Abstract

Currently, the transportation sector is responsible for about 30% of the CO$_2$-emissions. In the near future, this percentage is expected to increase, partly due to the further growth in mobility as well as a result of climate-friendly innovations and behavioral changes in other sectors such as housing and industry. CO$_2$-reduction in the mobility sector is difficult to achieve; as CO$_2$-emissions deriving from factories and houses are easy to identify, mobility related carbon emissions are not location-specific and therefore difficult to assign. In other words: there is not a clear ‘owner’.

The municipality of Breda (an ‘average’ Dutch city in the south of the Netherlands) has set a goal to be completely carbon-neutral by the year 2044. In this article we explain how traffic modeling can be used to gain a quantitative insight in assessing the potential for realizing the goal of a carbon neutral mobility system by the year 2044.

First, we defined four geographical ‘transport markets’: (1) inner city trips (directly linked to local transport policy), (2) regional trips within a distance of 7,5 km (the ‘bicycle fringe’), (3) regional public transport (cities with a direct train connections) and (4) the ‘remaining trips’ (the additional areas). By defining these four markets and geographically assign these to areas in a transport model, we were able to calculate the amount of future trips made by each transport mode. An additional CO$_2$-module connected to the traffic model gave insight in the amount of CO$_2$ emitted by each mode, specified on each geographical transport market. Inner city trips produce 17% of all CO$_2$-emissions, the regional ‘fringe’ 18%, trips related to areas connected by regional public transport 20% and the remaining area’s are accountable for 45%. By defining these ‘transport markets’ we were able to assign CO$_2$ emissions towards policy measures on both local and regional levels, which is needed in order to create a valuable discussion between stakeholders.

The second step was an assessment on the feasibility of these sustainable policy measures. We set up a multidisciplinary workshop in which we asked municipal experts which measures
would be suitable for the municipality and which reasonable effect could be expected. We used the 'Avoid-Shift-Improve’-framework, which prefers the avoidance of trips above a modal shift towards sustainable transport modes, which is preferred over cleaner fuels and electric vehicles. By calculating the effect of these strategies on modal shift, we were able to give insight in the 'reasonable potential' for the reduction of carbon emissions by the year 2044, which was 40% less CO₂ emissions compared to the business as usual scenario. This means the total amount of CO₂ emitted by the mobility sector within the municipality itself in this scenario will be equal to the level of 1990. This is however not enough to meet the political goals for 2044 to become a climate-neutral city. To reach the 2044 goal an additional reduction of 60% CO₂ from current emissions levels is needed.

The calculations were useful in order to have a 'sense' of realistic measures: where are we now and how far can we go? By setting up these discussions within a multidisciplinary team, connections can be made (on the level of content as well financially) between departments within the municipality such as urban development, economic and social policy, etc. This broadened the discussion on sustainable mobility, instead of a discussion about 'electric vehicles' or 'e-bikes'. Mobility was therefore positioned as a 'means for economic and social goals', not as a 'goal itself'.

By itself the municipality of Breda can reduce 10% in mobility related carbon emissions (the inner city emissions). For the remaining part collaboration is needed between public and private partners. This requires a different, more facilitating government role. Following this study, new bicycle and public transport action plans were made and measures implemented (the 'shift’-strategy). Next to this, the interdependence between urban development and mobility patterns was explicitly mentioned in the new strategic urban development plan, focusing on development within the city rather outside the city, reducing the need for mobility (the 'avoid’-strategy). Finally, ‘sustainability-sessions’ were set up between the municipality and private stakeholders, creating small-scale sustainable measures (the 'improve’-strategy).

**Keywords:** Sustainable mobility, Breda, Netherlands, Traffic modeling, CO₂-emission, SUMP, Sustainable Urban Mobility Plan
1 Mobility main contributor in sustainability debate

Sustainability is becoming a serious factor. The Dutch government has signed agreements on carbon-emissions which state that in the year 2020 these emissions should be reduced with 20% compared with 1990’s emissions. In 2050 carbon emissions related to the industrialized countries should be reduced with 80% compared to the figures from 1990.

