LUXEMBOURG IN TRANSITION

Stage 2:
Luxembourg in Transition

Date 17.05.2021
Client Ministère de l’énergie et de l’aménagement du territoire
KCAP Architects&Planners
+ Arup
+ Cabane Urbane Strategien

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ARUP

CABANE
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Team

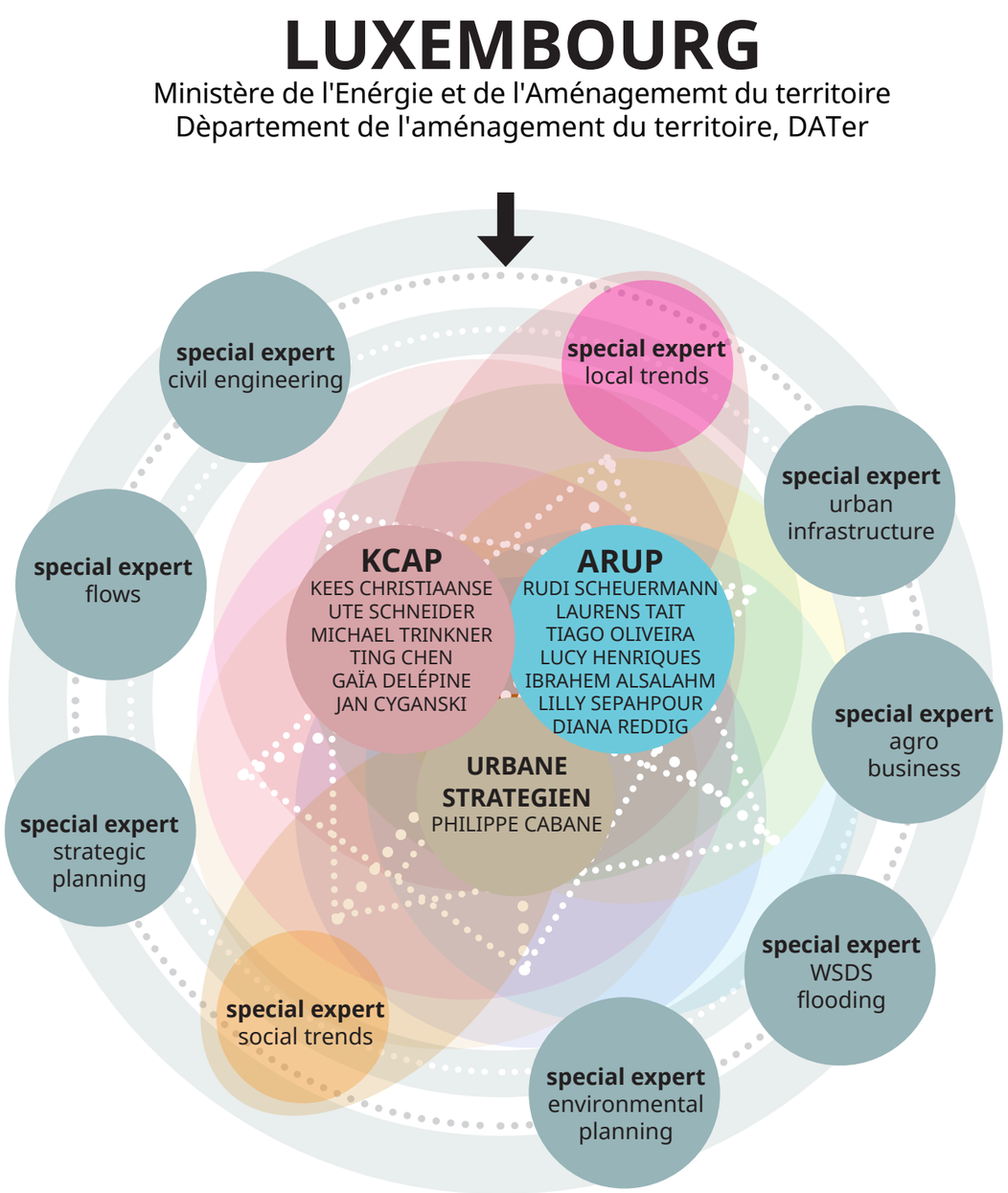
A multi-disciplinary approach to complex design issues

It is with pleasure that we submit our proposal on spatial visions for a transition framework for a zero-carbon and resilient future of the Luxembourg Functional Region.

In the previous year, our capacit to communicate and physically meet has been severely jeopardized by the Covid pandemic.

Nevertheless, we think we have managed to produce an exemplary strategic trajectory for a carbon neutral future for Luxembourg.

While in Phase one, we identified the GHG-producing factors with the strongest impact; in Phase two we focused on mobility and logistics within the Luxembourg contexts, as these two domains constitute the greatest challenge in the path towards a carbon neutral future.



KCAP Architects&Planners
Urban design
Urban planning
Territorial planning
Architecture
Landscape

Arup
Zero-Carbon & Decarbonisation
Resilience
Demography and contextual trends
Strategic Planning & Economics
Active Transport Strategy

CABANE Urbane Strategien
Sociology
Urban development
Strategic planning
Transborder planning

External experts:

Prof. Dr. Marco Mazzotti
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Mechanical Engineer who specializes in the strategic development of renewable energy infrastructure. Since 2018 he works as a consultant for the Dutch company DAREL, where he works on several large-scale energy projects in the industrial complex surrounding the Port of Rotterdam.

READERS GUIDE

Our strategy of Radical Pragmatism (**Chapter I**) brings us to two key GHG domains (Logistics and Mobility) for Luxembourg in Transition (from Phase 01) and a representative zone of Luxembourg (what we call the Banana Belt) that captures many of the potential gains in these two domains.

With that in mind, we then analyse the domains of Logistics and Mobility and determine detailled specific strategies (**Chapter II and III** for Logistics and Mobility respectively; **Level 1** and **Level 2** within those chapters for Analysis and Strategy development respectively).

We apply the logistics and mobility strategies determined in the previous chapters on an Exemplary Site (Bettembourg-Dudelange) in **Chapter IV**.

Finally we Consolidate the learnings from the Domain / Agglomeration / Exemplary Zone analyses and strategies in **Chapter V**, a concluding chapter.

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Executive Summary

Radical Pragmatism

To support Luxembourg's vision to approximately halve greenhouse gas emissions by 2030 and to become carbon neutral by 2050, we primarily address the domains, which have the highest impact on greenhouse gas generation, and to develop pragmatic tools to influence and transform them. In this way, we hope to enable a sharp reduction of GHG emissions in the coming years via concrete approaches in the field, which may establish an improved physical condition and a renewed mindset, which in turn will trigger innovative solutions, beyond what is known and conceivable today.

Phase 1

In Phase 1, we raised the «Radical Pragmatic» approach, detected 7 Domains which produce most GHG-emissions: Mobility, Logistic, Buildings, Built Footprint, Material Flows, Energy and Agriculture. These were investigated against the backdrop of 4 Contexts: Luxembourg's Zones, Centralities, EU & Covid links and Resilience. Specific CO2 mitigation trajectories were then outlined in the timeslots 2020-2030-2050.

Phase 2

In Phase 2, we zoom in further into the Domains of Logistics and Mobility, as these are the greatest GHG-producers, and their physical impact with respect to Built Footprint and Centrality.

We actually shifted Built Footprint from Domains to Contexts, as improvements in Logistics and Mobility tend to lead to spatial concentration and thus positively impact the Built Footprint (and Centrality) Context.

Banana Belt

As Logistics and Mobility activity are negligeable in the Northern 2/3 part of the Functional Zone, we focus on the Southern 1/3 of the Functional Zone as a field of operation. This area, which, apart from the city of Luxembourg spans from Arlon, Longwy and Petange, via Esch-sur Alzette to Thionville, forms a continuously urbanized, Banana-shaped agglomeration. In our view this densely settled area catches the majority of the GHG wins to be made.

Hardware & Software

In the next step, Logistics and Mobility are divided into two categories, "Hardware" and "Software":

- Hardware relates to physical traffic infrastructure, industry sites and mobility/logistics hubs, as well as spatial contexts, like centrality, and built footprint
- Software: relates to strategies, policies and pricing tools for modal split/fuel-type/cargo-type

Exemplary Site

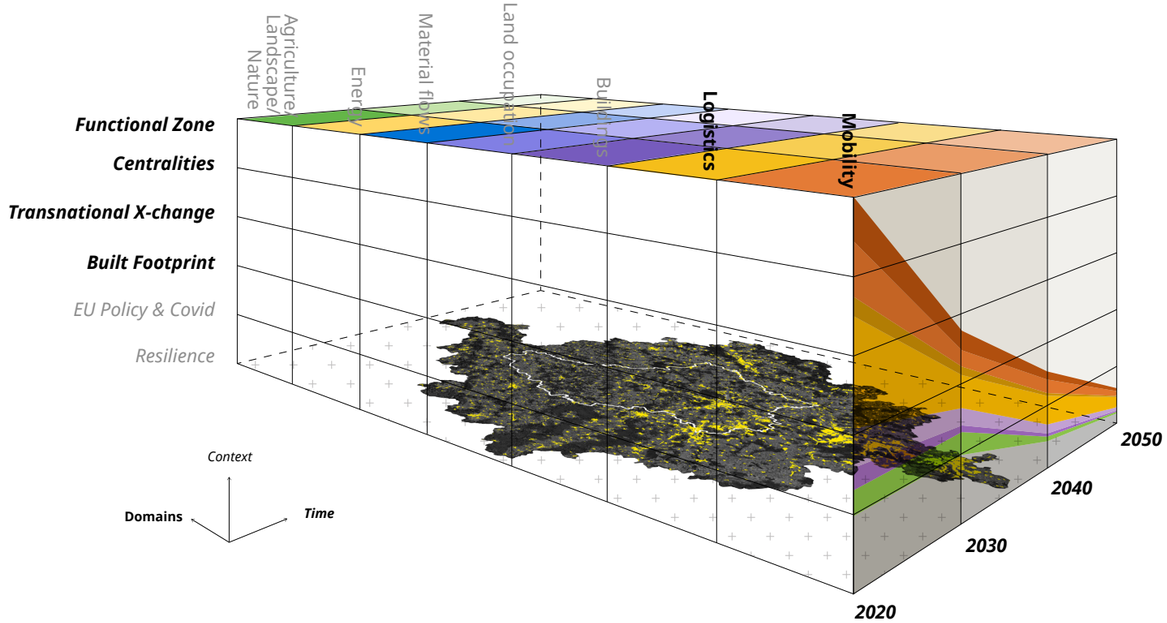
Within the Banana Belt, we have selected one exemplary area, which is representative of the interaction and challenges between Mobility, Logistics, Built Footprint and Centrality: Bettembourg/Dudelange,

In this area we tested the optimization of public transport and the installation of mobility/logistics hubs and sharing systems. Built footprint can be stabilized and help strengthen the centrality of the area. Logistics can be re-organized and concentrated, leading to a considerable land-use saving potential and enabling double use on roofs. In addition, propositions have been made on the level of renewable policies for cargo and pricing.

From Downscale to Upscale

The GHG wins have been estimated for these combined operations and then generalized for the larger territory of the Banana agglomeration and then to the Functional Zone.

The potential gains within the GHG Domains of Logistics and Mobility identified in Phase 1 are assessed from a Bottom Up perspective, establishing the potential to change modes and fleet, then determining how many tonnes of CO2 are saved from these potential changes.



L. RADICAL

PRAGMATISM

A Radical Pragmatic Methodology

Recap Phase 1

In Phase 1, we narrowed the research down in an approach of «Radical Pragmatism», detecting those Domains which produce most Green House Gases in Luxembourg:

- Mobility (25% of total GHG-emission in Luxembourg)
- Logistics (33%)
- Buildings
- Built Footprint
- Material Flows
- Energy
- Agriculture/Landscape/Nature

We elaborated the research against the backdrop of four Contexts:

- Luxembourg's 6 Character Zones (North, Middle, South, Luxembourg-City, Border Zone, Transnational Zone)
- Centralities
- EU-policy/Learning from Covid
- Resilience

Methodology in Phase 2

In Phase 2, we build on Phase 1 and zoom further, investigating exclusively the Domains of Logistics and Mobility in relation to the Contexts of Centrality and the Domain of Built Footprint. In fact, Mobility and Logistics are by far the greatest producers of GHG-emissions in Luxembourg. This is abnormal compared with many other European countries (Fig. I-1). An effective GHG-mitigation approach will therefore have a major impact towards a 0-emission condition for Luxembourg.

We acknowledge that there are potential gains outside of these domains, but have excluded these GHG potential benefits.

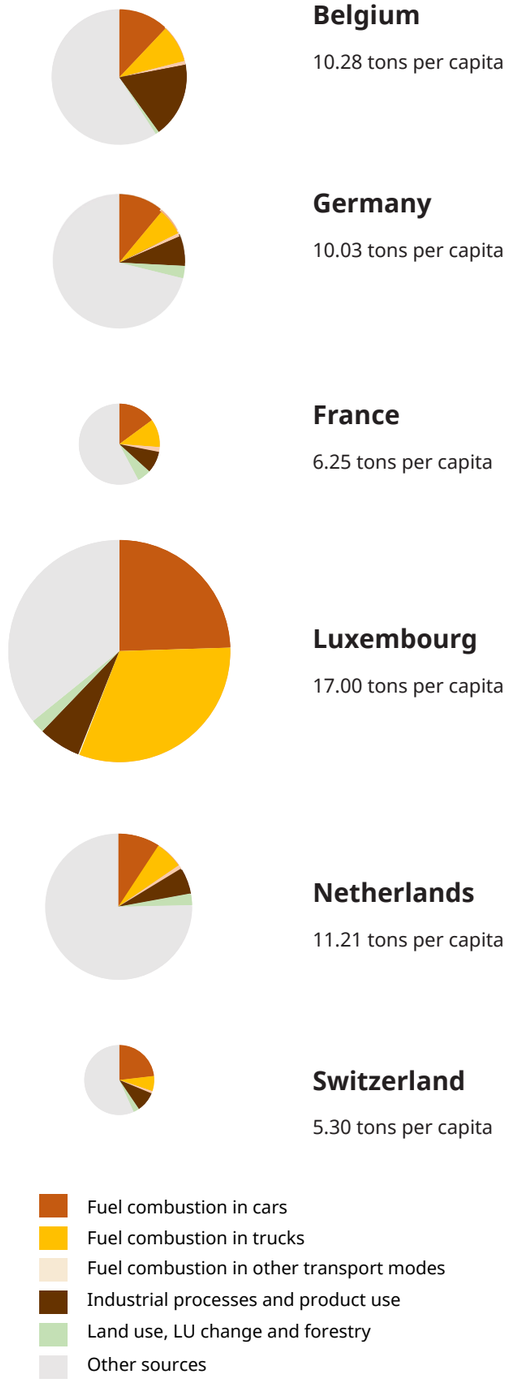


Fig. I-1 : Comparison of GHG emissionn structure and GHG emission per capita (based on Eurostat)

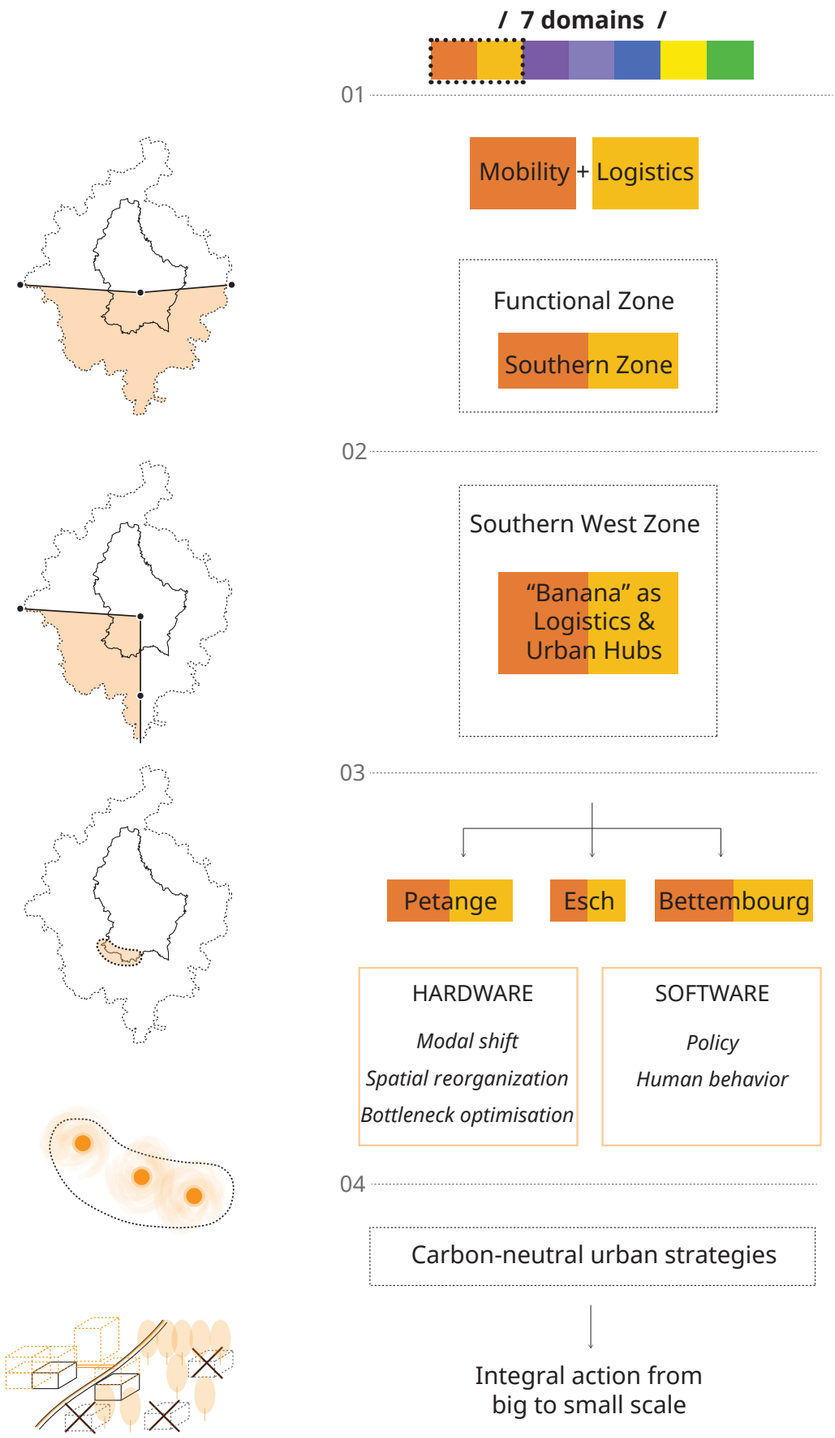


Fig. I-2 : The Radical Pragmatic Methodology

Geographically, we shifted the focus from the Context of Luxembourg's 6 Character Zones to the transnational Functional Zone around Luxembourg. However, after surveying the Functional Zone, we concluded that Mobility, Logistics in relation to Centrality and Built Footprint mainly concentrate South of the line Arlon – Luxembourg - Trier. Our view is that this concentration catches the majority of the potential GHG wins, and activity in the rest of the zone is less representative.

In a further step, we acknowledged that the main activity and inter-relationships in Mobility, Logistics and Built Footprint take place in the Western part of the southern Zone, namely the area West of the A3 and South of the A6. This area, spanning from Arlon via Longwy and Petange, via Esch-sur Alzette to Thionville, forms a continuously urbanized, Banana-shape agglomeration. Apart from the City of Luxembourg this is the zone where the potential GHG wins are to be found.

In the next step, Logistics and Mobility are divided into two categories, "Hardware" and "Software":

- Hardware relates to physical traffic infrastructure, industry sites and mobility/logistics hubs, as well as spatial contexts, like centrality, and built footprint
- Software: relates to strategies, policies and pricing tools for modal split/fuel-type/cargo-type

Within the Banana Belt, we have selected one exemplary brownfield site, which is representative of the interaction and challenges between Mobility,Logistics, Built Footprint and Centrality: Bettembourg/Dudelange.

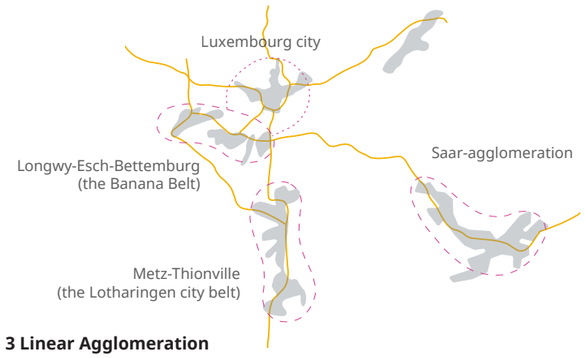
The analysis of this area shows, that public transport can be optimized, combined hubs for mobility/logistics and sharing systems installed, built footprint can be stabilized and concentrated to form a centrality.

Logistics can be re-organized in a far-reaching way, combining existing enterprises in larger co-buildings, leading to a considerable land-use saving potential and enabling double use on roof surfaces, like solar farms, urban farming or office spaces. The released brownfield can be used for housing, mixed-use developments and for strengthening the centrality of the area.

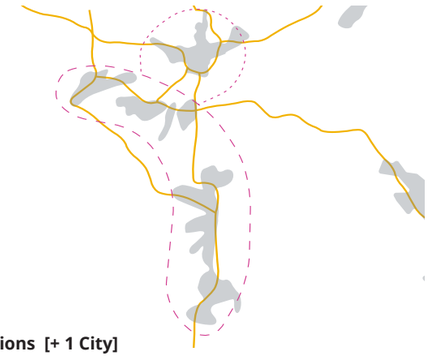
On the software level, we have proposed interventions on the level of policy, as well as pricing. These interventions we then pull together in a hypothetical GHG reduction model.

After this process of steadily Downscaling, we Upscale, by firstly rendering a future vision of the spatial lay out of the banana agglomeration; and secondly by extrapolating from the estimated Green House Gas emissions for the three in area to the larger agglomeration and consequently generalize them theoretically for Luxembourg.

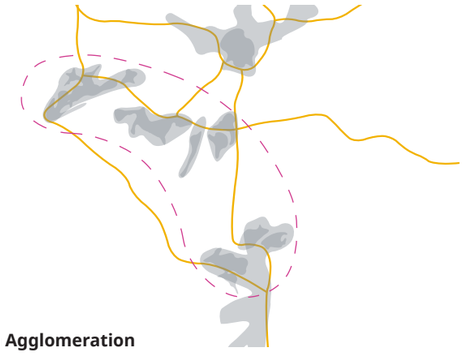
The final figure, the potential reduction of GHG emission on the level of Mobility, Logistics and Built Footprint, then can be discussed vis à vis the total emissions. For mobility and Logistics, we are looking to take this on from the Bottom Up, establishing the potential to change modes, and then determining how many tonnes of CO2 come from this mode change. These are potential absolute benefits.



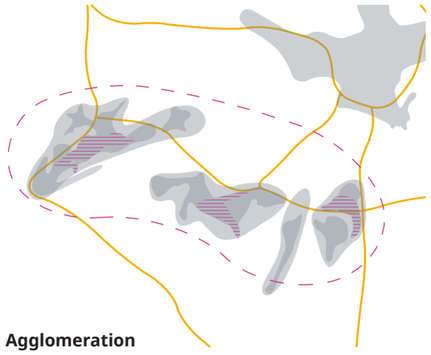
3 Linear Agglomeration



2 Agglomerations [+ 1 City]



Large Banana Agglomeration



Small Banana Agglomeration

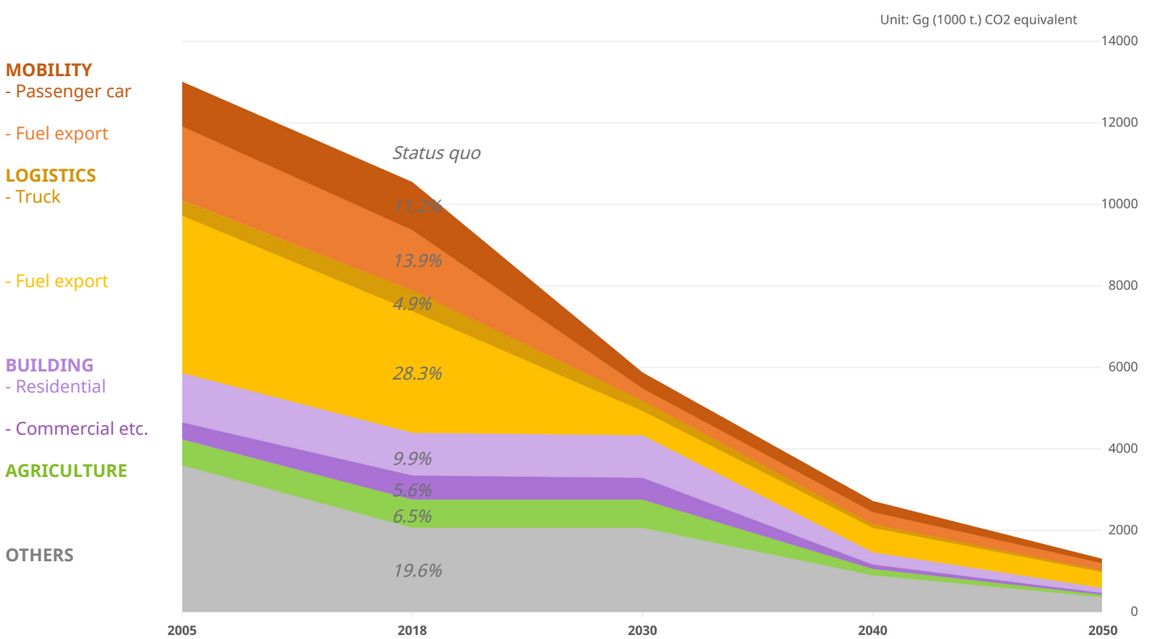


Fig. I-3 : Suggested GHG reduction scenario: focusing on main GHG emitters - mobility and logistics - only (based on data from MECS, 2020)

Potato plan of the ‘Banana Belt’

0 5 10km

LUXEMBOURG

LONGWY - ATHUS - PETANGE

DIFFERDANGE

BETTEMBOURG - DUDELANGE

ESCH-SUR-ALZETTE

KAYL

THIONVILLE

- Borderline
- Multifuntional centralities
- Urban District
- Outskirt Settlment
- Industrial-logisticszones
- Logistics zones for improvement
- Main agglomeration
- Farmland
- Forest
- Waterway
- Railway
- Mobility extension
- Highway
- Prinary Roads
- Train stations
- Railway stops
- Railway stops - project
- Mobility hubs

II. LOGISTICS

Introduction

As logistics belong to the major producers of GHG emissions in Luxembourg and its surroundings, it is necessary to make an inventory and analysis of the logistics activity. Consequently, we can conceive interventions and policies, which positively affect the emissions balance.

Cargo inventory

- For a logistics inventory, we have to have an insight in cargo flows, transport modes, and cargo types.
- What kind of logistics companies have a base in and around Luxembourg, why they are in Luxembourg – tax reasons, out of tradition, to be in the centre of Europe, for local markets, etc.
- How much and what kind of cargo is flowing through Luxembourg – through the country and through the economy? Wat is the share in consumer goods, food, fuel, clothes, natural resources, construction materials, wood, cattle, machines, digital equipment, etc.?
- What is the origin and destination of cargo? What is the share for local markets and what is transfer?

Transport

An assessment has been made of the modal split between transport modes:

- Large scale transport by road (trucking and containers)
- Medium scale transport by road (vanning)
- Small scale transport by road (couriering, last mile biking)
- Railway (bulk and containers)

Hub

- An inventory of logistic hubs has been made and their position in the networks.
- Rail-road terminal
- Distribution centres
- Peripheral hubs (transit from large to small scale transport)
- Railway station

Vehicles

- fuel-type
- size
- speed
- place of registration

Hinterland

- Which are the catchment areas for local markets?

Governance

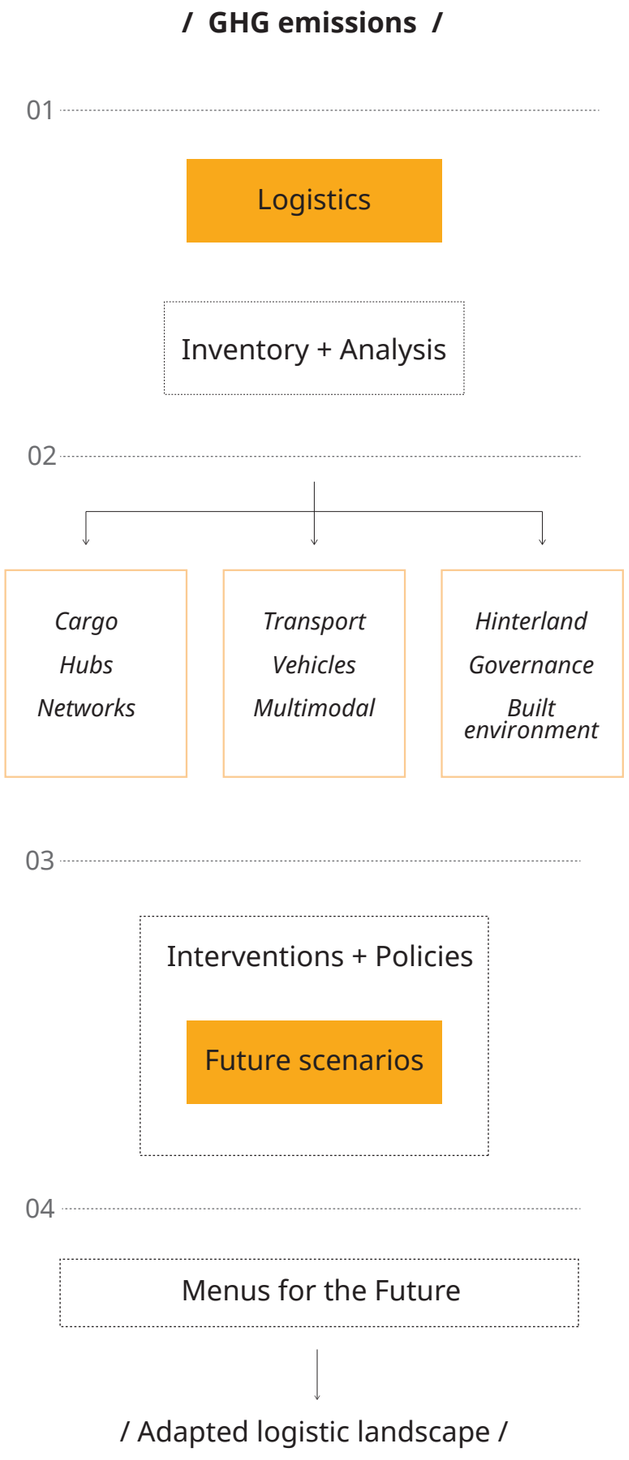
- What is the current legislation concerning registration of logistics companies and vehicles.
- Taxes and other pricing
- Policies towards a balanced and sustainable logistics condition.

Buildings, Built footprint and Centrality

- Where is logistics concentrated, in what kind of buildings, what is their connectivity, etc.

Menu

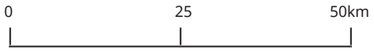
Having obtained a panoramic view across the above mentionned logistics landscape. We may modify certain figures and parameters and develop future scenarios for the logistics landscape, a menu for the future. In the following we will choose and describe a menu as an exemplary illustration of our strategy.

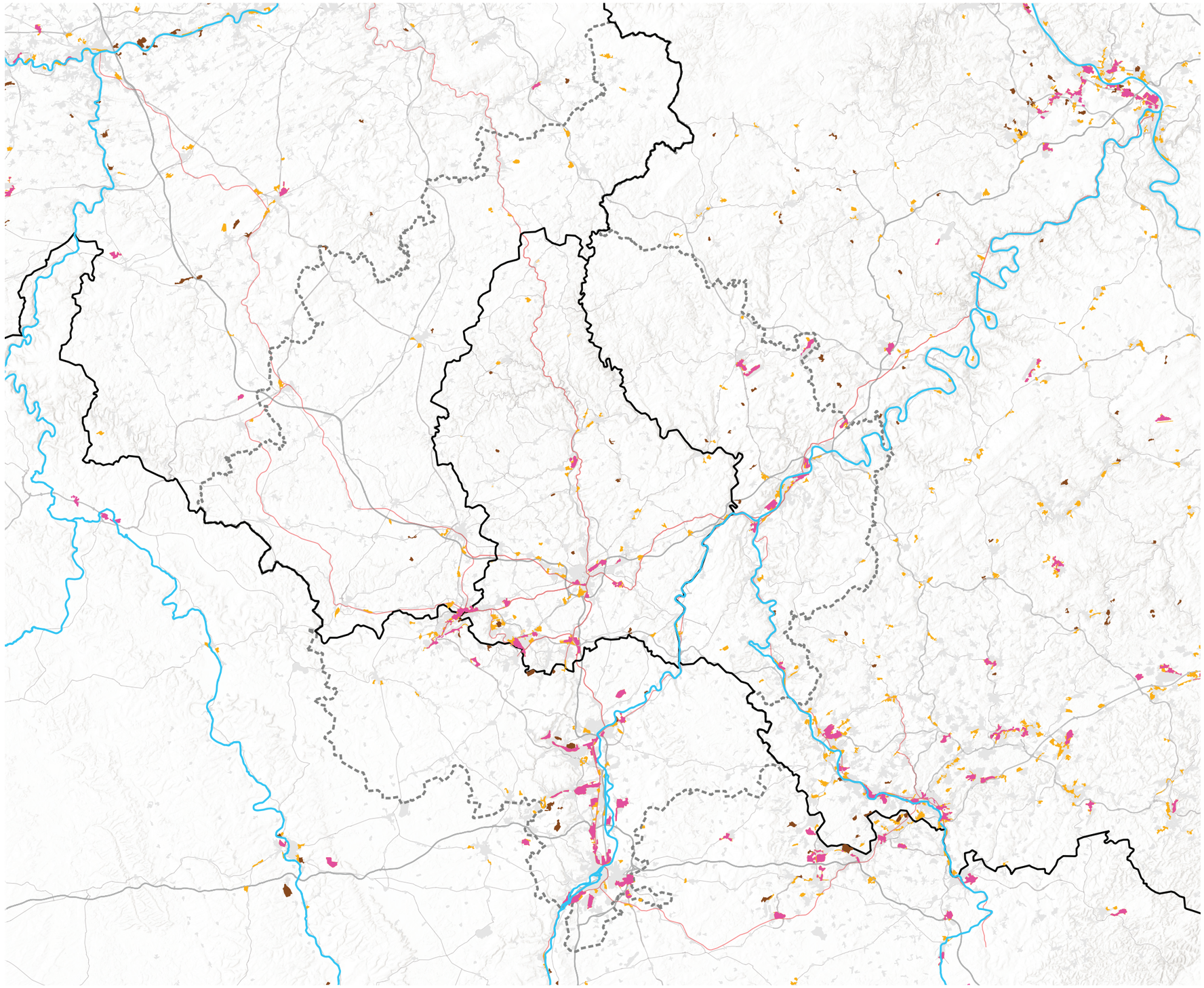


Level 1 - Functional Zone

Regional Logistics System

Regional logistics system





- Warehouse zone
- Built surface
- Mining sites
- Other industrial or extraction zone
- Trans-European freight network -- core rail network
- Trans-European freight network -- core road
- Motorway
- Primary road
- Country borderline
- Functional Zone

Fig. II-1 : Logistics infrastructure in the functional region of Luxembourg (based on Eurostat)

High international logistics demand in Luxembourg

Importance of the logistics sector in the era of global trade

How important is transport within the life-cycle GHG emission of a product? Although it differs from case to case, growth in international trade has made supply chains longer and more complex, as logistics networks link more and more economic centres across oceans and continents. As a result, for instance, for Samsung's electronics products, transportation accounted to 21.3 % of its GHG emission (Samsung, n.a.); for soybean imported from China to Denmark, it accounted to 51% (Knudsen et al., 2011). It was estimated that international trade-related freight transport currently accounts for around 30% of all transport-related CO2 emissions from fuel combustion, and projections based on the International Freight Model foresee an increase of trade-related freight transport emissions by a factor of 3.9 to 2050 (OECD, 2015).

Luxembourg as an important node in the Trans-European Frieght network

As a small country, Luxembourg is not only heavily realying on import. Located in central Europe, it is also a key transit node. Within the nine principle multimodal pan-European road transport corridors, the North Sea-Mediterranean Corridor stretches from Amsterdam and Rotterdam, via Luxembourg to Strasbourg and Basel and via Lyon to the southern French ports of Fos/Marseille. Within the territory of Luxembourg, a principal line goes from Athus/Petange to Bettembourg.

Those corridors are envisioned to enhance multimodality on a better rail infrastructure, as well as innovative technologies to induce modal shift, reduce congestion on the road, cut emissions of greenhouse and polluting gases. (TENTEC, n.a.)

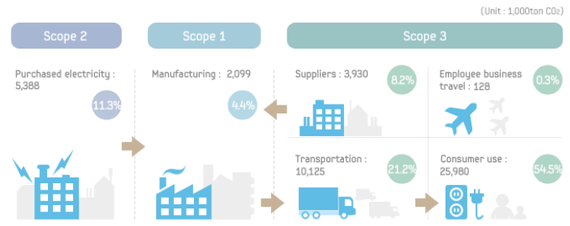


Fig. II-2 : Transportation acounts to 21.2% of the total GHG emission of Samsung's electronics business, 2012 (Samsung, n.a.)

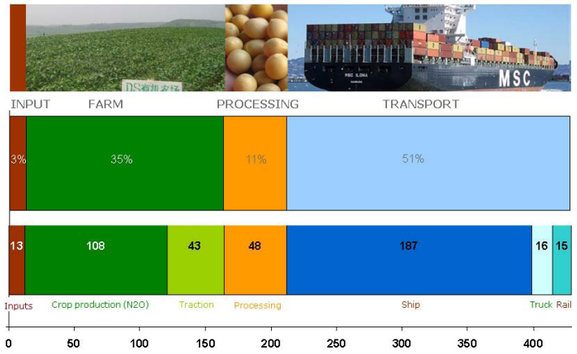


Fig. II-3 : Transportation acounts to 21.2% of the total GHG emission of Samsung's electronics business, 2012 (Knudsen et al., 2011)

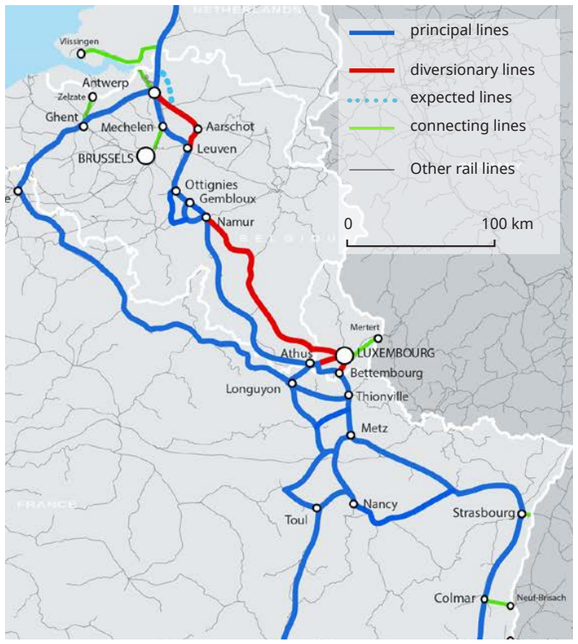


Fig. II-4 : Rail Freight Corridor 2 connecting Luxembourg to other parts of Europe (RFC, 2015)

International trade in Luxembourg: driven by value-added exports

Exports (in value added terms) contribute for around 74% of Luxembourg's GDP. The top manufacturing exporting industries in Luxembourg are basic metals, rubber and plastic products, food and beverages.

Across most industries, there is a strong correlation between higher import content of exports and a higher share of their domestic value-added being exported (export orientation), illustrating the strong complementarity of exports and imports. As a result, Luxembourg has the highest services content in its exports at 86% among all OECD countries, over half represents foreign value added content. (OECD, 2017)

On the other hand, the contribution of direct and indirect imports to domestic final demand measured 40% in 2014 (OECD, 2017).

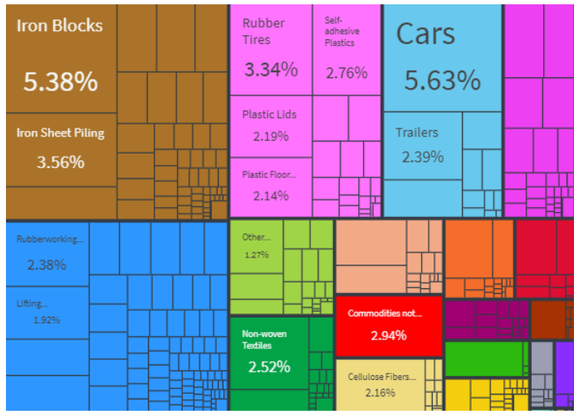
Current import and export structure

The main export commodities (via land) in Luxembourg and their destination country can be summarised as (country classification according to the value of the exports):

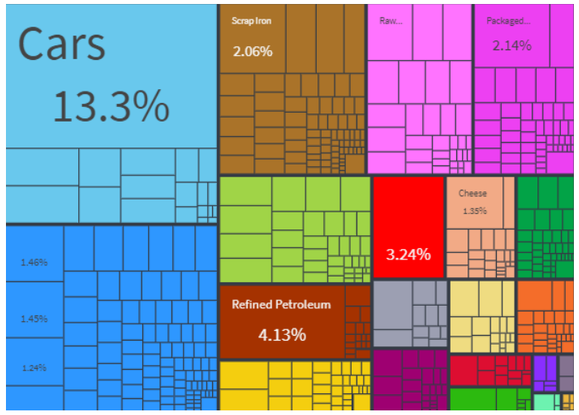
- Basic food and food products: Germany
- Ores and metals: Germany, France, Belgium, Netherlands.
- Chemicals: Germany
- Office, telecom and electrical equipment: United Kingdom

The sources of main import commodities (via land) are:

- Fuels: Belgium
- Ores and metals: Germany
- Other manufactures and other products: Germany
- Road vehicles and transport equipment: Belgium and Germany



Annaul product export in value, 2019



Annaul product export in value, 2019

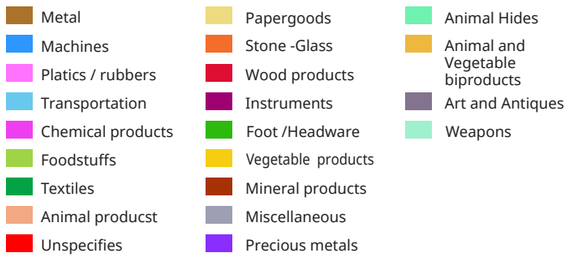
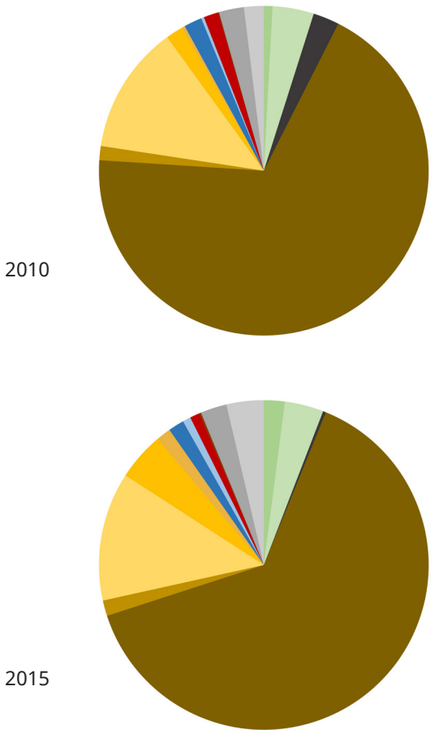
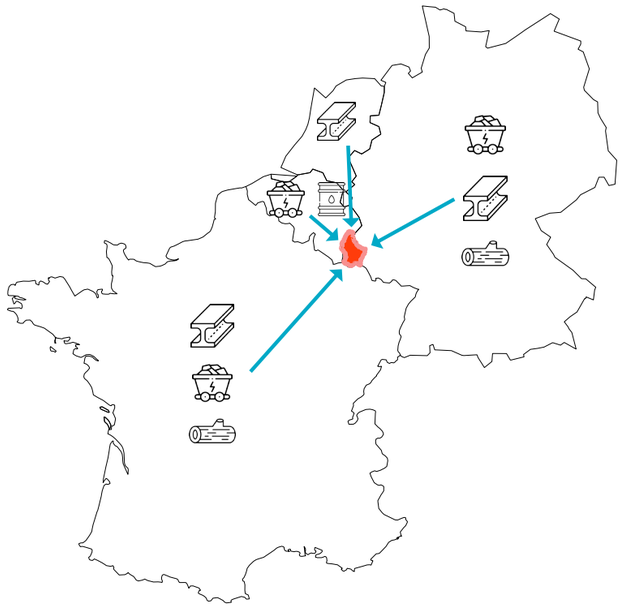


Fig. II-5 : Annual product import and export in Luxembourg, 2018 (OEC, 2021)

Volume of national and international logistics by types of goods





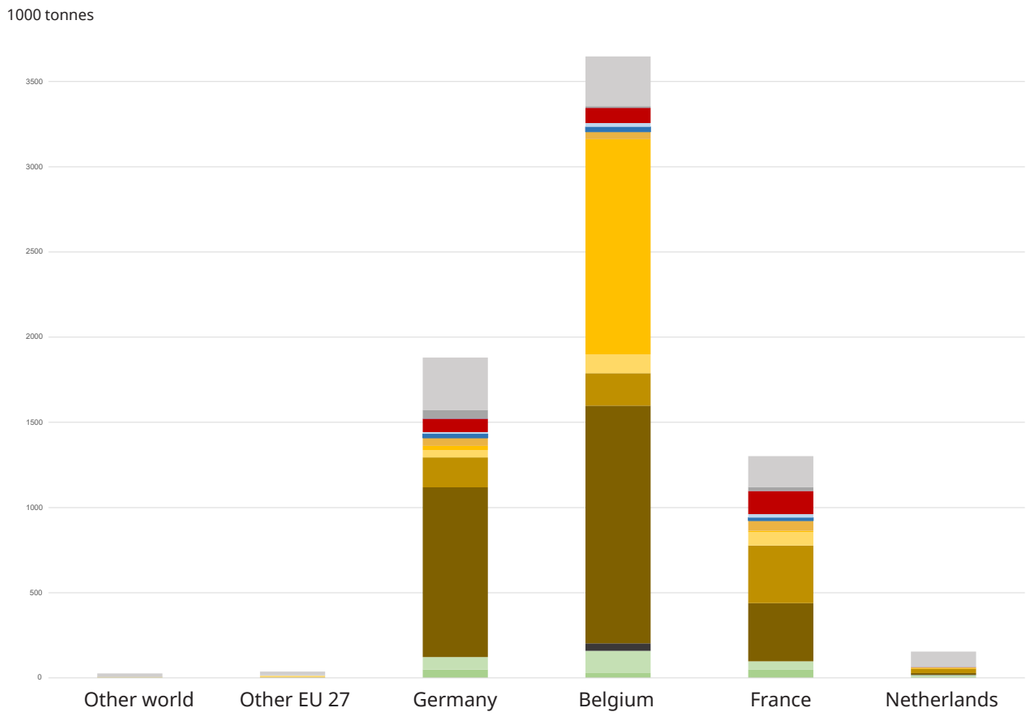
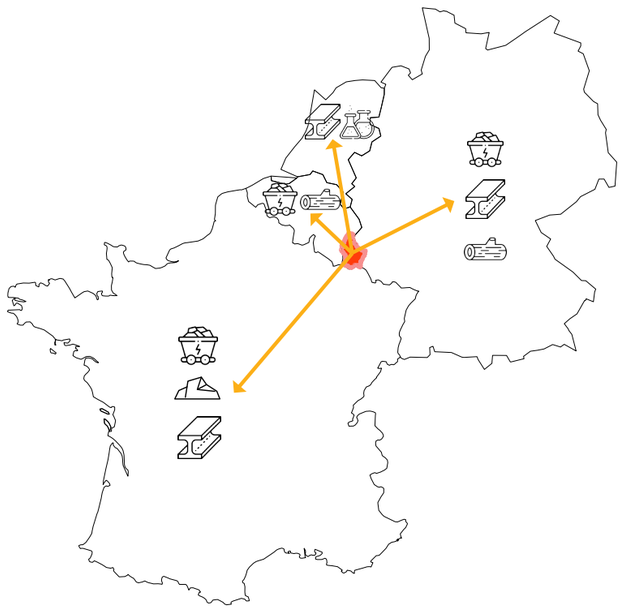


Fig. II-6 : National annual road transport from 2010 to 2019 (based on Eurostat)

Fig. II-7 : Goods imported by Luxembourg from other countries by road transport, 2019 (based on Eurostat)

- Products of agriculture, hunting, and forestry
- Food products, beverages and tobacco
- Coal and lignite; crude petroleum and natural gas
- Metal ores and other mining and quarrying products
- Basic metals; fabricated metal products, except machinery
- Other non metallic mineral products
- Coke and refined petroleum products
- Chemicals, chemical products
- Machinery and equipment, etc.
- Transport equipment
- Wood and products of wood and cork (except furniture)
- Furniture; other manufactured goods n.e.c.
- Textiles and textile products; leather and leather products
- Secondary raw materials; municipal wastes and other wastes
- Others



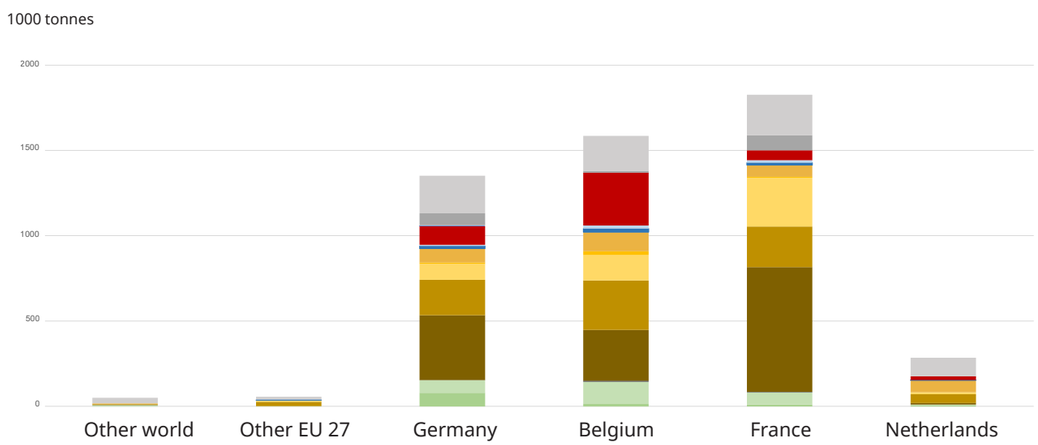


Fig. II-8 : Goods exported from Luxembourg to other countries by road transport, 2019 (based on Eurostat)

Dependency on road freight transport and the potential for change

A traditional hotspot for road freight

Located at the heart of the main traffic axes in Western Europe, Luxembourg has traditionally had a high volume of road transit traffic for both goods and passengers. For road freight transport, about 800 transport companies are established in Luxembourg and 400 operators are specialized in international transport. (CFL, n.a.)

