Summary

Introduction

Especially in the previous century, the passenger and freight mobility has increased significantly. The development to mass mobility stimulated world trade and human exchange. Although the benefits of a growing transportation are considerable, the negative side effects of the mobility industry cannot be denied. Transportation causes local air pollution, acidification and contributes to the global greenhouse effect. To outline the subject, the report focuses on the Port of Rotterdam, located in the south-west of Netherlands. As a result of the aim of the port to improve their accessibility, a modal shift and modal split are considered. However, besides accessibility, sustainability is also a key issue. An insight in the environmental effects of modal shifts and splits is therefore of great interest. Only passenger and container transport on the landside of the port will be considered. Both freight types are of great importance for the harbour and can be handled multimodal. The main research question of this literature report is:

What are the emissions of CO_2, NO_x and PM of the different transportation modes with respect to passenger and container transport in the port of Rotterdam, in 2010 and in 2020?

Modalities

The modalities are split into road, rail and water transport for both passenger and container transport. As a result of the infrastructure characteristics of the Port or Rotterdam, air transport is not included.

Calculation method

Not only the operational emission, but the whole lifecycle emission is used in this report to compare the different modalities. Three types of emissions are considered: the globally acting greenhouse gas CO_2, the locally acting smog gas NO_x and the locally acting particular manner (PM_{10}). The emissions are measured in gram per passenger-kilometre (g/p-km) or gram per tonne-kilometre (g/t-km). Per considered route, the total emissions per modality are calculated in gram per passenger or gram per tonne. As a result of differences in global and local emission and immission, this report does not integrate all emissions into one environmental score.

2010 emissions

The analysis of 2010 emissions showed a remarkable difference between passenger commuter traffic and container transport. *Figure a* shows the performance of passenger transport modalities filled up to its maximum capacity based on average values per group of transport modes. It can be concluded

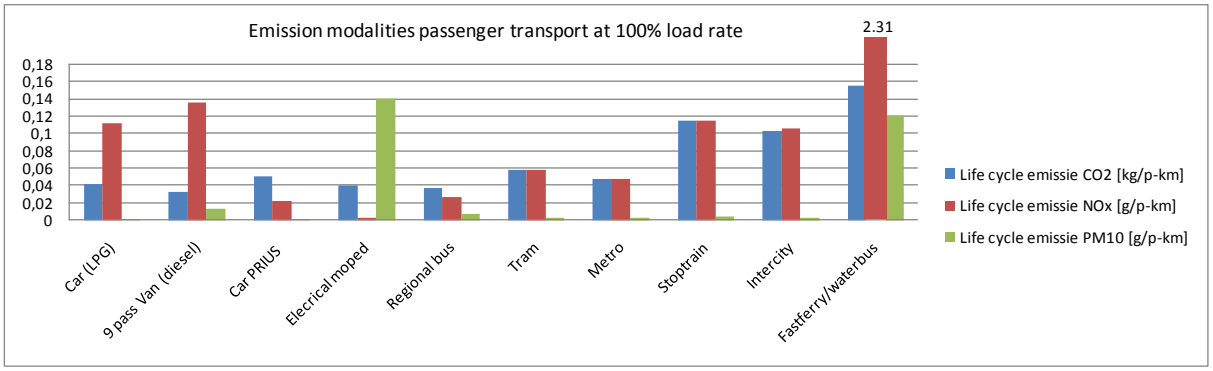

***Figure a**:The emission of passenger modalities at 100% load rate (this implies the lowest possible emission in g/p-km per modality)*

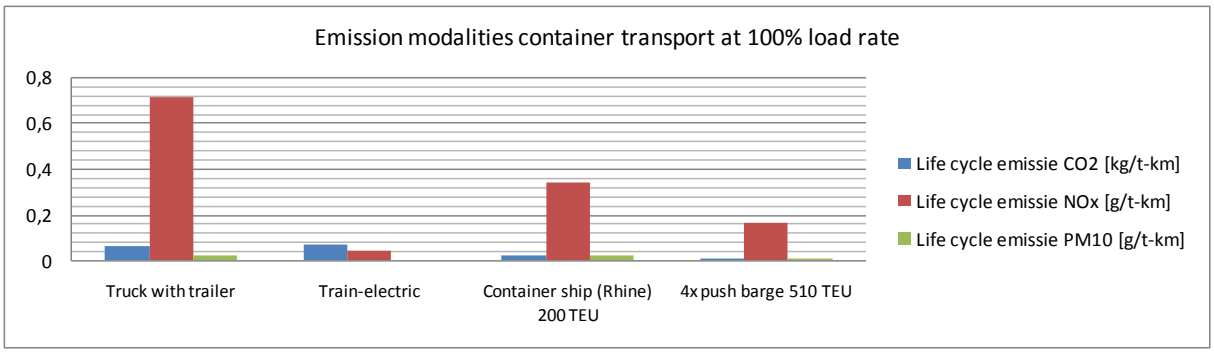

***Figure b**:The emission of freight modalities at 100% load rate (this implies the lowest possible emission in g/t-km per modality)*

that a shift from road to water and rail does not necessary result in a decrease of emissions, moreover, in some cases it would lead to an increase of CO_2 and NO_x emissions. *Figure b* shows the performance of container transport modalities filled up to its maximum capacity based on average values per group of transport modes. The best case scenario shows that a shift from road to water (4x barge) will result in a decrease of all emissions, however, a shift of road to rail will result in a decrease of NO_x and PM_{10} levels, but an increase in CO_2.

2020 emissions

2020 is a short term future outlook. Since most technology has a long lifetime and a slow development trajectory, many phenomena will still be the same in 2020 as in 2010. The changes are expected to happen slowly.

Not all described future developments have an effect on all considered emissions. A number of developments do only effect the CO_2 emissions (for example the CO2 capturing and storage), while others effect the levels of NO_x and PM only (for example filtering and catalysing). The combustion of bio diesel is a rare phenomena, although the amount of emitted CO_2 is decreased, the emission level of NO_x will increase under normal operation methods. The shift from fuel combustion to grey electric energy results in an increase of all emissions. Changing grey electric energy to green will cause a decrease of CO_2, but as a result of the large biomass content, it will also result in an increase of NO_x emissions. To decrease all levels, combinations of different developments are possible: a shift to green electricity, centralized filtering and catalysing and the use of plug-in hybrids.

Conclusions

The environmental performance of both passenger and container transport in the Port of Rotterdam is a complex, multidimensional and interrelated field of study. Technological development, human behaviour and governmental regulations all interact in this field.

The choice of modalities does influence the life cycle emissions per p-km or t-km, however, the degrees of freedom, such as the operation mode and length of route does influence the life cycle emissions even more. A general trend towards economy of scale exists, but the biggest challenge is to only operate the vehicles under maximum capacity. A large vehicle combined with a low load rate will result in high emissions per p-km or t-km.

An overall best concept concerning environmental performance does not exist. Modalities with the lowest levels of CO2 do not have the lowest levels of NOx or PM and vice versa. Prioritizing is very important to be able to make decisions. The question to be answered is: are global CO_2 emissions more important than local NO_x and PM_{10} emissions in the Port of Rotterdam? Concerning the future, combinations of developments can cause synergy and will result in a decrease of all emissions.