forward an integrated stakeholder process to design sustainable urban transport strategies and motivate their implementation. These cities were Barcelona, Malmö, Freiburg and Sofia.

The process had four distinct stages: 1) Stakeholder self-assessment on transport-related challenges and existing policies; 2) Stakeholder meetings and interviews in

cities evaluating the current situation and the existing set of policies; 3) quantitative evaluation of key sustainability dimensions and construction of low-carbon and sustainability scenarios of increasing ambition; and 4) a stakeholder workshop to communicate the quantitative scenarios and integrate stakeholder feedback into these scenarios. This process is summarized in Figure 1.

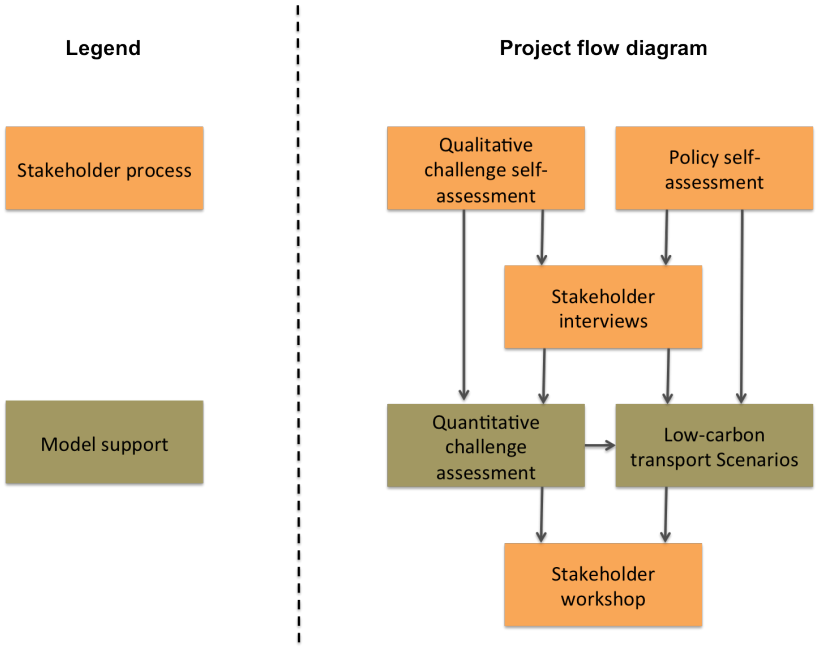


Figure 1: Overview of the project.

3. Methodology

A significant change towards sustainable mobility can only be achieved by a smart combination of a wide range of policies, but not by stand-alone measures. Careful considerations in the design of policy combinations are rewarding: the effect of a combination of different policies is generally not the sum of the effects of each single policy. Policies might be mutually amplifying or mutually diminishing. To assess such effects for all four cities, we composed a set of four different scenarios, i.e. bundles of transport related measures over the next 40 years. By using a computer based scenario simulation engine, we calculated the response of transport users to these policy packages.

The computer model consists of three modules, calculating the temporal development in the following output dimensions: a) modalshare; b) co-benefits; and c) CO_2 emissions. All measures proposed on urban transportation are not only evaluated with respect to their impact on functionality or CO_2 emission savings but also with respect to their side effects on urban quality of life. It turns out that most measures leading towards globally sustainable mobility have also positive effects on local environmental quality. We call these effects co-benefits (Creutzig und He, 2009, Zusman et al., 2011), and in this work, we investigate all measures with respect to the following five co-benefit dimensions:

1. Air quality, which is considerably impaired by combustion engine emissions of air pollutants and leads to asthmatic conditions, lung cancer and premature death;
2. Traffic noise, which leads to stress mediated health impacts;
3. Traffic congestion, which results in time losses on a daily basis and is thus an indirect economic factor;
4. Transport related accidents and fatalities;
5. The city's annual fuel spending as an indicator for the local economy's dependence on the non-local resource of fossil fuels and as an amount of capital annually lost by the local economy.

The transition towards a functioning and sustainable mobility system is a complex task and thus requires a combination of different kinds of policies in a continuous fashion during a period of several decades. Such measures can roughly be divided into four categories (Mühlhoff and Creutzig, 2011):

- Technological improvements and advances towards higher energy efficiency of vehicles. Such improvements can be controlled via emissions or energy consumption regulations, as controlled by the European Union (e.g. EC, 2009; Creutzig et al., 2011).
- Pull measures, making the use of public or non-motorized transport (cycling, walking) more attractive. Specific measures are: Increasing the density, speed and comfort of the public transit network; reducing fares; extension of bicycle lanes, bicycle parking stands, and reduction of barriers to pedestrians and cyclists.
- Push measures, rendering the use of the private car or motorizes vehicle less attractive. The spectrum of push measures reaches from reduction of street capacity (in favour of separate lanes for buses or bicycles) or speed limitation to 30km/h, to a progressive prizing of parking facilities or introduction of road charges.
- Land use policies, decreasing the demand of driven kilometers by controlling the urban topology and utilization of urban space. Densification and mixed use policies aim at distributing places for living, working, shopping and leisure in a homogeneous fashion such that the city becomes largely self-contained in its facilities already on a district level, and the need to travel long distances is reduced (Banister, 2008).

The four future transport scenarios set up and simulated for all four cities combine all four kinds of measures. The model's simulation of market-based policies relies on so-called demand elasticities, values that were transferred from the scientific literature and adapted to the city's concrete traffic situation. The impact of these policy combinations is assessed with respect to the five mentioned co-benefit dimensions.

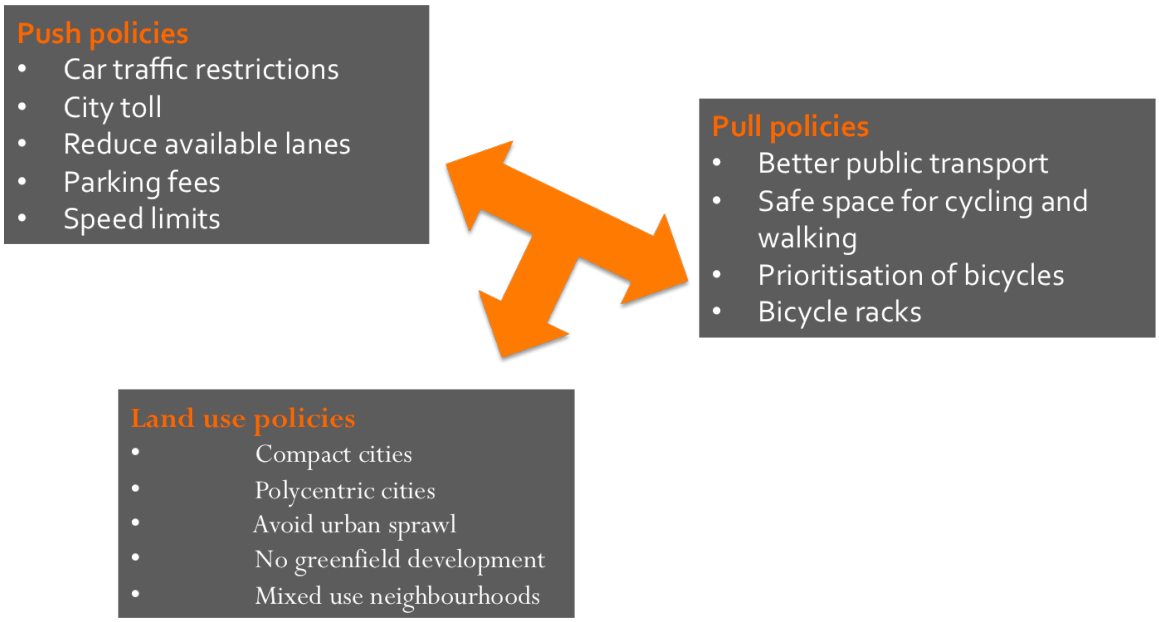


Figure 2. Policy packages belong to three distinct classes of policies: pull, push, and land-use. Communication and stakeholder involvement is an additional metadimension, enabling the implementation of proposed policies, and allowing for modifications based on stakeholder experience.

4. The Cities

Mitigating global warming is a hard and – from the local city perspective – indirect goal, but a close consideration reveals: with respect to transport it is largely concurrent with immediate local incentives related to urban quality of life and the city's economic prosperity. Thus, participating in a joint effort on all levels (city, state, nation, EU, world) to reach at least an 80% reduction of CO_2 emissions in the transport sector is highly beneficial for cities themselves.

4.1. Barcelona

Barcelona is a city in Spain restricted by Mediterranean and mountains with a compact urban core. The transport sector of Barcelona is responsible for a fourth of the city's energy consumption and GHG emissions. While the modal share differs between the districts, the inner city travel has a high share of non-motorized slow modes of about 51,5%, followed by public transport with a 33% share. Private motorized vehicles have a relatively low share of about 16%. On the other side there is a relevant commuting from Barcelona region with a 50% car share. In fact, relatively low fuel prices and a real estate boom have caused rapid urban sprawl in the last two decades. In addition more than 50% of the cars driving through the city are diesel vehicles. These cars are most responsible for high NO_X-emissions in Barcelona, which is a huge problem in terms of air pollution as a whole. The noise problematic differs between the districts but is also a serious issue for the city (Torrent & Pol, 2011).

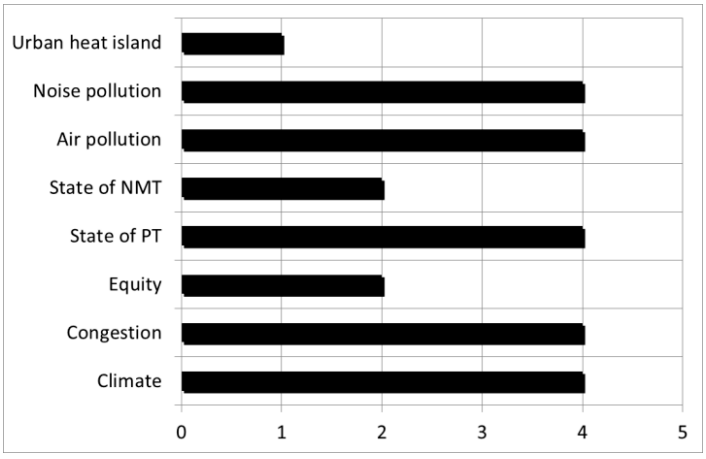


Figure 3: Problem self-assessment for Barcelona. Noise and air pollution as well as congestion, climate and the state of public transit are the most serious issues for the city.

Results

For Barcelona, we simulated the following four scenarios of increasing ambition (Figure 4).

Scenario 1: Business as usual / technological transformations only	Implementation:
• 35% population increase • reordering of bus system	• PT speed, network density +5%
Scenario 2: + Pull measures	Implementation:
• PT: Rapid, high frequency bus and tram network, priority lanes • PT: Construction of L10 • PT: Extension of regional rail based PT (focusing on work commuters) • NMT: dense system of dedicated bicycle lanes	• PT speed, network density, service quality +5% • NMT density of bicycle lanes +50% • Road capacity: -10%
Scenario 3: + Push measures	Implementation:
• Traffic calming (30km/h) and pedestrian/bicycle-only streets in areas with high street density (such as l'Eixample); → wide-street version of Distrito di Gracia • Enforcement of traffic calming measures (motorbikes) • Rise in parking charges and reduction of parking space	• Streets with speed limit 30km/h: 30% • Parking charges +100% • Road capacity -10%
Scenario 4: + Land use measures	Implementation:
• Densification in the suburb areas. Develop city from inside. Settlements only in areas connected by PT • Mixed usage: support transition to suburban centers and polycentric topology • Congestion charge (dynamic road pricing)	• Population density: +35% • Congestion charge: 40%

Figure 4: Scenario Plan of Barcelona

Modal Share development

The simulated temporal development of modal share (Figure 5) displays that only a combined implementation of pull measures (such as considerably improved conditions for the slow modes) and push measures (restricting car use) will induce a significant change in peoples' choice of traffic mode. In particular, implementing improvements on public transport service quality and the slow modes as in scenario 2 alone is insufficient to induce a significant reduction of car usage. A noticeable change in car modal share can only be observed for those scenarios encompassing push and land use measures, i.e. scenarios 3 and 4.