Structure analysis of Logistics GHG emissions

In comparison with international traffic, domestic traffic plays only a relatively small role since it is responsible for only one quarter of the total road fuel sold in Luxembourg. Fuel quantities sold at Luxembourg's petrol stations, after having been converted into GHG volumes, are, according to IPCC reporting standards, totally included in the GHG balance, although around 71% of the emissions cannot be assigned to vehicles registered in Luxembourg and are emitted mostly abroad. (MECS, 2020)

Due to a policy of low taxed fuel (gasoline and diesel), Luxembourg is an attractive "fuelling station" for numerous trucks transiting through the country. Since the market is dominated by diesel vehicles in at least two of its neighbouring countries – namely Belgium and France, it is not surprising that diesel oil is the first liquid fuel in terms of volumes sold. (MECS, 2020)

Road as dominant transport method

The ratio of the volume for road to rail traffic in Luxembourg (in tonne-kilometer) increased from 6.5 in 2010 to 15.4 in 2019, high above the same year's value in surrounding countries such as Switzerland (1.91), Germany (3.9), Belgium (6.4) and France (8.8). Besides, as a lot of transit freight took place in Luxembourg, the ratio even added to 38.6 in 2019. (Eurostat)

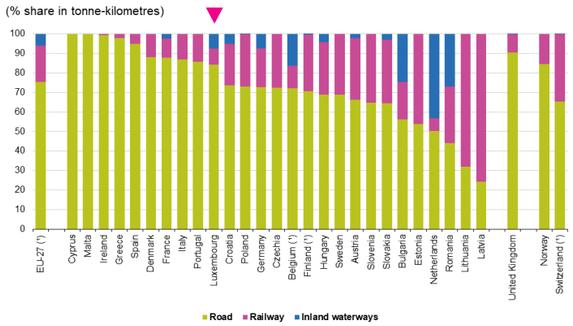


Fig. II-9 : Comparison of modal split of inland freight transport among EU countries, 2018 (Eurostat)

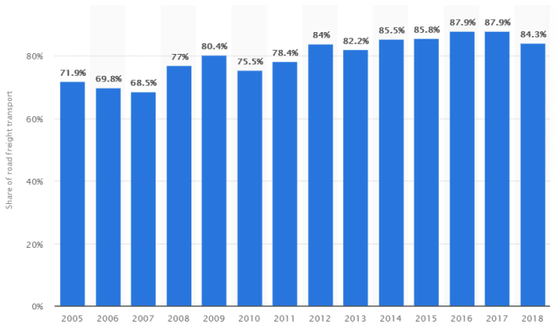


Fig. II-10 : Road freight transport as a percentage of total inland freight in Luxembourg, 2005-2018 (Statista.com)

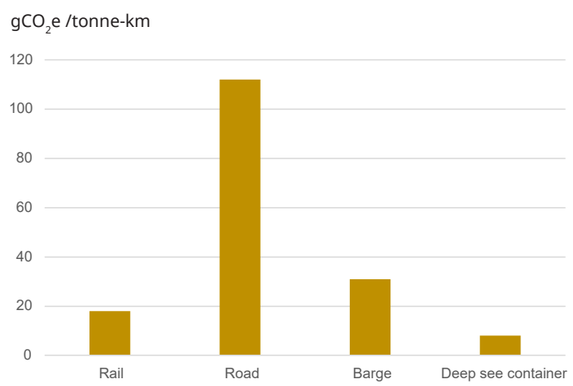


Fig. II-11 : Average emission factors for wide range of transport activities (based on Eurostat)

Time and costs for choice of road

On average, rail freight transport has experienced low levels of absolute growth across the EU since 2000. In relative terms, the share of rail freight has declined at the expense of road freight.

When shippers are mostly concerned with the timely delivery of goods, they are more likely to choose road transport. Conversely, when considerations about the costs of consignments are more important, shippers are more likely to view rail transport favourably. In addition, any significant and unexpected increase in fuel costs will affect the costs of road transport. However, fuel price impact tend to be offset by specific contracting arrangements, whereby shippers pay for the fuel costs incurred by carriers, as well as policy measures offering reimbursement of carrier fuel costs. (EP, 2015)

Potential in GHG reduction

For the total of non-waterway freight (rail and road), transit plays a similar important role in the two central European countries -- Switzerland (73.7%) and Luxembourg (66.2%). However, in Switzerland only 4.9% of the freight load (tkm) goes to road ; while in Luxembourg the number is 99.8%. Similarly, for exported goods, the share of road freight is 57.4% in Switzerland and 94.4% in Luxembourg. For imported goods, it is 52.2% in Switzerland and 91.8% in Luxembourg. Only on a national logistics level is road transport dominant in both countries. The main target for Luxembourg should be to change its operation mode in international trade and transit traffic.

When there is no change in fuel type, and the market demand stays the same as today, and if Luxembourg's logistics sector can reach the same modal split for non-waterway inland logistics as Switzerland, the GHG emission in the logistics sector will reduce with 59.3%, leading to 19.4 % reduction in the entire GHG emission of the country.

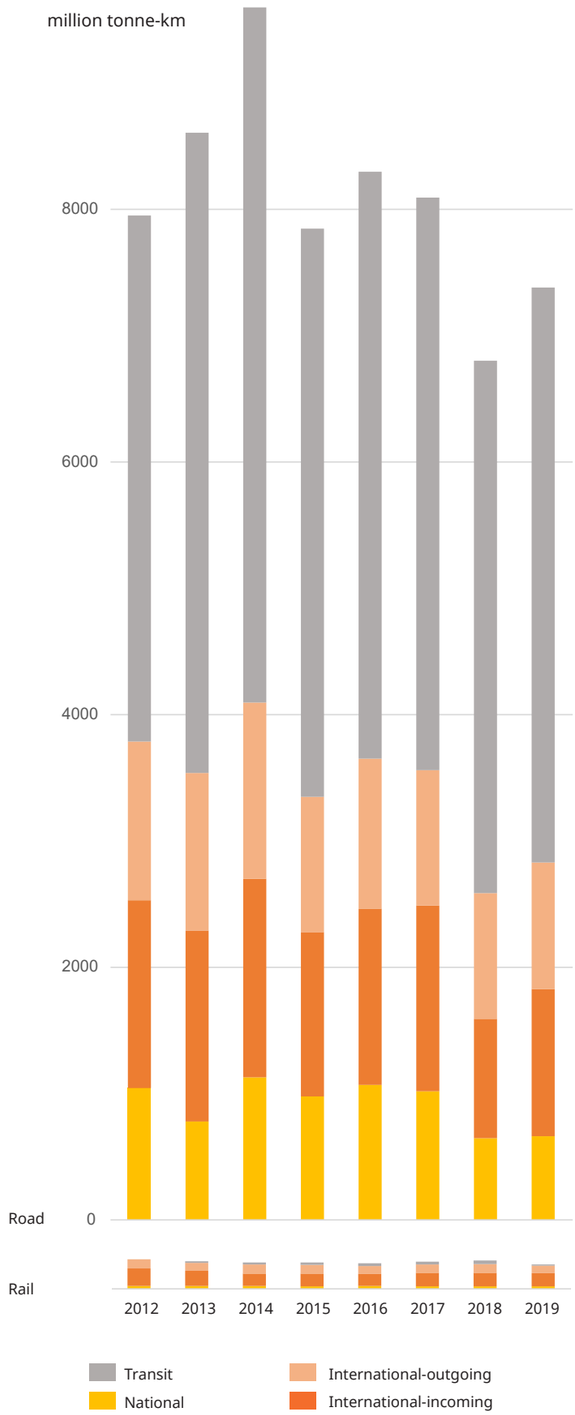


Fig. II-12 : Comparison of volume and structure of road and rail freight transport reported in Luxmebourg, 2019 (based on Eurostat)

Road transit through Luxembourg from other EU countries

Serving as a center for trans-continental freight trips, Luxembourg is an ideal stepping stone famous for its abnormally low fuel price, which is leading to the estimated 71% of the emissions that cannot be assigned to vehicles registered in Luxembourg and are emitted mostly abroad. (MECS, 2020)

However Luxembourg is easy for truck drivers to by-pass, should be implemented effective measures such as fuel tax, urban access regulations and higher motorway tolls. Of course this would only temporarily push the unavoidable GHG emission to the surrounding countries. However, when all countries start to work in the same direction, long distance road freight transport would be discouraged and instead more goods would be loaded on rail.

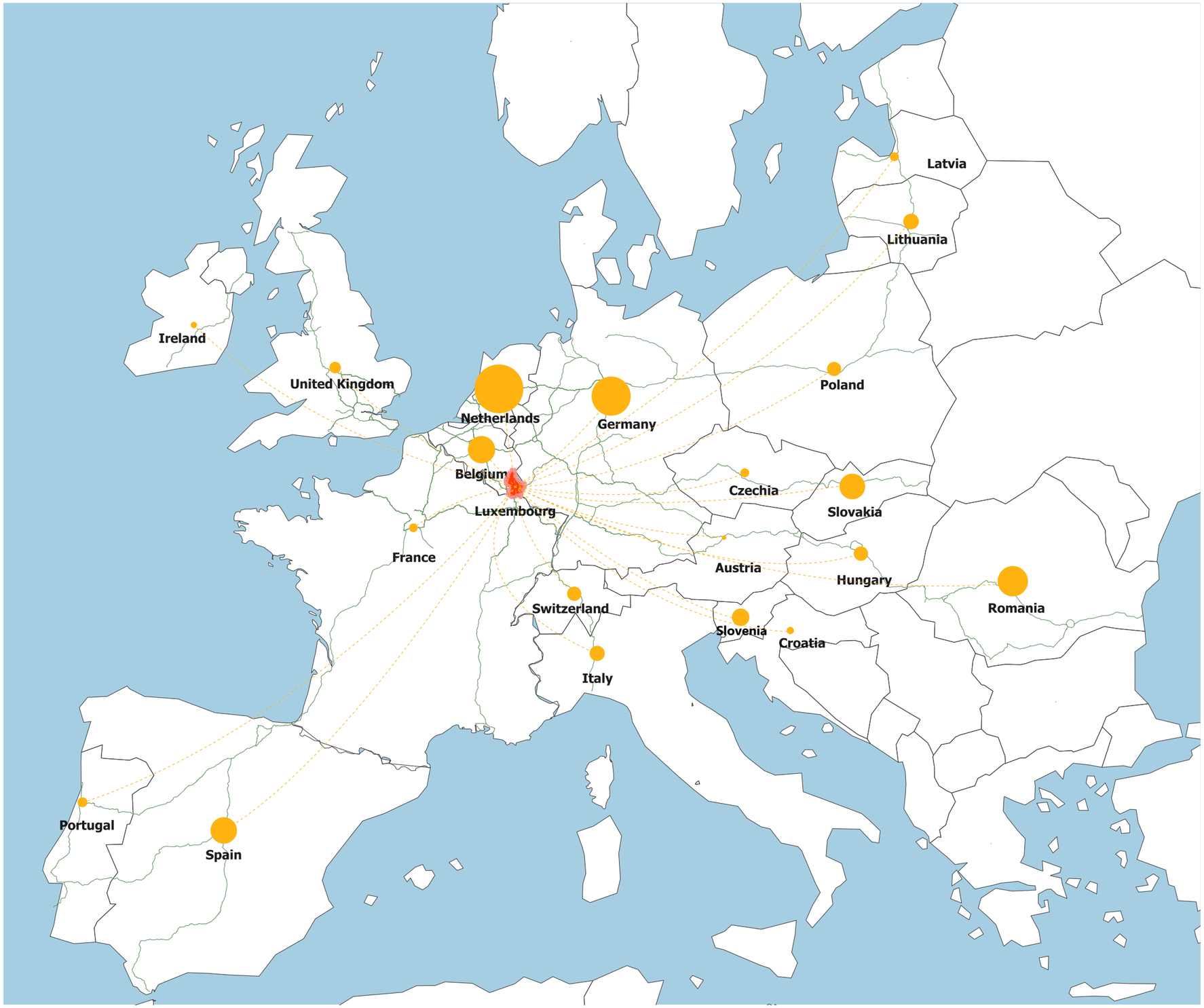


Fig. II-13 : Annual road freight transport for transit of goods from EU countries through Luxembourg, 2019 (based on Eurostat)

Regional road and rail freight transport - imports

It is usually useful to categorise the transport of goods by different commodity categories, since the choice between rail and road is often linked to the attributes of the goods transported. The first graph below shows the EU average modal split for inland freight transport for the products majorly exported/ imported by Luxembourg, which are generally heavy, and shows a much higher preference for train transport than other commodities.

However this rule does not particularly apply to Luxembourg, as the lower graph shows. It seems that no matter what goods are to be shipped, road transport is the first choice of shippers.

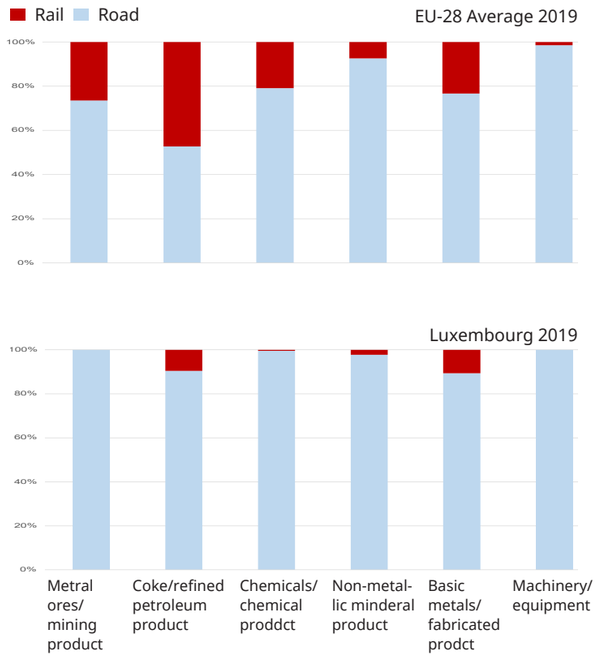


Fig. II-14 : Modal split of rail and road freight for major commodity categories of Luxembourg and the situation in EU, 2019 (based on Eurostat)

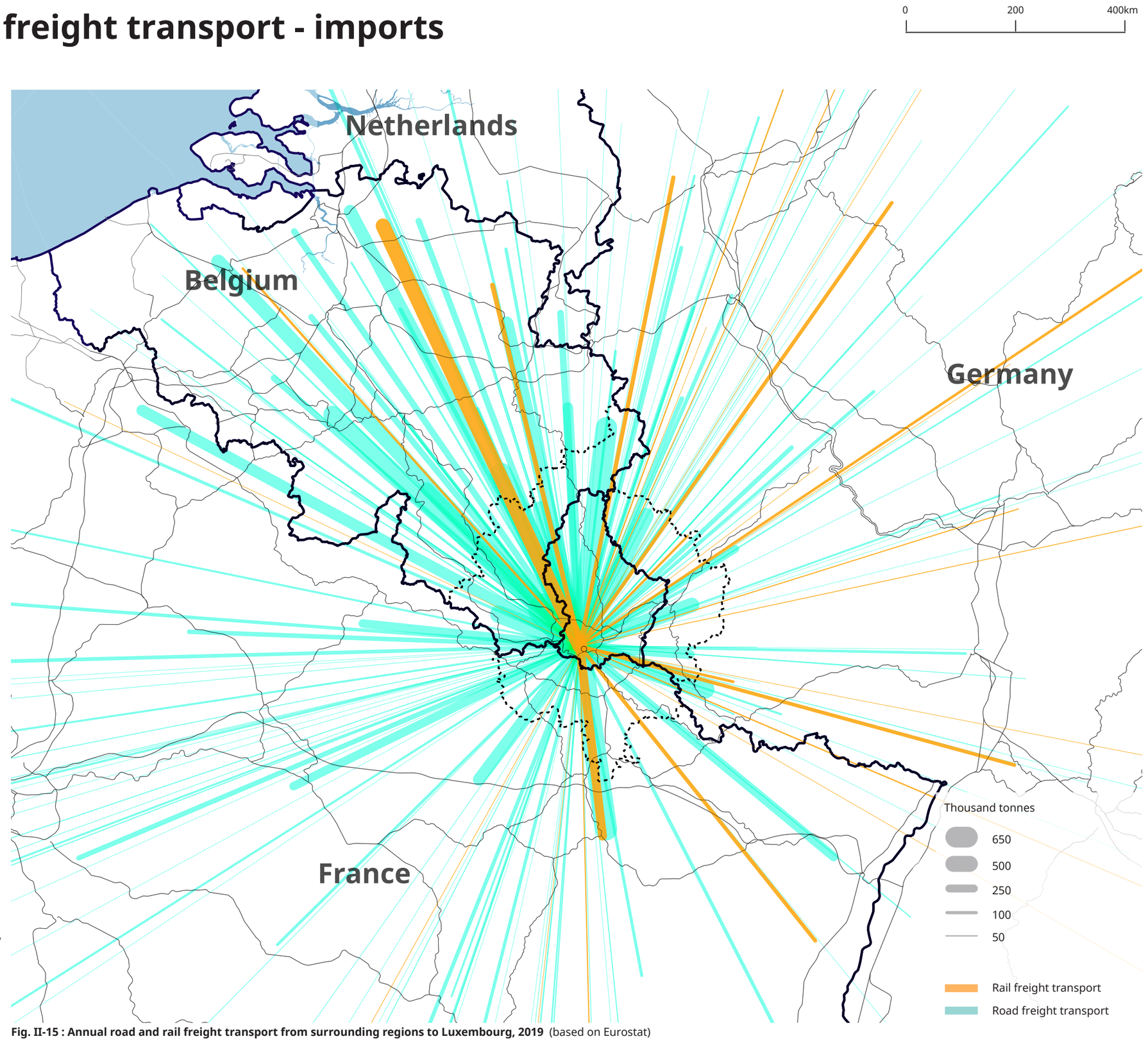


Fig. II-15 : Annual road and rail freight transport from surrounding regions to Luxembourg, 2019 (based on Eurostat)

Regional road and rail freight transport - exports

One of the biggest impediments for promoting a stronger rail transport in Luxembourg is the lack of appropriate connection between airborne and water shipment terminals to the rail infrastructure in origin points. This fact, coupled with an attractive pricing of road fuels in Luxembourg and a high quality of road infrastructure, creates the optimal situation for a road-based freight transport, while railway-based logistic only has approximately 6% of the total modal share in Luxembourg.

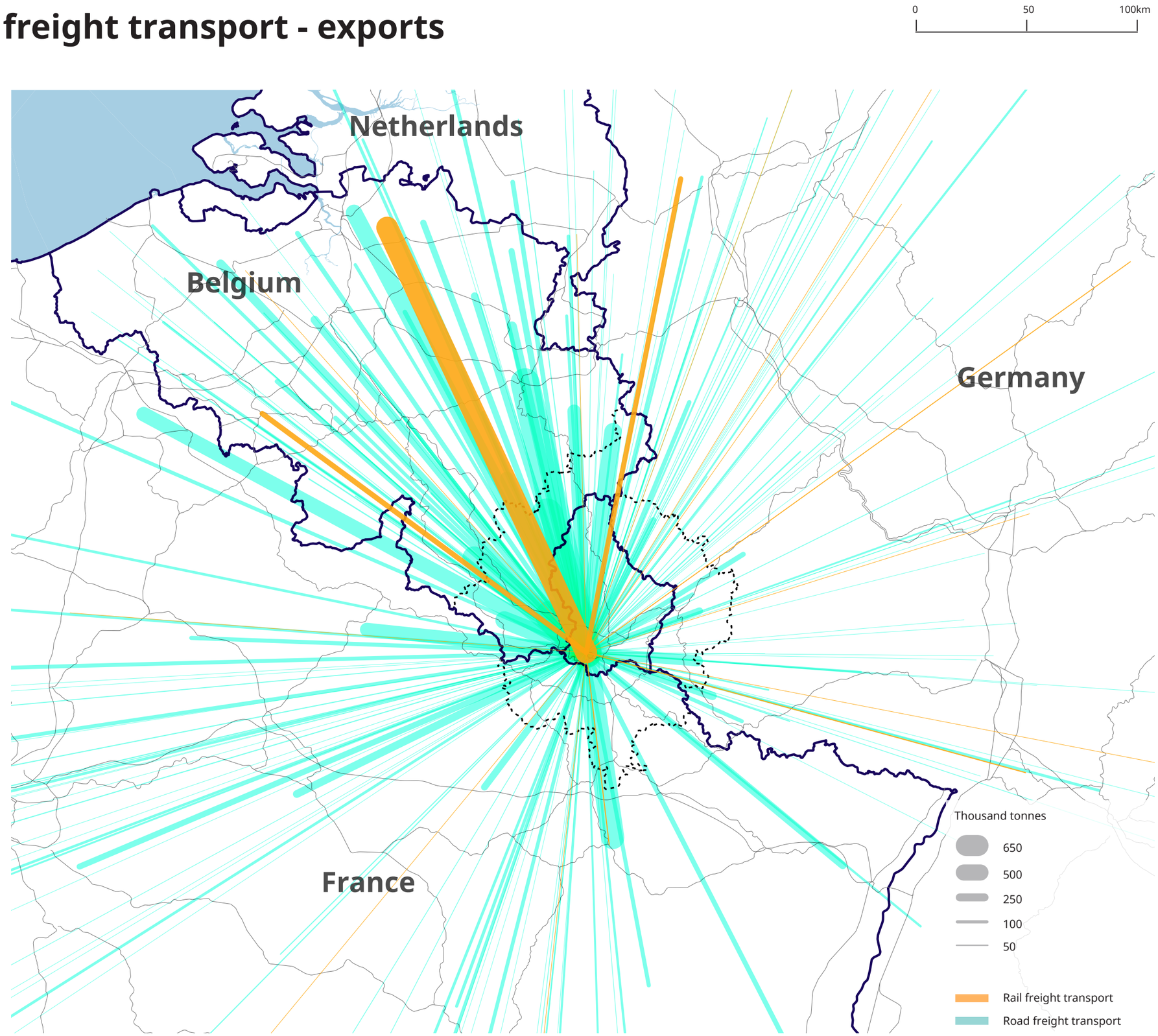


Fig. II-16 : Annual road and rail freight transport from Luxembourg to surrounding regions, 2019 (based on Eurostat)

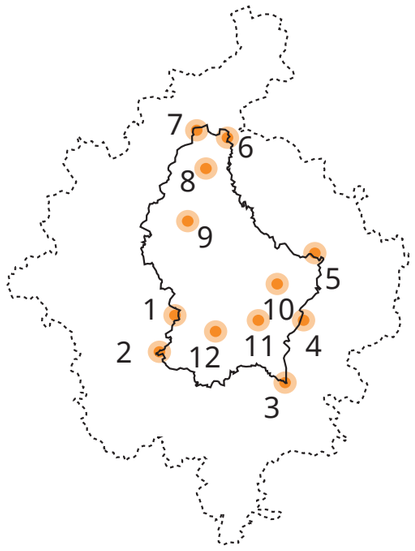
Spatial impact following the uncontrolled growth of road freight

Uncontrolled and inefficient land take

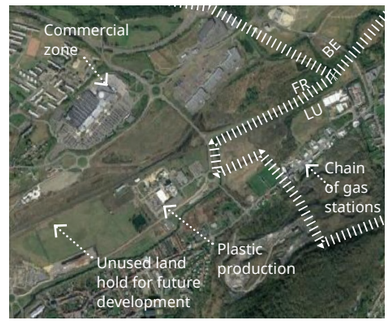
Lack of overall land regulation, the wide spread road traffic, along with different tax and pricing policies between the bordering countries, all these factors in the end led to uncontrolled land take in deep rural areas. For instance:

- A cluster of multiple gasoline stations in places along the borderline of Luxembourg to server the fuel tourism (site 2, 3, 7 in figure at right)
- Logistics parks for metal, machines, construction, chemicals, etc. along the border of Luxembourg or the main transport corridor (4, 5, 8, 9, 11)
- Unused greenfield plots are on hold, waiting for future logistics park development (2)
- Gigantic shopping malls along some major highways (2, 3, 6, 7, 10, 12)
- An Ikea mall at the border with Belgium, together with a logistics park development at the Luxembourg side (1)

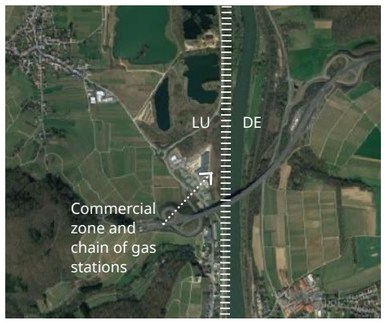
All those activities have led to significant decrease of green field and inefficient landuse with extremely low-density settings that result in car-driving-only environments. Resulting in great increase of GHG emission not only from the operation of the zones, but also via influencing collaborator companies logistics organization and individual customers consumption and mobility preferences.



1. Grass



2. PED

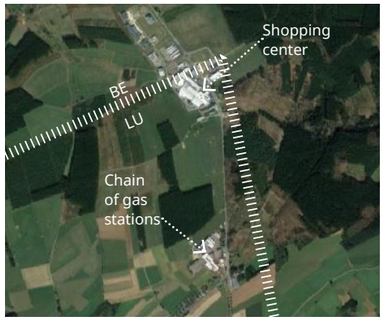


3. Schengen

4. Wormeldange

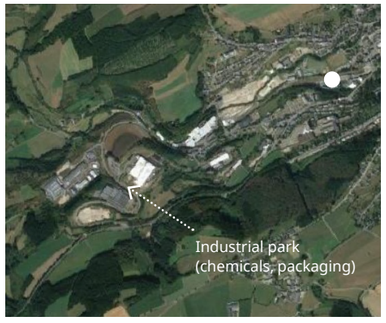
5. Echtermach

6. Massen



7. Schmiede

8. Op Der Sang



9. Salzbaach Wiltz

10. Junglister

11. Potaaschbierg

12. Am Bann

Fig. II-17 : Uncontrolled road-freight-driven sprawl in Luxembourg (based on Google Earth)

Logistic trends and impacts for urban space

New technologies, changes of behaviour and the ultimate need to reduce GHG Emissions will have impacts on the distribution of logistic spots in urban space. We are able to identify some trends on consumer behaviour and a develop to a new type of city logistic.

Consumer trends

Logistics will increase dynamically due to a fundamental change in consumers behaviour. While the 20th century may be marked by the change from routine daily shopping within inner city to a weekly one in shopping centers, the 21th century on the other hand will represent the change from physical to virtual shopping.

The Covid-19 effect is ambivalent and may show some accelerations by forcing people to use smart technologies for shopping. Covid-19 also shows the importance of organic and local food production and how it affects new social constellation. Local food-stores and organic-chains are the big winners of Covid-19.

Utilitarianism may be a type of behaviour we have known since centuries, but in the last decades we observe a systematic di-solidarisation between consumer and supplier. The traditional type of fidelity to a supplier of goods or services is replaced by an attitude of best value for best price out of a hugh offer of products. The technological changes to IT favors a type of lifestile called optimisers. They will change to e-commerce as fast as the supply chains enables. Finally consumers choice is determined by evaluation of prize, quality and last but not least the delivery time.

Another change with direct interdependence to logistics is the trend from shops to showrooms. What happens to the classical inner city shops or shopping centers? Different publications and in some cases also clothing (Bonobos, New York) are changing shops in showrooms. The complete range of goods may be touched, tried and orderd. The showroom without stock reduces costs. But to be accepted by the clients, the remote supply chain needs to be fast and effective. With smart technologies and automatization in logistics, the showroom scenario seems possible.

Logistic Trends

The main challenge of logistics in general is to organize the supply chains as fast as possible and reduce stocks as much as possible. The strategy called «just in time» was already implemented in the car industry since the 1980s and in Supermarket-Chains like Wallmart in the USA. It consists of a command - supply - produce - delivery mode, that reduces as much as possible stocks without wasting time. Identifying each component with a code makes it possible to realize a fast chain from the suppliers of components to the manufacturing of the car. The objective was, that with the choice of a car, all components are arriving at the same time to the manufacturer, where they are composed to the final product.

Today's automatization in logistic hubs and large access to smart technologies for consumers will change the logistics landscape and especially the city-logistic through new models of freight inside urban space.

Following strategic outlines of a reorganization of the city-logistic there will be an important impact on urban space.

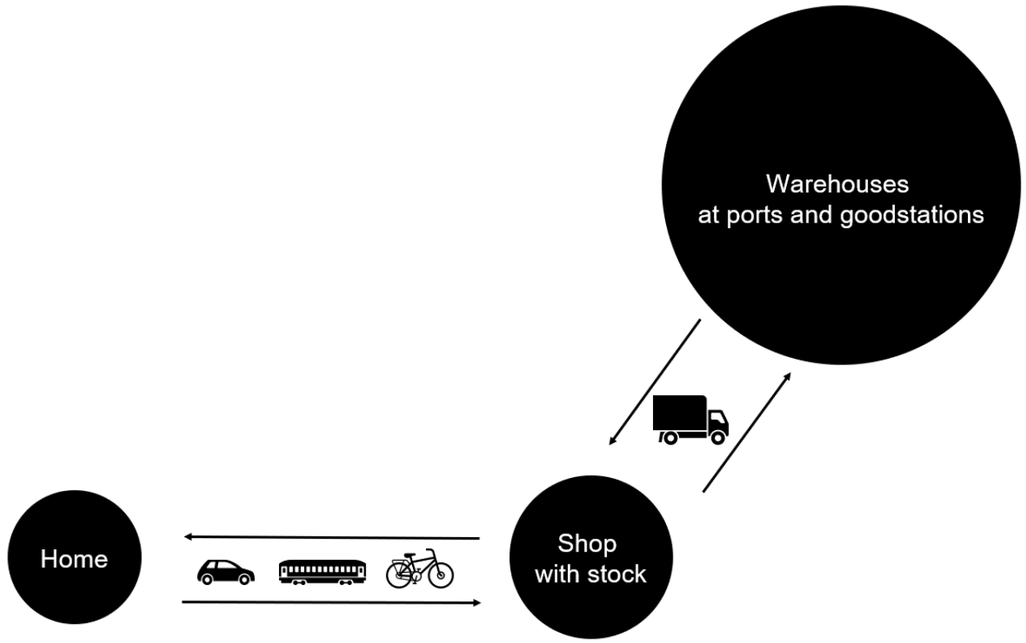


Fig. II-18 : Classical retail with stocks will mainly disappear

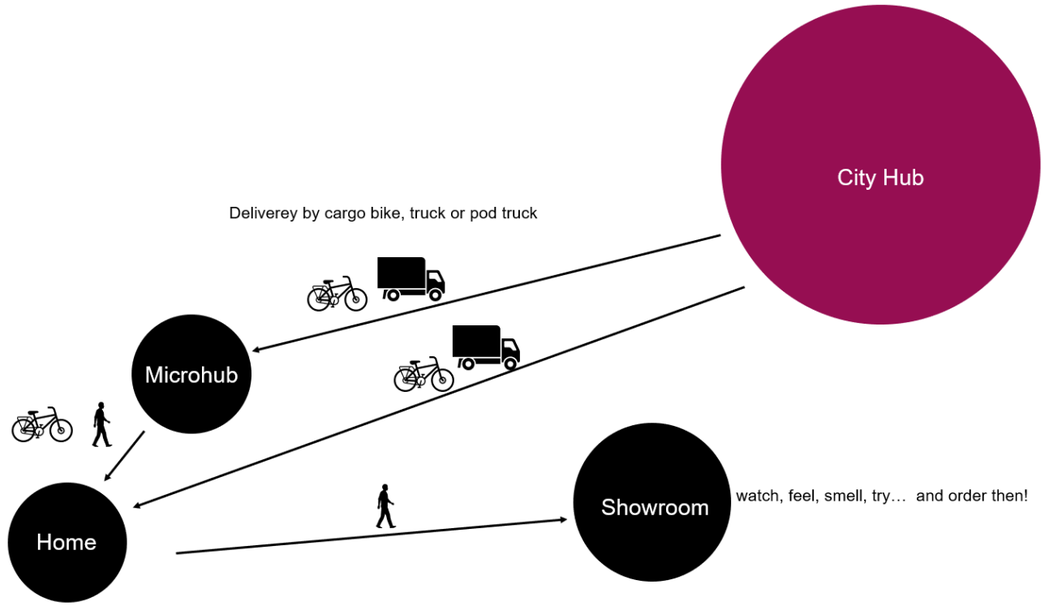


Fig. II-19 : Shops will transform in showrooms with smart delivery systems from warehouses

Level 2 - ‘Banana Belt’

Reshaping the Connecting Logistics Belt

Reshape the Connecting ‘Banana Belt’

The map of the southern functional zone shows 2 major logistics back bones:

One is the Moselle river connecting Metz and Trier. Luxembourg has a limited chance to promote this line of inland waterway transport, given the fact that it is concentrated on the eastern border with Germany with few industrial areas on Luxembourg’s side.

The other logistics back bone is the one from Athus to Bettembourg and then to Metz, where most industrial, urban and mining facilities are concentrated along the ‘Banana Belt’, the southwestern border with Belgium and especially France. Here the railway was designated as an important branch of the North Sea-Mediterranean corridor. However, the most frequently used method of transport is by road. Exploring the reconciliation of transport urbanisation and sustainable land use, this area can serve as pilot for this study.

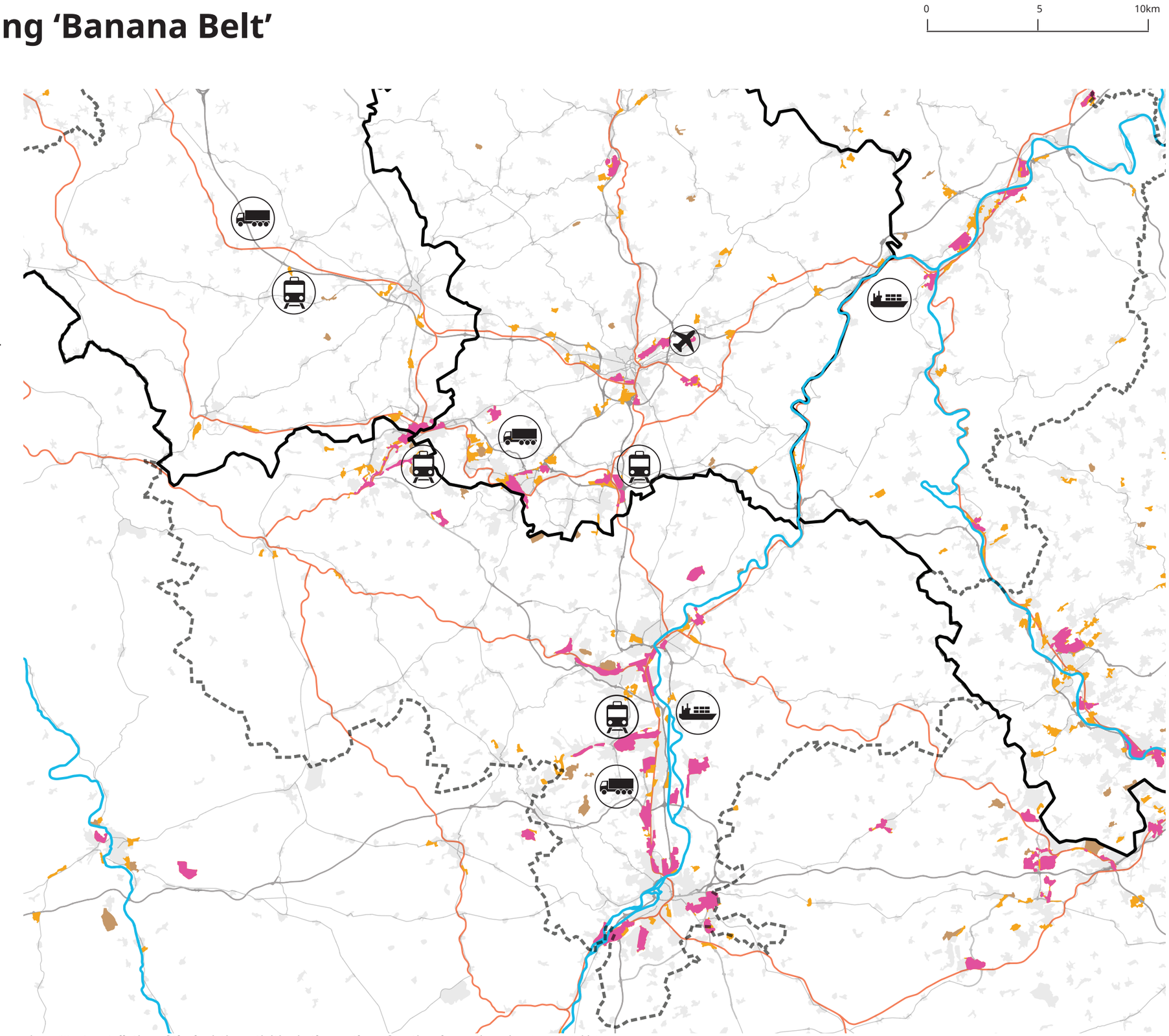
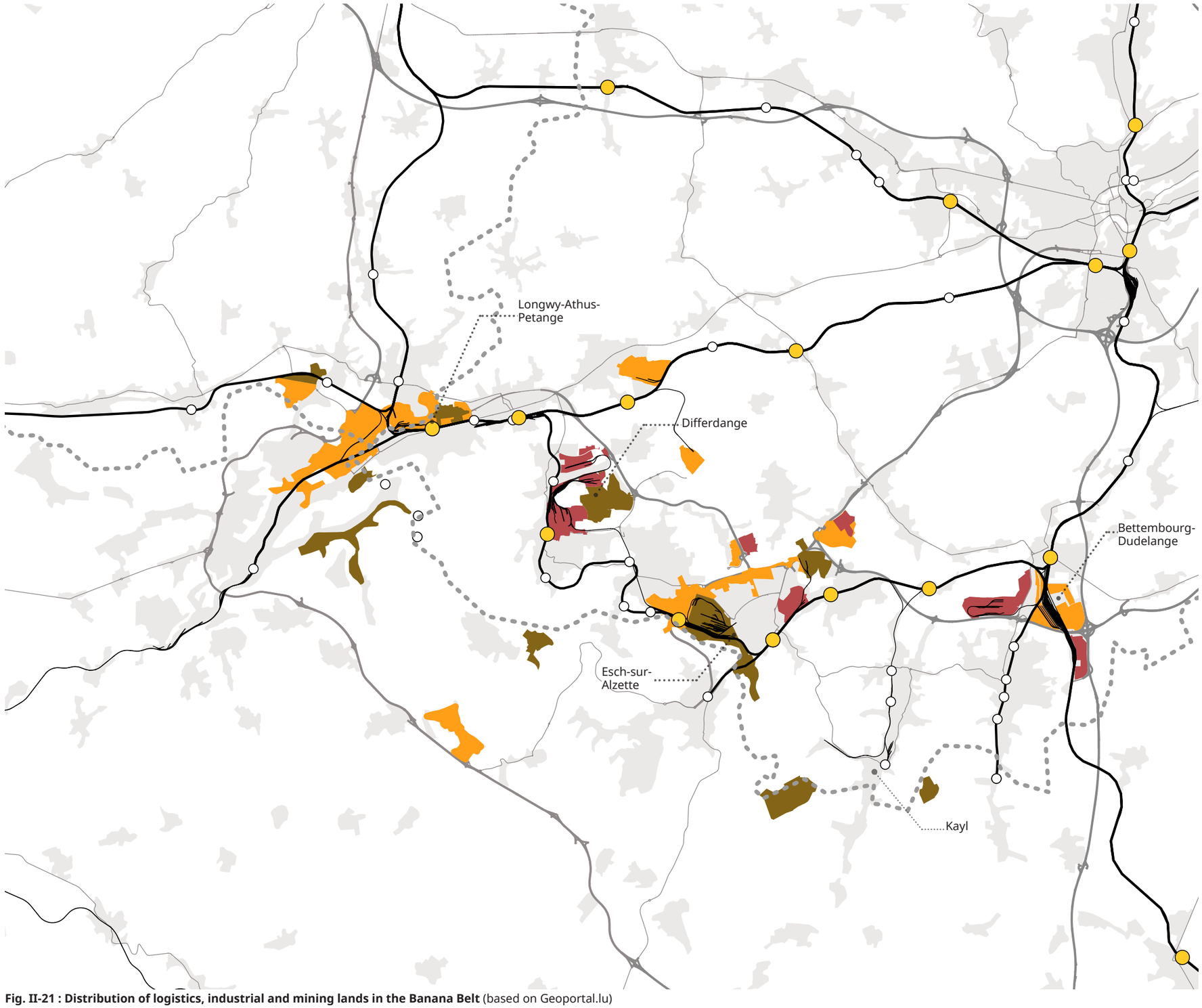


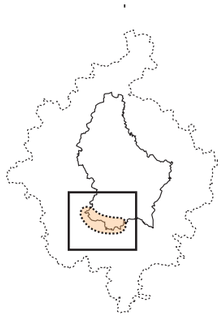
Fig. II-20 : Constellation of the logistics activities in the southern functional zone (based on Geoportal.lu)

The Southwest ‘Banana’ as a Logistics Belt

Large industrial complexes were built South West of the city of Luxembourg, of which some remains are visible today. Esch-sur-Alzette, Schifflange, Dudelange and other villages of the pre-industrial era saw an intense population boom. Around the First World War, Luxembourg ranked among the world’s six largest industrial producers.

