A comparative cost-benefit analysis of cycling within the Benelux and North Rhine-Westphalia

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Departement Mobiliteit & Openbare werken (Flanders)
Service Public Wallonie, Mobilité et Infrastructures (Wallonia)
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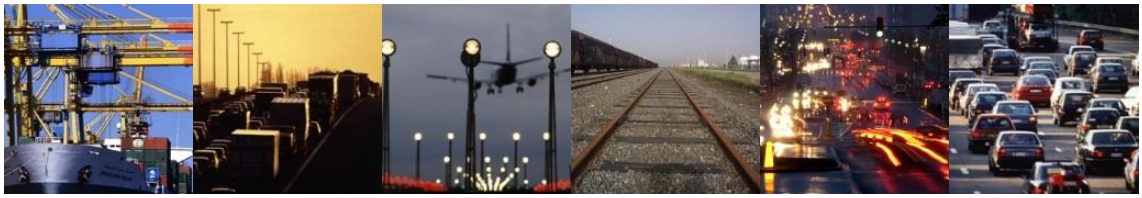
Author: Rosanne Vanpée, Bruno Van Zeebroeck

Graphics by Jan Vossen



Transport & Mobility Leuven
Diestsesteenweg 57
3010 Leuven
Belgium
http://www.tmleuven.be

Executive summary

Cycling is an active form of passenger transport that plays an unique role in our transport system. Riding a bicycle provides **affordable transport, improved health and enjoyment**. Regular cycling benefits users directly, but there are also **significant gains for society** as a whole. This means that even people who do not use a bike, benefit from others who do.

In this project, we investigate the **social costs and benefits of cycling in the Benelux and North Rhine-Westphalia (NRW)**. We investigate the potential for cycling in this region and analyse the benefits than can be achieved by a modal shift from passenger cars or public transportation to bicycles. Next, we develop a case study on a potential **cross-border cycling highway** between Arlon and Luxembourg. Finally, our study leads to specific **policy recommendations** to further stimulate cycling in the region.

Policy context: regions and countries have their cycle plans

Because of the large social benefits of cycling, there is growing attention for cycling among public authorities and policy makers. Recently, several countries and regions developed dedicated action plans to stimulate cycling. We name a few examples:

- In Germany, the **National Cycling Plan 3.0 (NCP3.0)** has the ambition to transform to country into a cycling nation. By 2030, the NCP3.0 foresees a significant increase in cycling mileages.
- The Belgian government has developed the **Be Cyclist Action Plan** that contains several action points from 2021 to 2024 to stimulate a regular use of the bicycle.
- In Luxembourg, a key role to cyclists is given in the **National Mobility Plan 2035 (PNM 2035)**. The PNM 2035 has the objective to drastically increase the modal share of cycling through integrating high-quality cycling infrastructure in all road projects.
- **National Cycling Vision of the Future** is a product by the Tour de Force. It presents the measures and investments needed to further stimulate cycling in the Netherlands.

Several initiatives exist to stimulate cycling. All countries provide **financial incentives** to cyclists, although in different forms. While Luxembourg offers a generous subsidy for the purchase of a new bicycle, a bicycle commuting allowance is granted in Belgium, the Netherlands and NRW. Apart from these national incentives, regional and local financial support for cycling exists.

Apart from these financial incentives, cycling is stimulated through the investment in new or existing **cycling infrastructure** and the creation of dedicated **cycling networks** (e.g. Holland Cycling Routes, Fietsnet, RAD Verkehrsnetz).[1,2,3]

Cycle highways encourage and accommodate cycling over longer distances. A cycle highway is a high-quality cycling route consisting of cycle lanes or tracks that separate cyclists from other road users.[4] They serve as transport corridors and typically connect two main cities. They accommodate

[1] https://www.hollandcyclingroutes.com/
[2] https://www.fietsnet.be/routeplanner/default.aspx
[3] https://www.radverkehrsnetz.nrw.de/
[4] https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/cycling/guidance-cycling-projects-eu/cycling-measures/13-cycle-highways_en

commuters, students and tourists. Cycle highways lead to lower travel times for cyclists and improve traffic safety. However, they are expensive to build, so should be used intensively to justify the costs.

