Impact of road High Capacity Transport on EU freight transport

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1 MOTIVATION AND OBJECTIVES

The European freight transport is challenged by several new situations: (i) increasing global economy, (ii) predominance of oil-depending transport means and (iii) its greenhouse gas (GHG) emissions. For this reason, we will analyse two new long-haul heavy duty vehicle (HDV) configurations: European Modular System EMS1 – combination of a rigid, a new e-dolly (with a battery package and an e-axle) application and a semitrailer with a length of 25.25 metres and up to 60 tonnes gross combination weight (GCW) – and EMS2 – combination of a tractor, a new e-dolly application and two semitrailer with a length of 32 metres and up to 74 tonnes GCW (see figure) – and their impacts on European freight transport and CO_2 emissions in the framework of EU project 'AEROFLEX', funded by HORIZON 2020. These truck types shall be used on specific European highways for a more efficient and more ecological-friendly transport.

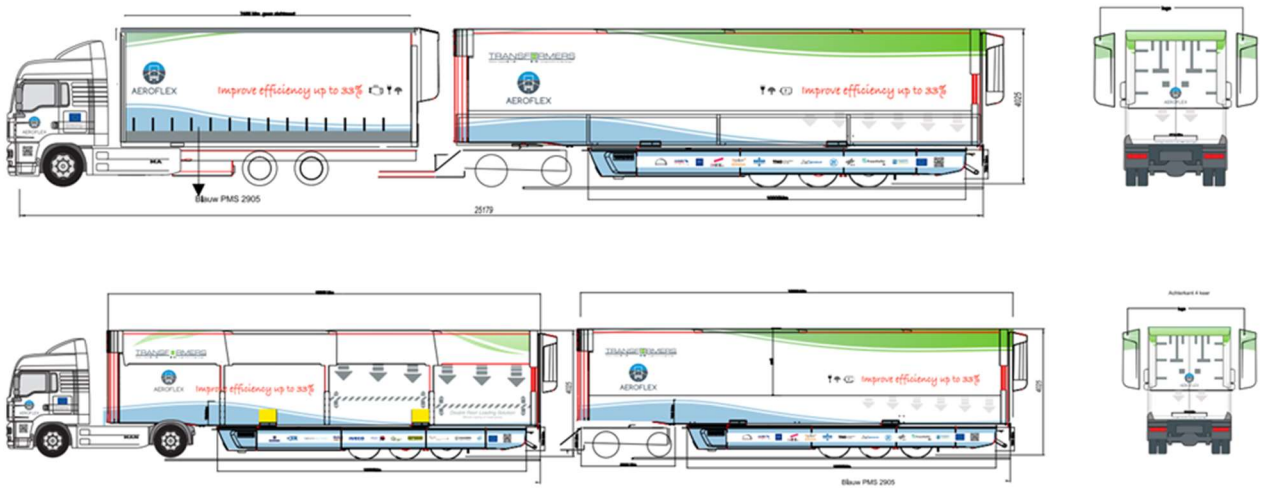

Figure: European Modular System; EMS1 (above) and EMS2 (below)

2 GERMAN FREIGHT TRANSPORT MODEL DEMO-GV

First, we use a German macroscopic freight transport model 'DEMO-GV'. It calculates the freight transport demand in Germany differentiated into the transport modes 'rail', 'road', 'inland waterways' in 2040. This model is a 4-step approach: freight generation, distribution, modal split, transport means split. Depending on the average transport costs on the three modes, we derive freight transport volume and performance between 601 European traffic cells. The freight demand is differentiated into commodity groups according to the classification NST 2007. 'DEMO-GV' can be configured by different transport costs on 'rail', 'inland waterways' and a flexible number of vehicles types for road freight transport. The 4-step approach of DEMO-GV is the following:

Step 1: Freight Generation

Depending on forecasted added values for each traffic cell for the forecast year 2040, the supply and the use of each commodity in each traffic cell is calculated. Especially, value-density of each commodity is used. Finally, there is the freight transport volume in every cell as source and sink.