Currently around 30% of Europe’s carbon emissions are related to transportation of people and goods. Within the sustainability debate the mobility sector will need special attention; in the future this percentage will rise, mainly as a result of innovations in other sectors such as housing, production industries and energy industries. In contrary to these industries, mobility as a sector does not have a clear ‘problem owner’ who should reduce mobility emissions. Neither the government, nor vehicle industries, nor the consumer is primarily responsible. Creating sustainable mobility needs a multi-actor approach, including all stakeholders.

Fig. 1 Projected carbon emissions in Europe: (Impact Assessment - Accompanying document to the White Paper on Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. SEC(2011))
One other issues is the geographical level: carbon emitted by mobility (or: transportation) will be harder to reduce as it is ‘fluid’ and not related to one particular geographical area. Most of the mobility (at least in the Netherlands) is regionally base. Therefore sustainable mobility policy on a local level will not be sufficient to reduce emissions. A regional or national approach will be necessary.

2 The sustainable mobility paradigm

It is recognized by many scholars that current transport planning is at a point of crisis: it underestimates the key challenges of current planning issues in terms of increasing congestion due to the growth of cities and CO$_2$-emissions (Banister, 2008). The question however is how the concept of sustainable mobility can be defined.

Sustainable mobility is a container concept and it is often explained differently by various stakeholders. It therefore is important to be precise about how this link between mobility and sustainability can be defined. Banister (2008) made a good attempt in his article ‘the sustainability mobility paradigm’ in how to achieve a more sustainable mobility system. He distinguishes four different possible actions:

1. The need to reduce travel (trip substitution)
2. Land-use policy measures (distance reduction)
3. Transport policy measures (modal shift)
4. Technological innovation (increase efficiency)

1. The need to reduce travel – trip substitution

The substitution of travel relates to the emergence of ICT and working from home. In its pure form it means that a trip no longer is made due to working from home, however in reality the consequences of working from home are more ambiguous. Nevertheless one cannot neglect that policy measures that encourage employees to work at home have positive effects on the sustainability of the mobility system.

2. Land-use policy measures – distance reduction

These policy measures have the main aim of distance reduction: the intention is to implement sustainable mobility into patterns of urban forms. One can think of increasing densities and concentration, or mixed use development (for example by combining shopping and living functions). Policy measures of this type are only possible when one (re)develops
neighborhoods, however when one explicitly addresses this at the design it has a dramatic effect on mobility.

3. Transport policy measures – modal shift

Transport policy measures can make the mobility system more sustainable by reducing levels of car use, promoting modal shift by stimulating walking and cycling and making the public transport system more attractive. Possible measures in this type of measures are road-pricing and promoting public transport when developing new neighborhoods, such as Transit Oriented Development.

4. Technological innovation – efficiency increase

Technological efficiency and behavioral change such as driving in a more sustainable manner make a mobility system cleaner and more efficient. It is therefore important to use the best available technology and stimulate these technologies. One can think of for example electric cars.

This definition of sustainable mobility will be use in order to propose measures improving sustainable mobility in our case-study of Breda in the Netherlands.

3 Case-study: Creating a sustainable urban mobility plan in Breda, Netherlands

Breda is a city of 180.000 inhabitants in the southern part of the Netherlands. Breda could be described as a ‘typical average Dutch city’: a medieval urban core, surrounded by different expansion added mostly during the 20th century. The municipal political decision makers have a goal to make Breda a climate-neutral city by the year 2044, meaning the city as a whole (including industry, energy, housing and mobility) does affect the climate by adding more carbon emissions than it can absorb. All energy the city needs should be sustainable. Any surplus of carbon emissions should be compensated.
3.1 Step 1: Where do we stand now?