Cost-benefit analysis of cycling in the Benelux and NRW: EACH KM CYCLED PROVIDES A BENEFIT TO SOCIETY

In the cost-benefit analysis we identify and monetize all costs and benefits that sprout from cycling and compare them with the costs and benefits of other modes for passenger transport. We include **private costs and benefits** and **external effects**. Together, they determine **the net social costs (if negative) or benefits (if positive)** of cycling. We do this for each of the Benelux countries and for NRW.

In the cost-benefit analysis, we consider the following aspects:

- **Total costs of ownership**: in general, a bicycle is cheaper to own and use than a passenger car.
- **Time costs**: because bicycles are slower than other modes of transport, they incur higher time costs to the user. However, this is not always the case in an urban environment, where (e)-bikes move faster than cars. In addition, bicycle riders loose less time searching for a parking spot.
- **Congestion costs**: driving a passenger car leads to significant congestion costs, which can be avoided by riding a bicycle.
- **Health benefits**: cycling contributes to physical and mental health, leads to lower mortality rates and prevents serious diseases. Regular cycling leads to savings in social security costs and a higher labour productivity.
- **Emissions**: while a passenger car emits CO_2 and other air pollutants like fine particles, bicycles generate no direct emissions. Therefore, riding a bicycle instead of a car reduces the CO_2 footprint and contributes to cleaner air.
- **Accidents**: currently accident risk and accident costs of cycling are higher than those of other passenger transport modes. To improve safety for all road users, investments in cycling infrastructure that separates cyclists from other road users are needed.
- **Noise**: bikes are silent. Cycling does not create noise pollution, in contrast to passenger cars, buses and trains.
- **Occupation of public space and quality of the living environment**: bicycles require less space than cars, both for parking and when in motion. In addition, cycling areas improve the liveability of a neighbourhood and prevent urban sprawl.
- **Infrastructure**: cycling infrastructure costs significantly less than road infrastructure for cars or public transportation.

We monetize all the above mentioned effects of cycling for the Benelux-NRW region. Country-specific costs and benefits are provided in the report. The social costs and benefits of the different passenger transport modes are represented by the black line in the figure below. They are comprised of private costs and benefits and external effects.

Every kilometre covered by a bicycle generates a net gain to society. The net benefits from riding a push bike are equal to 98 eurocent per kilometre. Each kilometre covered by an e-bike yields 22 eurocents in social gains. In contrast, a trip by car (as driver or as passenger) leads to a social cost of € 1.02 per km. **Differently put, if 100 000 people commute to work by push bike**

over a 5-km one-way distance, they generate a total benefit of 196 million euro per year. If they commute by car, they create a cost of 203 million euro per year. Of this total cost, 89 million euro is carried by the car user, but 114 million euro is for the rest of society to bear.

The costs of riding a speed pedelec are all borne by the user (private costs). The external effects of speed pedelecs are positive, meaning that the rest of society benefits from speed pedelec activity.

The reason why cycling is so beneficial to society is mainly because of the positive health effects from regular cycling. Cycling prevents premature death and many severe and chronical diseases. It contributes to a healthier and happier life. These positive health effects are translated into lower social security expenses, a higher level of labour productivity and reduced absenteeism from work. Because the value of labour productivity in the Benelux-NRW is relatively high, the **productivity gains from cycling lead to high economic gains**. The positive health effects from cycling are so large that they compensate all related costs, including the costs of infrastructure. Therefore, **an investment in cycling infrastructure is an investment in public health**.

