Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

FINAL REPORT //

# STISE – Sustainable Transport Infrastructure in the Strategic Urban Region Eurodelta

Final Report // Final Revision February 2022

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**Coordination:**
Stefanie Van Den Bogaerde, Pierre Van De Leemput (Tractebel Engineering)

**Outreach:**
Vassilen Iotzov (ESPON EGTC)

**Authors**
Matthijs Otten, Julius Király, Louis Leestemaker, Stefan Grebe (CE Delft) - Martijn de Kievit, Alex Vermeulen, Karin Kuipers (Goudappel) - Luuk Boelens, Rob van der Bijl; Loren Aernouts (Ghent University) - Pierre Van De Leemput, Mikaël Angé, Stefanie Van Den Bogaerde (Tractebel Engineering)

**Advisory group**
Stakeholders: Province of Zuid-Holland (NL) - Lead Partner, the Municipality of The Hague (NL), the Flanders Region (BE), the Metropolregion Rheinland (DE), the Province of Gelderland (NL), the Metropole Européenne de Lille (FR), the Municipality of Amsterdam (NL), the Brussels-Capital Region (represented by perspective.brussels, the Brussels Planning Agency) (BE), the Regionalverband Ruhr (DE), the International Society of City and Regional Planners (ISOCARP) – Observer, the network of European Metropolitan Regions and Areas (METREX) - Observer

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Contact: info@espon.eu

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**Disclaimer**

This document is an final report.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2020 Cooperation Programme.

The final version of the report will be published as soon as approved.

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# Abbreviations

| Abbreviations | Full name |
|---|---|
| AMS | Amsterdam Schiphol Airport |
| BRU | Brussels Airport |
| CBS | Centraal Bureau voor de Statistiek (Statistics Netherlands) |
| CGN | Flughafen Köln/Bonn |
| DUS | Flughafen Düsseldorf |
| EC | European Commission |
| ERTMS | European Rail Traffic Management System |
| ESPON | European Territorial Observatory Network |
| ESPON EGTC | ESPON European Grouping of Territorial Cooperation |
| EU | European Union |
| HDV | Heavy Duty Vehicle |
| HGV | Heavy Goods Vehicle |
| HSL | High Speed Line |
| HST | High Speed Train |
| IWT | Inland Waterway Transport |
| LDV | Light Duty Vehicle |
| LEZ | Low emission zone |
| LGV | Light Goods Vehicle |
| MaaS | Mobility as a Service |
| MODEV | France national model of which the input is based on a report from the French Ministry from Environment and Energy from 2016 |
| NST/R | Nomenclature uniforme des marchandises pour les Statistiques de Transport, Révisée (Standard goods classification transport statistics) |
| NUTS | Nomenclature of Territorial Units for Statistics |
| OD | Origin Destination |
| OEM | Original Equipment Manufacturers |
| Pkm | Passenger-kilometer |
| PSO | Public service obligation |
| RoRo | Roll-on - Roll-off |
| SDG | Sustainable Development Goals |
| STISE | Sustainable Transport Infrastructure in the Strategic urban region Eurodelta |
| SURE | Strategic Urban Region of the Eurodelta |
| TEN-T | Trans European Network-Transport |
| Transtools | TOOLS for TRansport Forecasting ANd Scenario testing |
| UITP | Union Internationale des Transports Publics |
| UVAR | Urban Vehicle Access Regulations |
| WLO | Welvaart en Leefomgeving (Future scenarios for the Netherlands) |
| ZEV | Zero emission vehicle |
| ZEZ | Zero emission zone |

# 1 Executive Summary

## Context and objective of the study

The main objective of the STISE study is to explore if, and to what extent, the Strategic Urban Region of the Eurodelta (SURE) is – and could be even more - moving towards greener mobility that contributes to the European sustainability goals, and therefore to more attractive and sustainable urban regions. Business as usual will not be sufficient to reach such a goal. The Eurodelta will need to move up a gear, by pursuing bold policy choices to (help) achieve the targets set in European agendas.

## Key Findings

The **baseline scenario** shows that, with the overall expected growth of transport (+30% to 2030 and +59% towards 2050 for freight, +10% in 2030 and +18% in 2050 for passengers), *sustainability appears to be far out of reach*. The share of road for both freight and passengers as a dominant mode is striking (and not surprising). The transport flows are combined with expected developments in emissions, which slightly changes the picture regarding the focus and the opportunities at hand. On the other hand, when looking at the overall sustainability goals, the pre-dominance of the car as the main mode of transport can be justified for example from a social inclusion perspective, displaying careful treating is necessary on this topic. Also due to the fact that the road network is congested and significant investments are necessary to alleviate specific bottlenecks, a focus on changing the way we travel is eminent. For freight an additionally complicating factor is the connection of transport with the seaside of transport, this is currently out of scope within this study, but the emissions from the seaside are (combined with air) forming a large part of the overall transport emissions. From a SURE area perspective, focusing on intermodality, but also long-distance freight transport by train can change and adapt this focus and, in that sense, partly tackle the seaside emissions.

A **STISE toolkit** (see Annex 9)[1] was built for better showing all the information (e.g. on maps) that is available within the datasets from Transtools3, and it offers the possibility to make the different selections depending on the interest and perspective of the user.

An **external trend analysis** indicates that the demand for freight transport in the SURE area is likely to decrease for all modes compared to the baseline scenario. This decrease is mainly due to growing circular economy and changes in the world freight routes (part of the further globalisation trend of the transport sector). For passenger transport the trends indicate a shift from air and road to rail compared to the baseline scenario, when the possible impact of autonomous vehicles (part of the trend on technical evolutions in the transport sector) is neglected. If autonomous vehicles became available on large scale, they might result in a large shift from public transport to car usage, depending on the implementation in the overall transport system.

From the baseline scenario it became clear that *without any intervention in the **policies**, sustainability will not be reached* – the main conclusions of the policy analysis are the following:

- The *shift from aviation to high-speed rail for short and midrange distances will have a major impact on the $CO_2$ and noise reduction* in and around the four relevant airports in the Eurodelta. It will give a boost to HST and it will possibly double or even quadruple the volumes of HST-travel on the existing tracks. Therewith it could also have a major impact on domestic and short-range travel within the SURE area and lead to a shift form car to train.
- *Harmonizing ZEZ*s could have *substantial efficiency and societal benefits*, but specific population groups and economic actors could be adversely impacted if no targeted accompanying measures are implemented. Experience shows that it is very difficult to harmonize access criteria due to the subsidiarity principle, while harmonizing other aspects could appear to be very challenging due to the high number of actors to be involved and the absence of institutional framework to carry out such a process at Eurodelta level. An appropriate forum for policy dialogue should be set up to assess political feasibility, options for

[1] The target group for whom the toolkit has been made is on the one hand the Service Provider ESPON EGTC and on the other hand the STISE stakeholders group.

harmonization and their impacts. If areas for consensus are identified, a structured concertation process involving national and local authorities shall be launched to design, plan and implement the harmonization process.

- The Potential of MaaS measure shows a potential in realising more sustainable transport, however this potential is largely uncertain, strongly depends on the position public authorities take and the necessary investments in both digital and physical infrastructure that need to be done to facilitate a larger modal shift. This being said, the prerequisites as defined (regarding standardisation and sharing of data and information) are no-regret measures that can be started immediately. Furthermore, *development of a vision and implementation plan for MaaS and how it can contribute to the relevant societal goals is essential* to grasp the potential at hand.
- The assessment of the policy ambition to improve cross-border rail transport has shown that a shift from road to rail could be realised for several cross-border corridors in the SURE area. There is sufficient demand to operate profitable rail services, if the cross-border connections are well integrated with the national rail and bus services and passenger-friendly services are provided. The measure has the potential to contribute to more sustainable transport and is in-line with plans of the European Green Deal. Compared to the overall emissions in transport, the potential emission reduction of this measure is limited, since the regional cross-border passenger segment is rather small. However, the policy should be seen in the broader context of a shift from road to rail.

For the 4 assessed policy measures, indicative proposals for **high-level policy roadmap for their implementation** are presented, where useful also with the formulation of accompanying measures and policy recommendations (see Sections §5.2.5, §5.3.5, §5.4.5 and §5.5.5). A thorough institutional and stakeholder mapping was performed in an earlier phase of the project (cf. Interim Report) and, as already mentioned, a range of relevant stakeholders were also consulted in the light of these roadmap proposals. These roadmaps are a starting point - suggested by the research team, to have a first idea of which steps make sense in order to effectively start with (preparing for the) implementation of the measure. More detailed roadmaps require in-depth extensive research (beyond the scope and timing of this study), and even then, there are many factors that we cannot anticipate or make statements about in advance: the authorities that are (or can be) involved are many and are active at different levels, the political interests and priorities of those involved may not always be aligned or may even conflict. Along the way it may turn out that a sidestep is needed, or a (partial) plan B. What is certain, and each proposed roadmap shows, is that cooperation will be necessary, at all levels. Cross-border cooperation is crucial to enhance territorial cohesion and exchanges and collaboration between territories and citizens across borders. In this study, for each policy measure - in the context of the proposed policy roadmaps - attention is paid to which stakeholders should be involved in an implementation process. *Establishing project specific cooperation mechanisms* on an ad hoc basis, and for the time span needed, seems more efficient than setting up large structures at SURE area level.

Policy roadmap Aviation shift – HST

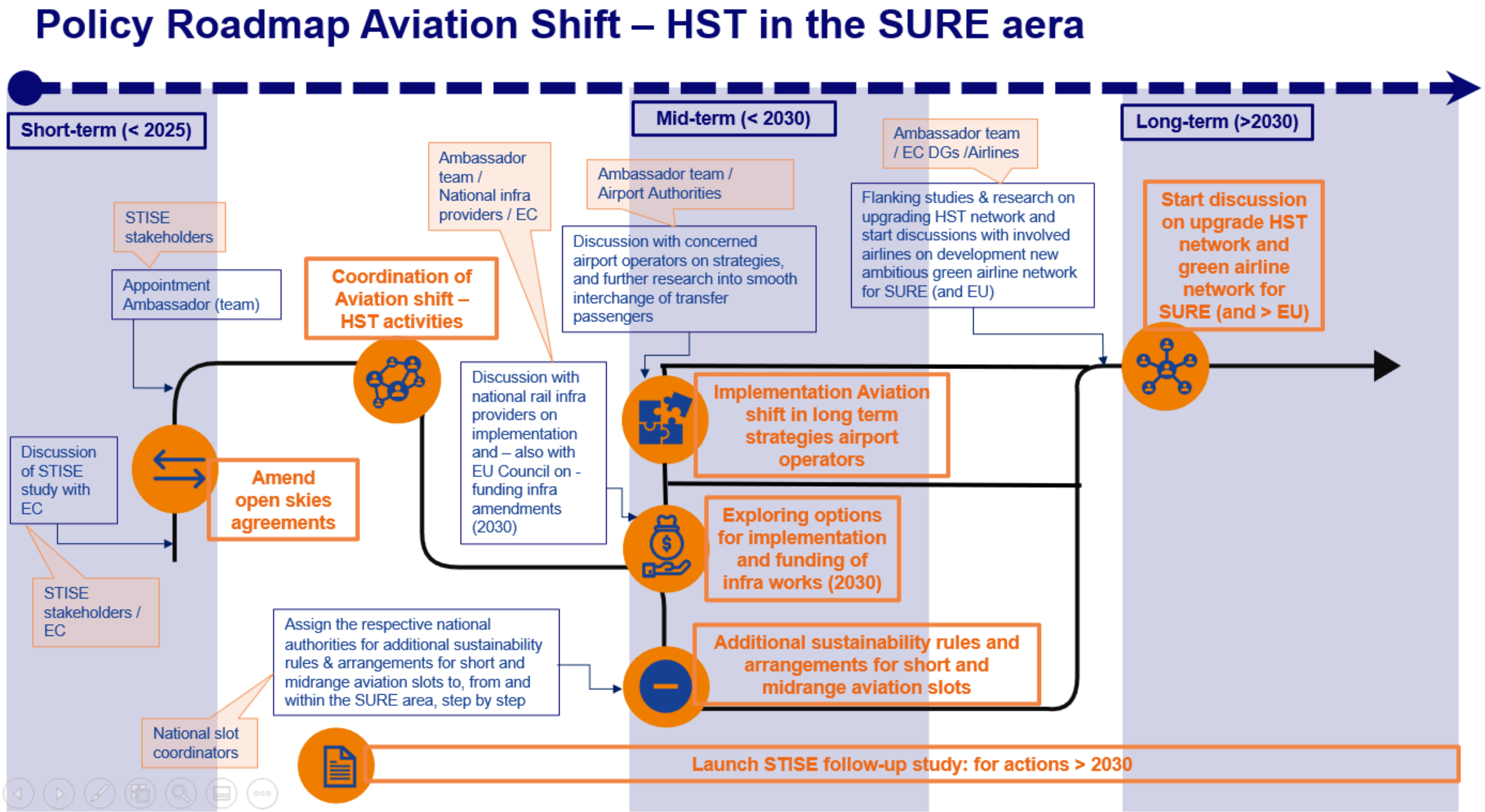



**Figure 1 – Policy roadmap Aviation Shift - HST**

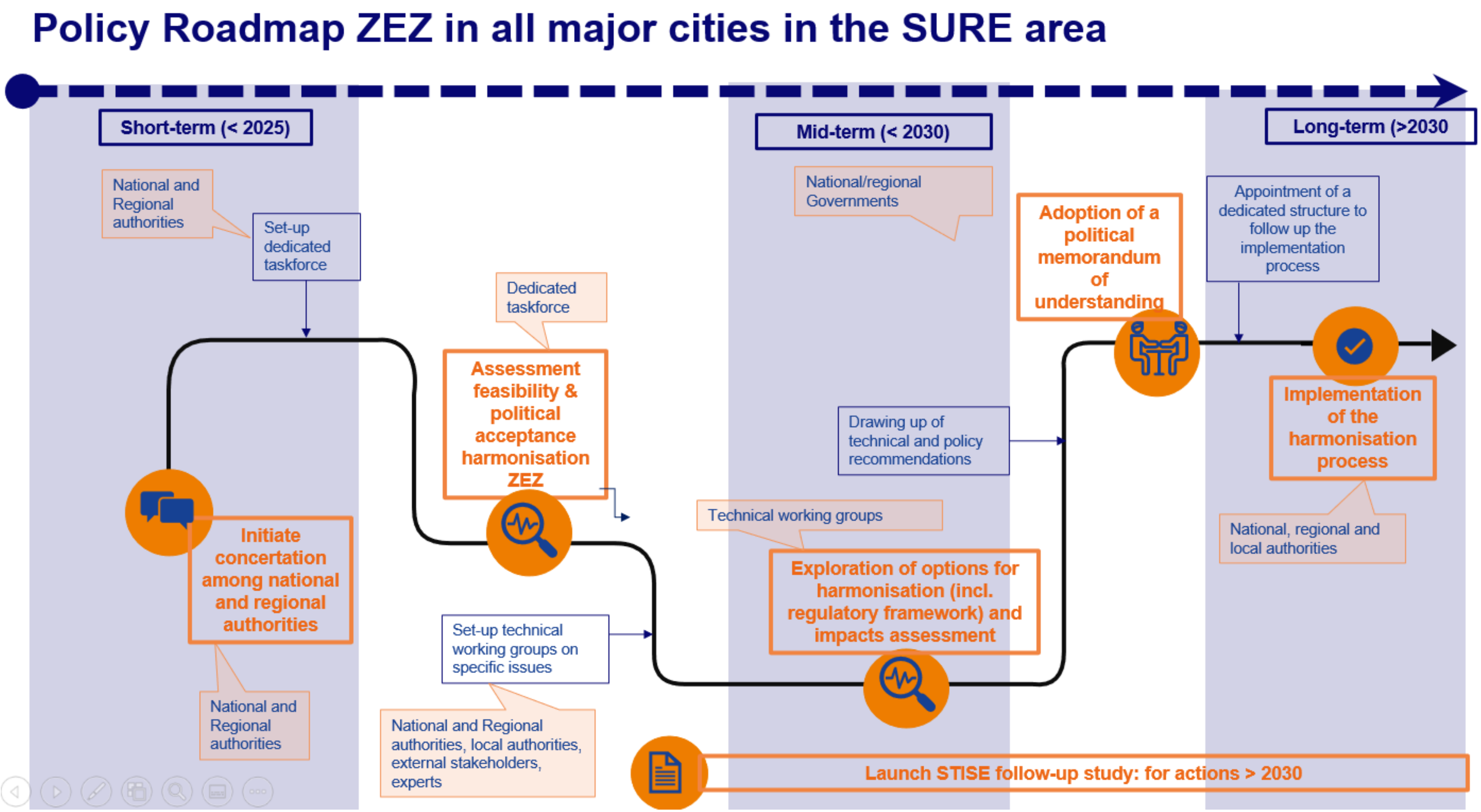



Figure 2 – Policy roadmap ZEZ

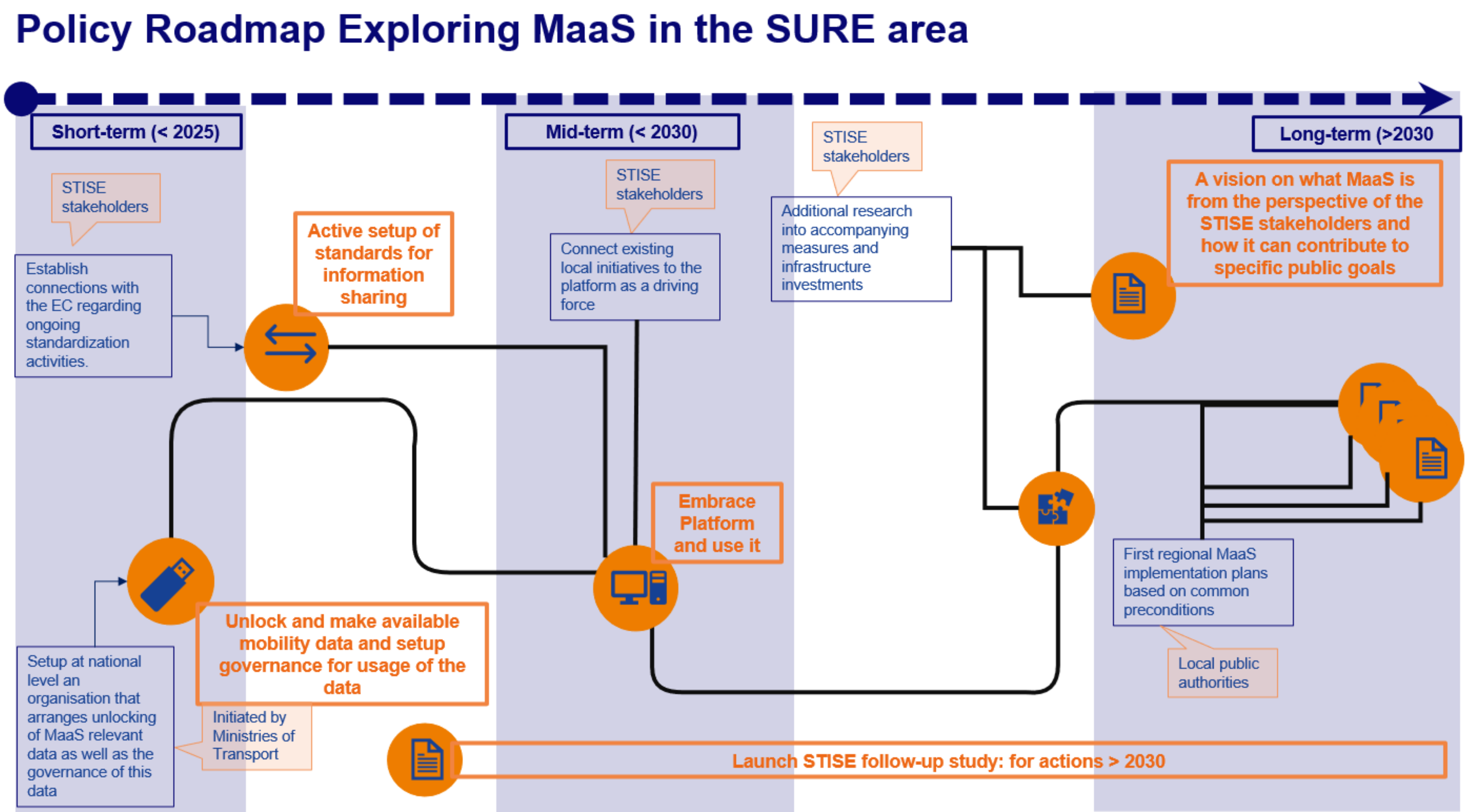



**Figure 3 – Policy roadmap Exploring the potential of MaaS**

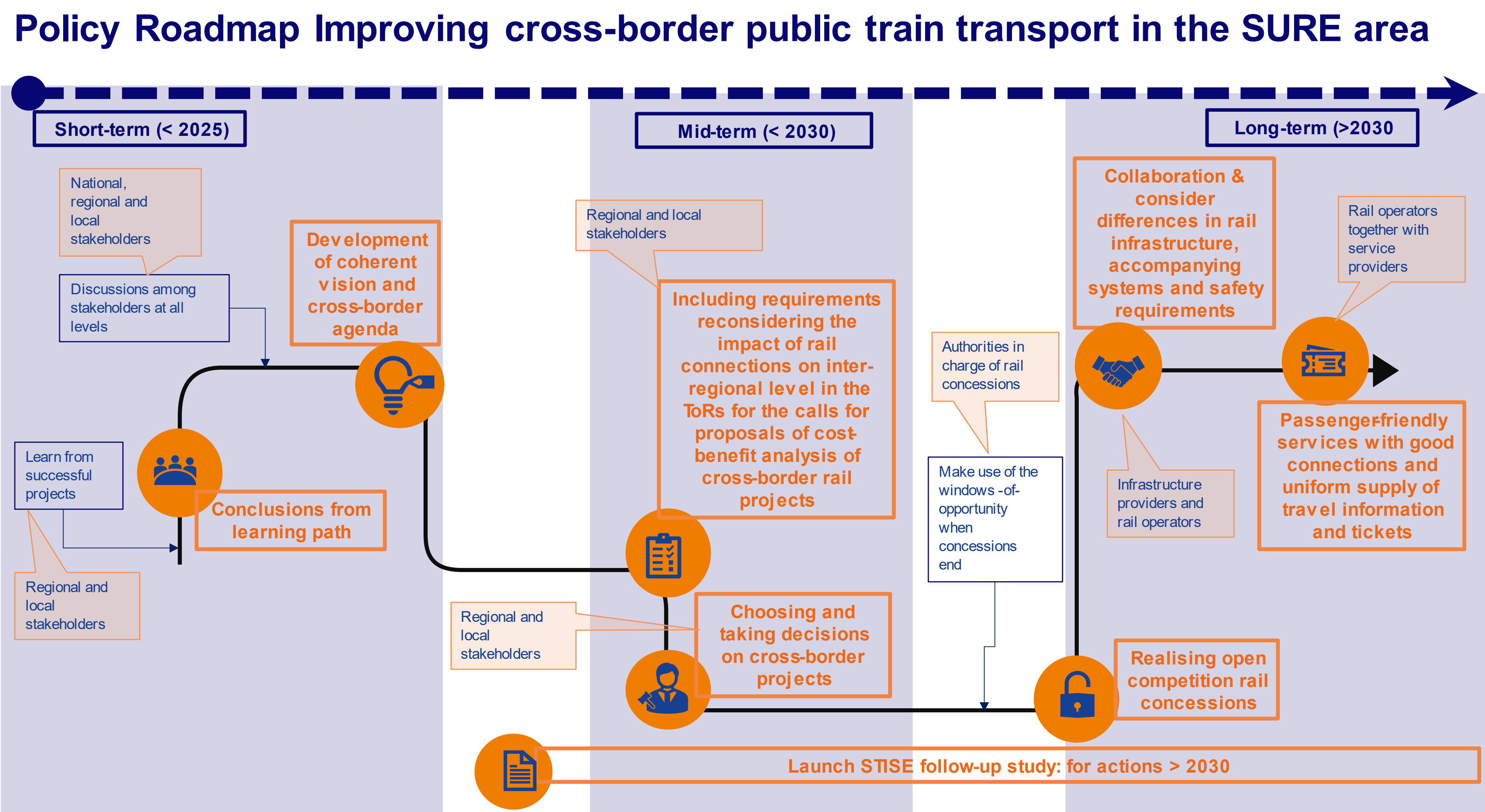



Figure 4 - Policy roadmap Improving regional cross-border train transport

## New insights from the STISE study

In order to achieve the study results that we propose at the end of this research - in addition to the usual desk and literature research, consulting stakeholders and experts, bringing together our own expert knowledge in this consortium – certain tools and approaches were proposed and used that are novel in the context of such research. Also, specifically for the (geographical) scope of the Eurodelta, a series of aspects were assessed in this STISE project that had not yet been examined.

- The structured way to categorize involved stakeholders and research tasks via a Market Arena model – with an actor analysis approach – was applied to a study at this level (Eurodelta).
- An in-depth stakeholder and institutional mapping for the Eurodelta was carried out, which showed that the institutional context in the SURE area is a mess.
- A European transport network model (Transtools3) was applied at the scale of the STISE study, resulting in a first-time network analysis at the Eurodelta level. The study revealed that insight in transport flows, especially cross-border, is complex to harmonise. It also showed that a slightly outdated European transport model (Transtools3) makes analysis on these kinds of topics complex. A more accessible and more up to date model would be beneficial for harmonized analysis of cross-border transport flows, similar to the alignment that is done at national level already between transport models of different geographical scales.
- Visualisation of transport flows needs specific attention, which has now been solved by creating a STISE Toolkit allowing for a larger quantity of data to be displayed in a more accessible manner. With more and more data becoming available in the mobility domain, attention to display of information becomes more and more important.
- The policy measures – as they are scoped in this study – have been studied for a first time, not only from a content point of view (cross-border policy analysis), but from a geographical viewpoint (SURE area):
    - With regard to the Aviation shift - HST measure, e.g.: existing studies only went into logistics, not into the alternative of trains, the shift, the social, economic and policy impacts, not about the needed investments etc. etc.
    - Regarding the ZEZ measure, e.g.: research into (more) harmonized ZEZ at international (mega region) level, not at national/regional or city level.
    - With regard to Exploring the potential of MaaS measure, e.g.: the focus on preconditions for new technologies has been looked into.
    - The improvement of regional cross-border train transport measure: The focus is on the 3 STISE project corridors, however the potential is shown of reducing the emissions from passenger transport and of contributing to the further integration within the SURE area reducing the barriers of its four internal national borders.
- The policy roadmaps for the 4 policy measures provide a first proposal for those involved to get started with the preparation of an implementation process.

## Conclusions

The *STISE study could only be the tip of an iceberg*. The inspiration and willingness – to cooperate at SURE level, to dream big and to make things happen - of the involved STISE stakeholders is high, many other ambitious policy measures could be explored in detail as well, and just as many challenges examined. In addition, the policy roadmaps of the 4 policy measures also show that additional research is needed - so there is potential in that too. This research can and should be a booster; an incentive to initiate and look for funding for subsequent research in order to facilitate actual implementation of the measures.

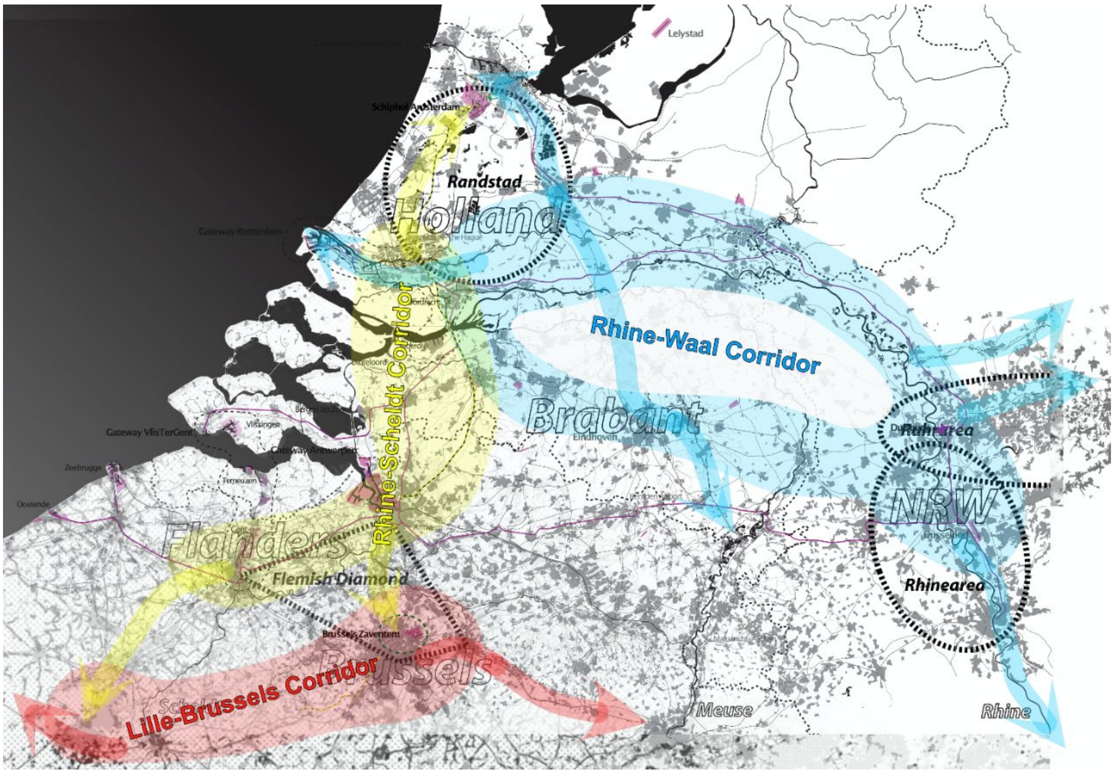
The *SURE area has a great potential to set an example in Europe in the ambitious pursuit of achieving sustainability goals*. Given its location, its corridors full of challenges and the drive of many involved stakeholders in this region, the Eurodelta can be an interesting and promising pilot area to try to implement ambitious policies and concepts and thus demonstrate the sustainability gains that can be made. If this can be achieved in the Eurodelta, it can serve as inspiration for other regions – only imagine the potential effect at larger, even EU, scale.

# 2 Introduction

## Scope of the study

The project's geographical scope was initiated from a focus on the **3 key corridors** considered in this study:

- Lille-Brussels corridor, with focus on this cross-border core area, including the relations to bordering regions of London-Paris-Liège;
- Rhine-Scheldt corridor, with focus on the cross-border core-area between Rotterdam-Antwerp-Ghent, and bordering regions towards Lille-Brussels-Amsterdam;
- Rhine-Waal corridor, with focus on the cross-border core area between the Randstad-Ruhr area through Arnhem-Nijmegen, including the side-corridor over Eindhoven and the Eastern region of the Ruhr metropolis, and the relations to bordering regions of Weert/ Sittard-Frankfurt-NRW.




**Map 1 - Corridor focus of the STISE study**

This corridor focus, however, has not been maintained throughout the project – more specifically with regard to the (selection of the) assessed policy measures. These policy measures are not particularly corridor-specific, at the level they are assessed here. In the Annexes (Annex 6, Annex 7 and Annex 8) cut-outs are included for each STISE corridor, containing the relevant findings for each of these corridors - mainly from the network analysis.

## Study approach

The starting point and central framework of the study is the **Three Market Arena model**, developed on a market based approach for spatial mobility planning, where there is a continuous challenge to meet the ongoing demand with sufficient supply. Within the broad setting of Mobility, three of such 'markets' evolve more or less in parallel, but related to each other, sometimes even using the same infrastructures: the travel, transport and traffic markets. Each of these markets have their own institutional settings and leading stakeholders, so they are called 'market arenas' here. This model is explained in more detail in Annex 2 to this report.

After refining the research approach in the inception report, the bottlenecks in the region and the corridors were mapped out - as a basis for the next steps in the project: an analysis of the network and a set of specific policy measures relevant for the area.

The core of the methodology for the network and policy analyses evolves around creating a consistent image of the future for 2030 and 2050 to better understand how sustainable transport is and what policy measures will be effective to reach specific policy goals. To be able to understand transport developments (focused on sustainability) in 2050, three components are combined in this study:

- In a first step a **baseline scenario** was built, using the Transtools3 model as the main model. The results of this model were validated with regional and national models - in case of inconsistencies, the Transtools3 results were scaled to match with the other sources to one consistent baseline scenario. The traffic demand was estimated to create an understanding of the transport flows for both passengers and freight within the study area and the expected growth of these flows towards 2050. These flows were then translated into emissions (for example $CO_2$), as a proxy for sustainability to understand the scope of the issues at hand. Section §3 is dedicated to the baseline scenario for the existing development of transport towards 2050.
- The baseline scenario was combined with **external trends** that will impact the existing transport growth as estimated in the baseline scenario (i.e. trend breaking developments) and how these affect the predicted future, as elaborated in Section §4.
- Finally, the estimations in the baseline scenario were complemented with the **assessment of the (potential) impact of 4 ambitious policy measures in the SURE area**: Aviation shift on short/mid-range distances, Zero Emission Zones in all major cities, the potential of MaaS, and exploring improved regional cross-border public train transport. The policy measures were analysed to see if they make transport within the SURE area more sustainable and what margin still exists when comparing the impact of these measures towards the sustainability goals. These findings, including how the measures can be quantified with respect to the baseline scenario and which trend(s) has (have) most impact, are explained in Section §5.

The 4 policy measures concerned were chosen through a selection process with the STISE stakeholders. A 3-step approach was followed: (1) based on the initial input received from the stakeholders and an analysis of the policy documents, a long list of potential policy measures was composed, (2) in a next step a short-list of policy measures was selected out of this long list, for a quick-scan, (3) a quick scan analysis was performed by assessing the policy measures with criteria such as: added value, jobs, accessibility (economic component of sustainability), social justice, wellbeing and acceptance (social component of sustainability), and the investment and operational costs and probable public support (factors related to the implementation of the measures). The scope of the policy analysis is not focused on already implemented projects or policies in (parts of) the Eurodelta, but on ambitious policy concepts that (can) affect the entire SURE area and/or its border crossings or the better connections in or between its (major) cities, and that could really make a difference.

## Stakeholder involvement

The project was co-supervised and - directed by the involved government stakeholders in the region (the STISE stakeholders). Throughout the project progress, these stakeholders were consulted on a regular basis for work sessions to exchange views and gather input, as well as to validate interim results.

In addition, other (types of) stakeholders were involved as well. Several stakeholders that might have interesting views or could share insights specifically regarding the implementation of the policy measures were invited to a consultation, a ‘Roundtable’. The initial idea of gathering stakeholders in round tables at STISE corridor level (Rhine-Scheldt, Rhine-Waal, Brussels-Lille), was abandoned throughout the study process. As the studied policies are not particularly corridor-specific – at the level they are assessed here – online consultations per measure were more relevant and useful.

# 3 Baseline Scenario

## 3.1 Baseline Scenario

### 3.1.1 Methodology

The baseline scenario is based on the output from the European Transtools3 transport model which is the latest available transport model on European scale. For comparability reasons as well as availability of future data Transtools3 was selected over a combination of the national and regional available transport models. The model uses a combination of ArcGIS & network analyst including a tailormade scenario manager to run the model.[2]

Within the Transtools3 model the origin and destination zones are (for most areas) similar to the NUTS3 division that is commonly used to distinguish geographical zones, this means that NUTS3 is the lowest geographical degree taken into account within this study. This geographical level is also displayed within a toolkit that has been developed as a side product to give more insight into transport flows that cannot be appropriately reported in the consecutive study reports. Annex 9 contains more details regarding this toolkit.

The Transtools3 model distinguishes both freight and passenger transport, and - for these modes - also modalities and type of goods or purposes. These are:

- For freight transport: modalities road, rail and inland waterways, distinguished in bulk goods, liquid goods, containers and general cargo;
- For passenger transport: modalities road, rail and air, distinguishing purposes for business travel, commuting or other purposes.

The model contains a baseline scenario which is used as the baseline for this study. This baseline scenario from the Transtools3 model does not contain any other policies except infrastructure that is expected to be available in the future years (e.g. already granted TEN-T projects). The model provided results for the base year (2010) and future years 2030 and 2050. To be able to combine these with the emission indicators an 'in between correlation step' was used to interpolate the results between 2010 and 2030 to create the year 2018. A linear growth was assumed to perform this interpolation.

The modelling results have been compared to available modelling results from national scenario studies. This step was taken to validate the results and create a better understanding of the quality of the transport flows that are an output of the model. This indicated that the overall numbers for passenger transport were slightly underrepresented in the simulation results, but, since growth rates were quite comparable no corrections were deemed necessary. For freight transport it was found that the numbers are either over- or underrepresented when comparing flows on country level and modality level. This goes for both the absolute numbers as well as the growth rates. Therefore, the numbers for freight transport need to be treated with care and not as an absolute truth. During the policy analysis phase, it was found that on a zone-to-zone comparison strange numbers occurred, for example with cross border transport. This results in the disclaimer that, although the transport flows indicate a direction of growth as well as an order of magnitude, the detailed numbers need to be used with caution and other tools and methods are necessary for detailed studies.

The results of the model as explained before will be shared and shown in a toolkit for further analysis purposes on a more detailed level. The output data from the transport model is also shared via the ESPON project results database. This includes the origin and destination data on NUTS3 level for the relevant transport flows including purposes and types of goods.

The overall results of the baseline scenario are described in the following chapters.

[2] All Transtools3 documentation can be found on the following website: http://www.transportmodel.eu/deliverables.html

### 3.1.2 Freight Transport

This paragraph contains an overview of the freight transport within the SURE area. – and starts with an overview of transport flows in the SURE area overall, and split out for the freight modalities (Road, Rail & Inland Waterways) as well as the type of goods transported. This is followed by a couple of specific observations regarding freight transport.

#### 3.1.2.1 Transport in SURE area

At first, we take a look at the general growth of the three available modalities, road, rail and inland waterways. Table 1 below shows that road transport is expected to almost double in the EU, this compared with a modal share of 78% shows the major impact road transport has in the overall transport system. If we look at the growth rates for the three modalities with growth rates from 2010 to 2050, road would grow by 93%, rail by 73% and inland waterways by 55%, where it is important to bear in mind that the absolute growth is higher in the second time period (2030 to 2050) due to the larger quantities of goods transported. A closer look at the SURE area reveals that the growth rates, road and inland waterways are comparable, road about 40% and inland waterways is 24% (comparing 2010 to 2030). For rail the growth rate is lower with only 25%, this might be an opportunity to make freight transport more sustainable.

**Table 1 - Growth rates from Transtools3 for freight transport in the entire EU and SURE**

| | Growth rate freight transport Entire EU (in percentages) | | | Growth rate freight transport SURE (in percentages) | | |
|---|---|---|---|---|---|---|
| - | 2010 to 2050 | 2010 to 2030 | 2030 to 2050 | 2010 to 2050 | 2010 to 2030 | 2030 to 2050 |
| **Road** | 93 | 42 | 35 | 88 | 41 | 33 |
| **Rail** | 73 | 34 | 30 | 66 | 25 | 33 |
| **Inland waterways** | 55 | 25 | 24 | 45 | 24 | 17 |

In Figure 5 a comparison is made in the total freight transport in million ton km per modality for both the EU and the SURE area. When looking in more detail at the freight transport within the SURE area itself[3], the presence of the inland waterways as second modality is a big change compared to the entire EU transport. This is not surprising, taking into account the availability of inland waterways in the Eurodelta. Secondly, the relatively low representation of rail compared to the overall EU transport is noteworthy. This is partially explained by the large share of inland waterways competing for similar type of cargo.

[3] This includes transport with an origin and destination within the SURE area

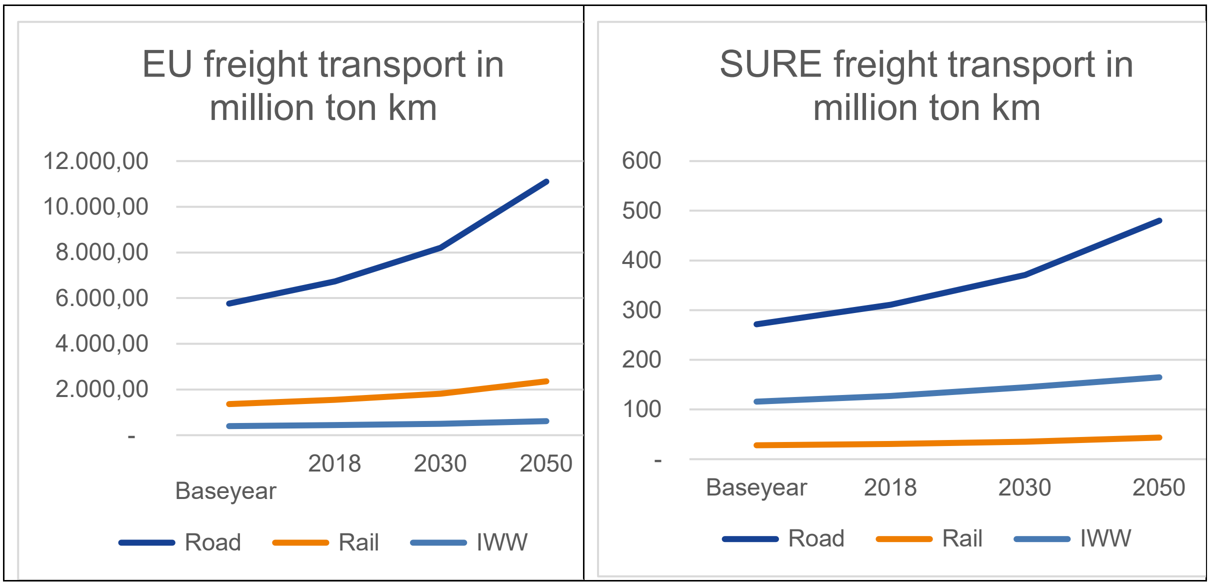



**Figure 5 - Internal freight transport in the SURE area in million ton km**

Taking into account the overall growth rates, we take a closer look at 2030 and more specifically the share of type of goods for the three modalities. In the table the first noticeable factor is that only road has the general cargo category, this contains all other goods that are not identifiable as bulk goods or containers, showing these goods can only be transported by road. Secondly the shares for dry bulk appear is comparable between rail and inland waterways while for liquid bulk rail takes the major share. In more practical terms it is also noticed that still a significant number of trucks are transporting bulk goods for which partly more sustainable modes (e.g. rail or inland waterways) could be available. For containers the train appears to be not competing most likely due to the attractiveness of the inland water ways transport in the SURE area.

**Table 2 - Share of modalities per type of good in 2030 for SURE transport**

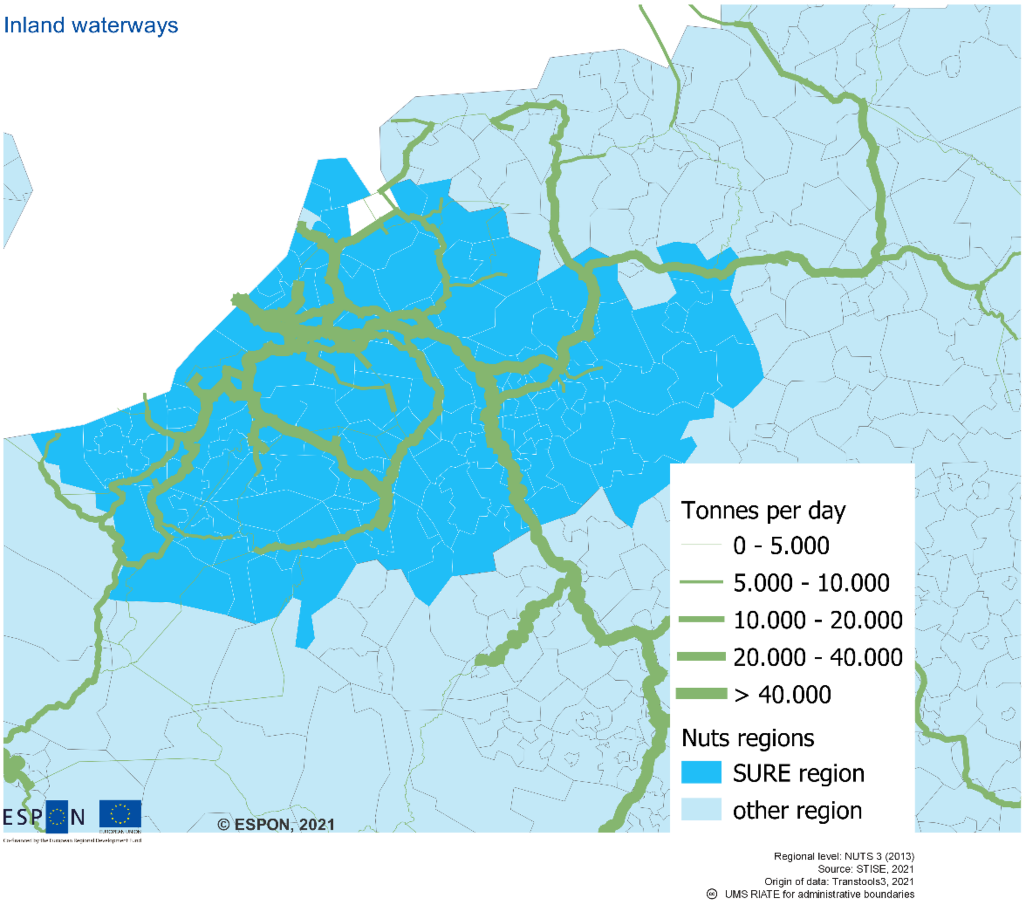
| | Share of modes per type of goods transported in 2030 internally in the SURE area | | |
|---|---|---|---|
| - | **Road** | **Rail** | **Inland waterways** |
| **Dry Bulk** | 13% | 44% | 43% |
| **Liquid Bulk** | 21% | 62% | 17% |
| **General Cargo** | 100% | 0% | 0% |
| **Containers** | 42% | 5% | 53% |

#### 3.1.2.2 Specifics Regarding Freight Transport

For freight, the two main corridors Rhine – Waal & Rhine – Scheldt are interesting to look into the specifics. In the Rhine Waal corridor, the share of containers for road and rail in relative terms is comparable (and comparable with the overall presentation of the SURE area). The total share of transport between the modes is as follows: 57% for road, 6% for rail and 37% for inland waterways. Furthermore, for road, the share of general cargo is the majority of goods transported. For rail the share of dry bulk is higher compared to the overall SURE area, for Inland waterways the numbers are rather specific for this corridor. For the Rhine Scheldt corridor it shows a higher share of containers for both road and inland waterways showing the transport between the ports of Rotterdam and Antwerp and the share of containers that is part of this flow. The overall share between the modes is as follows: 46% for road, 4% for rail and 50% for inland waterways. Also on the corridor, the share of dry bulk is lower compared to liquid bulk which can be explained by the dry bulk being transport by large sea vessels to the relative ports that have been mentioned before thus removing the need of further transport of these goods. However, when looking at the absolute numbers, inland waterways still have roughly 7 times more ton kilometres in transport for dry bulk. For liquid bulk this factor is about 3 times more compared to rail. In absolute numbers for road transport general cargo takes up 59% of its share. For Inland waterways containers have the major share (76%).

When looking at freight transport, the major arteries can be identified when for example looking at the share of freight vehicles on the road network where a set of links within the SURE area has a relatively high share of freight vehicles on the road network. For example, in Rotterdam, the A15 highway is highlighted as well as the connection from the SURE area towards the ports that connects to the United Kingdom (Dunkirk and Calais). Also, the ring of Antwerp can be seen with a high level of freight transport in 2030.

For inland waterways, the key waterways that have the major transport volumes are identifiable on the next map. The number represents the daily tonnes transported on the specific links. The map clearly shows the two major waterways from both the Rhine Scheldt and Rhine Waal corridors including the transport on these waterways. The map also shows that inland waterway transport continues further down along the Rhine, however, other waterways do not have such a large daily transport ratio.




**Map 2 - Daily tonnes transported per day on the inland waterways network in 2030**

### 3.1.3 Passenger Transport

This paragraph provides an overview of the passenger transport in the SURE area. A distinction is made for the three modalities: road, rail and air, and the three purposes that are identified for passenger transport: business, other and commute (for air travel no commute trips are modelled).

#### 3.1.3.1 Transport in SURE area

For the entire EU, the growth of passenger transport for the three modalities is shown in the table below. As can be seen, the passenger car grows the most towards 2050. For Rail a similar pattern can be distinguished. For air it appears that the majority of the growth lays in the first period towards 2030. This seems to contradict the current trends that have been observed in the past decade. The model doesn't provide a further explanation for this development.