First a benchmark was performed on the modal use of comparable cities in the Netherlands. We used measured data from the source ‘Onderzoek Verplaatsingsgedrag in Nederland’ (OViN) and compared Breda with Arnhem, Groningen, Eindhoven en Tilburg.

Figure 3 shows the modal share of bike (upper) public transport (middle) and car (below) for internal trips made within the city (left graphs) and external trips made to and from the city (right graphs). Inhabitants of Breda and its region are cycling less towards and from the city, compared to similar cities in the Netherlands. Inner city cycling trips are average (apart from Groningen, which is due to its infrastructural pattern). A similar pattern is visible comparing public transport trips made towards and from the city; a relatively low figure is visible here (apart from Eindhoven, which has higher external cycling trips). The benchmark showed us a reasonable potential for increasing the modal share of sustainable transport modes, especially on external trips made.
We also compared CO$_2$ emissions, using the same source (OViN). Figure 4 shows the amount of CO$_2$ emitted per inhabitant (left) and per visitor (right) measured in 1.000kg CO$_2$ per year. The figures show a relatively high emission per inhabitant for Breda and an average emission for visitors.
Fig. 4 Benchmark $\text{CO}_2$-emissions related to mobility per inhabitant (left) and visitor (right) measured in 1000 kg $\text{CO}_2$ / year: (Onderzoek Verplaatsingsgedrag Nederland)

When zooming in at the city Breda it becomes visible 73% of all trips (internal and external combined) are made by cars and it is expected that in the future this number will grow further. This means the already stressed infrastructure will further get more congested as autonomous growth will occur and new developments will take place within the city. The municipality aims at stabilizing car trips in the future at current absolute level, meaning no extra car trips should be made. In order to achieve this goal, the modal share of car will have to decline to 55% in the total modal split. This would imply the share of public transport should increase from 2% to 10% and the share of bicycle trips should increase from 31% to 35% of the total modal split. This is described by the municipality as a ‘quantum leap’ for sustainable mobility planning in the city.

Fig. 5 Current modal shares (red) and idealistic modal share (green) in Breda, defined by absolute numbers of trips. All future growth in the amount of trips made should be accomplished by cycling and public transport trips: (Goudappel Coffeng, 2011)
The following can be concluded from step 1:

- Breda scores relatively low on the use of cycling and public transport on trips made to and from the city;
- Internal trips are comparable to other cities, though improvement is possible;
- More effort on increasing the modal share of bicycle and public transport will benefit the sustainability score (measured in mobility related CO$_2$-emissions of the city), which now are slight below that of comparable cities.

3.2 Step 2: Where do we go without any interference?

After getting an image of the relative position of Breda concerning modal use and CO$_2$-performance, the next step would be to get a grip on the carbon emission footprint of the municipal mobility system. We take the projective year 2020 of the municipal traffic model in order to use make calculations. In order to get a grip on flows of traffic and their implications on carbon-emissions, we distinguished four main ‘transportation markets’:

1. Internal trips: mobility within the municipal boundaries of Breda;
2. Bicycle fringe: mobility flowing in and out of the municipality which has an origin or destination within 15 km distance from the city, such as: Alphen-Chaam; Dongen; Drimmelen; Oosterhout; Rucphen and Zundert;
3. Public transportation market: cities with a direct train connection, such as Bergen op Zoom; Dordrecht; Roosendaal and Tilburg;
4. External traffic: the remaining flows of traffic having an origin or destination in Breda.

Figure 6 shows the four transportation markets and its geographical boundaries. The definitions are based on ‘owners’ for measures: inner city traffic can be affected by municipal policy, the short distance trips are potentially interesting for the upcoming e-bike, public transport is related to national policy and the Dutch Railways. The latter category consists of remaining trips and is harder to assign to a particular stakeholder.
After assigning these mobility markets, we used the municipal traffic model for quantising flows of traffic within and between these markets. Only trips having an origin and/or destination in Breda are included. Passing vehicles (for example on highways) are left outside of these calculations. The reason for doing so is to get a clear idea of municipal related flows of mobility.