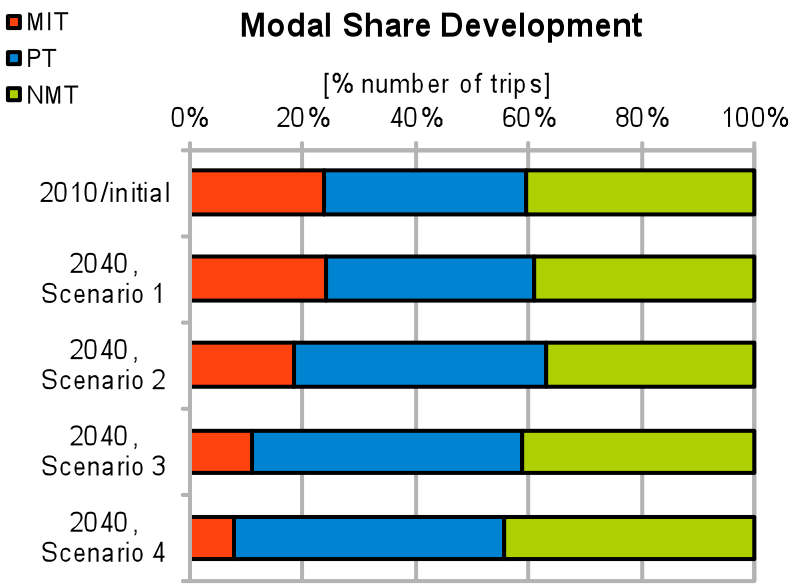


Figure 5: Simulated modal share development in Barcelona

Transport CO_2 emissions

Figure 6 displays the simulated temporal development of transport CO_2 emissions. Technological improvements resulting in CO_2 efficiency increase of combustion engines as prescribed by the EU regulations (scenario 1) are a core ingredient towards decarbonization transport, but they are – by far – not sufficient. The effects of pull measures alone (scenario 2) are merely marginal. However, both push measures and land use policies (scenarios 3 and 4) hold a significant potential to reduce CO_2 emissions, if they are combined with pull measures.

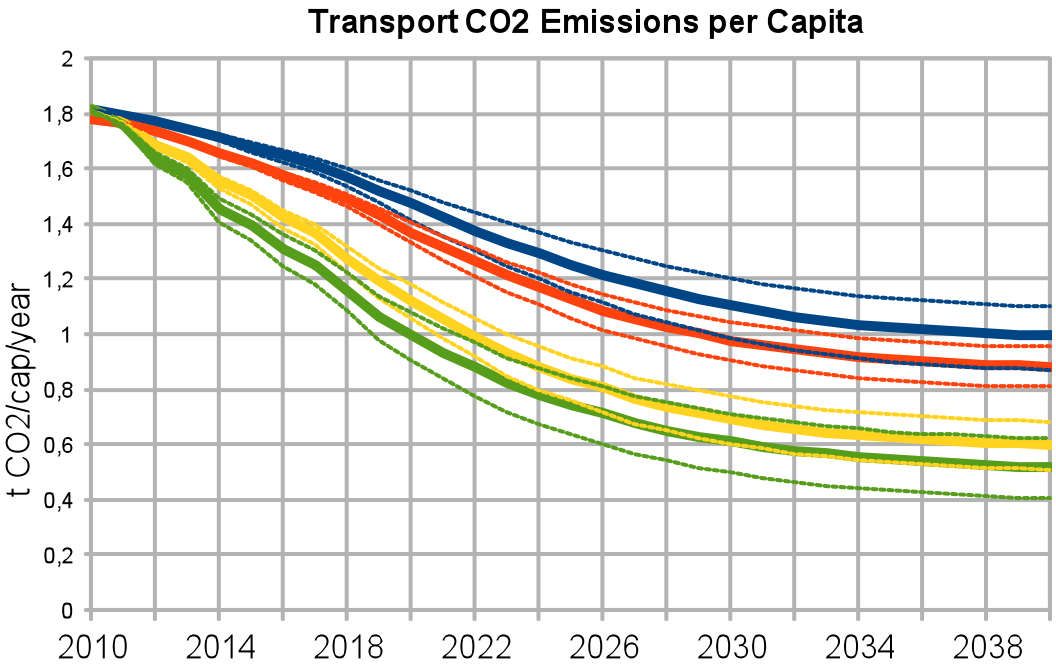


Figure 6: Simulated transport CO2 emissions per capita of Barcelona

As can be seen by comparing to the modal share diagram above, the effect of push measures is through a modal shift while the effect of land use policies is additionally based on decreasing average trip length. Moreover, land use policies take effect in the long run while push measures are more immediate.

Co-benefit analysis

Figure 7 and Figure 8 display the improvements in five co-benefit dimensions until 2040 with respect to the reference year 2010: The number of annual transport accidents, air quality impairment by particulate matter and other pollutants resulting from combustion, and the background noise level caused by traffic are immediate health issues and thus related to urban quality of life. Traffic congestion results in time losses on a daily basis and is thus of indirect economic relevance, as is the city's dependence on fossil fuels, measured here in terms of annual fuel spending – which is capital getting lost for the city or municipal economy.

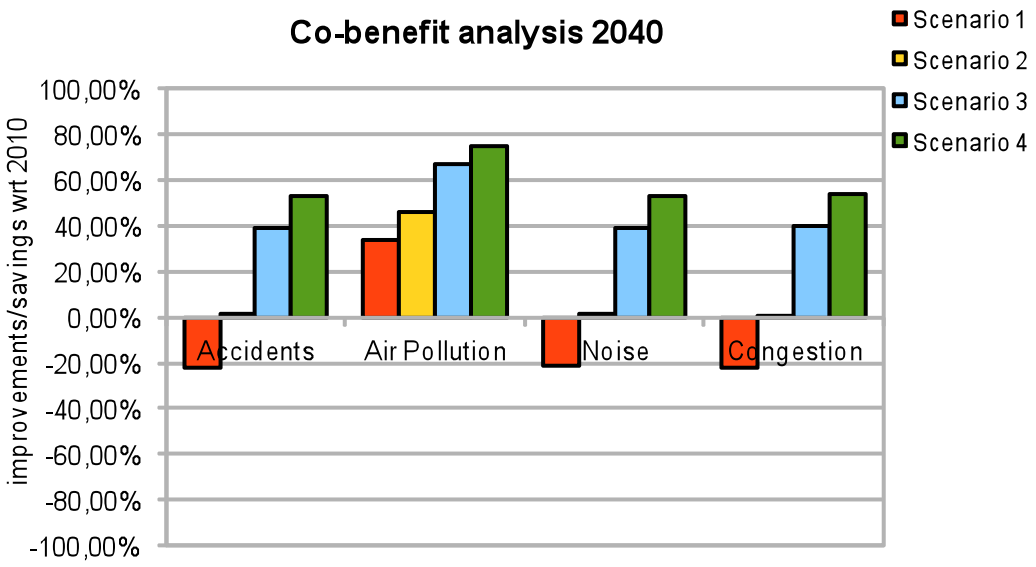


Figure 7: Barcelona co-benefit analysis 2040

Figure 7 and Figure 8 show that scenarios 1 and 2 (EU emissions policies and pull measures) prove largely ineffective in terms of transport accidents and fatalities, noise impairment, congestion level and the city's dependence on fossil fuels. This is because in those dimensions, a significant change can only be effected in reducing the amount of car transportation, i.e. the modal share of motorized individual transport. Push measures and land use policies are inevitable to this end. These policies affect peoples' traffic behavior in substituting car usage by alternative, more sustainable forms of mobility.

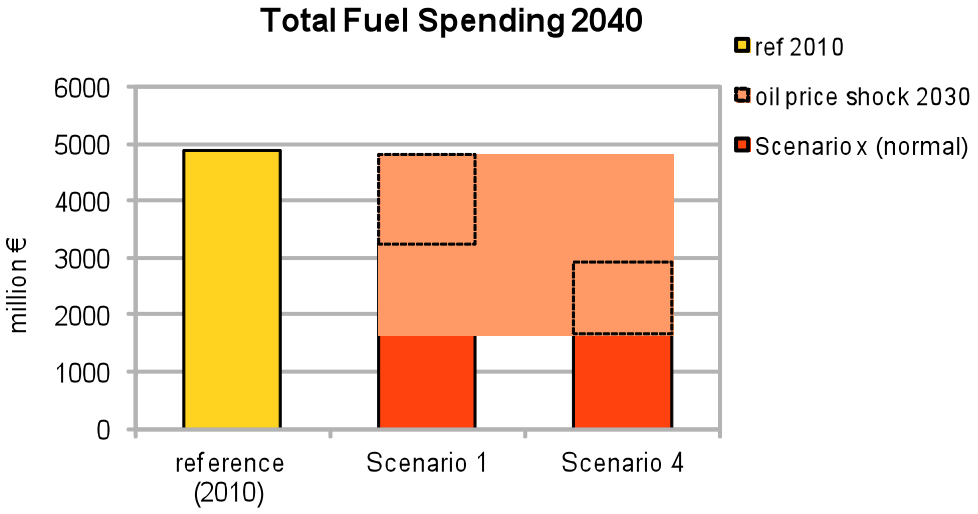


Figure 8: Simulated total fuel spending 2040 of Barcelona

Conclusion

As the simulation runs for Barcelona demonstrate, the transition to a state of sustainable mobility cannot be left to mere technological transformation. Neither are incremental implementations of pull measures, i.e. extensions of public transport or non-motorized transport (bicycling, walking) infrastructures sufficient to induce a substantial decrease in car usage. Pull measures are but a necessary condition towards this goal (as it increases availability of alternatives to individual motorized transport), whilst a significant change can only be made by facilitating push measures (i.e. measures to discourage car usage by making it more expensive or less effective) and land use policies (which are policies aiming at reducing the need for transportation by transformation of city topology and land usage).

For Barcelona, the following measures may help to achieve the goal of low-carbon mobility, at the same time adding to urban quality of life and economic prosperity:

- Pull measures: An introduction of a transparent, high frequency, prioritized bus rapid transit network, emphasizing network speed and comfort. There should be an extensive system priority lanes and light signals for busses. The connection of two tram lines along Avinguda Diagonal would be a particular measure to increase public transit network speed. Crucially, speed and frequency of regional PT connections must be improved, and the regional train network extended. A dense bike-lane infrastructure, as in Freiburg or Malmö, could easily increase the current low modal share of bikes. If bike lanes are clearly separated from car traffic and well-marked, the increased cyclist security can further improve attractiveness of this environmentally-friendly mode. Public awareness of air pollution, noise, climate change and energy consumption issues can be increased, e.g., by a public relations campaign. A transition from motor bikes to electric bikes can very effectively reduce harmful and stress-inducing noise

levels, and can be enhanced by providing charging infrastructure and public awareness campaigns.

- Push measures: Closing most of the streets for cars (such as in Distrito di Gracia) or strictly enforced speed limitations of 30km/h in L'Eixample further increase attractiveness of the bicycle and pedestrian modes. Parking of motor bikes on the side walks is best prohibited and suitably enforced. Parking space can be further reduced, and parking prices increased in order to stop the hidden subsidies of valuable inner-city space for non-moving cars. Car fuel should be taxed much more progressively on the national level as fuel prices in Spain are below EU average (though this is beyond scope of Barcelona municipality, it is important to realize the importance of this issue). Motor bikes may be banned from the inner city to reduce noise pollution.
- Land use: If new settlements are only allowed in proximity of commuter train station, further induced car traffic can be avoided. This existing regional regulation needs to be strictly enforced. Accordingly, green field development of big boxes must be prohibited. Affordable housing close to the inner city should be explicit policy target of Barcelona and the metropolitan region.