**Table 3 - Growth rates from Transtools3 for passenger transport in the entire EU and the SURE area**

| | Growth rate passenger transport Entire EU (in percentages) | | | Growth rate passenger transport Entire EU (in percentages) | | |
|---|---|---|---|---|---|---|
| - | **2010 to 2050** | **2010 to 2030** | **2030 to 2050** | **2010 to 2050** | **2010 to 2030** | **2030 to 2050** |
| **Road** | 26 | 14 | 11 | 19 | 11 | 7 |
| **Rail** | 22 | 11 | 10 | 17 | 10 | 6 |
| **Air** | 17 | 10 | 5 | 11 | 9 | 5 |

In the figure below the growth of the passenger transport towards 2050 is shown in billion passenger kilometers for the entire SURE area. The graph displays both the internal and the internal – external (and v.v.) kilometers that are travelled for the respective years and the respective modalities.

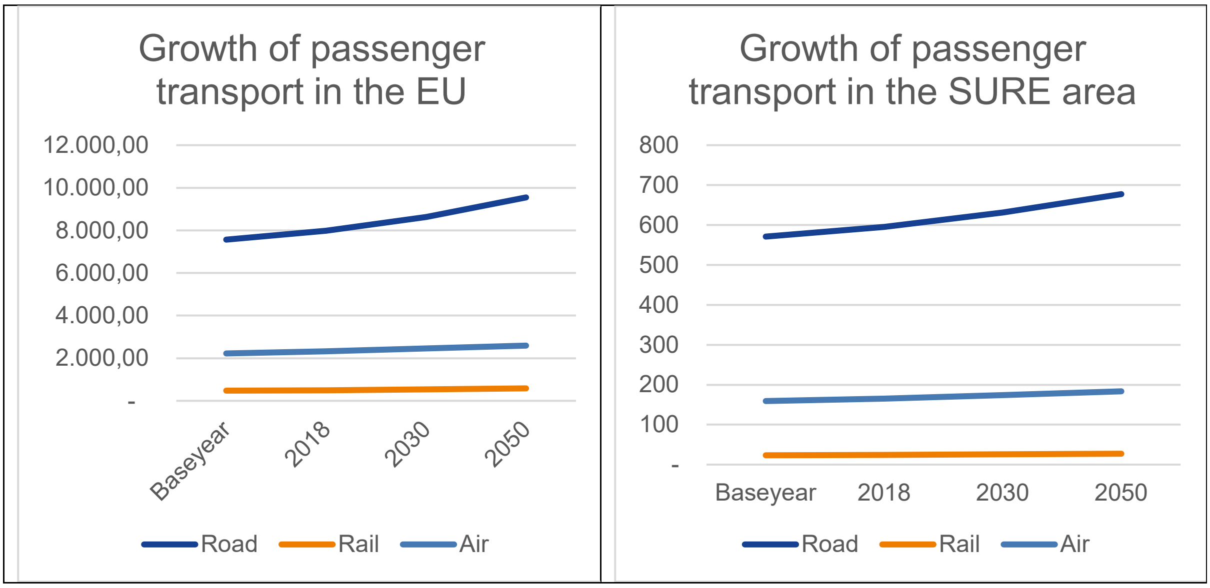



**Figure 6 - Growth of passenger transport in the EU and the SURE area towards 2050 in billion passenger kilometers**

The overall passenger transport in the SURE area shows a steady growth towards 2050 for all modalities. For road the growth (approximately 20%) is similar over all geographical selections. This could be seen as a generic proxy for the overall growth of transport used in the entire model. For rail the growth of 'internal-external (v.v.)' transport is higher than the internal transport flows (appr. 13% versus 26%), this can most likely be explained by the already high demand on rail traffic internally within the SURE area, whereas towards connecting areas around the SURE, more room for growth can be found. For air the overall growth of transport is approximately 15% for the SURE area; this seems to be an underestimation of the trends that have been found before the COVID-pandemic struck. Therefore, we assume that for air transport the total numbers are an underrepresentation towards 2050.

When looking at a more detailed distribution of travel in 2030, similar to the freight transport combining the share of the modes with the purposes of travelling, the following table is generated. Hereby one difference is made, namely, due to the nature of air travel, the selection of transport combines both internal & internal-external (v.v.) transport. For internal transport within the SURE area, the share of air transport compared to rail & road is too low to make any useful statements. Secondly it needs to be noted that the commute purpose is not used for air travel, therefore it has no share in this overview. The table shows that for all purposes the road is dominant (as could have been expected from the overall transportation figures). Road & Air travel are comparable purpose wise when comparing passenger kilometers travelled, however, the quantity of trips for road of course is a multitude due to the length of average trips between both modes. Rail takes its share for commuting trips, when looking only at the internal SURE area, this share is similar.

**Table 4 - Share of modes and purposes for passenger transport in 2030 in the SURE area**

| | **Share of modes per purpose for passenger transported in 2030 internal and internal – external (v.v) in the SURE area** | | |
|---|---|---|---|
| **-** | **Rail** | **Road** | **Air** |
| **Business** | 5% | 49% | 45% |
| **Other** | 1% | 71% | 28% |
| **Commute** | 14% | 86% | N/A |

### 3.1.3.2 Specifics Regarding Passenger Transport

For passenger transport a more detailed look is given to the Lille-Brussels corridor comparing the numbers for rail transport, and more specifically the purposes of rail passenger transport for both the internal & internal-external (v.v.) transport.

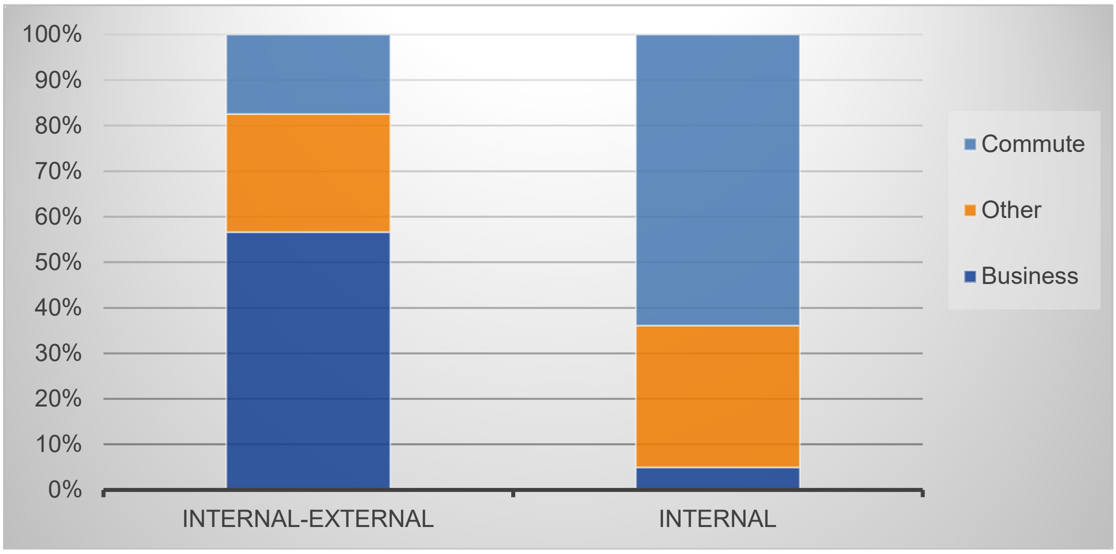
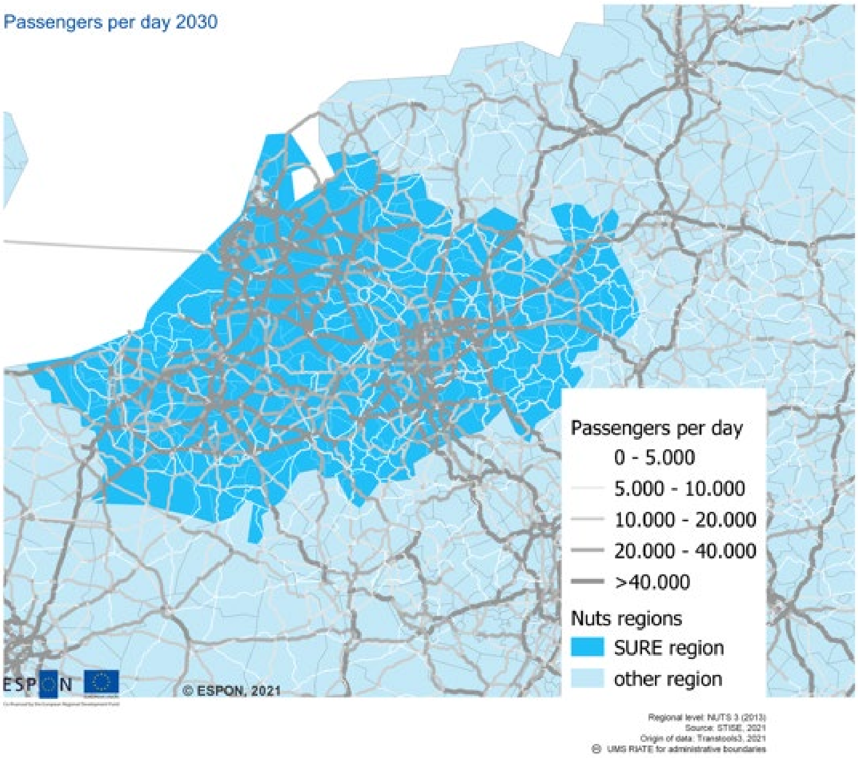



**Figure 7 - Purposes for rail transport in 2030 internal to the Lille Brussels corridor, compared to complete rail transport in the Lille Brussels corridor**

From the figure it can be noticed that the internal corridor transport focuses mainly on commuting transport, whilst for the rail transport coming into and going out of the corridor the share of business travel is much higher. Most likely this can be explained by the HST-network that is part of this corridor and which connects the corridor to major metropolitan areas such as Paris, London, the Ruhr area and the Randstad.

For rail transport, the share of commuters on the rail network shows that (not surprisingly) around the metropolitan areas the railway network has a high share of commuters using the train for their daily commuter trips. Interestingly, the commuter percentages in the Ruhr area appear to be relatively low, but this might be explained by the fact that business travel has a higher share in rail transport on these specific links.

For the specific input of the passengers that travel on the road network per day, the network shows that most of the highways within the SURE area are heavily used with a daily intensity of over 40.000 vehicles (see Map 3 below). It is expected that with this quantity of traffic, passengers are experiencing congestion on a regular basis. This leads to the conclusion that for passenger transport the growth towards 2050 for road transport will be difficult to accommodate on the existing network. Therefore, a key challenge lays within the study area to find other solutions to allow transport to grow in a more sustainable way.




**Map 3 - Passengers per day on the road network in 2030**

### 3.1.4 Overall Observations

The baseline scenario shows that with the overall expected growth of transport, sustainability appears to be far out of reach. The share of road for both freight and passengers as a dominant mode is striking (and not surprising). In the following section the transport flows are combined with expected developments in emissions, this slightly changes the picture regarding the focus and the opportunities at hand.

However, when looking at the overall sustainability goals, the predominance of the car as the main mode of transport, also from a social inclusion perspective, needs attention and combining various driving factors for this change might make it happen. Also due to the fact that the road network is congested and significant investments are necessary to alleviate specific bottlenecks, a focus on changing the way we travel is eminent.

For freight an additionally complicating factor is the connection of transport with the seaside of transport, this is currently out of scope within this study, but the emissions from the seaside form (combined with air) a large share of the overall transport emissions. From a SURE area perspective, focusing on intermodality, but also long-distance freight transport by train can change & adapt this focus and, in that sense, partly tackle the seaside emissions.

## 3.2 Result Emission Indicators

For this study, emission indicators have been defined for the different transport modes and categories corresponding to the traffic model output from Transtools3. The evolution of the emission indicators towards 2030 and 2050 are taking into account standing policies and improvements based on historical trends. The combinations of the traffic model output and these indicators are used to calculate the emissions of $CO_2$, $NO_x$ and $PM_{10}$, as well as the energy use. First, we present the expected development of the $CO_2$ emissions for passengers (all modes) and freight (separately for aviation). In the following chapters these are combined with the transport volumes to get a better understanding on how the emission indicators are developing.

An overview of the $CO_2$-emission factor development is shown in Figure 8 to Figure 10. In these figures, the CO2-emissions from the well-to-tank (WTT) phase and from the tank-to-wheel (TTW) phase are differentiated. Figure 8 presents the $CO_2$ emission factors for passenger transport. For freight transport, aviation is presented separately from the other transport modes, because the emissions per ton-kilometer are much higher for aviation. Light commercial vehicles are excluded from these figures, as both the emissions per passenger-kilometer and the emissions per ton-kilometer are not a good indicator for this category. The figures show that emissions per kilometer decrease in time for all modes of transport. For both passenger and freight transport, emissions of rail transport are the lowest, emissions by road transport are higher and aviation has the highest emission indicators.

The full set of emission indicators for $CO_2$, $NO_x$. $PM_{10}$ and energy use and the description of the sources on which they are based is provided in the Interim report of this study.

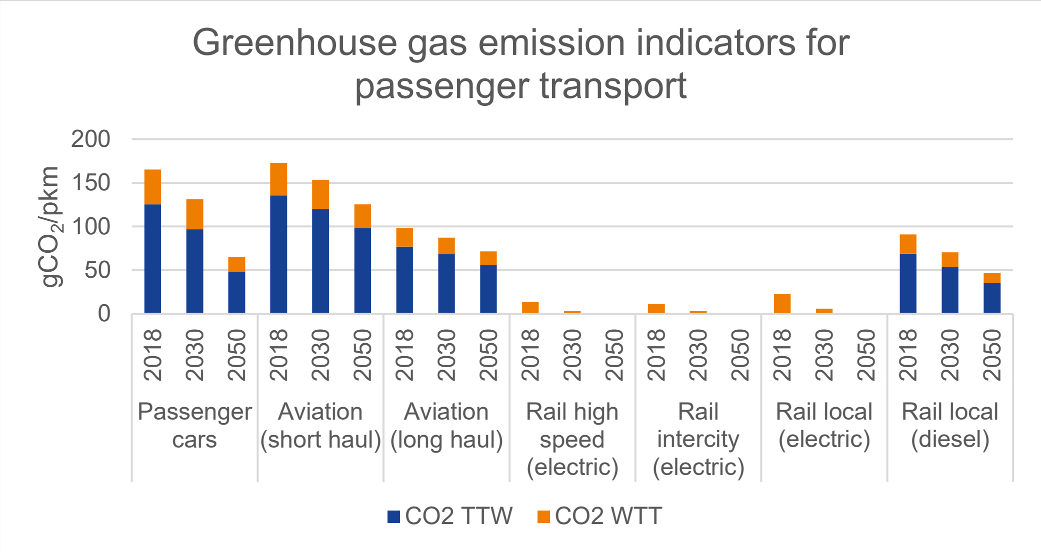



**Figure 8 - $CO_2$ emission indicators of passenger transport**

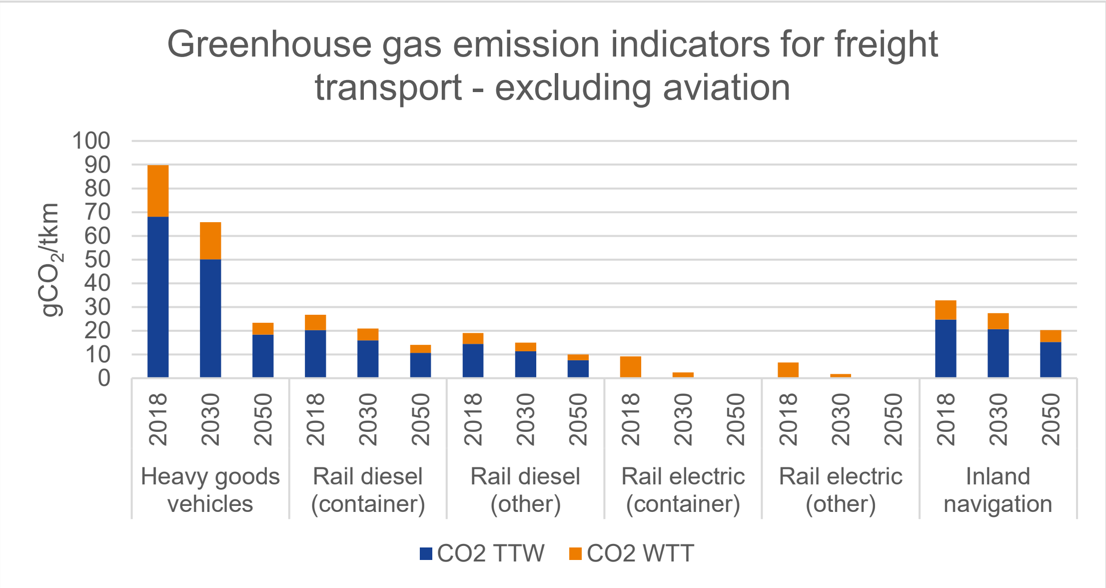



**Figure 9 - $CO_2$ emission indicators of freight transport excluding aviation**

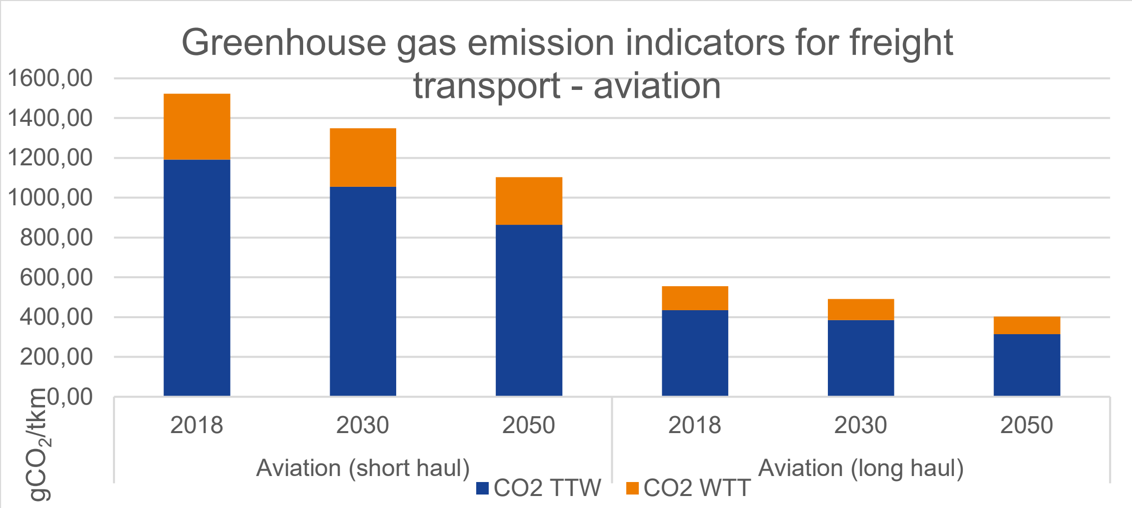



**Figure 10 - $CO_2$ emission indicators of freight transport (aviation)**

## 3.3 Transport Emissions

The transport emissions have been calculated on the basis of the transport flows resulting from the baseline scenario and the emission indicators presented in the previous sections. For these emissions, only information for the entire SURE area (including internal and internal - external v.v. traffic) is presented in the paragraphs below. More details could be calculated based on the numbers that are available in the baseline scenario. For readability purposes these are not used here in the report.

### 3.3.1 Passenger Transport

The 4 emission indicators that are quantified are the following: $CO_2$, $NO_x$, $PM_{10}$ and Energy use. For each of the indicators the emissions per mode are presented below in Table 5. It should be noted that for rail it is assumed that all trains are electric. In reality, a small percentage still runs on diesel.

**Table 5 - $CO_2$-, $NO_x$-, $PM_{10}$-emissions and energy use – passenger transport**

| | $CO_2$ [Mton] | | | $NO_x$ [Mton] | | | $PM_{10}$ [kton] | | | Energy [$10^9$ MJ] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | 2018 | 2030 | 2050 | 2018 | 2030 | 2050 | 2018 | 2030 | 2050 | 2018 | 2030 | 2050 |
| **Rail** | - | - | - | - | - | - | - | - | - | 3,3 | 2,7 | 1,9 |
| **Road** | 96,9 | 79,3 | 41,9 | 0,3 | 0,1 | 0,0 | 3,1 | 0,8 | 0,3 | 1.411 | 1.248 | 884 |
| **Air** | 13,1 | 12,2 | 10,5 | 18,7 | 17,5 | 15,1 | 108,6 | 101,5 | 87,5 | 222 | 207 | 179 |
| **Total** | 110,0 | 91,6 | 52,4 | 19,0 | 17,6 | 15,1 | 111,7 | 102,3 | 87,8 | 1.636,4 | 1.457,7 | 1.064,7 |

For the $CO_2$-emissions, the first noteworthy aspect is the high share of air transport in emissions. In 2018 the share is 12% and it increases to 20% in 2050. Secondly, the impact of the forecasted availability of electric vehicles for road transport can clearly be seen with a negative trend of road transport emissions compared to the expected growth rate.

For the $NO_x$-emissions and the $PM_{10}$-emissions, aviation and road have comparable shares with the highest share for aviation (between 97% and almost 100% over the period). The emissions for this mode decline slightly (-20%) between 2018 and 2050. For road transport the impact of the stricter regulations and guidelines regarding emissions combined with the increased market share of electric vehicles lead to a reduction of emissions over time, with almost no emissions in 2050. Electric railways emit no $NO_x$ and $PM_{10}$.

For the energy use, the car is by far the largest consumer during the entire period. Here, the impact of the switch from combustion to electric engines is lower since they still use energy. However, despite the increase in demand, the total energy use decreases due to the higher efficiency of electric engines. The share of rail is relatively low in comparison to the others, and for air the decrease in energy use for kerosine compensates the expected growth in transport kilometres.

### 3.3.2 Freight Transport

For freight transport the same indicators are presented below in Table 6 below for the rail, road and inland waterways (IWW) modalities based on the transport figures of the baseline scenario for the entire SURE area.

**Table 6 - $CO_2$-, $NO_x$-, $PM_{10}$-emissions and energy use – freight transport**

| | $CO_2$ [Mton] | | | $NO_x$ [Mton] | | | $PM_{10}$ [kton] | | | Energy [$10^9$ MJ] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | **2018** | **2030** | **2050** | **2018** | **2030** | **2050** | **2018** | **2030** | **2050** | **2018** | **2030** | **2050** |
| **Rail** | 0,7 | 0,6 | 0,5 | 0,0 | 0,0 | 0,0 | 0,2 | 0,0 | 0,0 | 10,5 | 9,2 | 7,4 |
| **Road** | 14,1 | 12,3 | 5,9 | 1,5 | 1,2 | 0,1 | 5,7 | 2,6 | 1,4 | 2.543,4 | 2.360,6 | 1.569,7 |
| **IWW** | 1,9 | 1,8 | 1,5 | 0,0 | 0,0 | 0,0 | 0,8 | 0,7 | 0,3 | 18,0 | 17,2 | 14,7 |
| **Total** | 16,6 | 14,7 | 7,9 | 1,6 | 1,2 | 0,2 | 6,7 | 3,3 | 1,7 | 2.572,0 | 2.387,0 | 1.591,8 |

For the $CO_2$-emissions the overall prospective share of road transport is clearly visible. However, until 2050, the emissions of road transport decrease by 58%, whereas rail and IWW reduce by 29% and 18%, thus their relative shares increase towards the future.

For the $NO_x$-emissions the observations are similar. The large decrease for road transport is only expected to happen after 2030 with the increase in electric and fuel cell operated trucks. For rail and inland waterways, the decreasing trend is a positive development.

For the $PM_{10}$-emissions, the share of the road transport is still large, but, with the decreasing trend, there appears to be a rather favourable evolution of these emissions. After 2030 rail will have almost zero emissions.

For the energy used by road transport, we expect a decrease to result in an overall reduction of 38% in 2050 compared to the 2018 level, due to better availability of cleaner and more efficient trucks. The other modes decrease monotonic towards 2050 with reductions of 29% for rail and 18% for IWW.

# 4 Effects of External Trends on the Outcomes of the Baseline Scenario in 2030 and 2050

The baseline scenario is designed as a business-as-usual scenario and includes forecasts for 2030 and 2050. It is based on the European Transtools3 model developed between 2011 and 2016. Hence, the assumptions for the model forecasts have been defined several years before the current study has been carried out (2021). Meanwhile, a series of external trends are evolving, that are not taken into account (sufficiently) in the baseline scenario. These trends are likely to affect the forecasts for 2030 and 2050. Within this study, it was not possible to update the Transtools3 model, since Transtools3 has been developed by consultants which are not part of the consortium and because such an update was not in the scope of this project and would require a significant amount of time and resources.

However, the consortium has determined together with the stakeholders of this STISE-project an overview of external trends that may significantly affect the transport flows for passengers and freight within the SURE area in the future. Of these trends six have been selected and the possible impacts have been briefly studied in qualitative terms. The external trends that have been analysed are:

1. Climate change & energy transition
2. Technical evolutions in the transport sector
3. The future of growing globalisation in the field of transport
4. Growing Circular Economy
5. Health/economic crises/effects after Covid
6. Possible (Dis)integration in the EU

For each of these trends the most likely impacts on the different modes of passenger and freight transport have been estimated globally and in qualitative terms. The summary is presented in Table 7. These uncertainties on the outcomes of the baseline scenario are taken into account in the analyses of the policy measure presented in Chapter § 5. In this way the trends can be seen as a robustness check of the baseline scenario. In the following sections of this chapter the likely impacts of the external trends are discussed.

### Table 7 - Qualitative estimation of the possible impacts of the external trends in the SURE area relative to the baseline scenario [4]

| External trend | Passenger road | Passenger rail | Passenger air | Freight Road | Freight rail | Freight inland waterways |
|---|---|---|---|---|---|---|
| **Climate change & energy transition** | – – | + | – | – | + | + |
| **Technical evolutions in the transport sector** | + + | + / – – | 0 | + | 0 | 0 |
| **The future of growing globalisation in the field of transport** | 0 | 0 | 0 | – | 0 | – |
| **Growing Circular Economy** | 0 | 0 | 0 | – | – | – |
| **Health/economic crises/effects after Covid** | 0 | – – | – – | 0 | 0 | 0 |
| **Possible (Dis)integration in the EU** | 0 | 0 | – | 0 | – | 0 |

[4] Qualitative estimation of the possible impacts of the external trends in the SURE area relative to the baseline scenario on a 5-point scale: + + strong increase, + moderate increase, 0 minor effect, – moderate decrease and – – strong decrease.

## 4.1 Trend 1 - Climate Change & Energy Transition

Recent national and international incentives are likely to result in additional taxes and other measures that increase energy costs and fossil fuel prices. Within the Fit-for-55 proposals of the European Commission, the revisions of the Emission Trading System (ETS) and the Renewable Energy Directive (RED) as well as the recast of the Energy Tax Directive (ETD) affect the cost for all modes of transport. The impacts vary per vehicle type depending on the energy consumption, type of engine and the emissions. In addition, specific proposals like for instance the ReFu-elEU Aviation regulation set targets for specific modes of transport. All these proposals at European level and recent national incentives in the countries of the SURE area are probably more ambitious than the assumption in the business-as-usual scenario developed several years ago.

It is likely that the increasing costs result in a decrease in overall travel and transport demand and in a shift from aviation and road transport to rail transport, since road and aviation costs and prices are expected to increase more than rail costs due to the incentives and proposals.

## 4.2 Trend 2 - Technical Evolutions in the Transport Sector

There are several ongoing technological trends, which could lead to increased travel speed or comfort. In this chapter, the possible impact of such trends on the transport system is explored.

For passenger transport, increases in travel speed are associated with longer distances travelled. Historically, the average time travelled per person per day has been relatively constant at about 70-90 minutes per day (Hupkes, 1982)[5]. This directly implies that faster traffic leads to more kilometers travelled. However, research also indicates that the amount of time that people are willing to spend on travel per day might increase as travel becomes more comfortable (CE Delft;TNO, 2020)[6].

Car driving is expected to become more and more autonomous in the coming decades with driver support systems currently picking up. If it would become fully automated, this would imply an increase in transport demand for four reasons (CE Delft;TNO, 2020): 1) autonomous cars drive more efficiently, which increases the effective capacity of the infrastructure, 2) travel becomes more comfortable, since it becomes possible to perform other activities while driving, such as working or relaxing, resulting in a reduced value of time, 3) current 'non-drivers' (e.g. elderly, disabled and low income households) gain access to car travel and 4) cars are able to drive empty and pick-up passengers.

There is a relatively large uncertainty about the concrete effects of automated driving on transport demand. (Milakis, et al., 2017) found that the passenger car transport demand would go up by 3 to 27%, (Cohen & Cavoli, 2019) expect an increase in car kilometres between 20 to 25%. The European Commission estimates a potential long-term effect of 50-60% increase in vehicle kilometres (European Commission, 2019).

This increase in car travel can be expected to go hand in hand with a decrease in other passenger transport modes which compete with car travel, especially public transportation (Milakis, et al., 2017; European Commission, 2019). It might therefore become more difficult to maintain already economically unfeasible public transportation systems, especially local bus services. High-capacity rail transport can coexist much better. Some studies concluded that public transport demand might rise or drop dramatically depending on the way automated driving will be established[7] . This uncertainty is indicated with +/ - - in Table 7. The effects of automated driving will be different in inner cities compared to rural areas and are in general very dependent on the specific context.

[5] This has been observed in communities all over the world.

[6] Consider for example the fact that trains become increasingly more suitable for working while traveling, due to comfort increasing factors such as comfortable seats with a place for your laptop and Wi-Fi connectivity. When it is possible to work while being on the train, commuting becomes less of an obstacle which could be a reason for people to live further from the office.

[7] Driver at the wheel? Self-driving vehicles and the traffic and transport system of the future, KiM | Netherlands Institute for Transport Policy Analysis, The Hague 2015

## 4.3 Trend 3 - The Future of Growing Globalisation in the Field of Transport

The developments in recent years show that e-commerce growth rates are very high[8] and probably above the assumptions in the baseline scenario. In addition, a further increase of import and a decrease of export due to further shift from production within Europe to low wage countries might induce additional demand for freight transport. However, a shift from containers from the ports in the SURE area to long distance rail/road shipments due to the new silk road might reduce freight transport in the SURE area as it would enter Western Europe at a different point.

The main impact of this trend is foreseen in the reduction in transport overall within the SURE area. This basically means the transport flows will shift, with an overall similar image for the EU. Rail is likely to be less affected than road and inland waterway transport in case the new silk road by rail will be established.

## 4.4 Trend 4 - Growing Circular Economy

Growing circular economy implies more recycling and less intercontinental transports of raw materials and products. In addition, it is likely that the demand of coal and oil within the SURE area and its Hinterland would decrease and long- distance transport flows for plastic, food and feed could decrease compared to the baseline scenario. Most of these goods enter the SURE area at the seaports. It is likely that the road, rail and inland waterways connections to the ports will decrease.

The emissions of air cargo are much smaller than those of maritime transport, due to the much smaller volume. In addition, important air cargo goods (like machines, pharmaceuticals, plants and food) are probably less affected by this trend than others.

Overall, this external trend might reduce the demand for freight transport in the SURE for all modes by a few percent since these goods are transported with all modes from the ports to their final destinations.

## 4.5 Trend 5 - Health / Economic Crises / Effects after Covid

All used sources (Transtools3 and national/regional transport models) have been developed before the outbreak of the ongoing Covid19 pandemic. Therefore, none of them takes possible lasting effects on our travel behaviour into account. If they will manifest cannot be determined at the moment when the pandemic is still ongoing. However, several scenario studies have been developed to forecast possible effects[9]. Potential lasting effects are:

- A reduction of demand in commuting for jobs that can be done from home. Working from home has been obligatory during the pandemic for the majority of office jobs. Employers and employees got used to home office. Travel time savings and other advantages are likely to lead to a lasting reduction in the number of commuting trips. However, a part of the travelled kilometres is likely to be compensated by employees that accept larger commute distances than before the pandemic.
- A reduction of demand in business travel especially in business air travel. Videoconferences may replace part of physical business meetings since they save travel time, costs and transport emissions.
- A reduction of demand for public transport. During the pandemic the use of public transport has been discouraged. Public transport travellers got used to utilize individual transport modes like passenger cars and (electric) bicycles more frequently and may partly stick to this.

The above-mentioned could lead to a significant reduction in rail and air travel. Road traffic is likely to be less affected. The reasons are that office jobs (often located in the surroundings of stations) have a higher market share of public transport than jobs which require physical presence, business travel has a relative high market share of rail and air travel, and the third point describes a potential shift from public transport to car usage.

[8] 2021 EUROPEAN E-COMMERCE REPORT, https://ecommerce-europe.eu/wp-content/uploads/2021/09/2021-European-E-commerce-Report-LIGHT-VERSION.pdf

[9] For instance: CROW-KpVV, Toekomstverkenning naar mogelijke effecten van corona op mobiliteit – Inzichten aan de hand van drie verhalen. Ede 2021 https://muconsult.nl/wp-content/uploads/2021/05/CROW.toekomstverkenning-naar-mogelijke-effecten-van-corona.pdf

## 4.6 Trend 6 - Possible (Dis)integration in the EU

Due to Brexit, trade and business trips between the SURE area and Great Britain may be reduced compared to the baseline scenario. Other potential extension or split-offs of the European Union are most likely to occur with countries that are located at larger distances, so that it would only marginally affect traffic and transport within the SURE area. The case that one of the SURE countries (BEL, FRA, GER, NED) exits the Union is not considered, since it seems very unlikely in the current political situation and since the impact would be so big, that this entire study would become completely irrelevant.

Brexit as a given fact, will probably result in less trade, less freight transport and less business travel between the European mainland and Great Britain. The consequence might be a minor reduction in passenger travel and freight transport within the SURE area compared to the baseline scenario.

# 5 Analysis of Policy Measures

## 5.1 Introduction

The estimations in the baseline scenario are complemented with the assessment of the (potential) impact of 4 ambitious policy measures in the SURE area: (1) Aviation shift on short/mid-range distances (§5.2), (2) Zero Emission Zones in all major cities (§5.3), (3) Exploring the potential of MaaS (§5.4), and (4) Exploring improved regional cross-border public train transport (§5.5). The policy measures are analysed to see to what extent they make transport within the SURE area more sustainable and what margins still exist when comparing the impact of these measures towards the sustainability goals. These findings - including how the measures can be quantified with respect to the baseline scenario, which external trend(s) has (have) most impact, and the proposed policy roadmaps - are explained in the chapters below. In the process of drawing up the policy roadmaps, various stakeholders were consulted for each policy measure to gather feedback and exchange ideas on the points of attention for possible implementation of the measures.

Some summary and overall policy conclusions are presented in the last chapter §5.6 .

## 5.2 Aviation Shift on Short/midrange Distances

### 5.2.1 Description Policy Measure

The EU Green Deal is amongst others focused to stimulate carbon neutral scheduled collective air travel in mid-ranges (up to 500-700 km) by 2030 (EU Green Deal 2019). Although the Green Deal also focuses on market ready zero-emission aircrafts by 2030/2035, given the state-of-the-art aviation techniques, this seems to be hardly doable for collective scheduled air travel, at least in the volumes we expect (see further on) and within a foreseeable future. Therefore, there is a need to shift air travel on short and midrange distances towards more sustainable transport modes, such as High Speed Trains (HSTs). At the moment, within several engaged (non)governmental organizations this shift towards more sustainable transport means on short flying distance is already regular policy. Therewith, the EU Green Deal is also focused on doubling high speed rail traffic by 2030 and to triple this by 2050, next to stimulate EU night train services again.

Slots to start, land and fly within the airspace of a given country, are still provided by the national aviation authorities, and (within a maximum slot frame) by the nationally controlled airport authorities. Therewith, at first sight, a strategic policy ban of all the regular aviation services on short/mid ranges could be relatively easily implemented by the coordinated national authorities, under aegis of the European Commission. There have been already several studies and experiments to that effect. Nevertheless, these studies were mostly focused on national level and were mostly focused on logistics. Therewith, it is still unclear what the impact of this measure is, and how each of the EU aviation authorities could be convinced to support this cross-border ban. Furthermore, it is unclear if the existing infrastructure capacities could cope with the modal shift; and in particular if the HST infrastructure could cope with more or less comparable travel times. Therewith there is a need to explore in more detail what this measure would mean for a given EU-region; in this case the cross-border region of the Eurodelta as a major HST-connected polynuclear megalopolis in West-Europe. This SURE region could serve as a testbed, to further roll out the measure over Europe, after evaluation. Therewith the major research questions of this measure are:

- What are the pros and cons of a ban of regular aviation services in midrange distances, within, to and from the SURE area?
- Could (most importantly) collective HST rail services deal with this and what would be the impact on socio-environmental costs and benefits on the medium and long run?

### 5.2.2 Three Market Arena Model

This measure is intensively connected to all the three components of the three-market-arena model, although for the moment we have only briefly scanned the transport market arena.

We have started with the ***Travel Market Arena*.** Here we have looked into the existing data of inbound and outbound passengers < 500-700 kilometer of the involved airports for the year 2019, since the covid year 2020 is not representative. If not available we have contacted the Airport Authorities for additional information. Moreover, we have connected these data to the baseline scenario in order to receive a rough indication for the expected growth of these numbers for the year 2030 and 2050. We have adapted these rough estimations to the trends described above and the recovery covid scenario of SEO's aviation department, according to the so-called U-scenario[10]. Moreover, we have contacted the Eurostar, ICE and Thalys in order to receive their data on HST-travelers, within, to and from the Eurodelta. But since we didn't receive these data, due to competence reasons, we have made our own estimations, based on the capacities of the High Speed Trains and the year reports of these High Speed rail companies for the year 2019.

Next, we have turned to the ***Transport Market Arena***. Here we have first selected the involved city pairs, based on the differences between air to rail travel times. We have only selected those city pairs where the travel time difference was no more than 60 minutes in favor of air travel. Based on this we have estimated the extra demand for HST travel on the three corridors (Amsterdam-Brussels-London/Paris; Amsterdam-Cologne-Frankfurt-Basel/Munich and London/Paris-Brussels-Cologne-Hamburg/Berlin). Four possible scenarios on how to deal with this extra demand were delved into, and a combination based on extra HS-train frequencies was selected. The rail and aviation companies were only briefly consulted on this. Finally, we have analyzed the impact for the ***Traffic Market Arena*****,** by consulting the respective national infra providers if and how this extra demand for HST travel would be feasible. In discussion with them we have listed the necessary infrastructure and measures to guarantee and enhance a better flowing, traffic efficiency, including the baggage handling and custom and safety measures. Finally, we have analyzed the possible impacts, especially on financial resources, climate and environment, and welfare and social equity.

#### 5.2.2.1 Travel Market Arena

At the moment there are some 21 airports within SURE with scheduled airflights.[11] However only four of them – Amsterdam Schiphol Group (AMS)[12], Brussels Airport (BRU), Flughafen Düsseldorf (DUS) and Flughafen Köln/Bonn (CGN) – serve scheduled flights up to 700 air km. Within this range some 34 destination are being served on a regular basis. However, not all of these destinations could also be served by an alternative, within reasonable comparable travel times. For that purpose, we have made several assumptions. We have defined 'reasonable' as the case where the alternative should not take more than 1 hour compared to the aviation travel time. As such, and for our destinations and overall, only HST-travel is regarded as a 'reasonable, sustainable alternative'. Moreover, we have defined 'travel time' as the door-to-door travel time. In this respect and for HST-travel (with stations within the urban frame) we have taken into account an extra pre- and after travel time of in average1 hour, and for the airports (situated mostly in the fringe of the urban scape) an average of 2 hours. Moreover, we have added an extra 2 hours for customs and lingering on airports, and an extra 30 minutes for customs in regard to HST UK services. This is comparable with previous studies in this regard. With these assumptions, we have selected the following city pairs for our study.

[10] The U-scenario refers to a post-covid recovery after a few years. Other scenarios refer to a L-scenario (no recovery), W-scenario (recovery with several hick-ups) and a V-scenario (quick-recovery after 1-2 years)

[11] That is for France: Aeroport de Lille-Lesquin; for Belgium: Brussels Airport, Brussels South Charleroi Airport, Liege Airport, The International Airport Oostende-Brugge, The International Airport Antwerp and The International Airport Kortrijk-Wevelgem; for the Netherlands: Airport Schiphol Amsterdam, Eindhoven Airport, Lelystad Airport, Rotterdam-The Hague Airport, Groningen/Eelde Airport, Twente Airport, Maastricht-Aachen Airport and Teuge International Airport; for Germany: Flughafen Dusseldorf, Flughagen Köln-Bonn, Dortmund Airport, Airport Weeze, Münster Telgte Airport and Paderborn Lippstadt Airport.

[12] Eindhoven Airport and the Rotterdam-The Hague Airport are part of the Schiphol Group and taken here into account.

### Table 8 - Differences between real travel time HST versus Aviation (minus means that HST travel is even faster, plus that Aviation travel is somewhat faster; source: Consortium 2021)

| | Amsterdam/Rdam | Düsseldorf | Köln/Bonn | Brussels |
|---|---|---|---|---|
| **London** | +30/0 minutes | | | -90 minutes |
| **Southampton** | +50 minutes | | | |
| **Amsterdam** | | -3h. 20 minutes | | -2h 45 minutes |
| **Paris** | -55 minutes | +20 minutes | | -2h. 20 minutes |
| **Frankfurt** | -10 minutes | -2h. 20 minutes | | -40 minutes |
| **Hamburg** | +55 minutes | -20 minutes | similar | +30 minutes |
| **Bremen** | +20 minutes | | | |
| **München** | | +55 minutes | +30 minutes | |
| **Berlin** | | +10 minutes | -10 minutes | |
| **Dresden** | | | +20 minutes | |
| **Nurnberg** | | -2h. 10 minutes | | |
| **Stuttgart** | | -3h. 30 minutes | | -1h 30 minutes |
| **Leipzig** | | +35 minutes | | |
| **Friedrichshafen** | | +45 minutes | | |
| **Hannover** | | | | -1h. |

For these city pairs and as a start, we took the most recent travel data of 2019, since the year 2020 was not representative due to covid. In 2019 almost 18 million passengers travelled by air on these city-pairs; of which some 4 million in Transfer, and some 14 million OD passengers (see Table 9). Most of these passengers (some 8 million) travelled to and from AMS, subsequently to and from DUS (some 5 million), to and from CGN (3 million) and to and from BRU (2 million).

The most important corridors in this respect are (rounded numbers annually, both directions):

| | |
|---|---|
| Amsterdam-London vice versa | 4,7 million passengers (345 km.) |
| Düsseldorf-Munich vice versa | 1,5 million passengers (492 km.) |
| Köln/Bonn-Berlin vice versa | 1,4 million passengers (479 km.) |
| Amsterdam-Paris vice versa | 1,4 million passengers (417 km.) |
| Düsseldorf-Berlin vice versa | 1,2 million passengers (476 km.) |
| Köln/Bonn-Munich vice versa | 1,0 million passengers (456 km.) |

Next to that also the corridors between Brussels and London (0,9 million passengers), between Amsterdam/Brussels/Düsseldorf and Frankfurt (in total 1,8 million passengers), and between Düsseldorf/Amsterdam/Köln/Brussels and Hamburg (in total 1,6 million passengers), show impressive numbers on short- and midrange aviation distances.

**Table 9 - Aviation volumes in selected city pairs, both directions in 2019 (source: selected airports)**

| ***To/from AMS*** | OD | Transfer |
|---|---|---|
| Frankfurt | 245.000 | 640.000 |
| Hamburg | 250.000 | 225.000 |
| Bremen | 115.000 | 60.000 |
| | | |
| Paris | 565.000 | 820.000 |
| | | |
| London | 3.840.000 | 885.000 |
| Southampton | 115.000 | 60.000 |

| ***To/from DUS*** | OD | Transfer |
|---|---|---|
| Berlin | 1.230.000 | - |
| Frankfurt | 195.000 | 185.000 |
| Friedrichshafen | 15.000 | - |
| Hamburg | 445.000 | 75.000 |
| Leipzig | 95.000 | 10.000 |
| Munich | 1.260.000 | 225.000 |
| Nurnberg | 125.000 | 20.000 |
| Stuttgart | 100.000 | 25.000 |
| Paris | 385.000 | 100.000 |
| Amsterdam* | 140.000 | 120.000 |

| ***To/from CNG*** | OD | Transfer |
|---|---|---|
| Berlin | 1.435.000 | - |
| Dresden | 125.000 | 5.000 |
| Hamburg | 430.000 | 30.000 |
| Munich | 880.000 | 135.000 |

| ***To/from BRU*** | OD | Transfer |
|---|---|---|
| Frankfurt | 480.000 | 95.000 |
| Hamburg | 105.000 | 95.000 |
| Stuttgart | 55.000 | 20.000 |
| Hannover | 5.000 | 10.000 |
| Paris | 20.000 | 175.000 |
| Amsterdam* | 275.000 | 10.000 |
| London | 730.000 | 190.000 |

** Travel to/from AMS was added in these tables and not in the one of AMS to avoid doubling*

For the moment our hypothesis is that in post-covid times recovery will take place according to a U-scenario, meaning that aviation will recover to original volumes only after several years (SEO, 2020). That will mean that we expect on the long run aviation volumes to be slightly under the future expectations for aviation before covid, due to the fact that businesses will be done more online and from home. Our assumption is that this takes some 10% less aviation travel. These recovery data are being matched with the outlines 2030 and 2050 for aviation in the Baseline scenario; meaning that we expect some 20 million travellers on these city pairs in 2030, towards 23 million in 2050 according to a business-as-usual scenario.

#### 5.2.2.2 Transport Market Arena

Due to competitive reasons, data on HST transport volumes within, to and from the Eurodelta are hard to find; but a sophisticated guess would be that Thalys, Eurostar and ICE together served some 10-11 million passengers to, from and whitin the Eurodelta in 2019. Nevertheless, dealing with the 2019 data would mean that we need to cope with nearly trippeld transport volumes in 2030, towards almost a quadruppling of transport volumes in 2050. To that end we have considered several scenarios:

*Scenario 1:* a first scenario could be that part of the extra demand would be captured by other (more or less sustainable) modes, such as zero-emission aircrafts or climate neutral cars. This is especially the case for OD passengers, since transfer passengers would be probably captured by an integrated HST-Plane ticketing system, including a better flowing of the baggage handling. But capturing the extra demand with zero-emission aircrafts, on an average capacity of 10 passengers/plane, would mean that an extra 1,8-2,5 million airplanes would take the sky above the Eurodelta. This is not feasible given the already overcrowded aviation paths. The same goes for an extra 15-20 million climate neutral cars (based on an average passenger rate of 1,2), given the capacity of the interna-tional highways. Moreover, we have looked again into the real travel times of HST's compared to the maximum range and speed of these zero emission cars. Based on this, these cars would only travel faster on the city pairs Amsterdam to Bremen and Hamburg vice versa. Here we are dealing with 350-400.000 OD transport volumes vice versa annually. Therewith this scenario would hardly solve the extra transport needs.

*Scenario 2:* a second scenario could be to fill up the existing capacity of the HST-services to the max. Based on the existing capacities of the HST trains[13], and based on the existing services (see Figure 11) and the 'sophisticated guess' above we expect that overall, the HST's within, to and from the Eurodelta, do have an occupancy rate of in average 70%. Theoretically, therewith this scenario could lighten the extra demand with some 4,5-5 million pax annually. But in real life this scenario would prove to be hardly realistic, since passengers don't go all the way and step in and out along the way. Moreover, it isn't even preferable, because in order to become a realistic alternative, we don't want aviation passengers to wait for more than (half) an hour or so on the HST platforms of airports to proceed with their journey in case of transfer. In addition, there wouldn't be any reserve in relation to the growth expectancy rates towards 2030 and 2050. Therefore, we didn't delve so much into this scenario, but sticked to the present occupancy rates as 'a buffer capacity', in case of unexpected demands.

*Scenario 3*: a third scenario might be to lengthen the HST trains from 200 up to 400 meters, as is already the case with regard to most of the Eurostar services, and HST trains on longer distances. Another alternative might be that the HST service providers could use new material, like for instance double-deckers in some corridors. It would require an extra investment of the HST carriers (especially Thalys and ICE), and an extra investment at some stations to lengthen the HST platforms. Nevertheless, this wouldn't be matched by an even substantial improvement of the quality of the HST services. Similar deficits as expressed in scenario 2 are also the case over here. Moreover, at first sight – taken into account the corridors where already 400m trains are running, and to match these services where this is not the case – it would only result in an added capacity of some 20-30%, hardly enough to meet the extra demands from a ban on mid-range aviation. Nevertheless, this scenario might add to other solutions, especially in peak hours or in some overcrowded corridors on the long run.