Nowadays, the southern belt is still a most important hub of the country’s industrial sector; while raw material is still playing an important role, while high-value added processing industries and logistic services have been expanding.





- Built surface
- Logistics Service Zone
- Processing Industrial Zone
- Raw material Industrial Zone
- Major stations with high frequency of trains
- Other stations with little frequency of trains
- Railway
- Motorway
- Primary road
- Country borderline

Fig. II-21 : Distribution of logistics, industrial and mining lands in the Banana Belt (based on Geoportal.lu)

The juxtaposition of Logistics with the Urban

Meanwhile, urban quarters are also increasing in this region, more residents and companies of service sectors also came here. As the city of Luxembourg kept on growing as an officially defined centre of the country, the linear-shaped Banana agglomeration did not receive enough attention in spatial improvement.

Thus although it became a new hotspot for daily working commuters from the surrounding countries, it is still characterised by fragments, and monofunctional zones dominating the suburban landscape.

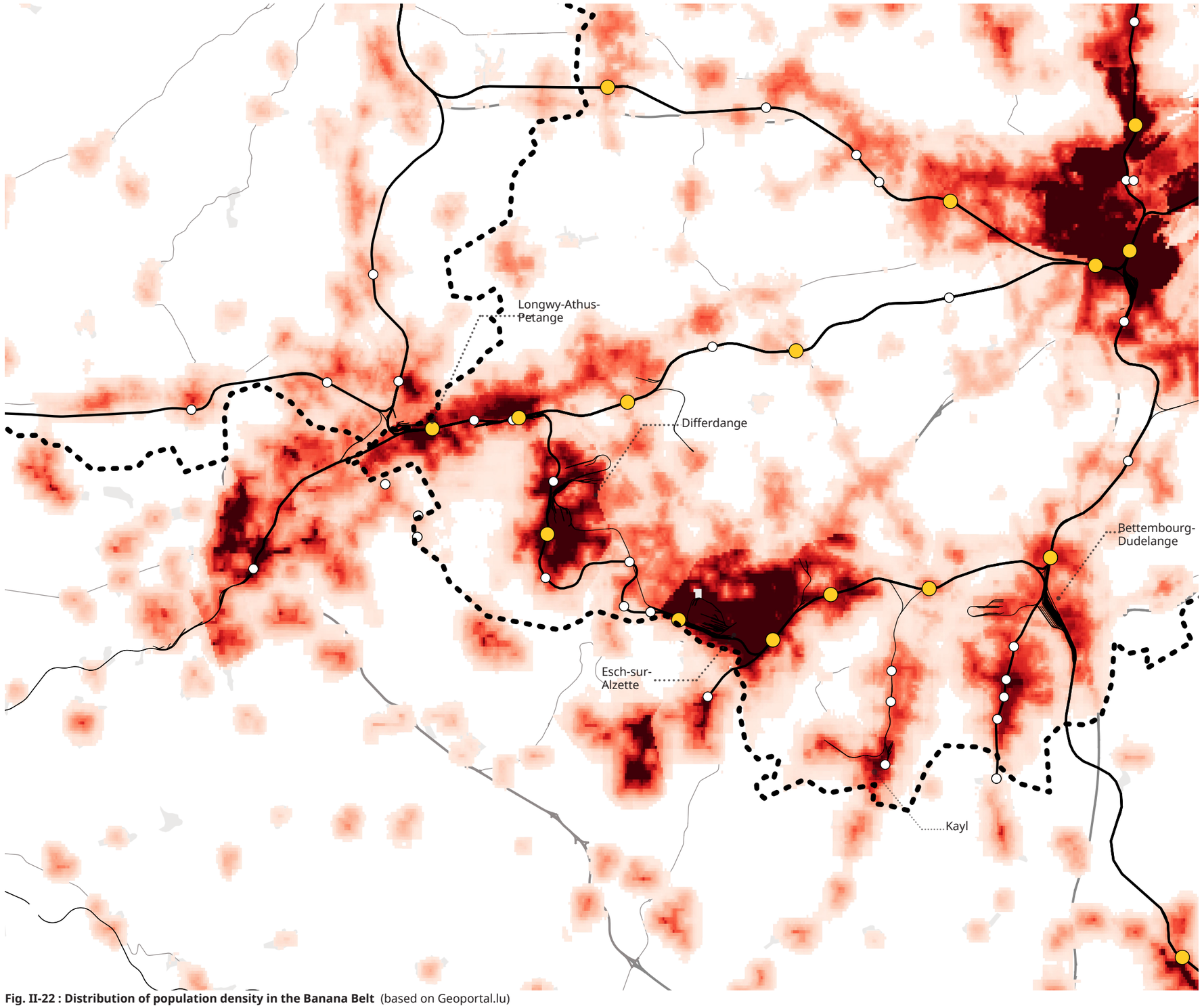


Fig. II-22 : Distribution of population density in the Banana Belt (based on Geoportal.lu)

Existing condition: Encouraging polluting road traffic and fuel tourism

To support car usage, Luxembourg has offered a large number of parking space in the cities and settlements along major road axis.

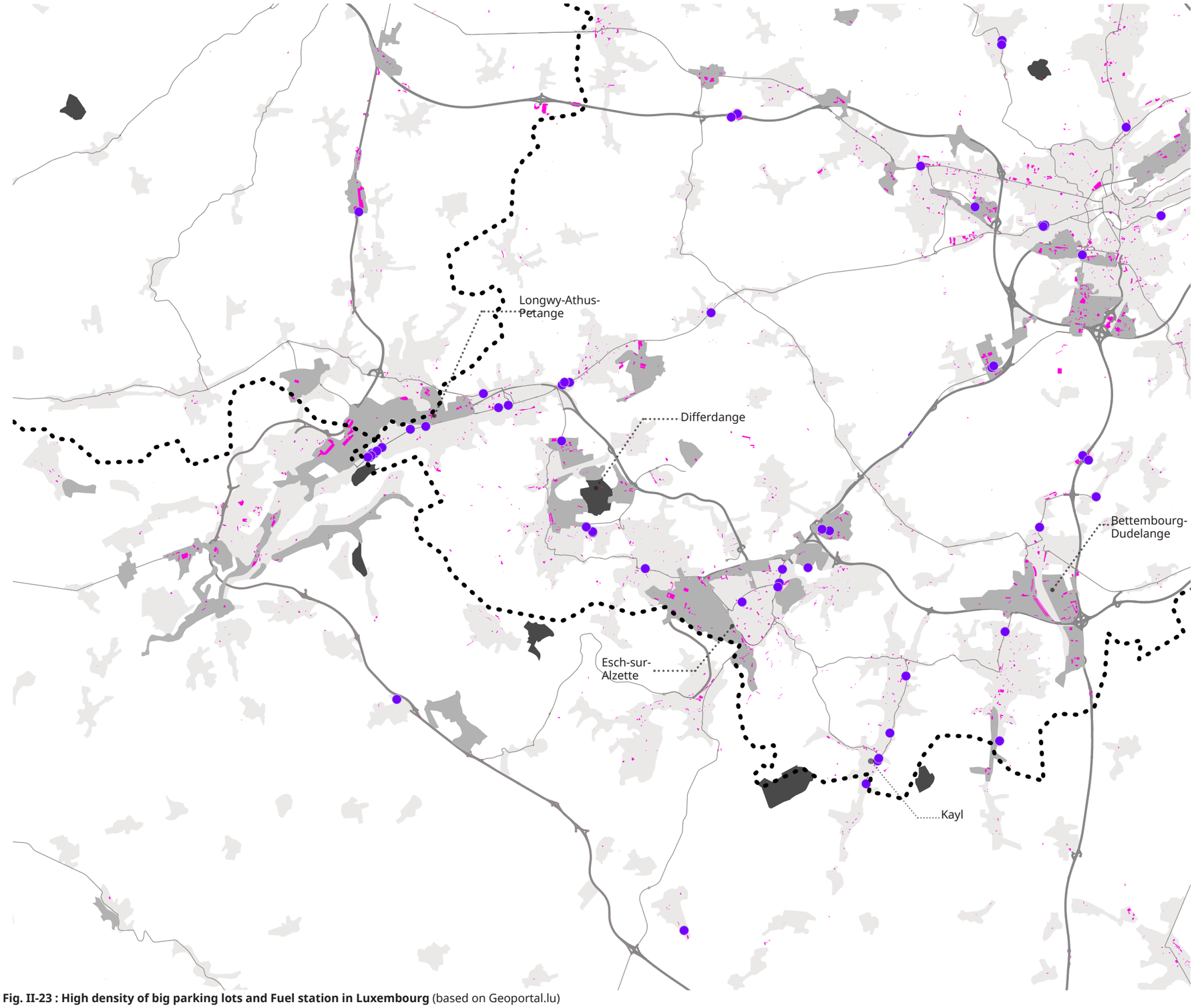


Fig. II-23 : High density of big parking lots and Fuel station in Luxembourg (based on Geoportal.lu)

Existing condition: Encouraging polluting road traffic and fuel tourism

As local artist Robert Viola noted in his painting of a petrol station: “These urban temples dedicated to the gods of petrol and the automobile have become places of life, bits of cities placed a little further along the roadside by the urban tide. Village squares without churches, coffee shops without boozers, grocery shops without grocers, gas stations are part of our lives and our cities.”

Thanks to the comfort and low fuel price, a lot of gas stations emerged at the border space in clusters, which contribute to Luxembourg’s high national GHG emission. As the infrastructure is already so convenient, the more it gets ‘improved’, the more difficult a sustainable modal shift will be to implement. Compared with surrounding countries such as Germany, Luxembourg’s density and accessiblity of E-charging stations is relatively low.

Fig. II-24 : Gallery BC/2 Bettembourg 2006: Oasis, Robert Viola (www.robertviola.lu)

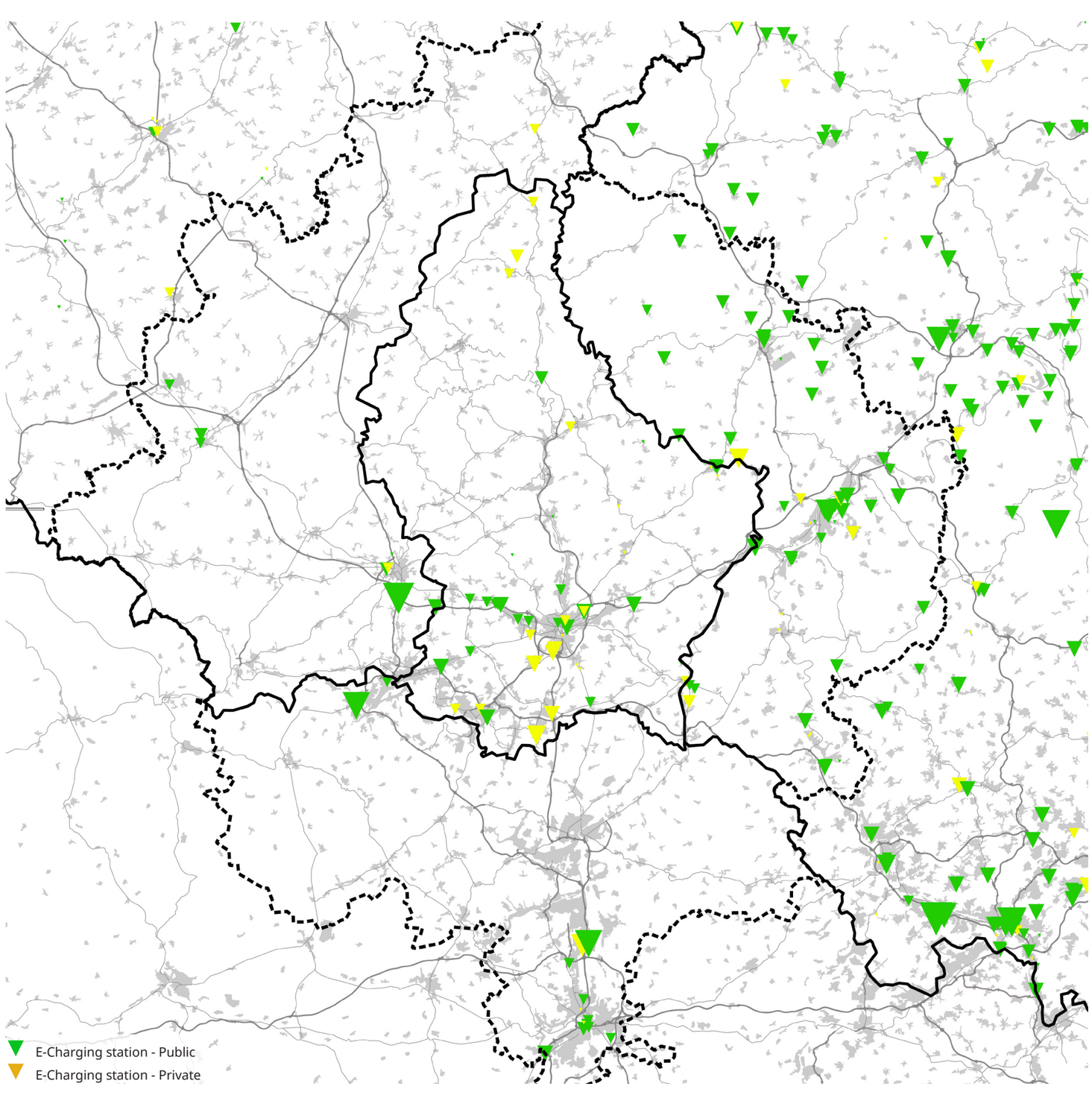


Fig. II-25 : Insufficient E-Charging station in Luxembourg (based on openchargemap.org)

Strategies for Logistics

Hardware: Promoting multi-modal logistics and industrial symbiosis

Increase multi-modal logistic chains and improve the connection the first and last-miles

Studies point out that sea transport is a more scalable, secure and economic viable mode of logistics than road transport (Unifeeder, n.d.). Therefore, improving the connection between major logistic terminals to the current railway infrastructure in both the first and last miles to enhance the synergy between international and local logistics to and from Luxembourg is paramount to improve efficiency. This could be done by further analysing the current state of rail freight corridors, such as the North Sea-Med (RFC2), that connects the southern area of Luxembourg to the North Sea.

Industrial symbiosis for the heavy logistics sector

Already tested on industrial sites in Denmark, such as the Kalundborg Industrial site (Symbiosis.dk, n.d.), the concept of industrial symbiosis has the potential to alleviate the current heavy logistics system by implementing a circular economy approach to the industrial sector and reducing the need to rely on logistics of heavy good from outside. Industrial symbiosis states that the output of one industry, such as the mining sector - can be turned into the input to another, like construction sites. This could be done by overhauling the current infrastructure at the local scale to implement connections from one industry to the other.

Fig. II-26 : The North Sea-Mead (RFC2) rail corridor (European Commission, n.d.).

Hardware: Energy

Promote hydrogen usage

H2 is an alternative energy storage medium for long-distance, heavy-duty road transport in vehicles, given no offer exists for electric long-haul, heavy-duty goods transportation as their cost-performance ratios must yet be improved. Since the production of hydrogen in Luxembourg is either not economically viable or politically blocked, the alternative for Luxembourg to source hydrogen as a fossil fuel substitute is by importing it.

H2 can directly be used in electric vehicles as storage to run the vehicle's fuel cells. A decentralised use of H2 in fuel cell vehicles is, however, currently challenging by lack of comprehensive H2 fuelling infrastructure and serial-production of affordable fuel cell-powered long-distance mass-passenger or heavy-duty goods transport vehicles. Both challenges could be addressed through an EU initiative by installing hydrogen fuelling infrastructure along the TEN-T Core Network Corridors. Following that, vehicle manufacturers and transport companies can then be motivated to switch to fuel cell vehicle production. (Gas for Climate, 2021)

Currently, the interregional hydrogen pipeline project between France and Germany called « mosaHyc » would offer Luxembourg the possibility to connect to a cross border H2 transportation network (Apelt, 2020). The project makes a case for repurposing an existing natural gas grid. It may become a cross-border regional network for the transportation and distribution of unblended hydrogen between Germany, France, and the Luxembourg border. Luxembourg should try to maximise the benefits of this project, ideally via repurposing its natural gas grid. It could be injected as a blend into the gas grid, ans supplied as a fuel to transport sector or aviation (Trauffler, 2020)

Luxembourg's network operator, Creos, operates a network of 2.130 km with interconnections to surrounding countries. It mostly serves residential clients and industry mostly in the South. In the longer-term, according to a plan for the EU, Luxembourg could also serve as transit of hydrogen for a North South connection by 2040 (Gas for Climate, 2021).

Pipe repurposing as priority

If a significant decrease in both residential and industrial gas flows allow it, and hydrogen demand picks up, a new pipeline would be built connecting to Belgium at Bras to the MosaHyc project near Remich at the German border. Another even preferable option might be a repurposed pipeline, if the structure of end customers would no longer justify continuing the conventional operation and provided that security of supply of the customers can be guaranteed. The network of Luxembourg would connect Germany to Belgium and thus in the future could also serve a transit role.

A theoretical complete substitution of diesel by H2 in the transport sector could enhance the national carbon footprint by 25%. (Trauffler, 2020)

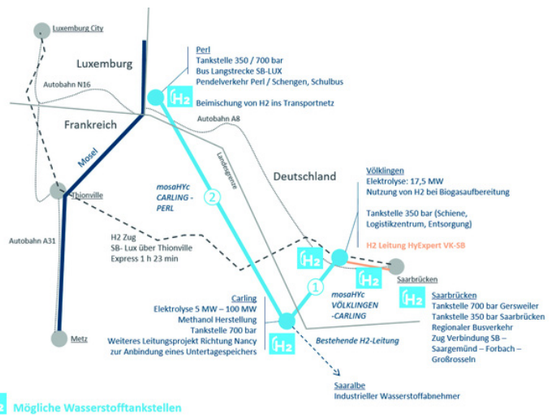


Fig. II-27 : The mosaHYc project (by Creos)

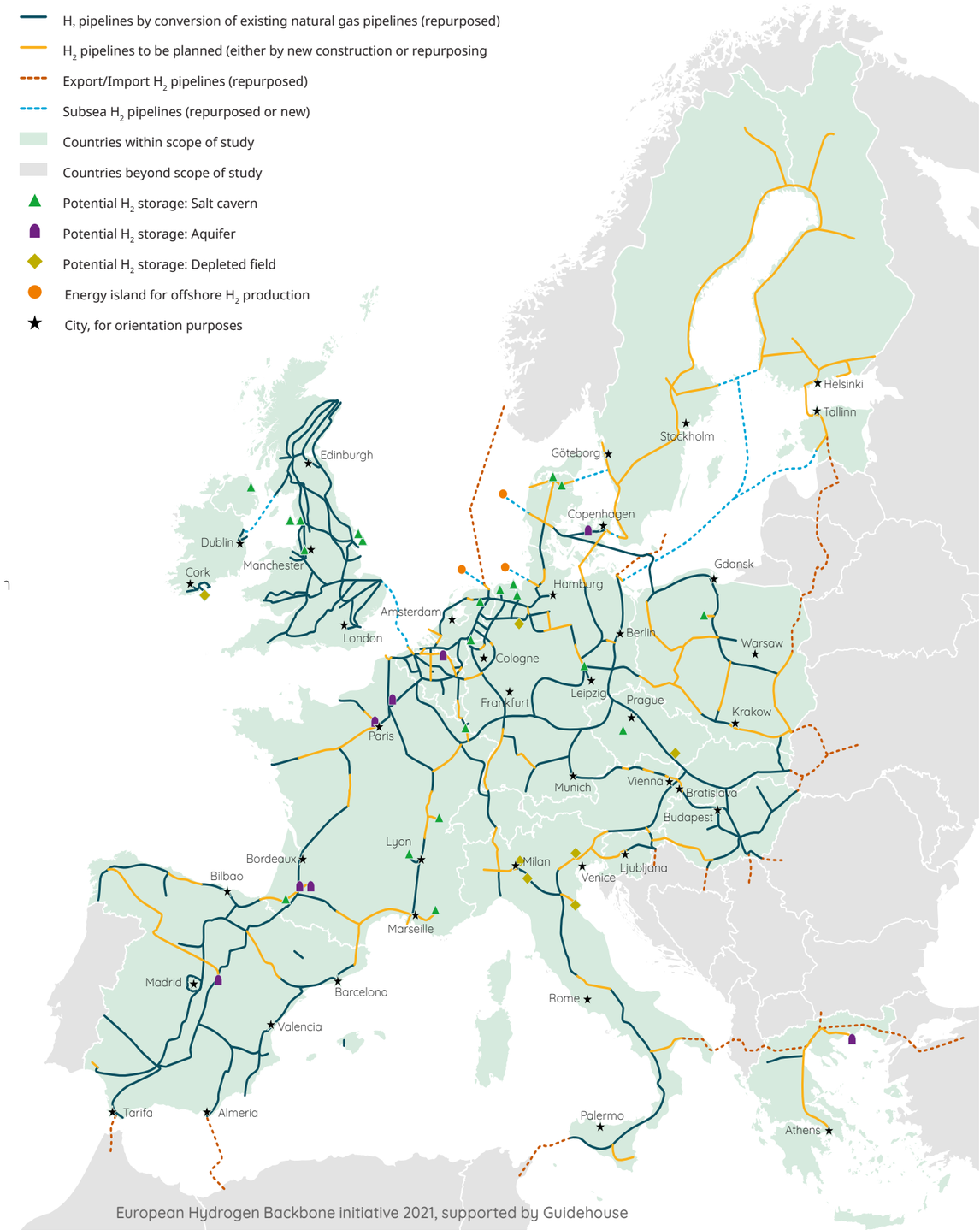


Fig. II-28 : European hydrogen backbone initiative 2021, a plan for 2040 (Gas for Climate, 2021)

Software: Tariff and Regulations

Determined increase Tariff and VAT for fuel consumption

For a long time, Luxembourg has been serving as a fuel tourism destintation due to its abnormally low fuel price. since January 2021, a CO2 tax came into effects. Currently it is EUR 20 per ton of CO2 emitted. The tax will gradually increase over the next few years, i.e., EUR 30 per ton of CO2 emitted in 2023. The government anticipates that retail prices should increase by about EUR 0.05 per liter of gasoline or diesel (DCL, 2020)

However, comparing Luxembourg's most recent diesel price (1.15) with its surrounding countries - Belgium (1.41), Germany (1.32), France (1.38), Netherlands (1.41), it will remain as the cheapest place unless the price would increase another 0.2 Euro per litre.

Charging distance-based toll for heavy goods vehicles

During the last few decades, the European Union has promoted distance-based charges on heavy goods vehicles for the use of main roads. This approach has progressively been implemented by many European nations. The toll is applicable to all trucks that have a gross vehicle weight of 3.5 tonnes or more, and could be higher depending on the weight of the vehicle, or less with certain EURO class trucks that emit less air pollution. (T&E, 2016)

Urban Access Regulations

Urban access regulations are applied where certain types of vehicles are regulated or restricted from entering a part of an urban area. They regulate the use of city roads to help mitigate issues such as air pollution, noise or congestion. Major types of urban access regulations include (UAR, 2021):

- ***Low Emission Zones (LEZs)*** : areas where vehicles with higher emissions cannot enter the area or have to pay more if they enter the zone. Most low emission zones operate 24 hours a day, 365 days a year. They usually affect heavy duty goods vehicles (usually over 3.5 tonnes Gross Vehicle Weight (GVW)), buses and coaches. For example, the Low Emission Zone in the Rotterdam Port for trucks has a tight standard: only Euro 6 lorries are allowed. Before this regulation's full enforcement on Januray 2020, policy makers have since 2014 given exemption for 'companies at risk' and time to invest in new equipment.

- ***Urban road toll:*** where entry to an area is subject to payment. In most cities the money raised from the schemes is usually spent in the improvement of transport in and around the city. The urban road toll can be operated by camera enforcement, an electronic transponder, or by paying on entry to the area. Taking London's scheme as an example, traffic entering the zone was reduced by 18%, traffic circulating the zone was reduced by 15%.

- ***Heavy Goods Vehicle Management:*** a specific urban access regulation practiced in Dublin. it bans 5+ axle vehicles during the hours of 07.00-19.00, seven days a week from a designated cordon area and provides a limited permit scheme for 5+ axle vehicles that need to load/unload within the city centre area.

In the case of Luxembourg, Urban Access Regulations could be applied to both the city of Luxembourg and the southern Banana Belt. We advise Luxembourg to make use of existing European Legislation (EETS Directive) and existing ISO standards to design a pricing implementation policy that enables interoperability - a crucial success factor in any such scheme for logistics vehicles.

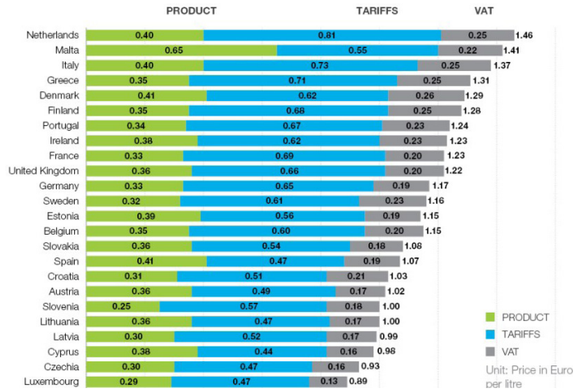


Fig. II-29 : Luxembourg is one of the countries with lowerst tarriff and VAT for diesel in EU (FuelsEurope, May 2020)

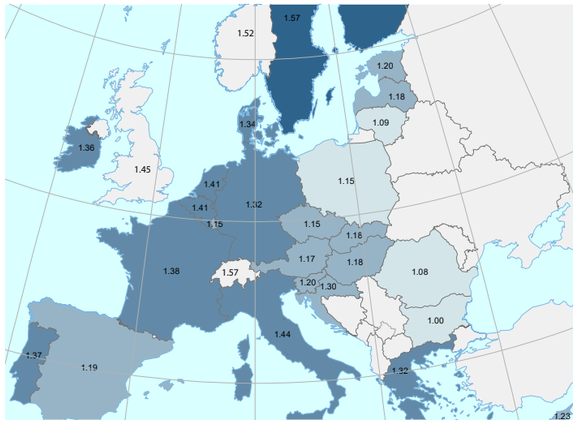


Fig. II-30 : Consumer price of Diesel (€/L) (Eurostat, May 3. 2021)

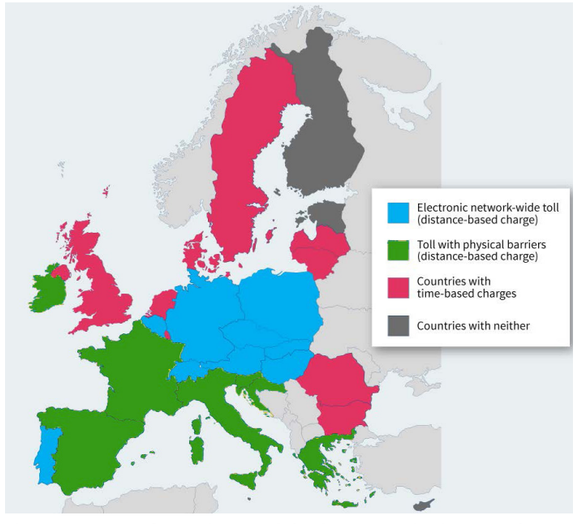


Fig. II-31 : Luxembourg is one of the few countries in central Europe without distance-based toll (T&E, 2016)

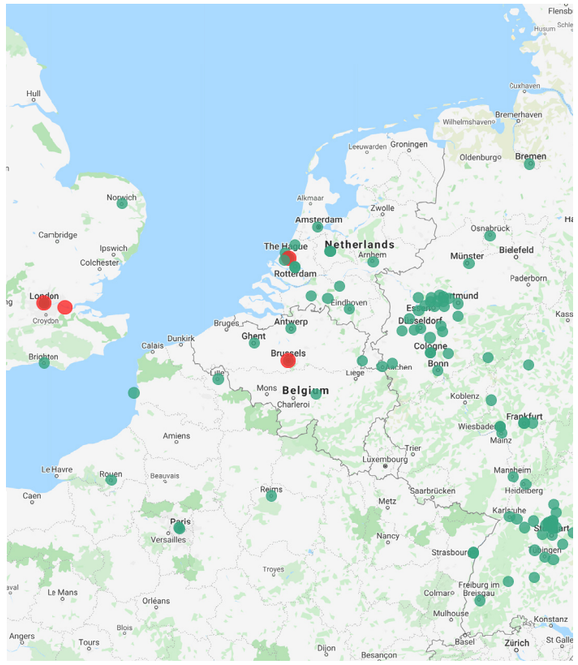


Fig. II-32 : Luxembourg do not have any type of urban road toll or low emission zone regulation (UAR, 2021)

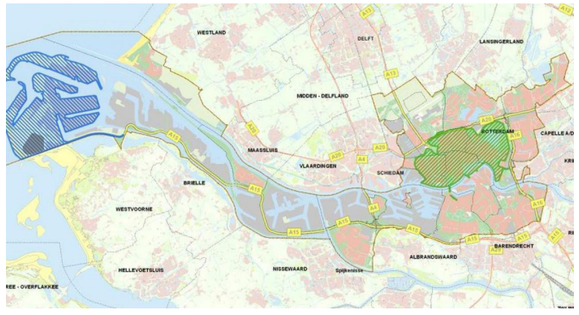


Fig. II-33 : Rotterdam's Low Emission Zones (milieuzone) since 2020 (HSBA 2017)

Software: Tariff and Regulations

We make a priliminary demonstration with a software strategy for Luxembourg.

A. Increase the fuel price to reach a similar level as surrounding countries or even higher, nation-wide

B. Changing the time-based into distance-based toll for heavy goods vehicles, nation-wide

C. Imply urban access regulations for both the agglomeration of Luxembourg and the agglomoration of the southern Banana. The principle of creating the zones are:

- Urban road toll zones for all the urban agglomeration with Job opptunities. where trucks and cars meeting the requirement of low emission (EURO 6 or higher) are allowed to enter, but need to pay a high toll.
- Low emission zones for all key logistics and industrial areas related to them, only vehicles mmeeting the requirement of low emission are allowed to enter.

The exact location and regulation need further in-depth study with detailed data.

Fig. II-34 : Demonstration of possible urban road toll zones and low emission zones (based on Geoportal.lu)

Software: Urban Cycle logistics

An alternative for Last Mile

Today's distribution systems inside cities are organized by different logistic enterprises with their own warehouses and truck fleet. All are covering individually the same larger area from one logistic site with trucks.

Vans, light-duty trucks and SUVs are important GHG emitter in cities, For example in Toronto, they contibute to 16.4% if the GHG emission. In congested areas where delivery vehicles are stopping, starting and idling, their emissions are much greater than in free flowing traffic.

As a greener alternative, cycle logistics services can improve goods delivery and transport passengers more efficiently compared to motorised transport. Examples include last and first-mile delivery services, home deliveries, goods shipments in cities, etc. (EC, 2020)

Potential for increased efficiency

In England, Last Mile Manchester, a cycle logistics delivery service company, is able to perform more deliveries per hour than a traditional delivery service vehicle, as it is more flexible in traffic and parking. For example, DHL vans in Manchester are able to perform 6-8 deliveries per hour, while Last Mile's emissions-free electric cargo bikes make 10-12 deliveries per hour. In addition, the environmental benefits are clear, with bicycles producing zero carbon emissions. (EC, 2020)

Cycling facility requirements

Cycle logistics services can be introduced in cities with both low and high levels of cycling. Cities with a low level of cycling may require additional motivational support aimed at stakeholders or potential users of the services, and the implementation of appropriate cycle infrastructure required to support their use (e.g. cycle parking facilities, cycle lanes etc.).

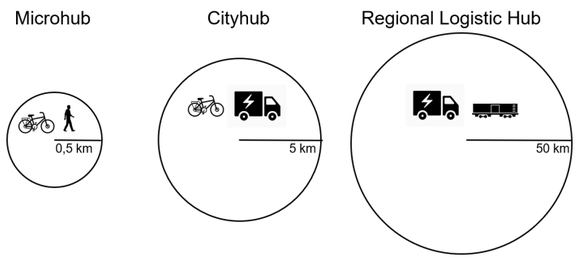
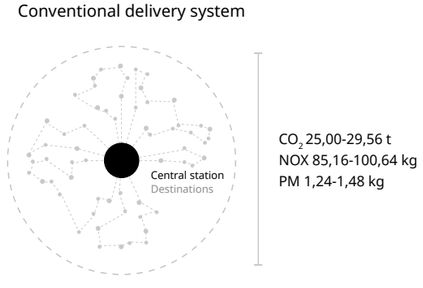


Fig. II-35 : Introduce new scales of logistic hubs



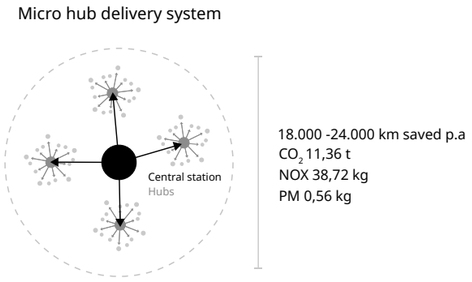


Fig. II-36 : GHG Emission reduction and driving distance saved through UPS Hamburg model of micro-hub system (HSBA 2017)

Location selection and adaptation

Cyclelogistics are likely to be appropriate in city centres, as deliveries like first and last mile services benefit from a concentration of businesses in one or several locations. Cities with particularly hilly topography may face initial barriers to introducing cyclelogistics, which could be overcome through the use of electric powered cargo bikes.

Finance

The finance required depends on the services on offer. Working with private actors, such as a cyclelogistics provider, can help to keep investment and ongoing costs low. The required financial resources also depend on the scope of the measure. Extreme variations can be seen e.g. in high costs of establishing a consolidation centre hosting several logistics actors.

GHG emission reduction

The integration of electric vehicles in vehicle concepts can also significantly reduce all "direct" emissions. In the Hamburg case, this results in a reduction of CO2 emissions by at least 50% (3.4 t) for each of the micro-hub locations. In the field of NOX and PM emissions, the savings potential is also over 50%.

More attractive in the new labor market

The working conditions with low wages and many working hours plus on-call times do not make the urban logistics' occupational profile attractive for the younger generation. The micro-hub can contribute to coping with the challenge of driver shortage: 1) Using cargo bike and hand truck means as no drivers' license is needed anymore; 2) the working conditions become more attractive in last mile deliveries, the early morning parcel sorting at the depot is no longer needed. Part-time and mini-job models become possible.

Fig. II-37 : Possibility for cargo vehicle parking along streets

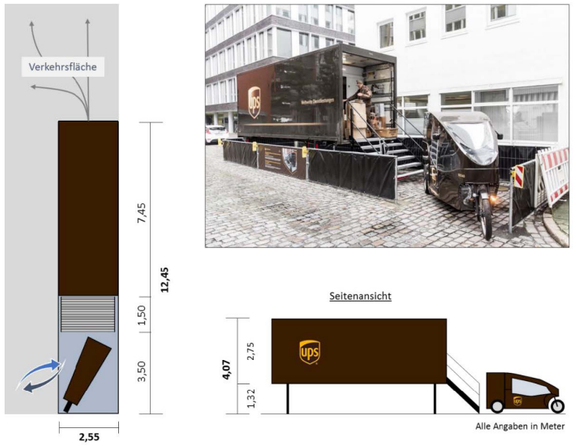


Fig. II-38 : Principle sketch of a micro-hub, UPS Hamburg (HSBA 2017)

Software: Urban Cycle logistics

Distribution principles

Cycle logistics hub (micro-hubs) should be:

- located in dense urban areas. They are not directly served by the central sorting center.
- served by intermediate hubs, covering an area of 6km radius, to reduce truck and van traffic within residential areas.
- implemented in brownfields or existing commercial structures, as well as parking spaces. Their appropriate size covers 3 parking spots.

In these micro-hubs, parcels are sorted and redirected on cargo bikes throughout the city. Their recommended catchement areas cover a distance from 800m to 1km, depending on the type of delivery vehicle. This ensures a short travel time and an accessible level of physical effort for carriers. (EC, 2020)

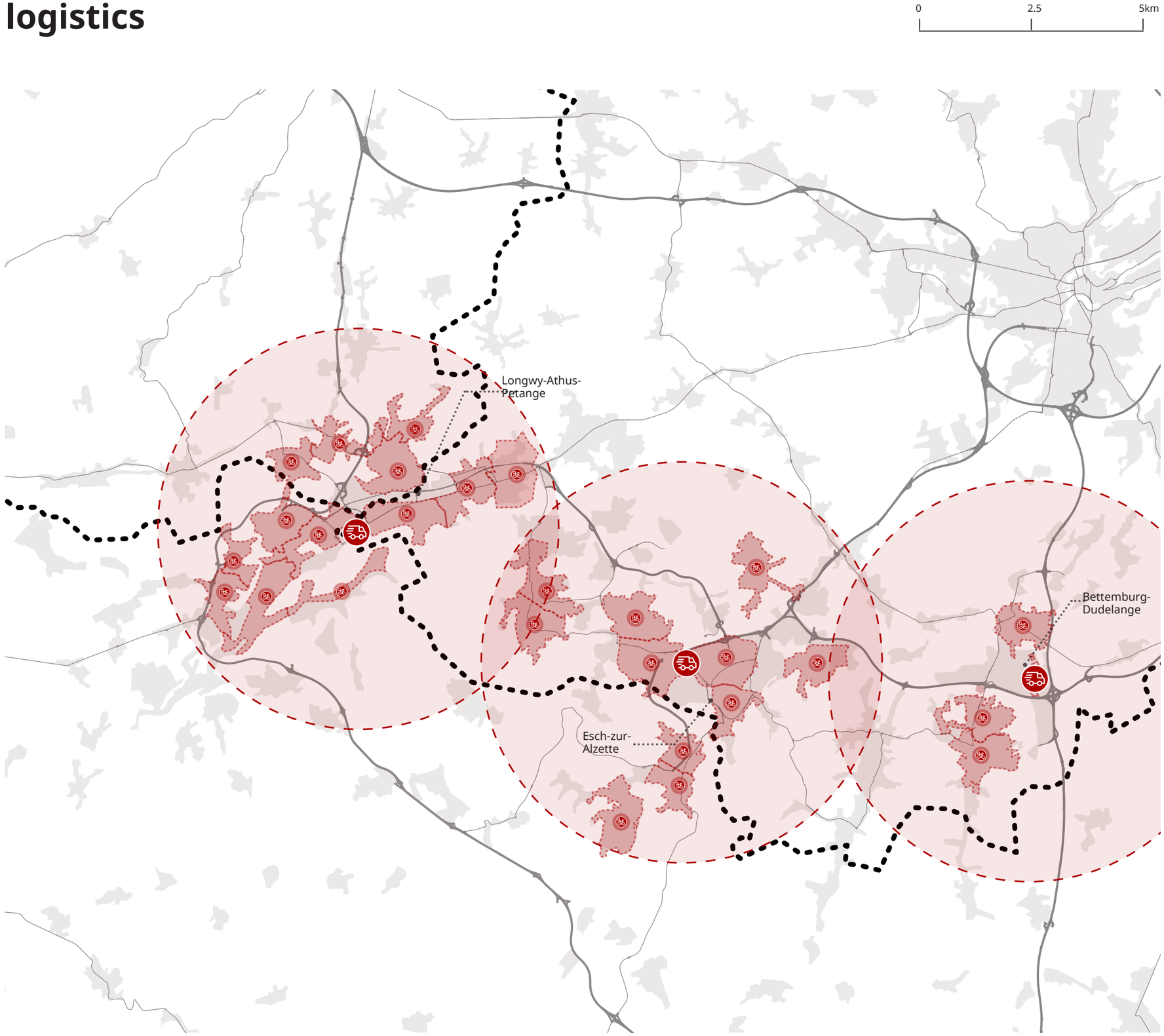


Fig. II-39 : Indicative micro-hub system for urban settlments of the Banana Belt

IN MOBILITY

Introduction

Due to the amount of cross-border commuters, the heavy car dependency and the lack of good service of the public transportation system, personal mobility plays a major role in the GHG emissions in the functional region. We performed a set of spatial analysis to understand the major strenghts and constraints in the functional region, which combined to our strategies and spatial interventions may promote a positive balance to the overall GHG emissions in the functional region. An assessment of the following points has been made:

Understanding the current cross-border commuters dynamics

- What are the main corridors for cross-border commuting in the functional region?
- Why is the car such an appealing mode of transport for commuting?
- Which corridor presents a predicted development of growth?
- Is there a concentration of cross-border commuting flows in the functional region?
- How many cross-border commuters are in the functional region?

Understanding the public transport service and reach

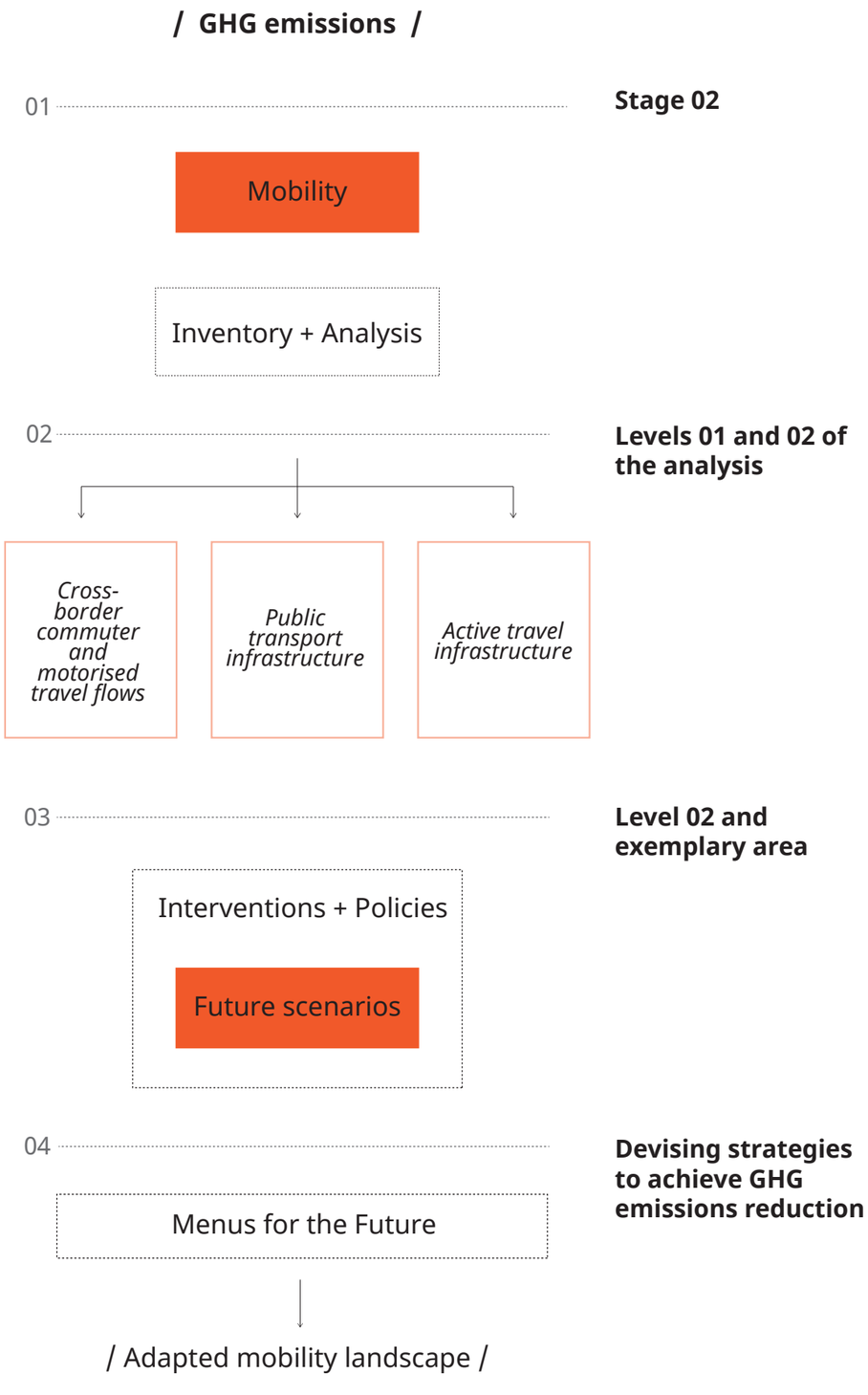
- How is the current public transport infrastructure in the functional region?
- How is the current service of the public transport infrastructure in the functional region?
- How is the synergy between the public transport system and the current cycling facilities?
- What percentage of the population has access to public transport within an accessible catchment area?

Understanding active travel patterns and infrastructure

- How is the current state of the national cycling infrastructure?
- What is the current travel pattern for different types of trips?

Supporting our analysis with qualitative research

On the first of may our group met with the Citizen's Comittee of Luxembourg (Bierger-kommitee) and discussed the subject of mobility and our initial findings from Stage 1. During the month of May the attendees of the committee gave insights and feedback through a structured survey, which can be found in the Annex of this report. Narratives were also shared with the team via a survey, many of which can be seen within this study.



Level 1- Functional Zone

Transnational Commuters Mobility

Transnational Commuters Mobility: Understanding the dynamics

"The choice (for a mode of transport) is quickly made. A one-way trip takes around 35 to 45 minutes by car, the same distance by public transport takes 1h45 min."

Testimonial from Survey made with Citizens in May 2021

3.1.1 Spatial analysis of the current commuter loads (rail and roads)

Understanding the mobility patterns of cross-border commuters is paramount for ensuring a plausible transition towards carbon neutrality, as they represent approximately 43% of the workforce in the country (ESPON ACTAREA). As of 2015, Luxembourg City received 181 thousand cross-border inbound commuters (Eurostat, 2018), nearly 150 thousand within the functional region (LISER, 2017).