Step 2: Distribution

The relations between the sources and sinks of the generated freight transport volume will be determined by an 'iterative proportional fitting'.

Step 3: Modal Split

Based on the costs for an average delivery between source and sink of the three modes for a commodity, we calculate the utilities (calibrated by the modal splits of 2010.) for all three modes [1]. The utility u represents the value of a freight transport from the origin (source) to the destination (sink) with the specific mode, corresponding to the logit model [2]:

$$p_i = \frac{\exp(u_i)}{\exp(u_{rail}) + \exp(u_{road}) + \exp(u_{iww})} \quad (1)$$

p_i is the probability for the transport of an average delivery between origin and destination cell for each mode i. If transport volume tv is the total mass which is transported between origin and destination of a commodity, tv_i is the mass which is transported with mode i between these two cells (modal split):

$$tv_i = tv \cdot p_i \quad (2)$$

Step 4: Mean Split
The transport volume tv_{road} which is transported on the road can be differentiated into different truck types. We use EUROSTAT data [3] for estimating the parameters for each truck type for a maximum likelihood model (probability p_{mean}). This probability provides the transport volume tv_{mean} which is transported by a specific truck type (mean split) between origin and destination cell:

$$tv_{mean} = tv_{road} \cdot p_{mean} \quad (3)$$

3 UPSCALING TO EUROPEAN LEVEL

The modal split and the means split on the road of 'DEMO-GV' have to be upscaled to European level. First, we calculate the freight transport performance tp at German level:

$$tp = tv \cdot d_{Germnany} \quad (4)$$

The following is an extension on the freight transport performance tp which exists at European level. We assume:

$$\frac{tp_{German,c,i}}{total\ tp} = \frac{tp_{EU-28,c,i}}{total\ tp_{EU-28}} \quad (5)$$

$tp_{German,c,i}$ = Freight transport performance (ftp) at German level for commodity c, mode i [tkm]
$total\ tp_{Germany}$ = Total ftp at German level [tkm]
$tp_{EU-28,c,i}$ = Freight ftp at European level for commodity c, mode i [tkm]
$total\ tp_{EU-28}$ = Total ftp at European level [tkm]

We assume the European territory as the territory of the EU-28. The assumption (5) is the result of the same mode ratios in Germany and the EU-28 [4]. Based on equation (5) and the total projected freight transport performance in EU-28 of EUREF in 2016, a disaggregated freight transport performance in EU-28 in 2040 is derived. The freight transport performance is disaggregated by NST-2007-classification and the three modes.

Our projection of freight transport performance at European level in 2040 can be extended by new truck types, like EMS1 and EMS2 with their specific vehicle characteristics (i.e. payload, transport costs).

4 CO_2 EMISSIONS AT EUROPEAN LEVEL

The projection of freight tonnes-kilometres for each cell-relation is used for calculating the truck mileage m. m is calculated by standard vehicle loads, depending on distance, vehicle-type and commodity:

$$m\ [km] = \frac{tp\ [tkm]}{vehicle\ load\ [t]}$$

The truck mileage m is used for calculating CO_2 emissions (tank-to-wheel) for HDV configurations for standard trucks (up to 40 GCW) and EMS1 and 2:

$$m \cdot fc_{km} \cdot \beta_e$$

fc_{km} = average fuel consumption [l/km]
β_e = specific CO_2 emission factor [kg/l]

5 SCENARIO DEVELOPMENT AND EXPECTED RESULTS

Within this project, we develop four scenarios for the projection year 2040: (i) EMS1 without any restrictions, (ii) EMS1/2 without any restrictions, (iii) considering external costs for the three transport modes and (iv) EMS1/2 considering external costs of transport. Based on this, DEMO-GV is prepared and parametrized to carry out the simulations for the baseline and the four scenarios. Afterwards, the steps of chapter 3 and 4 are conducted to show the transport-related impact on CO2 emissions of EMS1 and 2 at European level in comparison to the baseline scenario.

References

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