TOWARDS A ZERO EMISSION CORRIDOR ROTTERDAM – VENLO; REALITY OR AN ILLUSION?

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1. Introduction

The transport sector has a huge challenge to achieve the climate goals stated by the Dutch government and the European Commission. Because of this challenge many companies, knowledge institutes and governments are working on developing and implementing decarbonization measures to reach the goals. However, based on an analysis of these initiatives, it becomes clear that required insights in the impact of these measures and the contribution to the goals is missing in many cases. Questions that arise and that can currently not be answered are:

- What is the impact of specific individual decarbonization measures?
- What is the impact of technological measures and of logistics measures and how do they compare?
- What is the impact of decarbonations measures for the different modes of transport road, rail and barge and how do they compare?
- If all measures are combined, what is the total impact and to what extent are the climate goals achieved?

Because the answers to these questions will provide necessary insights to determine where and how to put our scarce efforts and budgets to reach the goals, a project has started to find these answers. In the 'Zero emission corridor Rotterdam – Venlo' project financed by the Topsector Logistics/Connekt and carried out by TNO an analysis has been made to get to these answers [1]. To make the analysis more specific, it has been decided to focus the project on the Rotterdam – Venlo corridor with substantial large volumes for each mode of transport. This VLW paper is a summary of the final report of this project and a number of follow-up activities.

The outline of this paper is as follows. In chapter 2 an explanation is given about the decarbonization measures that are included in the study and the development of three scenarios with combinations of decarbonization measures. Chapter 3 gives a brief overview of how the measures in the scenarios are implemented and how the impact is calculated on the corridor Rotterdam – Venlo. Chapter 4 gives an overview of the main results for the three scenarios. Finally, in chapter 5 the most important conclusions are described followed by a discussion on the findings and recommendations for further research.

2. Decarbonisation measures and scenarios

Decarbonisation measures

For the analyses, different types of decarbonisation measures are distinguished according to the Green Logistics Framework [2]. This framework describes five broad strategies that stakeholders in the logistics sector can follow to decarbonise transport:

I. Managing (reducing) freight demand growth;
II. Shifting freight to low-carbon intensity modes;

III. Optimising use of assets and vehicle loading;

IV. Increasing energy efficiency of freight vehicles;

V. Reducing the carbon footprint of energy used.

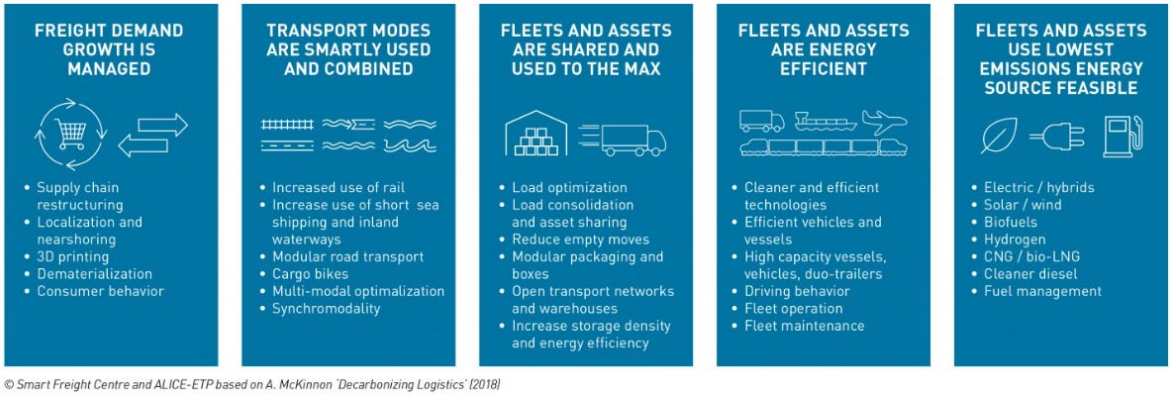


Figure 1: Green Logistics Framework

Based on stakeholder consultation by ALICE (Alliance for Logistics Innovation through Collaboration in Europe), it was concluded that there is no silver bullet and that all measures are needed to achieve climate goals. The following measures were ranked as most important in terms of impact and feasibility [3]:

1. Renewable energy in combination with electrification, hybrids and hydrogen
2. Multimodal optimisation
3. Load consolidation and optimisation
4. Use of efficient vehicles, vessels and fleets
5. Synchromodality and flows synchronisation
6. Improve fleet operation
7. Supply chain restructuring
8. Consumer behaviour

These measures will have an impact on amongst others the number of trips, kilometres travelled, and/or emissions. Logistics stakeholders will not adopt these strategies in isolation. Rather, these follow from their preferences, decisions and behavioural reaction to external factors [4]. The first three strategies in figure 1 focus on logistics measures, which means that these affect the logistics performance and by that have an impact on emissions (in absolute terms or e.g. per ton or per ton-kilometre). The last two strategies are related to technological measures and affect the emissions per vehicle kilometre. The main focus of this research will be on the effect of logistics measures. However, it is important to note that if vehicles emit less CO_2 and NO_x per kilometre due to technological adaptations, the possible impact of logistics measures, such as consolidation of goods, will be reduced.

Scenarios

As the study primarily focusses on the logistics measures, the scenarios consist of three different sets of logistics measures with the same set of technological measures for the year 2030. A short description of the three scenarios is given below.

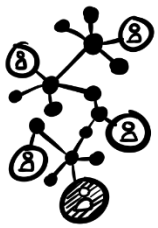
Go solo

Transporters mainly focus on measures that can be implemented within their own company (no/limited other transport partners / horizontal collaboration required) and some load consolidation or asset sharing might already occur, but only to a limited extent.

Partner up

Transporters start to look beyond their organization's boundaries and – compared to the *'go solo'* scenario – focus more on load optimisation and consolidation through horizontal collaboration, facilitated by online platforms for example. Also, multi-modal optimisation and synchromodal transport are more and more applied in the logistics and transport sector. Synchromodality in this scenario refers to the extensive cooperation between partners by which real-time mode shifting becomes possible.

All together



The transport and logistics sector has undergone a paradigm shift whereby focus is on reducing (unnecessary) freight demand by restructuring transport networks and supply chains, reducing bidirectional transport of the same / similar products between regions and influencing customer behaviour. Transport networks are open and connected and synchromodality and asset sharing are at the core (in line with the physical internet concept).

3. Scenario analysis corridor Rotterdam – Venlo

Implementation decarbonisation measures

The scenarios are further elaborated by selecting the measures and the extent to which they are applied in each of the three scenarios. Based on expert opinion it is decided whether measures are appropriate for long-haul transport and specifically for the Rotterdam-Venlo corridor. As explained, the study focusses on the logistics measures with three different scenarios. For the technological measures one scenario is applied that is consistent and aligns with the KEV (Klimaateconomische Verkenning) from PBL [5]. A global overview of the measures per scenario is given in the table below.