Spatial analyses show that daily commuters are mainly concentrated on the south, southwestern and eastern areas of the functional region. From the total cross-border commuters, approximately 98,000 people come from France (52%), 45,000 from Belgium (25%) and 44,000 from Germany (23%) (IBA-OIE).
For daily commuters within Luxembourg and in the functional region, the automobile is the preferred transportation mode, covering around 83% of the total modal split distribution. Other means of transportation, such as public transport, are not attractive enough. Citizens' testimonials often describe the lack of connectivity and uncoordinated frequency to other urban nodes as some of the reasons to continuing using the private automobile, despite Luxembourg being the first country in the world to effectively make its public transport free.

Analysis of commuter loads identifies three main corridors for cross-border commuting (as see on Figure III-1): the first one concentrated on the A3 and A31 between Thionville/ Metz and the centre-southern and southern regions of Luxembourg; the second corridor concentrated on the A6 being between Arlon and Luxembourg City; and the third being on the A1, the corridor between the centre-southern and Trier. Commuters' primary destination is the City of Luxembourg, the economic powerhouse of the functional region, which alone receives 400,000 commuters every day, from inland and outland (ELTIS, 2020).

Research points that the proportion of cross-border commuters between France and Luxembourg (correspondent to the first corridor) is slowly but continuously increasing over the years, when compared to the other corridors, as noted in Figure III-2 (ESPON Actarea). Furthermore, research points out that the total number of cross-border commuters in the French region is expected to double by 2030 – specifically in the region of Grand Est to Luxembourg City there is an expectation to reach 130,000 cross-border commuters by this period (COREST, 2018).

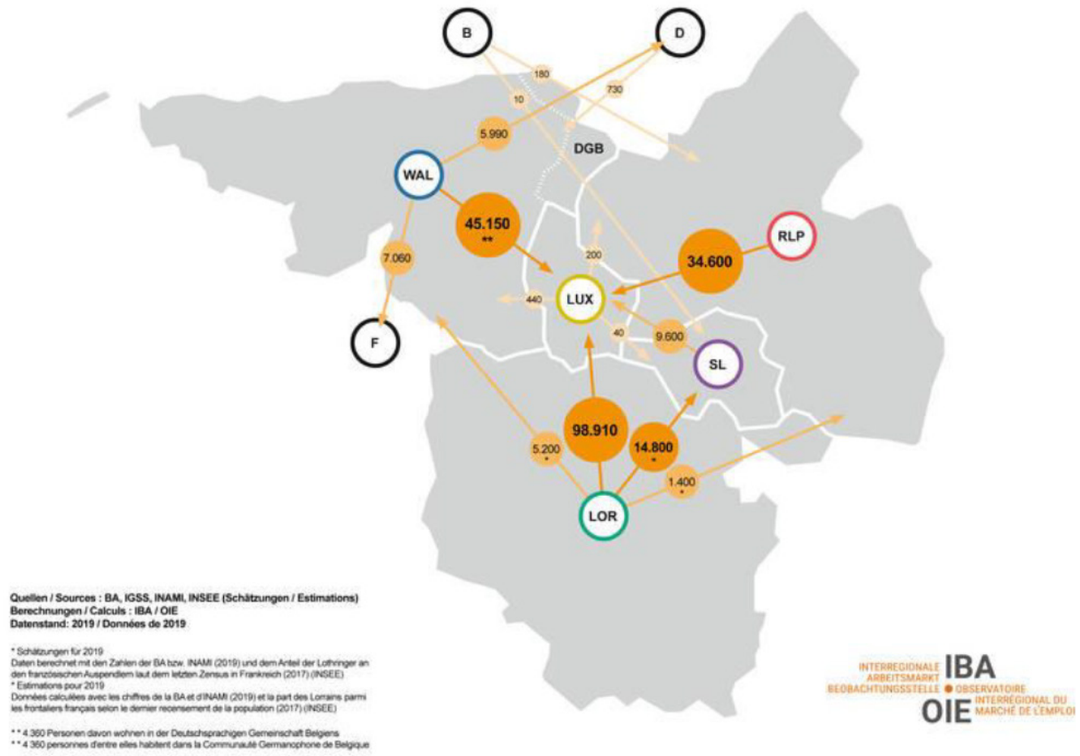


Fig. III-1 : Corridors identifying daily cross-border commuting in Luxembourg's Greater Region in 2019. Three main corridors are identified here. (IBA-OIE, 2019)

		2015	2016	2017	2018	2019	2020
Germany		25.2 %	24.9 %	24.5 %	24.3 %	24.0 %	24.4 %
	Rhineland-Palatinate	18.6 %	18.4 %	18.1 %	17.9 %	17.6 %	17.9 %
	Saarland	5.1 %	5.1 %	5.0 %	5.0 %	4.9 %	5.0 %
Belgium		25.3 %	25.1 %	24.8 %	24.6 %	24.2 %	24.1 %
	Province de Liège	4.6 %	4.5 %	4.5 %	4.4 %	4.3 %	4.3 %
	Province du Luxembourg	18.2 %	18.1 %	18.0 %	17.9 %	17.8 %	17.8 %
France		49.5 %	50.0 %	50.7 %	51.1 %	51.8 %	51.5 %
	Meurthe-et-Moselle	12.7 %	12.8 %	13.0 %	13.1 %	13.2 %	13.1 %
	Meuse	0.9 %	1.0 %	1.0 %	1.0 %	1.0 %	1.0 %
	Moselle	33.5 %	34.0 %	34.7 %	35.0 %	35.5 %	35.4 %

Fig. III-2 : Growth of cross-border commuting to Luxembourg by surrounding country over the years (ESPON Actarea, 2020)

Three main corridors for cross-border commuting

The modal split in Luxembourg is heavily car-oriented (see Figure III-3.). In 2017. 69% of the total trips (including work, school and leisure) in the country made with the private automobile, followed by public transportation. Walking and cycling played a minor role.

Our spatial analysis point that car traffic loads diverge during different periods of the day. During the morning, car traffic is mostly concentrated on the southern zone of the the functional region. During evening hours, car traffic loads become more scattered, but still concentrated along the three main cross-commuter corridors identified (see Figures III-4. and III-5.)

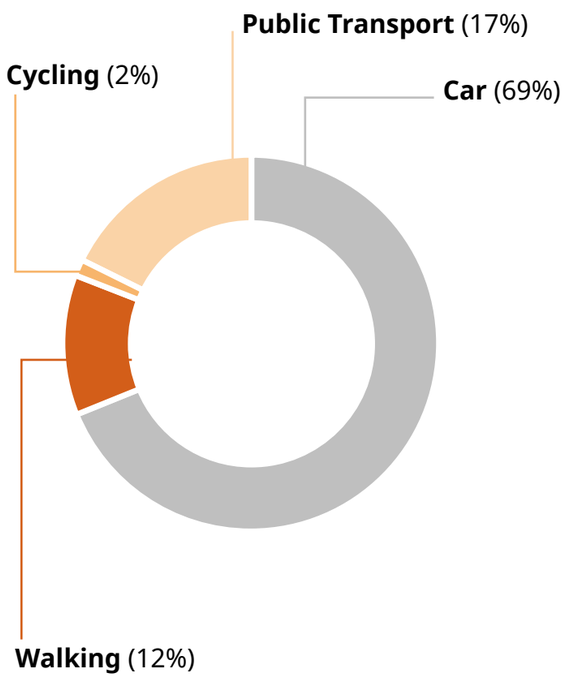


Figure III-3: Modal Split in Luxembourg (MECDD, 2018)

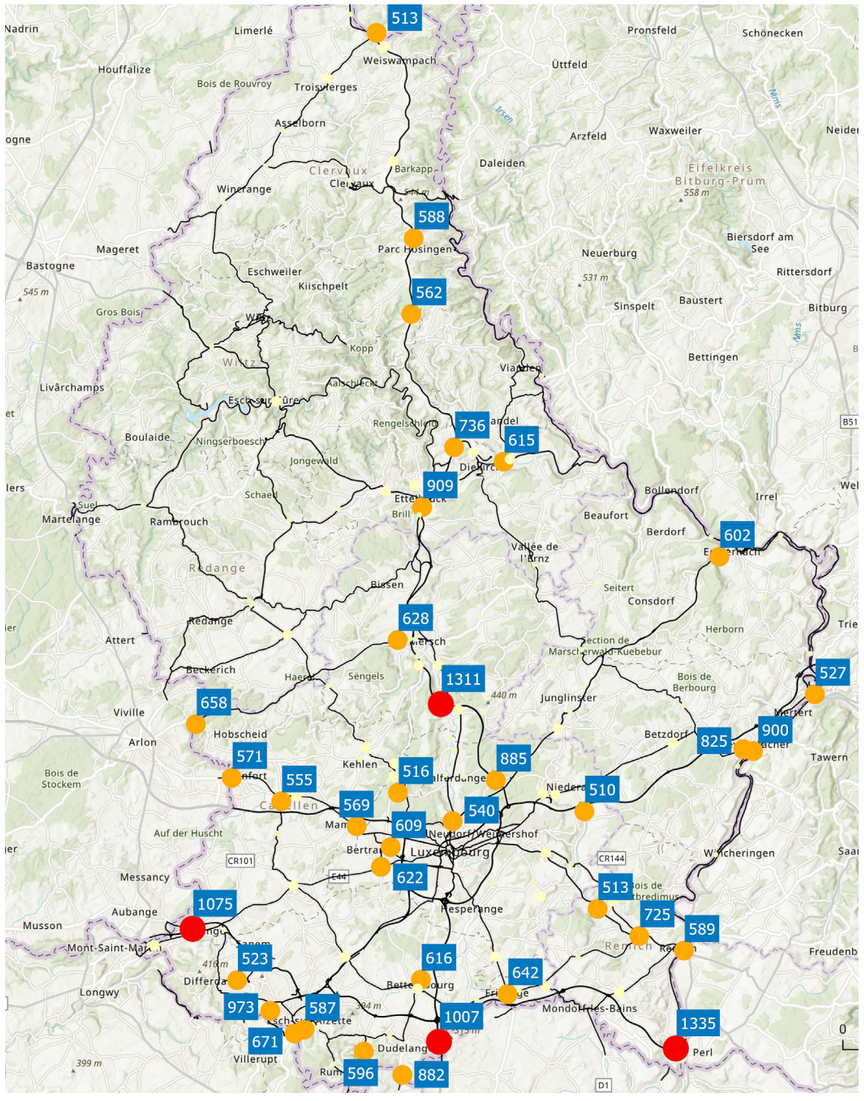


Figure III-4: Car traffic inbound during morning hours (hourly average counted at specific points). (Based of Portail Open Data Luxembourg, n.d.)

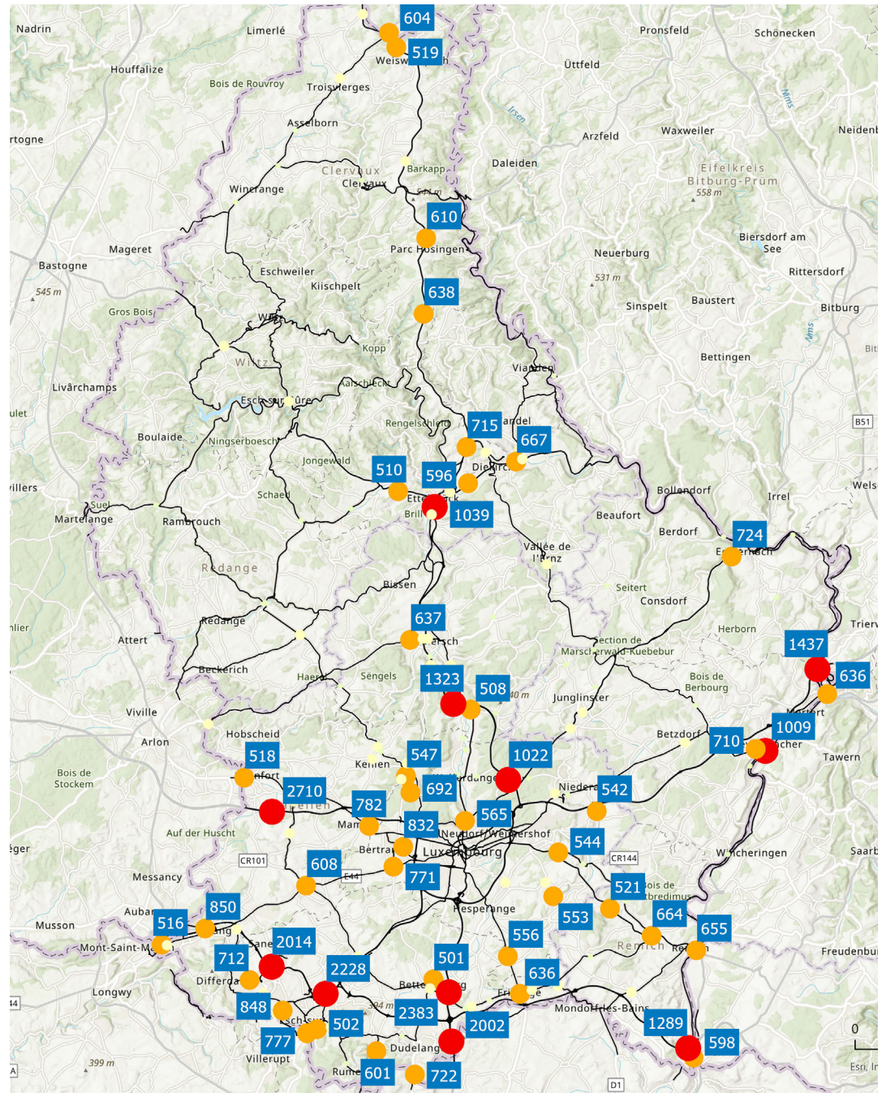
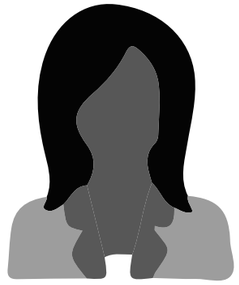


Figure III-5: Car traffic outbound during evening hours (hourly average counted at specific points). (Basis of Portail Open Data Luxembourg, n.d.)

Monocentric public transport infrastructure

“To take public transport, I have to pass through the capital to continue towards Esch. It would take me 3 hours round trip per day. Considering my obligations as a mother, I still cannot afford to waste all this time on the daily commute. By car, I have it for 1 hour at most (round trip).“

Testimonial from Survey made with Citizens in May 2021



“Frankly, if I could get to the city in 15 minutes by bus and if I had a direct bus without having to stop in Esch, I would use them immediately.”

Testimonial from Survey made with Citizens in May 2021

3.1.2 Rail and bus mobility situation in the region

The statements above illustrate the current public transport situation in Luxembourg: although its citizens have a financial incentive to use it, public transport is not a viable option as a means of transport in comparison to the private automobile. In a nutshell, our spatial analyses and citizens’ testimonials reveal that the service of public transportation lines is uncoordinated and its coverage deficient if compared to the private automobile.

Testimonials rate the quality of the public transport as average (Figure III-6).

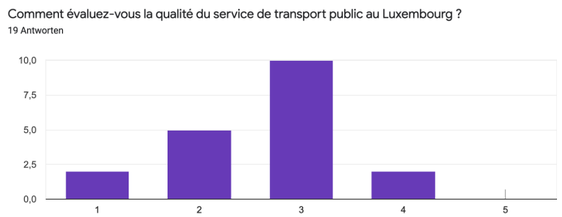


Fig. III-6: Results of the questionnaire made with citizens of the functional region reveal that their perception of the quality regarding the service of the public transport in Luxembourg is average.

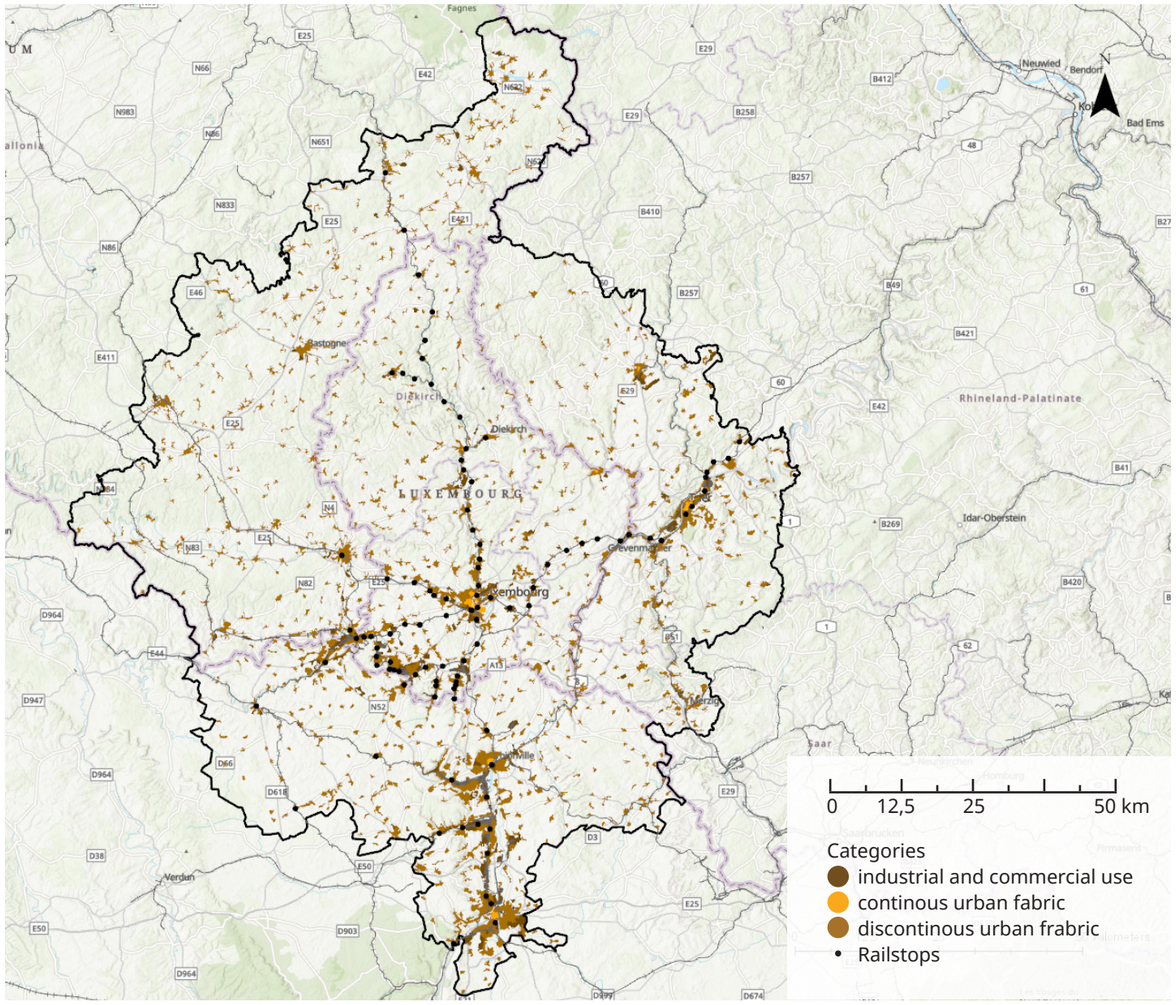


Figure III-7: The current rail infrastructure in Luxembourg and its functional region is a classic spoke shape, with all lines leading towards Luxembourg City. With this, the monocentric development of transport and the lack of options for public transport-based commuting are reinforced. (Based on OpenStreetMap and CORINE, 2018)

Transport infrastructure in Luxembourg is highly monocentric (Figure III-7): accessibility analyses show an unbalanced concentration of rail lines connected towards Luxembourg city and to the southern areas of the functional region, turning these urban agglomerations into the most well-connected nodes in the functional region.

Comparison of the travel time using public transport with travel time using the car

Figure III-8 illustrates the average travel-time from Luxembourg City's center to other areas of the functional region using the existent rail, tram and bus systems: many of the major centers in the functional region are reachable within 60 minutes from this station – however these connections require at least one interchange, while the travel time with the car from major centers is much reduced, as seen in Figure III-9.

Currently, only around 8% of the total population from the functional region is included within the maximum accepted travel time threshold from Luxembourg City (40 minutes).

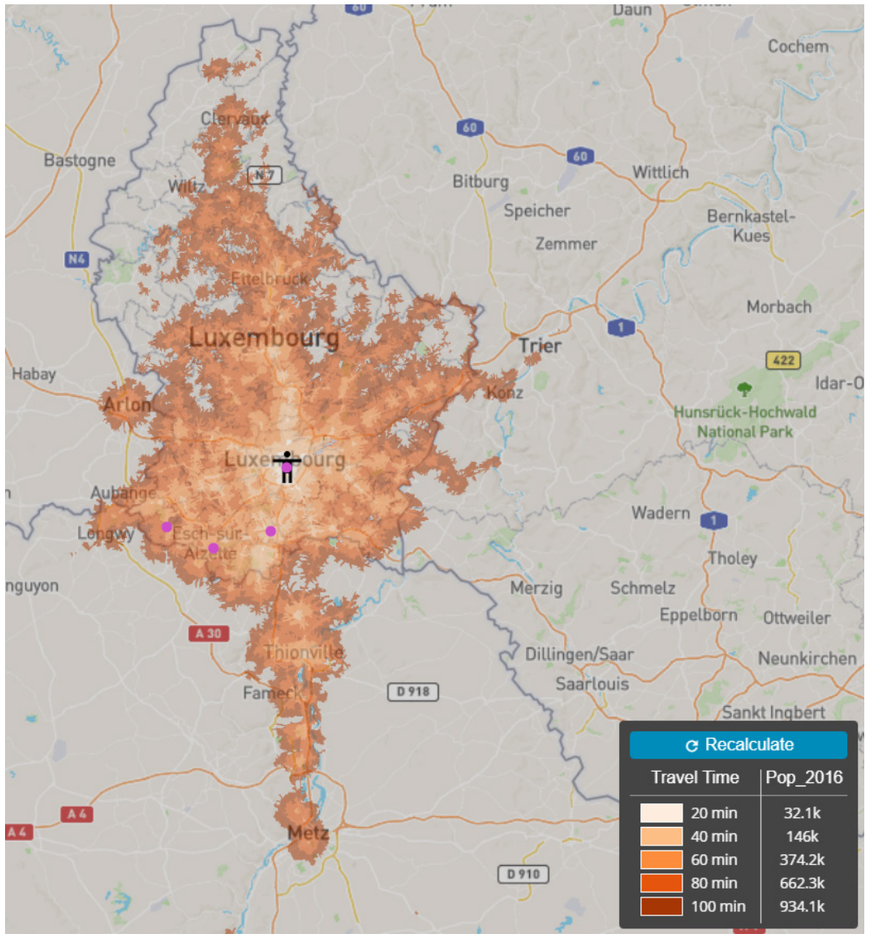


Figure III-8: Public transport travel time analysis from Luxembourg City's center showing the total population reached within different time installments (based on Data.public.lu and Podaris). **A quicker connection between Luxembourg City and the south (towards Bettembourg) and a scarce connection towards the northern region is noticeable.**

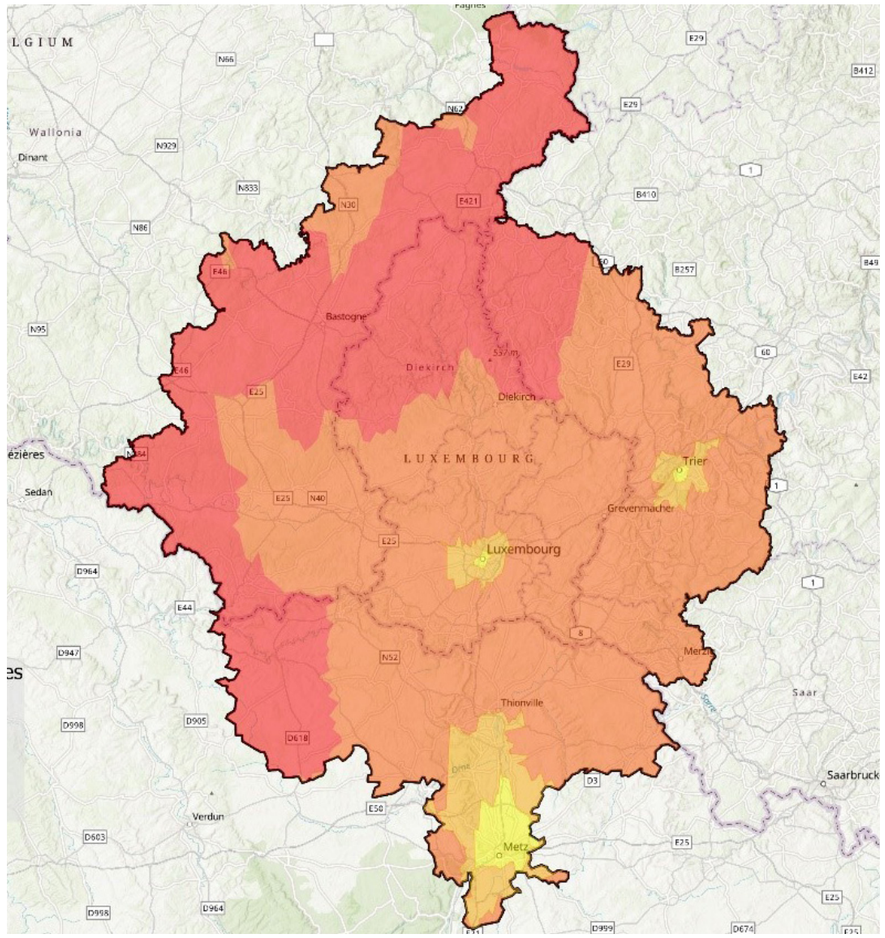


Figure III-9: Estimated car travel time from major cities. The attractiveness to Metz is clearly noted and a large amount of the population and resources of the functional region are quickly accessible by car (based on Data.public.lu (n.d.))

Car travel time in min

- less than or equal to 15 Minutes
- less than or equal to 30 Minutes
- less than or equal to 45 Minutes
- less than or equal to 60 Minutes

Public transport (bus, rail, train) travel time from other urban agglomerations

A similar situation is noted when the travel time of the public transportation from other agglomerations in the functional region is analyzed. (Figures III-10, III-11, III-12 and III-13). In general, bigger urban agglomerations - such as Bettembourg - are relatively well-connected to their immediate surroundings.

However, when longer distancing commuting is considered, a lack of direct connectivity to other urban centers is noted and the travel time with public transportation is much longer than the travel time using the automobile.

For example, travelling during peak hours from Esch-sur-Alzette to Luxembourg City with the public transport would take approximately 50 minutes and possibly at least one line interchange, while travelling with the private automobile takes half of the same time.

This lack of balance is aggravated since public transport lines tact is unreliable (MDDI, 2018: 16) and can be overcrowded during peak hours according to Citizens' testimonials.

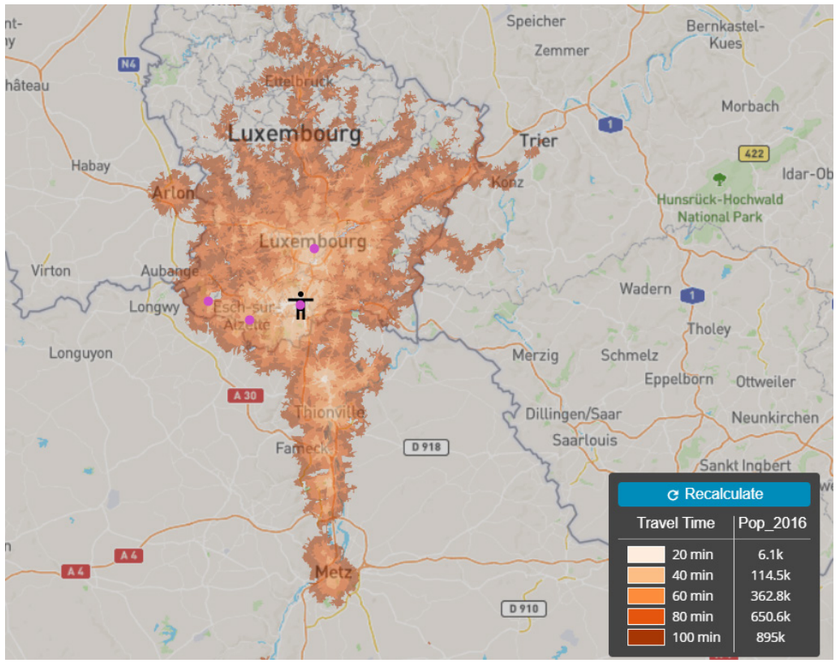


Figure III-10: Public transport travel time analysis from Bettembourg's center. Approximately 6% of the population in the functional region falls within the 40-minutes accessibility threshold (based on Data.public.lu and Podaris)

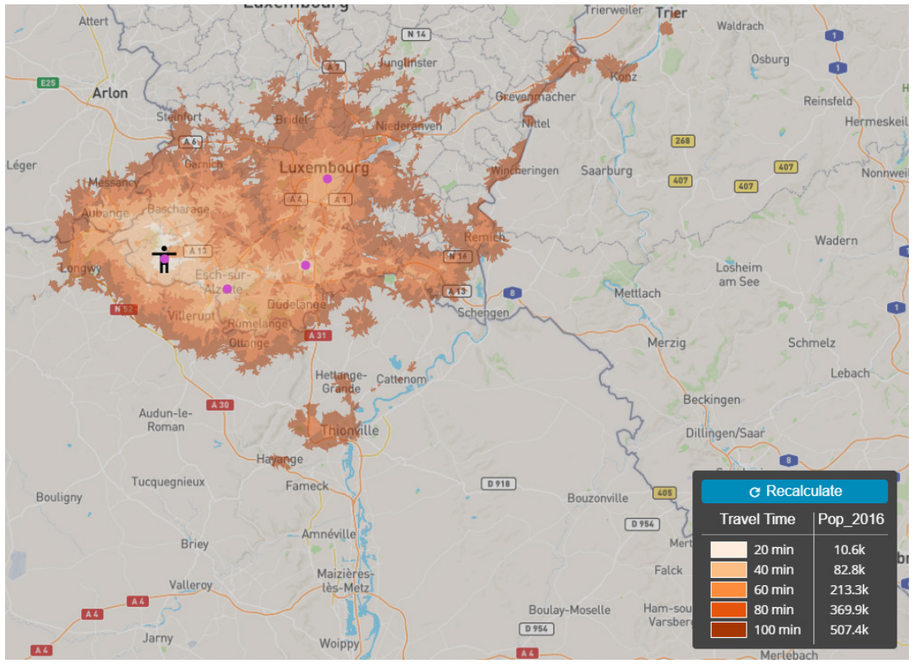


Figure III-12: Public transport travel time analysis from Differdange's center. Approximately 4% of the population in the functional region falls within the 40-minutes accessibility threshold (based on Data.public.lu and Podaris)

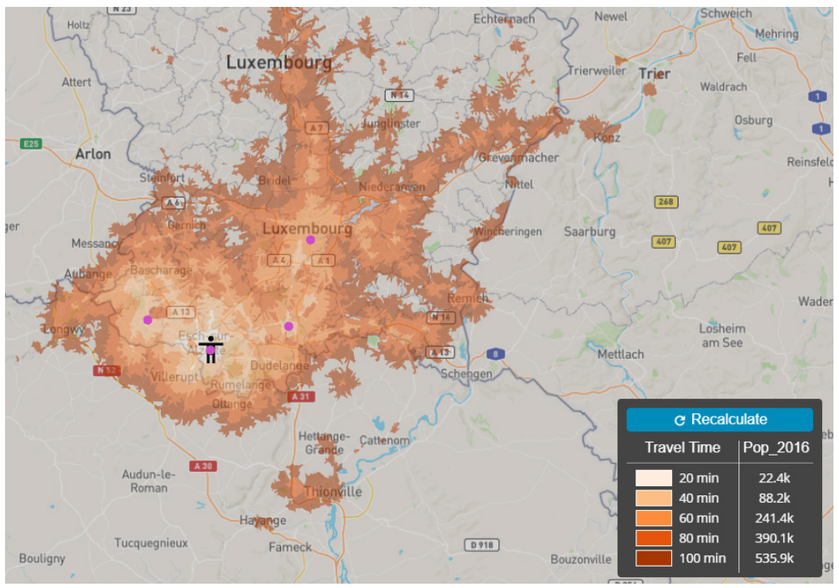


Figure III-11: Public transport travel time analysis from Esch's center. Approximately 5% of the population in the functional region falls within the 40-minutes accessibility threshold (based on Data.public.lu and Podaris)

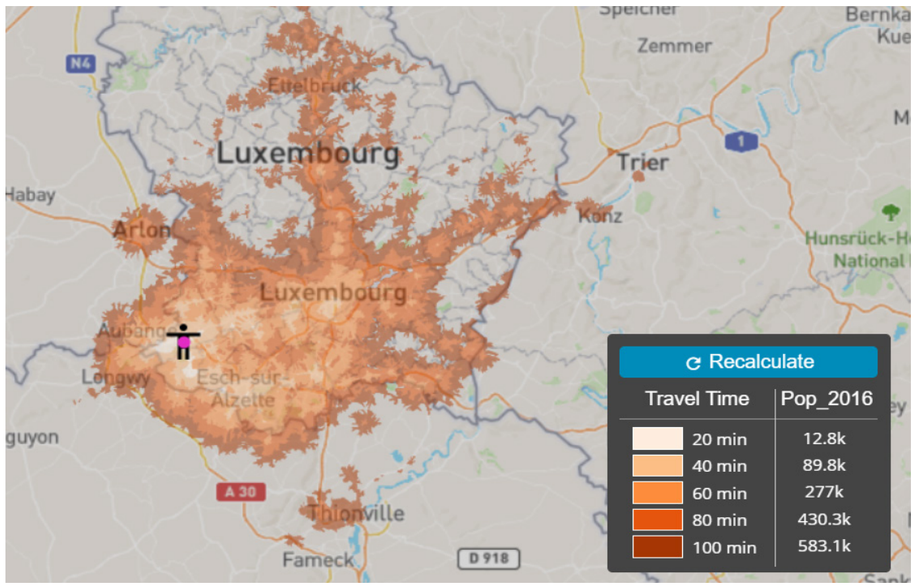


Figure III-13: Public transport travel time analysis from Petange's center. Approximately 4% of the population in the functional region falls within the 40-minutes accessibility threshold with the public transport (based on Data.public.lu and Podaris)

Public transport accessibility on main cross-border commuter corridors

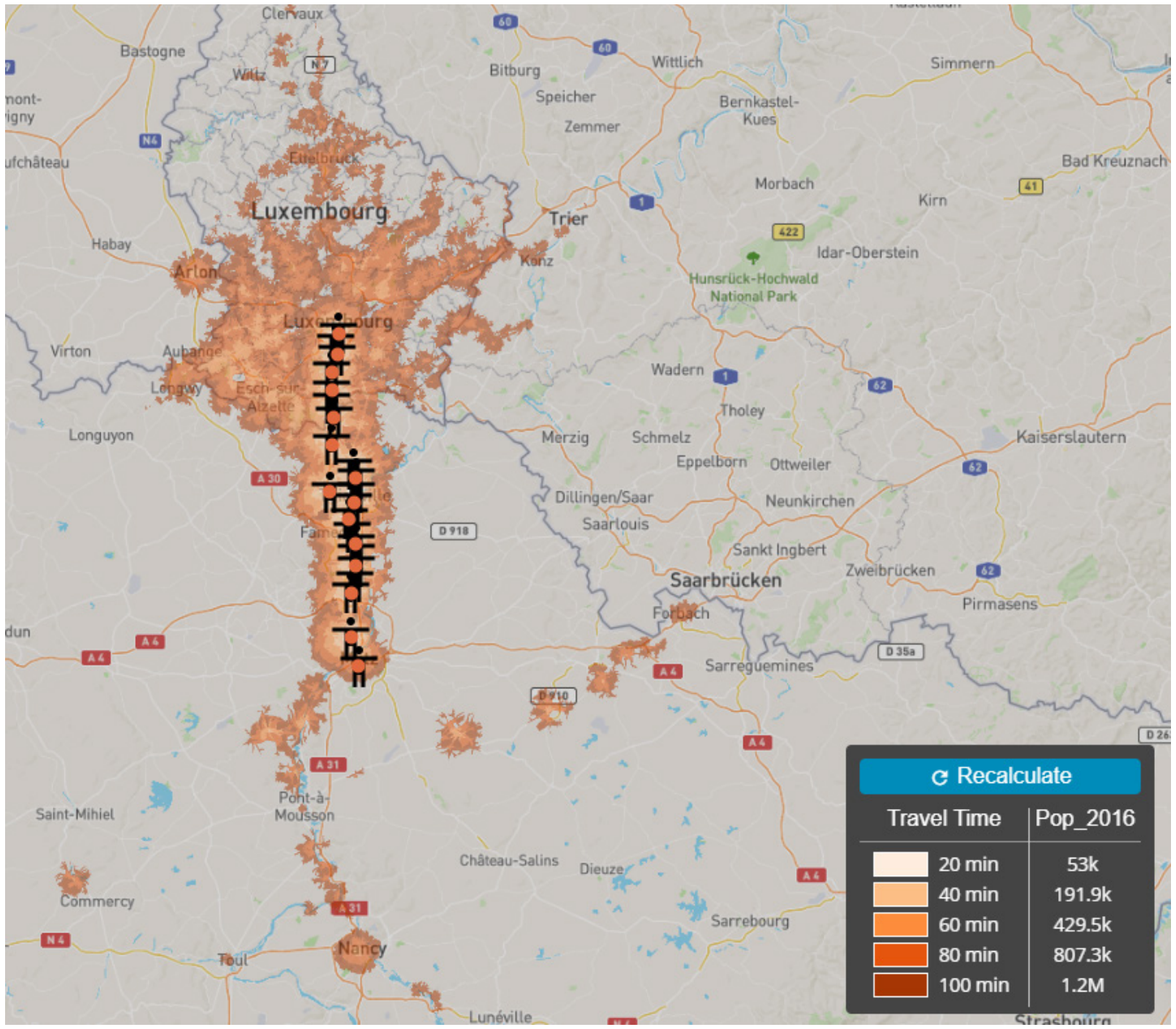
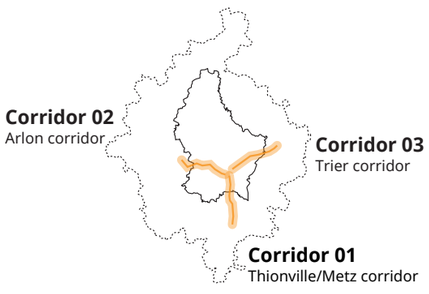


Figure III-14: Travel time analysis of the Thionville/Metz corridor (Corridor 01) in the functional region. Approximately 9% of the population in the functional region falls within the 40-minutes accessibility threshold with the public transport (based on Data.public.lu and Podaris)



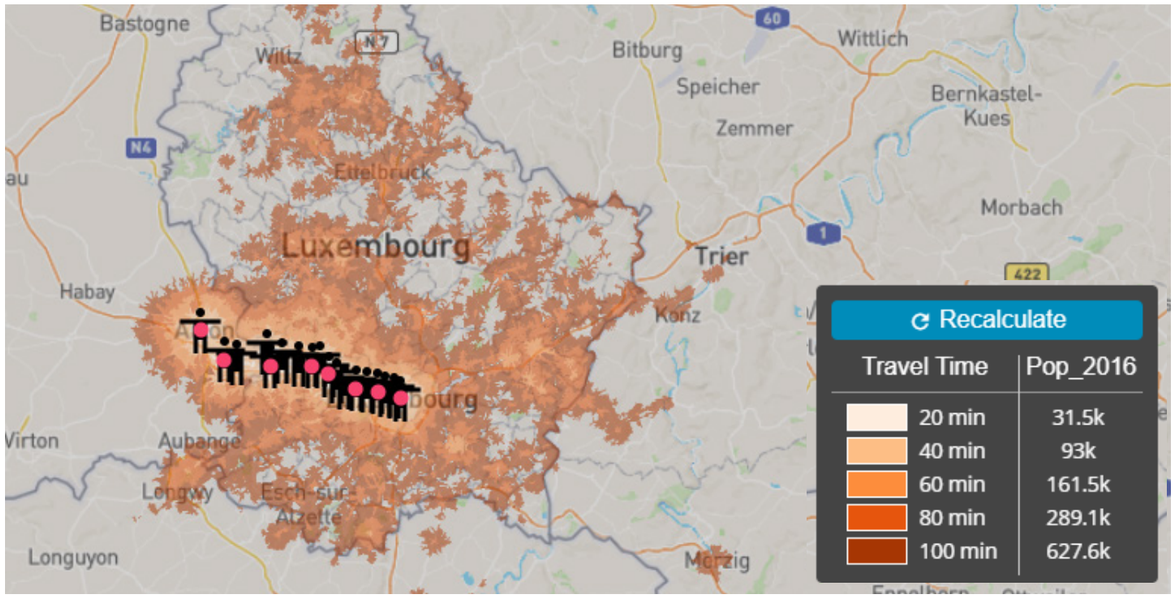


Figure III-15: Travel time analysis of the Arlon corridor (Corridor 02) in the functional region. Approximately 4% of the population in the functional region falls within the 40-minutes accessibility threshold with the public transport (based on Data.public.lu and Podaris)

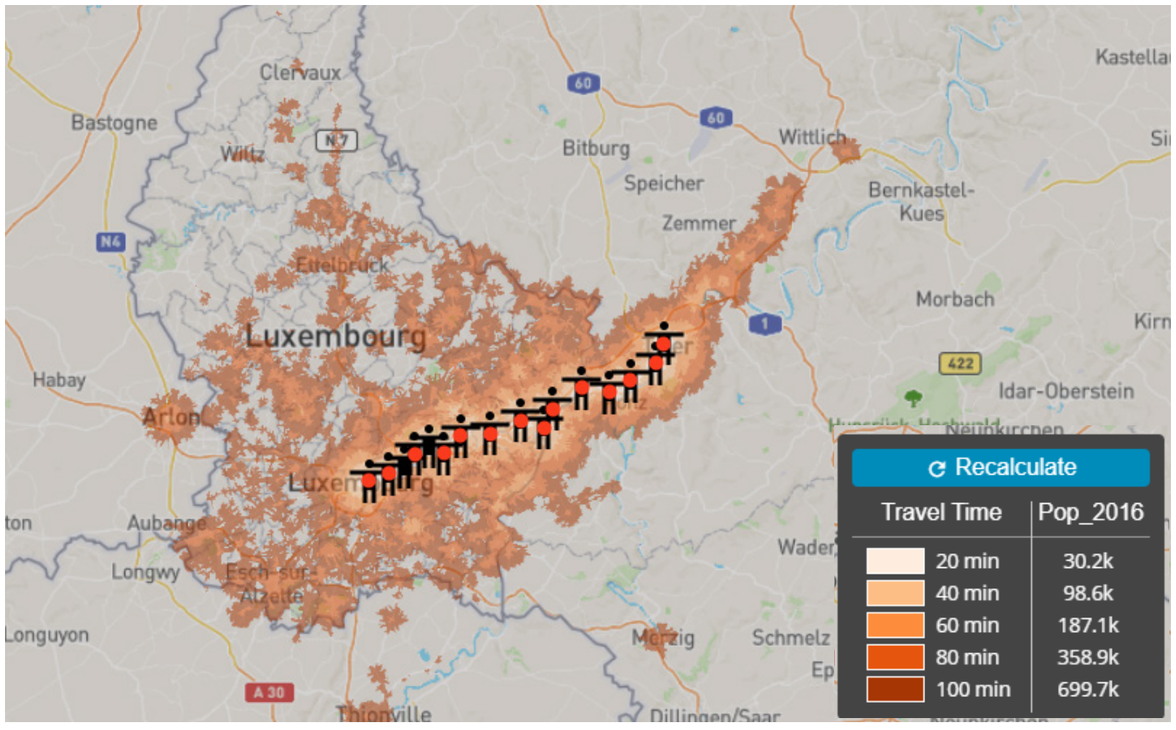


Figure III-16: Travel time analysis of the Trier corridor (Corridor 03) in the functional region. Approximately 5% of the population in the functional region falls within the 40-minutes accessibility threshold with the public transport (based on Data.public.lu and Podaris)

Public transport service and bike-and-rail combination in the functional region

During peak hours of the morning (7:00 – 09:00), the capacity of trains coming from France of the CFL lines are either at 100% or almost exceeded, as shown on Figure III-17. Almost in opposition to this, studies estimate that there are approximately 250,000 empty car seats travelling around Luxembourg City every day and the rate of occupancy in a cross-border commuting car is about 1,22 people. Our analyses of the service frequency of public transportation (only rail considered) in the functional region show that there is a marginal disparity of the rail transport service offered during the morning and evening peaks. In general, a higher frequency of service and higher concentration of rail stations is observed in the southern of the functional region – considering this, Luxembourg City remains the area with the highest frequency. The northern area of the functional region and the surrounding area around Trier have remarkably lower service and lower density when compared to the others.

The maps on the right show an analysis of the cycling catchment area around public transport stations in the functional region in combination with the number of lines passing through each station. Results of the spatial analysis show that approximately 80% of the locations inserted within a 15-minute cycling catchment area have access to a relative lower number of public transportation lines, while approximately only 9% of these locations have access to stations with a higher amount of lines.