*Scenario 4:* Therewith we have primarily looked into a fourth scenario e.g. to intensify the frequency of HST trains according to the extra transport demand calculated. In reference to the specific corridors this would result in up to a doubling or even tripling of the frequency of the HST services on specific routes (including a raise towards a 80% occupancy rate in average on the existing and/or new services, with partly new material and an extended service realm of 5:00-22:00). Specifically with regard to tracks and corridors, this might result in

- a 40 minutes HST service on the Amsterdam-Frankfurt route (in average 50% more)
- a 20 minutes HST service on the Berlin-Cologne route (almost doubling of the frequency)
- a 30 minute HST service on the Cologne-Brussels route (in average 50% more)
- a 25 minute HST service on the Amsterdam-Brussels route (more than a doubling)
- and a 15 minute HST service on the Brussels-Lille route, with connection every 15 minutes towards London and/or Paris
- including a better connection to/from the main airports within the Eurodelta (mainly BRU and CGN), and a HST connection via Eindhoven (see figure 3 b, and the argument below).

[13] 377 passengers per Thalys train (120 1st class, 257 2nd class), 458 per ICE train (98 1st class, 360 2nd class) and 750 per Eurostar train on these tracks (206 1st class, 544 2nd class)

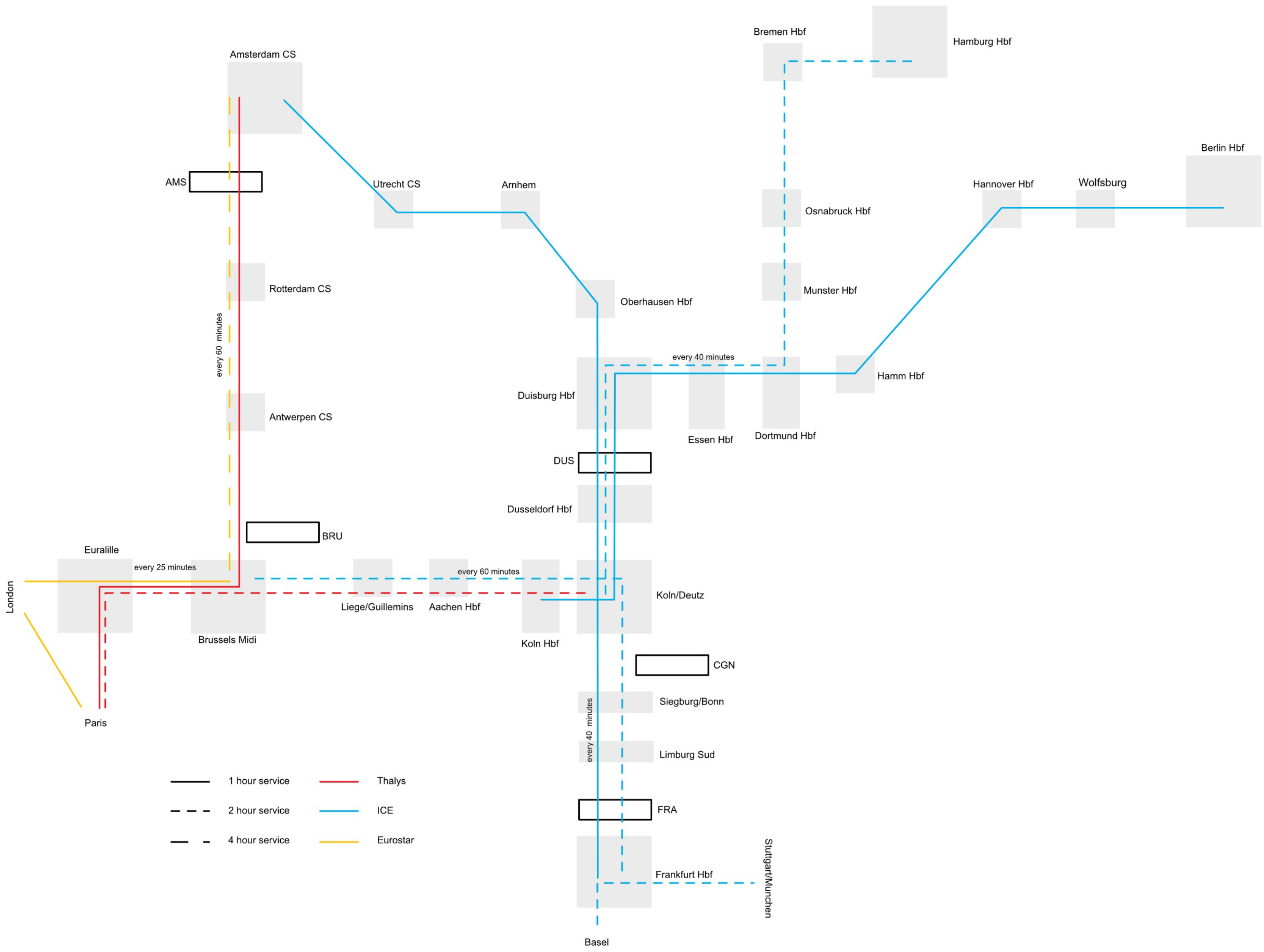



**Figure 11 - Current HST track plan within and towards SURE area (source: STISE research consortium)**

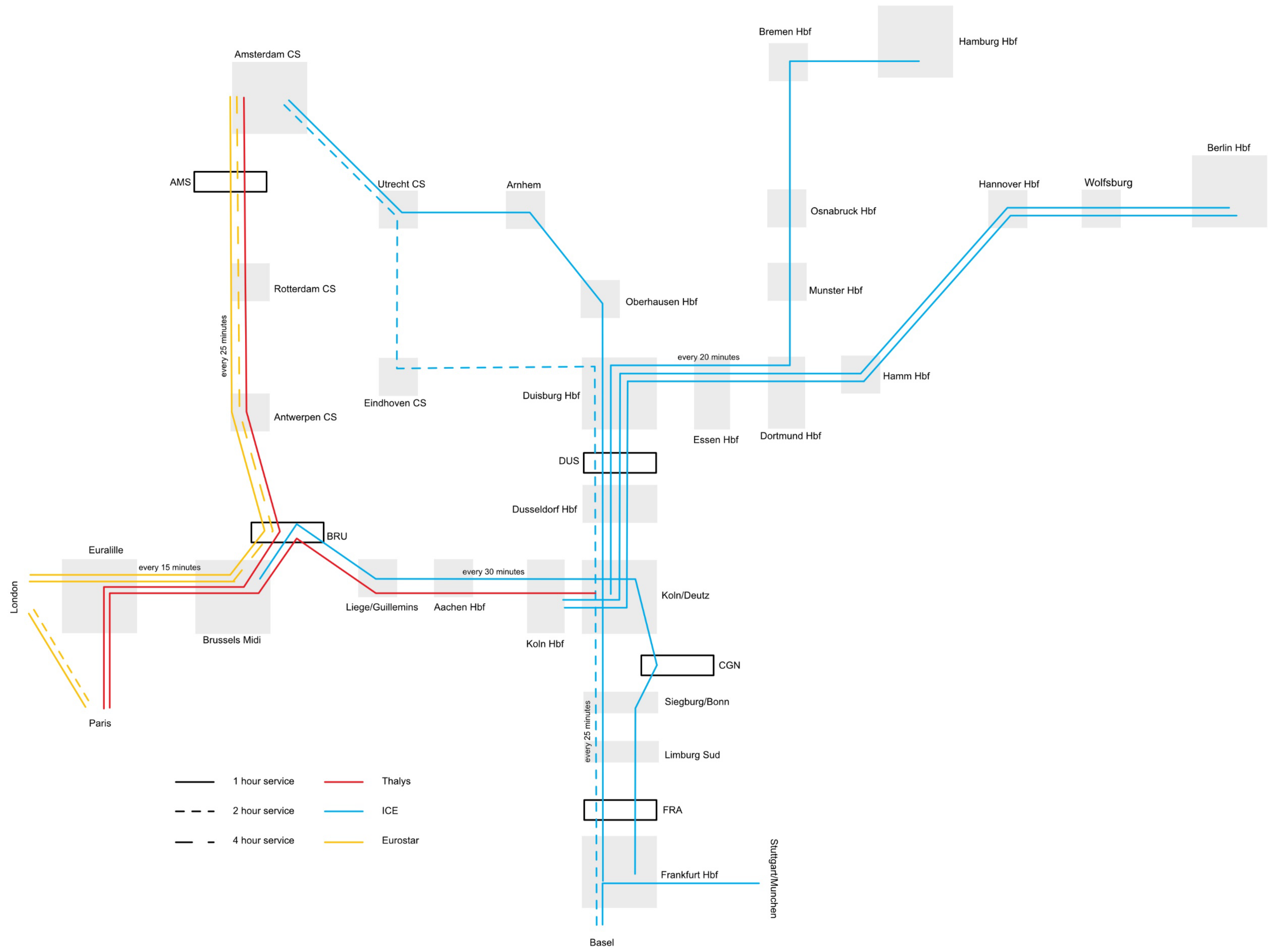



**Figure 12 - Possible new track plan with aviation shift within and towards the SURE area (source: STISE research consortium)**

Due to the economies of scale, this could also have a major effect on the ticket price, and therewith a spin off for the domestic travel (modal shift) on these corridors. There is a need for additional research to what extent this might take place. Nevertheless, it is expected that this would have a major impact on the quality and sustainability of travel within, to and from the Eurodelta.

#### 5.2.2.3 Traffic Market Arena

Nevertheless, this fourth scenario might already have a major impact on the capacities of the current (high speed) rail infrastructures, given also the plans and needs for domestic travel. Therefore, we have consulted the respective national infra-providers where bottlenecks might occur, and if/how these might be solved. From these interviews we received the following overview:[14]

*Corridor Randstad-RheinRuhr-Frankfurt*

- The existing track between Oberhausen and Arnhem is currently being upgraded. Also given the overcrowded rail paths within the Rhein-Ruhr area and Arnhem-Utrecht for HST and for domestic travel as well, it would not be easy, if not impossible to further upgrade this track. Therewith and when there is a need for further extensions, one might reconsider a new HST-track between Eindhoven-Venlo-Krefeld-Düsseldorf airport to meet up with demands. This needs an additional Cos-Benefit Analyses and Environmental Impact Assessment in order to be implemented. This might take several years and - if politically acceptable this assessment needs to be taken up a.s.a.p.
- Already at the moment there is a need (and it is partly already decided upon) to upgrade the Köln/Deutz station as a Rail-Hub. This won't be possible at the existent Köln Hbf. With this policy measure there is an extra pressure to upgrade services, including a custom service for travellers to/from the UK.
- Within the context to the Rhein-Ruhr-Express-Concept (RRX) an extension of regional public transport to the Airport of CGN is foreseen. Nevertheless, with a ban on aviation at short- and mid-range distances, there would be an extra need to travel directly with HST (and without exchange) between this Airport and especially Berlin, Munich and Hamburg. Domestic ICE services should then start or end, and/ or pass through CGN.

*Corridor Randstad-Brussels-Paris/London*

- The regional authorities have already decided about the need for an extension/new rail tunnel underneath Schiphol Airport for local/domestic reasons. But in order to meet the aviation shift demands (especially towards/from the UK) there is a further need to expand the station with customs facilities and baggage logistics.
- The existing HST station of Antwerp CS has to be upgraded too with customs facilities if and in order to receive Eurostar trains and meet the needs of UK travellers.
- The same goes for the station Brussels National Airport; this station has to be extended with two tracks in order to serve as a HST stop.
- The North-South rail tunnel underneath Brussels is already a major bottleneck in as well the domestic and international rail services. On the short run there is a need to optimize operations through a mix of systems improvements, harmonisation of train paths and circulation measures. On the long run there is a need for an extra tunnel between Brussels North station and Brussels Midi.
- Station Brussels Midi needs to be upgraded with two platforms in order to meet the extra HST Rail demands.
- The Eurotunnel has to be extended with two rail tracks. In fact, this is already needed in the present situation.

*Corridor Brussels-Rhein-Ruhr*

- There are minor improvements needed on the existing tracks;
- Nonetheless there is a new (east-west) station Brussels National Airport needed, including new east-west tunnels in order to create an efficient stop for HST's on this corridor at the airport.

[14] Of course this is only a first outline, partly based on existing studies, which need further to be elaborated in detail.

### 5.2.3 Assessment of Impacts of the Measure

**Environmental impact**

This policy measure will have a major impact on the $CO_2$-emissions. $CO_2$ emissions for air travel on short and midrange distances in the SURE area are estimated at 0,93 million ton in 2019. With the implementation of the aviation shift to high-speed trains policy measure, a reduction of 0,94 million ton of $CO_2$ in 2030 and 0,86 million ton in 2050 would be achieved. This will contribute around 0,1% to the overall ambitions of the EU Green Deal[15] - which is already fairly high for an area that covers hardly 1% of the European territory. But if we compare these numbers with the $CO_2$ emissions of the SURE, with the transport flows resulting from the baseline scenario (see Table 5), this measure would contribute with reductions of 0,9% in 2030 and 1,4 % in 2050 of the total emissions from transport in the area, and with some 10-12 % to the ambitions of passenger air travel.[16]. Next to that we don't expect extra environmental burdens with regard to noise or footprint of the HST. Except for the optional extra HST line between Eindhoven and Dusseldorf Airport (for which an additional Environmental Assessment Report is needed), the shift will be predominately realised on existing tracks. On these tracks impact reduction measures have already been taken.

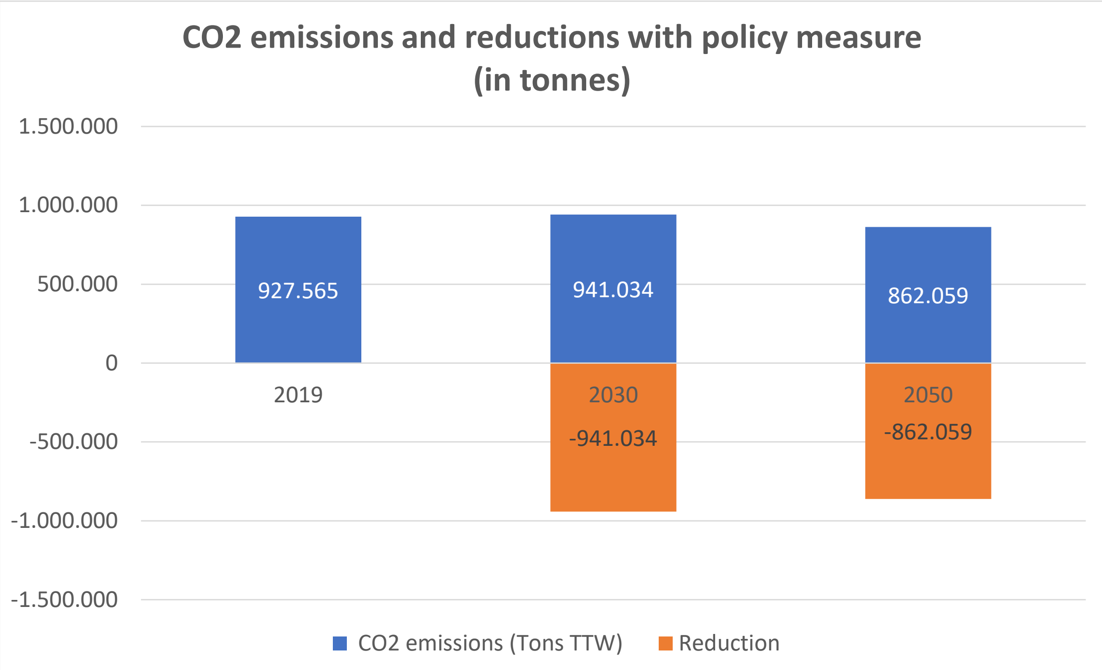



**Figure 13 - Estimated $CO_2$ tonnes reduction (source: STISE research consortium)**

Expected reductions of $NO_x$ and $PM_{10}$ emissions would be more limited (in the range of -0,01% to -0,03% compared to the emissions in the baseline scenario for the SURE in 2030 and 2050).

[15] The EU intends to reduce its carbon emissions by some 55% in 2030 with reference to the 1990 situations (3.753 million ton); meaning emissions of 2.064-million-ton $CO_2$ In 2030. In reference to the 2020 situation (some 2.550 million ton) the intention is therewith to reduce the emissions with a further 860 million up to 2030, towards climate neutrality in 2050.

[16] Based on an average reduction of $CO_2$-emissions compared to 2020 levels (see note 14)

Moreover, we expect a reduction of the noise hindrance around the four involved airports with some 10-20%, provided the open slots will not be taken by an extra growth of aviation over long distances.[17]

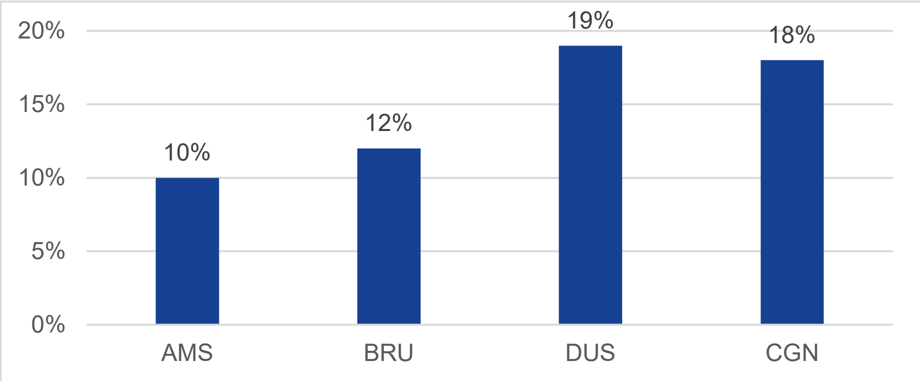



**Figure 14 - Estimated Noise reduction at selected airports (source: STISE research consortium)**

Last but not least we expect to obtain a reduction of the energy use by 11.000 to 12.000 $10^6$ megajoules. Next to that, kerosine will be replaced by (more and more sustainably produced) electricity and/or hydrogen sources, which will highly contribute to a more climate neutral Europe.

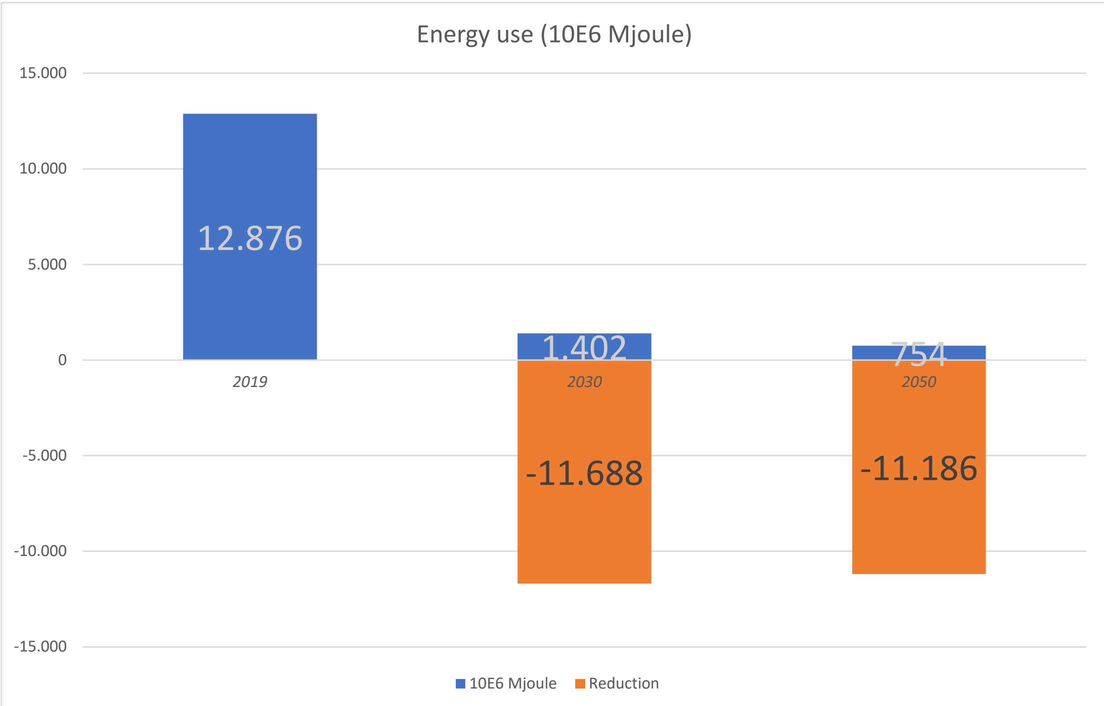



**Figure 15 - Estimated Energy reduction in $10^6$ Mega-joule (source: STISE research consortium)**

**Socio-economic impact**

This measure will not really result in a reduction of travel times. Nevertheless, it will contribute to the reliability of internal transport means, and therefore also contribute to the economic recovery, growth and

[17] Due to the larger passenger numbers of AMS, apparently this airport only allows relative bigger airplanes in reference to its SURE colleagues in order to stay within the domestically allowed ceiling of in- and outbound planes.

borrowed size effects of the Eurodelta (a.o. Van Oort et al. 2017). Moreover, this could enhance a further Transit Oriented Development at each of the HST-stations. Therewith the accessibility of jobs will be improved, next to the added value and spin off to other businesses.

Furthermore, due to the increased volumes and upgraded frequencies, we can expect a reduction of ticket-pricing and thus also (provided an integrated boarding system of Thalys, Eurostar and ICE) a major improvement of cross-border domestic travel. Mid- and lower-income groups could therewith also benefit from this policy measures. Next to that, it could further lead to a shift from car to rail on domestic and cross-border travel demands. Further research is needed to which extent this shift might result. Moreover, provided that the pre- and after transport to and from the HST-stations are improved also or that the interchange would be as seamless as possible, also other cities (not connected by HST) - e.g. The Hague but many other (regional) cities in the SURE area as well – could benefit from the increased HST frequencies. Furthermore, domestic train services, which are now using the HST tracks, could be shifted towards the traditional, non-high-speed tracks, and therewith improve the overall rail connectivity (see also measure 4). This could further enhance a shift to more sustainable and climate neutral travel, also domestically.

**Financial impact**

The financial costs of the infrastructural measures mentioned above are roughly estimated between € 15- 25 billion excl. and € 25-35 billion including an extension of the Eurotunnel (meaning in average hardly 0,4% of the total budget foreseen in the EU Green Deal annually)[18]. In return there is little improvement in travel times, but most importantly the reliability of the international HST services will improve massively. Where necessary, improvement of stations has been taken into account. As such, the HST-services to/from and within the Eurodelta would begin to meet Asian standards, as is already the case in Japan, China and elsewhere.

## Table 10 - Estimated infrastructure costs (based on inputs of the national infra providers)

| When | What | Estimated costs |
|---|---|---|
| <2030 | New tunnel AMS | already planned |
| | Bagage system Aviation Rail | € 500 million |
| | Optimize Operations North-South Axis Brussel | € 100 million |
| | Start MKB/MER Eindhoven-Venlo-Duisburg | € 5 million |
| | Upgrade track Arnhem-Oberhausen | already planned |
| 2030-2040 | New tunnel east-west BRU | € 2,5 billion |
| | New station + baggage handling BRU | € 800 million |
| | Upgrade Brussels Midi | € 200 million |
| | Upgrade Antwerp station (if needed) | € 200 million |
| | Upgrade track Antwerpen-Mechelen | nn |
| | New North-South tunnel CGN | € 500 million |
| | Optimize DUS (incl. baggage handling) | € 500 million |
| | Upgrade Köln-Deutz station | already planned |
| | Upgrade track Liege-Aachen | € 500 million |
| | Upgrade ERMTS | € 3 billion |
| >2040 | New North-South tunnel Brussels | € 2,5 billion |
| | Extension Eurotunnel with 2 additional tracks | € 10 billion |
| | Upgrade Lille Europe | € 500 million |
| | New HST track Eindhoven-Duisburg (if needed) | € 8 billion |
| | | |
| | *TOTAL* | *circa € 30 billion* |

[18] Meaning 260 billion € annually

### 5.2.4 Impact Relevant External Trends

Trend 1 (Climate change & Energy reduction) is affecting the aviation shift measure. The trend will further enhance the need for the shift from Plane to Train (or fossil to electricity produced by climate neutral energy sources). To achieve this, additional policies on regional, national, European (or SURE) levels are needed. According to increasing aviation (and decreasing HST) prices of the air travel demand will be further reduced with several percentages compared to the baseline scenario in 2050. Also trend 5 (effects after Covid) has an impact: The U-scenario of SEO (2020) was used, so we worked with 10% less air passengers in 2050. This is congruent with this trend of the Baseline scenario. Trend 6 (Disintegration EU) is relevant too: Brexit will further result in a reduction of demand for air travel. Nevertheless, if Brexit were to lead to an extension and a doubling of the capacity of the Eurotunnel, it could reduce the negative economic impact of Brexit.

### 5.2.5 Policy Roadmap for Implementation

***Consultation stakeholders***

In the process of drafting this policy roadmap various stakeholders - of the involved travel, transport and traffic market arena - were invited in an online roundtable meeting to exchange views on the implementation of such a policy measure: representatives of the four main Airport Authorities on short flying distance in the Eurodelta, representatives of the three HS providers, representatives of the four infra providers in the Eurodelta countries and some representatives of (regional and local) public authorities in the Eurodelta.

***Policy roadmap***

This policy measure matches the ambitions of the European Green Deal (with regard to the doubling of high-speed train connections in 2030 and tripling by 2050), and could already fill in the overall climate ambitions of the SURE massively. In addition, also climate neutral domestic travel could benefit from the measure, and it could further lead to a shift from car to train on cross-border travel. Due to financial and time constraints we could not include these effects into these analyses; thus further research on these impacts is needed. But we expect a further reduction on cross domestic non-sustainable transport means. Nevertheless, the outcomes of this analysis (including the conclusions of already previous research) already urge to prepare the next steps for implementation; Doing nothing is no option, especially in regard to the rapid post-covid recovery which takes place at the end of this writing. Flying is already catching up fast, especially within the sector of Low Cost Carriers. There is a need for a swift and decisive recovery strategy for more climate neutral cross-border travel in order to enhance sustainable cohesion once more. When this would work in the SURE area, the measure could be rolled out for the entire European Union to enhance a level playing field. For that purpose, we recommend the following policy roadmap for implementation.

1. Discuss the results of this analysis with the involved directorates of the European Commission, with the intent to amend the open skies agreements, which is already in place for more than 15 years, to exclude air travel < 500km. from this treaty.

   ***Task to take on by: joint stakeholders of the SURE area / European Commission***

2. From here appoint an ambassador (team) of the Aviation-HST shift, who will further coordinate the activities, and investigate if the current developments around the HST-tracks, HST-stations and operational contracts are future proof.

   ***Task to take on by: joint stakeholders of the SURE area***

3. From there assign the respective national authorities to come up with additional sustainability rules and arrangements for short and midrange aviation slots (including a respective decrease of the total allowed slots at the Airports) to, from and within the SURE area, step by step. The included city-pairs in this research would have priority. In a second phase a similar operation could be carried out up to 700 km air travel.

   ***Task to take on by: national slot-coordinators***

4. Parallel to this discuss with the four involved Airport Operators how to implement this shift in a long-term strategy plan, and investigate further what is exactly needed to guarantee a smooth interchange for Transfer passengers.

   ***Task to take on by: Ambassador Team, with the Airport Authorities***

5. Parallel to this discuss with the National rail infra providers to implement and finance the first package of infrastructure amendments until 2030 (see Table 10) and open up discussions with the EU-Commission to include (part of) the infrastructural costs in the EU recovery and/or Green Deal plan.

   ***Task to take on by: Ambassador Team, with the National Infra providers and EC***

6. In addition, start up the needed supporting studies to enhance the upgrade of the HST network and start up discussions with the involved airlines how to develop a new and more ambitious green airline network for the SURE, and in extension Europe.

   ***Task to take on by: Ambassador Team, involved EU-directorates and Airlines***

7. Based on these groundings, a follow-up phase of this STISE project (> 2030) could be initiated, and the necessary policy decisions in-between should be prepared

   ***Task: Joint Stakeholders SURE/Ambassador Team***

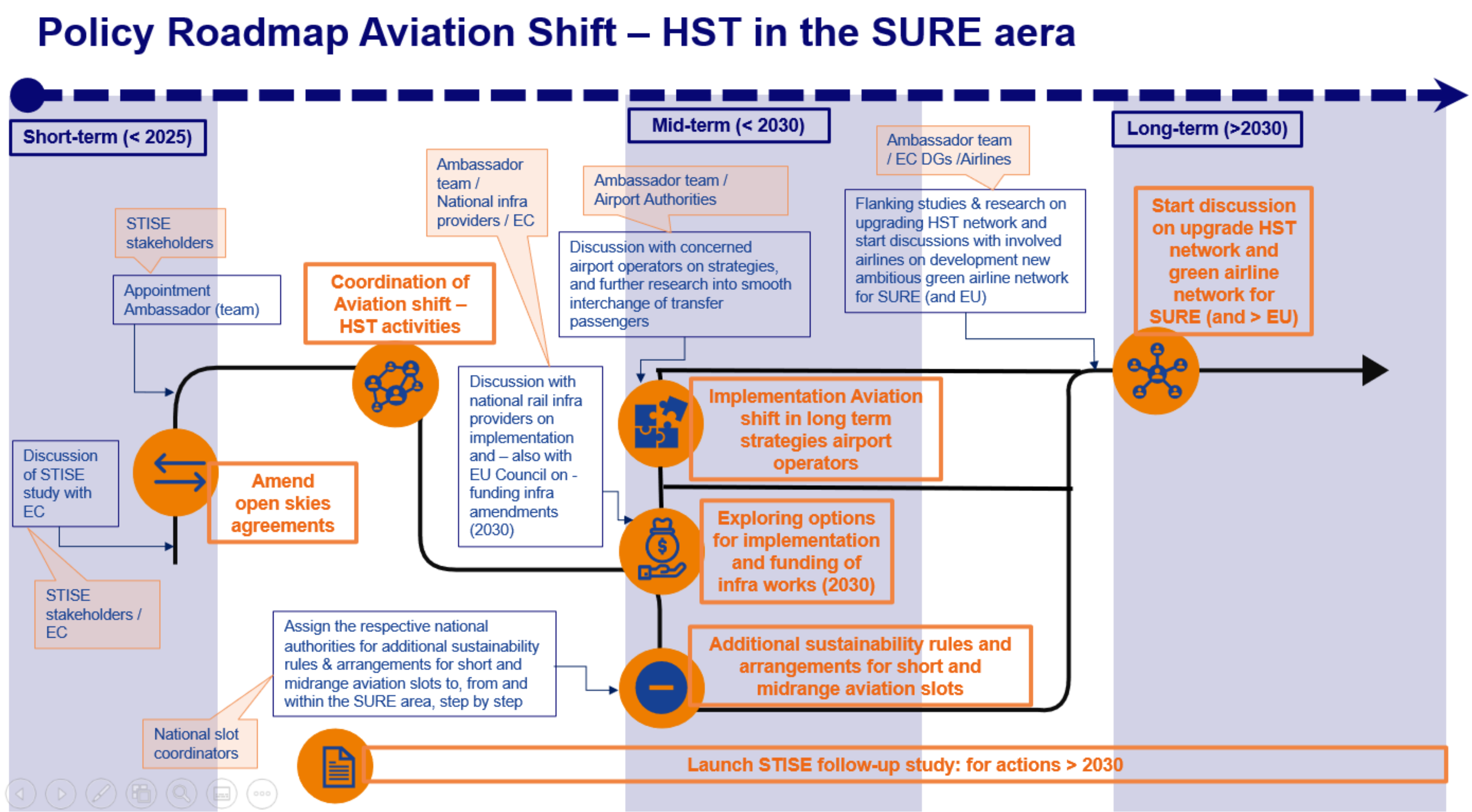



Figure 16 - Policy roadmap Aviation shift - HST

## 5.3 Zero Emission Zones (ZEZ) in all Major Cities in the SURE area

### 5.3.1 Description Policy Measure

Implementation of harmonized Zero Emission Zones (ZEZs) in all major cities (> 100.000 inhabitants) located in the SURE area for passenger cars, Light Duty Vehicles (LDVs) and Heavy Duty Vehicles (HDVs), by 2035. [19]

This measure is proposed for effective and full implementation in 2035, as by this time it seems realistic to align the different (existing and planned) initiatives regarding Low Emission Zones (LEZs) and ZEZs in the different regions and countries in the SURE area – with set timings often in 2025 and 2030. A shared ambition for 2035 will give a strong signal to Original Equipment Manufacturers (OEMs), transport companies, shippers and inhabitants, that changes will be real and standards widely applied.

Approximately 14 Low Emission Zones have been implemented so far in the SURE area: 3 in Belgium (Antwerp, Ghent, Brussels), 2 in the Netherlands (Utrecht and Rotterdam), and (partly) 9 in Germany (Aachen, Bonn, Dinslaken, Düsseldorf, Eschweiler, Hagen, Krefeld, Köln and Mönchengladbach).

As shown in Annex 3, existing LEZ implemented in Belgium, the Netherlands and Germany, targeting different groups of vehicles (where, in the French part of the SURE area no LEZs are launched yet[20]). Most LEZs currently fall within national or regional schemes, that allow different implementation options (e.g. location, standards, timeframe…).

Harmonisation of ZEZ standards would be based on the following criteria: **categories of vehicles affected by the ZEZs** (passenger cars - M1 vehicles -, light commercial vehicles - N1 vehicles – and heavy duty vehicles - M2, M3, N2, N3 vehicles) and **emissions standards** - only zero-emission vehicles, i.e. vehicles that produce no emissions of pollutants from the on-board source of power, such as all-electric or hydrogen fuel cell vehicles – will be allowed to access restricted areas. Annex 3 gives a brief overview of existing relevant research related to ZEZs. It also summarises the expected behavioural changes and impacts on the transport sector, and identifies the main EU policy goals ZEZs would contribute to. Usual benefits and disbenefits of this policy measure are reminded in the table below.

**Table 11 - Usual benefits and disbenefits of LEZ**

| Benefits | Disbenefits |
|---|---|
| Improved air quality (NO2, PM, others…) | Disproportionate impact on expensive 'specialist' vehicles (e.g. coaches, specialist lorries…) |
| Progress towards EU Air quality limit values | Greater relative impact on smaller companies |
| Health benefits - lower lost time at work, lower health care costs | Greatest relative impact on road haulage, the wholesale, trade, manufacturing sectors, and smaller construction/building companies |
| Small reduction in noise | Higher potential business costs for companies (which could negatively affect attractiveness) |
| More attractive environment for companies and people | |
| Safety benefits of newer vehicles | |
| Economic and employment benefits for the vehicle manufacturing sector | |

[19] See map in Annex 3
[20] A permanent environmental zone in Lille (France) was planned to enter into force early 2021, but its implementation has been postponed to early 2022.

### 5.3.2 Three Market Arena Model

This policy measure is in essence focused on the ***Transport Market Arena.*** We expect that the (modal shift of the) travel market remains more or less the same and according to the baseline scenario for the years 2030 and 2050. Instead, the measure is in particular focused on the ambition that road travel within inner-city areas needs to be done climate neutral; this because these inner-city areas suffer the most from heavy carbon dioxide levels, particulate matter and traffic noise. If all the major cities within the Eurodelta will have implemented this measure by 2035, there would be not only a level playing field in regard to, for instance, the threat of economic activities or inhabitants' relocation, but also the vehicle and transport equipment manufacturers will be addressed strongly to produce climate neutral light duty and heavy vehicles more quickly. Therewith in extension, this measure could also have a major effect on sustainable road transport in other parts of the Eurodelta. We expect that due to these inner-city restrictions, most of the fossil fuel vehicle stock within the Eurodelta, would then have been replaced by climate neutral ones. Nevertheless, and especially on the short run, there is a need to adapt the existing infrastructure too. Therewith this measure also addresses the ***Traffic Market Arena*** slightly. On the short run there is a need to install cameras and vehicle registration equipment, and if necessary (temporary) car parks in the periphery of inner-city areas for the parking of fossil fuel cars and the interchange to more climate neutral transport means. The same goes for inner-city freight traffic. Therewith, in extension, there is also a need for an integrated traffic and parking policy in the major cities, and additional investments in the hardware. Impacts can be measured predominantly with regard to climate change, air quality, noise reduction and congestion reduction, including the social equity balance between on the one hand higher individual travel costs, but on the other hand improvement of (sustainable) public transport means.

### 5.3.3 Assessment of Impacts of the Measure

As illustrated by numerous case studies (see Annex 3), the introduction of ZEZ could potentially trigger various behavioural changes, or variations in the willingness to adhere to the measure, from the current car users. These changes could have no impact on the mode of transport such as a shift to zero emission private vehicles or to car sharing with zero emission vehicles, or could imply a modal shift, such as shift to public transport and other modes: bicycle, scooter, walk, or imply a reduction of mobility (fewer trips).

Several studies on this topic indicate that the main impact of the introduction of ZEZ leads to "motor shifts" i.e. a shift towards low-emission or zero-emission vehicles.

Regarding the volume of travel, several feasibility studies of ZEZ indicate no or little effect on the number of vehicle-km expected to be performed. This is for example the case in Brussels where a recent study[21] has shown that for a realistic scenario studied, 97,2% of the current car trips will still be done by car in 2030, and 2,8% by other modes. It should be noted that, in parallel to the introduction of ZEZ in the Brussels Capital Region, many policy measures are considered in order to render urban transport more sustainable ("Good Move" plan), with the objective to reduce car use and increase the use of public transport and active modes: bicycle, walk, etc.

#### Environmental impact

The approach that has been followed to assess the impacts of the Zero Emission Zones policy measure on the environment in the SURE area is presented in Annex 3. The city/region of Brussels (*Région de Bruxelles-Capitale*) has been considered as the reference and starting point city. Then a scale factor takes into account the population of the other cities with more than 100.000 inhabitants with reference to Brussels, and the forecasted growth of trips in 2030 and 2050.

As described in more detail in Annex 3, the introduction of ZEZ in all the cities over 100.000 inhabitants in the SURE with a diesel ban in 2030 and a thermic ban in 2035 for passenger cars, LGV and HGV would globally avoid the emission of 578 Mtons of $CO_2$eq (-55% compared to the reference), 1,1 Mton of $NO_x$ (-37%) and 21 ktons of $PM_{10}$ (-54%) over the 2022-2050 period.

[21] Stratec (19 mars 2021), « Etude d'impact sur la mobilité, sur les aspects économiques et sociaux et sur l'énergie et roadmap vers une sortie des véhicules thermiques, Partie 4-Impacts sur la mobilité des personnes, Enquête de préférences déclarées et simulation MUSTI », Bruxelles Mobilité

By contributing with about 3% to the overall $CO_2$ ambitions of the Green deal[22] in 2030, the environmental impact of the ZEZ policy measure could be huge - considering the relatively small geographical scope of this particular policy measure.

### Economic impact

The costs and benefits of the implementation of ZEZs concern the residents and the companies implemented in the area, as well as the public authorities. The nature of the costs and benefits is listed in the following table. It should be noted that the costs for certain actors constitute benefits for others, like the fines paid by the road users. The qualitative assessment of cost (-) and benefits (+) is summarized in the table below.

| Costs | Inhabitants, road users | Companies | Public authorities |
|---|---|---|---|
| Implementation: access control, registration, signaling, communication, … | | | - |
| Replacement of vehicles | - | - | - |
| Operation of ZEV | + | + | + |
| Permits for exemptions | - | - | + |
| Fines | - | - | + |
| Health (Indirect benefits) | + | + | + |

It should be noted that the evaluation of the costs and benefits depends on specific characteristics of the economy of the cities where ZEZs are implemented, such as: types of economic activities, car ownership, distribution of vehicles by type of fuel and evolution, length of trips, relations with surrounding areas, levels of revenue, etc. Specific socioeconomic studies should be carried out for each city in order to evaluate and quantify the costs and benefits of the implementation of a ZEZ. Most of the socioeconomic feasibility studies reviewed consider that ZEZs have positive results (Sum of socioeconomic costs < sum of socioeconomic benefits over a 10 year period) if the (indirect) benefits on health are duly taken into account.

### Social impact

As described with additional details in Annex 3, the relationship between social inequalities and air pollution is threefold: inequalities in terms of (i) exposure to pollution, in terms of (ii) vulnerability, and in terms of (iii) contribution to pollution.

Generally speaking, it can be stated that if improving air quality will benefit to all population groups, disadvantaged people will generally be more positively affected as the greatest benefits will be observed in areas where the air quality is worst. As a consequence, policy makers should ensure that measures implemented to improve air quality can contribute to address social inequities or, at least, do not exacerbate them.

Although vehicle owners from all socio-economic groups are theoretically affected by traffic restriction measures, some specific population groups will generally be more affected because of their greater vulnerability. It is important to note, however, that these profiles cover a wide variety of situations and that the actual impacts for these individuals will depend on many factors.

Costs incurred by the implementation of ZEZ, especially for disadvantaged population groups, should be assessed and weighted against health benefits to ensure these do not increase social inequalities and,

[22] The EU Green Deal includes EU's general ambition on reducing greenhouse gas emissions to at least 55% (net reduction) below the 1990 levels by 2030, and to become climate neutral by 2050. With reference to the 1990 situation (3.753 million ton); this means emissions of 2.064-million-ton $CO_2$ in 2030. With reference to the 2020 situation (some 2.550 million ton) the intention is therefore to reduce the emissions with a further 860 million up to 2030, towards climate neutrality in 2050.

when deemed necessary, to identify and implement accompanying measures to mitigate adverse social impacts. Possible appropriate supporting measures are described in section §5.3.5 on the policy recommendations below.

### 5.3.4 Impact Relevant External Trends

The ZEZ policy measure concerns both the passenger and freight transport. Therefore, the relevant external trends for this policy are, for passenger transport, Trend 1 (Climate change & energy transition), Trend 2 (Technical evolutions in the transport sector) and Trend 5 (health/economic crises/effects after Covid) which is also relevant especially in cities. For freight transport, the relevant external trends are Trend 3 (Growing globalisation in the field of transport) and Trend 4 (Growing circular economy). Trend 6 (impact of Brexit) has a negligible effect on urban traffic in the SURE area.

The effect on the overall passenger rail and road demand for Trend 1 and Trend 5 would result in a potential decrease in rail and road demand towards 2030 and 2050. Trend 2 might lead to a potentially even larger reduction in rail demand, since one of the biggest advantages of rail compared to car travel (travel time can be used for other activities) disappears if fully automated driving becomes available. However, as the development of autonomous cars is currently very uncertain, no clear effect can be considered.

For freight transport, the global effect of Trends 3 and 4 would result in a potential decrease in rail and road demand towards 2030 and 2050.

Therefore, the reductions of road transport emissions in the ZEZs would drop in parallel with the above-mentioned effects of the relevant external trends.

### 5.3.5 Policy Roadmap for Implementation and Policy Recommendations

#### *Consultation stakeholders*

Several stakeholders that might have interesting views or could share insights regarding the implementation of this measure were invited to do so: representative of some (local, regional and national) authorities, city associations, representatives of the automotive industry and NGOs/environmental organisations. Four online round tables were envisaged - one per country (Netherlands, Belgium, France, Germany). However, due to the limited interests, willingness and/or availability to discuss this point in a roundtable format, an easily accessible online questionnaire was launched to gather some feedback that was included in the research.

#### *Harmonisation of ZEZ in the SURE*

***Benefits of harmonisation***

While urban mobility is largely a matter of national and local competence, the diversity of low-emission zones (LEZs) has posed new challenges for passenger and freight transport by creating obstacles to the seamless mobility of vehicles across the EU.

As underlined by the European Commission[23], the lack of harmonisation or transparency has been the basis of concerns expressed by stakeholders when LEZs were initiated at local level, for example in relation to the availability of information online and in foreign languages, and to the difficulties for foreign drivers to comply with the rules and issues related to enforcement, the level of fines, or the lack of provision of sustainable alternatives such as public transport. There are also concerns relating to different rules for access of domestic and foreign vehicles.

A COWI & Ecorys study[24] concludes that standardisation and harmonisation of several aspects might have substantial efficiency and cost savings benefits. Further details about possible benefits of

[23] COMMISSION STAFF WORKING DOCUMENT Accompanying the document COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, Sustainable and Smart Mobility Strategy – putting European transport on track for the future, SWD(2020) 331 final, 2020.

[24] COWI & Ecorys. (2013). Study to support and Impact Assessment of Urban Mobility Package - Activity 32: EU Framework for Urban Road User Charging and Access Restriction Schemes. European Commission, DG MOVE;

harmonising ZEZ are provided in Annex 3. Economic benefits of harmonised ZEZ have been confirmed by the automotive industry, which has shown strong support during an interview conducted in the context of this study.

***Possible levels and areas for harmonisation***

The downside to full harmonisation is that while it may bring about efficiency savings to users and cities, it would also restrict the ability of cities to tailor LEZ rules, namely to local air quality conditions. As the raison d'être of establishing LEZs is to combat local air quality bad conditions, harmonisation of vehicle emissions standards would appear to be city-specific and, therefore, not subject to harmonisation. If cities maintain separate emissions limits, this could significantly limit many of the potential harmonisation 'efficiency' benefits outlined in the table above.

As an alternative, at the other end of the spectrum, harmonisation could be limited to ensuring interoperability of systems whereby cities establish a common LEZ framework, but remain free to set their own rules within this framework. For example, under a limited, interoperable system, cities may use the same type of vehicle identifier but would be free to set their own rules regarding emissions restrictions applied, exemptions granted, LEZ operation times etc. This partial harmonisation model could be in line with that put forward in the COWI & Ecorys study [25] whereby EU, national and local authorities are recommended to voluntarily put in place:

1. harmonised vehicle emission classes for defining LEZs;
2. method for identifying vehicle eligibility (stickers, licence plate recognition system, …)
3. a European database for vehicle emission characteristics to facilitate automatic recognition of the emission class of vehicles and provide an "electronic LEZ certificate" for each registered vehicle for obtaining stickers and permits; and
4. a European database and Internet information service for users on existing and planned LEZ.

In conclusion, under a full harmonisation model, the financial impact could be significant, in particular to freight transporters in terms of vehicle logistics. However, these savings may not materialise if a move to full harmonisation is deemed impractical or politically unacceptable. But even a partial harmonisation (e.g. of vehicle emission classes for defining LEZs, standards for sticker design/information and the creation of vehicle databases) could still lead to savings. For users, the main benefits of partial harmonisation would concern administrative compliance related costs. These could include lower retrofit certification costs, opportunity costs (resulting from less time spent registering and finding out about different LEZ rules) and other administrative costs relating to LEZ charges (e.g. stickers). The savings possible depend on the extent to which the various LEZs would like to harmonise their activities.

What would be therefore recommended is a harmonised framework that, without ultimately constraining local choices, would ensure such choices are appropriately informed and that they would be based on consistent and comparable criteria, while aiming to reduce costs for public authorities, companies and individual users. An optimum combination could be one that reflects significant city/region input, European legislation and non-binding guidance, drawing on examples of good practices in Europe.

### Possible accompanying measures

Several key elements should be taken into account to ensure the successful implementation of a ZEZ, notably to mitigate potential social and economic adverse effects and to increase social and political acceptance. These are briefly summarised hereafter.

1) **Well-defined geographical scope.** A simple ZEZ is easier to understand and will gain more public acceptance than a highly complex scheme. Using an existing boundary such as a ring road will help communicate on the ZEZ, and where there are several towns close together, adopting a single ZEZ may be more beneficial and easier to communicate than individual ZEZs.
2) **Predictability and progressivity.** Experience from existing ZEZ in European cities shows that the acceptability of a traffic restriction scheme can be improved by providing facilitative measures and communication[26] sufficiently in advance. A clear implementation planning specifying the milestones and applicable standards, their access condition according to the different stages of implementation

[25] COWI & Ecorys. (2013).
[26] ADEME, Zones à faibles émissions (low emission zones) à travers l'Europe, Rapport 2020.

and applicable standards, should be communicated from the beginning. This should not only increase the environmental effectiveness of the measure but also promote its social acceptability.