Table 1: Global overview of measures per scenario for the year 2030

		Scenario		
		Go solo	**Partner up**	**All together**
Focus on / **Decarbonisation strategy**		*Logistics measures for lowering emissions, limited load consolidation across organizations*	*Increased horizontal collaboration for load optimisation, consolidation and synchromodal transport*	*Paradigm shift whereby reducing freight demand growth has a central focus, for example by localisation and nearshoring, and influencing customer behaviour*
I. Managing (reducing) freight demand growth;	Road, Inland shipping			Supply chain restructuring Localisation and nearshoring Decentralisation of production and stockholding Consumer/ customer behaviour
II. Shifting freight to low-carbon intensity modes;	All modes	Increased use of rail and inland shipping	+ Multi-modal optimisation + Synchromodality	+ Autonomous transport technologies
	Inland shipping, Rail	Increased use of rail and inland shipping	+ Multi-modal optimisation + Synchromodality	
III. Fleets and assets are shared and used to the max;	Road	Load optimisation Load consolidation Back-hauling	+ Modular packaging and boxes	+ Open warehouses and transport networks
	Inland shipping	Load optimisation Load consolidation		
	Rail	Load optimisation Load consolidation		
IV. Fleets and assets are energy efficient;	Road	Cleaner and efficient technologies		
	Inland shipping	Rightsizing of engines		
V. Fleets and assets use the lowest energy source available	Road	Optimizing diesel systems CNG/LNG, Biofuels Hydrogen, Electric/ hybrid		
	Inland shipping	Electric/ hybrid shipping Biofuels		

These scenarios are used to explore the potential outcomes of applying various logistics measures to varying extents. The outcomes are presented as "*what-if*" scenarios and are by no means intended to forecast the future or predict emissions.

Impact calculation with DeCaMod (Decarbonisation Model)

These measures are further detailed by determining the impact of the measure and the segments to which the impact applies. For a detailed overview of the impact per scenario per segment, reference is made to the final report of the project [1].

To calculate the impact of the scenarios with the combined measures, DeCaMod has been used. DeCaMod is a tool that provides valuable insights into the total emissions of CO2 and NOx that are generated by freight transport on Dutch soil, both in the present and for future years [6]. As DeCaMod distinguishes many segments such as modalities, vehicle types, type of goods, and origin-destination pair(s) impact of measures can be assigned to these specific segments. The impact per scenario per segment as determined for the Rotterdam – Venlo corridor is applied on the 2030 volumes in DeCaMod to determine the overall impact of the scenarios. More information about DeCaMod can be found on the TNO website: www.tno.nl/decamod.

4. Results corridor Rotterdam – Venlo

Results road and inland shipping

For road transport the technological measures following the KEV lead to a 7% reduction of CO2 emissions in 2030. The logistics measures result in a further reduction between 2 and 11% dependent on the scenario. The total reduction for road transport in the all together scenario is 18%. For inland shipping the technological measures following the KEV lead to a 1% reduction of CO2 emissions. The logistics measures result to a further reduction between 1 and 2% dependent on the scenario. The total reduction for inland shipping in the all together scenario is 3%. It is noted that emission reductions for rail have not been analysed in detail since the rail emissions are already very low. However, rail is included in DeCaMod as well and can be added to the analysis relatively easy.

There is a big difference in results between road and inland shipping. Concerning the technological measures, for road electrification is already included to some extent towards 2030 while for inland shipping renewal of engines mainly focusses on cleaner diesel engines and not on zero emission technologies. In terms of local emissions such as NOx the reduction of emissions for inland shipping is very high with 23% (this has also been analysed in the study with DeCaMod, but is not the focus of this paper). Concerning the logistics measures, fleet and asset optimization, modal-shift and reducing transport demand have mainly an effect on road transport and to a limited extent on inland shipping

Results total transport (all modes)

The overall results (for all modes of transport) are shown in figure 2. It shows on the left side the CO2 emissions in the base year 2020 (light blue) and in the reference situation 2030 without reduction measures (dark blue). The next bar which is dark green shows the emissions of the 2030 situation including the technological measures. The following three light green bars represent the emissions of the three scenarios including technological measures and the logistics measures. Finally, the red bar shows the reduction target from the Dutch Climate Agreement for hinterland transport [7].

The figure shows that the technological measures lead to a CO2 reduction of almost 9% on the corridor Rotterdam – Venlo in 2030. With the logistics measures between 1,6 and 7,0% additional emission reduction can be achieved. In total the expected CO2 reduction ranges between 10,4 and 15,8% dependent on the scenario. This means that in the most pessimistic scenario only one third of the reduction target is achieved and that in the most optimistic scenario only half of the reduction target is achieved.