The proposed policies also realize significant co-benefits:

- Health benefits: Transport impairs human health due to traffic accidents, air pollution and noise. Reducing car transportation by strengthening non-motorized and public transport brings an immediate improvement in quality of life. Calming traffic (by limiting speed or by introducing car free areas and neighbourhoods) is one of the most important policies towards this end, especially in l'Eixample. By a consequent application of push measures, a 50-75% reduction of health impairment could be attained. Moreover, this is a way to provide space for non-motorized traffic (walking and cycling), which is separated from car transportation and therefore much safer. An additional modal shift from car to non-motorized transport will be the consequence, which increases overall physical activity of the population, which has again positive health impacts (Woodcock et al., 2009).
- Quality of life: Restricting car transportation by calming neighbourhoods and concentrating traffic to main roads (e.g. in L'Eixample) has a positive impact on urban atmosphere and quality of life. Streets with little or no car traffic will attract walkers, cyclists and everyday life on the street. Cafés and shops will find increased customer frequency. Combined with land use policies and a strengthening of public transport, the necessity to use an own car will decrease and the local residential neighbourhood as a living space will start to play a new role in people's everyday life.
- Social equity: Increasing speed, density and reliability of public transport as well as making non-motorized transport safer and faster (e.g. by implementing a comprehensive system of bike-lanes) will add to equal accessibility of transport in the city. Especially bus patrons, cyclists and pedestrians, i.e. the majority of Barcelona transport users, will gain from these policies.

- Economic prosperity: A transition from car to public and non-motorized transport, as well as a long-term reduction in average trip lengths induced by land use and settlement policies will result in significant time savings as traffic congestion will diminish. Congestion is one of the strongest cost categories and 50-75% cost reduction can be achieved by combined application of pull, push and land use measures. Moreover, there is a similar potential to reduce annual fuel spending – which is capital getting lost for the city or municipal economy. While in 2010 it amounted to around 890 million €, it could be reduced to around 260 million € in 2050 in scenario 4.

4.2. Sofia

Sofia is the capital of Bulgaria with about 1 259 446 inhabitants (2010) and a relative compact urban form with limited sprawl. The city's modal share is traditionally PT-oriented (64,7% PT, 17,4% car in 2000) because of a broad PT-network access and low motorization of the residents. The PT's vehicle stock is old and the space availability for cyclists, pedestrians and PT seems often to be insufficient. In the last ten years the motorization also doubled and therefore the modal share is shifting slowly but steadily in the direction of cars (49% PT, 30,5% car in 2009). The city becomes increasingly gridlocked in congestion. These development shows that the problematic of congestion will become more and more relevant. Noise and air pollution are already serious problems and will increase in the next years (Zaimov, Petrov, & Stefanov, 2011).

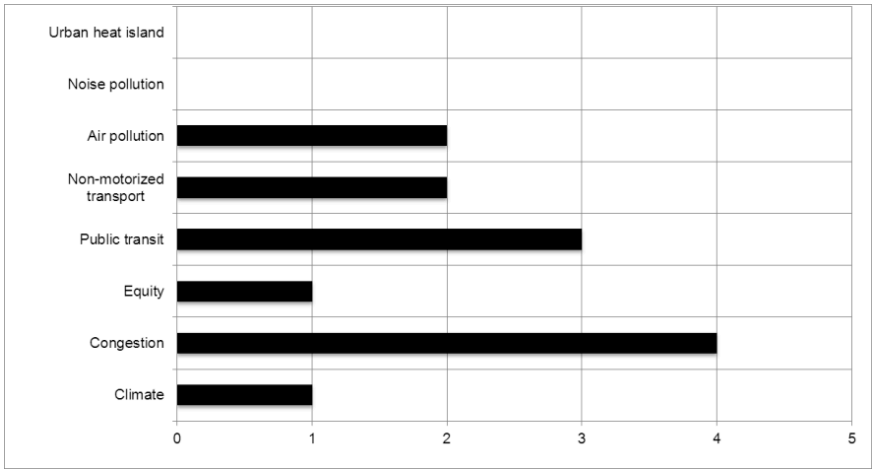


Figure 9: Problem self-assessment for Sofia. Congestion is the most serious issue for the city followed by public transit. Also air pollution and the state of non-motorized transport seem to be important problems. On the other hand urban heat island and noise pollution are not seen as serious issues.

Results

For Sofia, we set up the following four scenarios of increasing ambitiousness:

Scenario 1: Business as usual / technological transformations only	Implementation:
• Completion of Metro system within 10 years • Modernisation of road infrastructure throughout city • Bypass and ring roads to keep regional traffic out of Sofia (EU routes 4, 8, 10)	• PT speed and network density: + 12% • Road capacity: +37%
Scenario 2: + Pull measures	Implementation:
• Immediate modernisation of PT vehicle fleet • Tram + bus priority lanes • Modernisation of tram rail infrastructure • Introduction of bicycle lanes throughout city	• PT speed, quality: +25% • NMT speed, safety, quality: +100% • Road capacity: -15%
Scenario 3: + Push measures	Implementation:
• Low traffic zones (30km/h) or traffic free streets. Compensation for increased road capacity. • Parking policy enforcement and rise in parking charges	• 30% low traffic zones • parking charges +100%
Scenario 4: + Land use measures	Implementation:
• Congestion charge (dynamic road pricing) • Encourage mixed land usage • Promote suburban centers (polycentric topology)	• congestion charge 40% • average trip length: -20%

Figure 10: Scenario Plan of Sofia

We have no clear information on long-term projections of population development at hands. Underlying to all scenarios we assume a population growth in Sofia municipal region by 14% until 2050, with almost vanishing growth rate in the current decade but increasing growth rate after 2020. This population growth of Sofia will be largely due to inner Bulgarian migration and demographic shifts, as the overall population of Bulgaria is forecast to be rather decreasing until 2030 by a study of the Berlin Institute for Population and Development[1].

Modal share development

Analysis of the modal share development (Figure 11):

Scenario 1, the car-dominated business-as-usual scenario, contains the completion of the Metro project in three steps over the next 12 years (visible as kinks in the PT and MIT curves), but it does not contain further investments into the public transport system. Especially a very quick targeting of the public transport image deficit (due to life experienced vehicle fleet and slow speed) is missing. It is not surprising that the modal share development in this scenario is dominated by a significant increase of car modal share, which is due to continuous improvements of the city and regional street network.

[1] http://www.berlin-institut.org/fileadmin/user_upload/Studien/Kurzfassung_Europa_d_sicher.pdf

Scenario 2 is focused on improving public transport. In addition to the infrastructure building/renewing measures of scenario 1, this scenario contains a quick and focused targeting of public transport image, speed and convenience within the next 3 - 10 years. It is seen particularly well that this is able to sustain public transport modal share in the current level (supported by slight improvements due to new Metro lines becoming operational) for the next 10-15 years. After 15 years however, public transport modal share is again decreasing as we assumed still ongoing modernization of the street infrastructure, which effects in an increase of car road capacity.

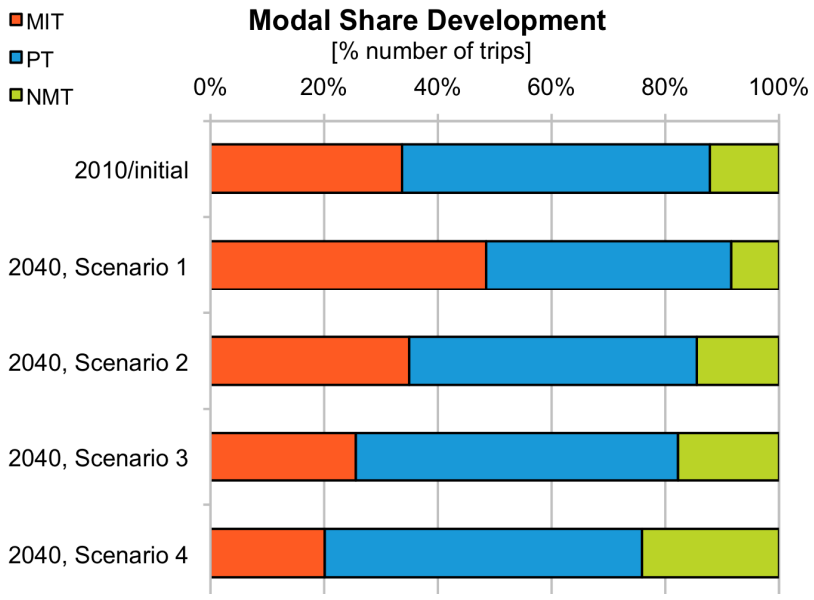


Figure 11: Simulated modal share development in Sofia

Scenario 2 is able to diminish but not stop the current increase in car modal shift. As a result of sweeping improvements on bicycle infrastructure, this scenario displays a significant increase in slow mode (actually: cycling) modal share. This effect is slow as it takes time for people to establish a culture of cycling. However, this scenario is not able to make the decisive fundamental transition to sustainable, low-carbon mobility. This is due to the fact that it lacks push measures, making car driving more expensive.

An immediate image campaign and investments in public transport are necessary to avert the worst, as we saw in scenario 2, but such pull measures alone are not sufficient to induce a fundamental transition towards car-free and thus sustainable mobility. Scenario 3 combines push measures with the measures of the previous scenarios. Most importantly, it contains traffic calming (30 km/h zones) and car-free areas in the city center, compensating for improved functionality and capacity of road infrastructure. Also, there is a comprehensive parking charging policy and

enforcement scheme implemented. This scenario is quite efficient. It shows that a combination of immediate public transport pull measures with continuous and long term car push measures is able to reverse the current trend towards private cars. Only the slow mode modal share could be further addressed by specific policies.

Scenario 4 adds land use policies to the previous scenario. Land use policies aim at a polycentric urban topology and at mixed land usage, both resulting in a reduction of average trip length. This then strengthens the relevance of the slow modes, as slow modes are available to shorter trips only. Land use policies come along with changing settlements, large-scale infrastructure and urban topology. Thus, they take effect only in the long run. This can well be observed here: While the first 20 years develop nearly similar to scenario 3, a substantial modal shift from public transport and private car towards the slow modes can be observed as a long-term effect.

In summary, if the only substantial measure on public transport is building the Metro, the effect will be overwhelmed by increased private car transportation within short time. Immediate strengthening of public transport by addressing the key issues responsible for its decreasing popularity (old vehicles, slow speed, negative image) can decisively slow down the current dynamics towards private car transportation. Introduction of bicycle lanes has great effect, but it takes a while until a cycling culture is established. This would be supported by land use measures. A transition to sustainability requires a profound public transport focus, including push measures, in particular traffic calming (30 km/h zones) and car-free areas in the city center.

Transport CO_2 emissions

In addition to the policies and measures on the city and metropolitan area level, our future projection of transport CO_2 emissions accounts for an increase in private car CO_2 efficiency, induced by the EU emissions policies for new vehicles (EC, 2009; Creutzig et al., 2011). There was no reliable data available on the total daily traffic volume (including cars, public transport and slow modes) in Sofia. Such data would be needed to calculate the absolute values of total transport CO_2 emissions per year. Nevertheless, our model is suitable to calculate the relative development with respect to the emission level of 2010. The result is displayed in Figure 12.