3) **Provision of alternatives.** A UVAR scheme should not be promoted in isolation, but as part of a wider strategic policy, including sustainable urban logistics planning. Residents and businesses must have access to affordable, attractive and convenient alternatives, which should be introduced at the same time as the ZEZ policies. Incentives to promote and support alternatives need to be well designed, publicised and funded. If road pricing is used, cities should consider ringfencing the revenue to pay for this investment.
4) **Facilitative measures**. Facilitative measures, such as subsidies or tax reliefs (in particular for most vulnerable population groups and economic sectors), exemptions, parking or driving lane privileges, park and ride facilities and development of charging infrastructure can encourage drivers to switch to cleaner models and make the implementation of vehicle access restrictions more palatable for drivers and politically acceptable for politicians to support the case for an ZEZ.
5) **Consultation and communication**. Prior to implementing a ZEZ, an effective stakeholder engagement process should be conducted to ensure its acceptability and effectiveness. As experience tends to show that the level of public acceptability rises significantly once a scheme is operational and functioning efficiently, trials can be helpful to gain the support of the largest number of people and companies. Simultaneously to the adoption of a UVAR scheme, the definition of a clear and comprehensive communication and information strategy should be elaborated to ensure its smooth implementation and long-term effectiveness. Information and communication should cover frequent, occasional and one-time users with different needs. Foreign businesses and visitors, and non-local users in general, should have access to high quality information about the rules and regulations of the ZEZ. It is essential to communicate about available alternatives, and to promote education and awareness to change people's transportation behaviour.

### Institutional framework

A table provided in  Annex 3 describes the possible roles and responsibilities of national and local authorities for the implementation of a national/regional legal framework.

### Policy roadmap

Harmonising ZEZ in the SURE area raises many challenges considering the numerous actors to be involved at local and national levels. Many established LEZ schemes are already in place at city level each with different criteria concerning legal basis, charging, enforcement approach and affected vehicle types. It remains unclear to what extent policy makers would be inclined to review these existing schemes, considering that it would require intensive concertation among authorities and that short term challenges of revising existing systems could be perceived as being greater than the long-term advantages of a coordinated and harmonised approach at STISE area level. Furthermore, numerous sub-national authorities and municipalities have already stressed the particular importance of respecting the subsidiarity principle whereby local authorities should remain responsible for defining standards and ambition levels. This opinion has been confirmed in answers to the survey conducted in the context of this study. Finally, considering that no existing institutional framework currently allows to conduct such concertation process in a formal and structured manner, it should be noted that specific institutional arrangements shall be set up.

The possible actions to be undertaken are listed below[27].

1. **Set up a dedicated taskforce to identify expectations and assess the political acceptance of national/local authorities to engage in a harmonisation process**

[27] Additional recommendations presented in a recent study are provided in Annex 3(“Specific recommendations related to National legal frameworks”).

Considering the absence of institutional framework to assess, plan and implement a harmonisation process of ZEZ, a dedicated task force comprising representatives from national authorities should be created. Many stakeholders have been contacted in the context of this study, but the low response rate does not allow to draw conclusions on the political acceptance of harmonising ZEZ. Hence the first activity of the task force should be to assess the feasibility and political acceptance of harmonising ZEZ.

**2. Set up technical working groups reporting to the taskforce to work on specific issues (ambition levels, areas for harmonisation, regulatory framework, …)**

If sufficient common ground is found within the task force, a political mandate should instruct technical experts to work on specific issues such as ambition levels, areas for harmonisation, regulatory framework, etc. Technical working groups reporting to the task force could be created, involving representatives from local authorities and the civil society. The role of these technical working groups would be to identify possible options for harmonisation and assess their environmental, socio-economic and mobility impacts.

**3. Adoption of a political memorandum of understanding**

Conclusions and recommendations developed by the technical working groups and endorsed by the task force could be translated in a political memorandum of understanding (MoU) which would frame the process of harmonisation. This memorandum of understanding should be adopted by all national governments and, possibly, national or regional parliaments.

**4. Implementation of the harmonisation process**

A dedicated body/structure (e.g. above-mentioned task force) shall be appointed to follow up the implementation of the MoU and report to a political steering committee. Its strategic, technical and legal recommendations shall be translated into laws, regulations and administrative provisions, to be adopted by relevant national, subnational and local authorities.

In conclusion, the ZEZ policy measure fulfils or is in line with objectives of various major European political agendas, such as:

- *EU Green Deal*: E.g. 13 million zero- and low- emission vehicles by 2025, 50-55% GHG emissions reduction by 2030 and 90% in the transport sector by 2050, …
- *EU Sustainable and Smart Mobility Strategy*: E.g. 100 climate neutral European cities and at least 30 million zero-emission vehicles by 2030, nearly all cars/vans/buses as well as new heavy-duty vehicles to be zero-emission by 2050, ….

Besides, ZEZ may significantly contribute to reaching EU air quality standards, in particular as defined in *Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe* which sets limit values for the concentration of pollutants in the ambient air in regard to nitrogen dioxide ($NO_2$), particulate matter ($PM_{10}$, $PM_{2.5}$), sulphur dioxide ($SO_2$), benzene, carbon monoxide and lead.

At local level, harmonising and upgrading ZEZ would contribute to reduce air pollution hence providing health benefits, improve quality of life, and reduce costs for citizens and above all freight transport companies to comply with local standards. However, such harmonisation process would require intensive concertation among numerous local, regional and national institutions and external stakeholders, considering the absence of existing institutional framework to organise such dialogue, and the subsidiarity principles whereby local authorities should remain responsible for defining standards and ambition levels.

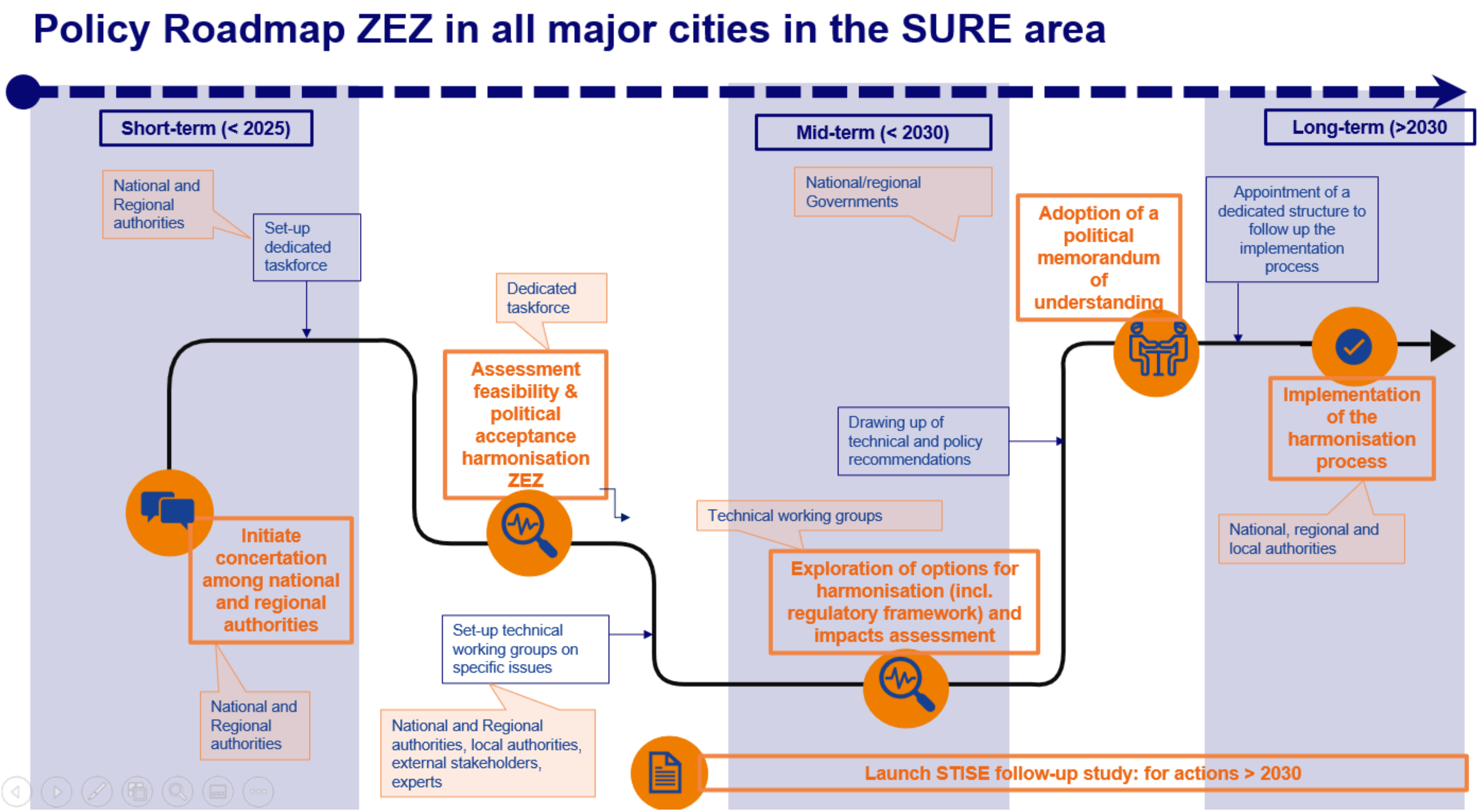



**Figure 17 - Policy roadmap ZEZ**

## 5.4 Exploring the Potential of MaaS

### 5.4.1 Description of Policy Measure

The transport world is becoming more and more digital, it is expected that mobility will be part of the fourth wave of digitalization where previous waves show that industries have significantly changed. To be more specific here we look into the aspect of Mobility as a Service (MaaS). This development is driven (amongst others) by the growth in data availability for various aspects in the mobility domain, e.g. actual arrival times for public transport and real-time traffic information collected from floating car data. Also, the change in ownership towards shared use not only of vehicles, but also concepts of shared space are becoming more generically available.

The complexity for Mobility as a Service is that mobility is not a private good such as a movies-on-demand service, mobility is also the enabler for inhabitants to generate income, to provide in necessary living needs and have physical social interaction. This indicates there is a role for public authorities to facilitate mobility for all. Public authorities in the past have taken up this role by providing (subsidized) public transport to provide inhabitants a way to travel and provide in their needs. This public transport is granted in concessions form to allow for a more market driven approach within this domain.

With the arrival of MaaS as an actual service (a small number of services are actually operational within the EU, with WHIM as starting point in Finland) quite some academic research has been done regarding the potential that this measure can bring. The potential (almost) always related to the shift in modalities but also the impacts it has on the entire mobility system and what public authorities can or cannot do.

Within this study for Mobility as a Service or MaaS we take the perspective from the public authority, in other words, what is the role public authorities have in this development, how can they operate and what is the potential benefit they can realize if the measure is effective. This also means that we take into account what accompanying measures need to be taken in order to realize this benefit.

### 5.4.2 Three Market Arena Model

From the **travel market arena,** the focus lays on meeting travelers' needs, a change that is expected here is the move from ownership to use just-in-time and space of mobility concepts. This is combined with the further development of new transport concepts that offer new types of transport that are (often) more sustainable compared to the classic modes. For example, in various cities shared electric scooters and steps can be found nowadays. But further down the line the automation of course also has an influence on further expanding the possible supply. For these systems matching with the travelers is key and the solution lays in connecting these concepts together in such a way that the travel market serves again as a whole. In more practical terms, create a platform where the different suppliers are combined and where the demand side (from for example a MaaS provider) can tap into to match the supply with travelers' needs. This obviously is not only a regional or national effort, but should take cross-border interoperability into account, an activity worth mentioning (amongst others) is the development of the TOMP-API[28] to create this interoperability for different stakeholders within the MaaS domain.

With new stakeholders entering the **transport market arena** (or existing stakeholders with a new role) starting in the market, new 'rules' need to be established to evolve out of the pilot stages MaaS currently is in. These rules are multifold, but strongly depend on the role MaaS gets from the perspective of the public authorities. This will be a learning process building on successes & failures from the pilot stages. At this moment the number of actual MaaS providers is rather limited due to the fact that many are still connected to the pilots and local solutions they have been constructing around. The growth of MaaS and its providers is also hampered by the lack of governance and mutual policy agreements between the involved public stakeholders to allow for fruitful expansion of these services. That being said, the prerequisites (as mentioned and explained in the Interim report) are key for further expansion.

[28] Application Programming Interface from Transport Operator to MaaS Provider (TO-MP API)

From the **traffic market arena,** the key lays in unlocking the data that drives MaaS. This means not only looking at the data from the involved mobility providers, but also unlocking related data such as pricing and availability of public space for storage of shared vehicle concepts. Unravelling the various data needs, the accessibility of this data and the governance concerning all this data is a complex matter that not only needs an IT-solution but also requires public authorities to be aware of the necessary steps that need to be taken.

### 5.4.3 Assessment of Impacts of the Measure

Various studies have attempted to estimate the impact of MaaS, but only limited information is available regarding the actual impact. However, for a better understanding of the potential, a scaling of the local impact of MaaS that has been found has been performed for the baseline scenario. For these numbers two of the more extreme scenario studies have been taken in order to show what the bandwidth is in which the potential for MaaS most likely can be found. This helps in selecting the role that public authorities should play, as well as what focus is essential to further develop the potential from MaaS.

First is the purely private scenario in which MaaS is mainly focused on car sharing and only limits itself to the higher income classes. This is the scenario in which large private companies focus on making transport by car more accessible causing the share of car transport to increase, public transport is reduced due to the longer trips that are made by car. Other impacts of this scenario are correlated with the quicker uptake in vehicle automation generating other benefits such as increased traffic safety and a quicker electrification of the vehicle fleet. A negative side effect will be that more urban space in cities will be used by cars, even if they move in and out of the cities fully automated.

The second is a highly publicly focused scenario in which public transport serves as the backbone for pure multimodal travel. Individual car travel becomes less attractive due to the seamless travel experience for multimodal trips. This results in a modal shift of up to 10% in 2050 that can be realized. Side impacts are the opening up of public space due to reduction in car ownership. Vehicle automation mainly plays a role in this scenario connected to first-and-last-miles that are being travelled. It is expected that in this scenario a small decrease in passenger kilometers is seen. As part of the first-and-last-mile public authorities actively seek for sustainable solutions to cover the first-and-last-mile taking into consideration the expected travelers and expected use. This means that per public transport stop a different set of solutions could be offered.

The numbers used for the scenarios are based on for example the MaaS study that has been performed in the Brussels area. Here the most 'extreme' values have been taken to maximise the difference between both scenarios.

**Table 12 - MaaS scenarios and their characteristics**

| Scenario | Characteristics | Impact in transport | Other impacts |
|---|---|---|---|
| MaaS as private car service | Private transport, with limited sharing, building on electrification & automation trend for cars | Increase in use of car as means of transport (+5% in 2030, +10% in 2050)<br>Slight reduction in public transport use (-1% in 2030, -3% in 2050)[29] | Traffic safety<br>Electrification<br>Car uses public space |
| | Deployment starts with high income population | Focus on longer (car) trips, no change in modal shift | |
| MaaS as a new form of public transport | Public transport as the backbone for multimodal travel | Modal shift of 10% towards public transport instead of car transport (this includes other shared electric modes) in 2050 | |

[29] MaaS study Brussels Capital region

| Scenario | Characteristics | Impact in transport | Other impacts |
|---|---|---|---|
| | | Decrease in car use of 5% due to more effective multimodal travelling[30] | |
| | Deployment starts in urban regions with strong public transport system | Focus on urban mobility and other trips | Opening up public space |

A second aspect that needs to be taken into account is the deployment speeds that are relevant for both scenarios. For the private car oriented scenario, the deployment is expected to start with higher income classes, slowly expanding further down to other users. This means concretely in 2030 that for 10% of the trips these impacts can be realized, in 2050 the share of this MaaS concept is expected to have grown up to 30% (based on the share of modal income in the Netherlands).

For the public transport scenario, the share of people willing to use the service is based on the existing share of public transport users in cities, estimated to be approximately 15%. This grows in 2030 to 20% and up to 50% in 2050 also due to accompanying measures (which are further elaborated in the next sections.

The numbers presented above have been combined with the overall numbers presented in the baseline scenario for passenger transport. In the table below, the impact on the transport kilometers is presented. For both scenarios the total kilometers traveled for internal SURE area passenger transport have been taken as the basis. In the table the percentages of change compared to the baseline scenario are project in brackets. As can be seen the first scenario has a moderate impact on the total numbers travelled with a further increase in car transport as expected. For the second scenario the strong impact of the modal shift on the share of rail transport can be seen, especially towards 2050 with a doubling of rail transport overall. To be able to facilitate this growth a significant investment program is necessary in order to accommodate such an increase in rail transport.

## Table 13 - Impact on transport flows for both MaaS scenarios

| Transport kilometers in millions pkm | Mode | 2030 | 2050 |
|---|---|---|---|
| Scenario 1 | Car | 452 (+ 0.5%) | 497 (+3,0%) |
| | Rail | 17 (- 1,0%) | 18 (-3,0%) |
| Scenario 2 | Car | 445 (- 1,0%) | 441 (- 8,7%) |
| | Rail | 22 (+ 26,6%) | 43 (+ 136 %) |

### Environmental impact

For the environmental impact focus is put on the $CO_2$ emissions (both TTW & WTT) for rail and road transport. All expressed as Ton $CO_2$/year. From an environmental perspective it is clear that rail transport has less impact on the environment as can be seen in the impact on the $CO_2$ emissions.

| Ton $CO_2$/year | Emissions scope | 2030 | 2050 |
|---|---|---|---|
| Car scenario 1 | TTW | 282 | 895 |
| | WTT | 101 | 326 |
| Car scenario 2 | TTW | -587 | -2587 |
| | WTT | -210 | -942 |
| Rail Scenario 1 | TTW | -1 | 0 |
| Rail scenario 2 | TTW | 14 | 0 |

[30] MaaS study Brussels Capital region

| Ton $CO_2$/year | Emissions scope | 2030 | 2050 |
|---|---|---|---|
| Total change scenario 1 | TTW | 282 | 895 |
| | WTT | 100 | 326 |
| Total change scenario 2 | TTW | -587 | -2587 |
| | WTT | -196 | -942 |

The other emissions are reported upon in the Annex of this report.

Although these numbers appear to be significant, an important reminder is that they still only show a very limited impact on the passenger transport emissions within the SURE area. For example, the change in emissions in ton / year for car for the second scenario is 2587 ton $CO_2$ / year. However total car transport in the SURE area represents 96 Megatons showing that we are still missing a factor of 1000 in order to realize a significant impact.

#### Economic impact

Organisation of the digital infrastructure to facilitate and allow MaaS to be fully used and developed is one key economic impact. This is partly due to necessary investments in the digital infrastructure such as unlocking data (both public & private) as well as connecting all this data together, being platform development as well as creating these connections and allow data to flow. As a proxy, the costs for obtaining all public road data in the Netherlands by NDW is 10 Million EUR for obtaining the data, another 5 Million EUR is added to make it available to other stakeholders, including following necessary rules and regulations.

The second, even larger economic impact from MaaS, is the necessary investment in infrastructure, more specifically maintaining public transport as a backbone and adding MaaS as an additional service to this, which requires further extension and integration of public transport hubs with new modes of transport. These hubs are strongly connected to existing public transport hubs, but many will need upgrading to create space, attractivity as well as capacity to facilitate the expected growth. Next to investments in hubs, the existing bottleneck in the main public transport network needs to be solved. This means, e.g. further upgrading of high quality public transport corridors to reduce travel times on the arteries of the system.

#### Social impact

Mobility as a Service can be used to include specific groups of travellers that are currently lacking opportunities to travel. It is also seen as an opportunity to keep low density areas accessible by a form of public transport as well as allowing people to travel.

An important social impact that is foreseen is the generation of more public space because of the potential reduction in car transport. However, this needs to be accompanied by rules and regulations for shared modes of transport, otherwise this space will be taken up by providers and not used in a productive way for inhabitants of cities.

### 5.4.4 Impact Relevant External Trends

The MaaS potential focuses purely on passenger transport. Therefore, the external trends affecting freight (trend 3 and 4) are not relevant for this policy. Trend 6 (impact of Brexit) has a negligible effect on MaaS travel within the SURE area. The external trends that can have an impact on this policy measure therefore are trend 1 (climate change & energy transition), trend 2 (technical evolutions in the transport sector) and trend 5 (health/economic crises/effects after Covid).

Trend 1 can be seen as stimulus for the second MaaS scenario as described above, it focuses on public transport more competitive and focus on its qualities, a win-win situation could be found here. On the other hand, trend 2 with a focus on automated driving has some similarities with MaaS scenario 1 and thus further strengthen the increase in car transport. For trend 5 a negative impact is foreseen for MaaS scenario 2 since this focuses on sharing vehicles which this trend is counterproductive towards.

### 5.4.5 Policy Roadmap for Implementation and Policy Recommendations

***Consultation stakeholders***

Different mobility service providers (in 3 countries) were invited for in-depth discussions regarding the policy roadmap for this policy measure. Furthermore, a visit to the ITS World congress in Hamburg was used to exchange thoughts on this with MaaS providers, public authorities, public transport providers.

To be able to implement MaaS and to influence the impact it has as a public authority, the main policy recommendations focus on setting the boundaries and creating the framework for MaaS to be able to be implemented. The recommendations can be divided into three categories, knowingly the platform to share information, the availability and governance of data and the physical infrastructure. The first two can be started immediately, especially since the processes mentioned will take time. The last category needs further study and further detailing in order to, for example, understand the costs and benefits of MaaS.

**Embrace a platform & setup (technical) standards to allow sharing of information**

Mobility as a Service is seen as a distributed system that has different local and regional implementations. Examples have been found (e.g. Osnabrück Germany) where cities have taken the lead in unlocking and connecting various data sources, on the other hand initiatives from existing car manufactures (such as MOJA recently displayed during the ITS World Congress in Hamburg) can also be found. Either implementation at this moment is a step forward towards MaaS, however the major and essential step forward is to be able to connect these implementations together. And by connecting them together this means not only sharing real time information, but also integrating booking, ticketing and payment. *In short, embrace a platform on national level that allows interoperability between various initiatives that already take place.*

To be able to realize these connections, standardisation is essential, which is in essence a task that should be performed with European backing. The exact form of standardization as well as the exact embrace is something to be further detailed especially since all involved stakeholders need to be able to have a say in the process. *In short, establish connections with the EC regarding ongoing standardization activities.*

**Unlock and make available mobility data and setup governance for usage of the data**

A second part is the unlocking of public and private data on which Mobility as a Service relies. This is data such as schedules, availability, ticket price and the like. Public authorities play a key role in unlocking this data, especially since most of the public transport is run under their authority. In short, *arrange contractually for transport providers operating under your authority to unlock their data to your specifications*. This has one important prerequisite and that is the human capital within public authorities which also needs to understand the digital world and how this works. In other words, not only the legal side but also the IT-side of public authorities needs to be up for this challenge.

Unlocking data is one aspect, however organization of this unlocking is not a simple task. When looking at the developments regarding road transport, the national access points that are currently being established appear to be a logical way forward also for data that is relevant for MaaS. However, this also requires setting up the governance of this national access point for MaaS as well as defining who has access to what and what terms and conditions apply. In short, *setup on national level an organization that arranges unlocking of MaaS relevant data as well as the governance of this data.*

**Accompanying measures and infrastructure investments**

During the period that the prerequisites above are being organized, one key element needs to be tackled, being how MaaS can be operated and used from a public authority perspective and what the additional framework looks like that allows MaaS to be contributing towards public and societal goals. This is something that requires more research and is dependent on local and regional factors such as the quality and availability of the public transport infrastructure. In short, from a regional point of view, establish a vision what MaaS is from your perspective and how it can contribute to specific public goals.

Based on the vision and the further detailed impact, necessary policies will be identified, for example the necessary infrastructure investments in mobility hubs to facilitate the sharing of concepts close to public transport or the necessary rules and regulations for mobility service providers to deploy sharing concepts. In other words, a complete policy package for the future that will make MaaS to be used towards sustainability goals including the management of the externalities.

As Indicated before MaaS although relatively new in the mobility domain has already been identified as potentially interesting by policy makers on all levels. In the EU Transportation White paper from 2006 the seamless travel ambition was already mentioned focusing on the traveler and taking away barriers of interchange between modalities, but also for ticketing as such. This has further evolved on the EU-level in e.g. the EU Sustainable and Smart Mobility Strategy (2020) in which the seamless multimodal passenger transport is seen as a major driver. This is all based on the idea that more multimodal travel will decrease the negative impacts that are associated with car travel.

For MaaS not only the EU itself has been active, various initiatives have been taken to bring MaaS to the next level, e.g. the MaaS alliance (creating the foundation for MaaS in the EU) started approximately 5 years ago bringing stakeholders together. But also lobby groups from involved stakeholders, e.g. UITP but also POLIS has developed white papers and visions on what MaaS needs and what actions are necessary on an European level. For the STISE stakeholders these are opportunities to take part in, but also hop on board to influence the direction that these organizations are going.

Next to the EU-level on national and regional level also MaaS activities take place. For example, the Netherlands have launched 7 MaaS pilots with as a major goal to learn, but also be able to further deploy the developed services once fully developed. But also in Flanders a set of basic rules of engagement is currently on the way to make a next step with MaaS. In other words, MaaS doesn’t have to start from scratch, and stakeholders can use the existing momentum to bring MaaS towards implementation.

And last but not least there are already MaaS providers active, including partners that are working on standardization already (e.g. the TOMB-API). This offers the opportunity for the involved stakeholders to e.g. require using these standards in newly given concessions to public transport providers.

All in all, MaaS appears to be well on the radar of the different involved stakeholders, however filling in the prerequisites as indicated above are key for public authorities to be able to influence the direction MaaS is evolving. Local public authorities can influence this in the right direction if they set up concrete MaaS implementation frameworks in their cities adhering to the standards & platforms as indicated before.

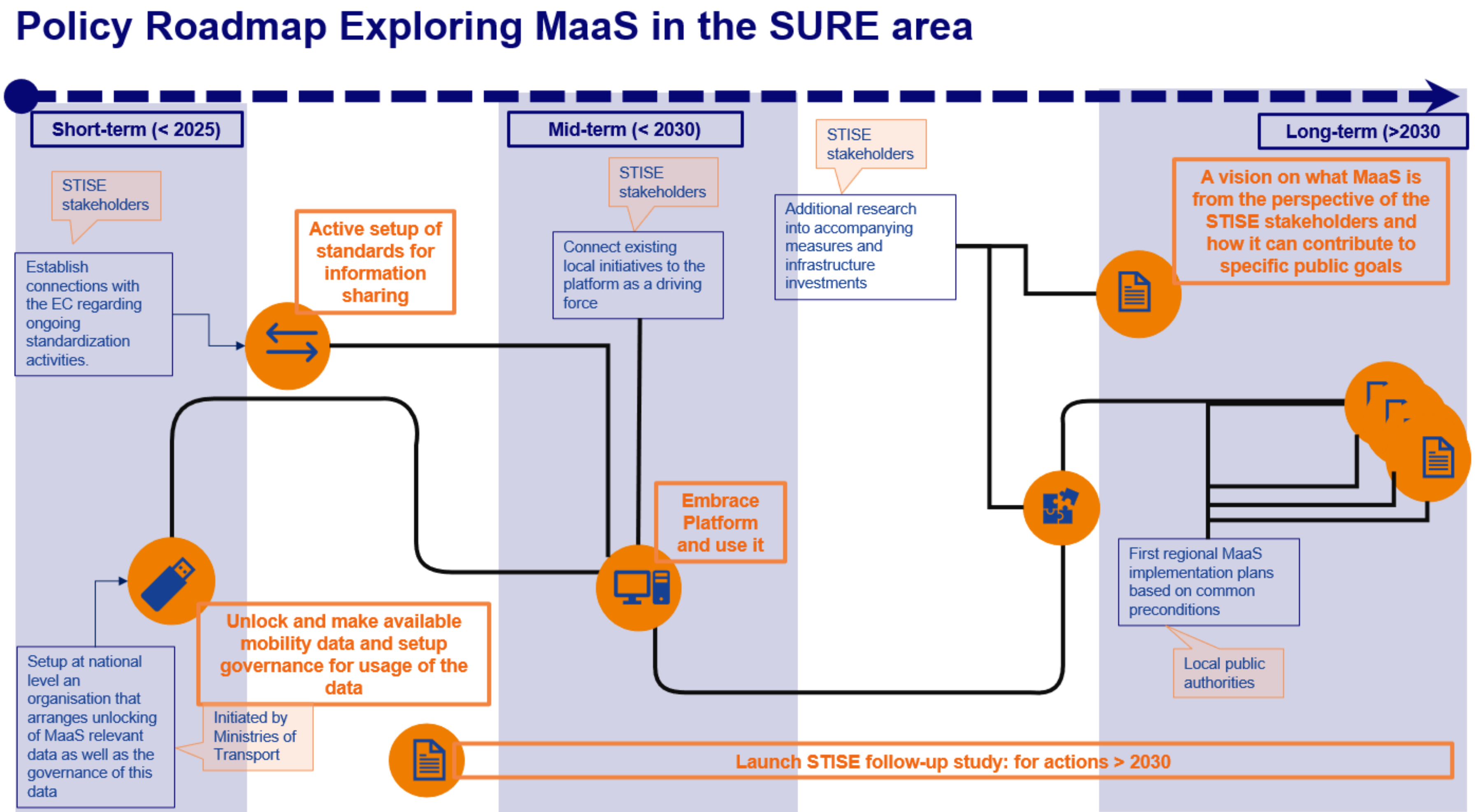



**Figure 18 - Policy roadmap Exploring the potential of MaaS**

## 5.5 Improving Regional Cross-border Public Train Transport

### 5.5.1 Description Policy Ambition

This policy focuses on the improvement of regional cross-border public train transport in the 3 STISE project corridors Rhine-Waal (NED-GER), Rhine-Scheldt (NED-BEL-FRA) and Lille-Brussels (FRA-BEL). The goal of this measure is to result in a shift from road to rail transport for regional cross-border passenger travel. One of the challenges is that public transport and especially rail infrastructure is usually organized by national or regional organizations and controlled by national authorities. Therefore, national borders often form relatively high barriers for this mode.

However, this measure has the potential to reduce the emissions from passenger transport and to contribute to the further integration within the SURE area reducing the barriers of its four internal national borders. Hence, the improvement of the regional cross-border public train transport system can result in additional societal benefits in the border regions.

Although the focus is on these corridors, the cross-border zones which are not part of these corridors, but are part of the SURE area, are included in some parts of the policy analysis. First of all, potential cross-border railway connections that have been identified in the literature, but are outside of these corridors, are included in the study. This ensures that potential rail connections are not missing in the analysis. Also, when calculating the emissions of cross border rail in the baseline scenario, all regional cross-border traffic in the SURE area is included.

Since the measure focuses on cross-border passenger transport, freight transport is not considered in this policy analysis. Local and regional bus services that offer public transport connections in the corridors are not studied in detail, although they already play an important role in the cross-border connections nowadays. Passengers currently using these services are considered as potential demand for rail connections, if missing rail connections are added to the rail network.

### 5.5.2 Three Market Arena Model

As mentioned in the title, this measure is predominantly and from the start focused on the ***Transport Market Arena***. It is in essence focused on the improvement (and often reinstalment) of regional cross-border public transport, which has been lost over time due to the focus on high-speed transport and/or national driven transport logistics. Therewith this measure is focused on those regional transport providers who are willing and able to comply to these cross-border transport needs, and modal shift from car to public transport. Probably of main importance is to delve into the institutional constraints at both sides of the border and to develop innovative policy measures to bridge these. Moreover, and next to that, there is also a need to delve into the respective ***Travel Market Arena***, in order to analyze if there is sufficient demand to boost regional cross-border public transport, including, if necessary, cross-border policy measures to boost a shift from road to public transport by for instance a more attractive layout, integrated ticketing, road pricing, or other supporting activities. In extension, there is, if necessary, also a need to connect to the ***Traffic Market Arena***. Nevertheless, for the moment we expect that on most of the involved corridors within the Eurodelta, the existing infrastructure is still sufficient to comply to the needs, and that, if necessary, there would be only a need to upgrade/update the infrastructure and cross-border safety measures. Impacts will be measured with regard to air quality, climate change, social equity, and congestion reduction respectively commuting time. But the measure could also have a major impact on the further integration of the SURE area, and therewith on regional economic and welfare benefits.

### 5.5.3 Assessment of Impacts of the Measure

In order to estimate the potential of improving cross-border rail connections, it is necessary to answer the following two questions; What is the current share of rail? What is the potential share of rail when the cross-border infrastructure or the services are improved?

Since the model output of Transtools3 was proven not to be reliable concerning the current shares of cross-border rail, it was not possible to answer the first question based on the data of the baseline scenario. Therefore, the choice was made to estimate the current emissions from cross-border transport on an aggregate level. The result is a current share of cross-border rail of 4%. Cross-border traffic could in theory, if conducted on the same level as national transport, account for a modal split share of around 10% of passenger-kilometers, which is comparable to the national modal splits of Belgium (9,0%), Germany (9,7%), France (11,0%) and The Netherlands (11,6%).

The second question also cannot be answered with the model output. However, we found that estimates from the literature (references are indicated in Table 14) for the potential passenger flows for missing rail connections could be used to estimate the potential demand for these rail services. The demand for rail connections for which we did not find useful information in the literature was estimated using information about the total passenger flows between the regions in the baseline scenario and the rail demand for similar links.

## Table 14 - Cross-border regions which are considered in the analysis

| Zone pair | Corridor | Potentially missing rail link | Extra rail demand [passengers per day] |
|---|---|---|---|
| Arnhem - Kleve | A | Nijmegen – Goch – Kleve | 3 400[31] |
| | | Kleve – Kranenburg – Groesbeek – Nijmegen | |
| | | Goch – Gennep – Nijmegen | -[33] |
| Venlo - Viersen | B | (Mönchengladbach [DE] -) Dalheim[DE] - Roermond [NL] | 1 200[32] |
| Kortrijk - Lille | E | Armentières [FR] - Comines/Komen [BE] (- Kortrijk [BE]) | -[33] |
| | | Lille Flandres [FR] -) Comines(France) - Comines/Komen [BE] | -[33] |
| Tournai - Lille | F | (Valenciennes [FR] -) St-Amand-les-Eaux [FR] - Antoing [BE] (- Tournai [BE]) | -[33] |
| Middelburg - Gent | - | Gent [BE] -) Wondelgem [BE] - Terneuzen [NL] | 2 500[34] |
| Middelburg - Sint-Niklaas | - | Sint-Niklaas [BE] - Terneuzen [NL] | -[33] |
| Tilburg - Turnhout | - | (Antwerpen [BE] -) Turnhout [BE] - Tilburg [NL] | -[33] |
| Eindhoven - Maaseik | - | Mol – Hamont – Weert – Roermond | 1 200[35] |
| **Total** | | | **8 300** |

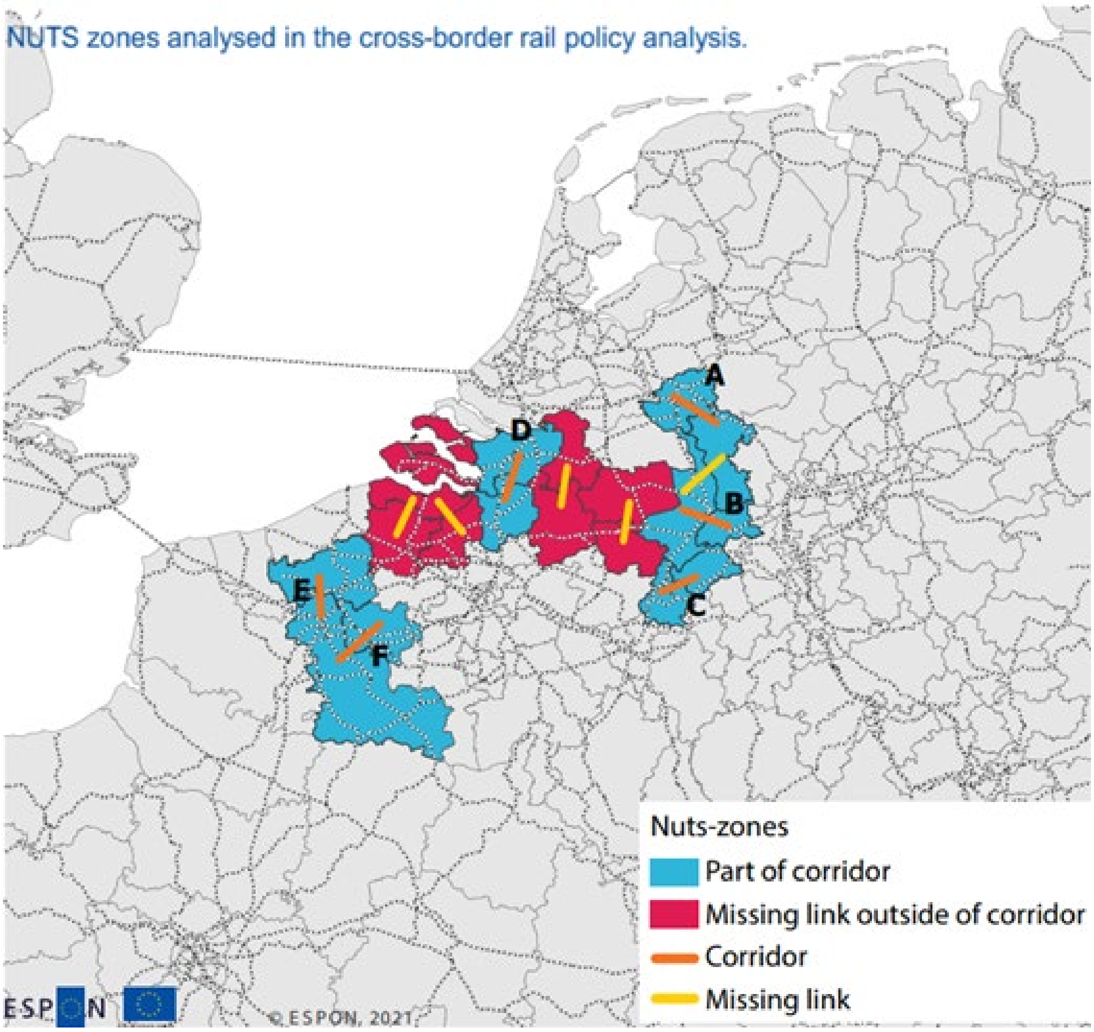
[31] This figure is for either one of the indicated links, if one of the links would be realized. (https://gelderland.stateninformatie.nl/document/7025710/1/BOC_-_Bijlage_notitie_reizigersaantallen_OV_Nijmegen-Kleve_(PS2018-751))

[32] This figure is an expert estimation.

[33] Entirely missing infra on at least an important part of this connection. Since most relevant stakeholders do not see a potential and estimations indicate a low passenger potential, it is unlikely that this connection will be realized. Hence, it is not considered in the potential emission reduction calculation.

[34] This is an average of estimates of the reported potential of this link (https://railghentterneuzen.eu/sites/default/files/eindrapport_studie_8_personenvervoer_definitief_0.pdf )

[35] https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2021/12/03/bijlage-2-eindrapport-mkba-weert-hamont/bijlage-2-eindrapport-mkba-weert-hamont.pdf




**Map 4 - NUTS zones analysed in the cross-border rail policy analysis.**

### Environmental impact

As a final step in the quantitative analysis, the $CO_2$ emission reduction due to an increase in cross-border rail transport is estimated based on the observed transport flows and elasticities for mode choice. It is assumed that the addition of new rail links does affect the mode choice of passengers (mainly from road to rail) but does not increase the overall travel demand. The effect of this policy measure on the $CO_2$ emissions in 2030 and 2050 is presented in Table 15. The total well-to-wheel $CO_2$ emission reduction in 2030 is 19kton per year. In 2050, the $CO_2$ emission reduction would be 10kton per year. The emission reduction in 2050 is lower, because the emissions per car kilometre decrease in time mainly due to the growing market share of electric cars.

### Table 15 - Effect of increased cross-border rail on tank-to-wheel and well-to-tank $CO_2$ emissions in tons per year

| Ton $CO_2$/year | Emissions scope | 2030 | 2050 |
|---|---|---|---|
| Extra emissions by rail | TTW | 0 | 0 |
| | WTT | 886 | 0 |
| Reduced emissions by car | TTW | 14 634 | 7 203 |
| | WTT | 5 239 | 2 624 |
| Total effect on emissions: $CO_2$ emission reduction | TTW | 14 634 | 7 203 |
| | WTT | 4 353 | 2 624 |
| | WTW | 18 987 | 9 827 |

Analog to the effect on $CO_2$-emission, the effects of the policy on $NO_x$ and PM emissions is calculated. For these emissions the location of the emissions is much more important than for $CO_2$. Therefore, only TTW emissions that occur at the location of travelling are reported in Table 16. The policy leads to a reduction in $NO_x$- and an increase in PM-emissions. PM-emissions have a combustion and a corrosion component. Local electric trains score worse on corrosion than passenger cars and cause the increase.

### Table 16 - Effect of increased cross-border rail on NOx and PM emissions (TTW) in tons per year

| Ton/year | Emissions scope | 2030 | 2050 |
|---|---|---|---|
| Extra emissions by rail | $NO_x$ | 0,0 | 0,0 |
| | PM | 3,9 | 3,9 |
| Reduced emissions by car | $NO_x$ | 17,5 | 2,3 |
| | PM | 1,5 | 1,4 |
| Total effect on emissions | $NO_x$ | 17,5 | 2,3 |
| | PM | -2,4 | -2,5 |

**Potential emission reduction in perspective**

To place the potential effect on the $CO_2$-emissions of this policy in perspective, it is compared to:

- The total emissions of cross-border transport in the SURE area
- The total emissions of transport in the baseline scenario in the SURE area

It can be concluded that adding cross-border rail connections has a positive impact on the $CO_2$-emissions in the SURE area. However, the potential effect is limited when compared to the total transport-related emissions. The reason is that cross-border traffic is a small segment compared to national traffic. Focusing in this measure on regional cross-border traffic only leads to a further reduction of the relevant transport flows, since many cross-border trips are long distance journeys. Taking into account the small size of the overall market segment, the almost 5% emission reduction is still moderate but not negligible. To increase the impact, it would be necessary to also improve national rail connections resulting in a shift from road to rail not only in the cross-border segment. The precise emission reductions for the analysed measure both 2030 and 2050 are shown in Table 17.

### Table 17 - Emission reduction due to an increase in cross-border rail as a percentage of total emissions

| Percentage reduction | 2030 | 2050 |
|---|---|---|
| Emissions of cross border transport | 4,71% | 4,57% |
| Total emissions of transport | 0,02% | 0,02% |

#### Economic impact

Creating a cross-border connection increases economic chances. Opportunities for cross-border jobs will create new opportunities for those working in the neighbouring regions. Also, tourist visits may be stimulated when cross-border traffic is made more accessible, benefitting the regions.

#### Social impact

A shift from road to rail is not only reducing $CO_2$-emissions but also improving air quality. This is a benefit for all population groups, especially in areas where the air quality is worst. Since a large fraction of passengers will replace car trips to densely populated cities, the measure improves the quality of life of the inhabitants and people working there. In addition, the parking pressure, passenger car inner city driving and congestion will be reduced if cross-border rail traffic is facilitated. All aspects will raise the liveability of urban areas and improve the connectivity.

Furthermore, facilitating cross-border rail traffic benefits people who travel cross-border for work and students studying in neighbouring countries. The social impact will benefit the entire region as the region (and crossing the border) will become more accessible. This is especially the base for current ‘non-drivers’, e.g. elderly, disabled, low income households and persons without driving license.

### 5.5.4 Impact Relevant External Trends

This policy focuses on the passenger segment. Therefore, the external trends affecting freight (trend 3 and 4) are not relevant for this policy. Trend 6 (impact of Brexit) has a negligible effect on local cross-border traffic within the SURE area. The potential relevant external trends for this policy are trend 1 (climate change & energy transition), trend 2 (technical evolutions in the transport sector) and trend 5 (health/economic crises/effects after Covid).

Trends 1 and 5 together are likely to result in a decrease in rail demand. Trend 2 might lead to a potentially even larger reduction in rail demand, since one of the biggest advantages of rail compared to car travel (travel time can be used for other activities) disappears if fully automated driving becomes available. It is possible that without a good policy framework rail is only considered as a travel option by those who cannot afford the use of autonomous vehicles. If prices of these vehicles are comparable to rail, there will probably be no future for improved crossed-border rail connections. In case autonomous vehicles are not dominating the market in 2050 or a policy framework stimulates the coexistence of autonomous cars and public transport, the most likely effect of the external trends is a small reduction of the overall rail demand compared to the baseline scenario. This implies that the emission reduction potential might be slightly overestimated in the policy analysis.

### 5.5.5 Policy Roadmap for Implementation and Policy Recommendations

#### *Consultation stakeholders*

Stakeholders from regional and local authorities, concession administrators, rail service operators and rail network operators from both Germany and the Netherlands were invited to join an online roundtable regarding the policy roadmap of this measure. During the roundtable the challenges of improving cross-border rail have been discussed for the example Nijmegen-Kleve-Krefeld and in general between the Netherlands and North Rhine-Westphalia.

#### *Policy recommendations*

Improving cross-border passenger rail transport is one of the measures in “Flagship 3 – Making interurban and urban mobility more sustainable and healthy” of the European Commissions “Sustainable and Smart

Mobility Strategy[36]". This strategy is part of the European Green Deal and states: "In 2021, the Commission will propose an action plan to boost long-distance and cross-border passenger rail services. This plan will build on efforts by Member States to make key connections between cities faster by better-managed capacity, coordinated timetabling, pools for rolling stock and targeted infrastructure improvements to boost new train services including at night. Platforms or other organizational structures for this purpose should be open to all Member States. Pilot services on some routes involving all interested stakeholders should be supported, and a combination of public service contracts and open access services could test different models for new connections and services, with the aim of boosting 15 pilots by 2030." The analyzed cross-border connections within the SURE area could be among these pilot projects. Stakeholders in the cross-border regions need to work out a good plan to be considered.

The policy ambition to improve cross-border rail for passenger transport is in line with the goals of the European Commission. It is not a new idea, but in the past practice has shown even an opposite trend. Several cross-border connections within the SURE area have been closed. Partly the infrastructure has been dismantled and former rail corridors have been transformed into housing areas. However, in recent years first examples of successful reactivations of lines and improvements of rail services have shown that there is a future for profitable regional cross-border rail transport (for instance in the region Aachen-Maastricht). We recommend to learn from these successful cases.

In many cross-border regions incentives to reactivate, extend or establish new rail services are less successful. A common argument is that cost-benefit analyses are negative for these projects. During the stakeholder consultation there was a broad agreement that in the majority of studies a too narrow scope has been evaluated and that sustainability benefits were underestimated. It is important that cross-border rail connections are not designed and evaluated as point-to-point connections between two municipalities separated by a national border, but as elements of inter-regional public transport, which are integrated within the national rail and bus services (including ticketing, timetables, …).

Another challenge for cross-border rail projects is the lack of coherent vision and policy. First of all, many policy makers prioritize investments within their own region above investments connecting the region with another cross-border region. As a direct consequence cross-border projects do not get enough priority and end-up on the long-term list rather than on the agenda for implementation. Concrete infrastructure plans often face a "not in my backyard" mentality, especially in municipalities that (plan to) construct houses along potential rail corridors. Last but not least there are problems in governance and decision-making. Policy-making and implementation of new cross-border rail connections has a challenging dimension as decisions and plans have to be discussed and approved by significantly more local and national parties compared to domestic cases. The governments of the Netherland and North Rhine-Westphalia have established a common cross-border agenda ('Grenz-/grensland agenda') drawing overarching goals and strategies for cooperation at several themes. In this agenda, ambitions for the development and maintenance of proper rail and public transport connections are stated. Decision-making processes at international projects where several authorities have to make consensus is known for its enduring processes.

To conclude we present the most important policy recommendations for the decision phase and for the implementation phase. The decision phase in this context covers the phase until a general agreement of the relevant stakeholders is reached to improve a specific cross-border passenger connection. This phase can take a few years. The short term and long term refer to the process of the implementation, upgrade or re-activation of a specific cross-border connection.

Decision phase recommendations (short term to midterm):

- Regional and local stakeholders should learn from successful projects (for instance from stakeholders of the region Aachen-Maastricht);
- Develop a coherent vision and develop a cross-border agenda with relevant local, regional and national stakeholders A good example is the 'Grenz-/grensland agenda' between the Netherlands and the German state North Rhine-Westphalia. It is important that all relevant

[36] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789

administrative layers are engaged in this process. An envoy from the European Commission might be of additional value, since many of the corridors have skeletons in the closet and European funding might be of additional value.

- Consider the impact of rail connections on inter-regional level and take sustainability and other benefits for society into account in cost-benefit analyses. These requirements have to be addressed clearly by the authors of the terms of references in the calls for proposals of cost-benefit analysis of cross-border rail projects.
- The relevant stakeholders have to take decisions. Many cross-border rail projects stay on the long-term agendas for decades. If it is feasible, it is important to go for it, if the cost-benefit analysis is negative, upgrading cross-border bus services might be a good alternative. Buses are less valued by passengers than trains and therefore attract less demand. However, they can have a positive environmental, social and economic impact.