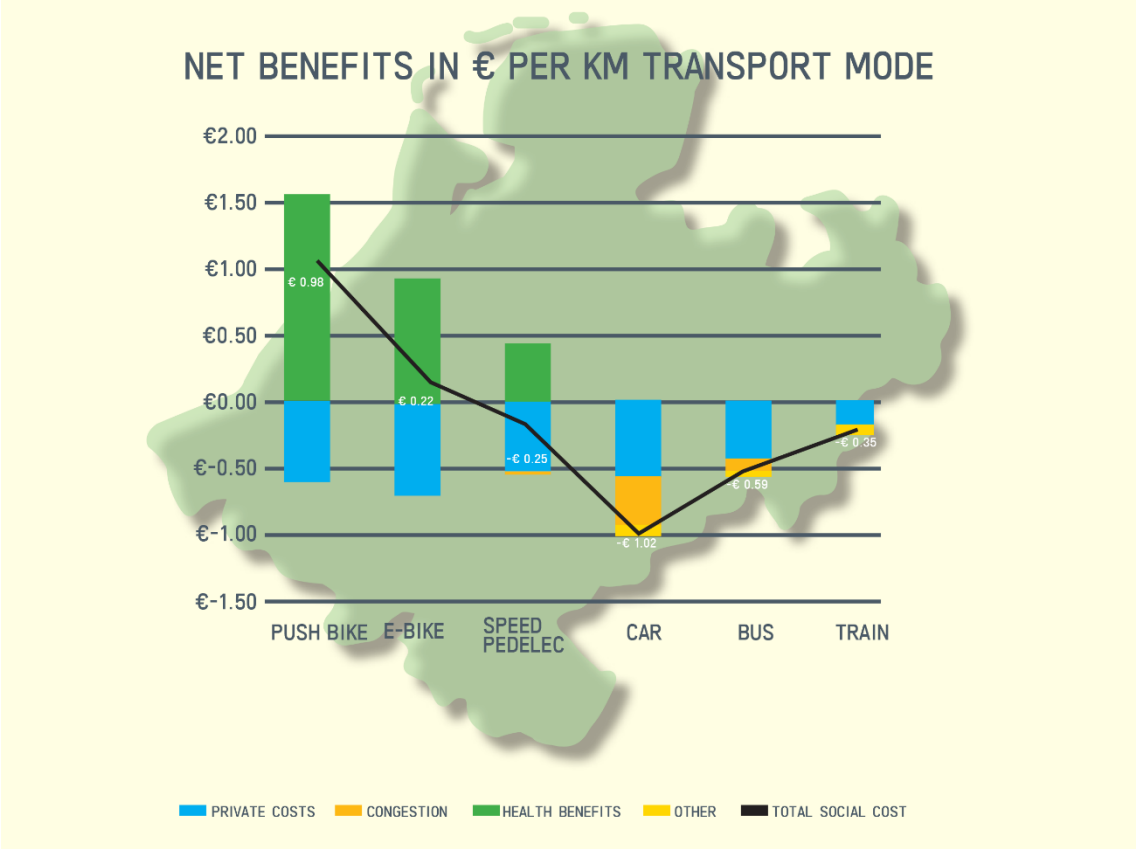


Figure 0-1 Social costs and benefits of passenger transport in the Benelux and NRW

The social costs and benefits represented in the figure above are expressed in per kilometre terms. When we take into account the average mileage of each transport mode, we can calculate the total benefit or cost an average person creates when choosing a mobility mode. **Every cyclist generates a net benefit ranging from € 260 to € 694 per year**. **Each car that drives 15 000 km per year, causes an annual social cost of € 15 227**.

Our results imply that **the economic value of a modal shift from passenger cars to bike rides is very large**. In per-kilometre terms, a modal shift to cycling is the highest for push bikes. A modal shift from passenger cars to biking leads to the largest benefits to society. The benefits are the result of the positive health effects that cycling generates, combined with the savings in congestion costs from lower car use. Other effects such as avoided CO2-emissions, clear air and avoided noise pollution also contribute to the social gain of a modal shift to cycling.