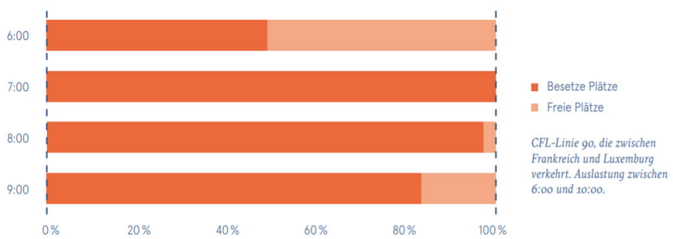
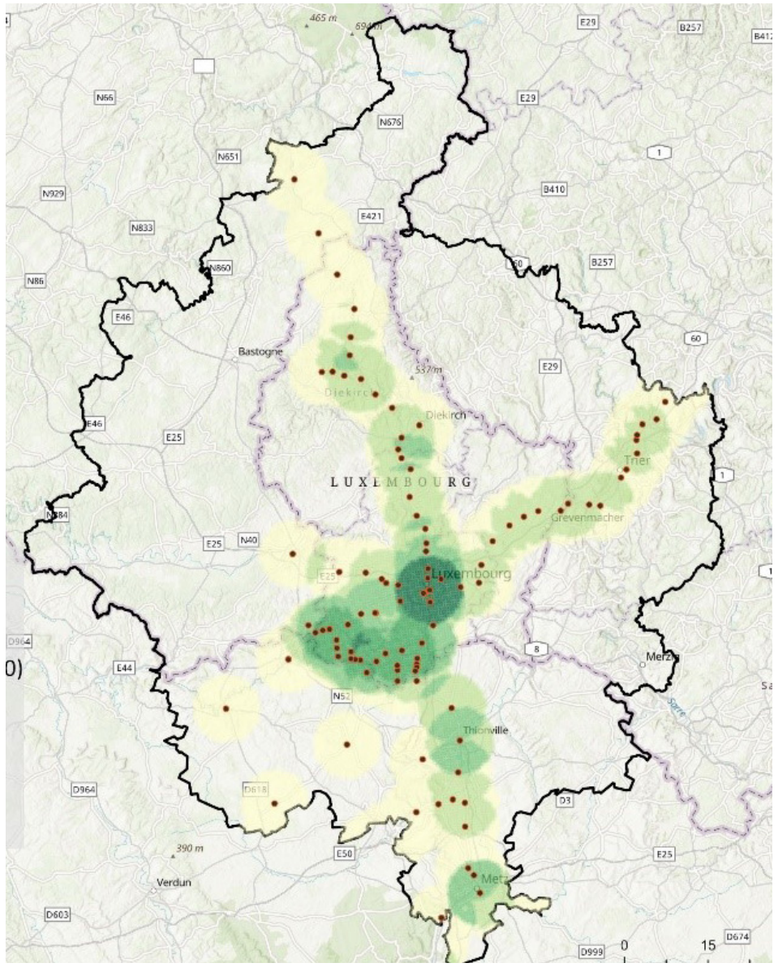
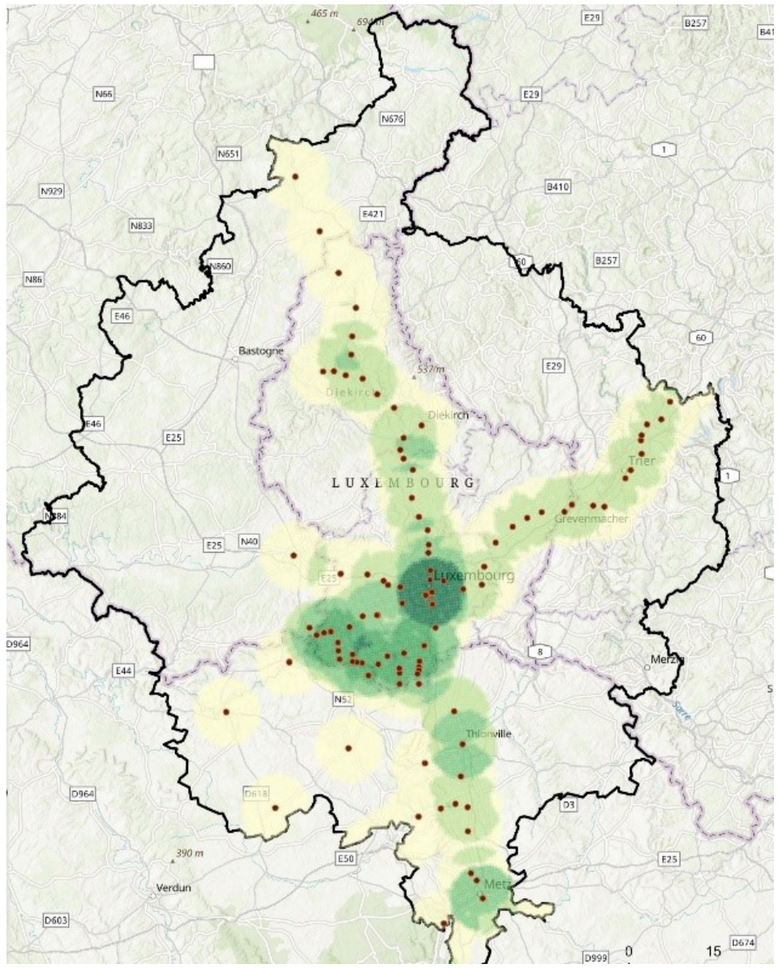


Fig. III-17: Capacity of CLF-line trains during early hours of the day.
(MCEDD, 2018)



Figures III-18: Service frequency at AM Commuter's Peak (between 07:00 – 09:00 hours)
(Based on Podaris)



Figures III-19: Service frequency at PM Commuter's Peak (between 17:00 – 19:00 hours)
(Based on Podaris)

Current bus service in the functional region

The current service quality of the bus system poses another challenge to citizens and cross-border commuters, especially to the ones that live in villages and smaller cities and wish to travel to bigger urban centers. Many of the intermunicipal lines and the ones that are fundamental to cross-border commuting only run by a 30 to 120-minute tact and are – according to citizens' testimonials – usually uncoordinated with the rail system.

According to the spatial analysis performed to understand the frequency of bus lines, the corridor between Trier and Luxembourg City has a higher frequency than the others.

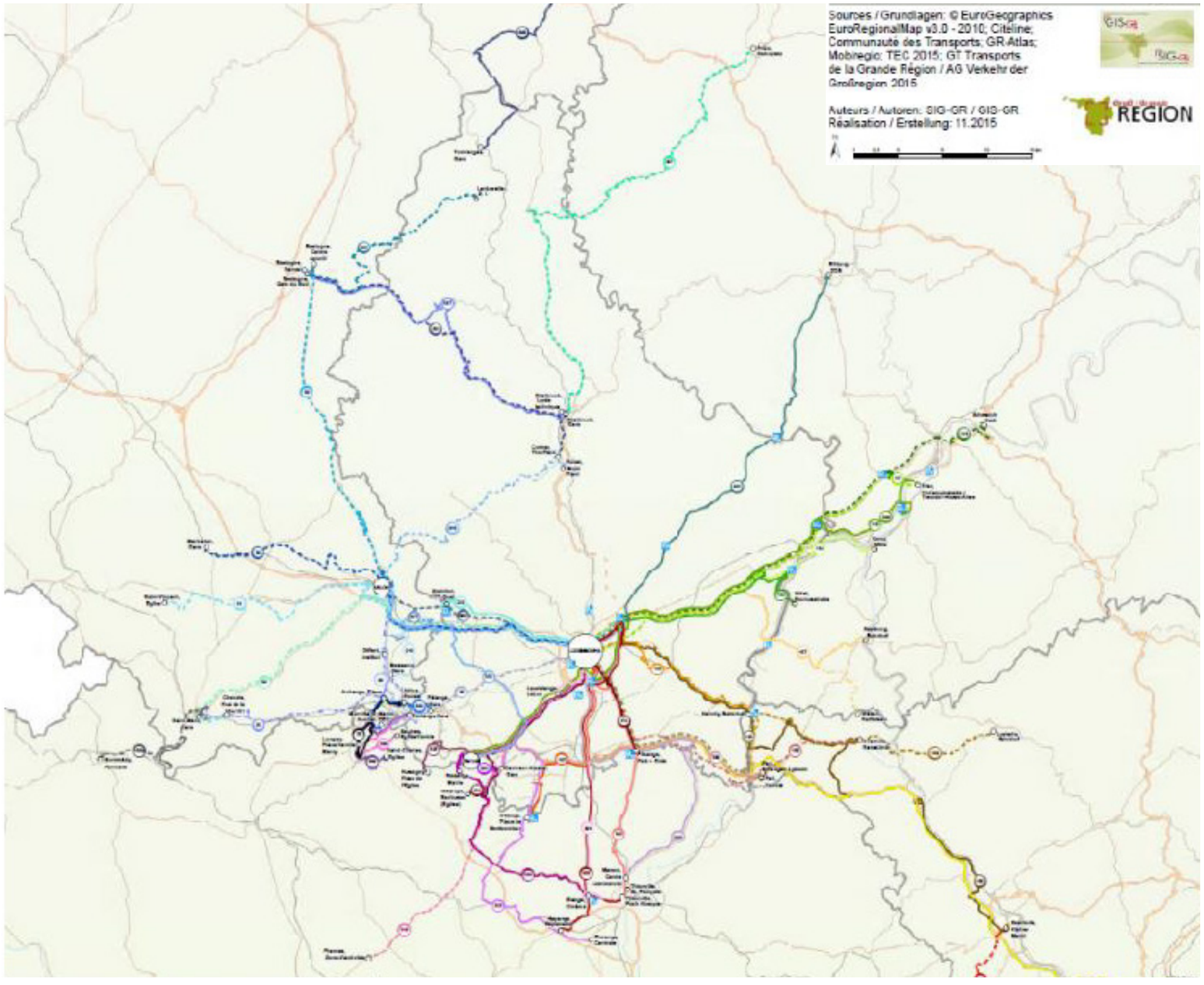


Figure III-20: Map displaying the cross-border bus lines in the functional region of Luxembourg. (SIG-GR, 2015)

Cycling as a commuter transport mode in the functional region

"(...) The bicycle is an alternative, but factors such as the danger on the road as well as the topography and the time lost during the journey mean that the car often wins."

Testimonial from Survey made with Citizens in May 2021

3.1.3 Evaluation of the existing cycling infrastructure

Even though efforts have been currently made towards implementing cycling safety measures in urban areas (i.e. pilot projects for the implementation of cycling streets in Luxembourg City launched in March 2020, The Mayor.eu, 2021), the national cycling infrastructure is fragmented and, in many places, uncoordinated with the existent public transport infrastructure and park-and-ride facilities (as displaying in Figure III-21), making the adoption to the bicycle and to the public transport rather difficult.

Figure III-22 shows a spatial analysis of the cycle infrastructure within a 15-Minute cycling catchment area. Only around 3% to 15% of the total road infrastructure included within these catchment areas present bicycle paths, which in turn do not promote an optimal situation for cyclists. The map displays a slightly better infrastructure in the surroundings of Trier, Saarland and Luxembourg City, while the cycling infrastructure along Corridor 01 (Thionville/ Metz) is not identified.

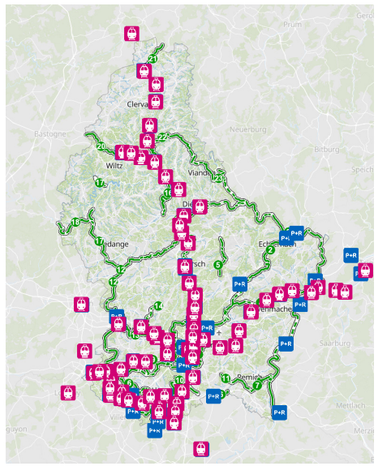


Figure III-21: Map overlaying transport stations, park-and-ride facilities and the national cycling infrastructure in Luxembourg (Geoportal Luxembourg, n.d.).

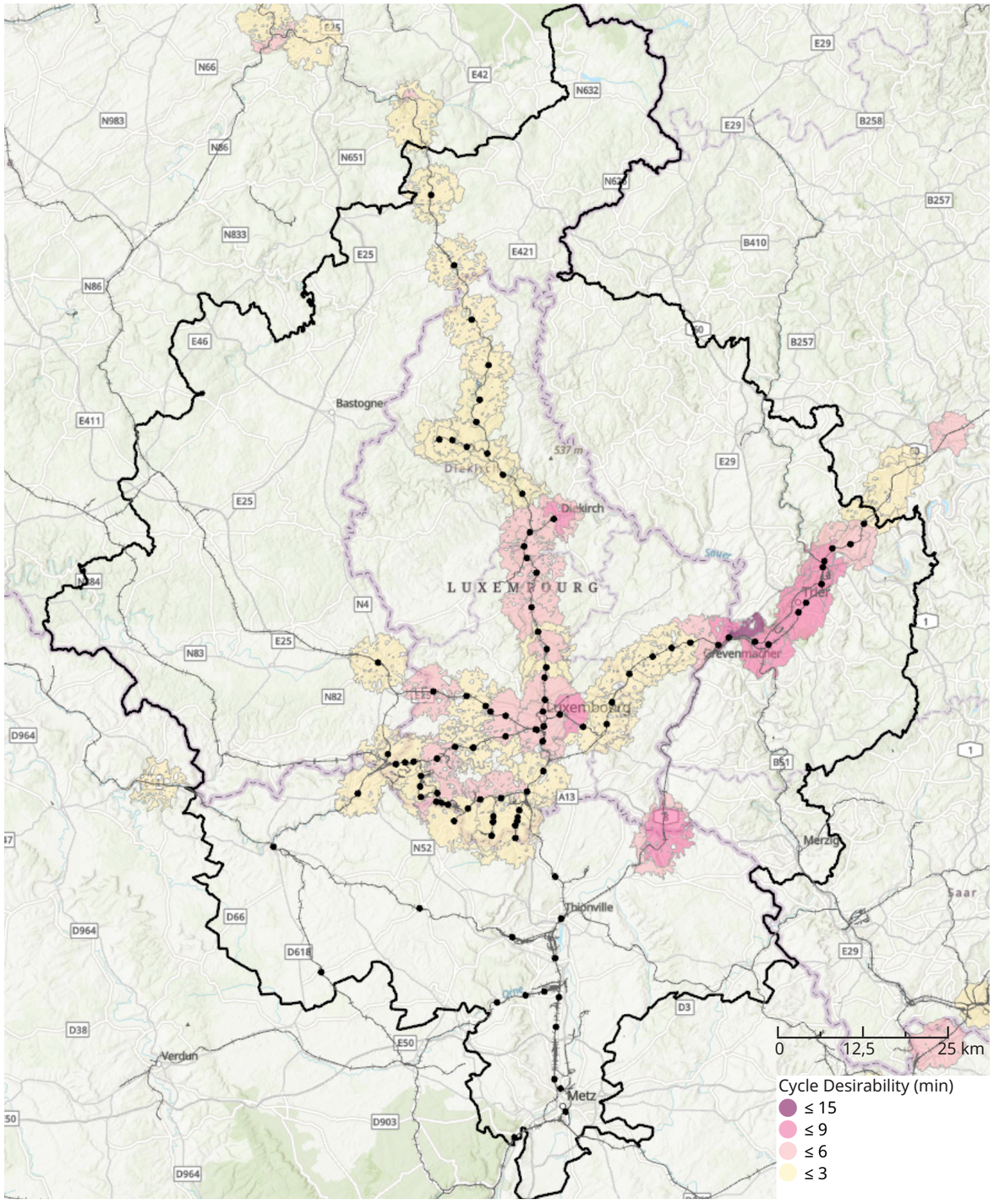


Figure III-22: Cycle desirability map displaying the presence of cycling infrastructure within a 15-Minute cycling catchment area. (based on Podaris and OpenStreetMap, n.d.).

Evaluating the cycling infrastructure in detail

According to citizens' testimonials, the current cycling infrastructure is regarded as "unsafe" and "uncomfortable". This is confirmed when the quality of the existent infrastructure is evaluated in further detail, as seen in Figures III-23 and III-24.

Studies show that 33% of the trips made to work of inhabitants in Luxembourg are currently under 5 km (MECDD, 2018) – and while the half of these trips are currently made with the private automobile, this points towards a great potential to increase cycling ridership for short rides. Similar results are observed for school trips both at elementary and at secondary levels, where respectively 78% and 37% of the total trips for this segment are within a cycling distance (less than 5km).

Figure III-23: Current state of cycling infrastructure is precarious. Here is the national cycle route 8 in the border of Esch-sur-Alzette, close to the station Belval Lycée. (Google Street View, 2021)

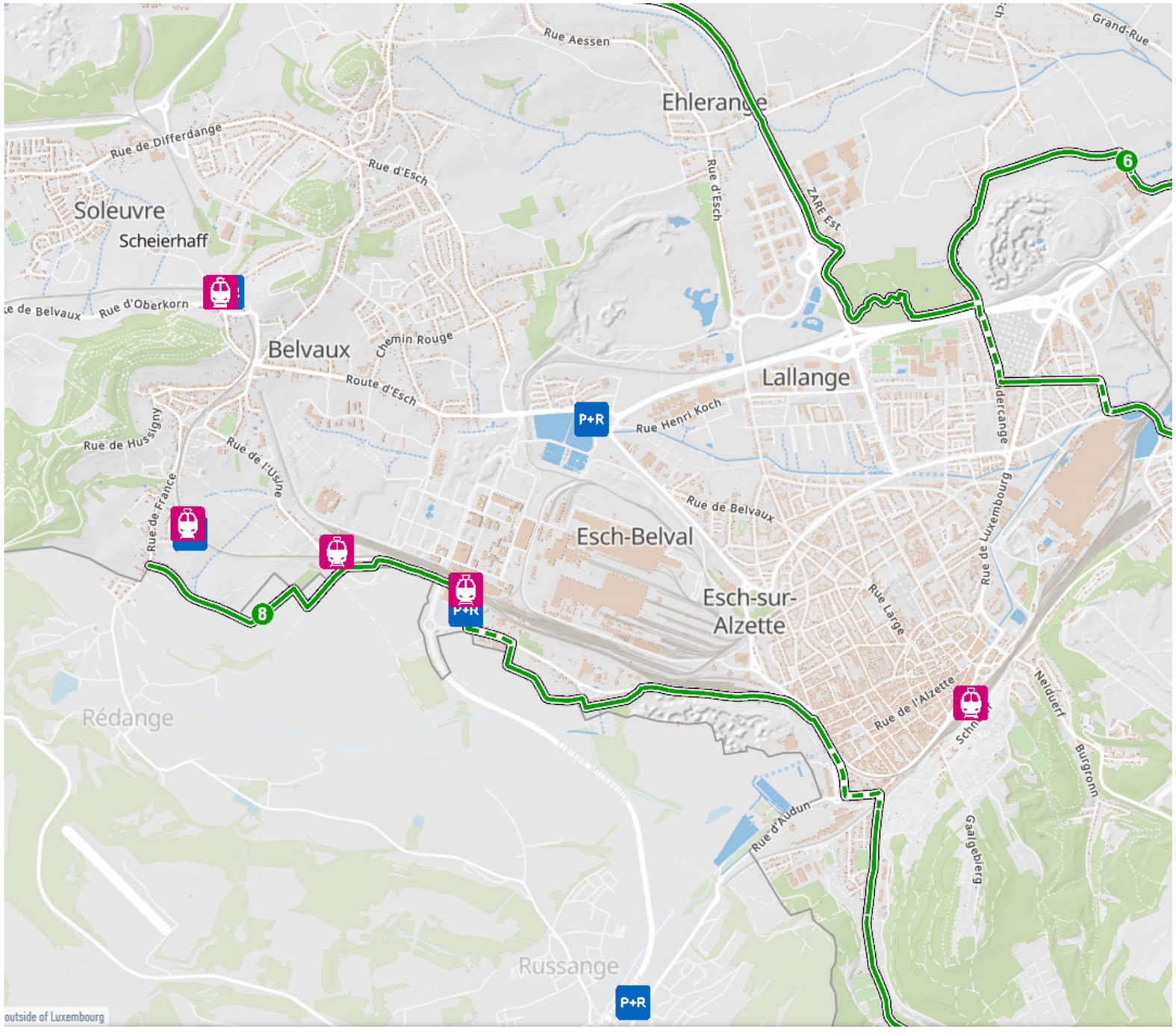


Figure III-24: Map displaying the current fragmented cycling infrastructure in the surroundings of Esch-sur-Alzette overlayed with public transport stations and park-and-ride facilities (Geoportal Luxembourg, n.d.)

Level 2 - ‘Banana Agglomeration’

Upgrading Mobility & Accessibility

Upgrading the ‘Banana Agglomeration’

The Banana Agglomeration, its surroundings cities and villages have approximately 250,000 inhabitants, corresponding to around 12% of the total functional region population (Data.public.lu, n.d.). It receives approximately 25% of the total commuters of the functional region (MDDI, LISER, 2018). Socioeconomically this urban agglomeration presents a high share of low-level occupation workers (according to the International Standard Classification Occupations system) – with communes like Petange and Rummelange having around 30% of its workforce in this classification tier (STATEC, 2017: 23). Perhaps, as a result, this urban agglomeration also presents one of the lowest salaries mean in Luxembourg (STATEC, 2017: 25).

In general terms, the banana suffers from consequences of the spatial inequalities inherent to the functional region, presenting still to this day several industrial sites and brownfields that are reminiscent of the mining activities, hence not being an attractive center to live or work when as compared to Luxembourg City. The area has nevertheless been presenting continuous developments in recent years, such as the University of Luxembourg campus in Belval, and also planning for new ones, such as the transborder IBA (Internationale Bauaustellung) in the Alzette Belval region, raising the momentum for attracting new talents and workforce to the region (Amenagement-territoire.public.lu, 2020).

Due to the projected growth of cross-border commuters and of the local population (CORREST, 2018; IBA OIE, 2019) the proximity to other important urban centers in the functional region, and the already existent cross-border commuting synergy to Thionville and Metz (Figure III-25), we believe that this urban agglomeration has the potential to become a complementary urban centrality to Luxembourg City if we unlock its potential by devising a set of strategies in the fields of mobility and land use management.

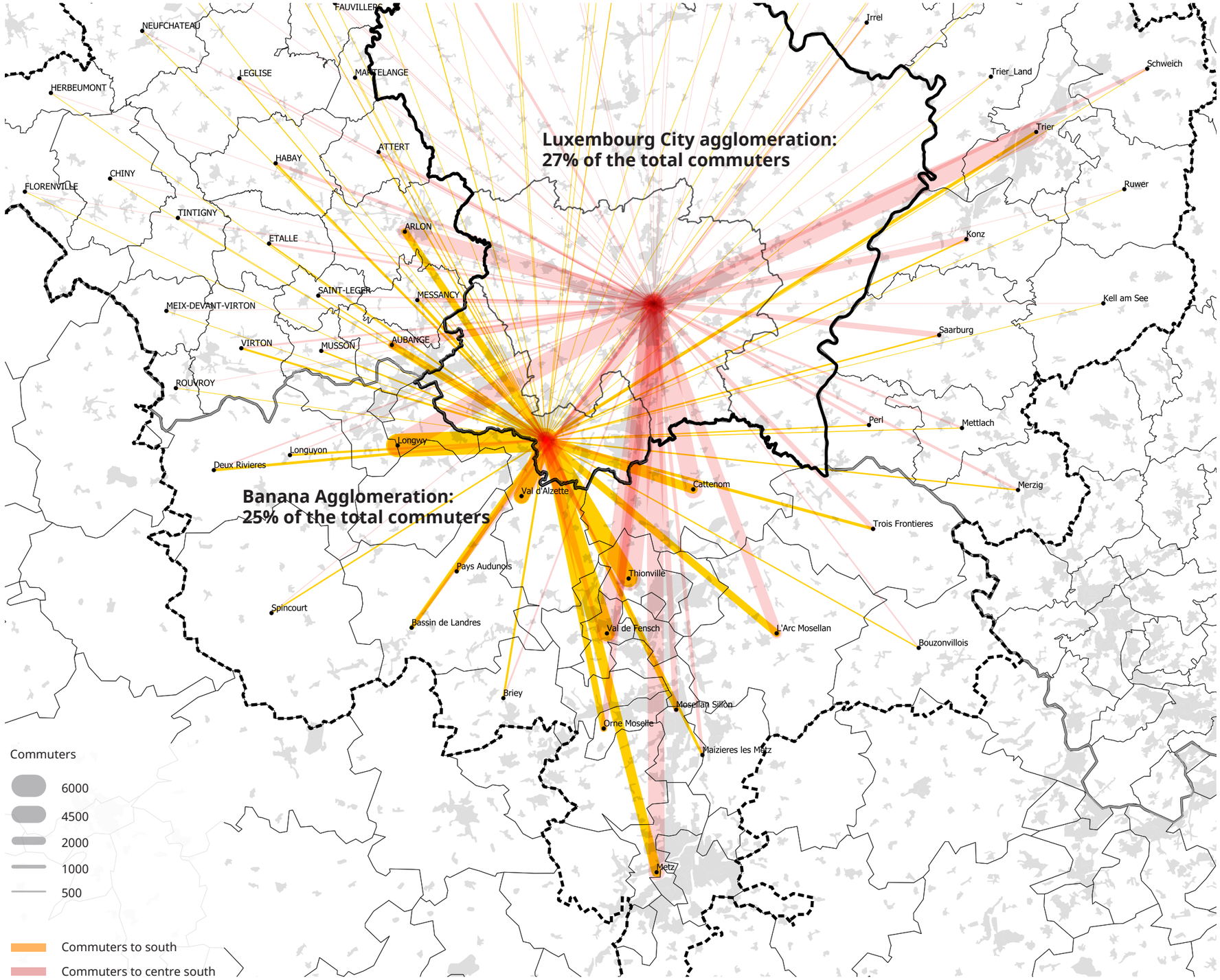


Figure III-25: Map displaying existing origin and destination trips in the functional region. The synergy of the Banana Agglomeration with surrounding urban agglomerations is evident
(Based on MDDI and LISER, 2018)

Mobility Analysis in the Banana: Opportunities and Constraints

The Banana Agglomeration currently presents a poor public transport accessibility – especially in relation to Luxembourg City's center, with many settlements not being reachable by other modes of transport besides the private car. A car dominance in this region is also specially noted on the border with France (as noted in Figure III-26).

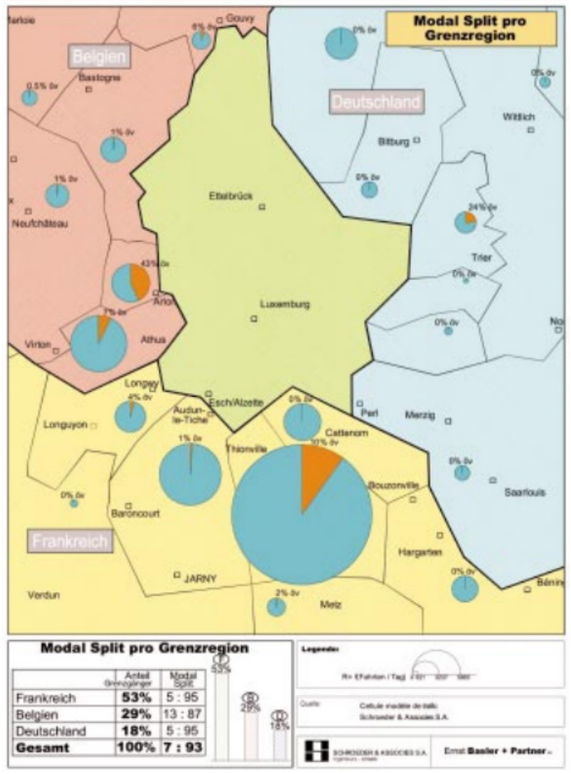


Figure III-26: Modal Split in the surrounding region in Luxembourg: A car dominance (blue) is clearly noted. (Mobilitéit.lu, 2002)

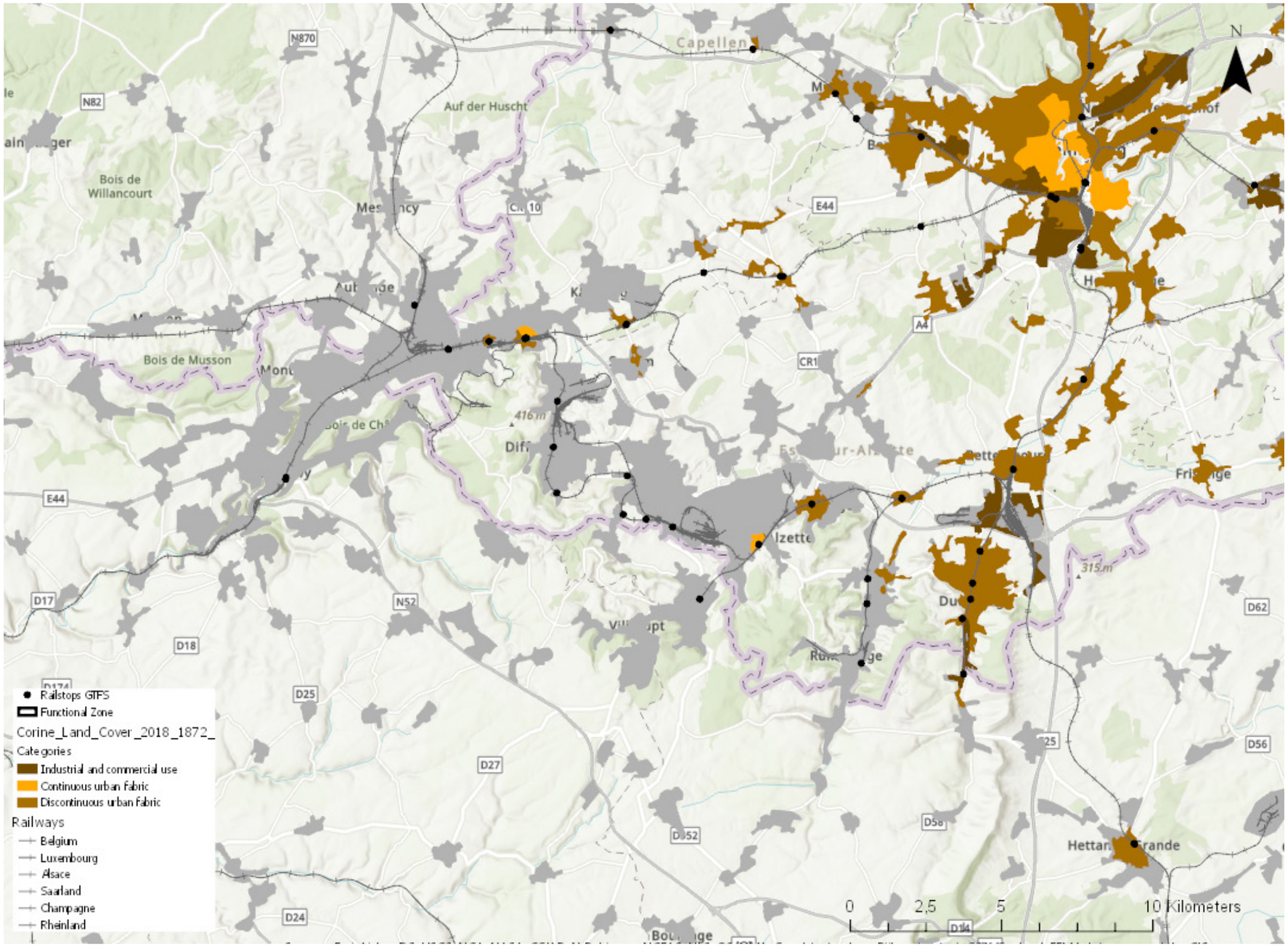


Figure III-27: Public transport accessibility from Luxembourg City to the banana: only Bettembourg and Dudelange are accessible within 40-minutes. Grey represent areas with high density that do not fall within the accessibility threshhold. Orange and brown represent areas accessible within 40 minutes. (Based on Podaris and Data.public.lu, n.d.)

Quality impressions of the cycling infrastructure

The quality and presence of the cycling infrastructure is insufficient, as observed in Figure III-28.

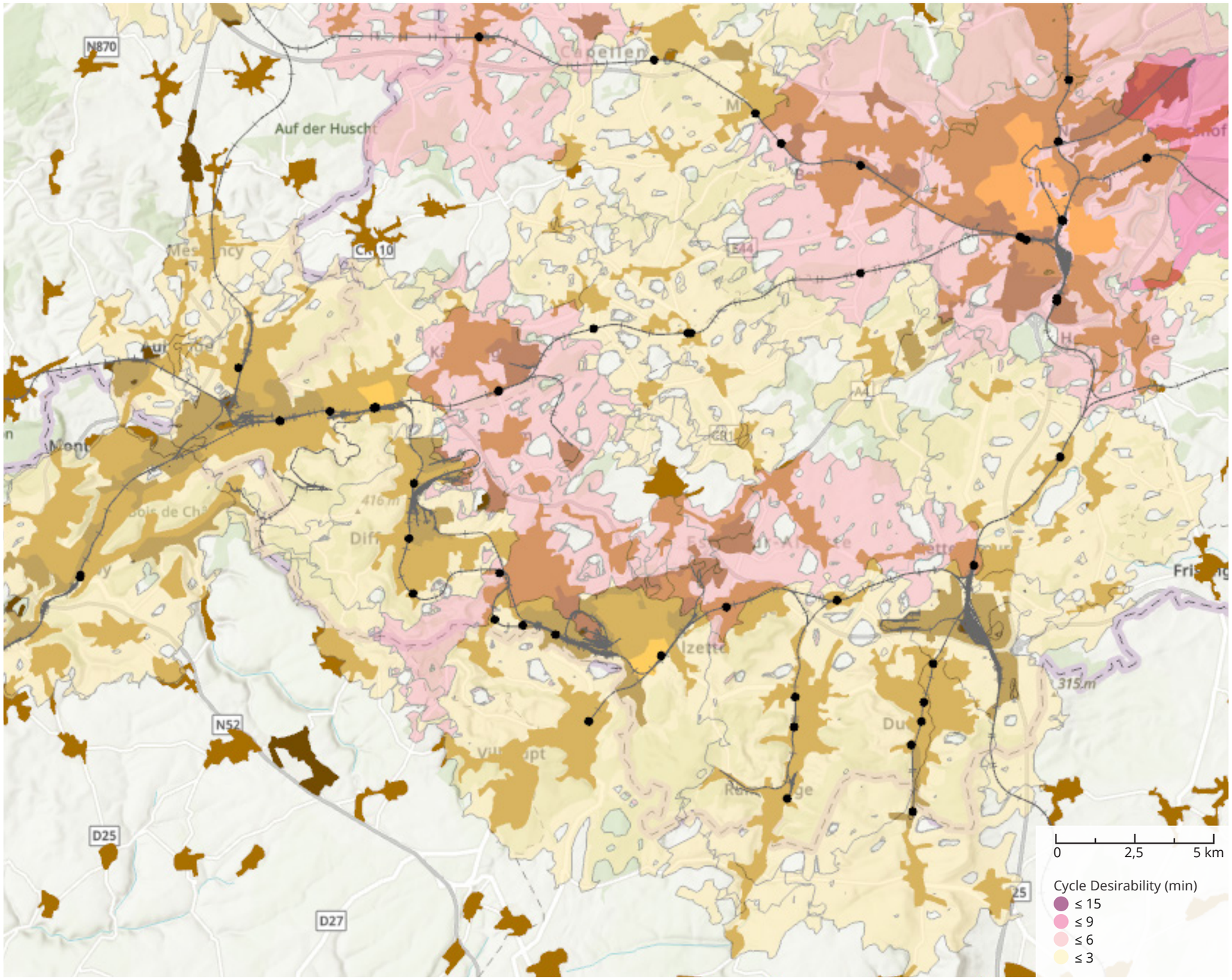


Figure III-28: This map shows the presence of cycling infrastructure within a 15-minute catchment area from public transport stations: only around 3% to 6% of the total streets within these catchment areas present some type of cycling infrastructure. (Arup, 2021, on the basis of Podaris and OpenStreetMap, n.d.)

Unlocking the potential of the Banana with active mobility

In terms of bicycle accessibility to public stations, this area currently presents marginal cycling infrastructure around stations, making the adoption towards more sustainable ways of commuting rather unrealistic. The further development of this type of infrastructure – especially around stations – is paramount for increasing walkability and cycling ridership in the Banana.

Spatial analysis nevertheless reveals that the banana has great potential to be unlocked: its cities' cores can easily be covered by walking distances, while longer distances can easily be covered by bicycles and electric bicycles – as observed in Figures III-29 and III-30.

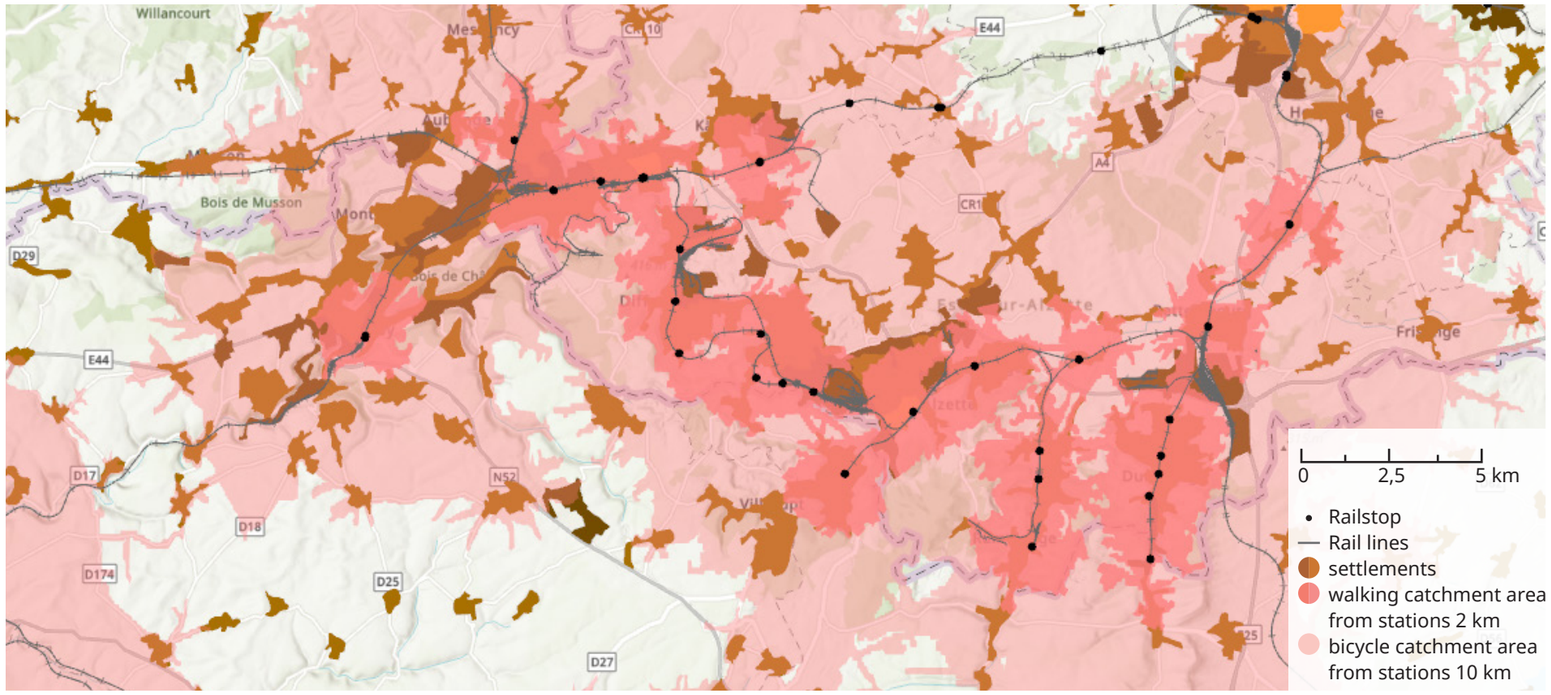


Figure III-29: Catchment areas for walking (2 km) and cycling (10 km) around stations in the banana reveal that a high share of settlements is reachable within short distances. Alas, the potential for unlocking active mobility in this area due to its short distance is notable. (based on Podaris and OpenStreetMap, n.d.).

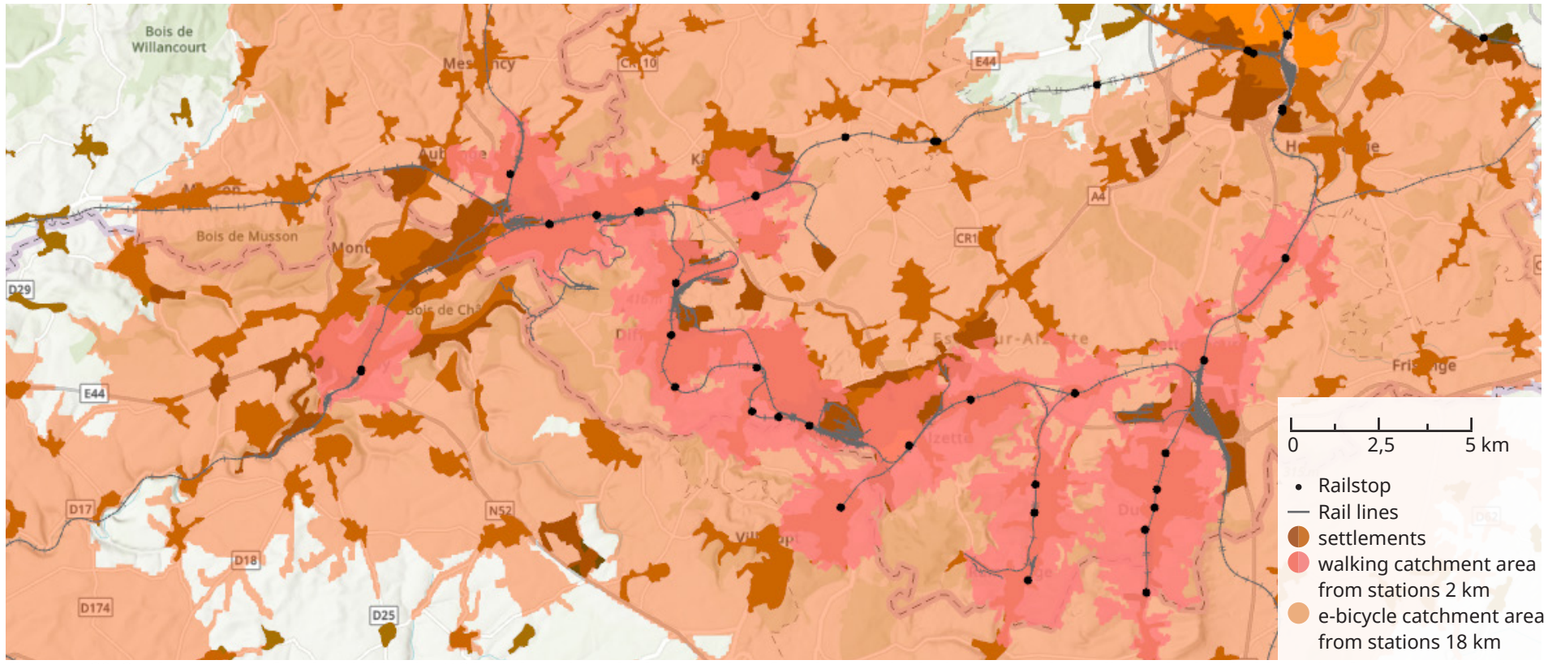


Figure III-30: Catchment areas for electric bicycles (18 km) show that a high proportion of settlements in the banana can be easily reached with this mode of transport. (based on Podaris and OpenStreetMap, n.d.).

Public transport frequency and service as biggest constraint

The current bus and rail infrastructure and services in the Banana are a big constraint in terms of mobility: due to insufficient service and low quality of interchanges, the accessibility in the area and to its surroundings is low.

A 30-minute bus ride would virtually take someone equally as far as the same time traveled by foot (Figure III-31). The same lack of accessibility is noted when an one-hour travel time with the current rail service is analyzed (Figure III-32).

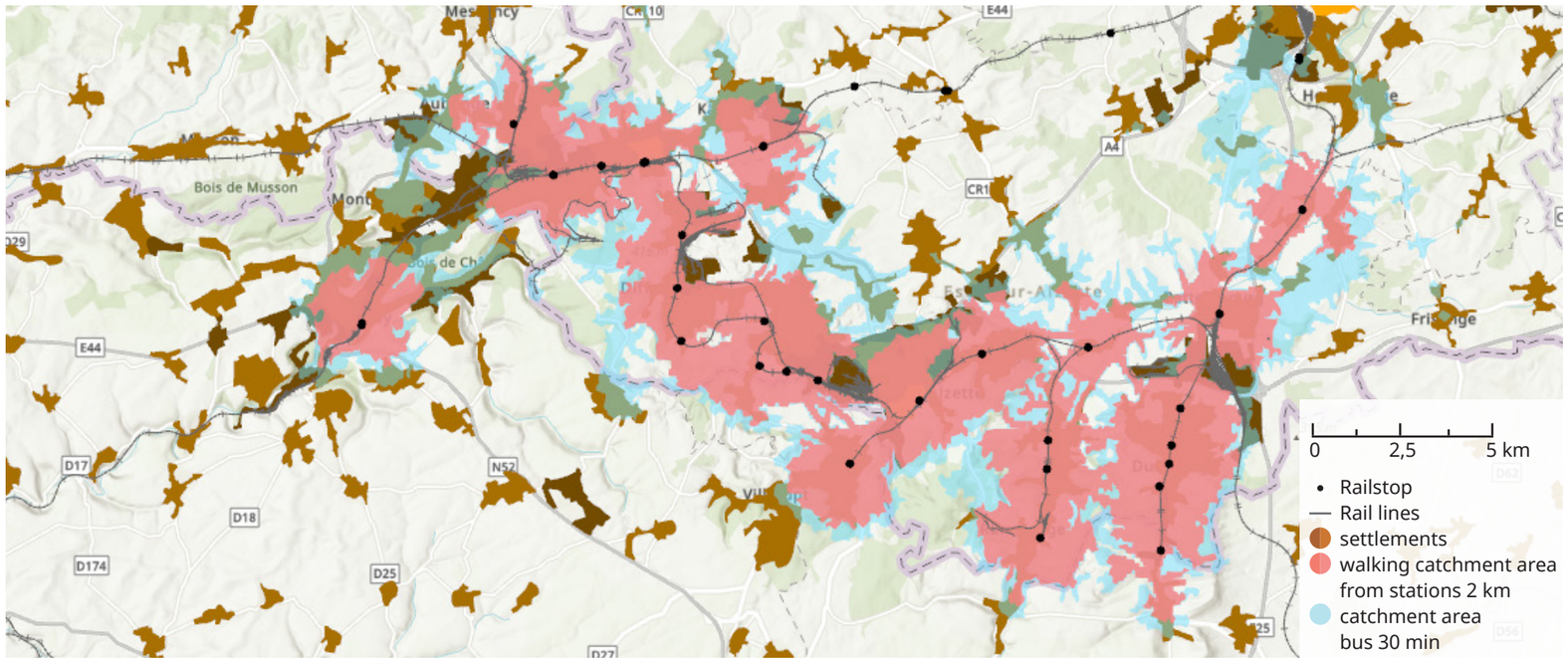


Figure III-31: Walking catchment area (2km, equivalent to approximately 25 minutes) overlayed with the catchment area of the current bus service in the area (here considered with a 30-minute commute). With the current bus service, only approximately 50% of the population of the Banana Agglomeration has access to this service. (based on Podaris and OpenStreetMap, n.d.).