Implementation phase recommendations (midterm to long term):

- Authorities that are in charge of rail concessions should realize open competition and make use of the windows-of-opportunity at the moments when concessions end;
- Infrastructure providers and rail operators have to work together and consider differences in rail infrastructure, accompanying systems and safety requirements;
- Rail operators together with service providers should aim for the most passenger-friendly services with good connections and uniform supply of travel information and tickets. Systems with good quality are generally highly used and profitable, whereas poor systems are not.

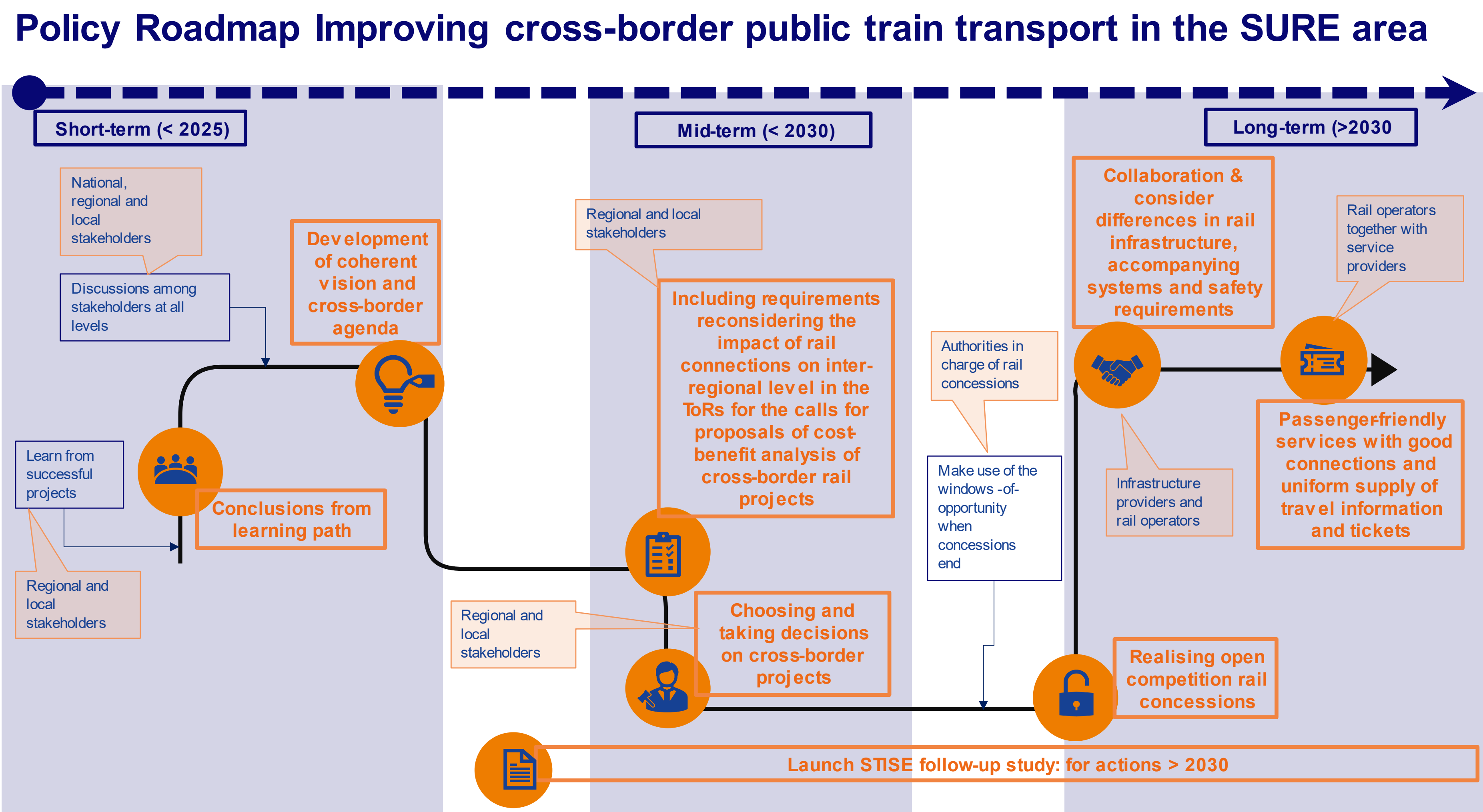



Figure 19 - Policy Roadmap Improving regional cross-border train transport

## 5.6 Overall Policy Analysis and Recommendations

From the baseline scenario it became clear that without any intervention on the policy domain the sustainability goals as set out will not be reached. Although the 'autonomous' development regarding cleaner (due to electrification) vehicles, the overall growing trend of transport will need additional measures. From a freight transport perspective, it is essential to value and where possible extend the potential that the railways and inland waterways are offering from a modal shift perspective. However, there also lies an important effort for sustainability. For passenger transport the dominance of the car is striking, this combined with the share in emissions that air transport has, it appears that the largest impact can be realized tackling these two modes.

The shift from aviation for short and midrange distances, will have a major impact on the $CO_2$ and noise reduction in and around the four relevant airports in the Eurodelta. It will give a boost to HST and it will possibly double towards even quadruple the frequencies of HST-travel on the existing tracks. Therewith it could also have a major impact for domestic and short range travel within the SURE area and lead to a shift form car to train. Nevertheless, for that purpose some tracks and stations need to be upgraded with in total a cost of some € 30 billion. In addition, there is a need to assign a SURE Aviation shift ambassador (team) to start up the process and assure a level playing field. But if so, also the integration of the EU and its surrounding regions could gain from this measure, including that it could serve as an exemplary case for a further role out over all the EU territory.

Increasing ambition level and harmonizing ZEZ could have substantial environment, health, efficiency and costs benefits, and facilitate their social acceptance. The scale of such benefits depends on the level of harmonization. Under a full harmonization model, the financial impact could be significant, in particular to freight carriers in terms of vehicle logistics. However, these savings may not materialise if a move to full harmonisation is deemed impractical or politically unacceptable. But even a partial harmonisation (e.g. of vehicle emission classes for defining LEZs, standards for sticker design/information and the creation of vehicle databases) could still lead to savings. However, costs incurred by the implementation/ harmonization of ZEZ, especially for disadvantaged population groups and vulnerable economic actors or sectors, should be assessed to ensure these do not increase social inequalities or economic distortions and, when deemed necessary, to identify and implement accompanying measures to mitigate adverse impacts (e.g. financial incentives limited to most vulnerable groups). Experience shows that it is very difficult to harmonize access criteria due the subsidiarity principle, while harmonizing other aspects could appear to be very challenging due to the high number of actors to be involved and to the absence of institutional framework to carry out such process at Eurodelta level. Appropriate forum for policy dialogue should be set up to assess political feasibility, options for harmonization and their impacts. If areas for consensus are identified, a structured concertation process shall be launched to design, plan and implement the harmonization, with special emphasis on supporting measures to ensure the feasibility and acceptability of the policy measure.

The potential of MaaS measure shows a potential in realizing more sustainable transport, however, this potential is largely uncertain, strongly depends on the position public authorities take and the necessary investments in both digital and physical infrastructure that need to be done to facilitate a larger modal shift. This being said, the prerequisites as defined (regarding standardization & sharing of data and information) are no-regret measures that can be started immediately. Furthermore, development of a vision and implementation plan for MaaS and how it can contribute to the relevant societal goals is essential to grasp the potential at hand.

The assessment of the policy ambition to improve cross-border rail transport has shown that a shift from road to rail could be realised for several cross-border corridors in the SURE area. There is sufficient demand to operate profitable rail services, if the cross-border connections are well integrated with the national rail and bus services and passenger-friendly services are provided. The measure has the potential to contribute to more sustainable transport and is in-line with plans of the European Green Deal. Compared to the overall emissions in transport, the potential emission reduction of this measure is limited, since the regional cross-border passenger segment is rather small. However, the policy should be seen in the broader context of a shift from road to rail.

Interesting, even required, potential additional research (not in scope of this STISE study) could or even should follow from the policy and implementation roadmaps (obviously), but also the (synergies in the) policy analysis results itself, e.g.

- How could larger (regional) cities in the SURE area – that are not connected by HST- be connected 'as seamless as possible' to that HST network (as alternative for using cars) – and therewith benefitting from the aviation shift measure?
- To what extent will MaaS improve the pre- and after transport in the respective destination areas in the aviation shift measure?
- There is a link to explore between the cross-border rail travel and aviation shift measure, since the doubling/tripling of HST frequencies on existing tracks, will diminish the opportunities for cross-regional rail.
- Opportunity of new means of steering (better insight because of data, creating better insights as such and thus having better policy information, making it more worthwhile).
- In this research MaaS is positioned twofold, one as an enabler for further digitalization of transport and as such opening up other positive opportunities for further sustaining transport. For example, MaaS in that sense can be seen as a driver for increased uptake in vehicle automation, which are expected to be more electric and thus cleaner compared to the conventional vehicle deployment. On the other hand, in combination with (re)initiation of discussions regarding pricing of mobility more towards use, MaaS could be the opportunity to implement these kinds of schemes in a larger policy framework which focuses on making mobility more sustainable. Please note that although focus has been put on passengers, similar initiatives for freight need to be taken, for example in connection with the ZEZ-measure as discussed before.
- The prerequisites of MaaS have another - not yet highlighted - impact that will support policy making, more specifically by unlocking the relevant data sources of the mobility system including access and governance, policy makers get a better insight. This insight is constructed from the unlocked data, translating this into information and using this information to make policy making more data driven. By closing the Plan-do-check-act cycle based on real data, policy making gets more support by data and as such becomes more efficient.
- Combination of MaaS and aviation ban will lead to a large increase in railway demand, specifics for this and the capacity for the rail network. A large vision for the rail network could be helpful for more detailed identification of bottlenecks and necessary investments.

**Summary table with key figures**

The summary table below shows an overall high-level view of the impact of each of the 4 assessed policy measures. Please note that the table does not want to emphasize the comparison of measures, as each measure has its own scope and approach.

**Table 18 - Summary table**

| Estimated impacts of development / policy measures | Impact on modal shift | Environmental impact (Comparison with the situation without the policy measures) | | | | | | Other impacts (socio-econ, fin…other) | Implementation (involved stakeholders, ease of implementation, time scale, replicability…) | Cooperation required (cross-border, inter-municipalities…) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2$ emissions | | $NO_x$ emissions | | $PM_{10}$ emissions | | | | |
| | | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | | | |
| Units | | Mton (TTW) | Mton (TTW) | Mton (TTW) | Mton (TTW) | kton (TTW) | kton (TTW) | | | |
| Estimated impact of **(extra) measure Aviation shift** | Modal shift of aviation to, from and within the SURE area on short and midrange distances. | -0,94 Mton | -0,86 Mton | -0,002 Mton | -0,002 Mton | -0,03 kton | -0,03 kton | A further noise reduction of 10-20% around the selected airports. A further energy reduction of approximately 11.000 $10^6$ mega-joule/per year. An extra boost to economic development around the HST nodes, and a better accessibility to jobs also for domestic travel | It needs an additional investment of some 0,5-1 billion € in the period 2022-2030, 7,5 billion € in the period 2030-2040 and 21-22 billion € beyond 2040 | There is a need to come up with a principal statement of all the involved SURE public stakeholders, including the relevant EC directorates on the short run, and the instalment of an Ambassador Team to further roll out the measure |
| Estimated impact of **(extra) measure Zero Emissions Zones (ZEZ)** | ZEZ schemes primarily aim at accelerating vehicle fleet renewal. They have very limited impacts on modal shift, unless they are coupled with additional modal shift policies and measures. | -25,9 Mton | -15,3 Mton | -0,06 Mton | -0,01 Mton | -0,95 kton | -0,60 kton | Harmonizing ZEZ could have substantial efficiency and societal cost savings benefits, but specific population groups and economic actors could be adversely impacted if no targeted accompanying measures are implemented. | Experience shows that it is very difficult to harmonize access criteria due to the subsidiarity principle, while harmonizing other aspects could appear to be very challenging due to the high number of actors to be involved and to the absence of institutional framework to carry out such process at Eurodelta level. | Appropriate forum for policy dialogue should be set up to assess political feasibility, options for harmonization and their impacts. If areas for consensus are identified, a structured concertation process involving national and local authorities shall be launched to design, plan and implement the harmonization process. |
| Estimated impact of **(extra) measure Potential of MaaS** | MaaS, with the right prerequisites can create a modal shift of up to 10% | -0,59 Mton | -2,59 Mton | -0,001 Mton | -0,001 Mton | 0,006 kton | 0,019 kton | MaaS if implemented like Scenario 2 ("MaaS as a new form of public transport") can enhance quality of living, realize societal goals but requires investments in both digital and physical infrastructure | The described prerequisites are no-regret measures to profit from digitalization of transport. A strong public vision and policy framework is needed to grasp the benefits. | Standardization is essential to allow MaaS to grow, but this requires cooperation on all levels. On national level, cooperation in data sharing is essential to realize economies of scale for data access points. |
| Estimated impact of **(extra) measure Improving Regional Cross-border public train transport** | In the border regions with sufficient traffic a shift from road to rail can be realized | -0,014 Mton | -0,007 Mton | +0,000017 Mton | +0,000002 Mton | -0,002 kton | -0,003 kton | Improving cross-border connectivity especially for commuters, students and inhabitants without cars, positive effect on the labour market and cohesion between SURE countries | Clear vision required to integrate cross border rail connections in national rail networks and local bus services. Construction of new rail infrastructure and reactivating closed lines are long-term projects; on short term services on existing infrastructure can be improved. | Challenging cooperation with multiple stakeholders from local, regional and national authorities together with rail infrastructure providers and rail operators. |

**Overall conclusion and the potential of the STISE study**

This study shows the potential of what the Eurodelta area can mean in Europe in terms of achieving sustainability goals. Given its location, its corridors full of challenges and the drive of many involved stakeholders in this region, the Eurodelta can be an interesting and promising pilot area to try to implement ambitious policies and concepts and thus demonstrate the sustainability gains that can be made. If this can be achieved in the Eurodelta, it can serve as inspiration for other regions – only imagine the potential effect at larger, even EU, scale.

Looking back on the course of this study, it appears that this study could only be the tip of an iceberg. The inspiration and willingness – to cooperate at SURE level, to dream big and to make things happen - of the involved STISE stakeholders is high, many other ambitious policy measures could be explored in detail as well, and just as many challenges examined. In addition, the policy roadmaps of the 4 policy measures also show that additional research is needed - so there is potential in that too. This research can and should be a booster; an incentive to initiate and look for funding for subsequent research in order to facilitate actual implementation of the measures.

# 6 Policy Roadmaps and Recommendations, Governance and Cooperation

## 6.1 Implementation of the Policy Measures

This chapter focuses on - and recapitulates the main elements from - the roadmaps proposed for the different policy measures. The policy framework is explained, the policy roadmaps for implementation are included again, and - where relevant - the corridor-specific points of attention are indicated, as well as possible good practices from elsewhere.

The steps in the roadmaps – and the indicative timings (short-term, mid-term, long-term) mentioned - have been proposed to the best of our knowledge based on the analysis done out so far. These roadmaps are a starting point, to have a first idea of which steps make sense in order to effectively start with (preparing for the) implementation of the measure. More detailed roadmaps and concrete actions plans for implementation, require in-depth extensive research (beyond the scope and timing of this study) and a better view, per measure, on many elements at stake and many circumstances. So there are many factors that cannot be anticipated or made statements about in advance: the authorities that are (or can be) involved are many and are active at different levels; the political will, interests and priorities of those involved may not always be aligned or may even conflict. Along the way it may turn out that a sidestep is needed, or a (partial) plan B... Once an implementation process starts, the necessary progressive insight will also have to be taken into account along the way.

What is certain, and each proposed roadmap shows, is that cooperation will be necessary, at all levels. In this study, for each policy measure - in the context of the proposed policy roadmaps - attention is paid to which stakeholders should be involved in an implementation process. Establishing project specific cooperation mechanisms on an ad hoc basis, and for the time span needed, seems more efficient than setting up large structures at SURE area level.

The four measures are not really linked - the nature of the measures is not the same, nor are the steps suggested in the roadmaps necessarily linked. Depending on the choice to go for one or more measures, the implementation processes of these measures can – but not necessarily have to – be coordinated with each other to be effective. Not one measure is recommended over the other - one, several al all four measures could be prioritised – depending on the willingness, acceptability, feasibility, priorities…

## 6.2 Policy Roadmap Aviation Shift – HST

### Policy context

In the EU Green Deal there is a focus on stimulating carbon neutral scheduled collective air travel in midranges (up to 500-700 km) by 2030 and on market ready zero-emission aircrafts by 2030/2035. The latter will be difficult to achieve for collective scheduled air travel - at least in the volumes expected and within a foreseeable future - considering the state-of-the-art aviation techniques. A need to shift air travel on short and midrange distances towards more sustainable transport modes, such as HST is necessary. At the moment, within several engaged (non)governmental organisations this shift is already regular policy – and the EU Green Deal also focuses on doubling high speed rail traffic by 2030 and to triple this by 2050, next to stimulating EU night train services again.

### Policy roadmap

Following policy roadmap for implementation is proposed:

1. Discuss the results of this analysis with the involved directorates of the European Commission, with the intent to amend the open skies agreements, which is already in place for more than 15 years, to exclude air travel < 500km. from this treaty.

   ***Task to take on by: joint stakeholders of the SURE area / European Commission***

2. From here appoint an ambassador (team) of the Aviation-HST shift, who will further coordinate the activities, and investigate if the current developments around the HST-tracks, HST-stations and operational contracts are future proof.

   ***Task to take on by: joint stakeholders of the SURE area***

3. From there assign the respective national authorities to come up with additional sustainability rules and arrangements for short and midrange aviation slots (including a respective decrease of the total allowed slots at the Airports) to, from and within the SURE area, step by step. The included city-pairs in this research would have priority. In a second phase a similar operation could be carried out up to 700 km air travel.

   ***Task to take on by: national slot-coordinators***

4. Parallel to this, discuss with the four involved Airport Operators how to implement this shift in a long-term strategy plan, and investigate further what is exactly needed to guarantee a smooth interchange for Transfer passengers.

   ***Task to take on by: Ambassador Team, with the Airport Authorities***

5. Parallel to this, discuss with the National rail infra providers to implement and finance the first package of infrastructure amendments until 2030 (see Table 10) and open up discussions with the EU-Commission to include (part of) the infrastructural costs in the EU recovery and/or Green Deal plan.

   ***Task to take on by: Ambassador Team, with the National Infra providers and EC***

6. In addition, start up the needed supporting studies to enhance the upgrade of the HST network and start up discussions with the involved airlines how to develop a new and more ambitious green airline network for the SURE, and in extension Europe.

   ***Task to take on by: Ambassador Team, involved EU-directorates and Airlines***

7. Based on these groundings, a follow-up phase of this STISE project (> 2030) could be initiated, and the necessary policy decisions in-between should be prepared.

   ***Task: Joint Stakeholders SURE/Ambassador Team***

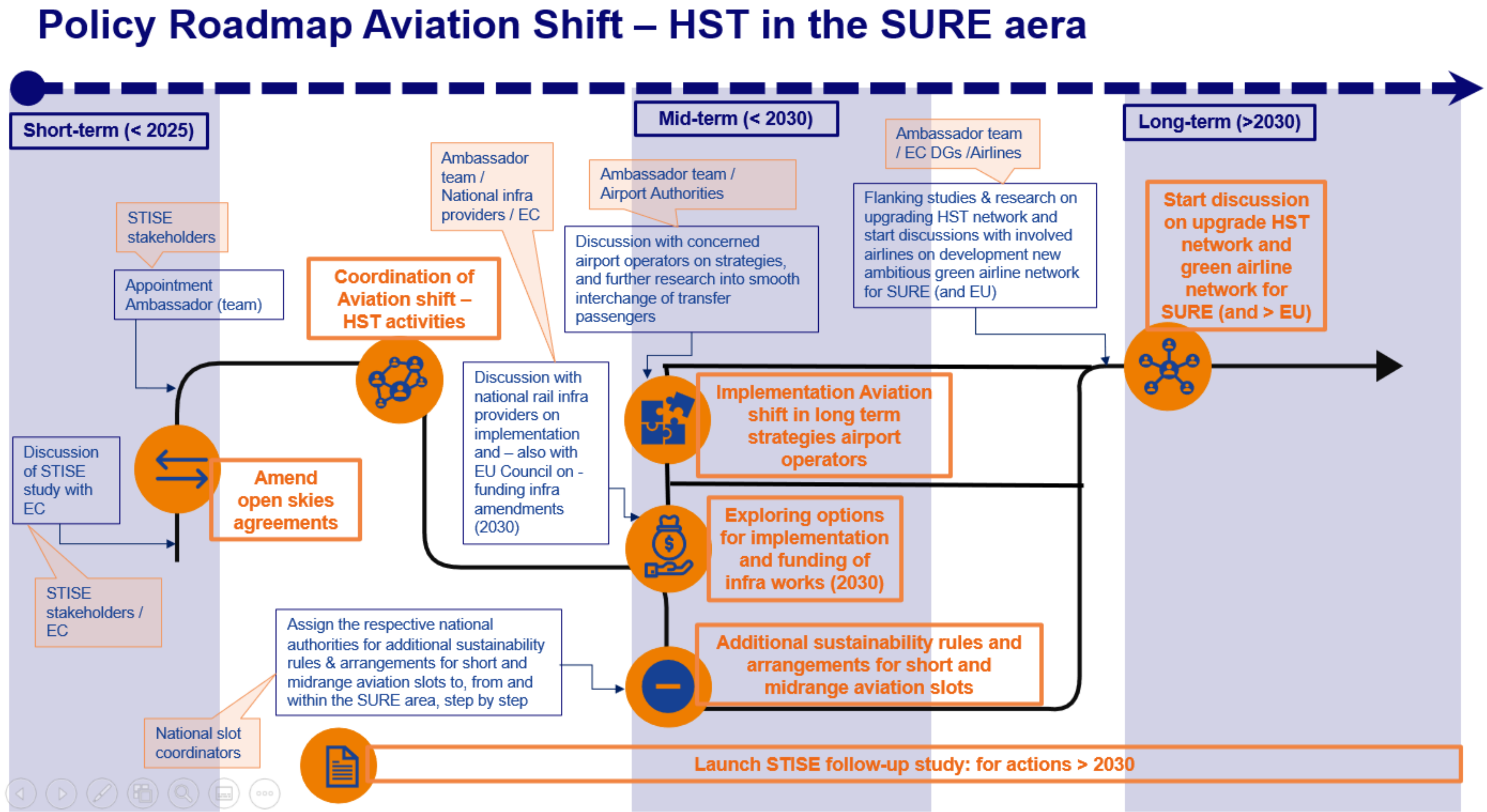


Figure 20 - Policy roadmap Aviation Shift - HST

### Implementation at STISE corridor level

The bottlenecks for implementation that might occur from an infra-provider's point of view, and if/how these might be solved are:

*Corridor Randstad-RheinRuhr-Frankfurt*

- The existing track between Oberhausen and Arnhem is currently being upgraded. Also given the overcrowded rail paths within the Rhein-Ruhr area and Arnhem-Utrecht for HST and for domestic travel as well, it would not be easy, if not impossible to further upgrade this track. Therewith and when there is a need for further extensions, one might reconsider a new HST-track between Eindhoven-Venlo-Krefeld-Düsseldorf airport to meet up with demands. This needs an additional Cos-Benefit Analyses and Environmental Impact Assessment in order to be implemented. This might take several years and if politically acceptable this assessment needs to be taken up a.s.a.p.
- Already at the moment there is as need (and it is partly already decided upon) to upgrade the Köln/Deutz station as a Rail-Hub. This won't be possible at the existent Köln Hbf. With this policy measure there is an extra pressure to upgrade services, including a custom service for travellers to/from the UK.
- Within the context to the Rhein-Ruhr-Express-Concept (RRX) an extension of regional public transport to the Airport of CGN is foreseen. Nevertheless, with a ban on aviation at short- and mid-range distances, there would be an extra need to travel directly with HST (and without exchange) between this Airport and especially Berlin, Munich and Hamburg. Domestic ICE services should then start or end, and or pass through CGN.

*Corridor Randstad-Brussels-Paris/London*

- The regional authorities have already decided about the need for an extension/new rail tunnel underneath Schiphol Airport for local/domestic reasons. But in order to meet the aviation shift demands (especially towards/from the UK) there is a further need to expand the station with customs facilities and baggage logistics.
- The existing HST station of Antwerp CS has to be upgraded too with customs facilities if and in order to receive Eurostar trains and meet the needs of UK travellers.
- The same goes for the station Brussels National Airport; this station has to be extended with two tracks in order to serve as a HST stop.
- The North-South rail tunnel underneath Brussels is already a major bottleneck in as well the domestic and international rail services. On the short run there is a need to optimize operations through a mix of systems improvements, harmonisation of train paths and circulation measures. On the long run there is a need for an extra tunnel between Brussels North station and Brussels Midi.
- Station Brussels Midi needs to be upgraded with two platforms in order to meet the extra HST Rail demands.
- The Eurotunnel has to be extended with two rail tracks. In fact, this is already needed in the present situation.

*Corridor Brussels-RheinRuhr*

- There are minor improvements needed on the existent tracks;
- Nonetheless there is a new (east-west) station Brussels National Airport needed, including new east-west tunnels in order to create an efficient stop for HST's on this corridor at the airport.

## 6.3 Policy Roadmap ZEZ

### Policy context

The ZEZ policy measure fulfils - or is in line with – the objectives of various major European political agendas, such as:

- EU Green Deal: E.g. 13 million zero- and low- emission vehicles by 2025, 50-55% GHG emissions reduction by 2030 and 90% in the transport sector by 2050…
- EU Sustainable and Smart Mobility Strategy: E.g. 100 climate neutral European cities and at least 30 million zero-emission vehicles by 2030, nearly all cars/vans/buses as well as new heavy-duty vehicles to be zero-emission by 2050….

Besides, ZEZ may significantly contribute to reaching EU air quality standards, in particular as defined in Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe which sets limit values for the concentration of pollutants in the ambient air in regard to nitrogen dioxide (NO2), particulate matter (PM10, PM2.5), sulphur dioxide (SO2), benzene, carbon monoxide and lead.

At local level, harmonising and upgrading ZEZ would contribute to reduce air pollution hence providing health benefits, improve quality of life, and reduce costs for citizens and above all freight transport companies to comply with local standards. However, such harmonisation process would require intensive concertation among numerous local, regional and national institutions and external stakeholders, considering the absence of existing institutional framework to organise such dialogue, and the subsidiarity principles whereby local authorities should remain responsible for defining standards and ambition levels

## Policy roadmap

Following policy roadmap for implementation is proposed:

1. **Set up a dedicated taskforce to identify expectations and assess the political acceptance of national/local authorities to engage in a harmonisation process**

Considering the absence of institutional framework to assess, plan and implement a harmonisation process of ZEZ, a dedicated task force comprising representatives from national authorities should be created. Many stakeholders have been contacted in the context of this study, but the low response rate does not allow to draw conclusions on the political acceptance of harmonising ZEZ. Hence the first activity of the task force should be to assess the feasibility and political acceptance of harmonising ZEZ.

2. **Set up technical working groups reporting to the taskforce to work on specific issues (ambition levels, areas for harmonisation, regulatory framework…)**

If sufficient common ground is found within the task force, a political mandate should instruct technical experts to work on specific issues such as ambition levels, areas for harmonisation, regulatory framework, etc. Technical working groups reporting to the task force could be created, involving representatives from local authorities and the civil society. The role of these technical working groups would be to identify possible options for harmonisation and assess their environmental, socio-economic and mobility impacts.

3. **Adoption of a political memorandum of understanding**

Conclusions and recommendations developed by the technical working groups and endorsed by the task force could be translated in a political memorandum of understanding (MoU) which would frame the process of harmonisation. This memorandum of understanding should be adopted by all national governments and, possibly, national or regional parliaments.

4. **Implementation of the harmonisation process**

A dedicated body/structure (e.g. above-mentioned task force) shall be appointed to follow up the implementation of the MoU and report to a political steering committee. Its strategic, technical and legal recommendations shall be translated into laws, regulations and administrative provisions, to be adopted by relevant national, subnational and local authorities.

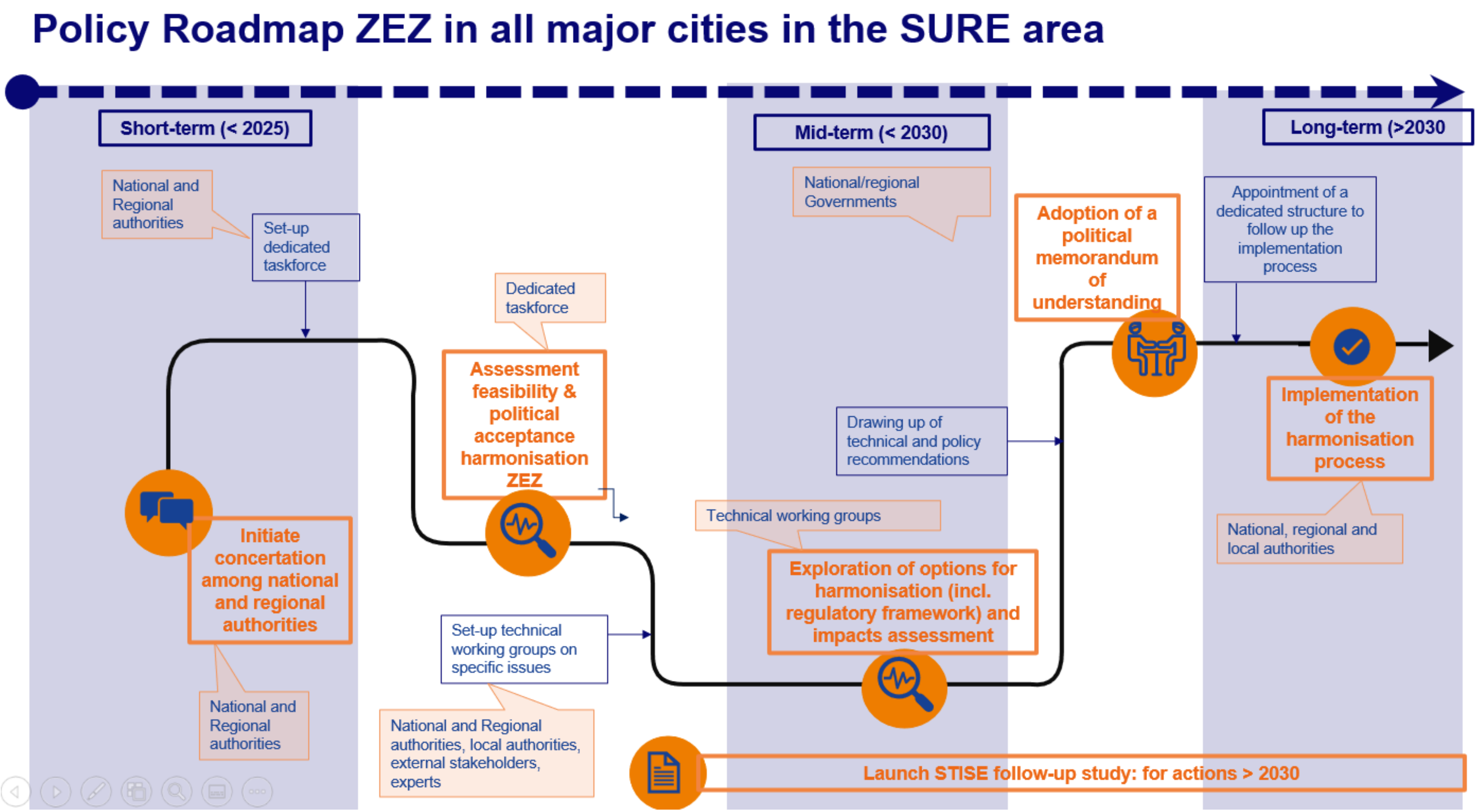



Figure 21 - Policy roadmap ZEZ

### Implementation at STISE corridor level

Not much in particular can be mentioned at this stage about a corridor-specific approach for implementation.

## 6.4 Policy Roadmap Exploring the Potential of MaaS

### Policy context

As Indicated before MaaS although relatively new in the mobility domain has already been identified as potentially interesting by policy makers on all levels. In the EU Transportation White paper from 2006 the seamless travel ambition was already mentioned focusing on the traveller and taking away barriers of interchange between modalities, but also for ticketing as such. This has further evolved on the EU-level in e.g. the EU Sustainable and Smart Mobility Strategy (2020) in which the seamless multimodal passenger transport is seen as a major driver. This is all based on the idea that more multimodal travel will decrease the negative impacts that are associated with car travel.

For MaaS not only the EU itself has been active, various initiatives have been taken to bring MaaS to the next level, e.g. the MaaS alliance (creating the foundation for MaaS in the EU) started approximately 5 years ago bringing stakeholders together. But also lobby groups from involved stakeholders, e.g. UITP but also POLIS has developed white papers and visions on what MaaS needs and what actions are necessary on an European level. For the STISE stakeholders these are opportunities to take part in, but also hop on board to influence the direction that these organizations are going.

Next to the EU-level on national and regional level also MaaS activities take place. For example, the Netherlands have launched 7 MaaS pilots with as a major goal to learn, but also be able to further de-ploy the developed services once fully developed. But also in Flanders a set of basic rules of engagement is currently on the way to make a next step with MaaS. In other words, MaaS doesn’t have to start from scratch, and stakeholders can use the existing momentum to bring MaaS towards implementation.

And last but not least there are already MaaS providers active, including partners that are working on standardization already (e.g. the TOMB-API). This offers the opportunity for the involved stakeholders to e.g. require using these standards in newly given concessions to public transport providers.

All in all, MaaS appears to be well on the radar of the different involved stakeholders, however, filling in the prerequisites as indicated above are key for public authorities to be able to influence the direction MaaS is evolving. Local public authorities can influence this in the right direction if they setup concrete MaaS implementation frameworks in their cities adhering to the standards & platforms as indicated before.

### Policy roadmap

Following policy roadmap for implementation is proposed:

1. **Embrace a platform & setup (technical) standards to allow sharing of information**

Mobility as a Service is seen as a distributed system that has different local and regional implementations. Examples have been found (e.g. Osnabrück Germany) where cities have taken the lead in unlocking and connecting various data sources, on the other hand initiatives from existing car manufactures (such as MOJA recently displayed during the ITS World Congress in Hamburg) can also be found. Either implementation at this moment is a step forward towards MaaS, however the major and essential step forward is to be able to connect these implementations together. And by connecting them together this means not only sharing real time information, but also integrating booking, ticketing and payment. *In short, embrace a platform on national level that allows interoperability between various initiatives that already take place.*

To be able to realize these connections, standardization is essential, which is in essence a task that should be performed with European backing. The exact form of standardization as well as the exact embrace is something to be further detailed especially since all involved stakeholders need to be able to have a say in the process. *In short, establish connections with the EC regarding ongoing standardization activities.*

## 2. Unlock and make available mobility data and setup governance for usage of the data

A second part is the unlocking of public and private data on which Mobility as a Service relies. This is data such as schedules, availability, ticket price and the like. Public authorities play a key role in unlocking this data, especially since most of the public transport is run under their authority. In short, *arrange contractually for transport providers operating under your authority to unlock their data to your specifications*. This has one important prerequisite and that is the human capital within public authorities which also needs to understand the digital world and how this works. In other words, not only the legal side but also the IT-side of public authorities needs to be up for this challenge.

Unlocking data is one aspect, however organisation of this unlocking is not a simple task. When looking at the developments regarding road transport, the national access points that are currently being established appear to be a logical way forward also for data that is relevant for MaaS. However, this also requires setting up the governance of this national access point for MaaS as well as defining who has access to what and what terms and conditions apply. In short, *setup on national level an organization that arranges unlocking of MaaS relevant data as well as the governance of this data.*

## 3. Accompanying measures and infrastructure investments

During the period that the prerequisites above are being organized, one key element needs to be tackled, being how MaaS can be operated and used from a public authority perspective and what the additional framework looks like that allows MaaS to be contributing towards public and societal goals. This is something that requires more research and is dependent on local and regional factors such as the quality and availability of the public transport infrastructure. In short, from a regional point of view, establish a vision what MaaS is from your perspective and how it can contribute to specific public goals.

Based on the vision and the further detailed impact, necessary policies will be identified, for example the necessary infrastructure investments in mobility hubs to facilitate the sharing of concepts close to public transport or the necessary rules and regulations for mobility service providers to deploy sharing concepts. In other words, a complete policy package for the future that will make MaaS to be used towards sustainability goals including the management of the externalities.

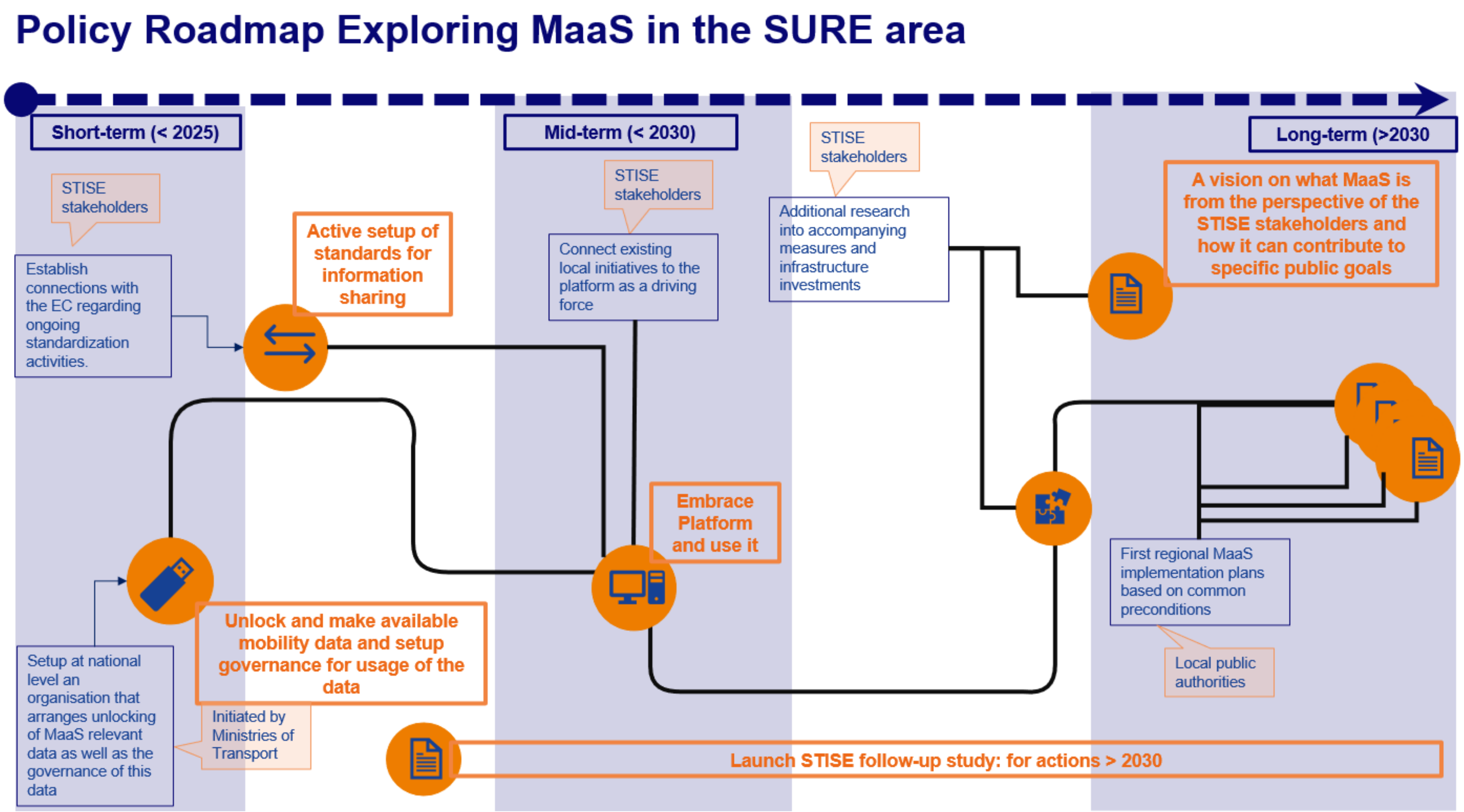



Figure 22 - Policy roadmap Exploring the potential of MaaS

### Implementation at STISE corridor level

It is expected that different variations might be seen across borders on a national level, but as long as the EU-standards are adhered to, this will not be an issue. A couple of remarks might be important here:

- For the Netherlands & Belgium the corridors cover a large part of the country already, making it useful to implement platforms on this level.
- For Germany * France it could be interesting to research if more local focused implementations e.g. in North Rhein Westphalia or Lille as separate entities.
- On a corridor level it appears that the Lille Brussels corridor is the most straightforward with two large agglomerations at either end and several connections in between.
- For the two Rhein oriented corridors this appears to be more diffuse thus involving more stakeholders as well as mobility providers (e.g. train operators, public transport operators, etc.)

### Good practices in other corridors

For MaaS many pilots have been undertaken however with Whim as a true MaaS provider starting in Helsinki including the benefits it realized it is worth to further investigate the preconditions.

## 6.5 Policy Roadmap Improving Regional Cross-border train transport

### Policy context

Improving cross-border passenger rail transport is one of the measures in “Flagship 3 – Making inter-urban and urban mobility more sustainable and healthy” of the European Commissions “Sustainable and Smart Mobility Strategy”. This strategy is part of the European Green Deal and states: “In 2021, the Commission will propose an action plan to boost long-distance and cross-border passenger rail ser-vices. This plan will build on efforts by Member States to make key connections between cities faster by better-managed capacity, coordinated timetabling, pools for rolling stock and targeted infrastructure improvements to boost new train services including at night. Platforms or other organizational structures for this purpose should be open to all Member States. Pilot services on some routes involving all interested stakeholders should be supported, and a combination of public service contracts and open access services could test different models for new connections and services, with the aim of boosting 15 pilots by 2030.” The analysed cross-border connections within the SURE area could be among these pilot projects. Stakeholders in the cross-border regions need to work out a good plan to be considered.

### Policy roadmap

Following policy roadmap for implementation is proposed:

Decision phase recommendations (short term to midterm):

1. Regional and local stakeholders should learn from successful projects (for instance from stakeholders of the region Aachen-Maastricht);
2. Develop a coherent vision and develop a cross-border agenda with relevant local, regional and national stakeholders A good example is the ‘Grenz-/grensland agenda’ between the Netherlands and the German state North Rhine-Westphalia. It is important that all relevant administrative layers are engaged in this process. An envoy from the European Commission might be of additional value, since many of the corridors have skeletons in the closet and European funding might be of additional value.
3. Consider the impact of rail connections on inter-regional level and take sustainability and other benefits for society into account in cost-benefit analyses. These requirements have to be addressed clearly by the authors of the terms of references in the calls for proposals of cost-benefit analysis of cross-border rail projects.

4. The relevant stakeholders have to take decisions. Many cross-border rail projects stay on the long-term agendas for decades. If it is feasible, it is important to go for it, if the cost-benefit analysis is negative, upgrading cross-border bus services might be a good alternative. Buses are less valued by passengers than trains and therefore attract less demand. However, they can have a positive environmental, social and economic impact.

Implementation phase recommendations (midterm to long term):

5. Authorities that are in charge of rail concessions should realize open competition and make use of the windows-of-opportunity at the moments when concessions end;
6. Infrastructure providers and rail operators have to work together and consider differences in rail infrastructure, accompanying systems and safety requirements;
7. Rail operators together with service providers should aim for the most passenger-friendly services with good connections and uniform supply of travel information and tickets. Systems with good quality are generally highly used and profitable, whereas poor systems are not.

# Policy Roadmap Improving cross-border public train transport in the SURE area

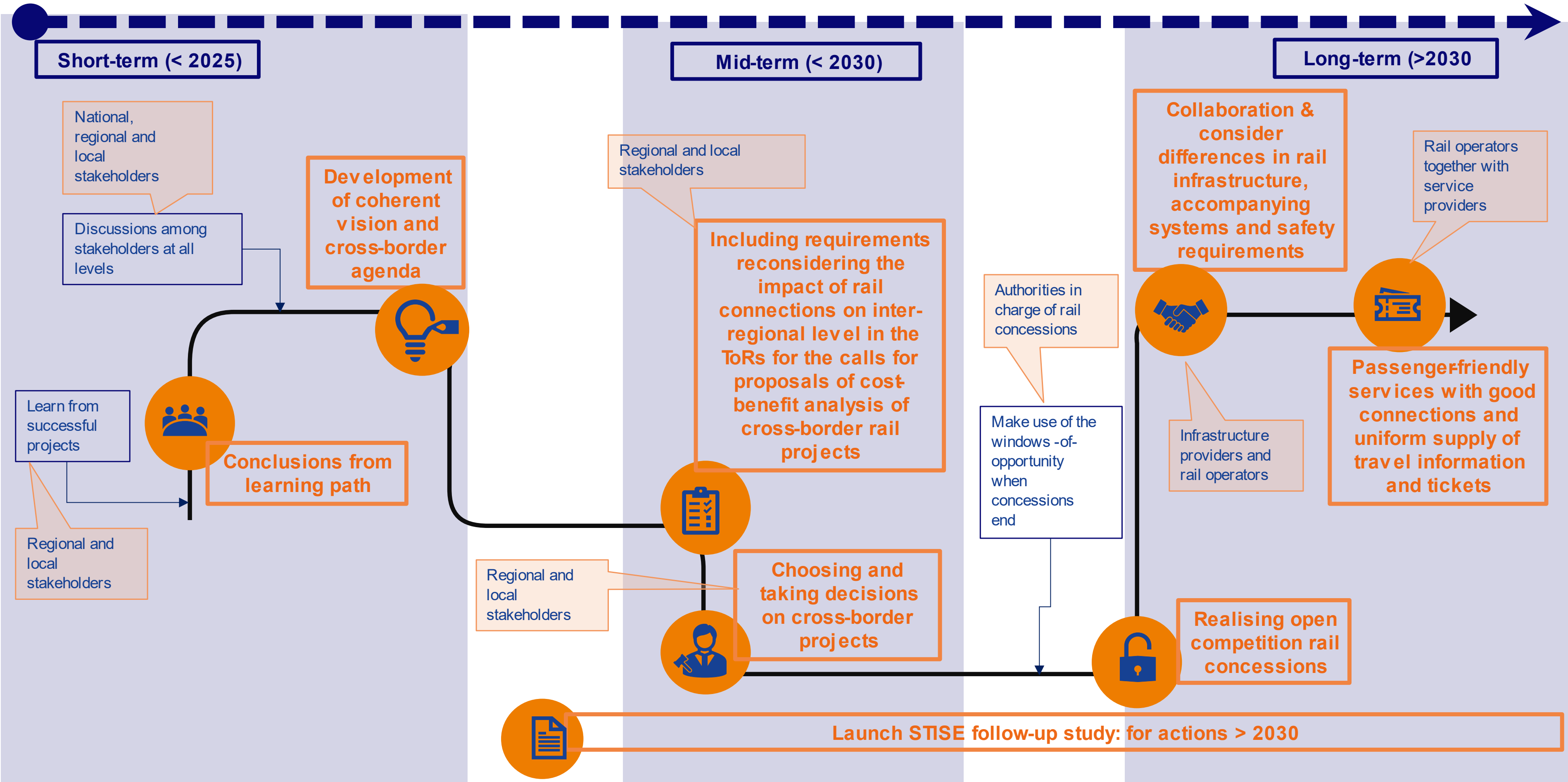



**Figure 23 - Policy roadmap Improving regional cross-border train transport**

## Implementation at STISE corridor level

Not much in particular can be mentioned at this stage about a corridor-specific approach for implementation.

## Good practices in other corridors

The promising approach the governments of the Netherland and Nord Rhein-Westphalia have established is a cross-border agenda (‘*Grenz-/grensland agenda’*) drawing overarching goals and strategy for cooperation at several themes.

Outside the SURE area the French-German cross-border railway Strasbourg-Lauterbourg (see https://ec.europa.eu/inea/en/connecting-europe-facility/cef-transport/2019-fr-ta-0046-s) is a promising example which will be further upgraded in the coming years.

# Annex 1. Scientific Report

## Study objective, scope and area

The study was launched with the main to explore if, and to what extent, *the Eurodelta* is – and could be even more - moving towards greener mobility that contributes to the European sustainability goals, and therefore to more attractive and sustainable urban regions. As business as usual will not be sufficient to reach such goals, the region will need to move up a gear, by pursuing bold policy choices to (help) achieve the targets set in European agendas.