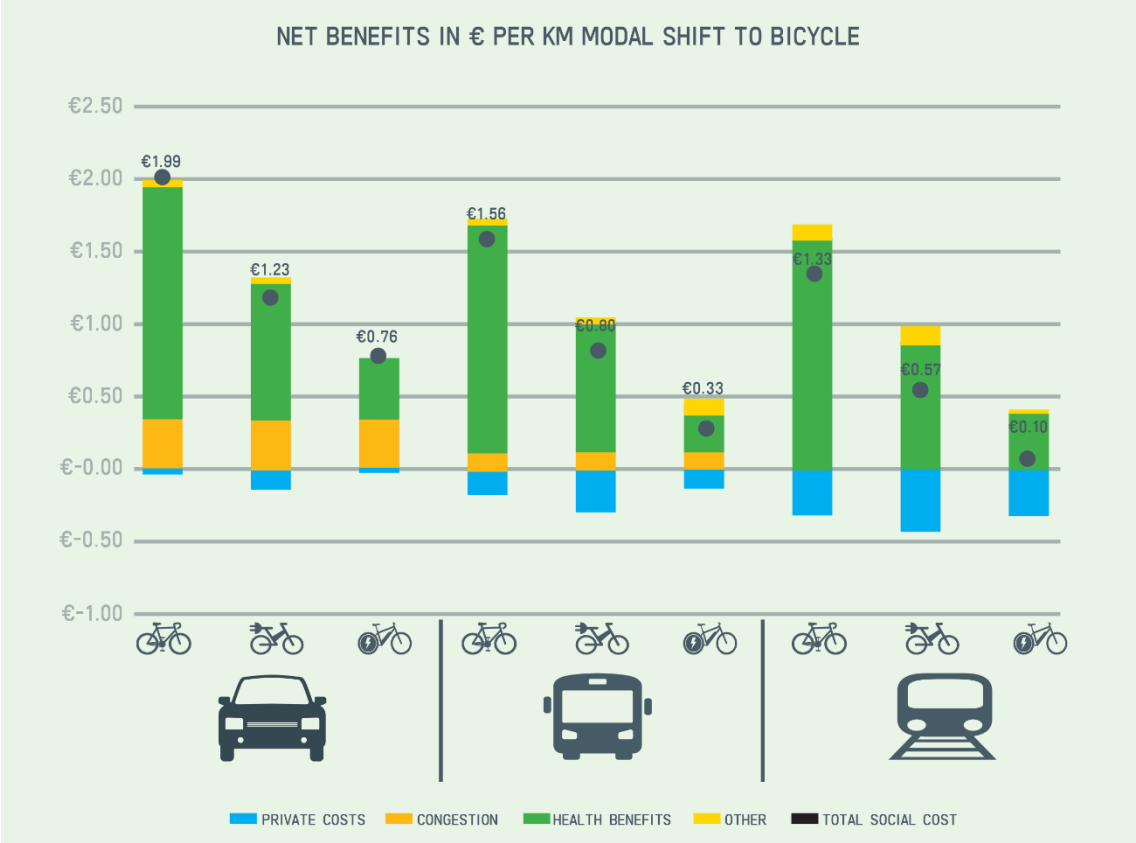


Figure 0-2 Impact of a modal shift to cycling in the Benelux-NRW

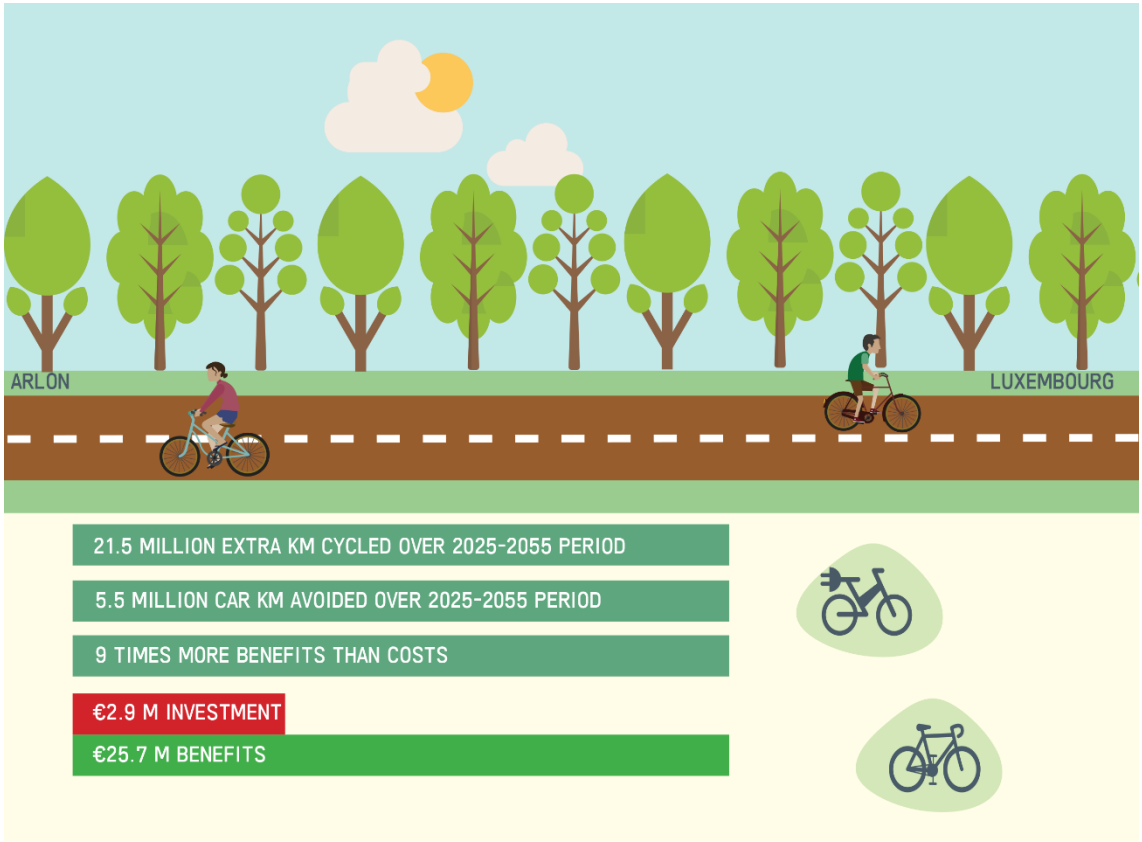
The lower per-kilometre gains from a modal shift to pedal-assisted bicycles are largely compensated by the higher distances covered on these bikes. Research shows that the average distance travelled on an e-bike is 1.7 times longer than by a push bike. Speed pedelecs cover trips that are 4 times longer on average that push bike rides. Each five-kilometre car trip that is replaced by a ride on a push bike leads to a net social gain of 10 euro. A 8-km car trip that is exchanged for an e-bike ride yields 9.8 euro to society. Riding a speed pedelec instead of a passenger car over a distance of 20 kilometres yields even 15.5 euro in social benefits.

Because 44% of all passenger car trips have a shorter distance than 5 km and 79% of all car trips are shorter than 20 km, the potential social benefits of a modal shift to cycling are enormous.[5] If **1% of all passenger-kilometres by car in the Benelux-NRW are replaced by bicycle kilometres** (40% push bikes, 40% e-bikes, 20% speed pedelecs), a **net social gain of € 13.6 billion** can be realised.

[5] Monitor (2019).