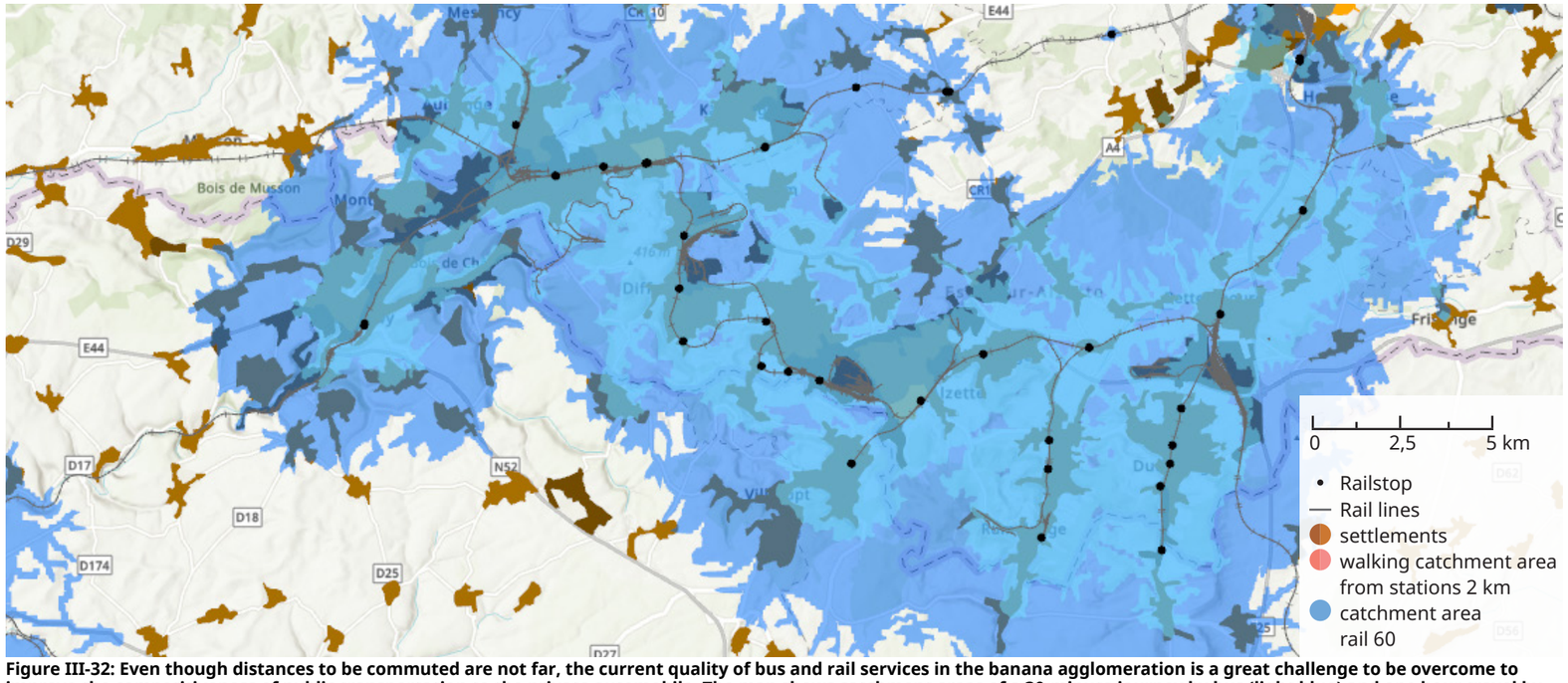


Figure III-32: Even though distances to be commuted are not far, the current quality of bus and rail services in the banana agglomeration is a great challenge to be overcome to improve the competitiveness of public transportation to the private automobile. The map shows catchment areas of a 30-minute journey by bus (light blue) and one hour travel by rail (blue) in the Banana. Several smaller settlements are not covered by the public transport service. (based on Podaris and OpenStreetMap, n.d.).

Strategies for Mobility

Strategies for Mobility

The strategies proposed in this chapter are divided between hardware – aiming to improve physical assets by spatial interventions – and software – including policies for catering human behavior to improve the adoption towards cleaner mobility and to discourage the use of the private car. The objectives of these strategies are three-fold: the first one is to turn public transport and active mobility into more competitive means of transportation, while discouraging the ridership of the private automobile; secondly, to increase the adoption to electrical vehicles; thirdly, to increase opportunities in the Banana Agglomeration by carefully densifying areas around transport stations. Figure III-33 schematically shows the proposed strategies in the Banana.

Our proposed strategies are:

Hardware:
1. Upgrade the “A” and promote a transport-oriented corridor development
2. Polycentric spatial development and the 15-Minute-City

Software:
3. Promotion of green fleets
4. Implementation of Mobility-as-a-Service for smaller settlements
5. Congestion charging combined with park-and-ride facilities
6. Parking management
7. Introducing pricing mechanisms

With the gradual but radical implementation of these measures, we expect a steady shift of the private automobile’s modal split in Luxembourg and in its cross-border region from 69% to 40%, as illustrated in Figure III-34 and III-35. We also believe that implementation of the following strategies will increase the share of active travel in the modal split by 19% and public transport ridership by approximately 10%.

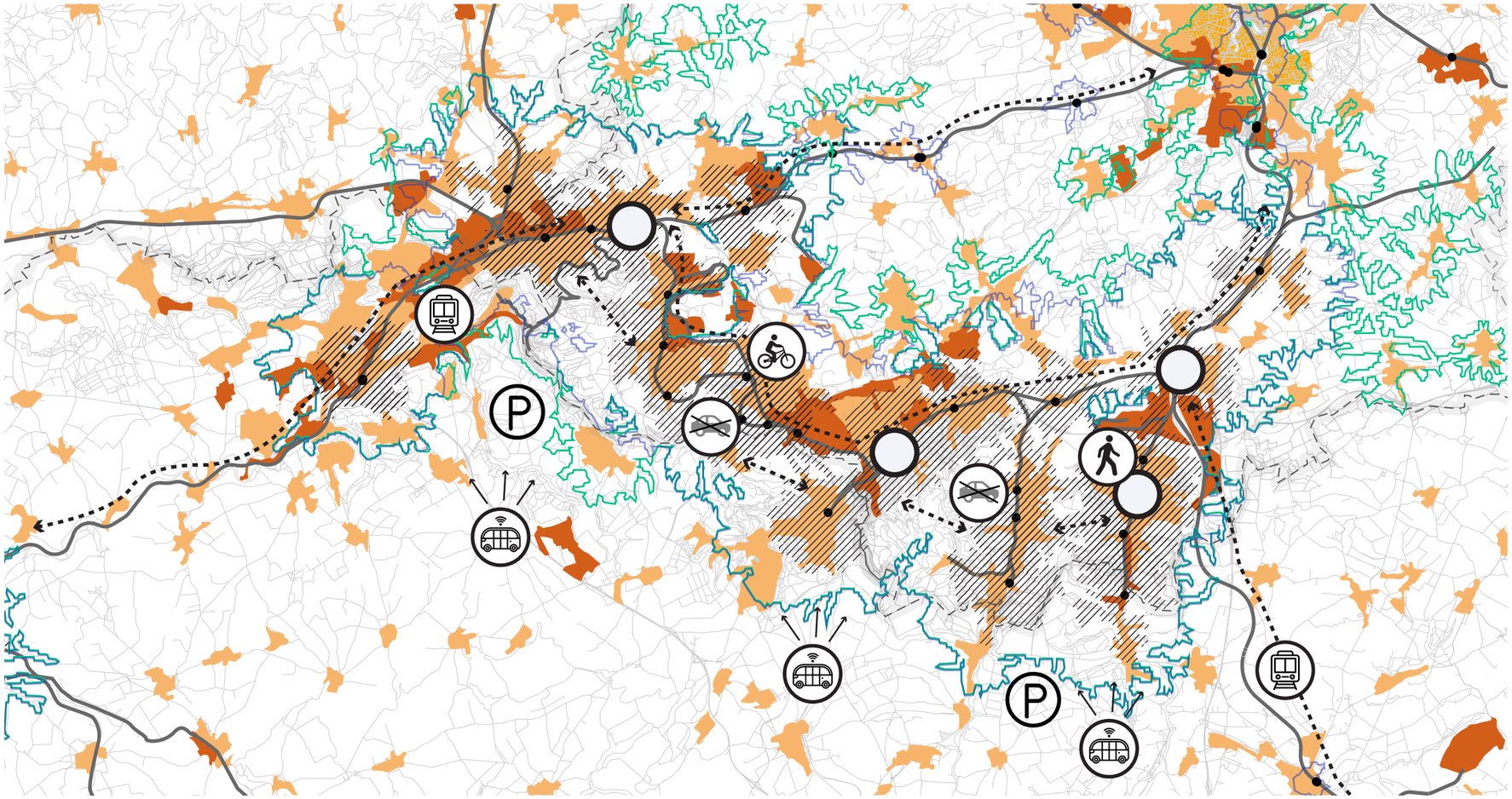


Figure III-33: Our mobility strategies involve the improvement of hardware structure by upgrading current rail and bus services, as well the current fragmented cycling and pedestrian infrastructure. It also aims to densify and qualify areas around stations, promote green fleets, and the revision of parking zoning plans with the promotion of financial incentives to curb automobile use. It also promotes congestion charging zones in densified areas to calm motorised traffic and the strategic placement of park-and-ride facilities close to stations. Finally, our strategies promote the further implementation of work-from-home measures to decrease the overall number of needed trips. (based on Podaris, CORINE, 2018 and OpenStreetMap, n.d.).

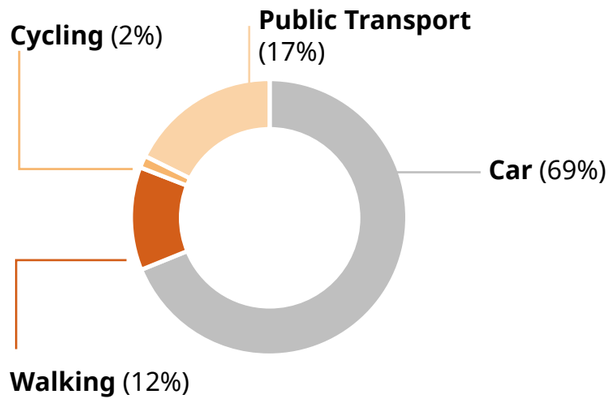


Figure III-34: Modal Split in Luxembourg (2017) (MECDD, 2018)

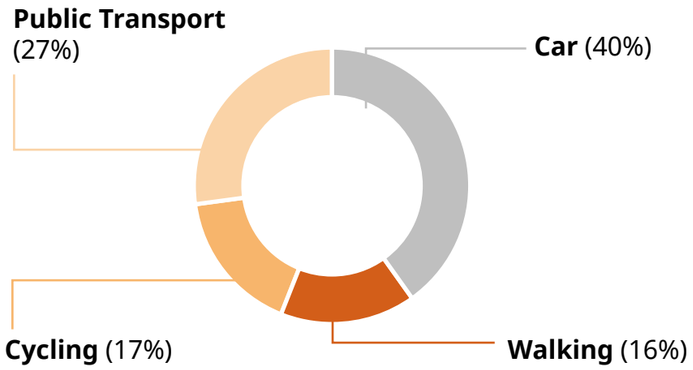


Figure III-35: Modal Split in Luxembourg (2050)

Hardware: Upgrade the “A” and promote a transport-oriented corridor development

Strategy 01

This strategy proposes infrastructure improvements in the “A” rail corridor – illustrated in Figure III-36, which encompasses Metz, Bettembourg, Esch, Petange, Longwy, and Luxembourg City, by improving the rail’s frequency, service, and quality of design in interchange. It also increases bus service and frequency with the promotion of new tangential lines between settlements.

Furthermore, as illustrated by Figure III-37, it includes the improvement of the areas surrounding public transport stations with the upgrade of distance-based catchment zones for different modes of transport, implementing state-of-the-art walkable and cyclable infrastructure, and enhancing the integration of rail stations to other modes of transport by complementing the currently fragmented pedestrian, cycling and bus networks.

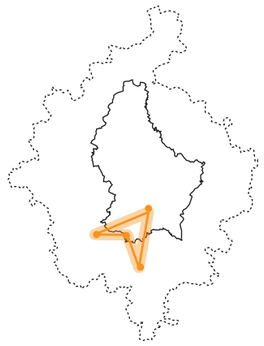


Figure III-36: Upgrade the service and frequency in the “A” Corridor.

SOLUTIONS

Walk

- Promote a pedestrian-oriented streetscape
- Prioritise pedestrians and cyclists over motorized traffic by using traffic-calming designs
- Invest in pedestrian-supportive land use mix schemes around public stations, including car-free zones when adequate

Cycle

- Promote a safe, connected and comfortable streetscape for cyclists
- Promote intermunicipal and transborder cycle commuting by implementing a cohesive cycling infrastructure between cities and improving the connection of cyclists to public transport stations
- Promote a transborder bike sharing scheme and bicycle around transport stations

Bus | Tram

- Create more tangential lines for buses or light rail between settlements
- Increase buses’ and trams’ tact between cities and in the cities’ cores

Regional

- Increase rail frequency and directness of service between bigger urban centers (Metz, Bettembourg, Esch, Petange, Longwy and Luxembourg City)
- Increase the quality of interchange in stations by improving their design
- Promote a higher rail tact, with special attention to commuter's rush hours

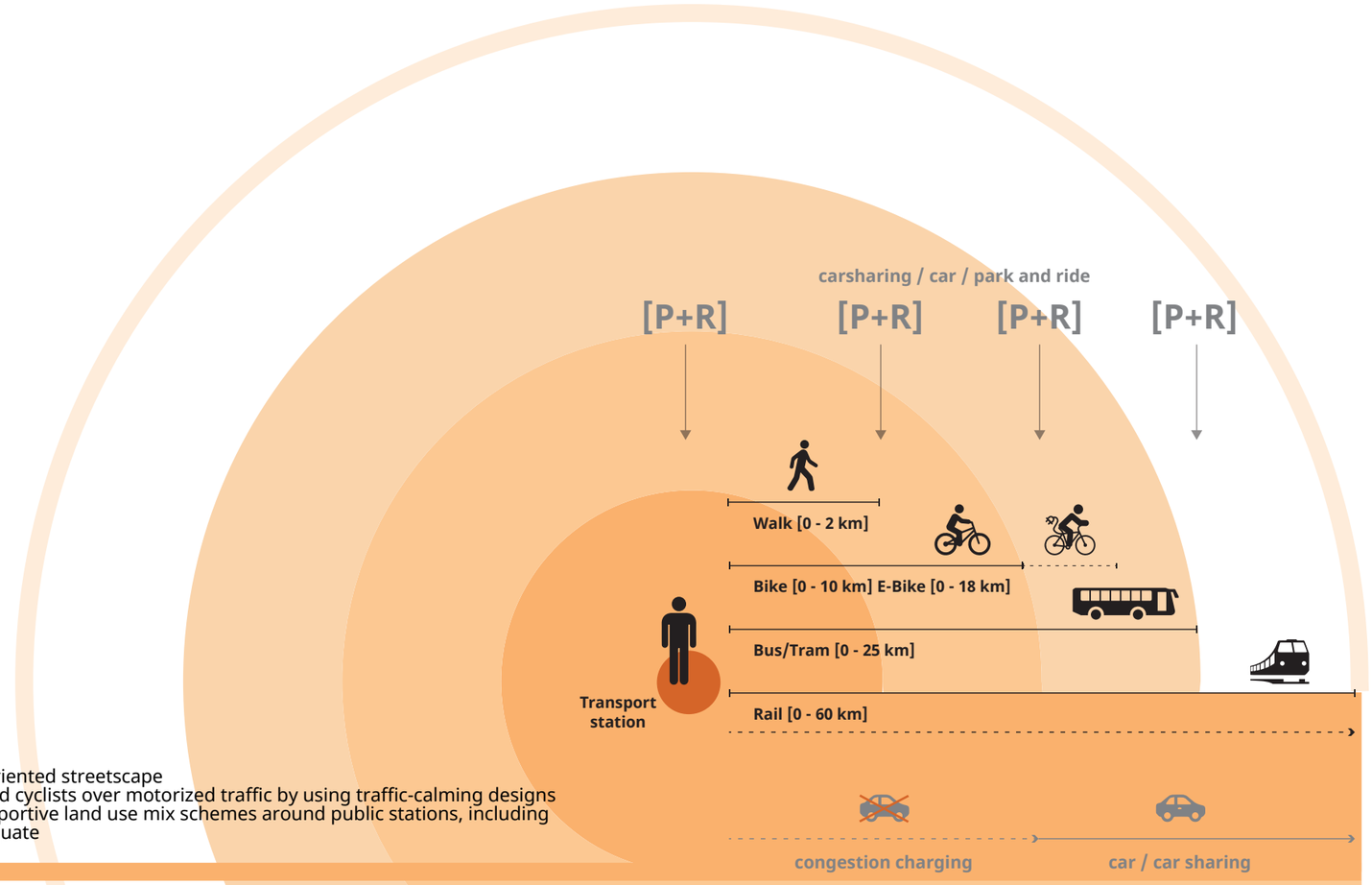


Figure III-3/: Transport-oriented corridor development to improve the areas around public tranport stations to increase ridership of more sustainable ways of transport. (Arup, 2021)

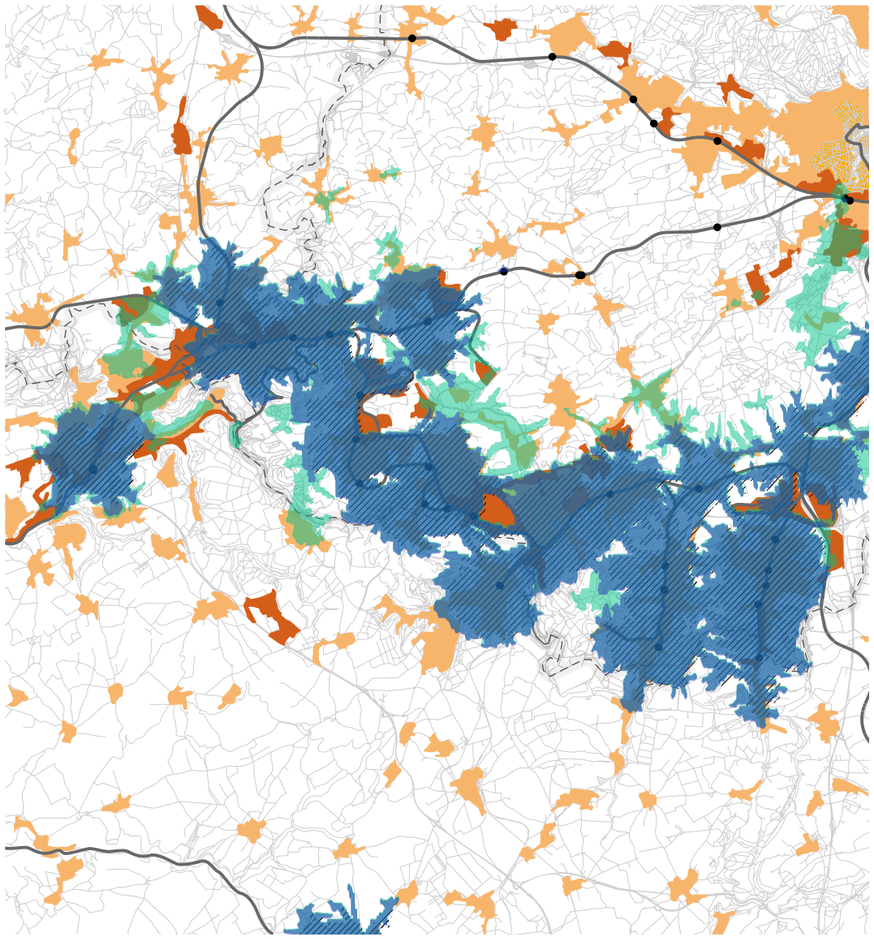
Spatial Implications of Rail and Bus Improvements proposed in Strategy 01

Upgrading the “A”

By promoting a higher frequency of rail lines in the “A” corridor and increase the number of lines and frequency of the bus service between settlements , it is possible to amplify the catchment area of both modes of transport (Figure III-38) and make public transportation more competitive with the automobile.

Improvements of the cycling and pedestrian infrastructure are displayed in more detail in the exemplary case study, in the next chapter.

Current situation (comparison with same travel time)



Improved situation (comparison with same travel time)

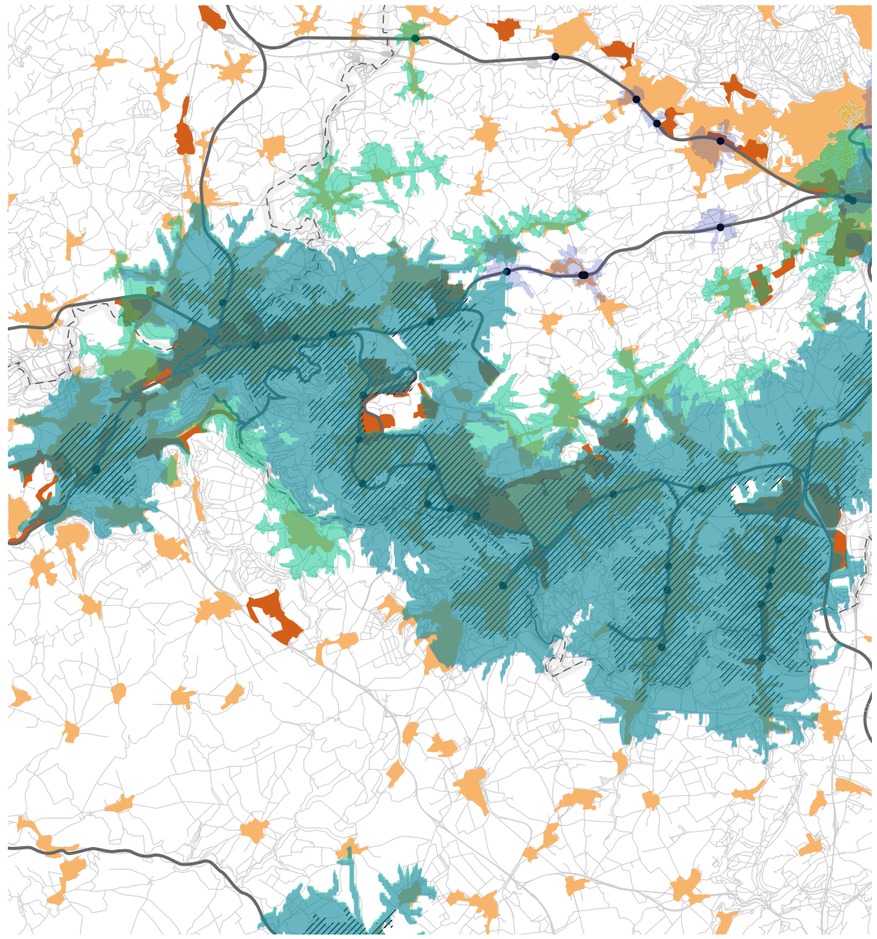


Figure III-38: Current and improved situation catchment areas of the public transportation system in the Banana Agglomeration

Hardware: Polycentric spatial development and the 15-Minute-City

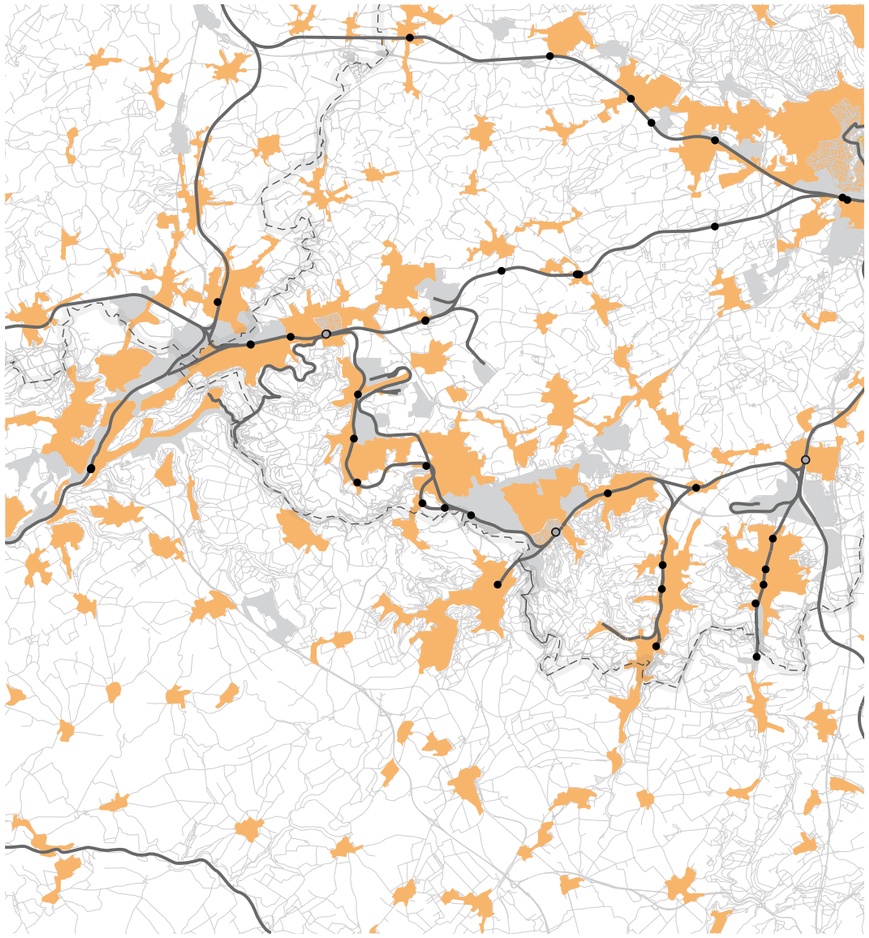
Strategy 02

Polycentric spatial development and the 15-Minute-City

Building on Strategy 01, the polycentric spatial development aims to raise the attractiveness of the Banana Agglomeration by strategically re-evaluating the zoning plan of existent industrial and brownfield areas near public transport stations (as illustrated in Figure III-39). With this, we aim to develop placemaking-oriented and affordable mixed-used urban typologies, that are also well-connected to the public transport system. The need to use the private automobile can thus be radically reduced, as everyday activities and amenities can be done effortlessly and independently from the automobile.

Stations surrounded by new densified areas can be transformed into mobility hubs to increase the synergy.

Current situation



Improved situation

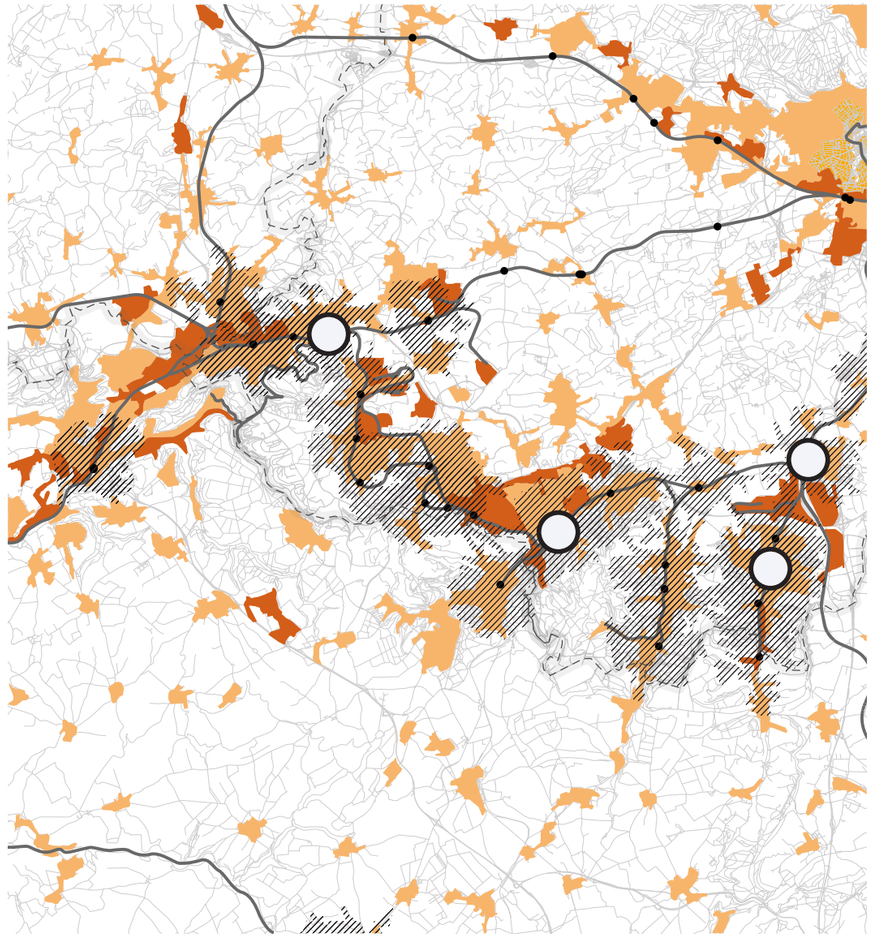


Figure III-39: Strategy 02 promotes the development of centralities by strategically revising the zoning plan around stations and upgrading existent brownfield and industrial zones

0 2,5 5 km

Brownfields
Settlements
Transport stations
Border line
Rail

0 2,5 5 km

2 km-walking catchment area
Mixed-use developments
Settlements
Mobility hubs
Transport Stations
Border line
Rail

Software Strategies

Strategy 03

Promotion of green fleets

Besides promoting active travel and public transportation, it is also important to increase the adoption of electric vehicles among the population. Among citizens of the functional region, the current adoption of electric vehicles is relatively low, however, according to citizens' testimonials, there is an appetite for adoption (as seen in Figures III-40 and III-41).

We believe that implementing financial incentives to increase the adoption of green fleets in the functional region is important to curb emissions from people that still need to drive the car. Although relatively contemptuous regarding the source of the subsidy, this strategy has been successfully implemented in Norway over the last decade, where the market share for new electric vehicles is around 60% - excluding hybrid models (Figure III-42).

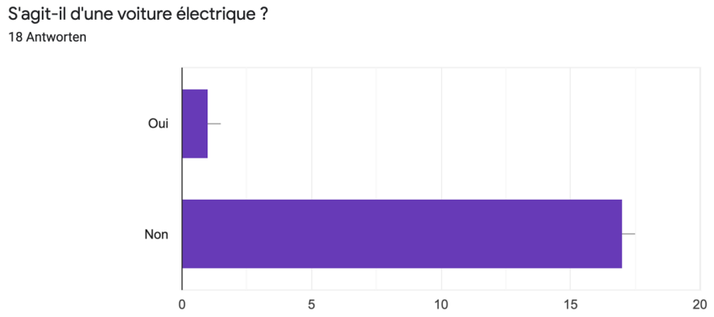


Figure III-40: The current adoption to electric vehicles in the functional regional is low.

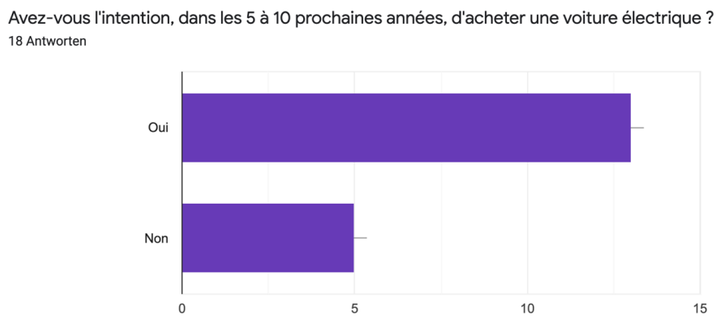


Figure III-41: Results of the questionnaire made with citizens of the functional region reveal that there is appetite for adoption to electric vehicles.

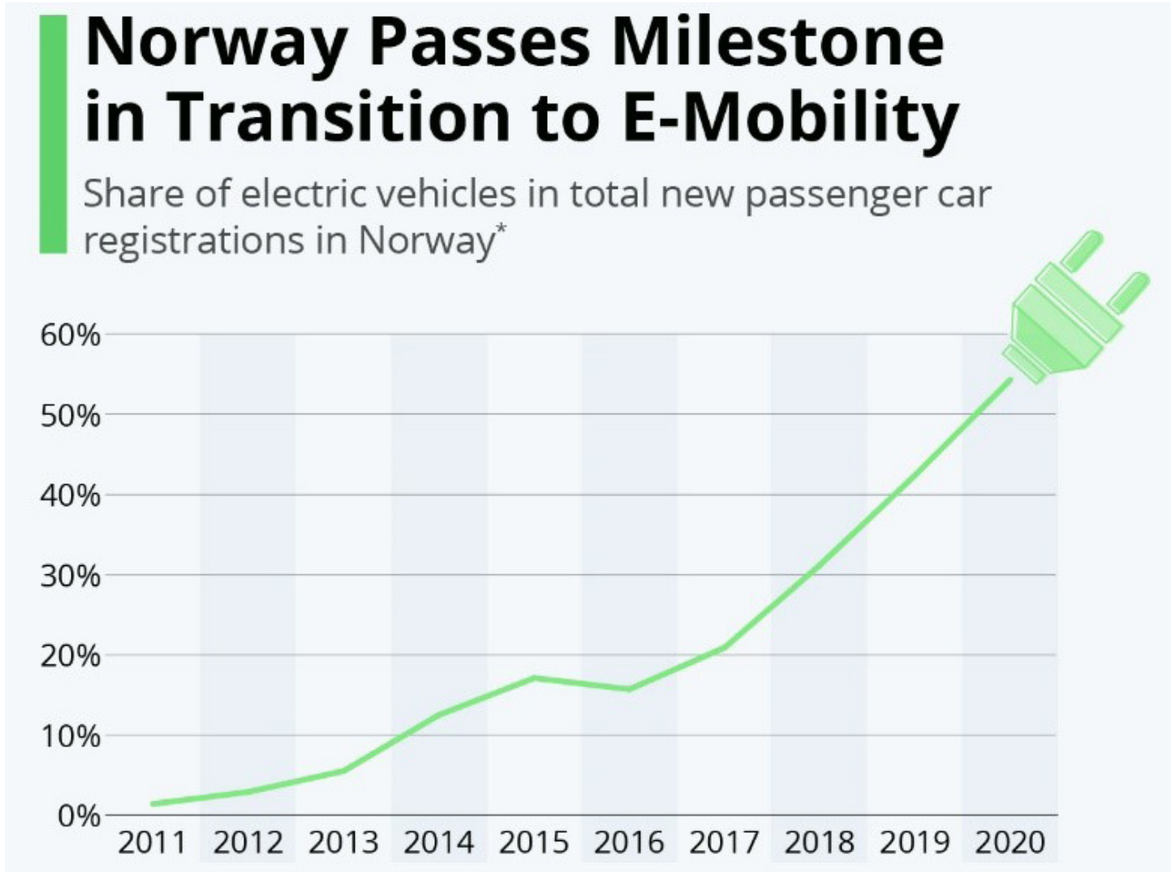


Figure III-42: Financial incentives turned Norway in a frontrunner for electric mobility in less than a decade. (Statista, 2021)

Strategy 04

Implementation of Mobility-as-a-Service for smaller settlements

This strategy aims to bring a flexible and cost-effective option for cross-border commuters that live in rural or smaller settlements that are currently not well-served by either rail or bus systems. It promotes the implementation of Mobility-as-a-Service-system to meet the demand of rural settlements that do not fall within the catchment area established by Strategy 01 and are thus not covered by adequate public transport service. This could take place in the form of Demand Responsive Transport (DRT) Shuttles coordinated with the public transportation system to optimize commuting and interchange time. Over the last years, the necessity of promoting cleaner ways of transportation to rural settlements that are poorly served by public transport and the advancement of integrative and smart mobility systems have resulted in the accelerated development of MaaS-Systems. Spearheaded by the German Federal Ministry of Food and Agriculture, the pilot project LandMobil is currently successfully funding the implementation of pilot projects for DRTs and other ride-sharing schemes in rural areas in Germany (BMEL, 2020).

Software Strategies

Strategy 05

Congestion charging combined with park-and-ride facilities

According to the citizens' testimonials, the habits of Luxembourgers is extremely anchored to the car. Therefore, the promotion of strategies to promote behavior change are essential. In combination with proposed hardware strategies, Strategy 05 (Figure III-43) promotes the adoption of road-pricing measures to discourage the use of the car. This could be done by promoting congestion charging during peak hours for commuting or completely restricting street sections to cars, combined with the walking and cycling catchment areas previously mentioned. To facilitate the interchange from these zones to public stations, we promote the reevaluation of existent and placement of park-and-ride facilities close to stations.

Strategy 06

Parking management

We propose the revision of zoning plans to reevaluate the need for parking spots for new developments. For existent urban zones and settlements, we suggest the gradual repurpose of inner-city parking spaces to further restrict the use of the private automobile at the first and last miles.

Strategy 07

Introducing pricing mechanisms

We suggest the introduction of pricing mechanisms s for private automobiles by implementing higher taxation on high-emitting vehicles and on car ownership in Luxembourg. It also promotes financial incentives for the adoption of public transport and low emitting modes of transport. This could take place by promoting financial incentives for companies to continue to promote work-from-home policies. Further pricing policies can be seen in the Logistics chapter.

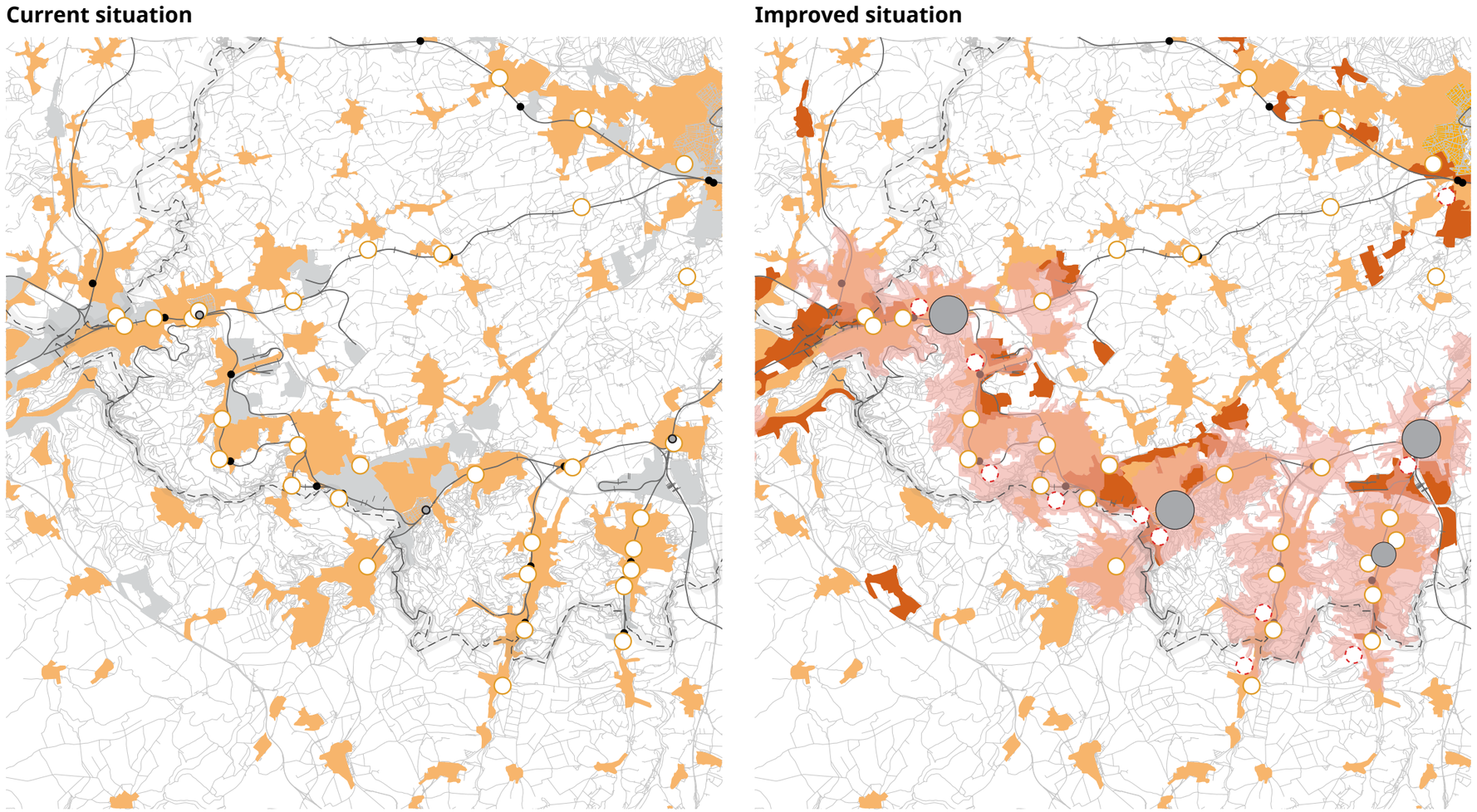


Figure III-43: Congestion charging combined with park-and-ride facilities

V.

EXEMPLARY ZONE

Case-study Bettembourg-Dudelange

Bottom Up Carbon Reduction Logistics

In this case study, we developed a bottom-up method to estimate carbon-reduction potential at the local level, on the basis of which we then generalize and upscale to the larger region.

Bettembourg-Dudelange forms a hinge-point between the three large linear agglomerations: Longwy-Esch-Thionville (the Banana Metropole), Metz-Thionville (the Lotharingen city belt) and the Saar-agglomeration. They are both situated on major trainlines and motorways at the border between Luxembourg, France and Germany. This context has led to the allocation of industry and later of distribution, service and logistics centres. Next to the traditional and gradual transforming metal and machine industry like Arcelor Mittal, companies like CFL multimodal Terminal, Fedex Express, TNT Express, Datacenter Luxembourg, Transalliance, Auchan, Goodyear have settled in the industry zone. But also, institutions like the National Health Lab are housed along the high-way.

The combination of favourable context and connectivity has led to a stable condition. However, despite the extensive and fragmented use of the traditional industry zones, the municipality is planning to develop new green field development for housing, businesses and other functions. This leads to a paradox situation of inefficiently used, partly empty brownfield zones vis a vis the subtraction of agricultural land and nature for development.

On the other hand, sustainable projects are realized, like the CFL Intermodal Road-Rail Terminal, constructed to increase the share of rail-transport at this important crossroads. The CFL terminal is planned to be covered with a solar farm across the total of the site. Below, we list up a set of possible interventions, which may greatly improve the carbon footprint of Bettembourg-Dudelange.

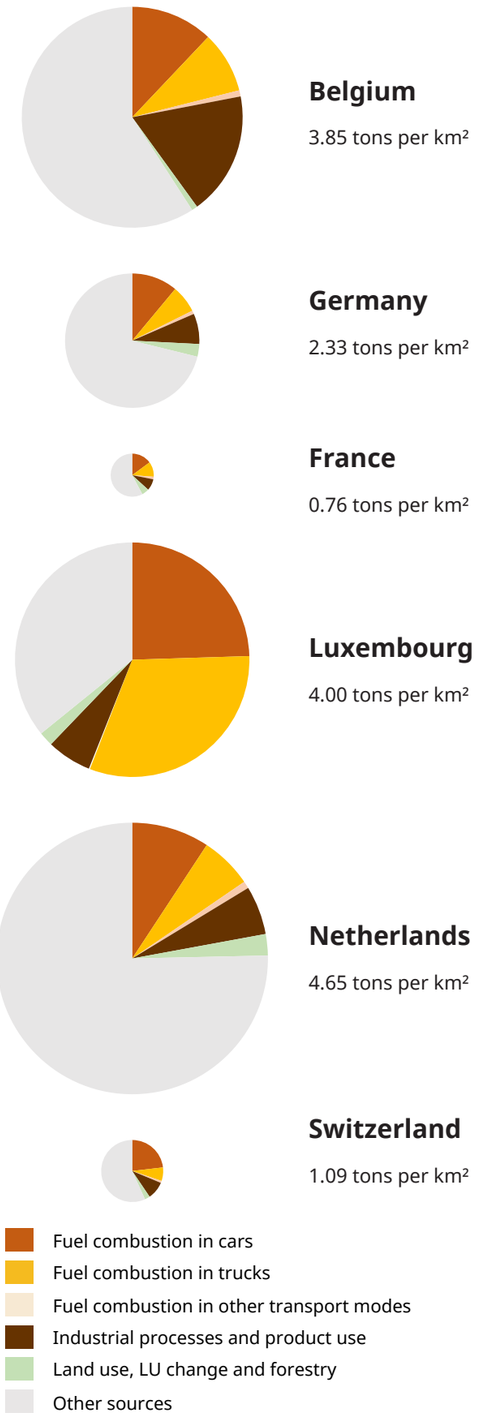


Fig. IV-1 : Comparison of GHG emissionn structure and average GHG emission density of the land (based on Eurostat)

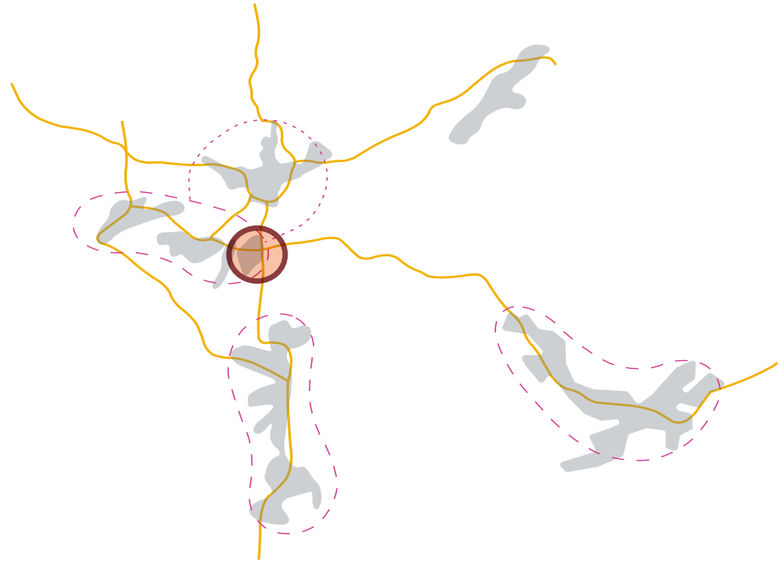


Fig. IV-2 : Location of the exemplary zone

Intermodal Hub

Current situation

Bettembourg has a new Intermodal Road-Rail Terminal, where containers can be transferred from truck to train and vice versa. In addition, the total surface of 33 ha is envisaged to be covered by a solar farm.