The project's geographical scope was initiated from a *particular focus on the 3 key corridors* considered in this study – corridors of particular interest to the stakeholders involved in the project and which are also core areas for certain challenges in the study region.[37]

## Study approach

### 1. Starting point: study framework and bottleneck analysis

The starting point and central framework of the study is the *Three Market Arena model*, developed on a market based approach for spatial mobility planning, where there is a continuous challenge to meet the ongoing demand with sufficient supply. Within the broad setting of Mobility, three of such 'markets' evolve more or less in parallel, but related to each other, sometimes even using the same infrastructures: the travel, transport and traffic markets. Each of these markets have their own institutional settings and leading stakeholders, so they are called 'market arenas' here. This model is explained in more detail in Annex 1 to this report.

A *bottleneck study* in the region and the corridors was performed first, as a basis for the next steps in the project: an analysis of the network and a set of specific policy measures relevant for the area (see below).

### 2. Network analysis and policy analysis

The core of the methodology for the network and policy analyses evolves around creating a consistent image of the future for 2030 and 2050 to better understand how sustainable transport is and what policy measures will be effective to reach specific policy goals. To be able to understand transport developments (focused on sustainability) in 2050, *three components are combined* in this study:

- A *network analysis* – building a *baseline scenario*:
  - combined with: *external trends*

    and
  - of which the estimations included therein, were complemented with a policy analysis, more in particular: the assessment of the (potential) impact of 4 ambitious policy measures in the study area

#### a. Network analysis: baseline scenario and project toolkit

In a first step a *baseline scenario* was built, (based on) using the (output from) *Transtools3 model* as the main model - which is the latest available transport model on European scale. For comparability reasons as well as availability of future data Transtools3 was selected over a combination of the national and regional available transport models. The model uses a combination of ArcGIS & network analyst including a tailormade scenario manager to run the model. The results of this model were validated with regional

[37] The corridor focus, however, has not been maintained throughout this project – more specifically with regard to the (selection of the) assessed policy measures. These policy measures are not particularly corridor-specific, at the level they are assessed here.

and national models - in case of inconsistencies, the Transtools3 results were scaled to match with the other sources to one consistent baseline scenario. The traffic demand was estimated to create an under-standing of the transport flows for both passengers and freight within the study area and the expected growth of these flows towards 2050. These flows were then translated into emissions (for example $CO_2$), as a proxy for sustainability to understand the scope of the issues at hand.

Within the Transtools3 model the origin and destination zones are (for most areas) similar to the NUTS3 division that is commonly used to distinguish geographical zones, this means that NUTS3 is the lowest geographical degree taken into account within this study. This geographical level is also displayed within a toolkit that has been developed as a side product to give more insight into transport flows that cannot be appropriately reported in the consecutive study reports. Annex 8 contains more details regarding this toolkit.

The Transtools3 model distinguishes both freight and passenger transport, and - for these modes - also modalities and type of goods or purposes. These are:

- For freight transport: modalities road, rail and inland waterways, distinguished in bulk goods, liquid goods, containers and general cargo
- For passenger transport: modalities road, rail and air, distinguishing purposes for business travel, com-muting or other purposes.

The model contains a baseline scenario which is used as the baseline for this study. This baseline sce-nario from the Transtools3 model does not contain any other policies except infrastructure that is expected to be available in the future years (e.g. already granted TEN-T projects). The model provided results for the base year (2010) and future years 2030 and 2050. To be able to combine these with the emission indicators an 'in between correlation step' was used to interpolate the results between 2010 and 2030 to create the year 2018. A linear growth was assumed to perform this interpolation.

As mentioned, the modelling results have been compared to available modelling results from national scenario studies. This step was taken to validate the results and create a better understanding of the quality of the transport flows that are an output of the model. This indicated that the overall numbers for passenger transport were slightly underrepresented in the simulation results, but, since growth rates were quite comparable no corrections were deemed necessary. For freight transport it was found that the num-bers are either over- or underrepresented when comparing flows on country level and modality level. This goes for both the absolute numbers as well as the growth rates. Therefore, the numbers for freight transport need to be treated with care and not as an absolute truth. During the policy analysis phase, it was found that on a zone-to-zone comparison strange numbers occurred, for example with cross border transport. This results in the disclaimer that, although the transport flows indicate a direction of growth as well as an order of magnitude, the detailed numbers need to be used with caution and other tools and methods are necessary for detailed studies.

The results of the model as explained before are shared and shown in a – specifically for this project built - *project toolkit* for further analysis purposes on more detailed level.[38]

### b. External trends

The baseline scenario is designed as a business-as-usual scenario and includes forecasts for 2030 and 2050. It is based on the European Transtools3 model developed between 2011 and 2016. Hence, the assumptions for the model forecasts have been defined several years before the current study has been carried out (2021). Meanwhile, *a series of external trends are evolving*, that are not taken into account (sufficiently) in the baseline scenario. These trends are likely to affect the forecasts for 2030 and 2050. Within this study, it was not possible to update the Transtools3 model, since Transtools3 has been devel-oped by consultants which are not part of the consortium and because such an update was not in the scope of this project and would require a significant amount of time and resources.

[38] The output data from the transport model is also shared via the ESPON project results database. This includes the origin and destination data on NUTS3 level for the relevant transport flows including purposes and types of goods.

Therefore, the baseline scenario was combined with *external trends* that most likely seem to have an impact on the existing transport growth as estimated in the baseline scenario (i.e. trend breaking developments) and how these could affect the predicted future. The consortium with the project stakeholders has agreed upon an overview of external trends that may significantly affect the transport flows for passengers and freight within the SURE area in the future. Of these trends six have been selected and the possible impacts have been briefly studied in qualitative terms. The external trends that have been analysed are:

- Climate change & energy transition
- Technical evolutions in the transport sector
- The future of growing globalisation in the field of transport
- Growing circular Economy
- Health/economic crises/effects after Covid
- Possible (dis)integration in the EU

For each of these trends the most likely impacts on the different modes of passenger and freight transport have been estimated globally and in qualitative terms. These uncertainties on the outcomes of the baseline scenario are taken into account in the analysis of the policy measure as well. In this way the trends can be seen as a *robustness check* of the baseline scenario.

#### c. Policy analysis

Finally, the estimations in the baseline scenario were complemented with the *assessment of the (potential) impact of 4 ambitious policy measures in the study area*, in this case: Aviation shift on short/mid-range distances, Zero Emission Zones in all major cities, the potential of MaaS, and exploring improved regional cross-border public train transport. The policy measures were analysed to see if they make transport within the study area more sustainable and what margin still exists when comparing the impact of these measures towards the sustainability goals – including some findings regarding the quantifications of the measures with respect to the baseline scenario and which trend(s) has (have) most impact.

The 4 policy *measures concerned were chosen through a selection process with the project stakeholders and client*. A 3-step approach was followed: (1) based on the initial input received from the stakeholders and an analysis of the policy documents, a long list of potential policy measures was composed, (2) in a next step a short-list of policy measures was selected out of this long list, for a quick-scan, (3) a quick scan analysis was performed by assessing the policy measures with criteria such as: added value, jobs, accessibility (economic component of sustainability), social justice, wellbeing and acceptance (social component of sustainability), and the investment and operational costs and probable public support (factors related to the implementation of the measures). The scope of the policy analysis is not focused on already implemented projects or policies in (parts of) the study area, but on ambitious policy concepts that (can) affect the entire area and/or its border crossings or the better connections in or between its (major) cities, and that could really make a difference.

*Policy roadmaps*

For each assessed policy measure, the policy framework is explained, high-level policy roadmaps for implementation are included, and - where relevant - corridor-specific points of attention are indicated, as well as possible good practices from elsewhere. These roadmaps are a starting point, to have a first idea of which steps make sense in order to effectively start with (preparing for the) implementation of the measure. The proposed roadmaps show that cooperation will be necessary, at all levels - so for each policy measure attention is paid to which stakeholders should be involved in an implementation process.

## Stakeholder involvement

The project was co-supervised and - directed by the involved government stakeholders in the region (the project stakeholders). Throughout the project progress, these stakeholders were consulted on a regular basis for work sessions to exchange views and gather input, as well as to validate interim results.

In addition, mainly in the process of drawing up the policy roadmaps, other (types of various) stakeholders were involved as well - stakeholders that might have interesting views or could share insights specifically regarding (points of attention for) the implementation of the policy measures were invited to a consultation, a ‘Roundtable’.

# Annex 2. Three Market Arena Model

The central framework of this study is the **Three Market Arena Model** as presented in the figure below. This model was composed taking into account existing and state-of-the-art academic research and is adapted to the specific needs of the stakeholders in the Strategic Urban Region of the Eurodelta (SURE). The core framework is based on:

- The conceptual model as put forward in the ToR for this research project (ESPON 2020),
- The three-market model of mobility and space (Egeter & van de Riet, 1999; Lauwers/Allaert, 2012; Witlox/Boelens, 2016), and
- The actor-relational approach to planning and the market arena approach (Boelens, 2009, 2015, 2019; Loris 2020)

Below is explained more in detail how the Three Market Arena Model is built and what it is composed of.

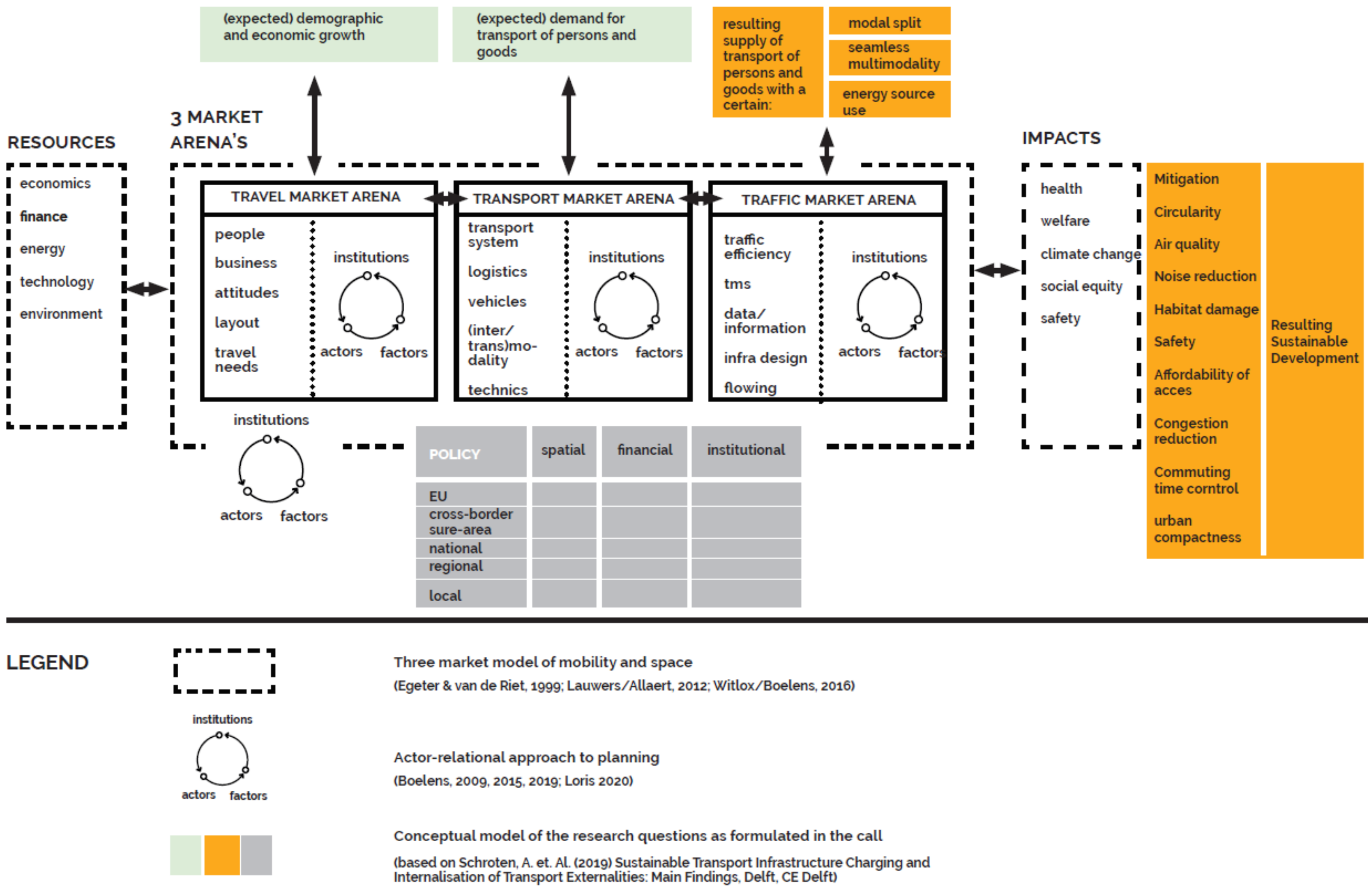



**Figure 24 - 3 Market Arena Model**

Of major importance within this framework are the following aspects:

**THE RELATIONAL TURN IN SPATIAL THINKING**

*(Massey 1991, Thrift 1998/2004, Amin 2002 etc.*)

Space is no longer seen as a pregiven abstract platform on which people, animals or other subjects act. Space is a dynamic entity made by humans, the climate, fauna & flora etc. and in turn influences the behaviour of these subjects. The interaction between all living things and space is mutually dependent, and is - in other words - always relational.

In the context of this study, mobility and space are relational as well. Better accessibility, for instance, makes certain spatial developments possible, just like a specific spatial layout can enhance the amount, the direction or even the mode of mobility; they continuously interact. The Three Market Arena model indicates clearly that relations are not linear. In a linear methodological framework, it is assumed that a specific economic growth would lead to a specific transport demand, which would enhance the need for additional transport means, which in turn would have an effect on energy demand and environmental issues etc. It also works the other way around, in that sense, for instance, that (1) traffic and mobility can also enhance economic growth (not only directly for car manufacturers for instance, but also as a spin off), (2) air quality demands can restrict certain traffic patterns or even enhance other transport modes, and (3) innovations in technology and energy resources can make some mobility patterns redundant etc. This also means that policy measures can influence this mobility-space interaction from everywhere: not only at the (linear) relation from the demand of transport towards the supply of transport, but also e.g. in the realm of spatial planning. The Three Market Arena Model takes these considerations into account.

**A SYSTEMATIC VIEW ON COMPLEXITY**

(*Luhmann 1992/1997; Assche et al., 2016; Boelens, 2016*)

The specific mobility-space interaction is dependent on the interrelations within that interaction itself, as well as on (political) changes in its surrounding, e.g. the economic realm, financial resources, changing ideas with regard to safety and air quality, technological innovations etc. In other words, a specific mobility-space interaction is made of multiple relations, inside as well as outside that interrelation. That makes the mobility-space interaction highly complex. There is no point in this complexity where the mobility-space interaction can be observed in its entirety. For that purpose, it is more workable to distinguish - within that complexity - various sub-systems which are more or less operating as a whole. These subsystems are in a way 'markets', or better 'market arena's'. Within each of these arena's all involved actors (e.g. stakeholders, agents, etc.) strive for a certain equilibrium of demand and supply. 3 markets are distinguished: (1) **the travel market arena** (in which the travel behaviour of people and businesses are at work, dependent on personal features and influencers in this regard, but also on demographic changes, spatial densities, functional diversity, geographic particularities etc.), (2) **the transport market** (in which intermodal transport choices are at work, based on path dependent travel patterns from the above, but also and specifically on the policies of public transport & logistic providers, and the price and efficiency of certain (inter)modal transport systems etc.), (3) **the traffic market arena** (where the offered traffic means for travel and transport are at work, dependent on the efficiency, price and quality of the vehicles and infrastructure, TMS or ERTMS technology, IT and innovative energy facilities, online and just-in-time, MaaS etc.). Each of these subsystems, market arena's, operate more or less operationally closed, by reducing the complexity in its surrounding according to the internal structure and the financial possibilities, needs and (institutional) codes of that market arena. Nevertheless, that wouldn't mean that the mobility-space interaction is highly fragmented, on the contrary. On regular basis each of these market arena's interpenetrates or irritates the other market arena's: for instance when an infrastructure provider - for instance the Dutch ProRail in the traffic market arena- can't comply always and at every moment to the needs of the public transport providers, for instance Dutch Railways, Arriva, the Thalys Alliance or DB etc. in the transport market arena, or when the transport product of one or several transport providers do not comply to the smooth (inter)modal demands of the travellers or freighters from door-to-door (in the travel market arena). As such, the 3 market arena's do need to respond to each other.

**AN ARENA APPROACH TO MOBILITY MARKETS**

(*OECD, 2015; Boelens, 2017/2019; Loris, 2020*)

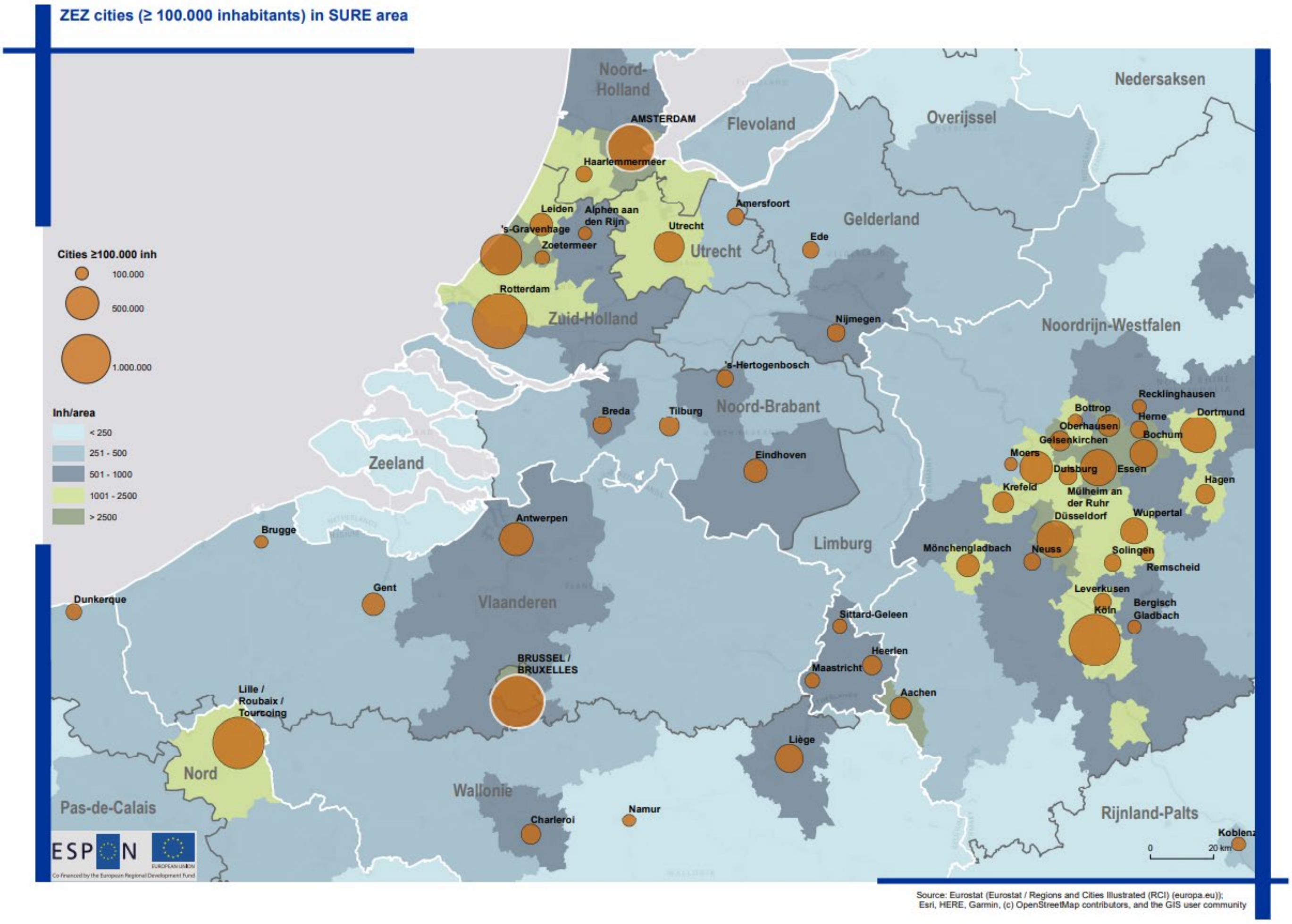
Moreover, and as such the three markets cannot be regarded as only specific systems or organisations, but as arenas wherein lots of actors operate, compete and interact. Different types of actors can be distinguished: business actors (such as entrepreneurs and companies), public actors (such as policy makers and public servants) and civic actors (such as the travellers, commuters and the like). When the input and interests of all three are apparent, the specific operation or action is the most robust or resilient, since at the same time, money, law and sufficient support is guaranteed. Furthermore, in each of the mobility-space markets a specific set of actors operate, such as the commuters, tourists etc. in the travel market; freighters, port authorities etc. in the transport market, and vehicle manufacturers, infrastructure providers etc. in the traffic market. And also here, the more these mobility-space arenas are interconnected and compliant with the available resources and environmental impacts, the more resilient and balanced the mobility flows will be. Nevertheless, actors don't act in a void, but in specific settings of time and place. Institutional settings (as the various and place dependent rules of the game, such as law, (mobility) culture, norms and the like) can be distinguished, but also factors of importance (such as geographical features, financial, economic or energy crises, or specific hazard as the Covid pandemic, floods etc.). Especially in border-crossing challenges these settings have to be taken into account, to come up with robust policy measures and effective space-mobility proposals.

# Annex 3. Assessment Policy Measure ZEZ: Additional Information

# A ZEZ in all major cities in the SURE area on a Map

Note: The approach followed for the identification and selection of the major cities in the SURE (> 100.000 inhabitants) is presented **under Section F hereafter**.

As shown on the following map, 53 cities currently have more than 100.000 inhabitants in the SURE area[39].




**Map 5 - Map of cities in the SURE area targeted by the ZEZ policy measure**

[39] Sources of data: Eurostat (Population 2017) and Transtools3 Baseline scenario (Population 2010)

# B Existing LEZ – Synthesis Table

| Country | # existing LEZ (2020) | # existing LEZ located in SURE area | Vehicles affected | Standards for passenger cars | | | | standards for other LDVs (N1): commercial vans, pick up trucks ... | | | | standards for HDVs (M2, M3, N2, N3): trucks, buses and coaches | | | | Legal framework |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | current (2021) | 2025 | 2030 | 2035 | current | 2025 | 2030 | 2035 | current | 2025 | 2030 | 2035 | |
| Germany | 87 | 9 (Aachen, Bonn, Dinslaken, Düsseldorf, Eschweiler, Hagen, Krefeld, Köln and Mönchengladbach) | all motor vehicles except motorcycles | Petrol : Euro 1<br>Diesel : Euro5/Euro4 / Euro 3(PM) | Petrol : Euro 1<br>Diesel : Euro5/Euro4 / Euro 3(PM) | / | / | Petrol: Euro 1<br>Diesel: Euro 3<br>**Stuttgart**<br>Diesel: Euro 5<br>**Ruhrgebiet**<br>Diesel: Euro 4 | / | / | / | Petrol : Euro I<br>Diesel : Euro IV | / | / | / | A National Framework sets out the Emissions Classes and main rules that can be used by cities for LEZs in Germany.<br>The cities or regions can decide whether, where and when to implement a LEZ (location, emissions standard - or sticker - and timings are set at local level) |
| The Netherlands | 13 | 2 (Utrecht, Rotterdam) | All LEZ affect N1 vehicles and HDVs. Some LEZ (e.g. Amsterdam, Utrecht, Arnhem, Den Haag) also affect passenger cars. | **Amsterdam/Utrecht/Arnhem**<br>Diesel Euro 4 | **Amsterdam**<br>Diesel Euro 5<br>**Utrecht**<br>Diesel Euro 4 | **Amsterdam/Den Haag**<br>petrol & Diesel ban | | **Utrecht/Amsterdam**<br>Diesel Euro 4<br>**Rotterdam**<br>Diesel Euro 3 | petrol & Diesel ban | | | Euro IV | petrol & Diesel ban ( *only Amsterdam LEZ also applies to coaches* ) | | | national framework for low emission zones, which are called "milieuzone". Location, emissions standard (or sticker) and timings are set at municipal level |
| Belgium - Flanders | 2 | 2 (Antwerp, Ghent) | All vehicles | petrol/gas: Euro 2<br>diesel: Euro 4 | petrol/gas: Euro 3<br>diesel: Euro 6 | petrol/gas: Euro 4<br>diesel: Euro 6d<br>(RDE, Real Driving Emissions | / | petrol/gas: Euro 2<br>diesel: Euro 4 | petrol/gas: Euro 3<br>diesel: Euro 4 | petrol/gas: Euro 4<br>diesel: Euro 6d | / | petrol/gas: Euro II<br>diesel: Euro IV | Diesel : EURO VI | / | / | Regional legislation (Decree) : Decreet van 27 november 2015 betreffende lage-emissiezones |
| Belgium - Brussels | 1 | 1 (Brussels Capital Region) | - Cars (category M1),<br>- (mini)buses (category M2),<br>- buses and coaches (category M3) and<br>- vans under 3.5T (category N1, with the exception of N1 vehicles with body code BC) | petrol/gas: Euro 2<br>diesel: Euro 4 | petrol/gas: Euro 3<br>diesel: Euro 6 | petrol/gas: Euro 6d<br>Diesel ban | petrol/gas & Diesel ban | petrol/gas: Euro 2<br>diesel: Euro 4 | petrol/gas: Euro 3<br>diesel: Euro 6 | petrol/gas: Euro 6d<br>Diesel ban | Diesel ban<br>petrol ban | petrol: Euro II<br>diesel: Euro IV | petrol/gas: Euro III<br>diesel: Euro VI | petrol/gas/diesel: Euro VId | **M2**<br>Diesel ban<br>petrol ban<br>**M3,N2,N3**<br>petrol/gas/diesel: Euro VIe | Regional legislation (Ordinance) : Code bruxellois de l'Air, du Climat et le la Maîtrese de l'Energie |
| Belgium - Wallonia | 1 | 1 (Walloon Region) (2023 onwards) | All vehicles with four wheels or more. | / | Petrol/gas : Euro 4<br>Diesel : EURO 6 | / | / | / | Petrol : Euro 4<br>Diesel : Euro 6 | Diesel Euro 6d | / | / | Petrol : Euro IV<br>Diesel : Euro VI | / | / | Regional legislation (Decree) : Décret du 17 janvier 2019 "relatif à la lutte contre la pollution atmosphérique liée à la circulation des |
| France | 1 | Lille (2022 onwards) | All vehicles with four wheels or more. | / | Petrol : Euro 4<br>Diesel : Euro 5 | / | / | / | Petrol : Euro 4<br>Diesel : Euro 5 | / | / | / | Petrol lorries : Euro V<br>Diesel lorries : Euro | / | / | National legislation : Loi n° 2019-1428 du 24 décembre 2019 d'orientation des mobilités |

# C Alignment with EU Policies

The ZEZ policy measure fulfils or is in line with objectives of various major European political agendas:

*EU Green Deal* (December 2019)

- By 2025: 13 million zero- and low- emission vehicles are expected on European roads
- By 2030: EU's climate ambition for 2030, with a 50-55% cut in greenhouse gas emissions (compared to 1990s levels)
- By 2050: a 90% reduction in transport emissions is needed, to achieve climate neutrality (by 2050)

*EU Sustainable and Smart Mobility Strategy* (December 2020)

- By 2030:
    - 100 European cities will be climate neutral
    - At least 30 million zero-emission vehicles will be in operation on European roads
    - Automated mobility will be deployed at large scale
- By 2050: nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission.

Besides, ZEZ may significantly contribute to reaching EU air quality standards, in particular as defined in *Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe.* This Directive sets limit values for the concentration of pollutants in the ambient air in regard to nitrogen dioxide (NO2), particulate matter (PM10, PM2.5), sulphur dioxide (SO2), benzene, carbon monoxide and lead. It also describes the actions to be implemented if these are exceeded.

| Pollutant | Limit value obligatory* | European limit value | WHO guideline values |
|---|---|---|---|
| $PM_{10}$ | since 1 January 2005 | 50 µg/m³ daily limit value may be exceeded on 35 days only | 50 µg/m³ daily limit value |
| | | 40 µg/m³ annual mean | 20 µg/m³ annual mean |
| $PM_{2,5}$ | from 1 January 2015 | 25 µg/m³ annual mean | 10 µg/m³ annual mean |
| | | 20 µg/m³ maximum 3-year annual mean (urban background) | 25 µg/m³ daily limit value |
| $NO_2$ | since 1 January 2010 | 200 µg/m³ 1-hour limit value may be exceeded on 18 days only | 200 µg/m³ 1-hour limit value |
| | | 40 µg/m³ annual mean | 40 µg/m³ annual mean |
| $O_3$ | since 1 January 2010 | 120 µg/m³ targeted value (maximum 8-hour mean in a day; may be exceeded on 25 days only (3-year mean) | 100 µg/m³ 8-hour limit value |

* Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe

**Figure 25 - Limit values for the concentration of pollutants in the ambient air (EU air quality standards)**

# D Overview Relevant Existing Research

There have been relatively few studies which have attempted to evaluate the impact of a LEZ using measured concentrations, possibly because of the difficulty in identifying small changes in concentrations following policy interventions.

As emphasised by Amundsen and Sundvor (2018), “there are several studies, both modelling and measurements with statistical analysis, which have been performed for LEZs, but the conclusion of the effects varies. The challenges in these evaluations are many, and for instance the use of wrong emission factors for diesel vehicles has been one important challenge for the modelling studies. For air quality measurement studies it is difficult to separate the effect of the LEZ from other measures introduced. This, however, does not mean the LEZs did not or will not have an effect. Increased diesel shares in the vehicle fleet and a general increase in number of vehicles and traffic volumes have contributed to more emissions, and hence counterbalanced the emission reduction effect of the LEZs.

There are, however, data showing that the zones do alter the vehicle fleet and hence reduce emissions from the targeted vehicle groups. For this to have significant effect on air quality the targeted group needs to be a significant source of the pollution. The non-exhaust contributions from traffic to PM10 is large, and PM also have several other sources. LEZs is today therefore not expected to have significant effects for this compound except if it is so strict that it significantly limits the total traffic volume. LEZs are, however considered to be efficient for NO2, CO2, black carbon and other exhaust compounds if targeting a large enough part of the fleet and/or are stringent enough. Several measures are needed to reduce air pollution and LEZs is one of the useful tools at hand for municipalities.”

These conclusions are confirmed by the Brussels annual LEZ assessment report[40], which clearly demonstrates that emissions from the transport sector have significantly decreased since the implementation of the LEZ. However, these results should be carefully interpreted due to the Covid context in 2020, which leads to comparability issues. Besides, while the evolution of pollutants concentrations is very encouraging, the report fails in assessing the impact of the LEZ scheme on these results due to the numerous factors influencing air quality measurements.

# E Identification of Expected Behavioral Changes

Several case studies are presented in this section, providing information on Expected Behavioral Responses in different contexts.

## E.1 **Source: ADEME, "**Low Emission Zones (LEZ) across Europe - Deployment, feedback, impact assessment and system efficiency", 2020 (Pages 128 et following)

**Sweden**

Sweden is a pioneer in the implementation of low-emission zones, since three Swedish cities implemented this scheme in 1996, including Stockholm. A report submitted in 2008 by the Stockholm City Transport Office shows that its low-emission zone has led to a change in the vehicle fleet and more specifically an energy substitution:

- For trucks: decrease in the number of gasoline trucks in favour of gas and diesel
- For buses: reduction in the number of petrol and diesel buses in favour of ethanol and gas

[40] Brussels Capital Region, Evaluation de la Zone de basses émissions, Rapport 2020.

**Netherlands**

The following graph shows the difference in the composition of the fleet between cities that have a low-emission zone and those that do not. The "less polluting" vehicles are in greater proportion in cities operating an LEZ, which proves the impact of the LEZ on fleet renewal. The study from which this graph is derived also indicates that the proportion of Euro V vehicles is 25% in cities operating an LEZ compared to 13% in cities without an LEZ.

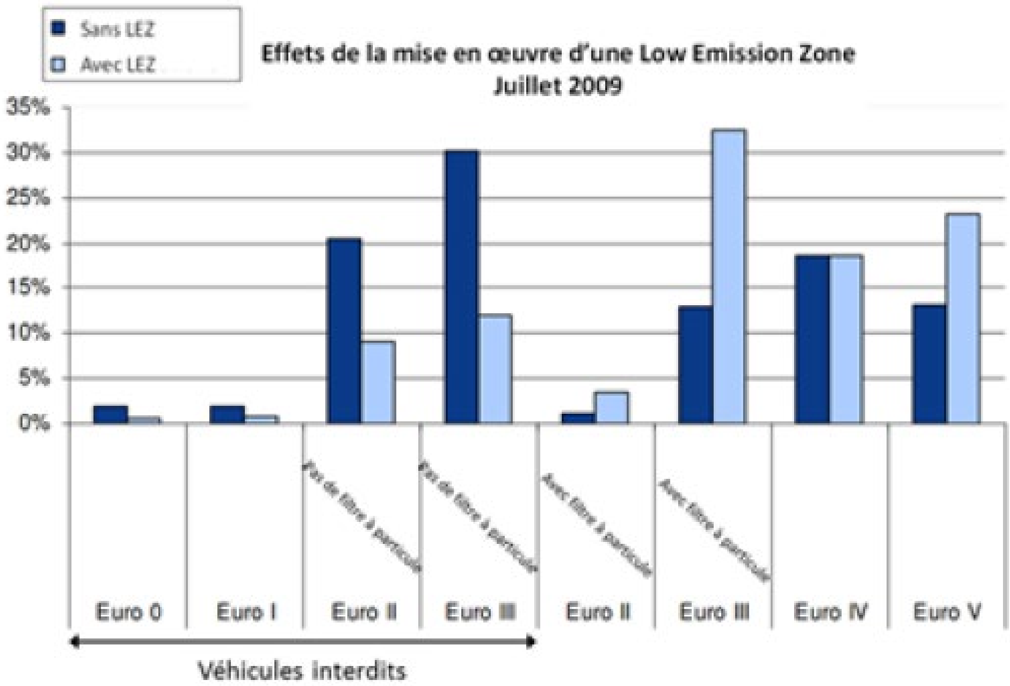



**Figure 26 - Composition of the park in and outside Dutch LEZs - Source: Buck Consultants International and Goudappel Coffeng (2009)**

According to an article by the Dutch Central Bureau of Statistics (Centraal Bureau voor de Statistiek,CBS) published in July 2017, the decrease in the number of old diesel vehicles is by far the most significant in Rotterdam and Utrecht compared to other cities in the country. Two municipalities have each introduced an LEZ in recent years for passenger vehicles, as well as a financial support program for the owners of vehicles affected by traffic restrictions. Since the beginning of 2016, a LEZ has been in force in Rotterdam for passenger vehicles. Between 1 January 2016 and 1 January 2017, the number of diesel vehicles prior to the Euro 3 standard almost halved (-45%), from around 3,200 to 2,200 vehicles (see figure below).

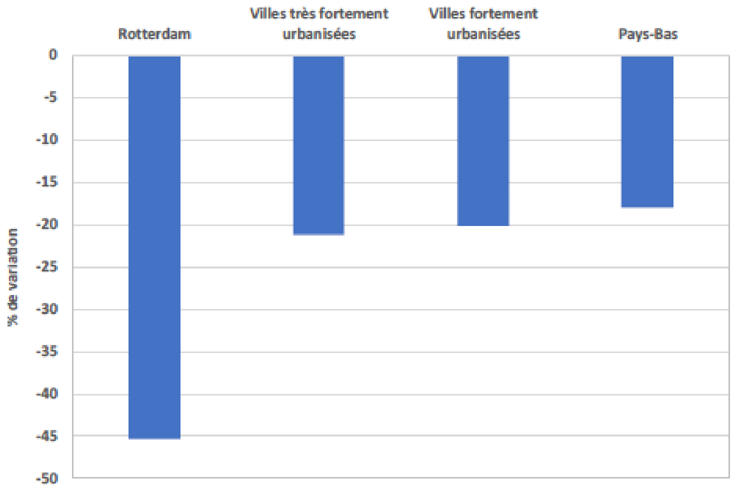



**Figure 82 : Variation de la part des véhicules diesel antérieurs à la norme Euro 3 entre 2016 et 2017**
Source : ADEME (données : CBS)

### Figure 27 – Decrease of number of Diesel vehicles 2016-2017 (LEZ Rotterdam)

By way of comparison, in the country's other highly urbanized cities, the number of older diesel vehicles decreased by 21% compared to the previous year. In the Netherlands, the average decrease between 2016 and 2017 is 18%.

In Utrecht, an LEZ for passenger cars was introduced in 2015 (traffic prohibited for diesel vehicles prior to Euro 3). In2014 and early 2016, the decrease observed on these vehicles is much greater than for other years and other cities in the country: about -40% between 2014 and 2015, about -35% between 2015 and 2016 (see Figure 28). Between 2016 and 2017, the decrease is less significant than the previous two years but is still -20%, up to the national average decrease. Thus, on 1 January 2017, the number of diesel vehicles prior to Euro 3 in Utrecht was the lowest of the four largest cities in the Netherlands. In Amsterdam and The Hague, there is still no LEZ for passenger cars. The number of older diesel-powered vehicles decreased in these cities at the beginning of 2017 by -24% and -20% respectively compared to the previous year.

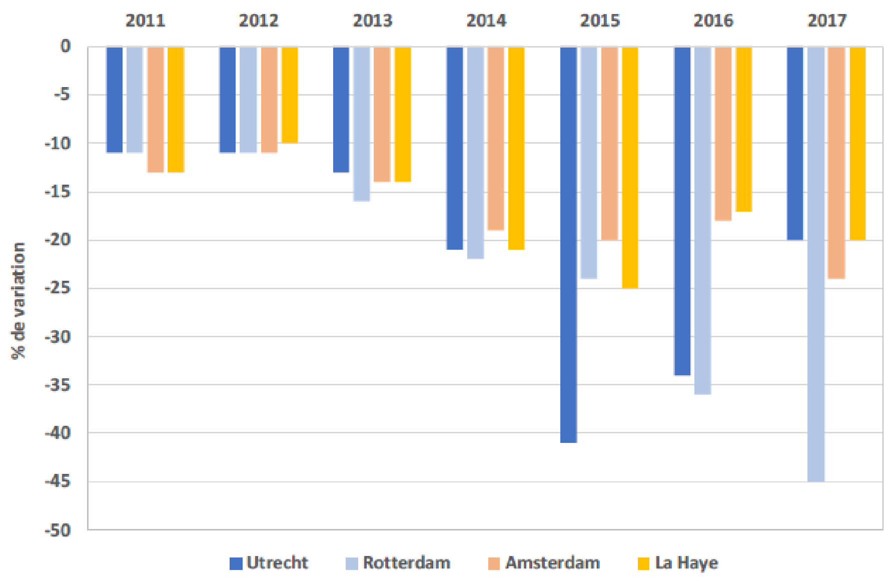



**Figure 83 : Variation de la part des véhicules diesel antérieurs à la norme Euro 3 par rapport à l'année précédente (période 2011 – 2017)**
Source : ADEME (données : CBS)

## Figure 28 – Impact of the Utrecht LEZ

**Germany - Berlin**

The Berlin Senate carried out an ex ante study of road traffic and the composition of the park following the establishment of the Low Emission Zone. This study shows that the LEZ does not really show a downward trend in the number of vehicles on the road. The sharp drop in traffic observed between 2007 and 2008 (as a reminder, the Berlin LEZ started in January 2008) is general and can be explained by the peaks in fuel prices and Berlin's transport policy to promote cleaner modes of transport.

On the other hand, the LEZ has had a clear influence on the modernisation of diesel vehicles.

Thus, in September 2010, euro 4 and euro 3 light diesel vehicles equipped with a particle filter represented 91% of the fleet, while the projection on the same horizon without an LEZ gave a rate of 49% for the same category of vehicle.

**Impacts on freight transport**

A study was conducted in 2011 by Danielis on the Milan Ecopass and brings results on the subject. The number of daily cargo vehicles in the Ecopass area was 13,040 before the introduction of the system, and 9,521 after. This means that the supply of companies and residents of the centre of Milan continued to take place (without any major problems identified) with 27% fewer vehicles. In addition, the number of alternative fuel or "zero-emission" cargo vehicles passing through the area increased from 92 to 1,089 during the period.

A study conducted by IFSTTAR as part of the RETMIF project between 2013 and 2015 had the objectives of understanding the extent to which the implementation of an LEZ influences and modifies the activity of freight transport. Of the three areas studied, the report concludes that the Low Emission Zone had no real impact on the number of vehicles circulated (car traffic in terms of volume). On the other hand, it has speeded up the renewal of the fleet of the vehicles concerned.

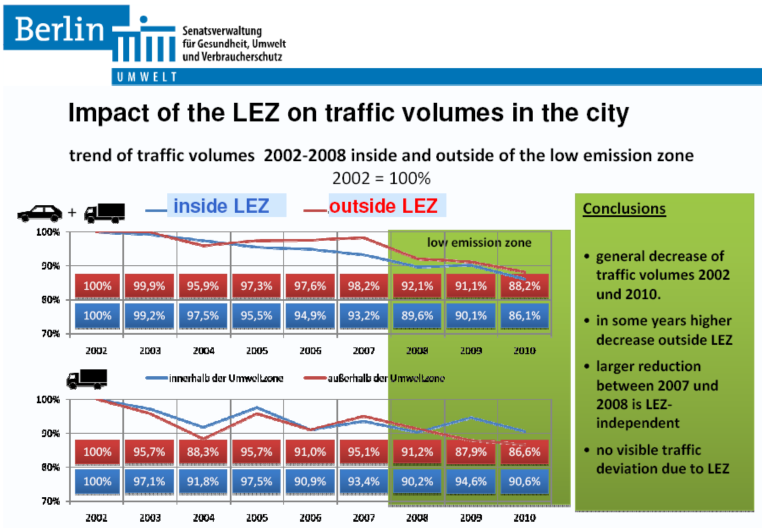



Figure 29 - Impact of the Berlin LEZ on road traffic (source: Berlin Senate)

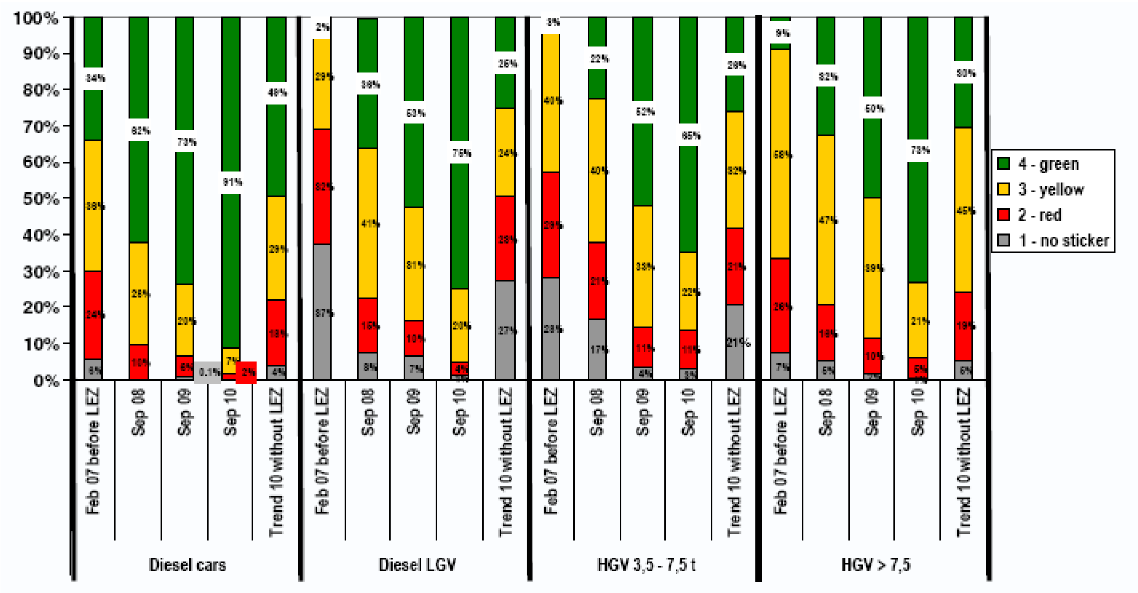
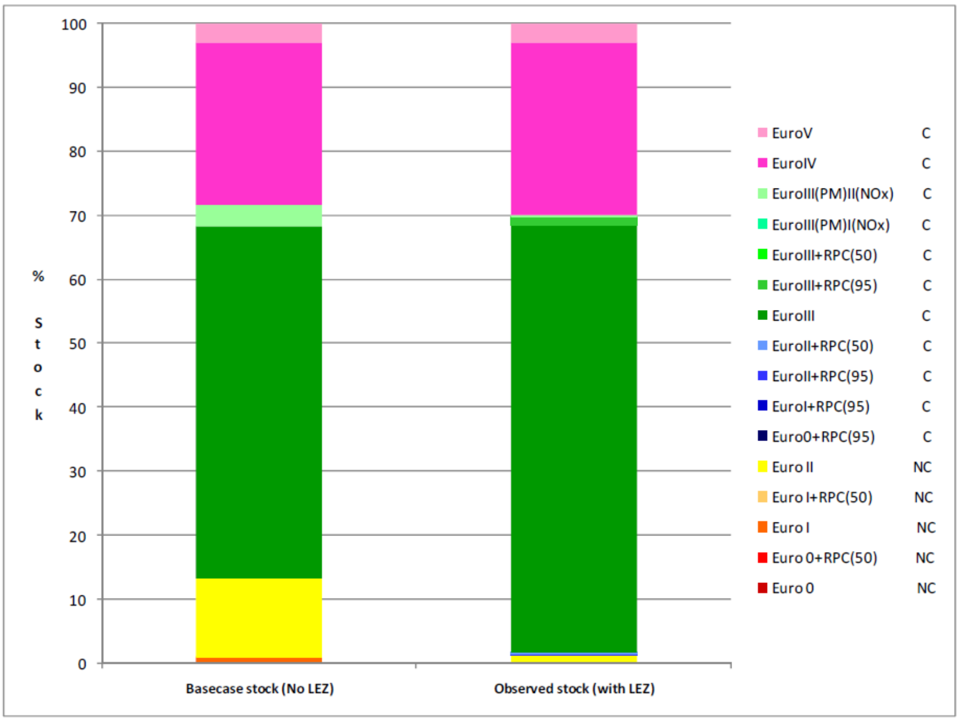



Figure 30 - Impact of the Berlin LEZ on the composition of the park (source: Berlin Senate)

### United Kingdom (London)

Transport for London studied the impact of the LEZ on the composition of the heavy goods vehicle fleet at the end of 2008 after a year of implementation of the first two phases of the London LEZ.




*Source: Kings College Environmental Research Group, based on data from TfL.*

### Figure 31 – Impact of the London LEZ on the composition of the heavy goods vehicle fleet

It can be seen that, in the absence of LEZs, on articulated heavy goods vehicles (Figure 31), 12% of vehicles would not have met the LEZ standard as it was at the end of 2008 (vehicles of Euro II or lower standards). With the introduction of the LEZ at the end of 2008, only 3% of vehicles did not meet the standards of the LEZ. The modernisation of the vehicles has taken place mainly in the form of the replacement of Euro II vehicles by Euro III vehicles.

A study published in 2013 shows continuity with the results at the end of 2008 concerning the modernisation of the heavy goods vehicle fleet. According to this study, the Low Emission Zone would have allowed 20% of heavy goods vehicles to switch to "cleaner" vehicles. In addition, vans over 1.3 tonnes, included in the LEZ since January 2012, seem to follow the same path as heavy goods vehicles with a reduction in the number of vehicles that do not meet the standards of the LEZ.[41]

## E.2 **HASKONINGDHV NEDERLAND B.V.,** Onderzoek effecten milieuzone Den Haag, 2019

### HDVs

Three years after the introduction of the environmental zone for freight traffic in 11 cities, a study has been carried out effects in practice (Goudappel Coffeng, Buck Consultants, 2010). The effects are based on the practical composition of truck parks (registration of registration plates) before and after the introduction of the environmental zone and model calculations based on those truck parks. It follows from the research that, by introducing the environmental zone, the number of vehicles that did not meet the admission requirements about 3 years after introduction had been halved (average picture the cities concerned). On average, 25% of the trucks observed did not comply with the admission requirements. Approximately 1/3 of these had an exemption (due to special vehicle or national or local exemption). The remaining 2/3 were in violation (about

[41] C Ellison, R.B., Greaves, S.P. & Hensher, D.A., 2013. Five Years of London's low emission zone: Effects on vehicle fleet composition and air quality. Transportation Research Part D 23, 25-33.