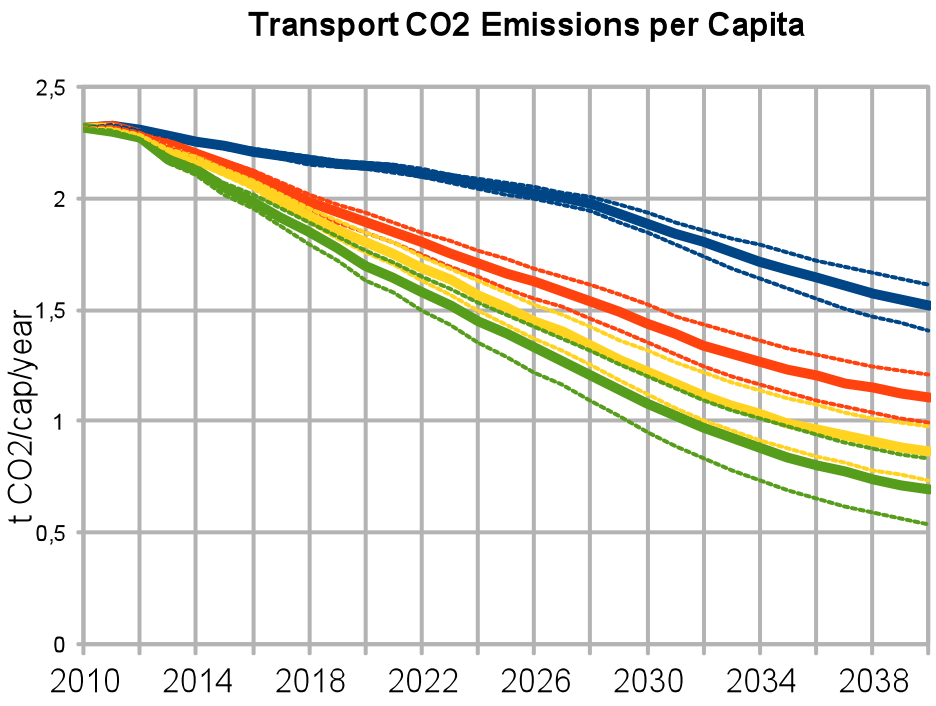


Figure 12: Simulated transport CO2 emissions per capita of Sofia

The emission savings in scenario 1 are entirely due to the technological car efficiency increase (but still toned down by the increasing car modal share). Resulting in about 67% of the emission level of 2010 in 2040, this scenario does not nearly meet with the requirements of the 2°C climate target. As the curve for scenario 2 shows, an immediate effort to strengthen the image of public transport and the slow modes is capable of initially pushing the development in the right direction. In this scenario, emissions level off at around 51% of 2010 emissions.

Scenario 3 incorporated not only immediate public transport modernisation and image measures but additional long term continued investments in public transport speed, service quality and network density together with push measures such as traffic calming and car-free zones in the city center. In terms of CO_2 emissions, this profound public transport focus makes a significant difference especially in the mid-term development, where the curve departs increasingly from the curve of scenario 2. With a final result of 36% the emissions level of 2010, this is already a substantial step towards sustainable and low carbon mobility.

The additional land use measures adopted in scenario 4, resulting in a reduction of average trip length and therefore in an increased relevance of the slow modes, are capable to induce a further reduction in CO_2 emissions towards 26% the level of 2010 in 2050. It is seen when comparing the curves of scenarios 3 and 4 that land use measures take their effect in the long run as they require large-scale changes in settlement and urban topology.

Co-benefit analysis

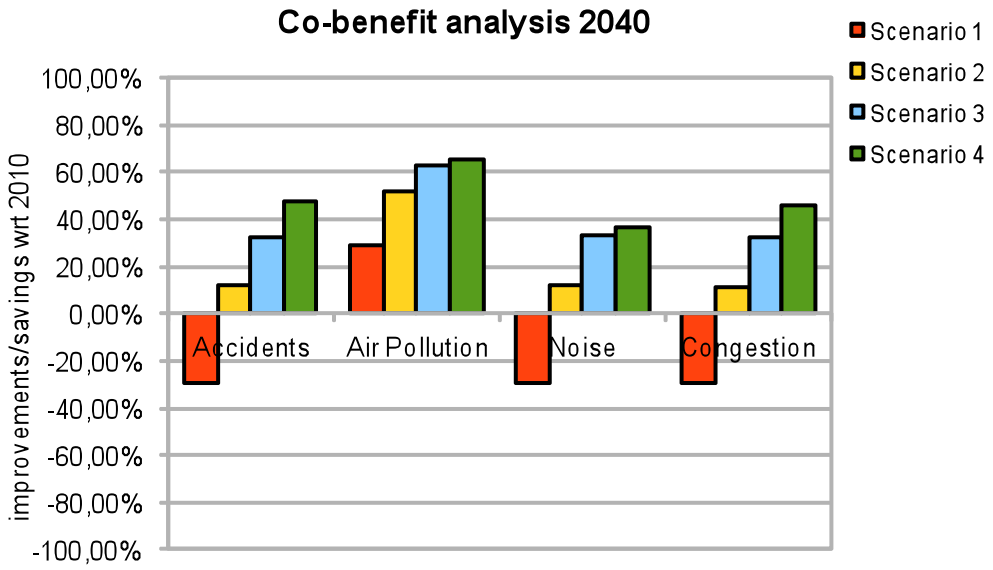


Figure 13: Sofia co-benefit analysis 2040

Figure 13 displays the results of our co-benefit analysis in four co-benefit dimensions. In Scenario 1 (Metro + car oriented measures), Sofia would face a yet severely increased impairment by traffic noise, congestion and traffic accidents (only because we accounted for substantial improvements in car emissions standards it is that air pollution keeps almost constant). In all these respects, Sofia's current situation is already rather problematic (cf. Masterplan 2009).

Especially in noise, accident rate and congestion, which are currently in quite poor state, scenarios 1 and 2 cannot bring a fundamental transition. We see that a combination with push and land use measures (scenario 3 and 4) is inevitable to solve the city's biggest transport related issues concerning urban quality of life. Figure 14 shows that Sofia is particularly vulnerable to oil price shocks in scenario 1.

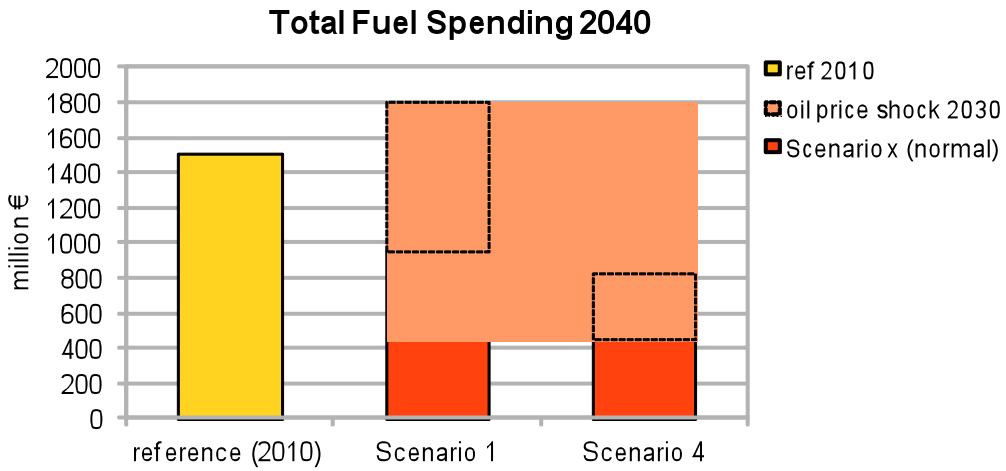


Figure 14: Simulated total fuel spending 2040 of Sofia

Traffic congestion, traffic accidents and noise impairment can only be addressed effectively by policy combinations that contain both push measures and land use measures, as these are the two kinds of measures that make people drive less kilometers. Future transport politics without ambitious measures such as push measures and land use measures would lead to a severely reduced urban quality of life in 2040 compared to 2010, especially in the dimensions noise impairment, traffic congestion and accidents.

Conclusion

With respect to the long-term development, we see three fundamental issues of urban mobility in Sofia:

a. Public transportation suffers from a profound image deficit and is rapidly declining in popularity. This is mainly due to poor speed and a large share of old vehicles in the vehicle fleet.
b. There is an unresolved discrepancy of individual benefits and social disbenefits of private car transportation and ownership:
   From the individual perspective, driving by car is faster (despite the congestion level), more convenient and it may even be associated with a higher social status as Sofia is in a state of economic and demographic transition. But from the point of view of society, increased car ownership and modal share leads to more congestion, air pollution, noise level, accident rates, and thus to an overall and significant disbenefit to everybody.
c. There is no culture of considering the slow modes (especially: bicycling) an alternative on short distance relations.

Sofia has good initial conditions to reach sustainable transport, because Sofia is currently in a state where many parts of transport infrastructure must be renewed or built from scratch; and there is not yet a culture of private car use deeply inscribed in peoples' behaviour. Thus, by good planning of the temporal order of the single measures Sofia can reach a state of sustainable and highly efficient transportation from the outset, without getting struck in the “private car trap" as many central European cities did.

The analysis of Sofia’s Masterplan 2009 is comprehensive and robust. Many measures are suggested there and some are already envisaged in urban planning. However, to make use of the good initial potential of Sofia towards sustainable and efficient urban transportation (see previous point), and in order to avoid getting trapped in a largely car oriented state getting out of which would take an enormous amount of effort, the following temporal order of measures must be taken:

a. Give highest priority to immediate replacement of old public transport vehicles by newer (possibly second hand) vehicles (cf. Master Plan 2009). Improve speed of on-ground public transport by improving the infrastructure (rails) where necessary and by avoiding interaction with traffic congestion (separate bus/tram lanes).

b. Introduce a dense network of bicycle lanes within the next 10 years. It will take some time until a widespread cycling culture emerges, but this measure bears great mid-term potential.
c. Start an image campaign on public transport and cycling. Promote intermodality of public transport with slow modes (also with cars by building park and ride parking facilities).
d. Improvements in road quality and capacity (leading to less traffic congestion) must always be compensated by implementing low traffic zones (30 km/h) or traffic free zones in the city. This goes for the new outer ring highway as well as for inner city road extensions. Established research indicates that every bit of new road capacity will eventually be filled to 90% with new (induced) traffic after 5-10 years (cf. Litman 2011). Closing roads (to build pedestrian zones) or calming traffic would prevent this effect and at the same time increase urban quality of life and make the city more accessible to walking and cycling.
e. Prioritize a transition towards a polycentric topology, reducing average trip lengths and thus encouraging use of slow modes. Do this before the street network is improved to such an extent that driving longer distances by car is equally convenient.

4.3. Malmö

Malmö is a city in the very south of Sweden near Copenhagen with about 300.000 inhabitants. Malmö transitioned from a manufacturing town to a knowledge-based city during the last 15 years.
The completion of the city tunnel and new train connections guarantee a fast access to surrounding settlements and to Copenhagen. In a few districts like Hyllie the traffic developments are PT and NMT oriented. But in others like Rosengard the access to the city's PT network is limited and social exclusion is a serious problem. Although the car share decreases significantly in the last few years especially on short trips less than five kilometers, it is still relatively high with about 41% in 2008. In addition commuting increased rapidly in the last 15 years. Hence, congestion is likely to become a serious issue. Noise is also a growing problem especially along the main arteries.
To deal with these challenges, Malmö has established a masterplan and action programs for traffic and urban development since 2001. Continuous evaluation and renewal keeps it up-to-date to implement the ambitious environmental goals of the city (Wickenberg, 2011).