Fig. 6 Transportation markets: (Goudappel Coffeng, 2011)

Fig. 7 Modal share in total and of transportation markets. Green is cycling, red is public transport, blue is car: (Goudappel Coffeng, 2011)
Table 1  Amount of trips yearly made per mobility market (Goudappel Coffeng, 2011)

<table>
<thead>
<tr>
<th>Mobility market</th>
<th>Total</th>
<th>Car</th>
<th>Public transport</th>
<th>Bike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal traffic</td>
<td>402.500</td>
<td>56%</td>
<td>226.000</td>
<td>10.900</td>
</tr>
<tr>
<td>Bicycle fringe</td>
<td>170.800</td>
<td>24%</td>
<td>142.100</td>
<td>3.100</td>
</tr>
<tr>
<td>Public transport market</td>
<td>74.000</td>
<td>10%</td>
<td>55.600</td>
<td>18.300</td>
</tr>
<tr>
<td>External trips</td>
<td>76.900</td>
<td>11%</td>
<td>58.500</td>
<td>18.300</td>
</tr>
<tr>
<td>Total</td>
<td>724.200</td>
<td>100%</td>
<td>482.200</td>
<td>50.100</td>
</tr>
</tbody>
</table>

Figure 7 shows the percentages of trips made to and from a certain transportation market, categorized by transport mode. Internal trips make up 56% of all trips made. The modal share of inner city cycling trips is 41%. Cars make up for 56% of all inner city trips and public transport 3%. Looking at the ‘bicycle fringe’ (which make up 24% of all trips made), 15% of all trips are made by bike, 2% by public transport and 83% made by car. A quarter of all trips made to and from neighbouring cities (10% of all trips made) are made by public transport (train). Regarding the rest of the surrounding areas, a similar image is visible.

We multiplied the amount of trips by the length and further multiplied these figures with carbon emission factors. This gives an overview of the amount of carbon emissions produced by traffic flowing within, towards and from the city. The total amount of CO\(_2\) emitted by transportation on land to and from Breda on a yearly basis is 0.37 Mton\(^1\). To give a point of reference: the total amount of CO\(_2\) emitted by transportation on land in the Netherlands is around 32 Mton (figures for 2007) and for cars only this number is 19 Mton (source: CBS Netherlands). When elaborated this 0.37 Mton of CO\(_2\) onto the four mobility markets, the following figure is visible: internal trips are responsible for 17% of all emissions; trips made to and from the surrounding area 18%, trips made to and from neighbouring cities 20% and all further external trips account for 45% of all carbon emissions.

This gives a first insight in the possibilities for developing a sustainable mobility action plan. The calculations showed the division of carbon emissions. ‘Only’ around one fifth of all emissions can be located within the municipal boarders. For the remaining 80% trips between municipalities are responsible. This gave us the first lesson: sustainable transport

\(^1\) 1 Mton = 1.000.000.000 kg or 1 billion kg
policy is mainly effective when being implemented on a regional scale. Municipal policy alone is not enough. It also gave further directions for regional policy measures: it is reasonable to think regional cycling and public transport-trips can be enlarged, considering the modal share in these markets.

Fig. 8  Carbon emissions of trips made within, towards and from Breda, per mobility market: (Goudappel Coffeng, 2011)

Based on these figures, each mobility market’s carbon emissions is further elaborated by transport mode (car, freight and public transport; bike is carbon neutral). Public transport has a low emission factor; freight accounts for a large factor.