1 in 6 trucks). In cities where there was enforcement with cameras, the percentage of offenders is significantly lower (75% to 80% lower) than in cities where random checks were carried out by special investigators (boas). For the Amsterdam situation, it was found that the truck park did not become significantly cleaner as a result. More exemptions were applied for there. It has been concluded that enforcement and exemption were found to be communicating vessels.

**Passenger cars & LDVs**

Utrecht : After the introduction of the environmental zone for passenger and order traffic (1 January 2015), TNO carried out research into the effects (Eijk, Voogt, 2016). The survey shows, on the basis of registration tests before and six months after the introduction of the environmental zone, the share of diesel vehicles that are not allowed in the zone13 had decreased by 70% (vans) to 80% (passenger cars).

Rotterdam : After the introduction of the environmental zone for passenger and order traffic (1 January 2016), the municipality of Rotterdam and the environmental service DCMR carried out research into the effects (Municipality of Rotterdam, 2017). The survey shows, based on registration tests before and 11 months after the introduction of the environmental zone, that the proportion of vehicles that are not allowed to enter the zone had fallen by 75% (petrol vans or LPG) to 93% (passenger and van diesel). The number of registrations within Rotterdam of vehicles that are not allowed into the environmental zone has roughly halved after its introduction. This applies to both vehicles registered within the environmental zone and vehicles registered outside the zone.

**Traffic effects: external influence and transit**

In terms of traffic effects, radiance effects and reversing movements can be relevant. The effects have been calculated within the environmental zone. The environmental zone will also have an external radiance effect because traffic with an origin or destination within the environmental zone is become cleaner. Where this environmental zone-related traffic is outside the environmental zone, there will also be effects (less emissions). These radiance effects have not been included in this study.

## E.3 Institute of Transport Economics, "Low Emission Zones in Europe - Requirements, enforcement and air quality", 2018.

**London** (p.16)

Ellison et al. (2013) studied the effect of the London LEZ in the period 2001 to 2011 and found that the zone increased the rate of fleet turnover in the first years after the introduction. They also report on an overall increase in freight vehicles in London and more HDVs inside the zone. At the same time some of the freight increase resulted in change of vehicle types with more use of LCVs.

**The Netherlands** (p. 43)

The actual traffic volumes passing the measurement sites are lacking in both of these studies. Panteliadis et al. (2014) discuss the uncertainty related to changes in traffic volumes, and that their reported effect of the LEZ could have been biased by this. They also indicate a lack of monitoring stations outside the LEZ, that would allow for getting a better understanding of the role of background concentrations. It should also be noted that the street used in Panteliadis et al. (2014) is also not the same as in Boogaard et al. (2012) for Amsterdam.

For changes in vehicle fleets, a study from 2009 referred to in Ademe (2018) report on clear differences in fleet composition when comparing cites with and without a LEZ. Cities with LEZ have fewer old vehicles and more of the newest models.

TNO have studied effects of possibly including light commercial vehicles, taxis and coaches in the LEZ in Amsterdam (Verbeek 2015). TNO looked at the effect of banning commercial vehicles older than 2000 year models, only allowing coaches with at least Euro IV and taxis with at least Euro 5. With the proposed restrictions it was found that almost all vehicles will anyway be compliant in the planned year of implementation which was 2017, and hence the non-compliant vehicles contribute to only a small fraction of the total km driven. The extra effect of these possible new zone restrictions would be negligible.

### E.4 Matevž OBRECHT, Bojan ROSI, Tajda POTRČ: REVIEW OF LOW EMISSION ZONES IN EUROPE: CASE OF LONDON AND GERMAN CITIES, 2017.

**Low emission zone in London**

Since implementation was phasal, data about its success are not yet sufficient. However, many improvements were identified in recent years, such as the turnover of fleet for problematic vehicle classes. In the second phase (starting in 2012), light commercial vehicles became subject of the low emission vehicle scheme and it also showed similar effect – turnover of a fleet. Despite the growth in freight vehicles operating in London, the number of pre-Euro 3 vehicles has been decreased and switched from rigid vehicles to light commercial vehicles.

Key achievements obtained with implementation of a low emission zone in London are:

- Vehicle fleet change (people buying new produced cars with better environmental performance)
- Downsizing - turnover from heavy to light vehicles;
- Additional 20% drop in pre Euro 3 rigid vehicles in London (in comparison with areas outside LEZ);
- Additional 10% drop in pre Euro 3 LCVs in London (in comparison with areas outside LEZ);

# F Environmental Impacts Assessment: Approach

**A simplified simulation model has been developed to take into account the input data from the Baseline scenario and the relevant parameters for the specific analysis of the ZEZ policy measure. The data from the Baseline scenario is the reference to which the impacts of the Zero Emission Zones policy measure are compared.**

The following steps have been performed for the impacts assessment of the Zero Emission Zones policy measure, both for the reference scenario and the scenario with the implementation of the Zero Emission Zones policy measure. The difference between these two scenarios provides an estimation of the impact of the policy measure on the environment.


The above-mentioned successive steps of the process are detailed hereafter.

### Passenger and freight flows in city

The city/region of Brussels (*Région de Bruxelles-Capitale*) has been considered as the reference and starting point city. The following information is available for Brussels, which represents a clear starting point:

- City boundaries= NUTS3 boundaries
- Transport and population data available from the Baseline scenario and from specific studies for Brussels:
    - Population (current, forecasts)
    - Number of passenger trips per year (vehicle-km)
    - Number of freight trips per year (vehicle-km)
- The ZEZ policy measure and the timeframe for implementation are well defined.

It should be noted that the HGV and coaches will not be banned in the Brussels Capital Region in 2035, for several reasons, such as: lack of non-thermic alternatives, potential risk of transfer to LGV, length of trips. A scenario with a ban of HGV and coaches has however been developed in this study in order to have an exhaustive view of ZEZ without thermic vehicles in 2035 in accordance with the definition of the policy measure considered.

### Scale factor: SURE area

The approach selected is to proceed with the same evaluation for all the other cities concerned in the SURE area. As shown on the map presented in section A above, 53 cities[42] currently have more than 100.000 inhabitants in the SURE area. The objective is to globally estimate the impact of the implementation of a ZEZ in all the 53 cities identified. Specific situations that could occur in these cities concerning the introduction of a ZEZ have not been considered in this study. Then, a scale factor takes into account the population of these cities with reference to Brussels, and the forecasted growth of trips at different horizons (Transtools3 results for 2030, 2050). This has been performed at the NUTS3 level.

### Fleet by type of fuel

The composition of the fleet of vehicles by type of fuel is available from the Baseline scenario for passenger cars and freight/ commercial vehicles. The same data is considered for all the cities selected in the SURE area. The time horizons considered are 2010, 2030, 2050 (data from the Baseline scenario). The values for the intermediate years are calculated by interpolation.

### Evolution of flows

The "Evolution of flows" parameter has not been used as a scale factor for the policy measure, referring to the foreseen stability of the behaviours following the implementation of the policy measure, as mentioned in section E - Identification of expected behavioural changes.

### Evolution of vehicle-km by power source

The evolution of vehicle-km performed by power source has been calculated in function of the following parameters:

- Evolution of flows in the baseline scenario for the fleet of vehicles by type of fuel
    - Diesel/ Gasoline (only for passenger cars and LGV)/ ICE gaseous/ Plug in Hybrid/ Electric/ Fuel cell
- Evolution of flows according to the implementation of the ZEZ policy measure for the fleet of vehicles by type of fuel (same categories of fuel)

### Emissions of CO2, NOx and PM10

The emissions of CO2, NOx and PM10 have been calculated on the basis of the following parameters:

- Evolution of flows for the fleet of vehicles by type of fuel as mentioned above
- Unit values of emission factors presented in Section 2.2 of the report, expressed in:
    - gCO2eq/vkm
    - gNOx/vkm
    - gPM10/vkm

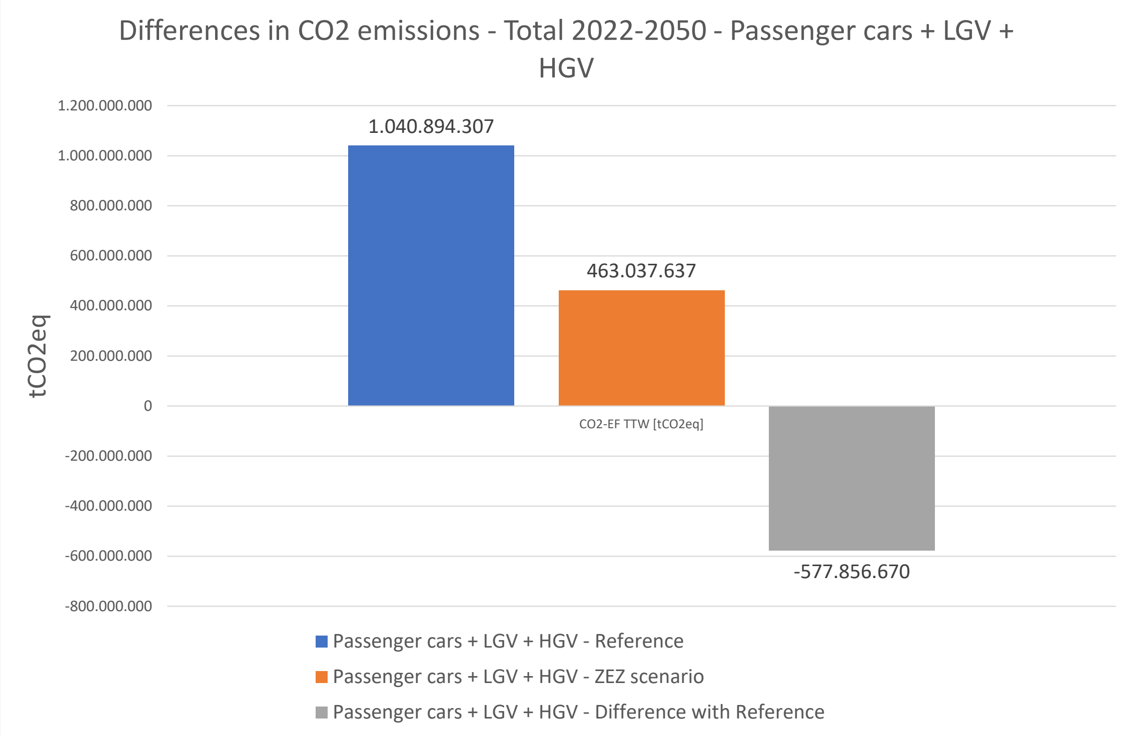
# G Environmental Impacts Assessment: Detailed Results

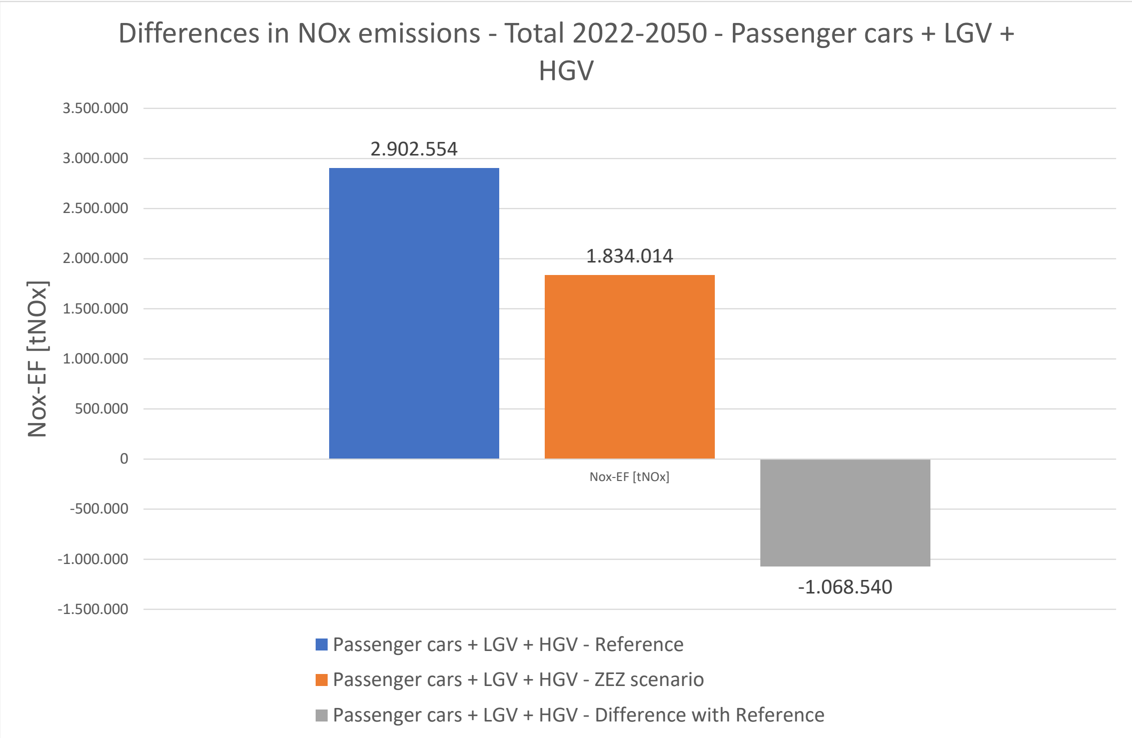
The difference between the reference situation and the situation with the implementation of the ZEZ policy measure in the SURE area provides an evaluation of the impact of the policy measure on the main emission

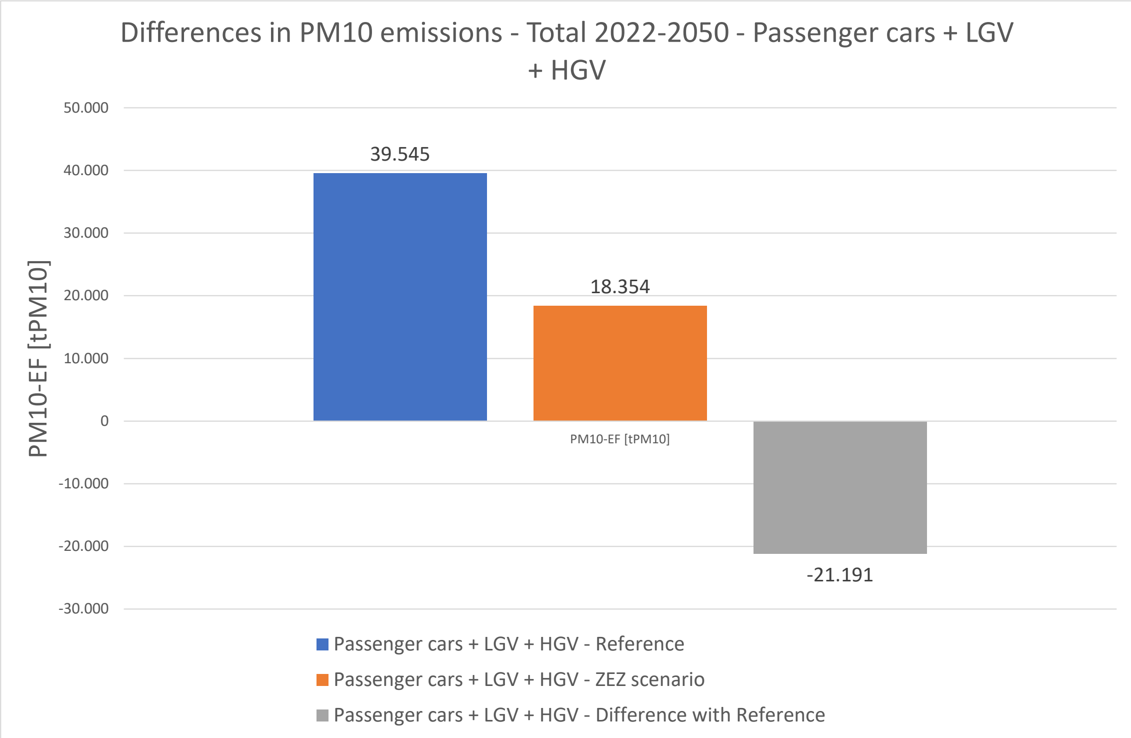
[42] In order to ensure a consistent approach at the SURE level, the sources of data used are Eurostat (Population 2017) and Transtools3 Baseline scenario (Population 2010, Forecasts 2030, 2050). The figures and forecasts provided in Transtools3 for the years 2010, 2030 and 2050 have been used for this study.

factors identified for road transport from the start of implementation of the policy measure (Assumed to be in 2022) until 2050.

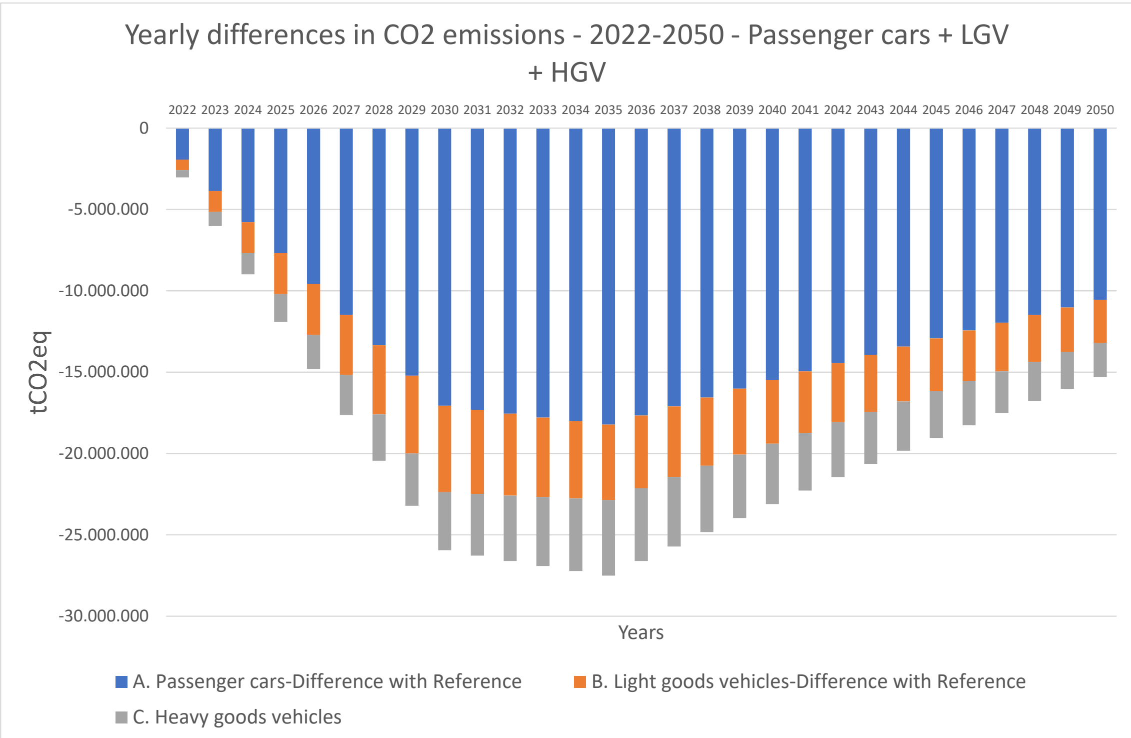
The scenario with a progressive ban of the passenger cars, LGV, HGV and coaches by 2035 has been analysed. It provides the following results.

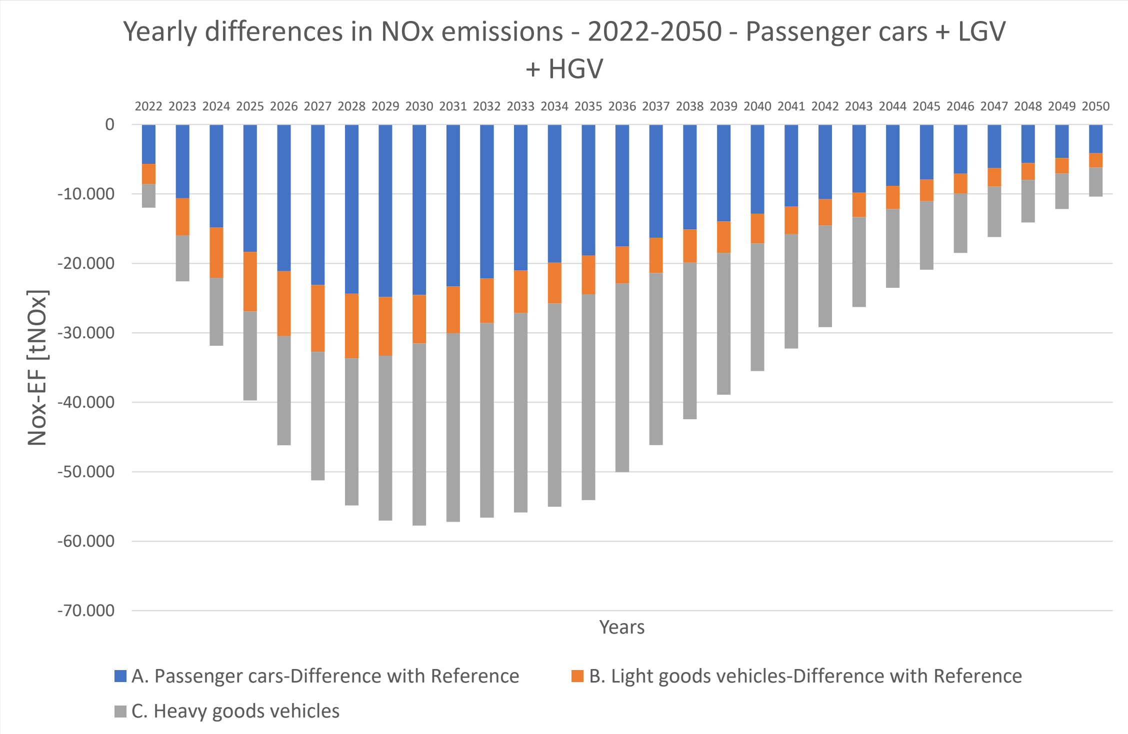


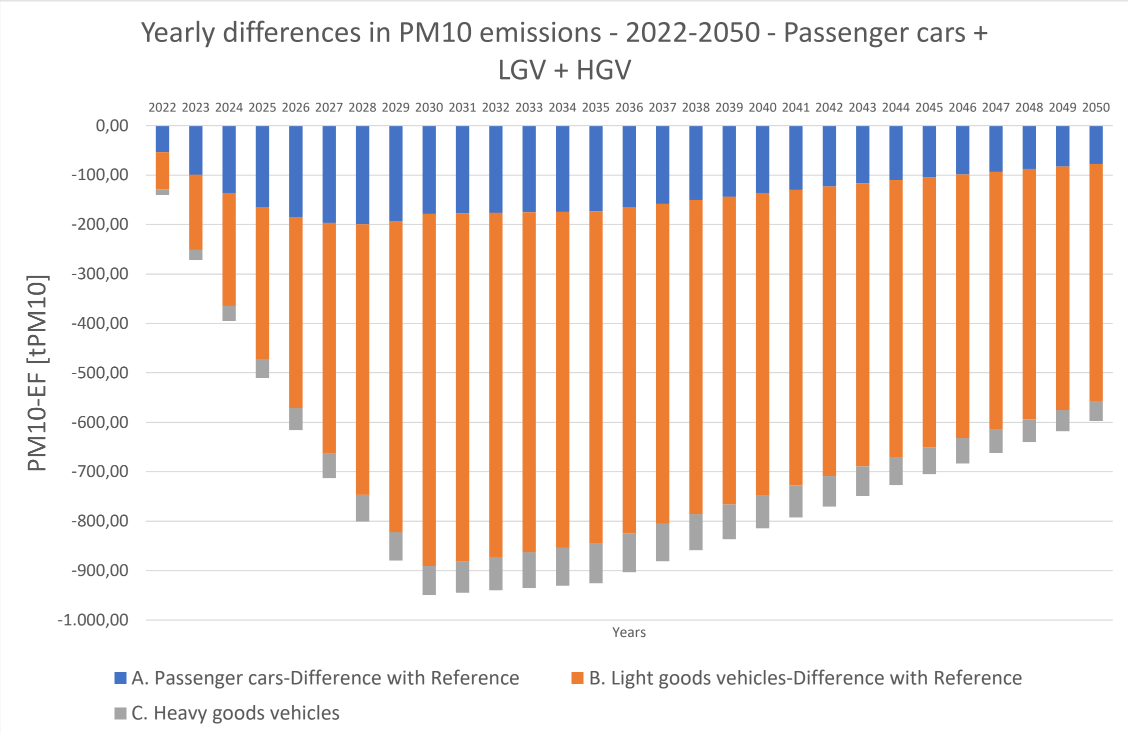






The yearly results (reductions of CO2, NOx, PM10 emissions) of the introduction of ZEZ in the SURE area for the 2022-2050 period are presented in the following graphs.




Yearly differences in NOx emissions - 2022-2050 - Passenger cars + LGV + HGV
2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
0
-10.000
-20.000
-30.000
-40.000
-50.000
-60.000
-70.000
Nox-EF [tNOx]
Years
A. Passenger cars-Difference with Reference
B. Light goods vehicles-Difference with Reference
C. Heavy goods vehicles


Yearly differences in PM10 emissions - 2022-2050 - Passenger cars + LGV + HGV
2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
0,00
-100,00
-200,00
-300,00
-400,00
-500,00
-600,00
-700,00
-800,00
-900,00
-1.000,00
PM10-EF [tPM10]
Years
A. Passenger cars-Difference with Reference
B. Light goods vehicles-Difference with Reference
C. Heavy goods vehicles

The results for the single years 2030 and 2035 are presented in the following table for passenger cars, LGV, HGV and coaches.

| Difference with reference | 2030 | 2035 |
|---|---|---|
| CO2 emissions | -80,5% | -100% |
| NOx emissions | -75,4% | -100% |
| PM10 emissions | -91,4% | -100% |

# H Possible Social Impacts

The relationship between social inequalities and air pollution is threefold: inequalities in terms of (i) exposure to pollution, in terms of (ii) vulnerability, and in terms of (iii) contribution to pollution.

- **Exposure to pollution.** Disadvantaged people are often the most exposed to air pollution, as they tend to live in areas where traffic is denser, resulting in higher levels of air and noise pollution[43,44,45]. These inequalities in exposure are not only observed at the local level, but also at the regional scale, as shown in a report released by European Environment Agency (EEA) in 2018[46]. The EEA identifies several factors explaining this increased exposure of lower socio-economic group to air pollution, including city planning, housing and employment markets, professional exposure, or general under-participation of vulnerable groups in decision-making processes.
- **Vulnerability.** It is widely acknowledged that disadvantaged people are usually more vulnerable to the impacts of air pollution. Socio-economic status is indeed an important determining factor of the population health status: the combination of poor housing conditions, a low-quality diet, reduced access to health care and a high level of stress results in an increased vulnerability to environmental risks, including air pollution[47].
- **Contribution to air pollution.** Disadvantaged population groups are often those less contributing to transport-related air pollution, due to a lower motorization rate, and a lower number and range of travels[48].

We can conclude from the three aforementioned inequalities that if improving air quality will benefit all population groups, disadvantaged people will generally be more positively affected as the largest benefits will be observed in areas where the air quality is worst. As a consequence, policy makers should ensure that measures implemented to improve air quality can contribute to address social inequities or, at least, do not exacerbate them.

### *ZEZs and social inequalities*

Although vehicle owners from all socio-economic groups are theoretically affected by traffic restriction measures, some specific population groups will generally be more affected because of their greater vulnerability. It is important to note, however, that these profiles cover a wide variety of situations and that the actual impacts for these individuals will depend on many factors.

[43] Barnes, J. H. et al. (2019) «Emissions vs exposure : Increasing exposure from road-traffic related air pollution in the UK». *Transportation Research*, 73, 55-66.
[44] Paavola J. (2017). «Health Impacts of Climate Change and Health and Social Inequalities in the UK». *Environmental Health*, 16(113), 61-76.
[45] Padilla C. et al. (2016). «City-Specific Spatiotemporal Infant and Neonatal Mortality Clusters: Links with Socioeconomic and Air Pollution Spatial Patterns in France». *International Journal of Environmental Research and Public Health*, 13(6) 624.
[46] EEA (2018), *Unequal Exposure and Unequal Impact: Social Vulnerability to Air Pollution, Noise and Extreme Temperatures in Europe.*
[47] EEA (2018).
[48] Jouffe et al. (2015). « Faire face aux inégalités de mobilité ». *Cybergeo : European Journal of Geography*.

However, the literature shows that people with lower incomes (with the exception of very low-income households, generally very little/not concerned), more specifically those with certain profiles such as the elderly, people with disabilities, people who have to go to hospitals regularly and people who have to travel at night, are generally those experiencing the largest difficulties to comply with urban access restrictions measures.

Cost incurred by the implementation of a ZEZ, especially for disadvantaged population groups, should be assessed and weighted against health benefits to ensure these do not increase social inequalities and, when deemed necessary, to identify and implement accompanying measures to mitigate adverse social impacts.

# I Possible Benefits of Harmonisation[49]

A COWI & Ecorys study[50] concludes that standardisation and harmonisation of several aspects might have substantial efficiency and cost savings benefits.

Under a full harmonisation model, the financial impact could be significant, in particular to freight transporters in terms of vehicle logistics (the COWI Ecorys study refers to comparatively small benefits for passengers – except for employees that frequently visit LEZ in different cities, such as salesmen – as it "becomes easier to find and obtain all relevant information and also passenger cars can be applied more efficiently").

However, these savings may not materialise if a move to full harmonisation is deemed impractical or politically unacceptable. But even under partial harmonisation (e.g. of vehicle emission classes for defining LEZs, standards for sticker design/information and the creation of vehicle databases) could still lead to savings. For users, the main benefits of partial harmonisation would concern administrative compliance related costs. These could include lower retrofit certification costs, opportunity costs (resulting from less time spent registering and finding out about different LEZ rules) and other administrative costs relating to LEZ charges (e.g. stickers). The possible savings depend on the extent to which the various LEZs would like to harmonise their activities.

What would be therefore recommended is a harmonised framework that, without ultimately constraining local choices, would ensure such choices are appropriately informed and that they would be based on consistent and comparable criteria, while aiming to reduce costs for public authorities, companies and individual users.

Possible benefits of harmonisation are:

- **Time and operational costs** in order to find and obtain all relevant information for more than one low emission zone may significantly decrease.
- The **fleet of service providers may be more efficiently applied**:
  - Planning of delivery becomes easier as exchangeability between the vehicles will increase (efficiency improvement);
  - There may be economies of scale for providers as the required types of goods vehicles may decrease. The fleet composition becomes more efficient. For example, a provider can handle its operations with 5 types of vehicles (specific environmental performance and fuel type) instead of 10 types of vehicles;
  - The fleet can be more efficiently used. Fewer vehicles may be required (lower operational costs).
- **Economies of scale savings for manufacturers of charging and payment technological devices**;
- **Lower operating costs for logistic service providers and other road users** as a result of mainstreamed design requirements for vehicles (via economies of scale for car manufacturers, although this assumes environmental technical standards to be a key determinant of manufacturing choices);
- **Positive impact on "the image and the business climate of (in particular) inner-cities"**. "In the present situation companies may be deterred by the different schemes in use and the unpredictability of possible adaptions. Harmonisation may lead to more consistently applied access

[49] Ecorys, Feasibility study : European City Pass for Low Emission Zones, 2014.
[50] COWI & Ecorys. (2013). Study to support and Impact Assessment of Urban Mobility Package - Activity 32: EU Framework for Urban Road User Charging and Access Restriction Schemes. European Commission, DG MOVE;

restriction schemes and also to greater predictability. This can contribute to the business climate and functioning of inner-cities in general";

- Potential reductions in the number of vehicles and vehicle-kilometres, thus resulting in **external benefits, such as lower emissions, lower noise, improved road safety**, etc. However, "some cities could benefit of harmonisation, others may not";
- **Greater citizen acceptance**;
- Uniform **requirements and procedures are easier to adapt to**;
- Increases **transferability of information and best practices**;
- Facilitate **development of innovative approaches** with wider applicability;
- **Help cities to efficiently implement LEZ**.

A table summarizing possible areas for harmonisation is presented below.

# J Possible Areas of Harmonisation

| | Advantages | Disadvantages |
|---|---|---|
| **1. LEZ planning and Implementation** | | |
| **Criteria defining LEZ:**<br>- **vehicle exclusion criteria based on technical criteria e.g. Euro emission classes;**<br>- **vehicle inclusion criteria e.g. vehicles equipped with particle filters, electric cars etc.;**<br>- **high-emitting vehicles;**<br>- **regulation criteria based on charging in relation to emissions.** | - maximum use of existing knowledge and experiences;<br>- preventing cities from pitfalls;<br>- cost and time savings for users and suppliers. | - subsidiarity issue;<br>- costs for adjusting existing local practices exclusion / inclusion criteria:<br>- no legal context / base;<br>- cannot be more specific than using Euro X standards;<br>- tension between overall mobility and air quality (for example old but full buses). |
| **Signage (road signs at LEZ boundaries and approach roads to LEZ).** | - cost savings design;<br>- service for the users (recognition). | - costs for adjusting existing local practices;<br>- subsidiarity aspect. |
| **Legal requirements (local, national, EU).** | - efficiency gains through harmonisation | - subsidiarity issue |
| ***2. Administration*** | | |
| **Procedure to obtain permits including applications for exceptions.** | - cost and time savings for users and cities | - how to deal with occasional / foreign visitors;<br>- to be sent by post ??<br>- It has to be determined which Euro class the vehicle is type approved into. This implies making available the conformity certificate to the authority or organization that issues the sticker. |
| **Rules for the approval, verification and certification of aftertreatment or retrofitting devices for older vehicles (particle filters, catalysts, etc.) to meet a higher EURO emission standard.** | - cost and time savings for users, suppliers and cities | - costs for adjusting existing national/local practices;<br>- subsidiarity aspect. |
| **Method of payment, if any (interoperable fare management, such as the European Electronic Toll Service, EETS).** | - cost and time savings for users and cities | - costs for adjusting existing local practices;<br>- very subsidiary as with parking and traffic subsidiarity aspect;<br>- how to deal with occasional / foreign visitors;<br>- uniform system difficult: Annual fee? Per entry fee? Link to actual km driven / pollution? |
| ***3. Information systems*** | | |
| **e-Reporting and database notification.** | - cost and time savings for cities;<br>- guarantee that the relevant info on LEZ's is up to date and reliable. | - costs for adjusting existing local practices;<br>- subsidiarity aspect. |
| **Information systems and services, including:**<br>- **translation;**<br>- **best practices and harmonization;**<br>- **information for users on LEZ status and requirements;**<br>- **real-time "mobility data" openly accessible to public and commercial users.** | - useful tool for cities, to set up and implement the LEZ scheme in the most efficient way | - costs for adjusting existing local practices;<br>- subsidiarity aspect;<br>- Stickers should be graphical (shapes, icons, colours) so that no translation is needed;<br>- Information campaigns must be set up to inform citizens. Without harmonisation, there is a threat that it will lead to an enormous confusion. |

# K Specific recommendations related to National legal frameworks[51]

- It is important that any national legal framework accounts for enough flexibility allowing cities to tackle their differing problems arising from different fleets and at the same time avoid stifling the possibility for innovation to produce new good practice schemes.
- Whether national legislation is formulated from a 'top down' or 'bottom up' perspective may determine how effective it will be in facilitating UVAR schemes in cities/regions within its national boundaries. An optimum combination could be one that reflects significant city/region input, European legislation and non-binding guidance, drawing on examples of good practices in Europe.
- It is important that national frameworks concerning UVARs schemes are designed in a transparent way, addressing all citizens and reflecting all stakeholder's views, thereby mitigating scepticism.
- National legislation should be clearly linked to EU and national policy goals in the fields of for instance air pollution or CO2 emissions. When under design, a national legal framework should clearly state the goals it is pursuing.
- Such legislation should give guidance to cities on how to establish sustainable mobility alternatives. In particular, when schemes create revenues through e.g. congestion charges, national legislation could encourage cities to invest these in sustainable modes of transport.
- National legislation should be written in such a way to include common issues which might apply to all UVARs schemes. An example might be legislation that is drafted to include general reference to issues that could be applied to any prospective UVARs in the country (e.g. types of vehicles exempt from any UVARs charge, classifications of road that could be included in UVARs scheme, emission levels of vehicles to which a UVAR charge might apply etc.) where possible.
- Before the design of a UVAR, a national legal framework should include provisions that allow a scheme to be subject to a utility test before its introduction and throughout its implementation to ensure its effectiveness and acceptability. In other words, the necessity for the envisaged regulations should be measured to justify the appropriateness to contribute to solving the identified problems. The decision should be supported by a proper impact assessment including the environmental as well as economic and social impacts of the proposed measures on the local economy and businesses.
- A national framework may include provisions and recommendations relating to the necessity to carry out a consultation process prior to the possible introduction of UVARs at local level which could involve commercial road transport industry and relating to timely information about such regulations to the commercial road transport operators.
- National governments could also consider the creation of a permanent national consultation and advisory group to regularly review UVARs and recommend actions to enhance best practice exchange and the participation of private sector stakeholders, including business stakeholders, in its activities.
- The evolution of vehicle technologies may bring additional challenges that should be taken into account when designing the legislation. This means that the future of a UVAR should be reconsidered in the light of the development of new technologies.

[51] PwC, Study on Urban Vehicle Access Regulation – Final Report, European Commission, Directorate-General for Mobility and Transport, 2017.

**Possible roles and responsibilities for the implementation of a national legal framework**[52]

| | |
|---|---|
| National government | • National analysis of UVARs impact and cost benefit analysis;<br>• National urban air quality legislation and mobility strategy;<br>• UVARs national legislation, including:<br>- Legal basis for municipalities to establish UVARs<br>- Definition of LEZ pollutant emission classes and sticker design<br>- National schedule for UVARs phases<br>- Definition and criteria for UVARs vehicle exemptions<br>- Retrofit approval scheme based on UNECE REC Regulation<br>- Incentives and complementary measures to support UVARs implementation<br>- National system for sale of stickers and approval of exemptions<br>• National UVARs database and website<br>• National vehicle database with emission characteristics and exchange of vehicle data with other participating countries<br>• New Retrofit certification (which should comply with UNECE REC retrofit standards)<br>• Nominate the competent authorities for<br>- Issuing of stickers and exemptions<br>- Type-approval, installation and inspection of REC devices and<br>- Identification of emissions standards for national vehicles.<br>• Capitalise on national stakeholder and interested parties' discussions. |
| Local government | • Information to the public and stakeholders, both at city and national level as well as EU websites<br>• Local stakeholder and public consultation and participation<br>• Local UVARs air quality assessment, impact assessment and cost-benefit analysis<br>• Local air quality management plan (Air Quality Directive), consistent with national air quality strategy<br>• Sustainable urban mobility plan (SUMP)<br>• Decision on which vehicle types are regulated (HDV, LDV etc.)<br>• Timescales<br>• UVARs boundaries and exempted routes (transit, port, airport)<br>• Enforcement method and infrastructure<br>• Information to the public and stakeholders<br>• Signage compliant with national standards<br>• Monitoring and ex-post evaluation of UVARs effectiveness and cost-benefit. |

[52] PwC, 2017. Elaboration on COWI-ECORYS (2014) Feasibility study: European city pass for low emission zones. Annex A: Standards and Guidance Document. European Commission, DG Environment.

# Annex 4. Potential of MaaS: Overview of Emissions for Car and Rail Transport

**Table 19 Emissions expressed in ton per year for both MaaS scenarios.**

| **Emission factors MaaS** | | **CO2 TTW** | | **Energy** | | **CO2 WTT** | | **PM10** | | **Nox** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| Scenario 1 | Car | 56763 | 30744 | 923 | 703 | 20322 | 11197 | 1 | 0 | 70 | 12 |
| | Rail | | | 2 | 1 | 51 | 0 | | | | |
| Scenario 2 | Car | 55893 | 27261 | 909 | 624 | 20010 | 9929 | 1 | 0 | 68 | 11 |
| | Rail | | | 2 | 3 | 65 | 0 | | | | |
| Baseline | | 56480 | 29849 | 918 | 683 | 20220 | 10871 | 1 | 0 | 0 | 0 |
| | | | | 2 | 1 | 51 | 0 | | | | |

# Annex 5. Roundtables Policy Measures

Several stakeholders that might have interesting views or could share insights regarding the implementation of the policy measures were invited to do so in a stakeholder consultation, a ‘Roundtable’. The initial idea of gathering stakeholders around ‘physical round tables’, per STISE corridor (Rhine-Scheldt, Rhine-Waal, Brussels-Lille), was abandoned throughout the study process. The policy measures that were selected and studied in this project are not particularly corridor-specific – at the level they are assessed here. Consultations of stakeholders per measure were more relevant and useful. In addition, the circumstances necessitated online sessions.

| Policy Measure | Date & type of consultation stakeholders | Invited stakeholders |
|---|---|---|
| **Aviation Shift - HST** | Online stakeholder consultation on 23/09/2021 | Representatives of the 4 main Airport Authorities on short flying distance in the Eurodelta, representatives of the 3 HS providers, representatives of the four infra providers in the Eurodelta countries and some representatives of (regional and local) public authorities in the Eurodelta. were invited, more in particular: Brussels Airport, Schiphol, Düsseldorf Airport, Infrabel, TUC RAIL, ProRail, Deutsch Bahn, NVR |
| **ZEZ** | Given the very low response rate to the request and/or low availabilities to participate in an online meeting, an online survey was launched to give the identified stakeholders the opportunity to provide input.<br><br>Online survey Oct-Nov. 2021 | Representative of some (local, regional and national) authorities, city associations, representatives of the automotive industry and NGOs/environmental organisations in the SURE area were invited, more in particular: SPF Mobilité et Transports/ FOB Mobiliteit & Transport, SPW Wallonie, Vlaamse Milieu Maatschappij, Ministère de la Transition Écologique (Bureau de la Qualité de l'Air), Direction Régionale de l'Environnement, de l'Aménagement et du Logement (DREAL Hauts-de-France, a regional French governmental unit of MTE), ADEME - French ecological Transition Agency, Ville de Lille, France Urbaine, German Federal Environment Agency (Umweltbundesamt), Deutsche Städtetag, Febiac, Chambre de Commerce et d'Industrie Grand Lille, CNPA, Verband der Automobilindustrie, Greenpeace (BE, FR & EU), Réseau Action climat |
| **Exploring MaaS** | Online stakeholder consultation on 6/10/2021<br><br>ITS World Congress in Oct. 2021 | Different mobility service providers (in 3 countries) were invited, more in particular: Kyyti, Tranzer, NS<br><br>Furthermore a visit to the ITS World congress in Hamburg was used to exchange thoughts on this with MaaS providers, public authorities, public transport providers; more in particular: Deutsche Bahn, Volkswagen (Moia), Whim, Rijkswaterstaat. |
| **Improving cross-border rail** | Online consultation 9/11/2021 | With focus on the cross-border part of the Rhine-Waal corridor between the Netherlands and Germany, Regional authorities, regional associations and network operators from the Netherlands and Germany were invited, more in particular: Deutsche Bahn Regio, Deutsche Bahn Netz, ProRail, NS, Arriva, Province of Gelderland, Regionalverband Ruhr, Metropolregion Rheinland |

# Annex 6. Corridor Rhine-Scheldt

## A. Rhine-Scheldt Corridor Bottleneck Study

| Main bottleneck | Details |
|---|---|
| Freight by rail: high risk of some cargo (flammable liquids) that passes through cities (e.g. Rotterdam), safety issue | Block trains as a solution? What about the ROBEL-line (R'dam-A'pen) from some years ago? This idea was not on the political agenda anymore (too expensive, Ports of Antwerp and R'dam did not want it, too little capacity…, not in line with the policy to not add extra infra…) |
| Transport at the range of 250-300 km is dominated by passenger transport by car due to the lack of reliable and time-competing rail connections on this corridor… | Is or isn't a real issue? Cross-border: The infrastructure is present but underused: too expensive? Not a good service? Could be better and faster, but is it as competitive as the other means? Instead of building new infra, go for the ambition to develop one integrated system for PT-transport? |
| More than other corridors, this corridor is a dense urban area. Most issues in this corridor are IN-city and not BETWEEN-cities. | |
| Big cities are not able to facilitate car traffic more yet. Further broadening of motorways is running up against spatial and safety limits. | Possible solutions are stricter parking policies and facilitating shared mobility by mobility hubs… but this is an issue of levelled playing field: ALL cities need to tackle this the same way (same policies) |
| Exchange of information (BE-NL) should be better | (e.g. for the modal shift), although this is better than before e.g. Contract "Vlaams-Nederlandse Delta" ("havenmonitor") |
| The city of Den Haag is particularly interested in the "sustainable side" of transport, Urban mobility, cross-border connections, logistics, connections at the person level | The city is not enough connected to the rest of the corridor (e.g. A'dam, R'dam); also, there are barriers in the cross-border (rail) connections to e.g. Antwerp, Brussels (low level of services). Not necessarily more rail infra, more trains ("hardware") are the solution, but the '"orgware" of the rail ("how we do it with each other?") should be looked into |
| More sustainable mobility in a very dense area in Europe | Making mobility more sustainable is one of the greatest challenges, where not only technical solutions must be put forward: spatial policy as a facilitator and governance (cooperation) is very important – e.g. improved cooperation between ports (making the port function and logistics more sustainable) |
| The climate challenge, energy transition, as well as circular economy are crucial | These will/can have a huge impact on e.g. the functioning of ports |
| Extra rail capacity | The Ghent-Terneuzen area needs extra capacity for freight transport by train. This is crucial for the ports (North Sea Port and Antwerp), and by extension for the entire region |
| Potential impact of big infra-projects | There is a lot of uncertainty about the (size of the) impact of the many large infrastructure initiatives (ECA (extra container capacity in the port of Antwerp, Oosterweel (Antwerp), Waasland port) on the traffic flow. This impact can be enormous on the North Sea Port region - sufficient rail capacity? The ongoing Rail Ghent-Terneuzen Project is a priority, in order to have a solution that is safe (double in and out) and sustainable (no lasting conflict between 2 sustainable modes water and rail). It is still a challenge to connect with the N-Z Corridor (towards the Mediterranean). |
| Sustainable development of scarce land | In contrast to other ports in the region (Antwerp, Rotterdam), the NSP has an important and considerable strategic stock of land that can still be developed. This can only be done once, and sustainability should be strived for: the right companies with the right modal shift must be attracted |

| Main bottleneck | Details |
|---|---|
| Toll (collection) | There should be a more (EU) integrated policy on tolling, given the impact of toll collection |
| The potential of the CUST (Clean Underground Sustainable Transport) project | In the cross-border port area of North Sea Port, research was conducted into the possible roll-out of a large-scale pipeline infrastructure for the transport of CO2, hydrogen, synthetic naphtha and heat. These pipes are important in order to reduce the annual CO2 emissions in the port area of almost 22 million tons in the next 5 to 30 years. And to realize the transition to a climate-neutral industry by 2050, in accordance with the goals of the Paris climate agreement. The study provides a number of recommendations for achieving this. |
| Inland waterways | NSP is the "port of Paris" ... provided that bottlenecks are removed from the SS project |

# B. Transport Flows in the Rhine-Scheldt Corridor

The Rhine Scheldt corridor is characterized by large flows of freight between the two major harbours Rotterdam & Antwerp. The freight modalities Inland Waterways & Road are the main forms of transport, next to (out of scope of the baseline scenario) short-sea shipping and intercontinental sea transport. Rail is mainly serving as a feeder to either port, but not as a connection between the two ports.

To make these characteristics more concrete two figures have been generated displaying the absolute ton km in 2030 for internal transport and internal – external v.v. transport for the corridor. A separation has been made per modality and the type of goods. From these graphs it can be seen that for internal transport within the region IWW has a strong position regarding container transport. But it also takes up the majority of the dry and liquid bulk showing the importance of this modality for the corridor. If we compare this to the transport coming in and out of the corridor road takes a larger share of the container transport and rail overtakes IWW as major modality for liquid bulk.