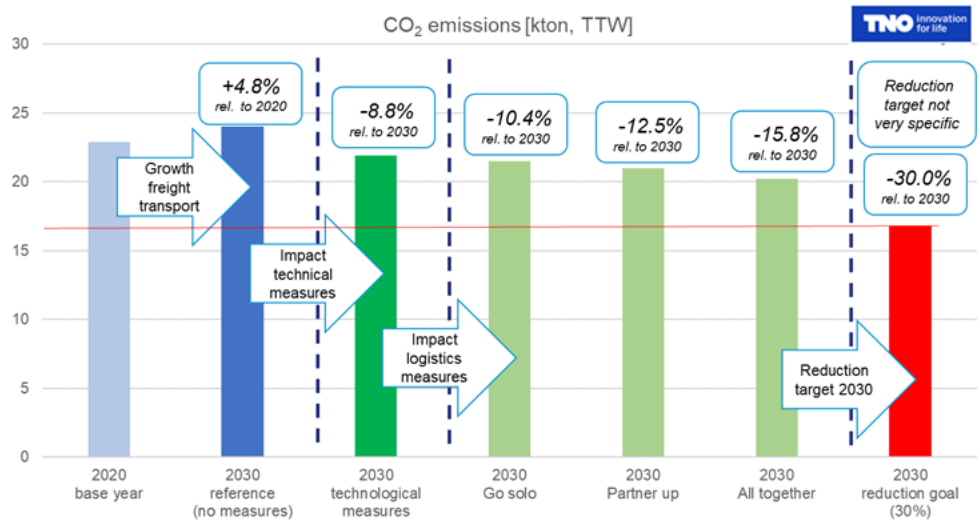


Figure 2: Overview main DeCaMod results scenario analysis 2030 on the corridor Rotterdam - Venlo

5. Conclusions, discussion and recommendations

Conclusions

The goal of the study was to gain insight in the impact of combinations of specific types op measures and in the impact of all combined measures. It can be concluded that DeCaMod is a very good instrument to get these insights that were not available until now.

Another conclusion is that logistics measures are needed on top of technological measures. In other words, logistics measures do matter. Though technological measures, such as the use of zero emission

vehicles, are effective in reducing tail-pipe emissions, the pace of their uptake is expected to be too slow to reach the emission reduction targets that were set for the transport sector in the Climate Agreement. Logistics measures can hence contribute to bridging this gap. It therefore deserves further research to better understand the effects, feasibility and boundary conditions of different measures to ensure targeted and effective implementation of measures. A tailored approach taking into account a more detailed decomposition (logistics segments, type of goods, vehicle types and vehicle technologies) of the corridor as can be done with DeCaMod is crucial to that aspect.

Furthermore, the results show a large difference in CO2 reductions between road and inland shipping. For road, there is quite some reduction potential both for technological measures and for logistics measures. The reduction potential for inland shipping is very limited, only 1 or 2%.

By far the most important conclusion is that even in the most optimistic scenario in terms of impact of measures only half of the reduction target from the Dutch Climate Agreement is achieved in 2030. This means that to double the impact, measures currently being considered should be intensified and/or new measures should be introduced.

To get back to the title of this paper: "Towards a zero emission corridor Rotterdam – Venlo; reality or an illusion?", if we stick to the currently considered measures, it will be an illusion, so the question is what is necessary to make it reality?

Discussion

The goal of the study was to provide insight in the impact of combinations of measures and all combined measures. However, the results raise two important follow-up questions:

- How to realise the impact of the measures already included in the scenarios given that this impact is not guaranteed due to uncertainties about the growth scenario, the feasibility of measures and possible rebound effects of logistics measures?
- How to double the impact of the measures to reach the climate goals?