Fig. 9  Transport related CO₂-emissions measured in kton/year divided on modality and mobility market (Goudappel Coffeng, 2011)
Table 2    Amount of CO$_2$-emissions measured in kton / year divided on modality and mobility market: (Goudappel Coffeng, 2011)

<table>
<thead>
<tr>
<th>Mobility market</th>
<th>Total</th>
<th>Car</th>
<th>Public transport</th>
<th>Freight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal traffic</td>
<td>64</td>
<td>17%</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Bicycle fringe</td>
<td>67</td>
<td>18%</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>Public transport</td>
<td>75</td>
<td>20%</td>
<td>39</td>
<td>7</td>
</tr>
<tr>
<td>market</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External trips</td>
<td>164</td>
<td>44%</td>
<td>61</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>370</td>
<td>100%</td>
<td>198</td>
<td>18</td>
</tr>
</tbody>
</table>

In total 53% of all emissions are due to car; 42% is related to freight. Inner city car trips make up 13% of all emissions (50 kton out of 370 kton). Car trips made to and from the bicycle fringe make up another 13% of all emissions (48 kton out of 370 kton). So about a quarter of all transport related CO$_2$-emissions can easily be shifted to sustainable modes of transport as they are short distance trips. Another 10% can be reduced when trips to and from the surrounding cities connected to public transport are shifted from car to train. Adding these figures, a third of all transport related CO$_2$ emissions have a reasonable potential to be performed by sustainable transport modes, such as walking, cycling and public transport.

Next to this, freight transport makes up a significant portion of emissions: 16% of all emissions are due to transport of goods within the city and to and from the bicycle fringe and surrounding cities. A larger part (44% of all emissions) is related to (inter)national transport, this is due to Breda’s geographical location along international transport corridors.

The following can be concluded from step 2:

- A third of all transport related CO$_2$-emissions have a reasonable potential to be transformed to sustainable modes of transport. Policy measures focusing on sustainable mobility should be focused on a modal from car to sustainable modes of transport especially on short distance trips (<15 km) within the city and to and from the surrounding region.
• Over another third of all emissions are related to transport of goods. On this topic (inter)national policy measures are needed in order to increase sustainability.

3.3 Step 3: Designing sustainability measures

The analysis of the mobility system of the city and its emissions gave us insight in the current state of emissions and its potential for creating a more sustainable mobility system. The next was designing sustainability measures and assessing its impact on the total CO₂ emissions. We used the sustainability framework from Banister (2008) and ‘translated’ this framework into four possible strategies, naming:

1. Avoid (avoid trips made through substitution by for example ICT);
2. Reduce (reduce distance & travel time reduction by infrastructural & land use measures);
3. Shift (modal shift towards sustainable transport modes);
4. Improve (increase efficiency by technical innovation).

Fig. 10 Sustainable mobility strategies:(Goudappel Coffeng, 2011)
During a workshop with a diversity of policy makers from the municipality of Breda, we translated these strategies into measures relating to sustainable transport. Next to that, we made an estimation what the effect would be on the modal split of Breda. In other words: what would reasonably be expected from a measure, considering the current modal split and the geographical setting of the city? This resulted in a number of 8 measures and it’s expected implications:

**AVOID:**

- **Teleworking:** new ICT developments and a shift in working regulations between employers and organisations will reduce the amount of commuting trips with 20% within 5 years;

**REDUCE**

- **Land-use measures:** Park & Ride and Transit Oriented Development are expected to reduce distance of car-trips with 10% on the long term as it takes time as commuters gradually will change travel behaviour;
- **Mobility-management:** Pricing measures, behavioural measures (using new smartphone technology) is expected to result in a 10% higher utilization degree of cars commuting within 5 to 10 years;

**SHIFT**

- **Stimulating the use of (e-)bike:** the rise of the e-bike are expected to increase bicycle use within the city and regional trips with 25% within 5 years time;
- **Stimulating the use of public transport:** Stimulating measures are expected to increase the use of public transport within the city and regional trips by 25% within 5 years time;

**IMPROVE**

- **Electric cars:** the gradual introduction of electrical cars over the last years are expected to increase the use of electrical cars by 25% between 5 till 10 years time;
- **Bio-fuels for freight:** the gradual introduction of bio-fuels for freight are expected to increase the use of sustainable bio-fuels by 25% between 5 till 10 years time;
• **Clean Public Transport:** it is expected clean public transport will reduce CO$_2$-emissions with 100% within 5 till 10 years time.