The capacity of the terminal is 600.000 intermodal loading units/year, and a storage capacity of 3425 containers. The impact, for example of the launch of a new rail connection between the Intermodal Terminal Bettembourg-Dudelange and the Terminal Schwedenkai in the Port of Kiel, will foster modal shift, allowing the transfer from road to rail of up to 10.000 trucks and CO_2 savings of about 11.000t per year. (CFL-Multimodal. 2020)

Interventions

- The analysis of existing cargo flows (origin-destination-transfer) at CFL Multimodal will provide clues how to modify these flows according to new legislation and policies. Is any cargo destined for the surrounding local industry area? Also, the influence of cargo-policy is to be considered
- The surface (33 ha) and the related power capacity of the solar farm will be calculated. This will provide concrete numbers for local reduction of fossil fuel for power-generation.

Fig. IV-3 : Media anouncement for the solar farm plan (Luxembourger Wort, 2019)

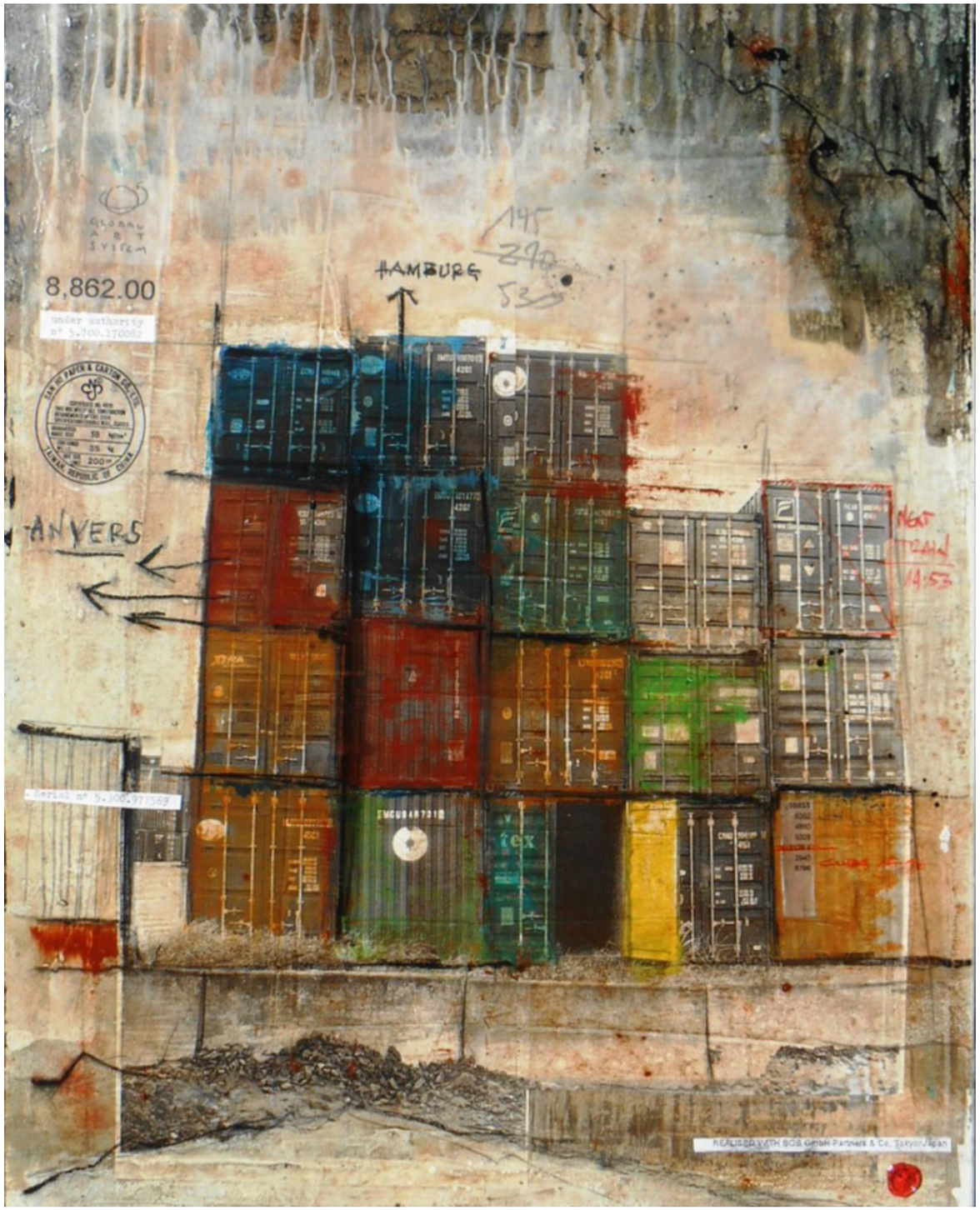


Fig. IV-4 : Local artist Robert Viola, Made in China (www.robertviola.lu/)

Logistics and Industrial Zone Investigation

0 1 2km

Current situation

- Industry and logistics buildings are scattered across fragmented industry parks in a very extensive way. Buildings are generally one storey high (sheds).

Interventions

- Make an inventory of buildings, typologies, state of maintenance and their GFA.
- Make a inventory of functions in buildings has been made, as well as an estimation of the activity's life-expectancy.
- Consequently remote, inefficient or underused buildings will be abandoned, their programme is reorganized and concentrated in larger shared & collective buildings. Although construction of new buildings produces emissions, the reduced building footprint, energy-efficiency and reduced traffic infrastructure will result in a positive CO2 balance.
- The roof surface of new buildings will be activated for double use, like sports, office park, greenhouse, farming, solar panels, rainwater management, garden centre, etc. Double use is a densification factor and results in double GFA per sqm of building footprint. Shared energy-systems and district infrastructure for heating and cooling produces CO2 gains.
- Data Centres will be obliged to share their heat production for district heating, which substantially saves fossil fuel consumption.

Fig. IV-5 : Business types of companies in the industrial and logistics regions surrounding the Bettemburg Terminal (based on GoogleEarth)

Typology Study and Densification Potential

Different typologies of space

Large Scale
(Dispersed form)

Small Scale
(Clustered form)

Mixed Scale
(Compact form)

Inventory of the key industrial zones in the Banana Belt

Scheleck III/VI	Large	Low	Dispersed
Scheleck II	Small	Low	Clustered
Wolser	Large	Low	Dispersed
Wolser West	-	-	To be built
Koibestrachen	Large	High	Clustered (to be extende
Krakelshaff	Small	Low	Dispersed
Eurohub Sud	Large	Low	Dispersed
Scheleck I	Small	Low	Clustered
Scheleck IV	Small	Low	Dispersed
Riedchen	Large	High	Dispersed

Esch sur Alzette:

ZONE	SCALE	RISE	ORGANIZATION
Ehlrange West	Small	Low	Clustered
Ehlrange Est	Mixed	Low	Clustered
A Sommet	Small	High	Clustered
EA1	Large	High	Clustered
EA2	Small	Low	Clustered
EA3	Small	Low	Clustered
Foetz	Small	Low	Clustered
EA4	Small	Low	Dispersed
EA5	Large	High	Clustered
EA6	Small	Low	Dispersed

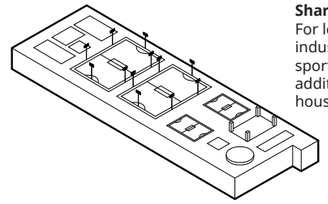
Athus Eurohub:

ZONE	SCALE	RISE	ORGANIZATION
ZI Aubange	Mixed	Low	Dispersed
Terminal Athus	Large	Low	Dispersed
PED Mont St Martin	Mixed	Low	Dispersed
Au Grand Bis	Small	Low	Dispersed
PED Lonwy	Small	Low	Dispersed
PED Saulnes	Large	High	Dispersed
PED Aubange	Small	Low	Clustered
PED Rodange	Large	Low	Dispersed

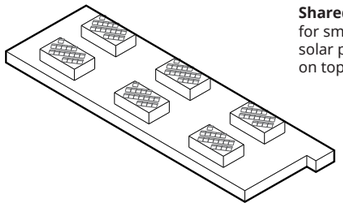
Mertert Trier:

ZONE	SCALE	RISE	ORGANIZATION
Wasserbilig Mertert	Small	Low	Clustered
Mertert	Large	Low	Clustered
Mertert Port	Small	Low	Dispersed
Trier Euren	Mixed	Low	Clustered
EA1	Large	Low	Clustered
Konzerbruck	Mixed	Low	Dispersed

New compact hybrid typology

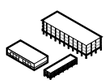


Shared Storage Center
For logistics as well as industrial companies, with sport fields and other additional functions like glass houses on roof top



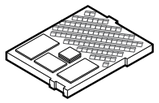
Shared Manufacture Space
for small manufacturers, with solar panels and green roof on top

Innovation Center
for innovative start-up's, with additional program, solar panels and green roof on top

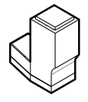


Specialized Campus
to promote research and development of emerging new industries

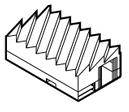
Exhibition center
for education to the public on sustainable behavior and technology



Shared Laboratory
for innovative start-up's SME's as well as big companies, with additional program, solar panels and green roof on top



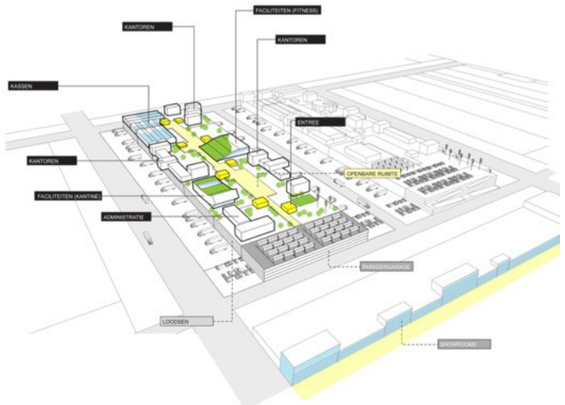
Density proposals in height
offices and laboratories for innovative start-up's as, individual companies or shared by several companies, with accessible productive or green roof tops



Cultural Center
with different types of gathering spaces

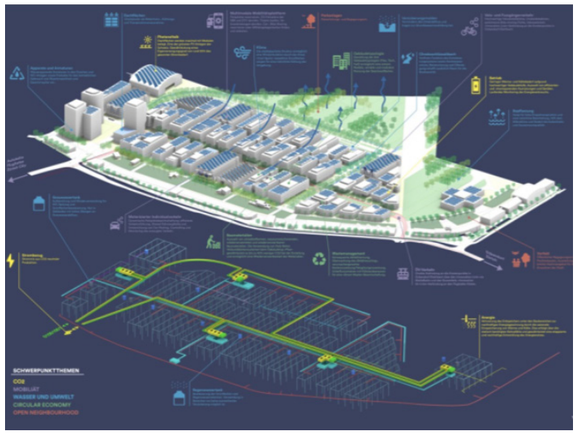
Implemented Compact Logistics-Business Zones and Integrated Mobility Hubs

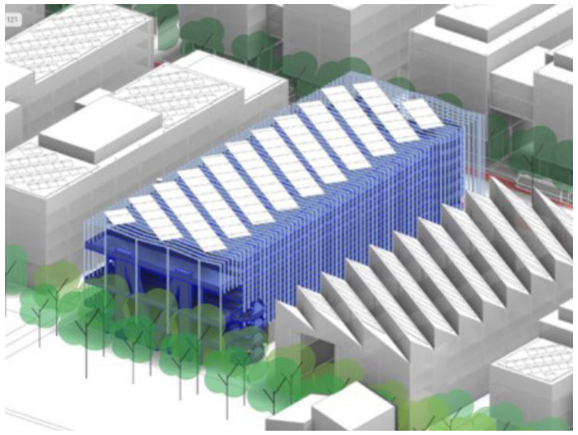
Trade Park



Schiphol Trade Park with solar plant, greenhouses, sports and office park on roof (KCAP)

Innovative Park





Innovation Park Zürich, Integrated logistics hub: cargo hub, parking, car & bike-sharing, powerplant, solar roof, waste collection (KCAP)

Mixed Industry Park

LaB Campus MUC Airport, a mixed, human industry park (KCAP)

Integrated Mobility Hub

Integrated mobility hub Uithof Utrecht: Park & Ride, Carsharing, Bus Terminal, Tramterminal, Bike Storage, Lounge, Convenience Store, Fitness & Climbing Wall (KCAP)

Landuse transformation

0 1 2km

Current trends in planning

- More landtake is planned in agricultural fields for logistics and industrial development.
- The entire space is defined as a monofunctional economic activity zone (ZAE). A first remotely located industrial area at the end of the sub-train-line is set for pure housing redevelopment.

Interventions

- Cancel any greenfield urban extension, there will be no new land-take. Newly built surface should be compensated by the return of brownfield into green surface.
- The relocation of scattered industrial and logistics activities into new, mixed and densified facilities results in potentially freeing up around 50% of brownfield.
- A connection to the future hydrogen pipeline is favorable. If industrial areas are clustered, they should connect to a hydrogen supply point, so to supply hydrogen to sustain logistic, industrial and mobility demands.
- Free space in the re-organized logistics and business parks can accommodate new industry buildings, creating a more compact condition, with respective CO2 gains.
- Obsolete and remote brownfield surface can be converted into agricultural land, woodland, or nature. CO2 gains can be regained through the renaturalization of the land.

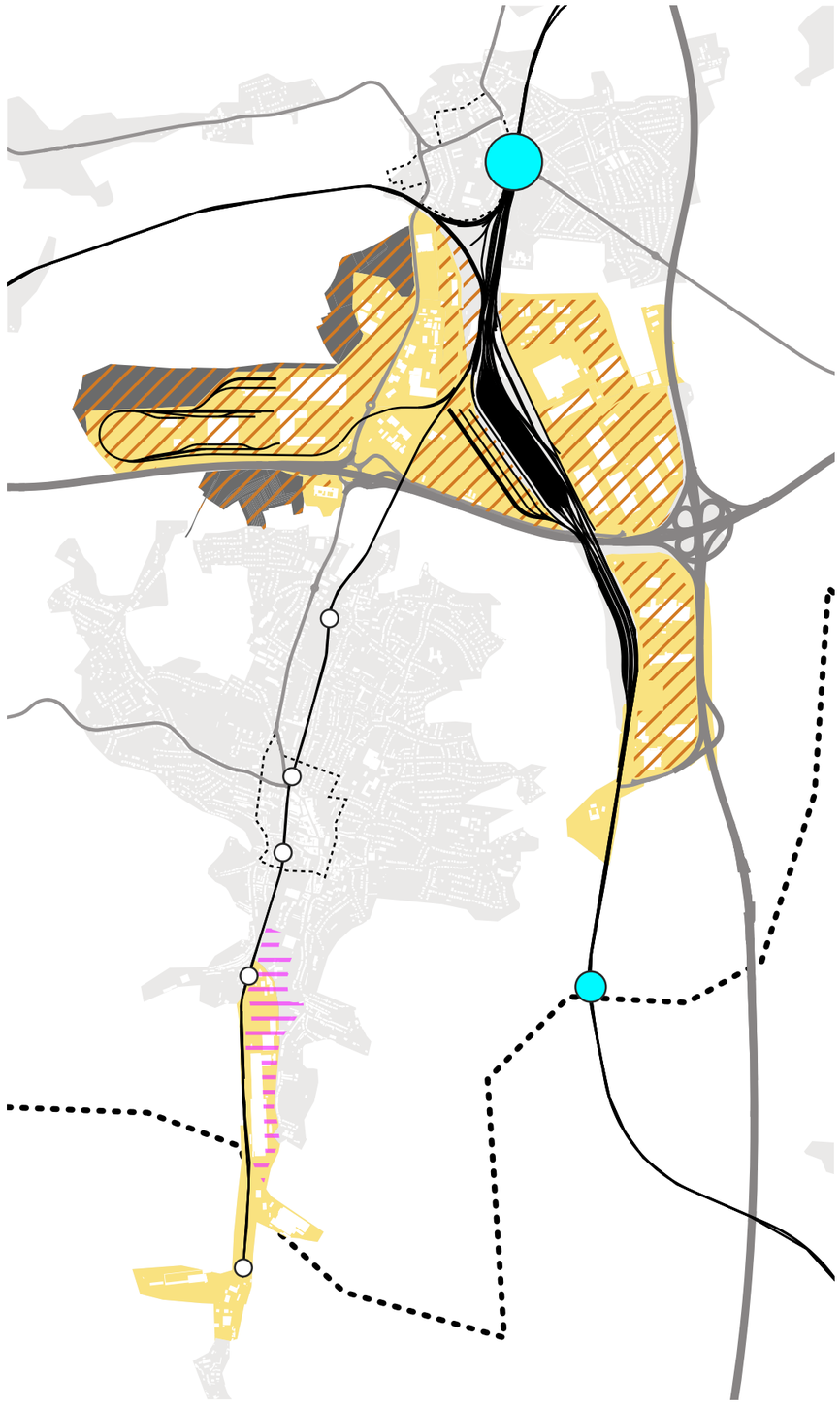


Fig. IV-6 : Summary of the existing official plan of the Bettembourg-Dudelange region

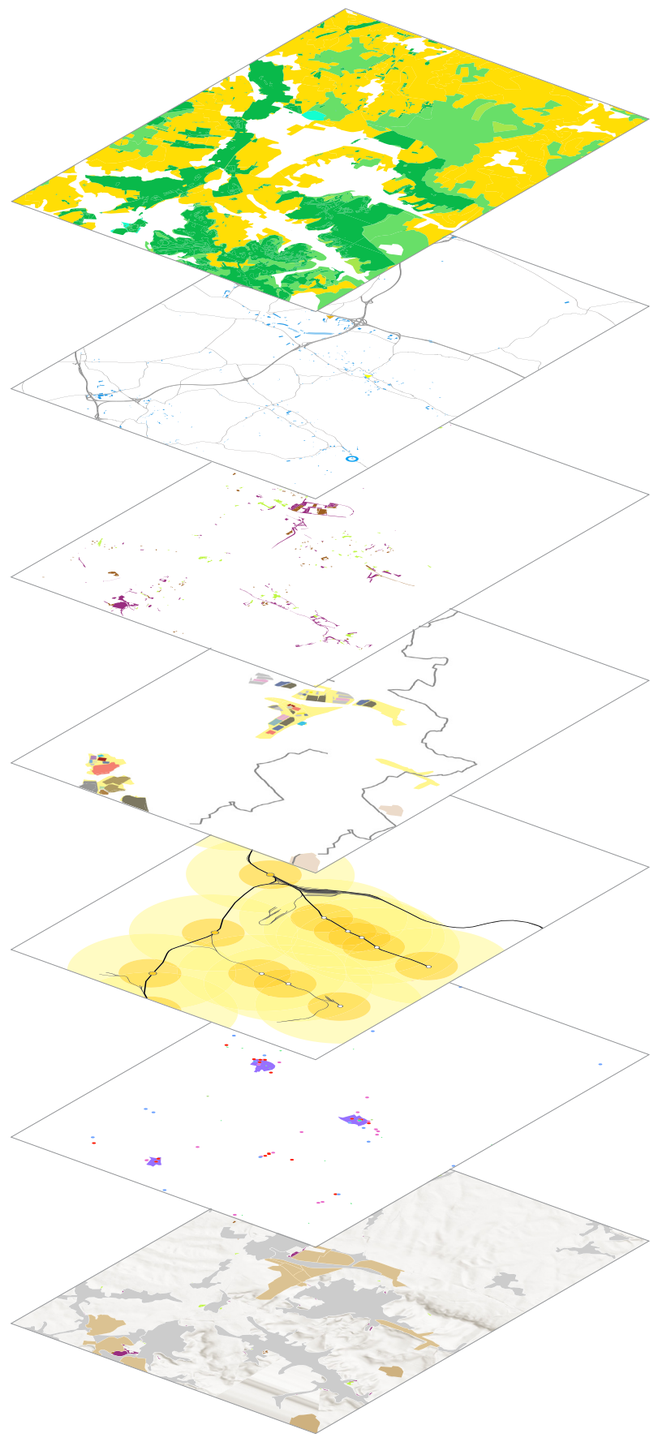


Fig. IV-7 : Low-emission landuse transformation principles (based on Geoportal.lu)

Spatial Structure Improvement

0 1 2km

Interventions

- The freed-up brownfield can be deployed for urban renewal to reorganize and connect the villages' centralities and meet demand for housing, public amenities or other real estate. The urban renewal process offers multiple opportunities to gain CO2 emissions by developing a more compact and efficient urban area.

- Option: A combined renewed urban centrality between Bettembourg and Dudelange is possible on the redeveloped industry areas around the tracks.
- Dudelange Gare Usines can either be redeveloped with multifunctional housing (requires improved train frequency), or returned as natural green surface.

Current situation map (left)

- Industrial and Logistics Land
- Built surface
- Centre
- Barrier zones
- 5 min catchement area (bike)
- 10 min catchement area (bike)
- Major stations with high frequency of trains
- Other stations with low frequency of trains

Transformation priority (right)

- H_2 Connection to Hydrogen pipe
- Barrier crossing design
- Built surface
- Consolidation zone for industry and logistics
- Densification zone for multifunctional urban environment
- Center
- Parking space to be reconditioned
- Unused urban space to be reconditioned
- Major stations with high frequency of trains
- Other stations with little frequency of trains

- Railway
- Motorway
- Primary road
- Country borderline

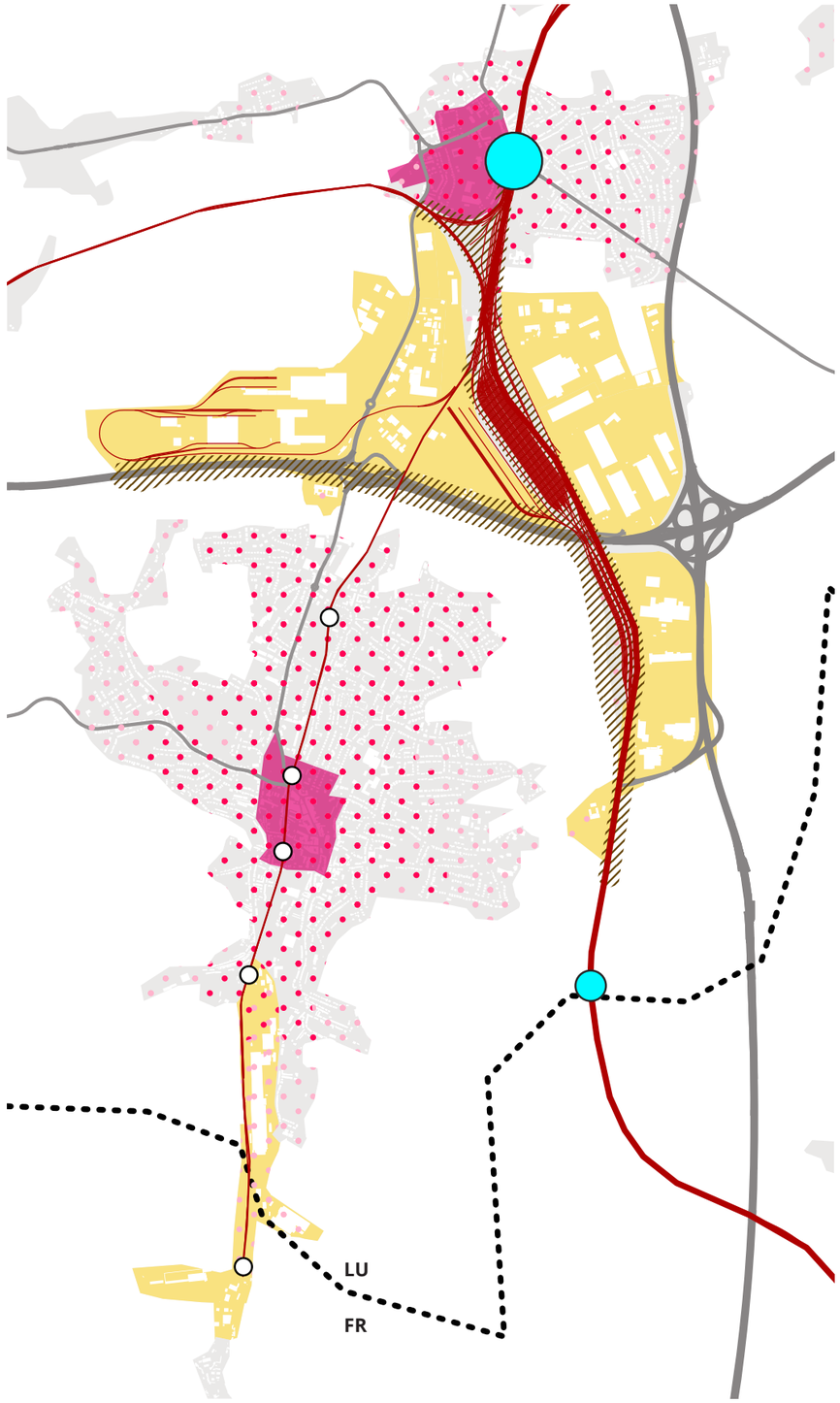


Fig. IV-8 : Current spatial structure of the Bettembourg-Dudelange region

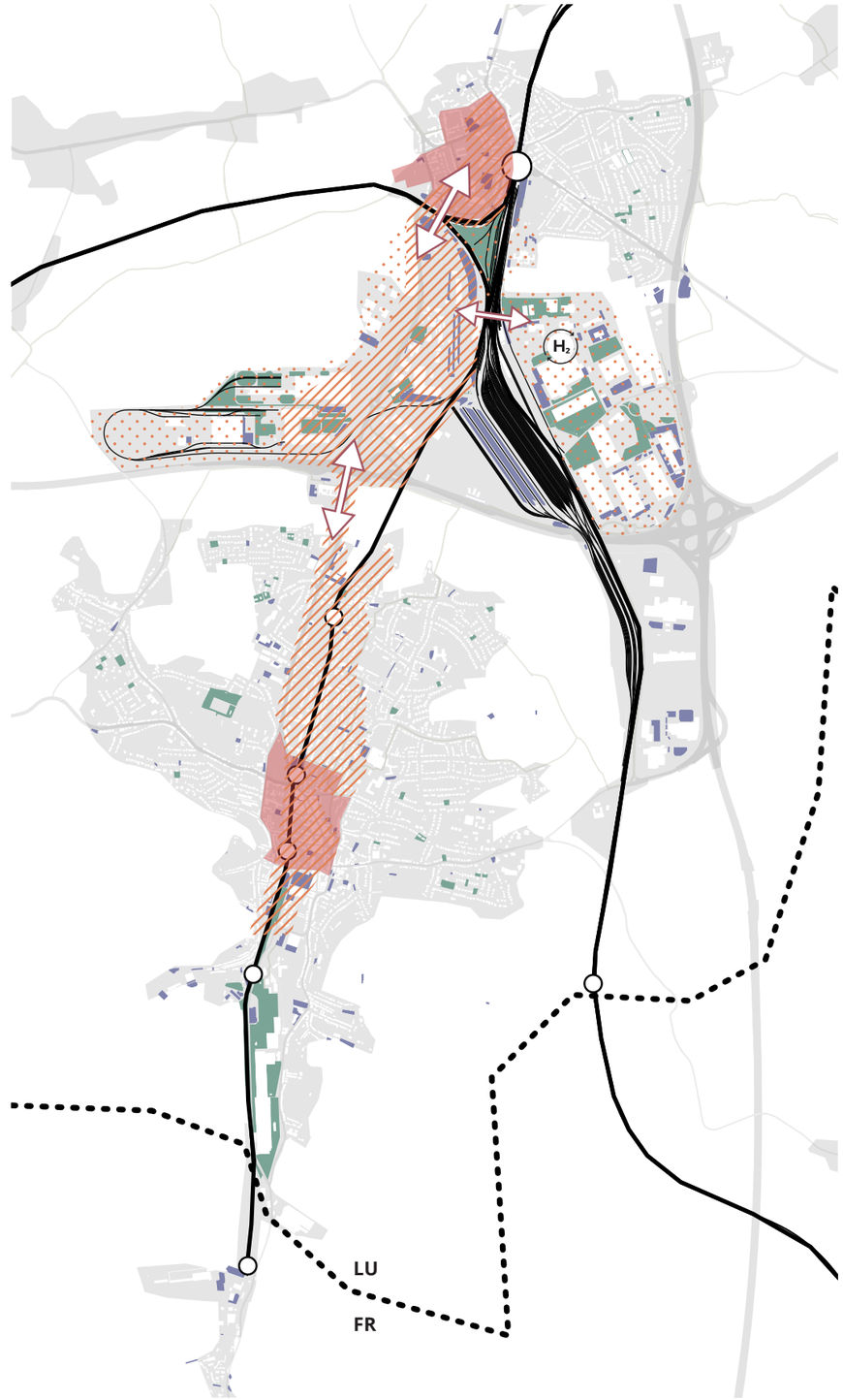


Fig. IV-9 : Low-emission landuse transformation principles of the Bettembourg-Dudelange region

Redistributing urban logistics facility

Reorganisation of distribution centers

Ideally located within a 6km radius from the central distribution centers of the main delivery companies, a local cycle logistic distribution system can be implemented throughout the towns of Bettembourg and Dudelange by reorganizing the existing infrastructure and the repurposing of unused urban space:

- Reorganizing infrastructure: during the process of densification of the Krakelshaff industrial area, the multiple distribution halls should be combined in a single structure, sorting and redirecting parcels to the micro hubs located in residential areas.
- Repurposing unused urban space: according to the necessary conditions for the creation of efficient micro hubs (located in well distributed streets, offering a catchment area of 1km covering a large portion of residential land), 3 potential locations have been identified.

Identified locations

1) Bettembourg, Route de Mondorf: repurposing of parking space
2) Dudelange, Route de Burange: reuse of brownfield space
3) Dudelange, Rue du Commerce: implementation within existing commercial cells

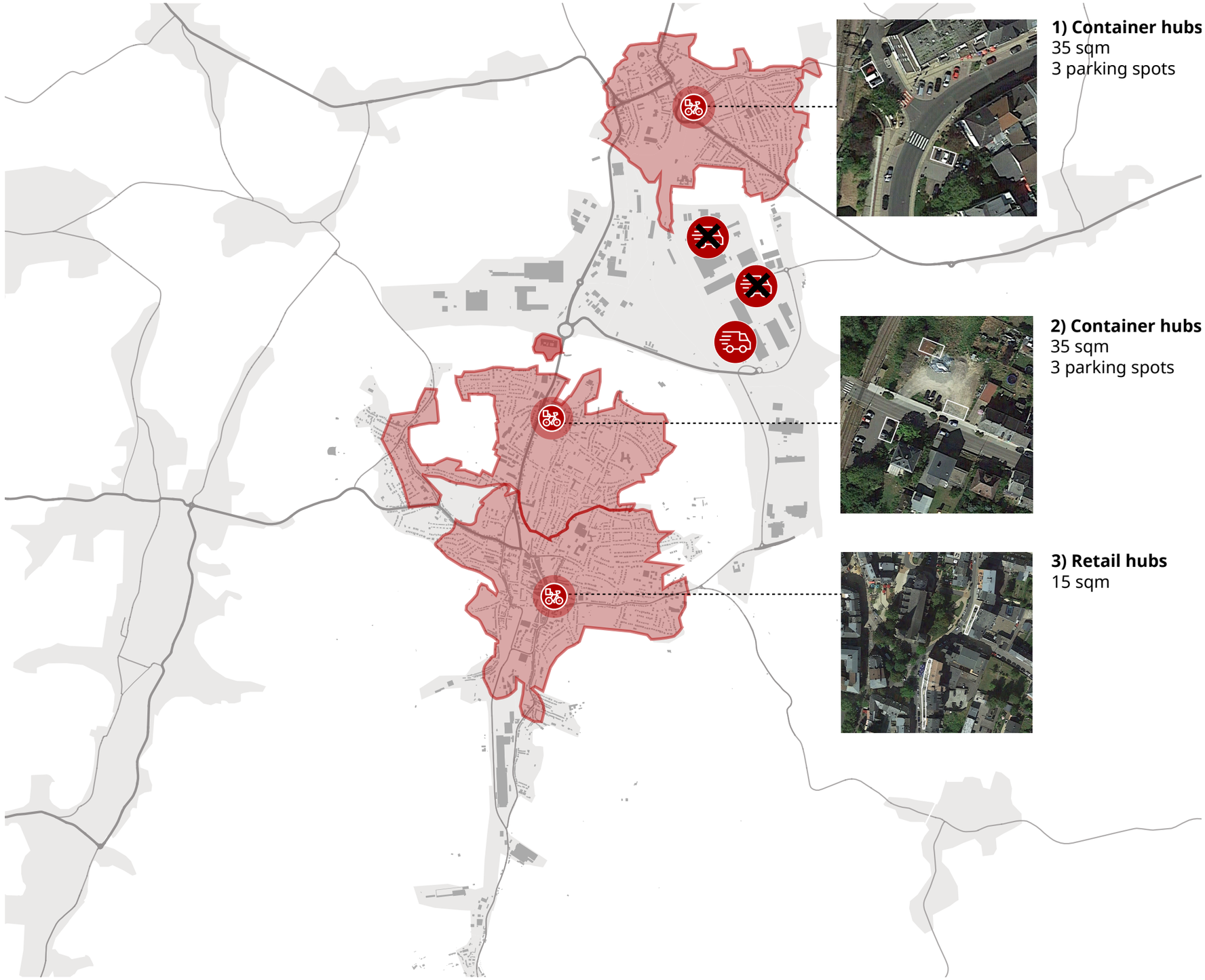


Fig. IV-10 : Indicative Micro-Hub System for Bettembourg-Dudelange region

Improve pedestrian and bicycle accessibility to attract population

Upgrading active travel infrastructure by creating more space for pedestrians and cyclists

By establishing a safe and comfortable network for pedestrians and cyclists in the city and between settlements, it is possible to unlock the potential for active mobility in Bettembourg and Dudelange. This can be done by implementing regional cycling and pedestrian infrastructure (to connect cities and neighborhoods) and by increasing the quality of the existent streetscape in terms of comfort and safety for pedestrians and cyclists (Figure IV-11).

Densification of the land use and promotion of traffic calming of areas close to stations

On the basis of the 15-Minutes City concept, we propose the pedestrian-supportive land-use schemes in areas surrounding stations. This can be done by evaluating existent brownfield areas close to stations and promoting mixed-use typologies.

Revision of parking space in traffic calming zones

To alleviate the use of the car, we also propose the careful revision of the zoning plan in traffic calming zones to progressively reduce car parking spaces and propose new functions for these.

Congestion charging zones and Park-and-Ride facilities close to stations

Especially on the border and between settlements, we propose congestion charging measures to discourage commuting by car. To increase the synergy between public transport and car usage, we promote the reevaluation of existent Park-and-Ride facilities in terms of their capacity and the establishment of new ones where deemed appropriate.

Fig. IV-11 : A before (above) and after (below) illustrated situation in the Route de Mondorf street in Bettembourg, where the priorisation of the public space to people is clearer

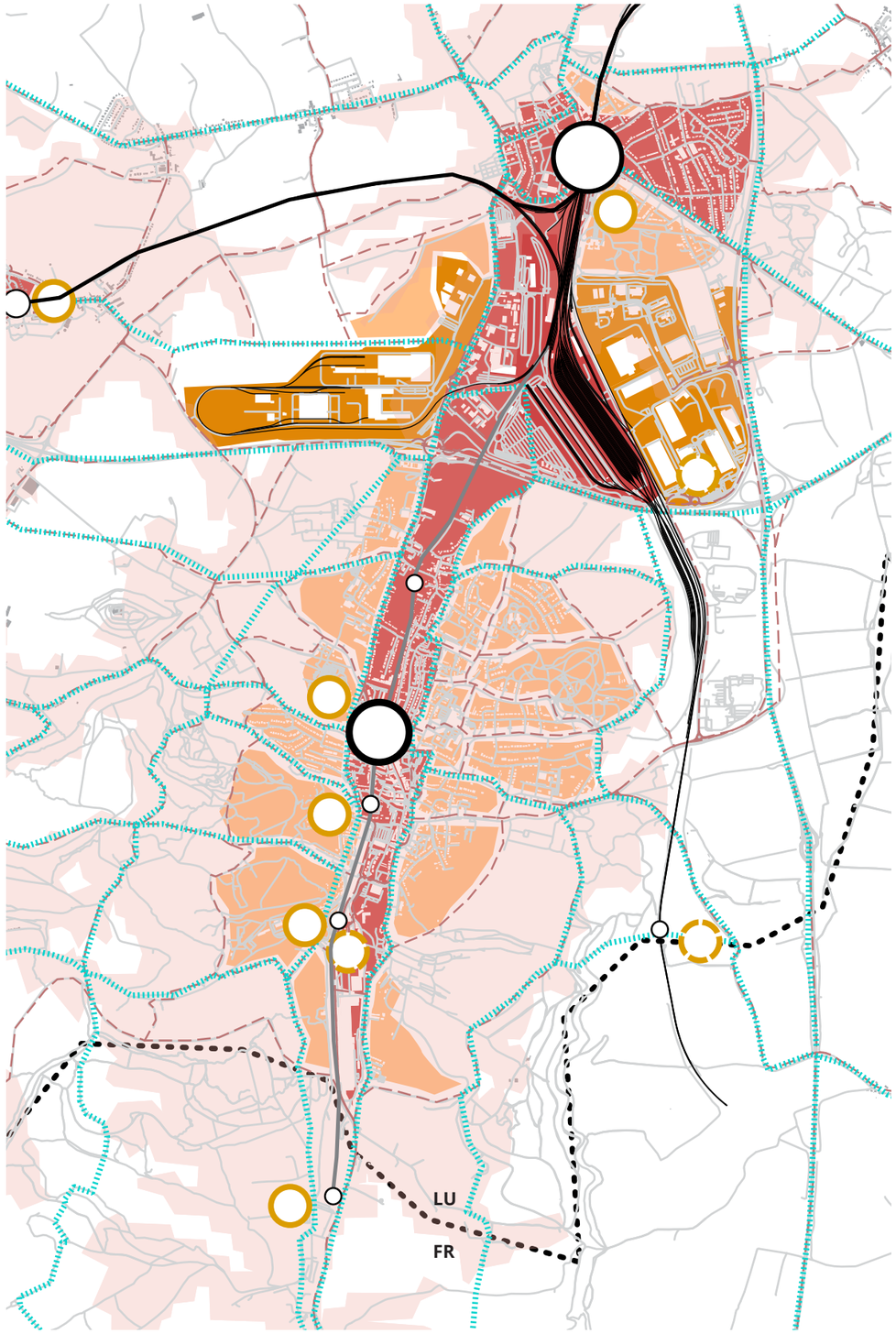
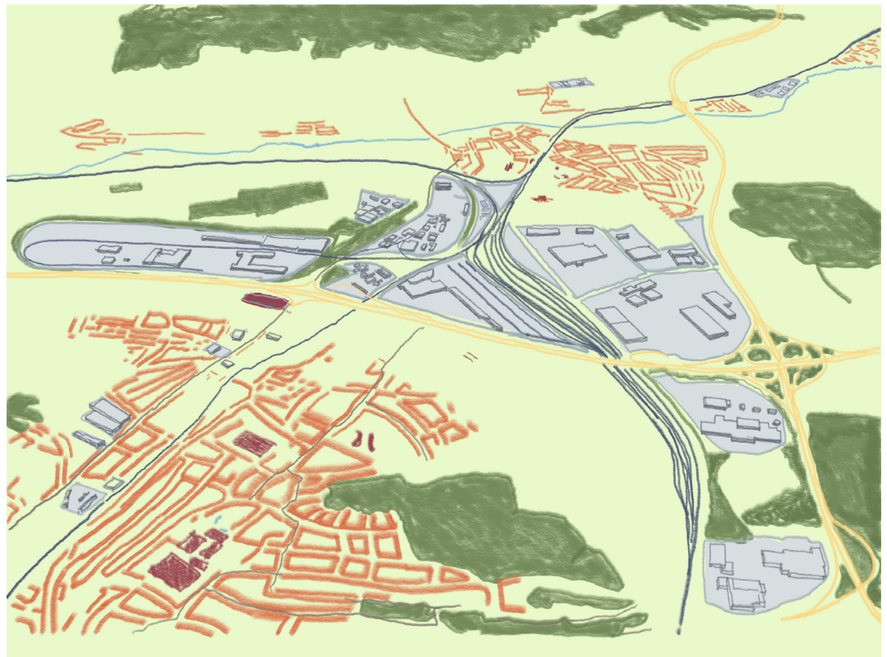


Fig. IV-12 : Strategies for improving public transport and active mobility in Bettembourg-Dudelange region

Transformation example Bettembourg-Dudelange

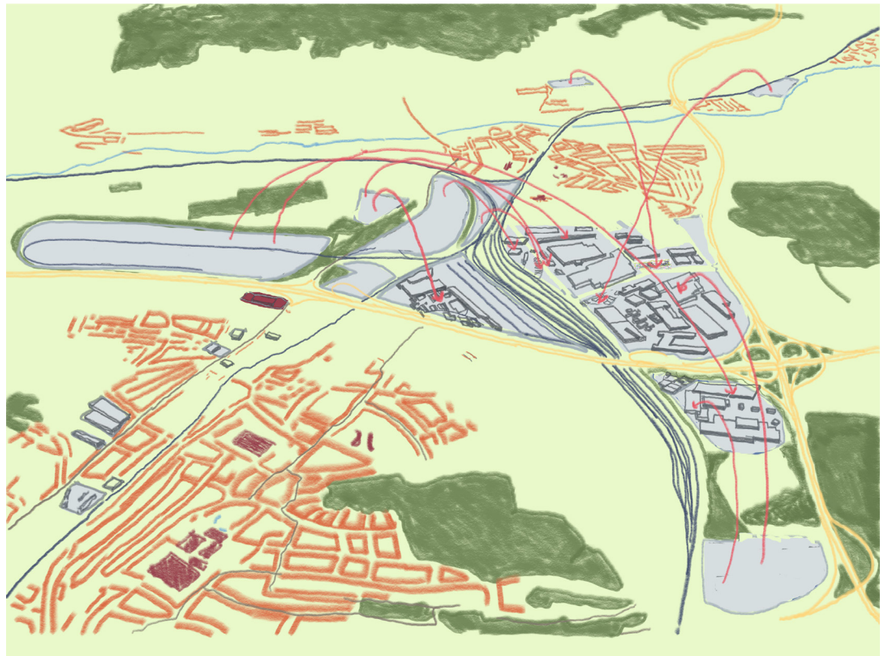
Status quo

Currently, the plots surrounding the rail terminal are occupied with buildings loosely scattered in a (4.42km²) brownfield. As a region of low energy and spatial efficiency, it completely blocked the spatial connection between the towns of bettemboug and Dudelange. The big Bettembourg terminal itself stays only as a monofunctional block serving mainly the heavy industries.



Phase 1

Cancel any greenfield urban extension. Promote relocation of scattered industrial and logistics activities into new, mixed and densified facilities results in potentially freeing up around 50% of brownfield.