A modal shift from public transport to cycling also results in social gains, although lower than when a car trip is replaced. In addition, train rides typically cover large distances that are not easily exchanged for bike rides. Therefore, the focus should be on accommodating **multimodal bicycle-inclusive mobility** rather than a modal shift from public transportation to cycling. Multimodal trips combine the advantages of cycling with those other transport modes (Tetteroo, 2015) (BiTiBi, 2016).

Case study: Arlon – Luxembourg cycling corridor: at least 80% more benefits than costs with a significant upgrade of existing infrastructure



Arlon-Luxembourg: highest cross-border potential and no existing plans

We investigate the potential of several cross-border cycle highways. Connections with the highest potential are:

- Arlon-Luxembourg
- Gent-Terneuzen
- Venlo-Mönchengladbach/Krefeld
- Maastricht-Genk/Hasselt
- Heerlen/Landgraaf Aachen

Among those, the Arlon-Luxembourg connection provides the highest potential. It is also the only corridor for which no cycle highway is planned already.

Two cycle highway alternatives: upgrading existing infrastructure or building a new cycle highway

Among four alternative possibilities for the cycle highway, we short-listed two alternatives: a scenario that involves upgrading existing infrastructure (alternative 2), and a scenario that consists of building complete new infrastructure (alternative 4).

At least 80% more benefits than costs in the improved infrastructure alternative

Based on literature, we posed several assumptions in order to estimate the potential gains and costs and benefits of the cycle highway. Table 0.1 shows the main results for different scenarios.

with 7% modal share (transport plan Luxembourg)						
	Alt 2 (improving existing)			Alt 4 (new infra)		
	share of increase in cycle trips attributed to cycle highway			share of increase in cycle trips attributed to cycle highway		
	4%	20%	40%	4%	20%	40%
cost (M Eur)	2.9	2.9	2.9	20.25	20.25	20.25
benefit (M Eur)	5.1	25.7	51.4	5.1	25.7	51.4
benefit/cost	**1.8**	**8.9**	**17.7**	**0.3**	**1.3**	**2.5**

Table 0.1: Overview of costs and benefits for two cycle highway scenarios

The green columns represent an intermediate scenario with a 7% in cycling modal share in 2035, as foreseen in the Luxembourg mobility plan (Ministère de la Mobilité et des Travaux publics luxembourgeois, 2022). The intermediate scenario estimates furthermore that 20% of cyclist users are there thanks to the cycle highway. The other 80% would have cycled anyway and their benefits are not taken into account.

Based on these hypothesis, **benefits are 8.9 times higher than the costs when upgrading the existing infrastructure** (alternative 2) for 100 000 EUR/km. **Benefits are 1.3 times higher if a new infrastructure (alternative 4) is built** at a cost of 750 000 EUR/km. Benefits are **mainly health benefits**, approximately 75%.

Figure 0-3 illustrates the benefits and costs for the upgrade alternative with 4%,20% or 40% of the increase in cycle km attributable to the cycle highway. This corresponds to the left hand side part of Table 0.1. The graph makes it also visually clear that benefits surpass costs.

