Environmental and economic assessment of current and future freight transport systems by road and rail in Switzerland

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Abstract

The transport sector represents 36% of the final energy consumption in Switzerland, and 14% of the CO_2 emissions of this sector are coming from heavy duty vehicles (Swiss Federal Office for Statistics, BFS 2013). Freight transport, involved in all supply chains, is a key component to achieve the goals of the Swiss Energy Strategy 2050.

This study presents a life cycle assessment (LCA) and a cost assessment of current and future goods transport by road and rail in Switzerland. The focus of the LCA lies on both infrastructure and vehicles, investigating impacts from climate change, terrestrial acidification and Particulate Matter (PM) formation. Concerning road transport, Liquefied Natural Gas (LNG) and Fuel Cell Vehicles (FCV) were explored in addition to conventional diesel trucks.

It was found that European vehicle tailpipe emission and fuel standards, have led to significant reduction of environmental impacts of trucks in the last decade. In particular, terrestrial acidification and PM formation impacts were reduced respectively by 66% and 48% for diesel trucks between 2000 and 2013. Expected near future fuel consumption standards could reduce fuel consumption by up to 30%, greatly improving the climate change potential of road freight in 2030. For FCV in 2030, climate change potential was found to be lower than that of conventional powertrains. Impacts are mostly due to the fuel production processes, with different hydrogen production pathways causing 30 to 70% of the total climate change impacts. FCVs were found to have higher impacts than other trucks in all other impact categories examined.

Regarding freight trains, mainly powered with hydro electricity, very high efficiency is already achieved and impacts of rail transport were found to be dominated by the infrastructure construction phase, accounting for 41 to 45% in the three impact categories considered. Climate change impacts of goods transported by train are in the range of 22 to 30% of the ones transported by diesel truck in the corresponding period. For terrestrial acidification and PM formation, trains were found to have 40 to 60% lower impacts than diesel trucks.

The cost assessment was designed to use comparable categories, including external costs, for all transport modes and technologies in order to improve consistency. It was determined that the total societal costs were higher for all road transport technologies than those for rail transport. However the costs are perceived in a different way by operators because rail transport, unlike road transport, pays the full costs of its infrastucture, representing more than 60% of the final expenses. The external costs of noise, global warming and human health impacts were found to be roughly equal for both modes, contributing 10-18% of total costs.

On the methodological side further research was found to be most necessary on infrastructure allocation and potential nonlinear effects of axle load on road pavement wear.

Keywords: Life Cycle Assessment, Life Cycle Inventory, Transport, Rail, Cost Assessment, Infrastructure allocation, Heavy Duty Vehicles, Freight train