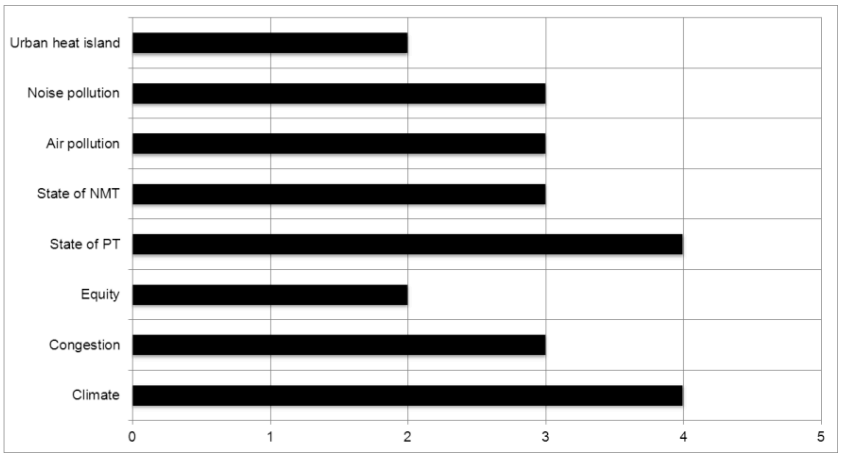


Figure 15: Problem self-assessment for Malmö. The Climate and the state of PT are the most serious issues for the city. But as well noise and air pollution, congestion and the state of NMT seem to be important problems.

Results

For Malmö, we simulated the following four scenarios of increasing ambition:

Scenario 1: Business as usual / technological transformations only	Implementation:
• 50% population increase	
Scenario 2: + Pull measures	Implementation:
• PT: extension of regional rail based PT (work commuters) • PT: introduction of tram network covering future traffic demand • NMT: encourage intermodality (cyclists and railbased PT) • Cycle lanes on most streets (reducing car street capacity) • Priority to NMT and PT in planning: more safety, removal of barriers	• PT speed, network density +22% • NMT: bicycle lanes, speed, safety +27% • Road capacity -8%
Scenario 3: + Push measures	Implementation:
• Rise in parking charges, reduction of parking space • Global maximum speed limit (40km/h) • Extend car free area in city center	• Parking charges +100% • Global 40km/h speed limit • Road capacity -12%
Scenario 4: + Land use measures	Implementation:
• Densification: develop city from inside, e.g. around Hyllie • Mixed usage: Introduce suburban centers • Prevention of outside shopping malls “big boxes” • Congestion charge (dynamic road pricing)	• Density +50% • Congestion charge 30%

Figure 16: Scenario Plan of Malmö

Modal Share development

Only a combined implementation of pull measures (such as considerably improved conditions for the slow modes), land use measures (densification and mixed use policies) and push measures (restricting car use) will induce a significant change in peoples' choice of traffic mode. If push measures are missing, a significant change in car modal share cannot be observed (compare scenarios 2 and 3).

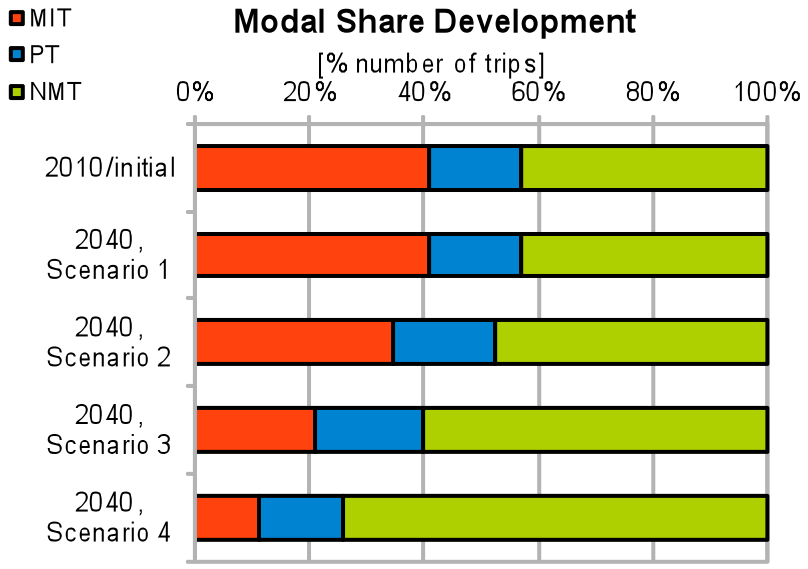


Figure 17: Simulated modal share development in Malmö

Transport CO_2 emissions

The official goal of the EU climate politics is limiting the average global heating until 2100 to 2°C. This is an ambitious goal as it means to reduce the annual emissions of greenhouse gases to 20% the amount of 1990 until 2050.

Technological improvements resulting in CO_2 efficiency increase of combustion engines as prescribed by the EU regulations (scenario 1) are a core ingredient towards decarbonization of transport, but they are – by far – not sufficient. The combined application of pull and land use measures (scenario 2) brings a reduction to about 60%. However, only if pull measures and land use policies are combined with push measures GHG emissions per capita will decrease to long-term sustainable values (scenario 3): this results in a reduction of emissions to 35% until 2040. In addition to these measures, scenario 4 implements a large scale transition to electric vehicles. As the CO_2 intensity of electricity is comparatively low in Sweden, a reduction of CO_2 emissions to less than 10% may be thus attained.

The total CO_2 emissions depend on the assumptions on population growth. However, slowing down population growth turns out not to be a solution towards sustainable transport; To induce reduction of CO_2 emissions per capita by 80%, push, pull and land use measures will be needed. The increase in CO_2 emissions due to population growth depends crucially on which settlement policy is applied, i.e. how close to the city center the new inhabitants locate. Locating new inhabitants relatively close to the city center has two advantages: Shorter distances, and higher likelihood of using slow modes. Both factors contribute to successful climate change mitigation.

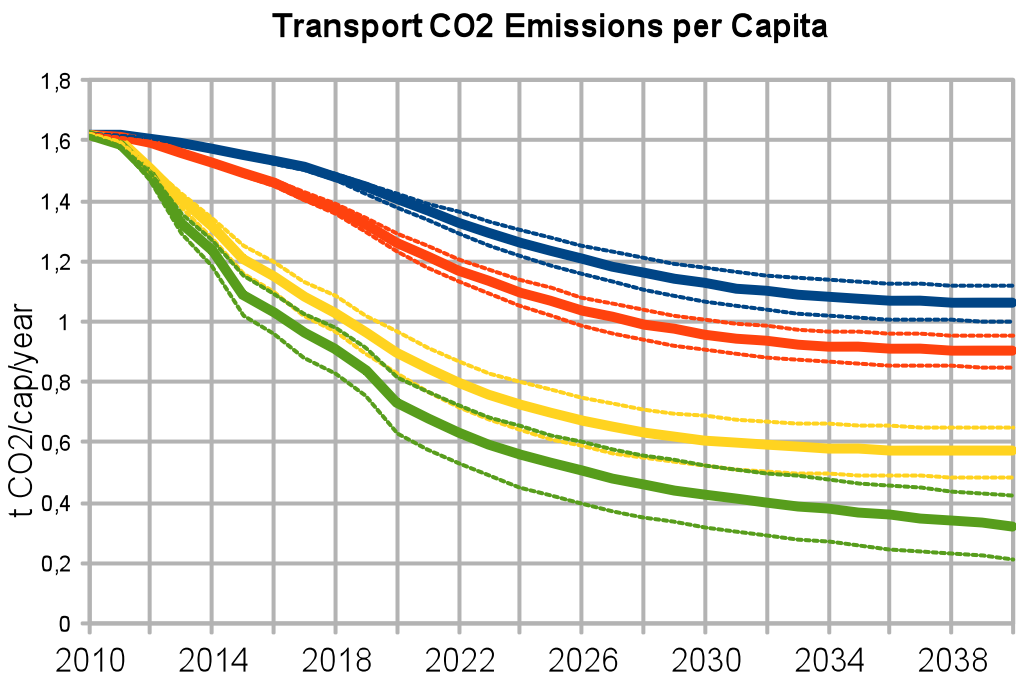


Figure 18: Simulated transport CO2 emissions per capita of Malmö

Co-benefit analysis

Four co-benefit dimensions (cf. Figure 19) were investigated for the target year 2040 with respect to the reference year 2010: The number of annual transport accidents, air quality impairment by particulate matter and other

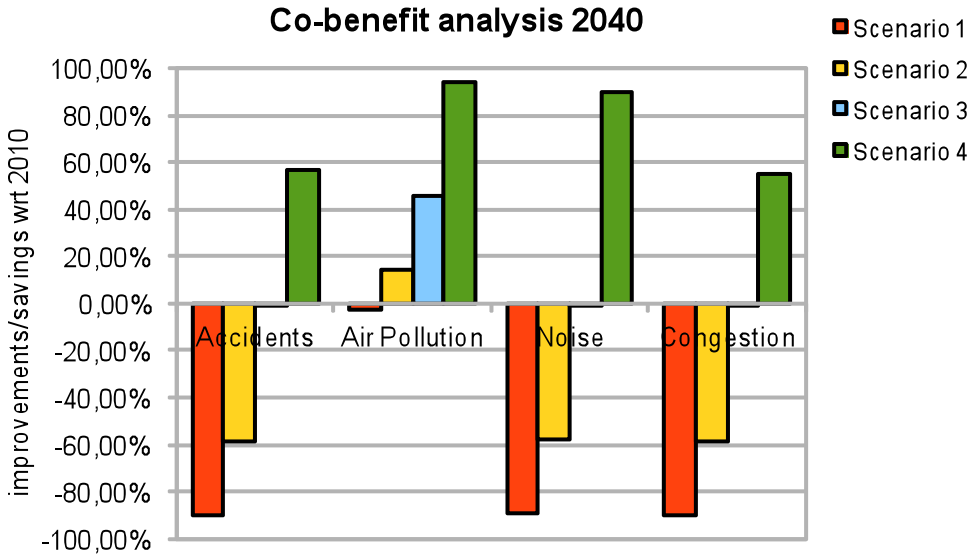


Figure 19: Malmö co-benefit analysis 2040

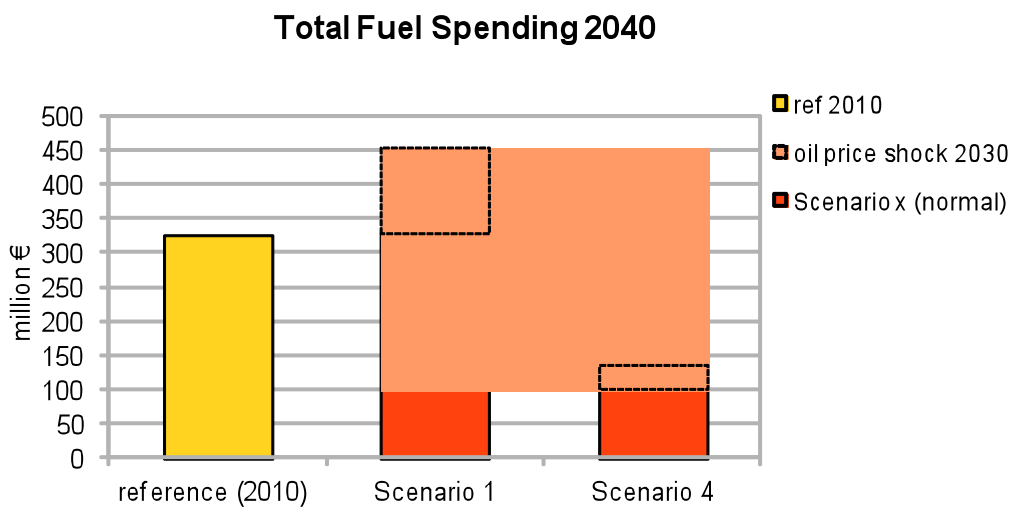


Figure 20: Simulated total fuel spending 2040 of Malmö

pollutants resulting from combustion, and the background noise level caused by traffic are immediate health issues and thus related to urban life quality. Traffic congestion results in time losses on a daily basis and is thus of indirect economic relevance, as is the city's dependence on fossil fuels, measured here in terms of annual fuel spending (cf. Figure 20) – which is capital getting lost for the city or municipal economy.