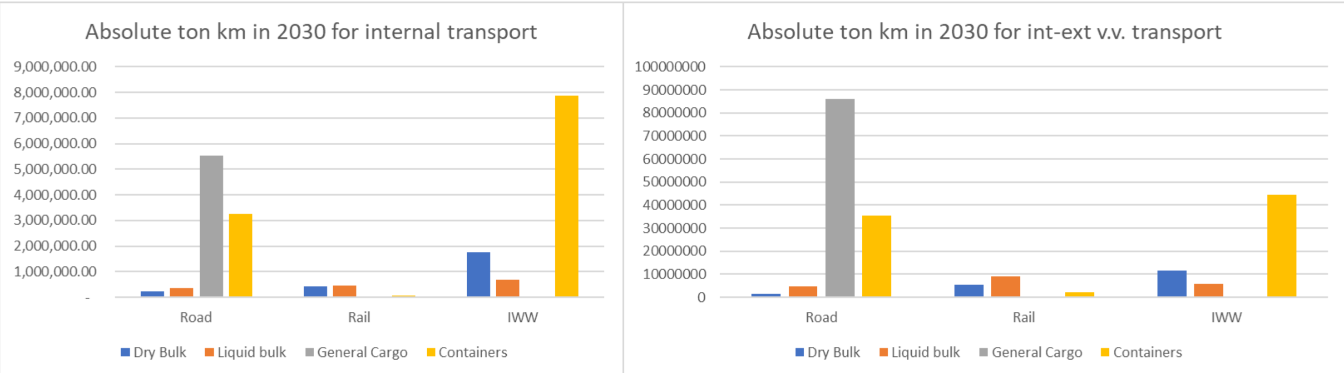



**Figure 32 - Absolute ton km in 2030 for internal transport and internal – external v.v. transport for the corridor Rhine-Scheldt**

# C. The Policy Measures in the Rhine-Scheldt Corridor

**Aviation shift**

- One has already decided for an extension/new rail tunnel underneath Schiphol Airport for local/domestic reasons. But in order to meet the shift demands towards/from the UK there is a further need to expand the station with customs facilities and baggage logistics.
- The existing HST station of Antwerp CS has to be upgraded too with customs facilities in order to receive Eurostar trains and meet the needs of UK travellers.
- The same goes for the station Brussels National Airport; this station has to be extended with two tracks in order to serve as a HST stop.
- The North-South rail tunnel underneath Brussels is already a major bottleneck in as well the domestic and international rail services. On the short run there is a need to optimize operations through a mix of

systems improvements, harmonisation of train paths and circulation measures. On the long run there is a need for an extra tunnel between Brussels North station and Brussels Midi.
- Station Brussels Midi needs to be upgraded with two platforms in order to meet the extra HST Rail demands.
- The Eurotunnel has to be extended with two rail tracks. In fact this is already needed in the present situation.

**ZEZ in all major cities in SURE**

The ZEZ policy measure concerns cities in the SURE area. Indirectly, this measure would also have an impact on the corridors, as a growing volume of ZEV would also travel on the corridors as a result of the implementation of ZEZ in the cities located on the corridors.

**Potential of MaaS**

The necessary infrastructure investments related to **MaaS** are supporting the further use of the rail network and thus rail as an improved means of transport between the cities connected to this corridor.

**Improving regional cross-border train transport**

For passenger transport the corridor combines a high speed rail network with two main motorway arteries, the A16 / E19, which is complimented by the A4 / A12. The high speed trains provide further connections to larger metropolitan areas within the rest of the Eurodelta and beyond (e.g. Paris, London, etc.). Air transport is not a key modality but it’s noteworthy that Amsterdam Schiphol airport next to Zaventem serves as a major hub for both Dutch & Flemish travellers.

In this corridor regional cross-border rail services could be improved for the following two sub-corridor:.

- Sub-corridor D: Rotterdam (NED) with Antwerp, Gent (BEL);
- Sub-corridor E: Lille (FRA) with Kortrijk (BEL).

Both sub-corridors have existing rail connections which could be upgraded for cross-border services. The main bottleneck seems to be lacking in common policy. Stakeholders at both sites should develop a common vision.

# D. Recommendations for the Rhine-Scheldt Corridor

*From the transport flows we can see that there is already a good usage of other modalities for freight transport on the corridor. Further optimization and for example more focus on intermodality (using more than one modality during transport from origin to destination) could help modal shift to occur away from road transport*

*Add the recommendations from the policy analysis (see § above) and the policy roadmaps*

# Annex 7. Corridor Rhine-Waal

## A. Rhine-Waal Corridor Bottleneck Study

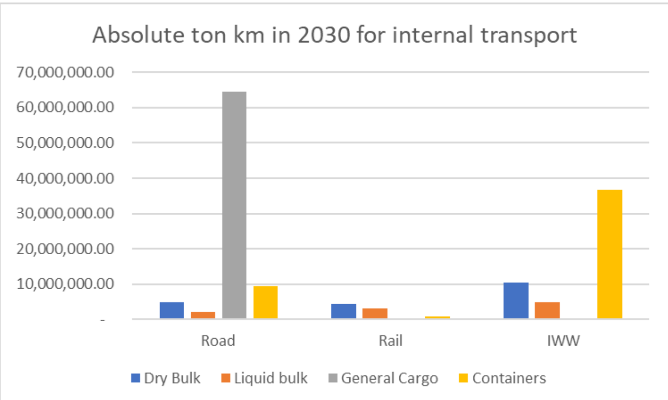
| Main bottleneck | Details |
|---|---|
| Duisburg - Antwerp no real solution yet | |
| Schiphol / Schiphol tunnel capacity | Agreements on BO MIRT, but also keep in mind requests to “Groeifonds” that have been made |
| Short flights between two areas | Rail is being solved for now with third rail connection.. maybe more? |
| Water connection from Duisburg: water level problem due to climate change | Ships at half capacity |
| Venlo - Duisburg Road connection | No direct rail connection Duisburg-Venlo - but only 1 h drive by truck, strong freight flow.<br>A possible solution could be: Establishment of a direct connection between Venlo and Duisburg, with the possibility of a turn-off to Antwerp --> Connection between the Venlo logistics hub and the Ruhr region "Viersener Kurve" (bypassing Viersen via the Brabant route with the Mönchen-Gladbach-Duisburg line) |
| Connection Duisburg to Antwerp | The Dutch want expansion via Venlo, if port of Antwerp is more attractively accessible, bad for sales in Rotterdam and Amsterdam.<br>A possible solution could be the expansion of rail of the "iron Rhine" from Mönchengladbach to Ruhrmont - from border NL and DE only recognizable as a route ; NL not very cooperative, Ruhr area - port of Antwerp (Duisburg port - Antwerp) |
| Reactivation Nijmegen-Kleve line (Bleek municipality opposes) (German students) | But project on hold, rail projects very difficult to implement because NL fears outflow of purchasing power (outflow to D.).<br>Municipalities, regions in Gelderland --> funding from the state, politicians would have to get behind it, German interests greater than Dutch ones |
| Can the capacity be managed related to the interaction between freight & passenger traffic? | ERTMS are a complicated area…<br>3-track good for now, but ERTMS expansion could achieve capacity increases |
| Main problem as a bottleneck between Brabant & NRW - no direct railway line | ERTMS freight capacity on these lines (Betuweroute) not competitive at this moment; too expensive to organise this.<br>Technical diversifications make it not really easy to get more transport on the rail.<br>No EU standards for ERTMS, still takes too long to develop technology etc., different levels 1,2,3 are complicated, not really capacity increase yet as no agreement on standards, national infrastructure systems, power standards, signalling and safety systems, expensive locomotive. A solution could be to develop compatibility further, make next level compatible, not only unified program, but based on some standard, reinforce project versions with funding. |
| Very busy developing the metropolitan transport system | Busy with regional transport. Link with national & international network needs to be made and taking a look at the network is necessary. This needs to be organised in a smart way |

| Main bottleneck | Details |
|---|---|
| Routing by rail is poor, road network good to Amsterdam, Antwerp, truck due to routing has significant advantages | |
| Climate change, (water level): railroads have no capacity to cope with crises, also no national train reserve possible | A possible solution: Rail expansion, because two lines right and left along the Rhine at the limit of capacity, at low water capacity would no longer be sufficient, starts Duisburg/Ratingen, double-track, so busy with freight traffic that passenger traffic not even possible |
| If freight traffic grows, local traffic can no longer grow, capacity not available, conflict of interest in the rail system, 15 % freight traffic for NRW cannot be increased | A possible solution could be: Infrastructure expansion (but: if only limited capacity is possible, whoever pays the highest train path price gets it) |
| | TEN-T hubs? |

# B. Transport Flows in the Rhine-Waal Corridor

The Rhine Waal corridor can be characterized by large freight transport flows coming from the ports of Rotterdam and Antwerp towards the hinterland (and more specifically the Ruhr area). The three modalities are competing in this sense and solving infrastructural bottlenecks (such as the third rail are essential). The road network in both urban dense areas is already at capacity and for rail interoperability between the two countries is an issue that needs attention. For the Inland waterways the availability of water in the rivers / canals is a matter of concern, but it still serves as good alternative especially for bulk goods.

To make these characteristics more concrete two figures have been generated displaying the absolute ton km in 2030 for internal transport and internal – external v.v. transport for the corridor. A separation has been made per modality and the type of goods. Noteworthy is the majority of road transport on this corridor in absolute terms, which is mainly caused by the general cargo that is transported by road. This raises the question if there is not an opportunity to generate modal shift for this type of cargo to other modalities alleviating road transport. Secondly it is noteworthy the high share of containers transported by inland waterways which is already a rather sustainable means of transport. The dry & liquid bulk categories appear to be of less interest.



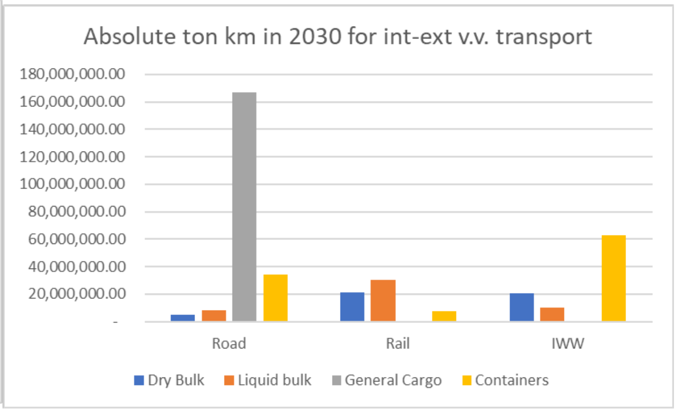




**Figure 33 - Absolute ton km in 2030 for internal transport and internal – external v.v. transport for the corridor Rhine-Waal**

# C. The Policy Measures in the Rhine-Waal Corridor

**Aviation shift**

- The existing track between Oberhausen and Arnhem is currently being upgraded. Also given the overcrowded rail paths within the Rhein-Ruhr area and Arnhem-Utrecht for HST and for domestic travel as well, it would not be easy, if not impossible to further upgrade this track. Therewith and when there is a

need for further extensions, one might reconsider a new HST-track between Eindhoven-Venlo-Krefeld-Düsseldorf airport to meet up with demands. This new track than needs an additional Cos-Benefit Analyses and Environmental Impact Assessment in order to be implemented. This might take several years and this assessment needs to be taken up a.s.a.p.
- Already at the moment there is as need (and it is partly already decided upon) to upgrade the Köln/Deutz station as a Rail-Hub. This won't be possible at the existent Köln Hbf. With this policy measure there is an extra pressure to upgrade services, including a custom service for travellers to the UK.
- Within the context to the Rhein-Ruhr-Express-Concept (RRX) an extension of regional to the Airport station of CGN is foreseen. Nevertheless, with a ban on aviation at midrange distances, there would be an extra need to travel directly with HST (and without exchange) between this Airport and especially Berlin, Munich and Hamburg. Domestic ICE services should then start or end, and or pass through CGN.

**ZEZ in all major cities in SURE**

The ZEZ policy measure concerns cities in the SURE area. Indirectly, this measure would also have an impact on the corridors, as a growing volume of ZEV would also travel on the corridors as a result of the implementation of ZEZ in the cities located on the corridors.

**Potential of MaaS**

For MaaS the interoperability cross border is one of the essential prerequisites that will make cross border travel by public transport more comfortable and easy. Furthermore, the high-density urban areas will be facilitated in making a modal shift from road to public transport in general, however this requires further investments also in physical infrastructure on either side of the border.

**Improving regional cross-border train transport**

In this corridor regional cross-border rail services could be improved for the following three sub-corridor:

- Sub-corridor A: Arnhem, Nijmegen (NED) with Goch, Kleve, Emmerich (GER);
- Sub-corridor B: Venlo (NED) with Mönchengladbach, Krefeld (GER);
- Sub-corridor C: Heerlen, Sittard (NED) – Aachen (GER).

The demand of sub-corridor A is driven to a large extend by German students in Nijmegen. Sub-corridor B has an important local and interregional function for different passenger segments. For sub-corridor C students in Aachen and Maastricht as well as commuters are relevant segments. All sub-corridors have their own challenges which are difficult to solved on the short term. On the longer term all three cases are potentially interesting when they are well integrated and sustainability benefits are considered in the cost-benefit analyses.

# D. Recommendations for the Rhine-Waal Corridor

*From the transport flows we can see that there is already a good usage of other modalities for freight transport on the corridor. Only the general cargo appears to be the major type of goods thus influencing the quantity of expected road transport. This type of cargo could use further research to investigate if intermodal solutions for this type of cargo are feasible.*

*Add the recommendations from the policy analysis (see § above) and the policy roadmaps*

# Annex 8. Corridor Brussels-Lille

## A. Brussels-Lille Corridor Bottleneck Study

| Main bottleneck | Details |
|---|---|
| Lack of specific and recent data on transport flows on the Lille-Brussels corridor | No precise information on transport flows of goods and passengers on the corridor, between the regions and the main metropoles => lack of visibility, lack of basic data for transport planning and management. It is a long-standing problem. Information is in general available at country level but not at a more detailed level.<br><br>A possible solution could be carrying out specific surveys on transport behaviours (passengers and freight) between Lille and Brussels focusing on topics of interest. This requires an agreement among the stakeholders at regional and national levels and a common budget. This has been done in the past for the traffic forecast study for the HSL PBKA Paris-Brussels-Köln-Amsterdam. N.B. There is an agreement on rail cooperation between France and Belgium. |
| High speed railway Lille-Brussels: inefficiencies | A better use of HST-services on existing HS-infrastructure would be useful.<br><br>Three competing railway operators on the Lille-Brussels corridor (Eurostar, SNCF, Thalys), with:<br><br>-No operational collaboration, no interoperability of services<br><br>-No coordination on frequencies, timetables<br><br>-Constraints to use Eurostar on the Brussels-Lille connection due to the further operation of the trains in the UK<br><br>-No competition on price<br><br>-Development of bus services on the corridor competing with the high-speed trains.<br><br>It's a long-standing problem.<br><br>No interoperability for passengers, makes it impossible to use a train of a railway company different from the one that issued the ticket. Very low or non-existent offer during certain periods of the day and in the evening. Using Eurostar from Brussels to Lille is not time-efficient: due to the security and border controls at Brussels-Midi, the time spent by a passenger before embarking (40 minutes minimum) is higher than travel time (35 minutes). High fares: 30€ one way for the three operators . Development of bus services on the corridor, which is a less sustainable mode of transport than railways.<br><br>A possible solution is to examine the possibilities of a better integration of services among the operators. In particular regarding interoperability of fares and distribution of services during the day. Connection of Lille with Brussels airport could be improved if Thalys served the airport en-route to Amsterdam or Cologne, thus avoiding a train change at Brussels Midi as currently the case. A service by bus exists with a longer travel time and higher environmental costs compared to rail. |
| Lack of tariff integration between long distance rail services and urban services | Also a long-standing problem… The consequences of this issue are:<br><br>-If no direct train according to the time period , transfer between 2 trains required<br><br>-Long travel times compared to the distance if no direct train<br><br>-Connection not secured or train does not cross the border in case of late arrival of a train<br><br>This is not an essential issue compared to inefficiencies of the High speed railway Lille-Brussels, and more difficult to solve due to the border effect compared to the same issue at national level.<br><br>Integration of the Last Mile/one ticketing system could be a useful policy measure. |

| Main bottleneck | Details |
|---|---|
| Short distance rail connections Lille-Tournai or Lille Kortrijk: inefficiencies | Strategic stake as the Mobility Orientation law in France gives a more important role to regions for defining mobility basins. Here, the transborder mobility and co-operation between France and Belgium are at stake. There is a declaration of intent of the French President, concrete actions should follow… |
| Urban transport: external effects | Development of LEZ in Lille and in Brussels could be policy measures to think about. |
| Inland waterways Lille-Brussels | Lille is not directly connected to the Seine-Scheldt project. The Seine-Nord Europe canal is expected to be put in service in 2028. |
| Urban distribution/ logistics | This a key issue, to be developed taking into account past experiences in Lille. Large distortions between France and Belgium due to subsidies for combined transport in Belgium.<br>T&D centres in the SURE area? |

# B. Transport Flows in the Brussels-Lille Corridor

The Lille – Brussels corridor is mainly focused on passenger transport that connects the Brussels (and Flemish) areas with the Lille area. Lille serves as a hub where the high speed rail connections from London and Paris are combined together towards Brussels. There is a significant difference in the road and rail transport infrastructure when looking at the focal points (e.g. Rail focuses on Lille Brussels, whilst car is more oriented towards Ghent). The corridor is characterized by a high share of business traffic on the rail network most likely explained by the European institutions and related organizations in Brussels.

The graph displayed below provides further insight in the passenger transport in the corridor split for the modalities road & rail as well as the motives. As can be seen, road is still the major mode of transport for both internal as well as int-ext v.v. transport. However, as can also be seen, rail takes up a significant share of transport for business travel arriving in or departing from the corridor. The motive other requires more insight to better understand what the potential is for this traffic and what potential for modal shift is present.

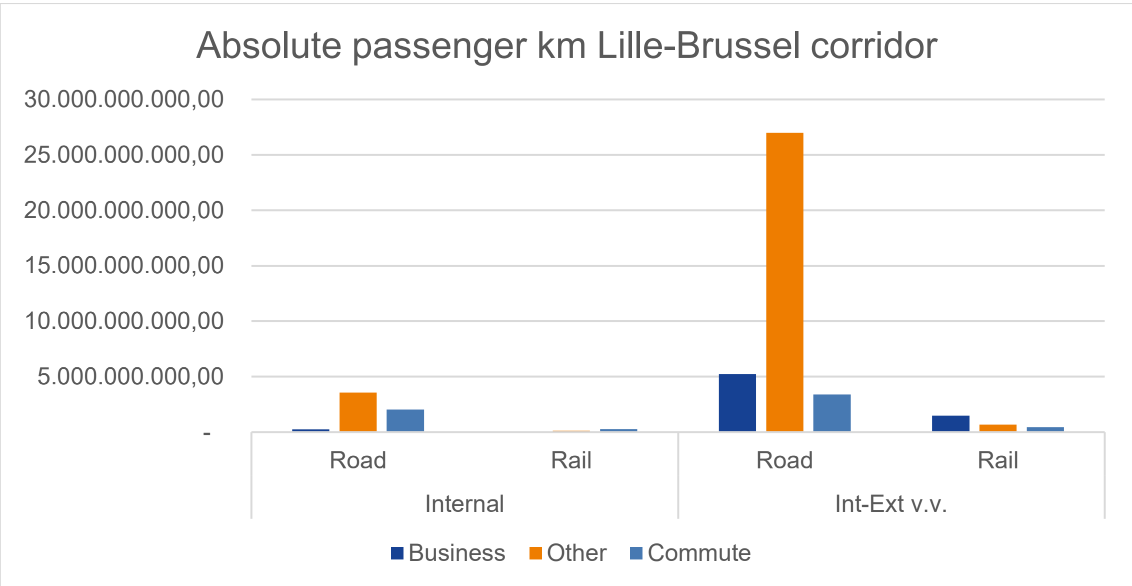



**Figure 34 – Absolute passenger km Lille-Brussels corridor**

# C. The Policy Measures in the Brussels-Lille Corridor

**Aviation shift**

- There are minor improvements needed on the existent rail tracks;
- Nonetheless there is a new (east-west) station Brussels National Airport needed, including new east-west tunnels in order to create an efficient stop for HST's on this corridor at the airport.

**ZEZ in all major cities in the SURE**

The ZEZ policy measure concerns cities in the SURE area. Indirectly, this measure would also have an impact on the corridors, as a growing volume of ZEV would also travel on the corridors as a result of the implementation of ZEZ in the cities located on the corridors.

**Potential of MaaS**

For MaaS the investments in the infrastructure for public transport are expected to alleviate the existing problems currently experienced for car transport especially in the Brussels area.

**Improving regional cross-border train transport**

In this corridor the connection between Lille (FRA) with Tournai (BEL) is the most promising connection to improve regional cross-border passenger rail. Lille is pushing the development of the connection, but on the Belgian site the enthusiasm is less. In a first place, a common vision is needed. Demand is expected to be sufficient to operate a profitable rail connection, which would improve the connectivity within the region and contribute to sustainable transport.

# D. Recommendations for the Brussels-Lille Corridor

With road as the major mode of transport on the corridor further research on how to realize modal shift and the existing bottlenecks could relieve the bottlenecks on the road and realize more sustainable and cleaner transport.

# Annex 9. STISE Toolkit

## A. Toolkit for the STISE study

The network analysis in the baseline scenario shows a snippet from the information that is available within the datasets from Transtools3. To be able to better show all the different cut throughs that the baseline information contains an online tool has been developed in which the involved stakeholders can make relevant selections from their perspective.

The toolkit can be approached via the following link without needing login credentials, for:

- Passenger transport:
  https://analytics.omnitransnext.dat.nl/public/vzYDW5PrvGYBMmIVFM7R3NA0
- Freight transport:
  https://analytics.omnitransnext.dat.nl/public/wGpCiiC4EQO6M1PKC392FRLA

The target group for whom the toolkit has been made is on the one hand the Service Provider ESPON EGTC and on the other hand the STISE stakeholders group.

This toolkit is strictly linked to the STISE study, and is part of the final deliverable - it will not be further developed or adapted by the research consortium. The research consortium proposed this toolkit in the course of the project, to make the data from Transtools3 more accessible in a certain way, and to provide various visualisations and maps.

## B. User Guide

Below is a brief description of how the STISE Toolkit is constructed, structured and how it can be used.

The first view is the standard overview of the SURE area with a basic set of information.

In the following description an overview is given for the passenger transport, but for freight similar functionality is available.

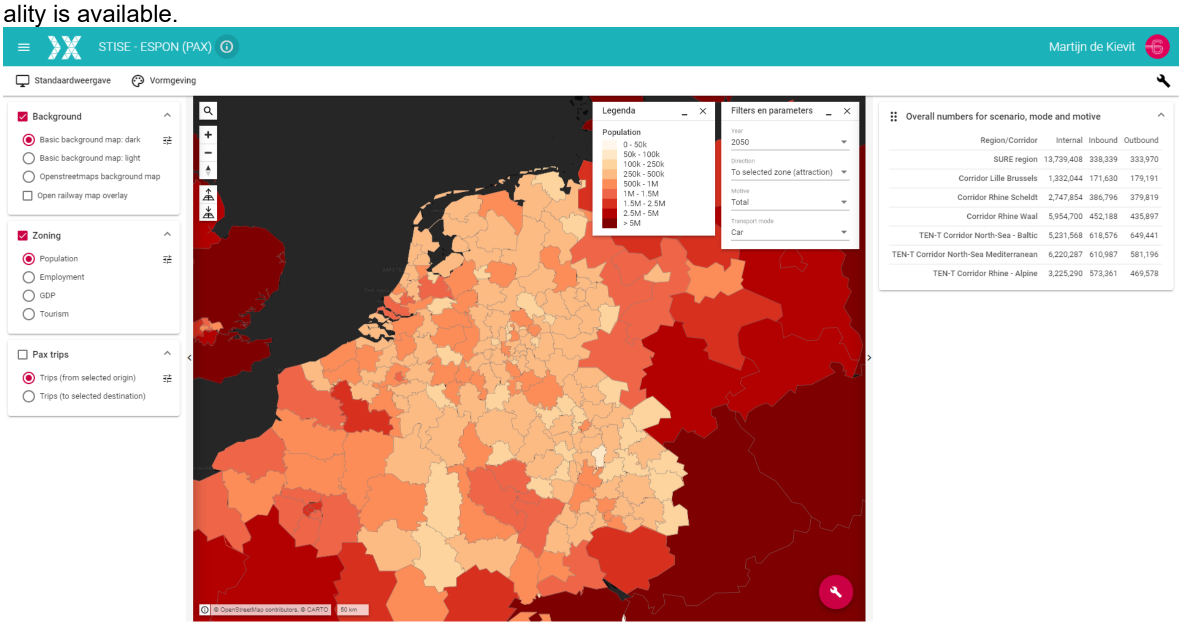



**Figure 35 – Overview of the toolkit for passenger transport**

The screen is split into three areas (see Figure 36). Each area is discussed in more detail in the sections below. The areas are:

1) Map selection options
2) The map itself with a legend and further filters & parameter selection options

3) The information pane displaying specific numbers regarding the settings selected in 1) and 2)

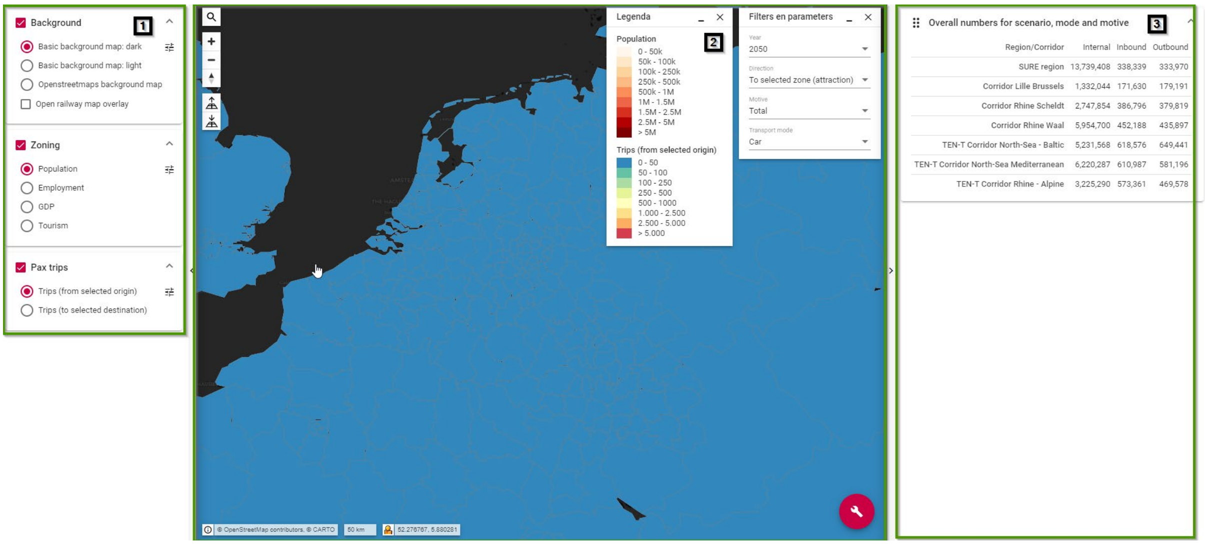


**Figure 36 – Different areas in the toolkit (screenshot)**

# B.1 Map Selection Options

In the map selection pane three blocks of selection options are presented, the checkmark box next to the titles switches these layers on and off:

1) Background
   Three default backgrounds for the map area are defined, a basic dark and light one background with very limited information. One background displays the open street map as a background. As an overlay function the railway network based on open railway map can be displayed.

2) Zoning
   As shown before a certain zoning principle has been adopted in the baseline scenario. In the zoning option there is the opportunity to select which information from the zones has to be displayed on the map. The options are Population, Employment, GDP and Tourism. The legend on the map section adopts accordingly to the selection that has been made.

3) Pax trips (or in case of freight, freight trips)

   Two options are presented as a selection, either to display trips leaving from the selected zone on the map or trips arriving in the selected zone. This information is also displayed in the legend on the map section and the map is adapted accordingly.

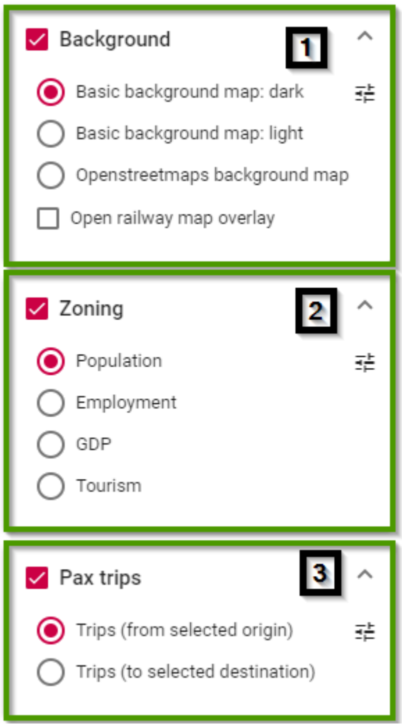


**Figure 37 Screenshot toolkit**

# B.2 Filters and Parameters on the Map

The map section has four interactive elements (see Figure 38 below):

1) Generic map controls, with for example zooming and tilting of the map

2) The map area itself (which has interaction by clicking on the respective zones, the map will change accordingly)

3) The legend (see for further explanation below)

4) The filter and parameters menu (see for further explanation below)

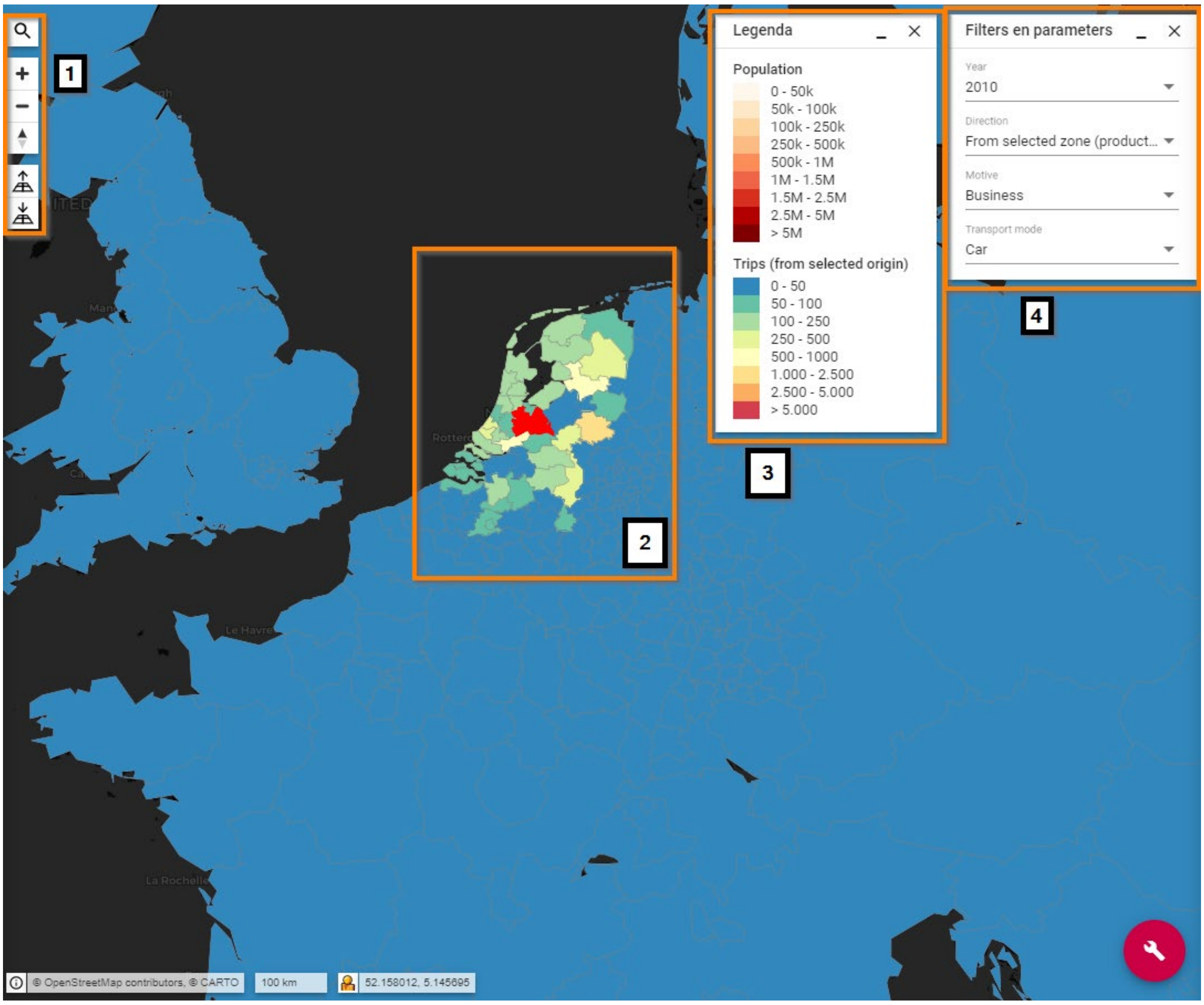



**Figure - 38 Screenshot toolkit map area**

The legend itself is interactive in the way that specific categories of the displayed maps can be turned on or off by clicking on the respective colour that belongs to a certain set of values. So for example, if I only want to see trips from the selected region larger than 50, a click on the blue square next to 0 – 50 is sufficient to remove this category from the map.

For the filters and parameters, the following options are available:

1) Year – here one of the three years can be selected that are part of the baseline scenario (i.e. 2010, 2030 & 2050)

2) Direction – the direction of travel for the trips, either leaving the selected zone (production) or arriving at the selected zone (attraction). Please note that this needs to be similar to the selection option in the Map selection option on the left for the numbers to be displayed correctly on the right

3) Motive – displays the motive for the travel (i.e. business, other, commute & total). For freight this will contain the type of goods instead of motive.

4) Transportation mode – displaying the three transportation modes that are part of the passenger transport model, car, rail & air. For freight these are road, rail & inland waterways.

## B.3 Information Pane

The information pane contains a set of tables and graphs that interact with the selections that are made in the filters and parameters on the map section.

The first table displays the generic information for the different geographical scopes that have been discussed making a distinction in internal transport, inbound and outbound transport. The scopes are the SURE area, the three corridors & the three Ten-T corridors.

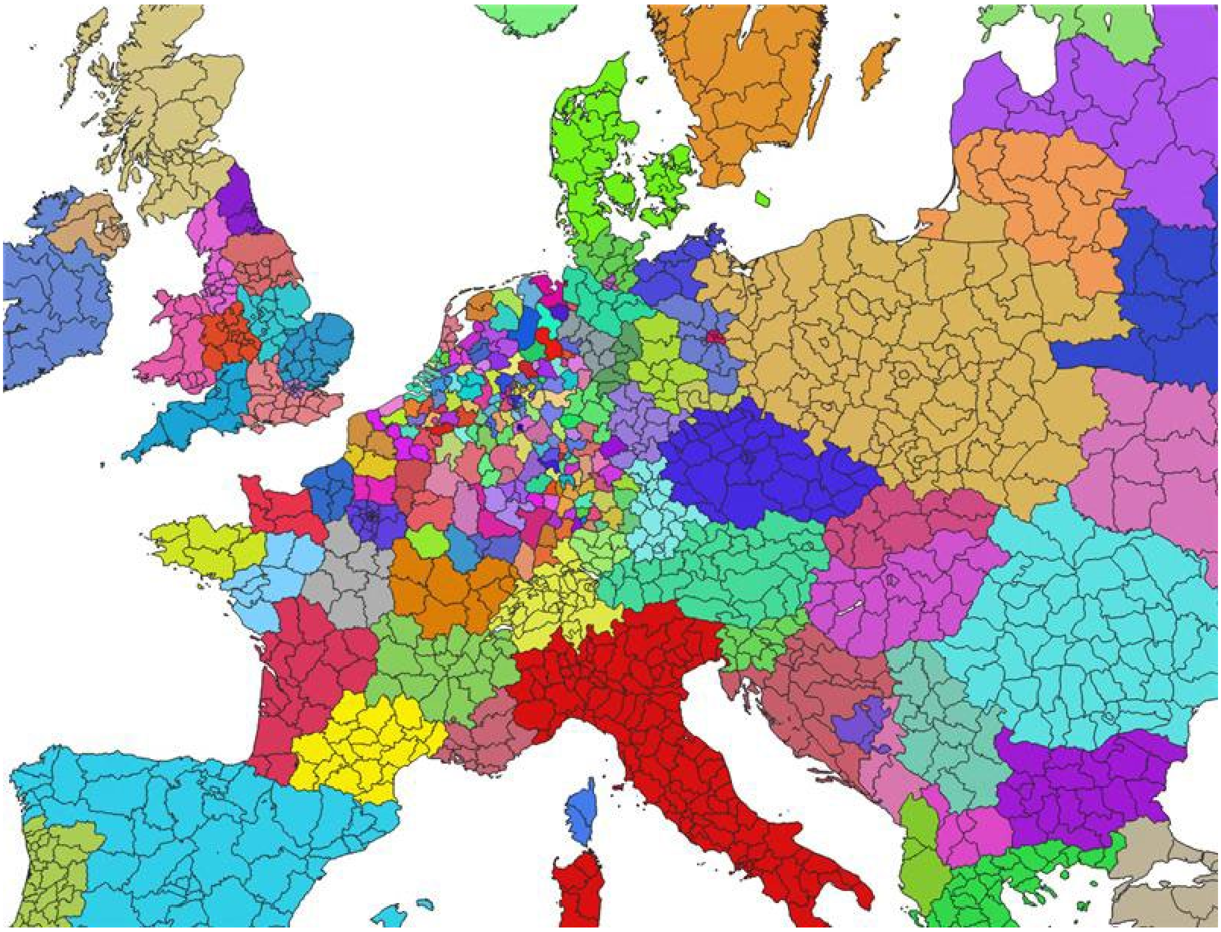
The selected zone contains meta information about the zone that has been selected.

After the selected zone meta information the tables below contain information for that specific zone, this is:

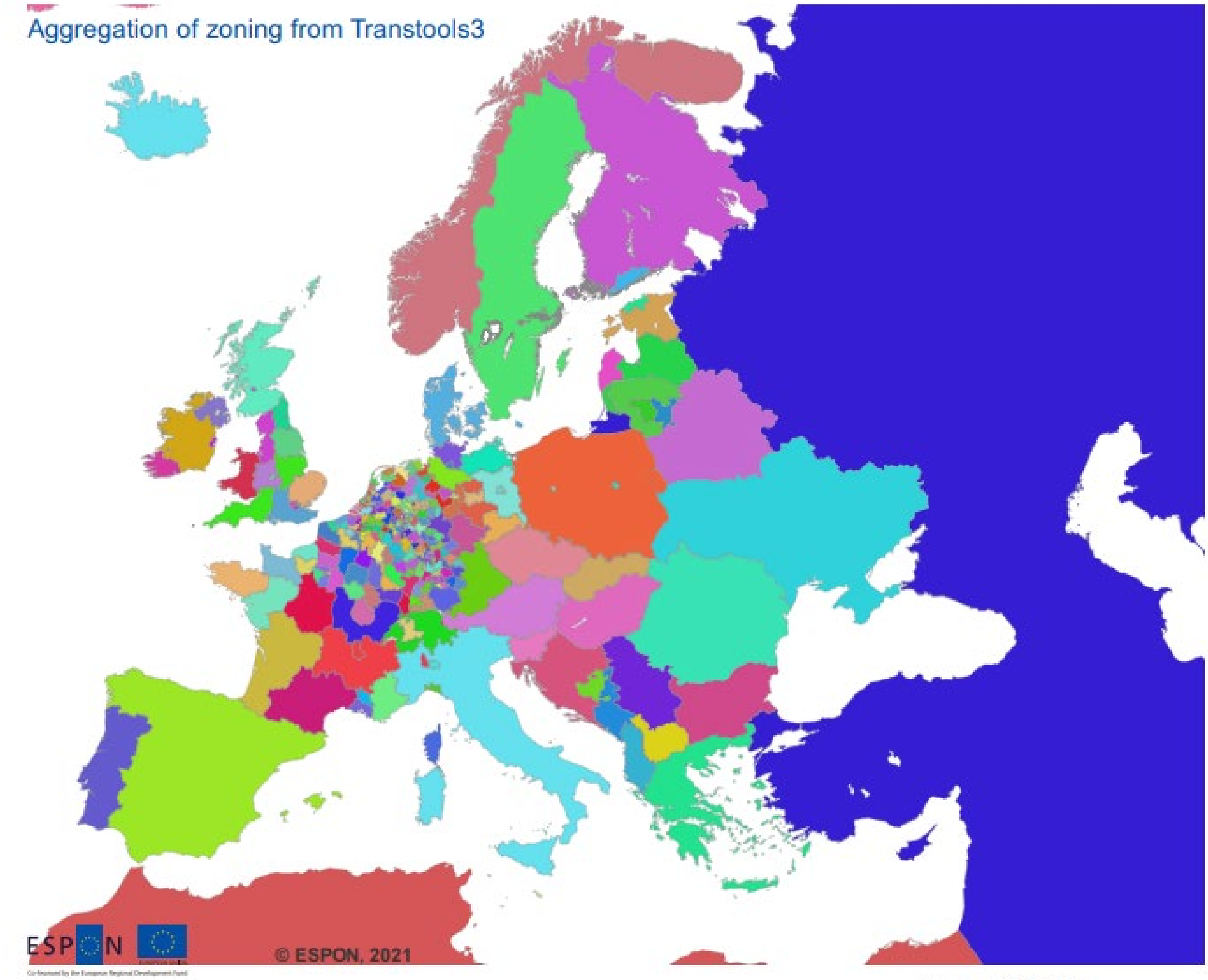
- For passengers the trips originating or arriving at the zone in relation to the geographical scopes as described above, the development of the modal split over the years and the development of the trip category division for the motives over the years.
- For freight the graphs are similar but based on the type of goods. Furthermore, for freight an extra table is added to display the tonnes, next to the ton kilometers.

# Annex 10. Maps from Transtools3

## A Zoning Used for Analysis



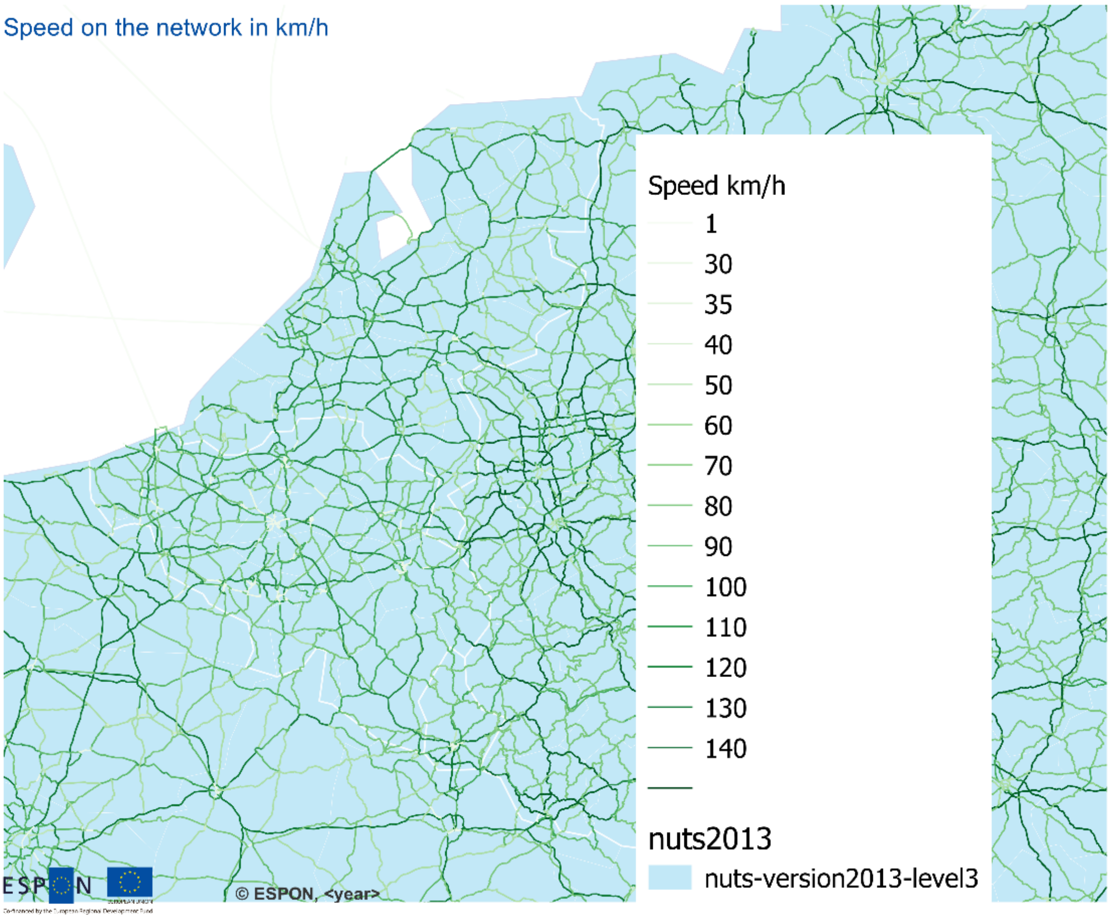
Map 6 – Map with zoning used for analysis




Regional level: NUTS 3 (2013)
Source: STISE, 2021
Origin of data: Transtools3, 2021
© UMS RIATE for administrative boundaries

**Map 7 – Aggregation of zoning from Transtools3**

# B Networks from Transtools3




Regional level: NUTS <level> (<version>)
Source: <ESPON activity acronym>, <year>
Origin of data: <data source>, <year of access>
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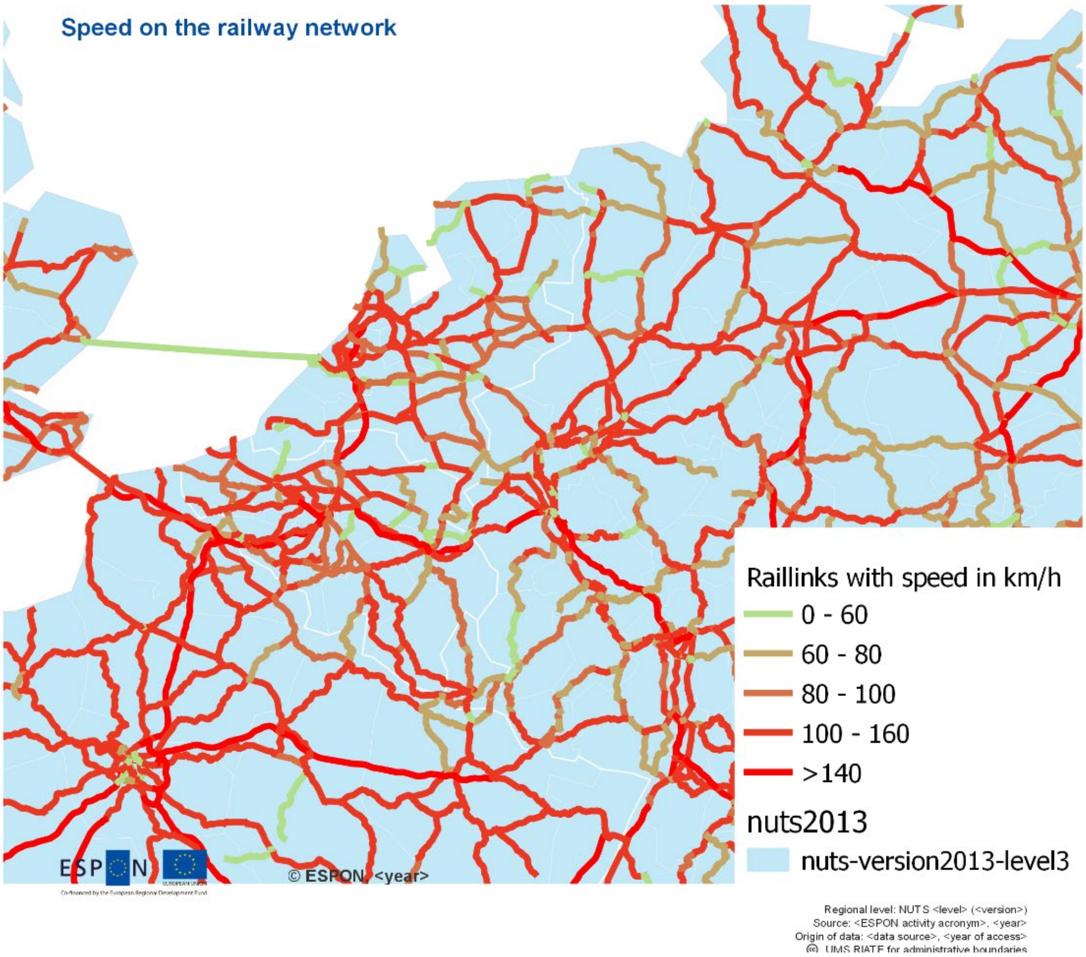
**Map 8 - Overview of the speed on the networks (in km/h) from Transtools3**




**Map 9 - Overview of the rail links with speed (in km/h) from Transtools3**

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4 rue Erasme, L-1468 Luxembourg
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