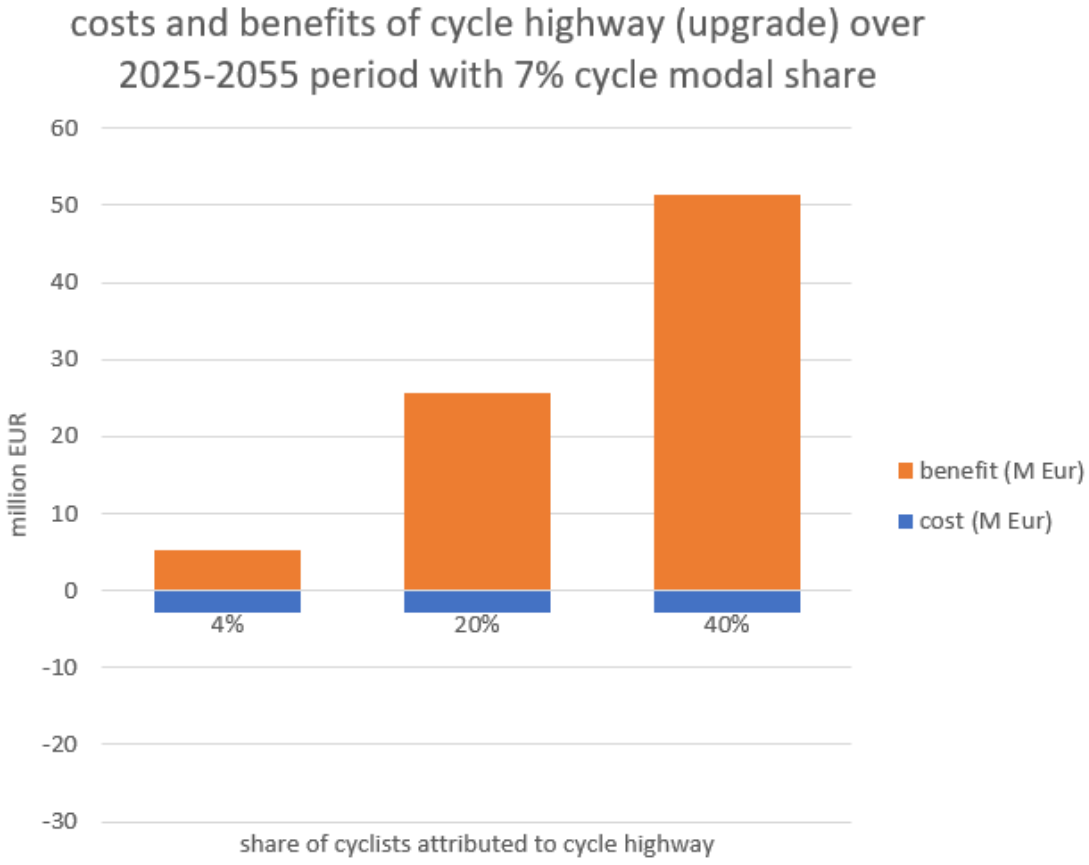


Figure 0-3: Costs and benefits of building the cycle highway (upgrade)

Results are robust, especially for the upgrade of existing infrastructure

The table shows that the benefits of the upgrade alternative (alt 2) remain 80% higher than the costs, even if only 4% of the cycle highway users are considered as being there, thanks to the cycle highway. This is however not true for the building of new infrastructure where costs (20.25 M EUR) surpass benefits (5.1 M EUR) in that case.

Other sensitivity analyses show that with a cost of 100 000 EUR/km for the upgrade, and with only 4% of the new cyclists, the cycling modal share needs to reach only 4.2% instead of 7% in 2035 to have benefits that are larger than the costs. Furthermore, with a cost of 100 000 EUR/km, and with 20% of the increase in cyclists that is attributed to the cycle highway, a 1.5% modal share is sufficient to generate benefits larger than costs.

Transparent hypothesis to realise the risks for over- or underestimation

The main assumptions, based on literature, used for our analysis besides those mentioned above are:

- Average distance of a cycle trip on the cycle highway: 8km
- Shares of different bicycles: 65% push bikes, 35% of e-bikes
- Shares of other modes that cyclists would use in the absence of the cycle highway; 25% would drive a passenger car, 45% would use public transport, 5% would walk, 10% would not have made the journey. 15% cycle already
- Costs and benefits of the different modes are based on the first part of the study

All sources are provided in the report.

Policy recommendations

The results of this study lead to the following policy recommendations, which are discussed in detail in the report:

1. Invest in safer, faster and more convenient cycling infrastructure,
2. Reduce the private costs of cycling,
3. Build and maintain the Arlon-Luxembourg cycle highway,
4. Create a cycle-friendly attitude and environment,
5. Develop multimodal bicycle-inclusive mobility plans,
6. Leave nobody behind, work on the image of cycling.