Scenarios 1 and 2 (only EU emissions policies, pull measures and land use measures) prove largely ineffective in terms of transport accidents and fatalities, noise impairment, congestion level and the city's dependence on fossil fuels. In fact, these measures enable sustainable transport, but leave harmful transport mostly untouched. Push measures in combination with pull measures and land use policies are necessary to achieve notable sustainability gains (scenario 3). Again, they prove highly efficient also regarding co-benefits, as they affect peoples' traffic behavior in substituting car usage by alternative, more sustainable forms of mobility. Finally, electric mobility (scenario 4) shows a high additional potential in the dimensions air pollution, noise and dependence on fossil fuels. Figure 20 shows that Malmö has great potential to become largely fuel independent.

Conclusion

The transition to a state of sustainable mobility requires a fundamental change in transport related behavior and mentality. This can only be induced by a sweeping combination of different measures, including pull measures (which increase availability of alternatives to individual motorized transport, i.e. cycling, walking and public transport), land use policies (which are policies aiming at reducing the need for transportation or for owning a car by transformation of city topology and land usage), and push measures (i.e. measures to discourage car usage by making it more expensive or less effective). Specifically, the following measures can help Malmö to achieve these goals:

- Pull: Increase spatial scope and frequency of rail-based regional public transit services, providing work commuters with a competitive alternative to using their cars. The planned tram network helps to provide mobility services to the increasing population, and may need to be extended beyond current plans. Implement an extensive priority system (separate lanes and light signals) for public transport to make it resistant to traffic congestion (which will be an increasing issue due to population growth and densification). More than half the car trips in Malmö are below 5 km. Give bicycles and walkers priority in planning over car traffic to make the slow modes faster and safer. Extend the network of cycle lanes at the expense of car street space. Promote pedelecs and e-bikes for commuters within the nearer region and provide incentives. Increase interconnectivity between slow modes and public transport to induce intermodality.
- Push: Reduce number of parking spaces in the city, and transfer this space to non-motorized modes (see pull). Persuade supermarkets to also reduce parking spaces, and reduce barriers for non-motorized local shopping. Increase parking prices. Extend the car free area of the city center and implement a maximum speed limit of 30 km/h (at night for all of the city, at day only city center). Charge a city toll for car drivers (cf. city of Stockholm). Precondition for all this: pull measures above.
- Land-use: Develop the city from the inside wherever possible (cf. alternative "inat", Dialog-pm 2009:1). Focus urban planning on polycentricity to render car usage unnecessary as each district is self contained in every day structures (living, shopping, leisure). Introduce car sharing and make it the goal that even owning a car is no longer the standard. Make an agreement with surrounding municipalities/ the region to integrate land-use and transport planning across the region with the specific aim of restricting new development to the proximity of train station, or planned train stations. Find a benefit-sharing agreement between city and region.
- Awareness: All these measures go along with a change of people's transport related behaviour and habits. While some of the measures seem to be unpopular, they may be widely accepted in hindsight and improve quality of life. A public information campaign focusing on communicating the details and intention of each measure can improve public acceptability tremendously. Emphasize that accessibility will be improved and point out the (locally relevant) social co-benefits.

4.4. Freiburg

Freiburg is the so-called „Eco-city“ in Germany with 220 000 residents and a long tradition of environmental city policy. Public transport, bicycles and pedestrians are playing a big role in the city's modal share. To increase it further, improvements are planned or in process. New developments like Vauban, a partly car free area inside of Freiburg, arose in the last ten years and a re celebrated worldwide (New York Times, 2009). Freiburg is surrounded by mountains therefore the urban sprawl developments are naturally restricted, which can be an advantage for ecological urban planning. Problematic are the few but high frequented main roads, primarily the B31 as the arterial road of Freiburg's car travel. There the problematic of noise and air pollution is highly present while in other parts of the city it does not play a significant role. In addition there are many commuters with a high car share although there is a supra-regional bus and train supply. This explains the relatively high per capita transport emissions of Freiburg and the whole region surrounding. The intention of Freiburg's traffic policy is therefore the reduction of Greenhouse gas emissions in the transport sector. (Schick, 2011)

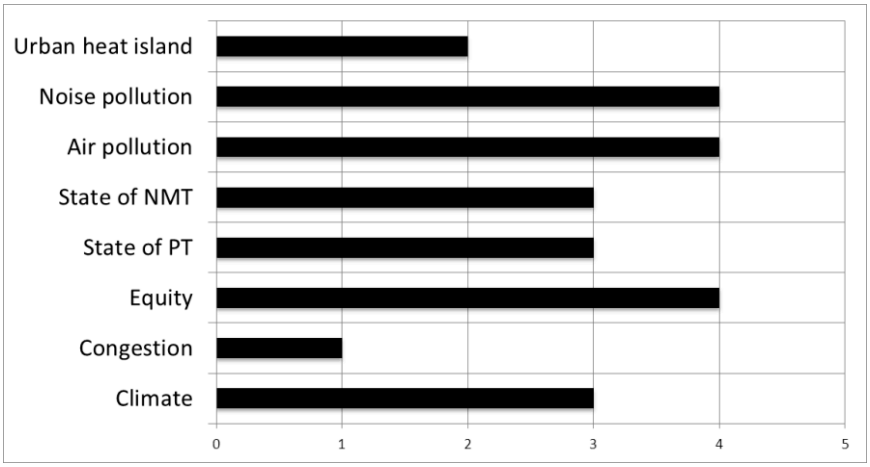


Figure 21: Problem self-assessment for Freiburg. Noise and air pollution as well as Equity are the most important issues for the city. Also the state of PT and NMT and the Climate seem to be important problems.

Results

For Freiburg, we simulated the following four scenarios of increasing ambitiousness:

Scenario 1: Business as usual / technological transformations only	Implementation:
• 25% Population increase	
Scenario 2: + Pull measures	Implementation:
• PT: extension of regional rail based PT (work commuters and leisure time traffic) • PT: extension of tram system (covering for future traffic needs) • Encourage intermodality (bicycle and rail based PT) • NMT: Bicycle priority lanes, especially in city center, more bicycle capacity on most frequent relations • NMT: Removal of smaller gaps and barriers; bicycle lanes away from pedestrians onto the streets (increase in safety and speed)	• PT speed, network density +20% • NMT: bicycle lanes, speed, safety +15% • Road capacity -4%
Scenario 3: + Push measures	Implementation:
• Rise in parking charges, reduction of parking space • Continued promotion of car free living and alternative mobility • Global maximum speed limit (40km/h)	• Parking charges +100% • Global 40km/h speed limit • Road capacity -10%
Scenario 4: + Land use measures	Implementation:
• Densification: develop city from inside wherever possible • Mixed usage: Introduce suburban centers “Stadt der kurzen Wege” • Prevention of outside shopping malls “big boxes” • Congestion charge (dynamic road pricing)	• Density +27% • Congestion charge 30%

Figure 22: Scenario Plan of Freiburg

Modal Share development

The simulated temporal development of modal share (Figure 23) displays that only a combined implementation of pull measures (such as considerably improved conditions for the slow modes) and push measures (restricting car use) will induce a significant change in peoples' choice of traffic mode. In particular, only implementing improvements on public transport service quality and the slow modes alone is insufficient to induce a significant reduction of car usage. A noticeable change in car modal share can only be observed for those scenarios encompassing push and land use measures, i.e. scenarios 3 and 4.

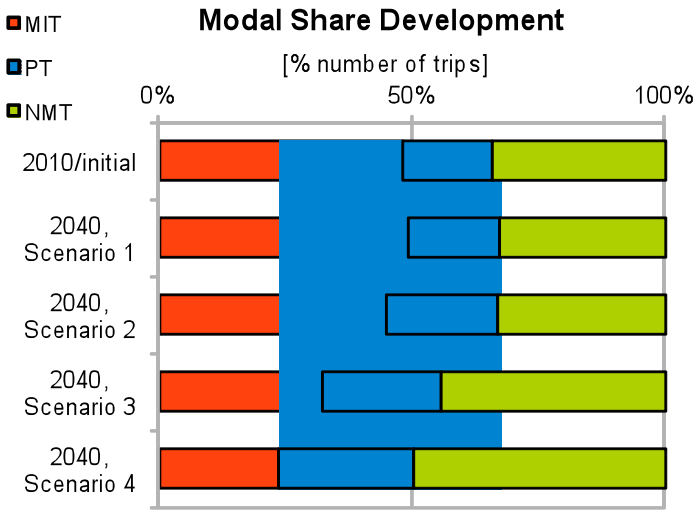


Figure 23: Simulated modal share development in Freiburg

Transport CO_2 emissions

Figure 24 below displays the simulated temporal development of transport CO_2 emissions. Technological improvements resulting in CO2 efficiency increase of combustion engines as prescribed by the EU regulations (scenario 1) are a core ingredient towards decarbonization of transport, but they are - by far - not sufficient. The effects of pull measures alone (scenario 2) are merely marginal. However, both push measures and land use policies (scenarios 3 and 4) hold a significant potential to reduce CO_2 emissions, if they are combined with pull measures.

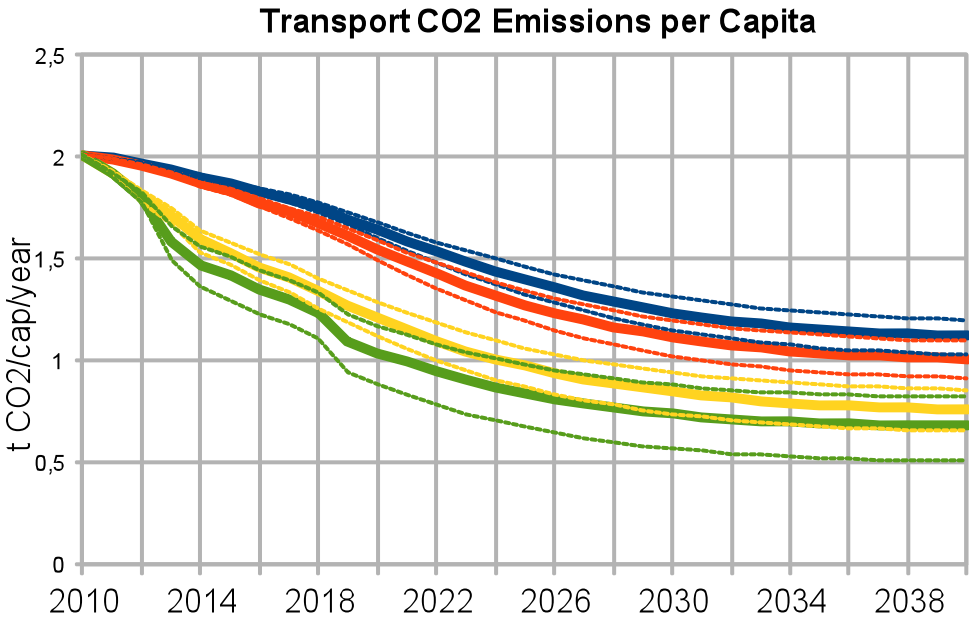


Figure 24: Simulated transport CO2 emissions per capita of Freiburg

As can be seen by comparing to the modal share projection (see Figure 23), the effect of push measures is through a modal shift while the effect of land use policies

is additionally based on decreasing average trip length. Moreover, land use policies take effect in the long run while push measures are more immediate.

Co-benefit analysis

Figure 25 below displays the improvement in four co-benefit dimensions until 2040 with respect to the reference year 2010: The number of annual transport accidents, air quality impairment by particulate matter and other pollutants resulting from combustion, and the background noise level caused by traffic are immediate health issues and thus related to urban life quality. Traffic congestion results in time losses on a daily basis and is thus of indirect economic relevance, as is the city's dependence on fossil fuels, measured here in terms of annual fuel spending (Figure 26)– which is capital getting lost for the city or municipal economy.