After setting up these measures, we calculated the effect with the same traffic model and CO$_2$-tool used in the previous steps. By changing the parameters in the model we are able to give an estimation of the effect on modal split and CO$_2$-emissions:

- Tele-working reduce 20% of trips made and will reduce CO$_2$-emissions by 4%;
- Land-use measures reduce 10% of trip-distances and reduce CO$_2$-emissions by 5%;
- An increase of 10% utilization degree in cars will reduce CO$_2$-emissions by 2%;
- An increase of 25% of bicycle trips reduce CO$_2$-emissions by 2%;
- An increase of 25% of public transport trips reduce CO$_2$-emissions by 1%;
- A share of 25% of electric cars (well to wheel) reduce CO$_2$-emissions by 13%;
- A share of 25% of bio-fuels for freight transport reduce CO$_2$-emissions by 11%
- Clean public transport (well 2 wheels) reduce CO$_2$-emissions by 5%;

Adding these figures, the measures above would imply a reduction of transport related CO$_2$-emissions of 43% in 2044, compared to the autonomic situation expected in 2020. In terms of CO$_2$-emissions this means a reduction of 0,15 Mton of CO$_2$ (from the projected amount of 0,37 Mton). To give a reference, this amount of saved emissions corresponds to the isolation of 300,000 houses. A Breda has around 84,000 households; this would imply over 3 times the amount of houses in the city.

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2The traffic model used consisted of the future scenario of 2020. We used this model in order to assess effects for the 2044, not changing demographical, infrastructural or economical parameters. Only primary effects were calculated, no secondary land use changing or modal substitution-effects are taken in account.
Fig. 11: Sustainable mobility measures and their effects on reduction of CO₂-emissions in 2044 (Goudappel Coffeng, 2011)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Policy term</th>
<th>Mobility effect</th>
<th>CO₂-effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teleworking</td>
<td>&lt; 5 years</td>
<td>-20% trips made in general</td>
<td>-4%</td>
</tr>
<tr>
<td>Land-use measures</td>
<td>&gt; 10 years</td>
<td>-10% distance in car trips</td>
<td>-5%</td>
</tr>
<tr>
<td>Mobility management</td>
<td>5-10 years</td>
<td>+10% utilization degree</td>
<td>-2%</td>
</tr>
<tr>
<td>Stimulating use of (e-)bike</td>
<td>&lt; 5 years</td>
<td>+25% more bicycle trips</td>
<td>-2%</td>
</tr>
<tr>
<td>Stimulating use public transport</td>
<td>&lt; 5 years</td>
<td>+25% public transport trips</td>
<td>-1%</td>
</tr>
<tr>
<td>Stimulating use of electric cars</td>
<td>5-10 years</td>
<td>25% cars are electric</td>
<td>-13%</td>
</tr>
<tr>
<td>Stimulating bio-fuels freight</td>
<td>5-10 years</td>
<td>25% bio fueled freight</td>
<td>-11%</td>
</tr>
<tr>
<td>Clean public transport</td>
<td>5-10 years</td>
<td>100% clean public transport</td>
<td>-5%</td>
</tr>
<tr>
<td>TOTAL EFFECT</td>
<td></td>
<td></td>
<td>-43%</td>
</tr>
</tbody>
</table>

The following can be concluded from step 2:

- The calculations showed that it is to expect that around 40% of all CO₂-emissions can be reduced within 30 years time, using current parameters and knowledge;
- As the majority of trip kilometers are made by car, short term measures such as improvement of vehicles efficiency will have a large effect on CO₂-emissions;
- Long term effects such as stimulation of bicycle use and the use of public transport will have a smaller effect on CO₂-emissions.
3.4 Step 4: where do we end up?