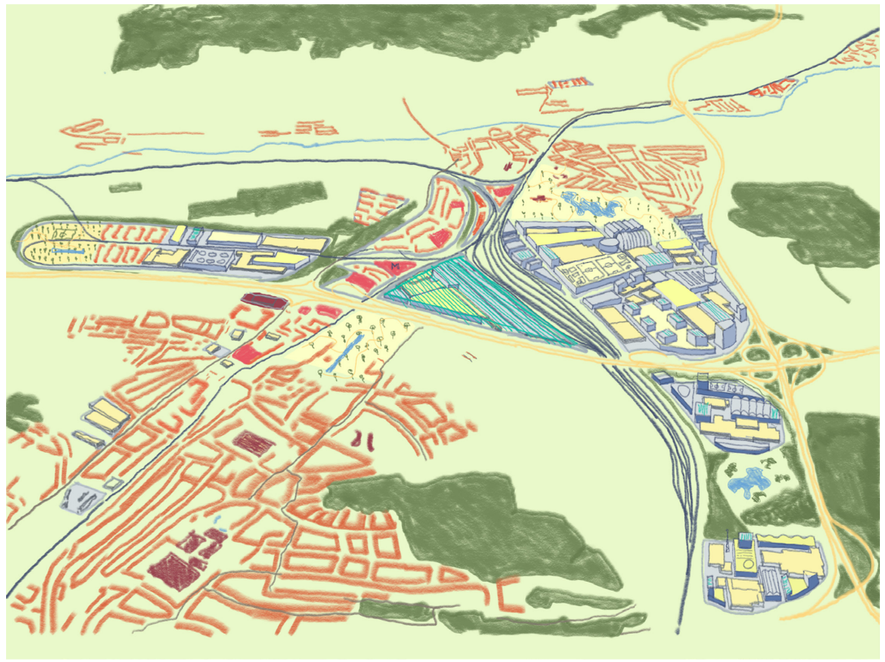


Phase 2.1

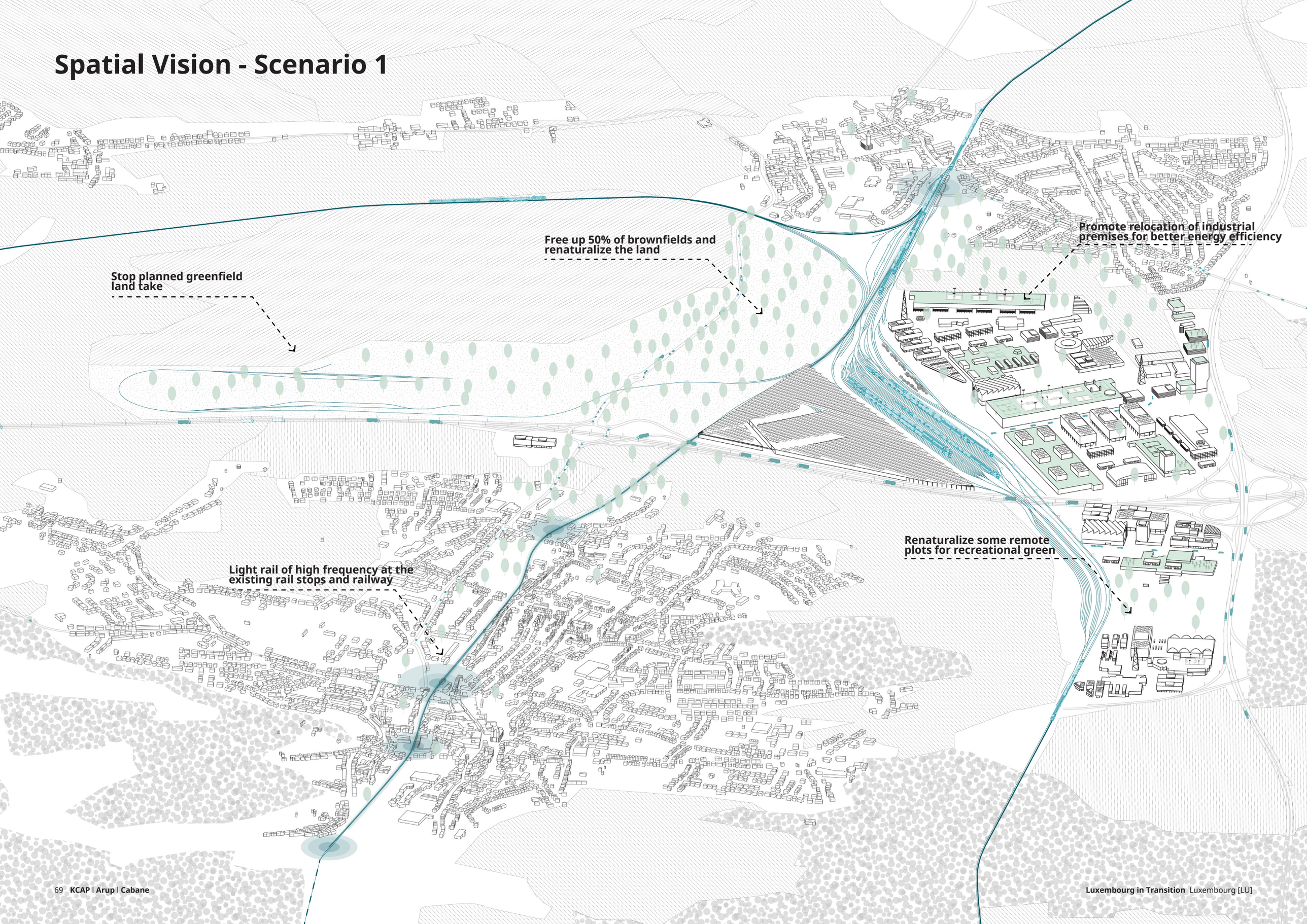
Obsolete and remote brownfield surfaces can be converted into agricultural land, woodland, or nature. CO2 gains are expected through the renaturalization of the land

Phase 2.2

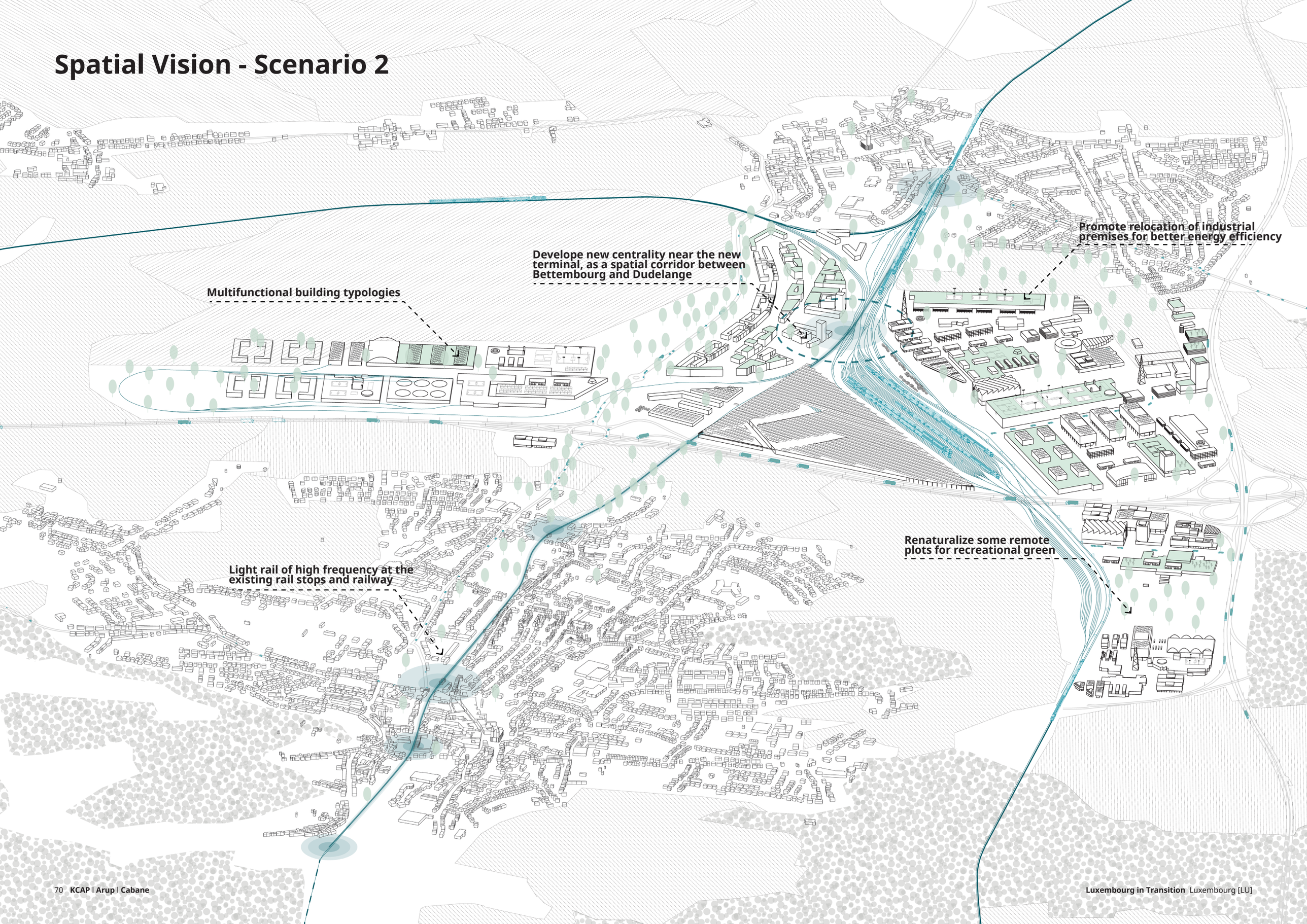
The freed-up brownfield can be deployed for urban renewal to reorganize and connect the villages' centralities and meet demand for housing, public amenities or other real estate. The urban renewal process offers multiple opportunities to gain CO2 emissions by developing a more compact and efficient urban area.



Spatial Vision - Scenario 1



Spatial Vision - Scenario 2



Focus on new mixed-use Logistics & Mobility Hub

Greenroof with Sport and Recreational facilities

Hydrogen supply in concentrated logistics and industrial zones

Increase energy efficiency through green roofs

Generate renewable energy through rooftop photovoltaic panels

Trucks and buses with alternative energy

More cargo and passenger trains

V. CONSOLIDATION

Consolidation

Applying Radical Pragmatism to the question

Our strategy of Radical Pragmatism (Chapter I) brought us to two key Greenhouse Gas domains (Logistics and Mobility) for Luxembourg in Transition (from Phase 01).

In a further step, we acknowledged that the main activity and inter-relationships in Mobility, Logistics and Built Footprint take place in the Western part of the southern Zone, namely the area West of the A3 and South of the A6. This area, spanning from Arlon via Longwy and Petange, via Esch-sur Alzette to Thionville, forms a continuously urbanized, Banana-shaped agglomeration. Apart from the City of Luxembourg this is the zone with potential GHG wins.

In the next step (chapters II and III), the situations in the functional zone in relation to Logistics and Mobility are analysed in more detail to draw strategies in two categories, “Hardware” and “Software”. “Hardware” types of strategies relate to physical traffic infrastructure, industry sites and mobility/logistics hubs, as well as spatial contexts, like centrality, and built footprint. “Software” types of strategies relate to policies and pricing tools for modal split/fuel-type/cargo-type.

Logistics – strategies for a reshaped connected banana

An inventory and analysis of the logistics activity has been carried out to conceive interventions and policies, which positively affect the emissions balance. This included an inventory of the Cargo itself, the Transport modes being used, the vehicles themselves, governance, taxes and other fiscal measures.
We have used this analysis to determine a bespoke toolbox of strategies that can be applied to positively affect change in the functional zone. They are summarized as:

Hardware Strategies
- Smoother Multimodal Transit
- Promoting hydrogen usage

Software Strategies
- Tariff and regulations
- Urban cycle logistics and new last mile distribution principles

The strategies proposed in this chapter aim at improving the logistics landscapes by reducing uncontrolled growth of road freight, and pushing for positive alternative outcomes for freight transit.

Mobility – strategies to grow an upgraded banana

An in depth spatial analysis of data relating to Transnational Commuters Mobility via analyses of traffic data and also qualified via interviews / surveys with the Citizen’s committee has led us to a number of observations and conclusions related to the accessibility in the functional region, public transport offers, cycling as a commuter option.

The toolbox of strategies is summarized as:

Hardware Strategies
- Upgrade the “A” and promote a transport-oriented corridor development
- Polycentric spatial development

Software Strategies
- Promotion of green fleets
- Implementation of Mobility-as-a-Service for smaller settlements
- Congestion charging combined with park-and-ride facilities
- Parking management
- Financial restrictions and incentives

The strategies proposed in this chapter aim to improve physical assets by spatial interventions – and software – including policies for catering human behavior to improve the adoption towards a cleaner mobility and to discourage the use of private cars. Our discussions with the Citizen’s committee convinced us that the application of these Mobility strategies to the Banana Agglomeration can be successful and place the banana as a low emission rival to Luxembourg City while at the same time increasing accessible housing and job opportunities.

Understanding the impact of the application of the strategies on GHG emissions

It is our belief as designers that the proof is in the pudding. Our understanding of the GHG impact of application of measures at a national, agglomeration scale needs a proof a concept at a local scale. For that reason we use the Case-study Bettembourg-Dudelange as a yardstick for potential GHG impact.

Bettembourg-Dudelange in Transition – a case study in GHG emission reductions

As stated, we use the case-study of the site of Bettembourg-Dudelange as a yardstick for potential GHG impact for the Banana Agglomeration and Luxembourg as a whole.
We apply the strategies determined in the domains of Logistics and Mobility on this Exemplary Site, which is summarized in Chapter IV.

Why Bettembourg-Dudelange? These towns form a hinge-point between the three large linear agglomerations: Longwy-Esch-Thionville (the Banana Belt), Metz-Thionville (the Lotharingen corridor) and the Saar-agglomeration. They are both situated on major train-lines and motorways at the border between Luxembourg, France and Germany. This context has led to the allocation of industry and later of distribution, service and logistics centres.

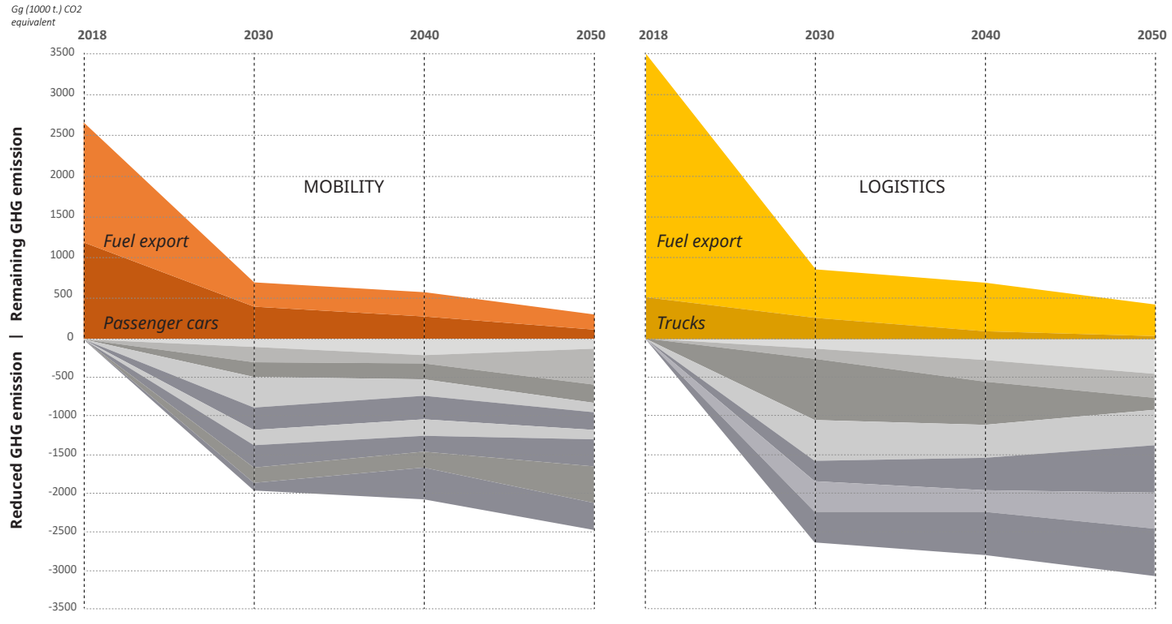


Fig. V-1 : GHG Emissions reductions for the Mobility and Logistics sectors over time (based on 2018 national data from MECS, 2020)

In the Case Study we propose the application of the Logistics and Mobility related strategies in an integrated way with Landuse and Land Use Development. More specifically we suggest the following 10 transformational measures, spread over 3 phases.

1. The development of an Intermodal Hub
2. Investigation of a Logistics and Industrial Zone
3. Typology Study and Densification Potential
4. Implemented Compact Logistics-Business Zones and Integrated Mobility Hub
5. Landuse transformation
6. Spatial Structure Improvement
7. Redistribute urban logistics facility
8. Improve regional public transportation services
9. Traffic management and control
10. Improve pedestrian and bike accessibility to attract population

Potential Benefits in GHG emission reductions – from the bottom up

The benefits at a functional region, national, agglomeration scale are tested in this case study from a bottom-up method to estimate carbon-reduction potential.

Through the application of these strategies in concrete interventions we have assessed the potential outcomes within the GHG targets for the two domains we are investigating. The potential outcomes are described in the summary graphics and are determined in the following way:

(i) For the logistics domain, the estimate is done via an assessment of the potential for reduction of GHG of each named strategy in terms of its effect on the outcomes of:

- Logistics travel
- Logistics travel modal use
- Logistics travel fuel for road based freight
- Logistics related industries
- Logistics and combined industrial land

GHG Reductions in the Logistics Sector - A Radical Pragmatic Scenario

Strategy Type	Main strategies	Break down	GHG reduction in logistics sector	GHG reduction in total national account
	HARDWARE			
Energy	Hydrogen usage in logistics sector		40.1%	13.3%
	1. Repurpose existing natural gas pipe or add new lines			
	2. Plug-in to the network of surrounding countries			
Modal split	Shift to rail from trucks in modal split, in similarly transit-cargo-heavy Switzerland		58.3%	19.4%
	1. Smoother connections			
	2. Regulatons low emission zone			
	3. Higher highway fee			
Industrial restructure	Reduce environmental expensive industries			
	MINERAL & IRON & STEEL (example)			14.9%
		*a. Industrial processes and product use**		*5.3%*
		*b. Energy**		*6.6%*
		c. Transport	*9.0%*	*3.0%*
Built footprint*	Land reorganization Scenario 1: Reduce built up land in logistics-industrial zones			14.0%
	1. Reducing 50% of the brownfield and turn into grassland			*5.9%*
	2. Improved Energy efficiency by collective and larger buildings (plot coverage rate 40%)			
		a. Solar panel (50% of the total built		*8.0%*
		b. Green roof (40% of the total built roof)		*0.1%*
	Land reorganization Scenario 2: Keep but re-organize the built land in logistics-industrial zones			16.3%
	Reorganize existing brownfield for better Energy efficiency by collective and larger buildings (plot coverage rate 40%)			
		a. Solar panel (50% of the total built		*16.1%*
		b. Green roof (40% of the total built roof)		*0.2%*
	SOFTWARE			
Tariff & regulations	Discourage fuel tourism of trucks		85.2%	28.3%
	1. Urban access regulations			
	2. Increase fuel price at least to the same level as surrounding countries or even higher			
	3. Distance-based toll			
Urban distribution regulation	Cyclelogistics		3.0%	1.0%
	1. Street profile adjustment			
	2. Microhub and Microhub			
	3. Reduce large distribution centers			

** These are indicative elements of GHG reduction in domains outside of Logistics,but as a result of logsitics space reorganizaion*

(ii) For the mobility domain, the estimate is a bottom up assessment done on the basis of an assessment of the potential for reduction of GHG of each named strategy via the strategies' effects on the outcomes of:

- Commuter travel
- Commuter travel modal use
- Commuter travel takeup of electric / H for private vehicle use

It is important to note that the GHG reduction potentials shown are order of magnitude estimates, informed by the learnings from the Banana Agglomeration analysis and the Case Study of Bettembourg-Dudelange (via the 10 transformational measures).

It is also important to note that we do not treat here the other potential benefits in GHG emissions, outside of the domains of Logistics and Mobility. This can be qualified as a bottom up exercise that can only go further up.

GHG Reductions in the Mobility Sector - A Radical Pragmatic Scenario					
	Main strategies	**Outcome**	**Breakdown**	**GHG reduction in mobility sector**	**GHG reduction in total national account**
HARDWARE					
Infrastructure upgrade	1.New public transport services to Improve public transport network and enhance service reach 2.Improve existing public transport services service quilty 3.New transport facilities and services to facilitate a better multimodality 4.Cycling and walking network upgrade	Modal Split Shift	*a.MaaS* *b.P+R* *c.DRT* *d.PT Service quality improvement* *e.Cycling and walking facilities and amenities*	**19%**	**5%**
Tariff & Regulations	1.Urban access regulations 2.Congestion charging				
Built footprint	1.Densifying around train stations				
Tariff & Regulations	Alternative feul station deployment	Fleet mixture changes			
SOFTWARE					
Tariff & Regulations	1.Fuel price policies 2.Pricing mechanism	Modal Split Shift	*a.MaaS* *b.P+R* *c.DRT* *d.PT Service quality improvement* *e.Cycling and walking facilities and amenities*	**8%**	**2%**
Built footprint	1.Parking areas management				
Tariff & Regulations	1.Fuel price policies 2.Pricing mechanism 3.Policies to promote green eet	Fleet mixture changes		**57%***	**14%**
Promote traffic-saving behaviour	1.Teleworking 2.Digital services 3.E-commerce 4.Demand management	Need for mobility reduction		**5%**	**1%**

** The value reflects the hardware impace as well . The expected reduction of GHG emissions is partly based on research done for fleet forecasting and adoption to electric vehicles in countries comparable to Luxembourg, such as the United Kingdom and Ireland.*

MaaS: Mobility as a Service
P+R: Park-and-Ride facilities
DRT: Demand Responsive Transport
PT: Public transport

In conclusion – Pragmatic Radicalism

To conclude we believe that to support Luxembourg's vision to approximately halve greenhouse gas emissions by 2030 and to become carbon neutral by 2050, the key domains with the highest impact on greenhouse gas generation need to be tackled by developing pragmatic tools to influence and transform them. We believe that the tools and strategies presented here and applied on a concrete case study as a proof of concept demonstrates the validity of the approach.

Finally, we hope to help Luxembourg with taking on the sharp reduction of GHG emissions in the coming years and the necessary concrete measures to apply in the field, which will help establish an improved physical situation and a renewed mindset. In turn, this change in attitude will trigger innovative solutions, beyond what is known and conceivable today.

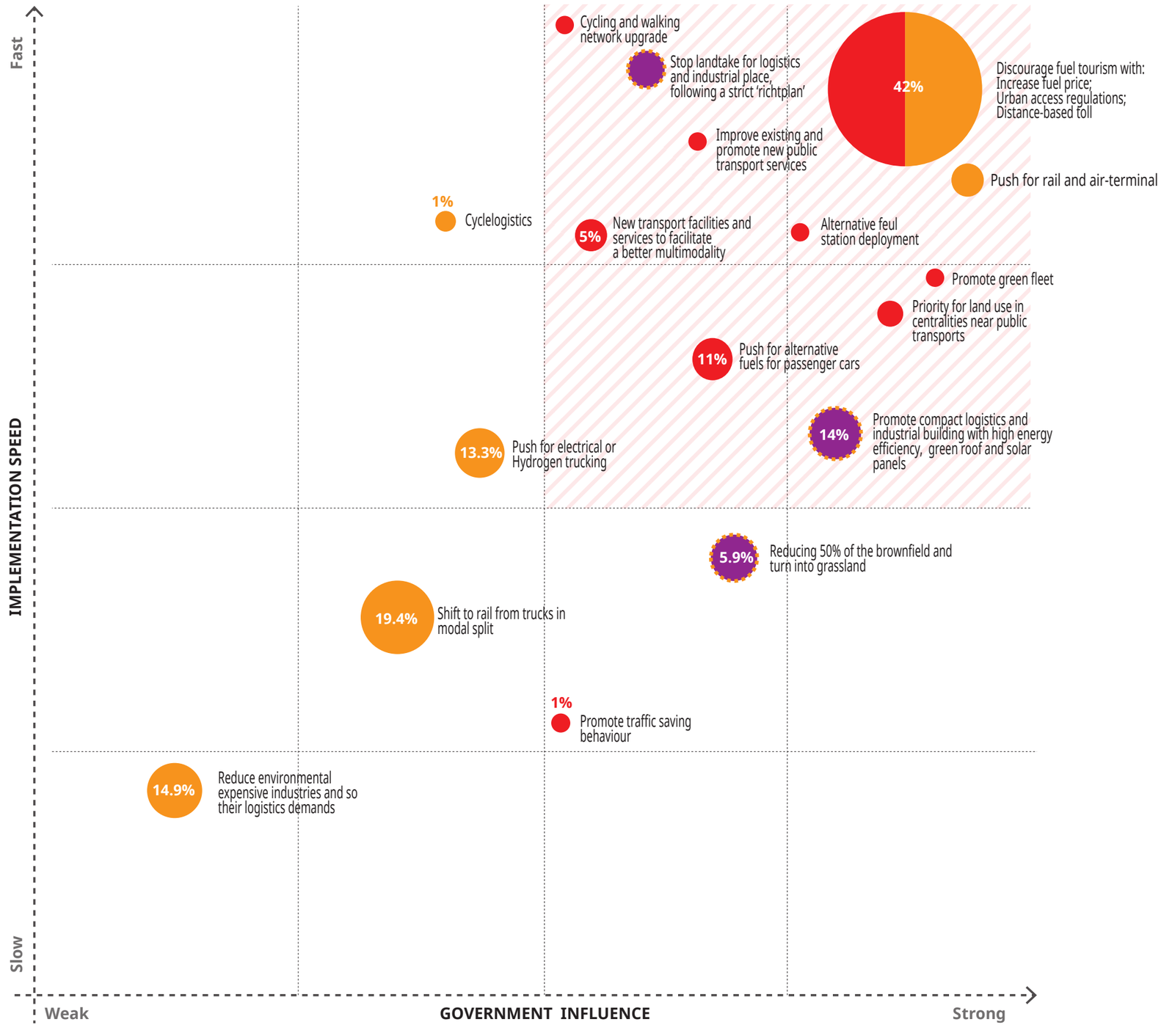


Fig. V-2 : Indicative comparison of GHG reduction strategies in implementation speed and how much the government could influence

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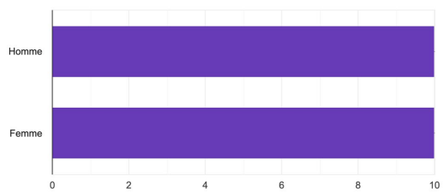
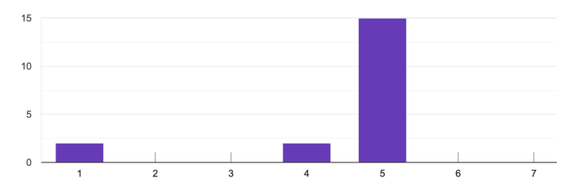
Mobility Survey Results

Questionnaire n°6 / mars 2021
Biergerkommitee Lëtzebuerg 2050 / Laurens Tait (ARUP/KCAP)

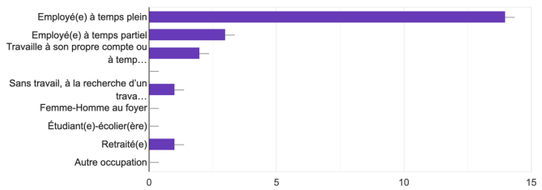
Vous êtes :
20 Antworten



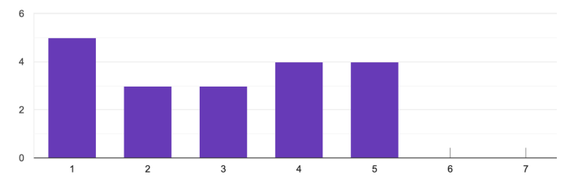
Combien de jours par semaine vous rendiez-vous au travail en 2019 ? [0-7]
19 Antworten



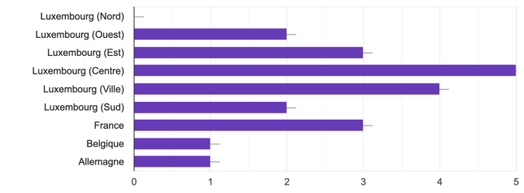
Votre profession est : [compléter]
20 Antworten



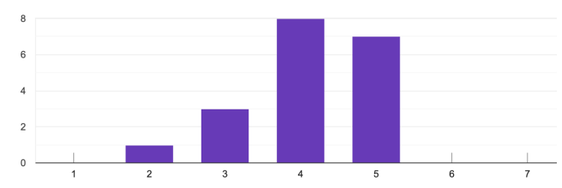
Combien de jours par semaine vous rendez-vous actuellement au travail (en COVID) ? [0-7]
19 Antworten



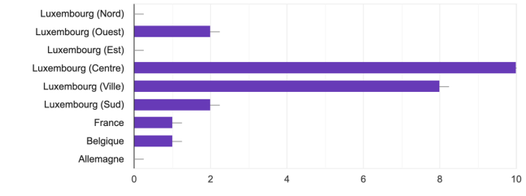
Votre pays & région de résidence est :
20 Antworten



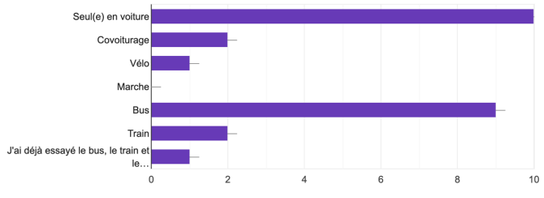
Combien de jours par semaine avez-vous l'intention de vous rendre au travail après le COVID (disons en 2022) ? [0-7]
19 Antworten



Votre pays & région de travail est :
19 Antworten



Pour les navetteurs avant COVID, quel est le principal mode de transport utilisé pour se rendre au travail :
17 Antworten



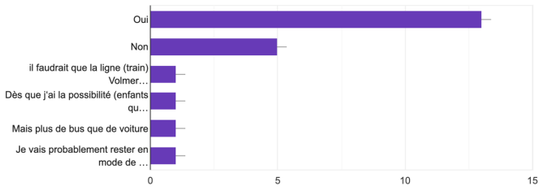
Commentaires sur votre choix actuel de mode de transport.

- voiture
- le choix est vite fait. un allé +-35/45 min en voiture. transport en commun un allé = 1h45 min
- Ich hatte mir vorgenommen wenn ich einmal in Pension bin, ich vermehrt öffentliche Verkehrsmittel benutzen werde.Jetzt bin ich in Pension und werde das nicht tun, bis die Pandemie irgendwann einmal vorbei ist. Bisher könnte ich den Bahnhof in Bascharage zu Fuss erreichen. Wird die Umgehungsstrasse durch die Natura2000 Zone gebaut werden, ist es möglich, dass ich den Bahnhof von Sanem aus nicht mehr erreichen kann weil die Strasse für Jahre gesperrt ist. Ausserdem bin ich in Sanem auf ein Auto angewiesen, weil es hier weder Post noch Bankautomat, Supermarché oder Apotheke gibt.
- Je prends toujours le bus pour me rendre au travail. La voiture est juste utilisée pour faire des courses ou déplacement plus éloignés
- Pour prendre les transports en commun, je dois transiter par la capitale pour poursuivre vers Esch. Cela me prendrait en aller-retour 3H de trajet par jour. Compte tenu de mes obligations de mère, je ne peut pas encore me permettre de perdre tout ce temps en trajet journalier. En voiture, j'en ai pour 1H tout au plus(aller-retour).
- En alternance bus et velo
- choix voiture: flexibilité et temps.
- de temps en temps je vais en vélo, quand il fait beau ;)
- La navette (bus) n'est pas adaptée aux horaires de train direction Luxembourg Ville. Le vélo est une alternative, mais des facteurs comme le danger sur la route ainsi que la topographie et le temps perdu pendant le trajet font en sorte que la voiture gagne souvent :(
- Je me rends en voiture sur un park & ride car il n'y a pas de bus direct de chez moi
- En bus, parfois en vélo
- Le plus confortable
- J'utilise ma voiture également pour visiter des clients.
- J'ai déjà commencé à utiliser le bus plus qu'auparavant.
- compliqué avec les bouchons selon l'horaire.
- Voiture pour la facilité car je ne me rends au bureau que une journée par semaine et en profite pour faire les courses.
- Voiture parce que cela prend le moins de temps et est le moins compliqué par rapport ä l'offre de transport publique de mon lieu de travail et ou j'habite.
- Voiture

Mobility Survey Results

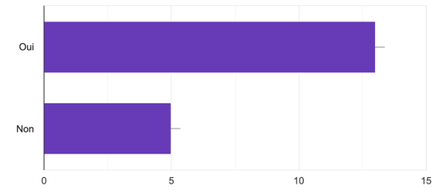
Pour les déplacements vers le travail après le COVID (disons en 2022), pouvez-vous indiquer si vous pensez que vous reviendrez à vos choix de mode de transport initiaux.

19 Antworten



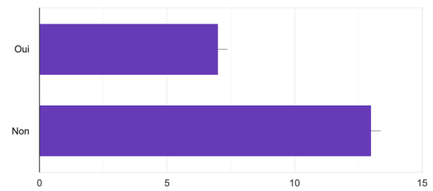
Avez-vous l'intention, dans les 5 à 10 prochaines années, d'acheter une voiture électrique ?

18 Antworten



Seriez-vous prêt à payer pour l'accès aux routes en fonction du temps et des niveaux de congestion (par exemple, prix par km parcouru sur …estionnées plus cher que sur les autres routes) ?

20 Antworten



Si non, quel mode avez-vous l'intention d'utiliser ? [Considérant l'utilisation de la voiture privée à l'intérieur et à destination du Luxembourg]

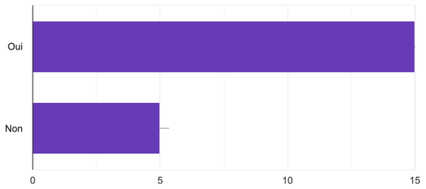
12 Antworten

Seriez-vous prêt à payer pour avoir accès aux routes du Luxembourg ?

20 Antworten

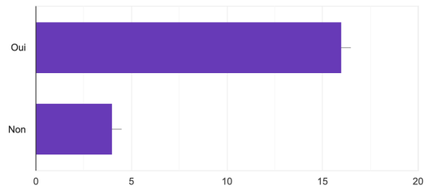
Possédez-vous une voiture ?

20 Antworten



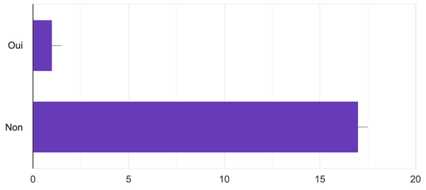
Seriez-vous favorable à un prix variable pour l'accès aux routes sur la base d'une catégorie d'émissions du véhicule (par exemple, un prix par …evé pour les véhicules qui émettent plus de CO_2) ?

20 Antworten



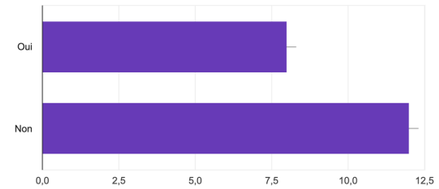
S'agit-il d'une voiture électrique ?

18 Antworten



Seriez-vous favorable à l'instauration d'un prix variable pour l'accès aux routes en fonction de l'heure de la journée (par exemple, le prix par km p… pointe serait plus élevé qu'aux autres périodes) ?

20 Antworten



Mobility Survey Results

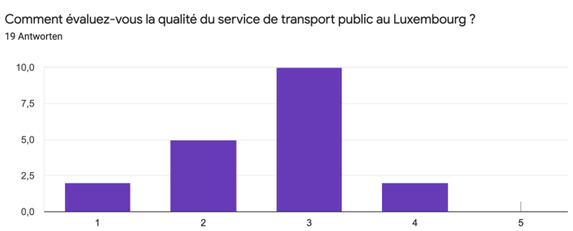
Avez-vous des commentaires sur l'une des questions ci-dessus ?

- simplement ce ne sont pas les employés qui décident des horaires, ce sont le politiques par des horaires inadaptés des heures de l'école (toutes commencent au même moment)voir encore les employeurs qui certain donne une flexibilité, mais pas assez grande pour éviter les bouchons.
- Ich möchte auf das Desaster der deutschen Maut aufmerksam machen. Ich meine dass eine Maut nur eine europäische Antwort sein kann. Ausserdem bin ich der Meinung dass im Falle einer Maut der Verkehr in den Ortschaften zunehmen wird. Die Collectrice du Sud ist da ein gutes Beispiel da der Verkehr trotz Autobahn und ohne Maut in den Ortschaften enorm zugenommen hat. Mehr Strassen, mehr Umgehungsstrassen werden noch mehr Verkehr anziehen. Auch ist die Idee Steuern zu erheben im Moment inflationär. Die Co2 Steuer auf den fossilen Brennstoffen wird doch jetzt jährlich ansteigen und Benzin/Diesel/Gas verteuern. Der Mouvement spricht von Soja-Steuer, Kerosinsteuer, warum nicht auch noch eine Klimasteuer usw...Um die Klimaziele des Parisers Abkommens zu erreichen muss die EU jährlich 260 Milliarden Euro für Investissionen ausgeben, was die Pandemie kostet weiss noch keiner, also ich wäre vorsichtig mit weiteren Steuervorschlägen:)
- Il faudra plutôt partir sur le principe du pollueur-payeur et augmenter/améliorer l'offre pour les transports publics et d'autres formes de mobilité, au lieu de faire payer les gens pour l'utilisation des routes. Plus je ne suis pas sûre de l'efficacité de cette méthode (pays très petit, courtes distances), et si vraiment les embouteillages diminueraient (ils vont plutôt se répartir). D'une part on veut moins d'embouteillages mais d'autre part on veut aussi moins de voitures sur les routes en total, et ainsi une baisse des émissions de GES. Dans toute cette discussion, il est très important de considérer les aspects sociaux.
- tarifs spéciaux « grande région » déductible des impôts;
- tarifs camions locaux;
- tarifs camions internationaux plus chers
- et tarifs tourisme transit
- le tout sous forme de vignettes annuelles (type Suisse)
- formules famille plusieurs immatriculations par foyer.
- Il faudrait plus tôt instaurer des horaires décalés de transit des camions sur les autoroutes (interdiction de rouler aux heures de pointe, p.ex. entre 7h-9h et 16h-18h).
- cela aiderait peut-être à fluidifier le trafic sur les autoroutes. Je pense que faire payer tous les habitants, cela me semble difficile à faire accepter par la population. Personnellement, j'essaie de me pas trop rouler en voiture et payer cela ne me dérangerai pas.
- Je suis d'avis qu'il est important de prendre en compte une éventuelle discrimination
- des personnes avec moins de moyens financiers et/ou des personnes transfrontalières. Ceci s'applique également pour l'idée de calculer une taxe selon les émissions d'un véhicule (p.ex. une voiture électrique a moins d'émissions CO2 qu'une Diesel, mais la production peut éventuellement être moins socio-écologiquement responsable. De même, la question se pose si une nouvelle voiture soit véritablement plus écologique qu'une plus vieille si on prend en compte le coût de la production et consommation.
- La 2e option pénalise les personnes qui doivent prendre la voiture pour se rendre au travail. La 3e option engendrait une utilisation des autres routes qui passent souvent par des communes, cités etc
- Par rapport à cette dernière question je dirais qu'en dehors du fait qu'il n'existe pas toujours des parcours alternatifs des études sérieuses ont démontré que dans la plupart des cas il est préférable de ne pas quitter une autoroute même congestionnée.
- RAS
- En fait, vu qu'il y a beaucoup des petites routes à côté des autoroutes les problèmes vont seulement se décaller vers les routes non-payantes. J'ai des horaires flexibles et je peux commencer entre 6.30 et 9h du matin, alors je dois quand même me rendre au travail jusqu'á un certain heure qui tombe dans les horaires normaux de travail, si je dois alors encore payer pour utiliser l'autoroute à cet heure là je prendrai les petites route à côté.

Mobility Survey Results

Quel est, selon vous, l'élément le plus important qui incite les Luxembourgeois ou les navetteurs vers le Luxembourg à choisir les transports publics ?

- masochisme (ou encore le fait de travailler en plein centre, Kirchberg ou encore quartier gare).. sinon il faut être fou...j'ai déjà pris le metro de paris dans des heures de pointe et il y avait toujours plus de place que dans nos trains dans les mêmes heures (il y a certainement des exceptions dans les deux sens mais pas trop...)
- Ich finde dass der Tram eine bequemes und nachhaltiges Transportmittel ist und ich finde es auch gut dass die Strecken weiter ausgebaut werden
- Selon moi beaucoup de gens profitent du moment dans les transports publics pour se relaxer ou même travailler.
- Meilleure offre + flexibilité + fiabilité
    - principalement la gratuité des transports
    - mais une gratuité à étendre à la grande région pour toutes les destinations vers luxembourg
- et pourquoi pas après période Covid la gratuité pour les nouveaux parking P+R encore insuffisants mais malheureusement payants comme celui à Thionville Metzange
- quand il n‘y a pas de moyen de stationnement pour le véhicule
- gratuité des transports public, moins de stress qu'avec l'usage de la voiture
- gratuit
- Acces parking velo/auto aux pôles d échange
- des places de parking et plus de train pendant les rush-hours (p.ex Volmerange-les-Mines - Luxembourg)
- Bonne connexion / densité du réseau
- Frequency of navettes
- Rapidité de l'offre, possibilité de rejoindre un endroit sans trop de changements
- La gratuité et les coûts d’entretien et du carburant d’un véhicule personnel.
- Trop de trafic et d’accidents surtout sur l’autoroute
- La possibilité de choisir son horaire. et la diversification des lignes.
- ratio temps et coût
- Des bonnes connections, ne pas être bloqués dans des bouchons. Pour les luxembourgeois: comprendre qu'on peut se rendre aussi par bus en centre ville quand on habite à Strassen. Il y a une certaine attitude en Luxembourg qui vient avec le prestige d'avoir une voiture et c'est trop "convenient" de toujours prendre la voiture.
- Bonnes connexions



Y a-t-il des éléments d'amélioration que vous verriez pour l'offre de transport public du Luxembourg qui permettraient d'améliorer la qualité du service ?

- disponibilité des places (trains bondé). si je prends p.ex les transports frontaliers france - tout se concentre sur l'axe metz-thionville-lux.ville. Mais pas tout le monde vient de Metz et de Thionville et va au centre ville. Je pense qu'il faudrait avec une app comme celle de mobiliteit faire une étude avec l'accord de utilisateurs sur leurs trajets professionnels. On pourraient certainement mettre en contact des gens, voir proposer des alternatives de transport à des soucis concrets. Je prends mon exemple, je suis frontalier dans un petit village de 300 maisons, je ne connais pas tout le monde du village, mais uniquement sur mes connaissances dans le village, je connais déjà 5 personnes qui travaillent dans proche un de l'autre. Sur les 5 nous sommes 2 à faire du covoiturage, mais que serait-il s'il y avait une analyse plus aprofondie. Est-ce que dans notre chemin, nous ne pourrons pas prendre un passage et le déposer quelque part (travail, arret de bus, gare, ...). Il y a tellement de possibilités, malheureusement comme le luxembourg est petit, les initiatives privés ne portent pas assez, donc je ne vois que le publique pour le faire.... bàv, Sergio Neves (désolé pour l'ortographe, pas eu le temps de relire)
- Ich müsste nicht unbedingt ein Auto besitzen. Wenn ich im Radius von 1 km in Sanem bei Bedarf eine E-Auto auf eine betimmte Zeit mieten könnte würde ich das toll finden. Noch besser wäre es ich könnte anstatt einer Pizza ein Auto bestellen das dann vor meiner Tür steht und mich selbstfahrend an meinen Bestimmungsort fährt:) Ich meine der Wert einer Maschine könnte darin bestehen sie zu nutzen und nicht sie besitzen, ja so gedacht würde das ein viel nachhaltigeres Bild einer Gesellschaft werden, das sich lohnen würde weiter zu denken:)
- Sans aucun doute faudrait-il revoir l'organisation des itinéraires. All roads lead to Rome, dans notre cas une grande partie des itinéraires se concentrent sur le centre du pays et les alentours sont moins bien désservis. Par exemple la ligne 5&6 connectant Bertrange à Luxembourg-Ville, Kirchberg et Bonnevoie passent toutes les 15 minutes lors du weekend (souvent les bus sont vides) tant que dans d'autres localités (qui ne sont pas plus loin du centre...) comme le Bridel on a des connections toutes les 1h30 voir 2 heures (pour le dimanche).
- En plus j'ai des doutes quant à la réalisation et finalisation d'itinéraires optimisés. Le but final étant une réduction de gazes à effet de serre, il s'agit d'une problématique assez complexe puisque même si les transports publics étaient accessibles à tout le monde, les habitudes des Luxembourgeois sont extrêmement ancrées quant à l'usage de leur propre voiture.
- Voies réservées pour les bus / augmentation du nombre de P&R pour voitures, vélos etc. / optimisation des trajets pour baisser le temps passé dans le bus / service régulier pendant le soir / plus de lignes de bus connectant les différentes communes
- des ceintures de transports (rayons 2-5-10kms ou plus) : transports périphériques rapides et directes nord-est-sud-ouest sans passer par le centre gare
- il faudrait des points de départ avec des navettes directes, sans arrêt partout afin de perdre le moins de temps possible en trajet.
- ponctualité, réseau
- Accès aves vélos et service décentralisés

Mobility Survey Results

- Améliorer les lignes entre les villages et les villes (p.ex. il est souvent très simple d’aller à Luxembourg-ville mais il n’y a aucun moyen de se déplacer plus localement (p.ex pour faires des courses)
- bus direct lors des horaires de pointe vers la gare / le centre ville depuis l‘est du pays
- mise en place de vignette de parking régionaux pour permettre aux résidents lux de se garer auprès de stations de bus
- increase frequency of tram and improve network
- Le service est trop centralisé, il faudrait plus d'offre transversale. Aussi, peut être que les gens devraient être mieux informés sur les options existantes et la rapidité des transports vers leur lieu de travail (certaines personnes habituées à prendre la voiture ne sont pas au courant de l'amélioration de l'offre)
- Trover des connexions transversales(
- Réduire la taille des autobus mais en augmentant le nombre.
- Le bus que je dois prendre pour me rendre au travail depuis ma maison vient 2 fois par heure et je trouve que cela n’est pas assez.
- Augmenter le nombre de train vers la France, augmenter le nombre d'asservissements des grand pôles d'activité (ex: gasperich)
- Ponctualité, alternatives aux trains supprimées sans raison, clarté et transparence des statistiques de retard
- Avoir des connections qui ne sont pas tous centralisés autour de la ville de Luxembourg/Kirchberg. Améliorer les connections pour les petites villages (même que là le réseau est encore très bien en comparaison avec l'Allemagne).
- Meilleures connexion à travers tout le pays

Remarques

- créer de nouveaux axes auto routiers périphériques aux frontières pour éviter engorgement et accidents trop proche de luxembourg ville par camions circulant vers Trier ou Arlon.
- Mettre en place itinéraires obligatoires pour camions selon destinations et imposées en amont (100 à 1000kms) et Interdire les transits « détours » pour carburant ou axes routiers gratuits non justifiés. une sorte de régulation type contrôleur aérien sur les camions du départ à l’arrivée !!!
- Franchement, si je pouvais me rendre en ville en 15 minutes par bus et si j‘y avais un bus direct sans arrêt vers Esch, je les utiliserai de suite.
- Je me suis déjà posé la question, si l‘on ne pouvait pas mettre en place des pools avec des mini-navettes électriques afin d‘augmenter l‘offre et que le trajet se fasse plus rapidement.
- RAS
- Sur la question Combien de jours par semaine vous rendez-vous actuellement au travail (en COVID) ? [0-7] je peux pas répondre avec le schéma prévu, parce que depuis covid mon mode de travail a changé 4 fois: pendant le 1er lockdown j'étais en télétravail tout le temps, à partir de juillet 2020 en système de rotation jusqu'en octobre 2020 avant d'être renvoyé en mode télétravail tout les jours jusqu'en février 2021 et depuis février je suis dans un système de rotation ou je me rends au bureau que tout les 3 semaines (2 semaines à la maison - presque pas d'utilisation de la voiture - 1 semaine au bureau, utilisation de la voiture chaque jour).

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