These questions have been discussed with several people and groups. It led to extensive discussions in the project team with people from TNO and Connekt, a special meeting has been organized with the Steering Group Multimodal Corridors of the Topsector Logistics to discuss the results and follow-up questions and as a result of that meeting a hackathon has been organized with 30 students from Maastricht University.

In the project itself, the following two directions to accelerate the reduction of emissions have been proposed:

- Speeding up the uptake of zero emission technologies
  On the one hand, these measures are often imposed by legislation which is a very good way to make sure that measures will be taken and implemented. Examples are strict requirements and European legislation for vehicle emissions, the emission zones in the port of Rotterdam and zero emission zones in cities. On the other hand, it is still difficult for companies to take up these measures for several reasons. The costs are very high, for example a heavy duty electric truck is currently about 3,5 times more expensive as a regular diesel truck. There is limited availability of electric heavy duty trucks, since summer 2024 Volvo is selling off the shelf heavy duty electric trucks, but most other OEMs are not ready yet. Charging infrastructure to recharge the battery is still not widely available. Some companies won't get a private charging station due to problems with the energy network and public charging stations are not available yet (very few opened recently). And there are still many operation challenges to use these trucks in the regular logistics operation. To deal with all these issues, companies need help to solve them. For instance in the Green Deal project MAGPIE [8] a demonstration project with 10 heavy duty electric trucks is organized with this purpose.
- Further reduction of the number of kilometers driven
  This can be done in two ways: by increasing the efficiency of transport and by reducing the transport demand. A problem with increasing the efficiency of transport is that logistics companies only take these measures if the costs of the new situation are lower than the costs of the old situation. First of all, it is the question whether this is the case if investment costs are taken into account and secondly, if it is, companies will re-invest the money they save in new activities leading to new energy demand with associated emissions (the so called Jevons paradox leading to rebound effects [9]). A problem with reducing transport demand is that relevant decisions on this are mostly not taken by logistics companies, but by industrial companies for who logistics is not their core activity. So further reduction of number of kilometers driven has quite some challenges.

In the discussion in the Steering Group Multimodal Corridor of the Topsector Logistics the conclusion was drawn that logistics measures can only be effective if some level of obligation to implement measures is introduced. Otherwise, logistics companies will focus on further growth of their business and cost reduction/increasing profit. Suggestions for certain levels of obligation were rules and regulations, pricing and carbon cap measures.

In the hackathon with students from University Maastricht, solutions such as ERS (Electric Road System) and carbon capture of trucks were suggested next to many other well-known measures.

Recommendations

The results of the study and the discussion about the follow-up questions lead to a number of recommendations:

- Further DeCaMod analyses
  In this study, one corridor – the Rotterdam – Venlo corridor – has been analysed. Given that this is a specific corridor with substantial volumes on all three modes of transport (road, rail and barge) and a relative high share of container transport, it has already been requested to analyse other corridors with other characteristics as well. Further request concern including rail in the detailed analyses and extending the studies from forecast year 2030 towards 2040 and 2050.
- Impact decarbonization measures
  In the project, several studies and reports have been used to determine the impact of specific measures. In some cases when no information was available expert opinion has been used. Given the importance of the topic it is recommended to improve the knowledge on the expected impact of decarbonization measures.
- Investigation rebound effects logistics measures
  An unwanted result of logistics measures is that measures leading to reduced emissions but also to lower costs, will also lead to re-investments of money, creating new activities with new energy and higher emissions. In theory, it is well-known that these rebound effects probably exist. However, for logistics it is unclear exactly whether, how and to what extent these rebounds occur. Better knowledge on this matter would help to identify these rebounds and to take measures to avoid them [10]. This is a recommendation from this study, but also related to the 'vrachtwagenheffing' and the 'terugsluis' this is an important topic for IenW and KiM as well.
- Inventory measures with substantial impact
  As a result of this study some discussions have been organized and already some additional measures have been identified to reach the climate goals. But it is clear, much more is needed. Further analyses should be done to develop and elaborate further required measures.

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