Breda has set a goal to be a climate-neutral city by the 2044. In order to do so, the city is implementing a set of measures to reduce the use of fossil fuels and transfer to sustainable fuels. Within the transport sector, achieving these goals is challenging. The calculations showed that a reduction of around 40% of transport related CO$_2$-emissions is possible within the timeframe of 30 years, considering certain demographical, infrastructural and economical parameters. But how does this relate to the expected change within these parameters?

Looking back at mobility growth between 1990 and 2010, the Netherlands has experienced a growth in the amount of carkilometers travelled of around 35% (Centraal Planbureau Nederland). Projecting trends, between 2010 and 2044 another 30% growth of automobile use is to be expected (using the SE-scenario, which impels a modest growth). This implies an indexed growth of 80% of CO$_2$-emissions between 1990 and 2044, excluding any sustainability measures taken by the government.

As measures are being taken in national policy, for example restriction in emissions for cars, the average emission per car is lowering and is expected to further decline. This will imply the amount of CO$_2$-emissions will grow 50% instead of the projected 80% by the year 2044. Adding the measures calculated in the previous steps, this would imply the transport related CO$_2$-emissions of Breda would level the amount of 1990, as shown in figure 9 for personal transport, freight transport and public transport.

The analysis showed the transport related CO$_2$-emissions will further rise between 2010 and 2044. Considering the municipal goals to become a climate-neutral city in that year, next to national measures, additional local measures are needed to reduce the emissions and meet the goals set.
Fig. 12 Trend projection of transport-related CO\textsubscript{2}-emissions in Breda: (Goudappel Coffeng, 2011)

4 Policy implementation: Sustainable Urban Mobility Plan

The analysis was a means in achieving a sustainable mobility system for the city of Breda. It gave insight in the current and expected state considering CO\textsubscript{2}-emissions and the effect of possible policy measures. It therefore had two functions:

- it gave insight in the effect of mobility measures on sustainability goals of the city and
- it gave insight in the importance of intersectoral and interorganisational cooperation in order to achieve these goals.

What can we conclude from this analysis for general sustainable mobility policy?
4.1 Lessons learned for policy

- Both short term and long term measures needed

As cycling and public transport often are mentioned as the main solutions towards a sustainable urban transport system, a majority of trips are still made by cars. In order to reduce car use with 1%, this would imply a multitude of cycling trips to be made. This explains the relatively low outcome of CO$_2$-reduction when increasing bicycle or public transport use with 25%. Contradicting these figures, measures such as implementation of electric cars and bio-fuels for freight transport will have a larger effect on the reduction of CO$_2$-emissions. The figures are the result of model calculations, including primary effects on the short term. On the longer term though, people will change behaviour that will further enhance modal shift effects. On the one hand the modal shift towards bike and public transport can further increase as infrastructural and behavioural policy measures are taken to stimulate these modes of transport and/or discourage unwanted car use. On the other hand will technical improvements such as electrification of cars and the use of bio-fuels have a 'one-time' effect: once electrified the effect will be accomplished, although people still will drive and mobility and accessibility problems will not be solved. Therefore both long term and short term measures are needed in policy.

- Integrated municipal policy approach strengthens results

The measures proposed have further effects than reducing CO$_2$-emissions and therefore need to be analysed within a bigger perspective, including social, environmental and economic aspects such as livability (pollution, noise), accessibility (parking, traffic jam) and attractiveness (safety, social cohesion) of the city. Electrical cars will not solve accessibility problems for example.