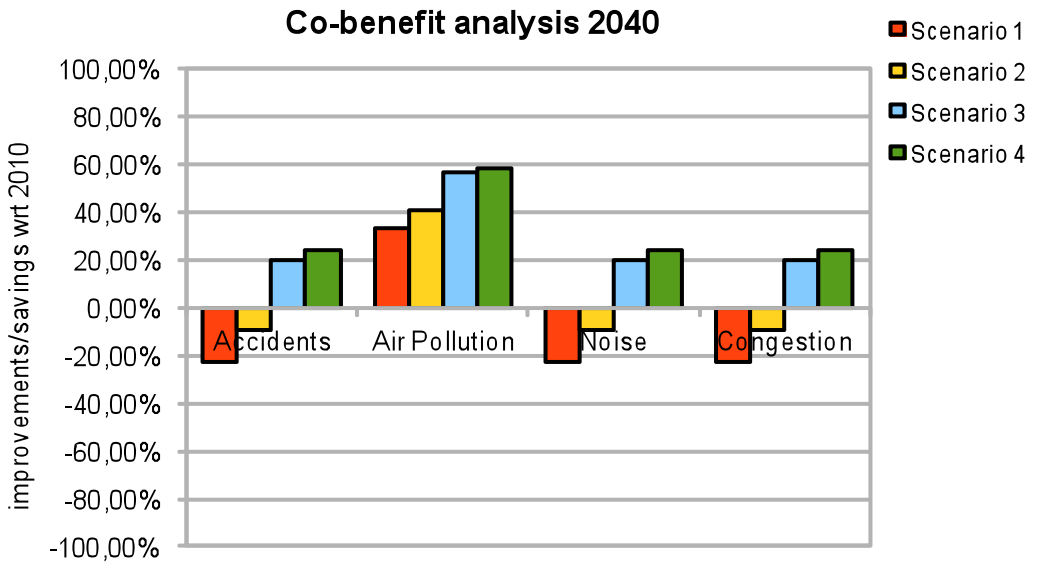


Figure 25: Freiburg co-benefit analysis 2040

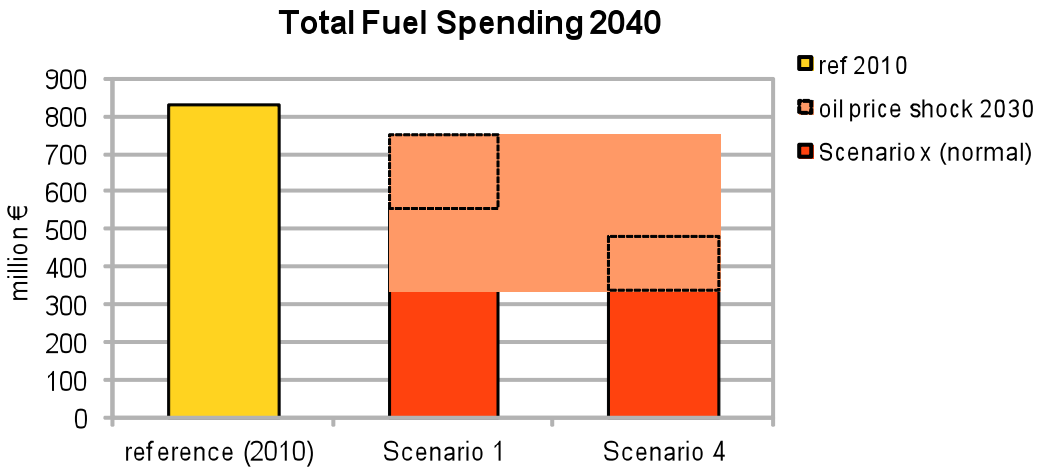


Figure 26: Simulated total fuel spending 2040 of Freiburg

Scenarios 1 and 2 (EU emissions policies and pull measures) prove largely ineffective in terms of transport accidents and fatalities, noise impairment, congestion level and the city's dependence on fossil fuels. This is because in those dimensions, a significant change can only be effected in reducing the amount of car transportation, i.e. the modal share of motorized individual transport. As was already evident before, push measures and land use policies are inevitable to this end. Again, they prove highly efficient also regarding co-benefits, as they affect peoples' traffic behavior in substituting car usage by alternative, more sustainable forms of mobility.

Conclusion

As the simulation runs for Freiburg demonstrate, the transition to a state of sustainable mobility cannot be left to mere technological transformation. Neither are incremental implementations of pull measures, i.e. extensions of public transport or non-motorized transport infrastructures sufficient to induce a substantial decrease in car usage. Pull measures are but a necessary condition towards this goal - as it increases availability of alternatives to individual motorized transport. A significant change, in turn, can only be achieved by facilitating push measures (i.e. measures to discourage car usage by making it more expensive or less effective) and land use policies (i.e. policies aiming at reducing the need for transportation by transformation of city topology and land usage).

The following specific measures can help Freiburg to achieve the goal of low-carbon mobility, at the same time adding to urban quality of life and economic prosperity:

- Pull: Increase spatial scope and frequency of regional public transit services, possibly by using existing rail tracks. Focus both on work commuters and on the regional leisure time traffic (e.g. into the Schwarzwald; e.g. see the envisaged regional PT measures Ö9-15, Tabelle 8-4, EB08). Concerning urban public transport, increase frequency and late night service of the tram network marginally. Provide additional bicycle-priority lanes within the city, especially in the quarters surrounding the city center, and bicycle highways into the nearer region (up to 20km). Promote pedelecs and e-bikes for commuters within the nearer region and provide incentives. Provide equal-level pedestrian service in, e.g., Herdern and Wiehre. Possibly provide tram service (in addition to the planed projects) on the Altstadtring.
- Push: Reduce the oversupply of parking places in the city, and transfer this space to non-motorized modes (see pull). Persuade supermarkets to also reduce parking places, and reduce barriers for non-motorized local shopping. Increase parking prices. Require maximum speed limits of 30 km/h at night for all of the city, perhaps extending this also to day times, e.g. for Dreisamstraße. Ambitiously: Charge a city toll for car drivers - in coordination with Land & Bund to address the problem of high through traffic.
- Land-use: Continue the paradigm of the “Stadt der kurzen Wege”. Make Vauban the standard for new developments. Make an agreement with surrounding municipalities/ the region to integrate land-use and transport planning across

the region with the specific aim of restricting new development to the proximity of train station, or planned train stations. Find a benefit-sharing agreement between city and region.

The proposed policies also realize significant co-benefits:

- Health benefits: Transport impairs human health due to traffic accidents, air pollution and noise. Reducing car transportation by strengthening non-motorized and public transport brings an immediate improvement in quality of life. Calming traffic by limiting speed, e.g. on Dreisamufer / the inner city part of B31, or by introducing car free areas and neighborhoods such as Vauban district, are the most important policies towards this end. By a consequent application of push measures of this kind (in combination with pull measures strengthening alternative transport modes), a 40-70% reduction of health impairment could be attained. This is a way to provide space for non-motorized traffic (walking and cycling), which is much safer when separated from car transportation. An additional modal shift from car to non-motorized transport will be the consequence, which increases overall physical activity of the population. This has again positive health impacts (Woodcock et al., 2009).
- Quality of life: Restricting car transportation by keeping it outside residential areas has a positive impact on urban atmosphere and quality of life. Streets with little or no car traffic will attract walkers, cyclists and everyday life on the street. Cafés and shops will find increased customer frequency. Combined with land use policies and a strengthening of public transport, the necessity to use an own car will decrease and the local residential neighbourhood as a living space will start to play a new role in people's everyday life. Also a reduction of the high amount of through traffic would add to quality of life: Especially the inner city part of the Dreisam river could be a singular natural resource for recreation and leisure activity if the high amount of through traffic on B31 could be slowed or reduced considerably.
- Social equity: Increasing speed, density and reliability of public transport, especially from and into the metropolitan region and to regional natural resources (e.g. Schwarzwald) would add to equal accessibility of transportation. Extending regional bicycle infrastructure will have the same effect. Especially bus patrons and cyclists, i.e. the majority of Freiburg's transport users, will gain from these policies.
- Economic prosperity: A transition from car to public and non-motorized transport, as well as long-term reductions in average trip lengths induced by land use and settlement policies will result in significant time savings as traffic congestion will diminish. Congestion is one of the strongest cost categories and 40-70% cost reduction can be achieved by combined application of pull, push and land use measures. Moreover, there is a similar potential to reduce annual fuel spending – which is capital getting lost for the city or municipal economy. While in 2010 it amounted to around 380 million €, it could be reduced to around 70 million € in 2050 in scenario 4.

5. Summary and Comparison

How do the four OPM cities compare? Figure 27 summarizes the initial and scenario CO_2 emissions of Barcelona, Freiburg, Malmö and Sofia. The upper part of the figure reveals that transport CO_2 emissions per capita are surprisingly similar. This similarity could be based in somewhat similar income levels and in a traditionally compact urban form inherent to all four cities. The relatively high per capita emissions of Sofia are rooted in an old vehicle fleet.

Scenario 1, displayed in the left panel of Figure 27, combines technological advance, as mandated by the European Union, with a limited level of pull measures, improving public transit. These measures are effective, in reducing per capita transport CO_2 emissions of about 30-40% in the four OPM cities. Crucially, such a reduction is notable and impressive but insufficient to contribute to ambitious climate change mitigation, which would require transport emissions per capita to be less than 0.5t CO_2e/cap[2].

Scenario 4, displayed in the right hand panel of Figure 27, adds additional more ambitious pull measures, providing pedestrian and cycling infrastructures and adds push measures, such a parking fees, and land-use measures, such as a soft densification. The graph reveals that ambitious targets are possible in all cities studied.

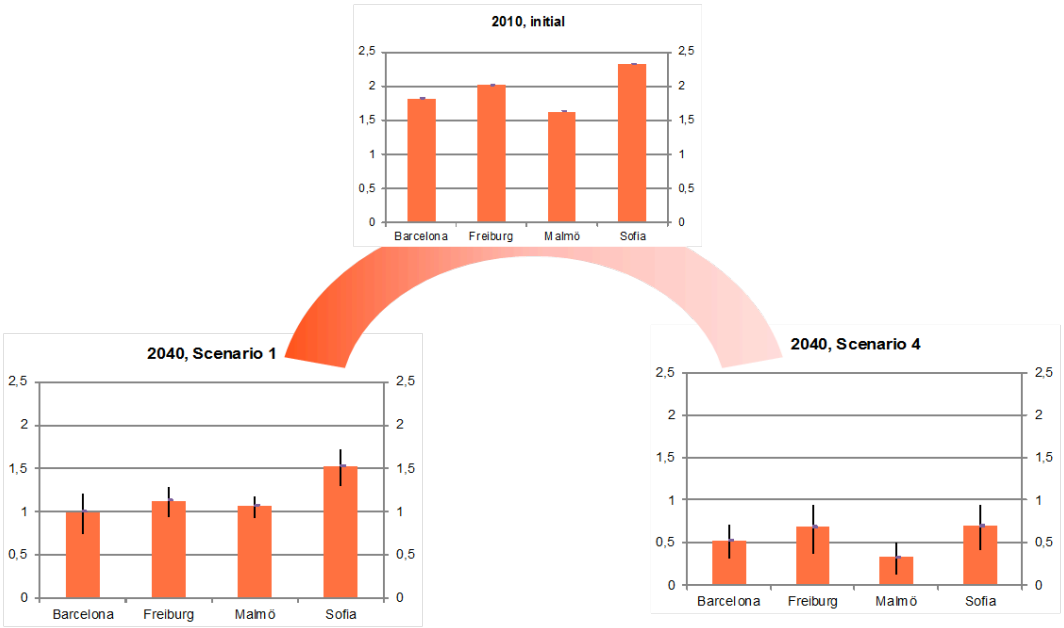


Figure 27: CO_2 emissions initial and expected for the four cities

[2] Higher emissions would be permissable, if other sectors decarbonize completely. Some studies suggest that decarbinization of the transport sector is more expensive than that of other sectors. Our co-benefits approach assumes that the social benefits of sustainable transport open avenues for socially cost-effective mitigation for urban transport mitigation beyond mitigation efforts imagined by studies that are focused on technologies.