- Intergovernmental and public-private cooperation deeded

The municipality of Breda will not be able to implement all measures due to legal, technical of financial restrictions. Therefore cooperation with private stakeholders is needed in order to get measures implemented (such as mobility management or electric vehicles cars). In the end, sustainable mobility is starting with people rethinking their mobility needs and habits. Next to this, cooperation between municipal sectors (such as infrastructure planning, urban renewal and economy) and between municipalities themselves is needed in order to create a regional sustainable mobility infrastructure. Public transport is provided by the Provincial
government and certain legal measures need to be taken on national or even international level.

4.2 Sustainable mobility planning in Breda

The municipality of Breda has been implementing measures to promote sustainable mobility. A large effort is being put on enhancing bicycle use in and around the municipality. The municipality has adopted a methodology focusing on specific user-needs and lifestyles. This ‘bottom-up’ approach is part of its philosophy to focus on demand instead of supplying infrastructure.

The municipality of Breda has set up ‘Climate Tables’ in which the government, local industries and other stakeholders are working together on creating a climate neutral city. These tables function as platform for agreements and action plans. The study also led to the creation of a sustainable urban mobility plan (SUMP) for the city of Breda. This plan was part of a process which included action plans such as a municipal public transport plan, an action plan for cycling and an environmental action plan. By doing so, the municipality is applying a ‘town-down’-policy approach that will facilitate a ‘bottom-up’-action plan approach, supported by the Climate Tables. The sustainable mobility plan is based on three main ‘tracks’ also used in the Dutch infrastructural design approach ‘Duurzaam veilig’ (translated as sustainable traffic safety):

- **Environment**: measures on urban & Infrastructural development
- **Vehicle**: measures enhancing vehicle efficiency
- **User**: measures creating a modal shift towards sustainable mobility behavior

![Fig. 13 Three policy tracks for SUMP: environment, vehicle, user (Goudappel Coffeng, 2011)](image-url)
The municipality does not have a similar role in implementing measures on all three tracks:

- **Environment:** urban and infrastructural measures belong primarily to the municipality such as implementation of urban development plans;
- **Vehicle:** vehicle efficiency primarily belongs to manufacturers. Policy measures are largely connected to national laws and partly local policy;
- **User:** user behaviour is part of municipal policy plans, but also need to be promoted by private parties and awareness campaigns.

Next to this, the analysis give input for the ‘Mobiliteitsaanpak Breda (MAB)’ – or Mobility-approach Breda – which was included in the Municipal Strategic Development Plan 2030. This plan is a master plan, functioning as a framework for the development of the city until 2030, integrating urban and infrastructural development, mobility management, economic development and social development. The main contribution is the shift from development outwards of the city towards development within the city. The Development Plan therefore aims at the ‘Avoid’ and ‘Reduce’ strategy, limiting the need to travel. Next to this, the plan strongly emphasizes public transport and bicycle accessibility within the majority of the city, aiming at the ‘Shift’–strategy.

Fig. 14: Overview of Municipal Development Plan Breda. The number represent urban renewal projects: (Gemeente Breda, 2013)
Conclusions

The case described in this article was a pilot-study on creating sustainable mobility. By using data, instruments and a traffic model we were able to analyze the mobility system of an average Dutch city such as Breda is in the Netherlands. It gave insight in the performance of the mobility system, considering the CO\textsubscript{2}-emissions. In doing so, we made a translation from the ‘mobility’ domain to the ‘sustainability’ domain.

The study was a starting point in further policy development and measures. It gave political awareness and created budgets for implementation of policy and measures: on a policy level connections have been made between urban development, environmental policy and mobility actions plans such as cycling plans and public transport plans.

Creating a sustainable mobility system – and therefore a sustainable city - though is more than analysis: in the end policy needs to be economical feasible in order to stimulate private stakeholders to implement measures. It also needs to adapt to user preferences in order to gain success. In times of limited budgets and growing needs for a sustainable city, experimental measures on a small scale, focusing on users’ needs and connecting to multiple goals such as livability, accessibility and sustainability are expected to be successful. Sustainability often starts small and will – in case of success - eventually have a large impact on people’s lives and the city itself.

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