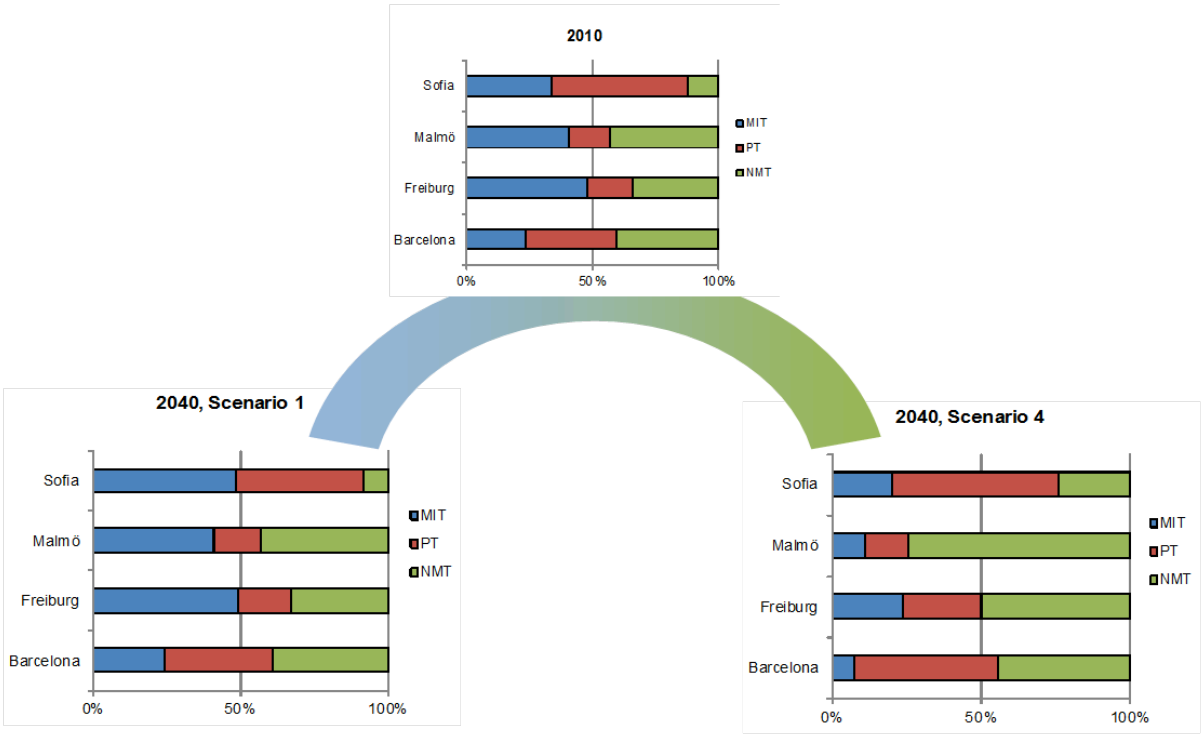


Figure 28: modal shares initial and expected for the four cities

Figure 28 summarizes the development of modal shares in the four OPM cities. Currently, the smaller cities of Freiburg and Malmö have higher car use than the larger cities of Sofia and Barcelona (top panel of Figure 28). In the technology-only based scenario (left panel of Figure 28), modal shares will remain mostly stable. The progressive scenario 4 (right panel of Figure 28), in contrast, demonstrates notable modal shifts: In the larger cities of Sofia and Barcelona, car drivers switch mostly to public transit and less so to cycling and walking. The smaller cities of Freiburg and Malmö switch mostly to cycling and walking, reflecting the comparatively shorter distances. These shorter distances can more easily be covered by non-motorized modes. The rise of electric bicycles might constitute an option where even distances up to 20-30 km are covered by two-wheelers on a regular basis, and providing a mode option also for hilly areas in Barcelona or Freiburg.

Figure 29, finally, summarizes the policy self-assessment of the four OPM cities. All cities have already important transport policies in place, notably with respect to public transit. Freiburg, Malmö and Barcelona have some explicit push policies in place, to limit congestion and other externalities in the crowded cities. Sofia has some distinct advantages, linked to its compact urban form and relatively low sprawl. But Sofia has to advance foremost on three policy fronts to initiate a more sustainable transport system: A) Monitoring of CO_2 emissions, air pollution and traffic flows; B) Developing a action program to lower CO_2 emissions and achieve sustainability targets by relying explicitly on public participation; and C) controlling automobile transportation in city that is not car dependent but still subject to considerable congestion, e.g. by enforced parking management. Malmö's main challenge is to handle the growing population by enabling transit-oriented

development and pricing car traffic along its main arteries. Freiburg, in turn, needs to keep with its progressive label as eco-city, and mainstream Vauban-like land-use planning into its master plans, limit parking and build bicycle highways also for the closer region. Freiburg, Barcelona and Malmö are all challenged by the need for increased regional cooperation to limit ex-urban sprawl and increasing rail-based suburban transit. An ambitious city toll, combined with bus rapid transit, could be a program for a high-profile municipal government in Barcelona.

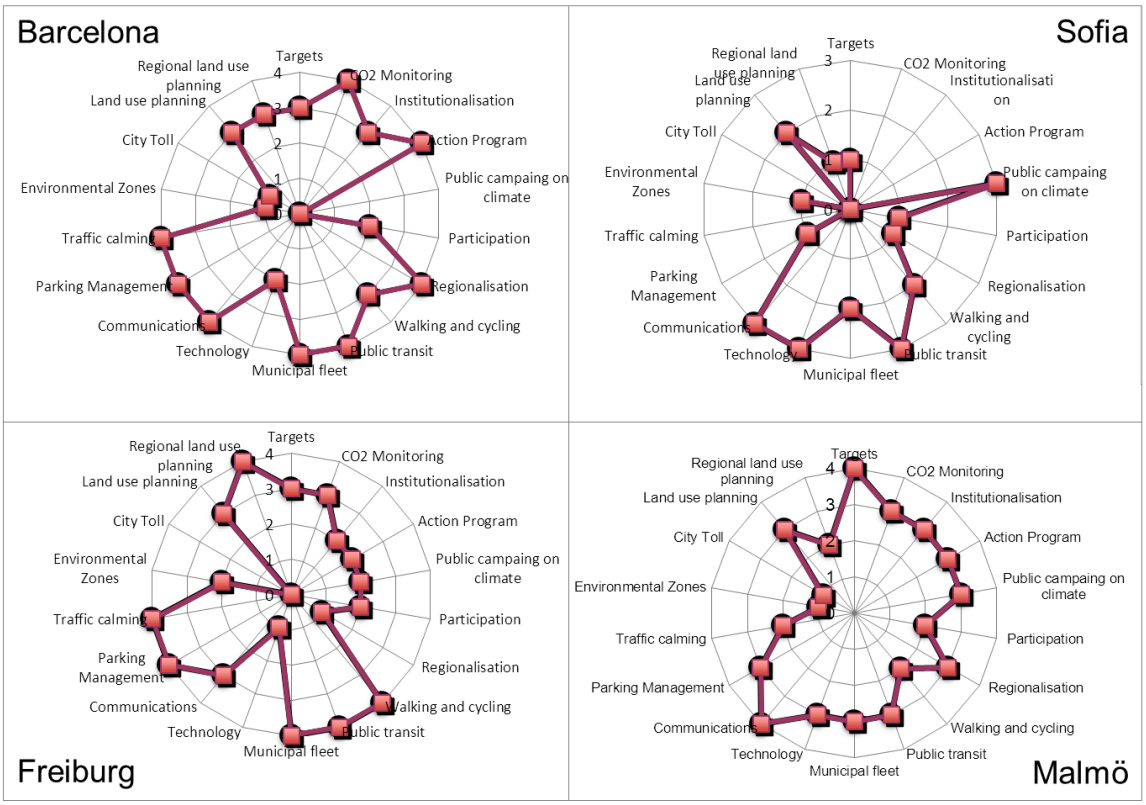


Figure 29: Policy self-assessment of the four cities. Note that Sofia expands only to level 3, whereas the other three cities expand up to level 4.

6. Conclusions

One Planet Mobility – Transforming Cities Towards Low-Carbon mobility demonstrates the feasibility of achieving ambitious mid-term greenhouse gas reduction targets. The approach chosen emphasizes the benefits of embedding the decarbonization of urban passenger transport into a coherent sustainability setting: A systemic change transforming the transport system and behaviour alike bring forth substantial improvements in terms of quality of life, and increase the resilience of the city and its inhabitants to future economic crises.

The problem self-assessments show that although the cities seem to be very different there are significant similarities due to the serious issues they have. For all of them air pollution and the state of public transit are essential problems they need to deal with. Noise pollution and the climate are crucial for three of the four cities, Barcelona, Malmö and Freiburg. Further the state of non-motorized transport is an important issue in Sofia, Malmö and Freiburg. According to the self-assessment equity seems to be no key problem in all of the cities except in Freiburg. Instead Freiburg is the only city without a high priority in the problematic of congestion.

The essentials of the transformation process are alike in all cities and are based on participatory involvement of citizens as a matter of democratic principle and to ensure stakeholder buy-in to fundamental changes. A reasonable approach starts in improving the environmentally-friendly modes, notable cycling, walking and public transit. Non-motorized transport, fortunately, is frugal and does not need huge investments, but rather careful design. Public transport can costs huge sums, but in dense and large cities, public transport will pay off in more efficiently transporting commuter crowds and increasing property taxes along rail-based transport. Notably, smaller cities like Freiburg and Malmö, can aim for up to 50% of cycling, possibly including e-bikes, whereas the larger cities of Sofia and Barcelona require public transport for the majority of its citizens.

The crucial ingredient for real transformation, however, is the political will to also limit the extent of car transportation in cities, i.e. to raise parking fees, limit parking space and possible introduce a inner city toll, a.k.a. congestion charge. It is these measures that push cities to notable reduction in GHG emissions while making other modes safer and faster, and by this improving overall accessibility and quality in transport.

For achieving the long-term goals, in addition to the policies suggested above, sound land-use planning will contribute to carbon lock-out and enable transit-oriented development, smart densification and appropriate balance between residential areas and jobs. Crucially, green-field development of retailers needs to be prohibited to avoid increased car dependence.

This research project has used a state-of-the art method to create a set of scenarios for low carbon mobility in four European cities. Most importantly it makes a clear case for each city about the existing opportunities to make use of a range of co-

benefits and create the sufficient political will to create cities that a are socially and environmentally sustainable with high quality of life for its citizens. It lays out a range of policies that need to be put into practice in a coordinated manner in order to bring the cities on a pathway of truly sustainable mobility.

However, as it was already acknowledged in the original project proposal for One Planet Mobility European Cities, a research project, a set of scenarios and policy recommendations – as much convincing and innovative as they might be – in itself will not create the transformational change so much needed in our cities. We therefore propose that the four project partner cities use results of this research project and start the implementation project of One Planet Mobility. The transformational change proposed in this report cannot be implemented by policy makers in a top down approach alone. It will require the active collaboration from change agents from all sector's of a city's society including business and leaders from civil society. We recommend that each partner city involves a range of key people (from local governemnt/administration, business and civil society) who have the will and capacity to contribute to the implementation of the scenarios. The aim would be to build project teams for different change and policy areas that would start exploring how the scenarios can be put into practice and start developing projects for change.

In addition and in a more long-term perspective it will be important to share the learnings from this project in the pioneer cities, with many other cities and inspire them to embarq on a similar journey.

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