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INNOVATIVE SOLUTIONS OF RAILWAY INDUSTRY FOR SUSTAINABLE MOBILITY

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Abstract

Innovative solutions of railway industry for sustainable mobility are presented in this document together with overview of present situation on sustainable mobility in railway sector.

Keywords

sustainable mobility, innovative, railway industry, interoperability, ERTMS, ETCS

1 INTRODUCTION

World Commission on Environment and Development, established under United Nations, defines sustainable transport as satisfaction of mobility needs present generations without restrictions of mobility needs future generations. Sustainable transport should meet a certain quality of life, which includes the clean air, quiet residential areas and economic prosperity without the harmful impacts on health and the environment and the depletion of limited natural resources [1].

The problem of sustainable transport is not only the technical (the provision of high quality transport infrastructure and the development of vehicles), but also it concerns the socio-economic issues (public expenditure in transport, congestions, pollutions and mobility) [2].

With growing freight and passenger transport, the risk of pollution and congestion is increasing. It is fundamental to design such a mobility that is sustainable, energy-efficient and respectful of the environment. Technical innovations and a shift towards the least polluting and most energy efficient modes of transport — especially in the case of long distance and urban travel — will also contribute to more sustainable mobility.

The target of the paper is to evaluate the situation with CO_2 emissions and its reduction ant the role of railway and the contribution of railway industry.

2 SUSTAINABLE MOBILITY

2.1 Present situation

Transport plays a key role for development of any society and economy, today and in the past. Transport systems are important for the competitiveness of any nation or regional economy as well as for the mobility of its citizens. On one sides there are benefits, on the other sides substantial costs.

Transport is currently responsible for 22.7% of global CO_2 emissions. European Commission at its European Strategy for low-emission mobility documents shows, that transport emissions are

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increasing at an alarming rate with a 53% increase between 1990 and 2011 making it clear that in the fight against climate change, a strategy to reduce transport sector emissions is crucial [3]. The significant transport sector contribution to overall CO_2 emissions is due to the reliance of the majority of transport on fossil fuels. Within the nearly 23% share of transport in overall CO_2 emissions, rail clearly stands out as the most carbon-conscious transport mode, contributing just over 3.3% to overall global transport emissions (or less than 1% of overall emissions) while transporting 9% of world passenger and freight-tonne kilometres.

Rail contributes to reducing the transport users' environmental burden to society with its exceptionally low total external costs.

Fig. 1 Picture on Specific CO_2 emissions per transport mode [4]

Furthermore, despite overall emissions of transport increasing, the emissions of the rail sector have decreased significantly in the past three decades and continue to do so. Following graph shows CO_2 emissions from passenger transport.

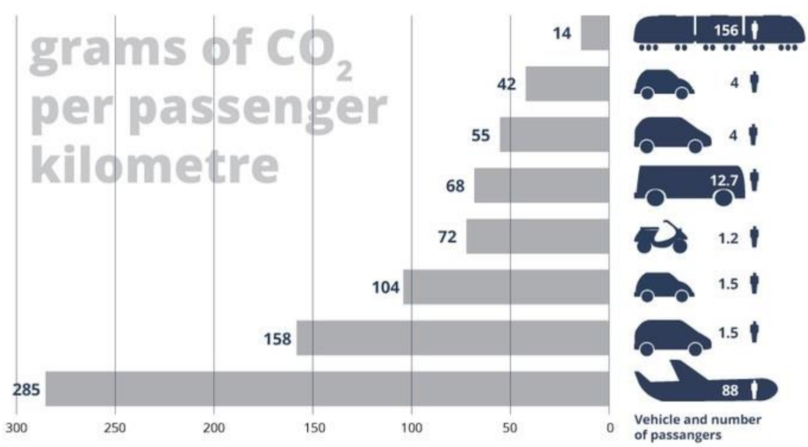

Fig. 2 Graph CO_2 emissions [5]

2.2 Paris Agreement

One of the aim of the agreement is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change [6]. The agreement also promotes the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production.

Comprising about a quarter of energy-related CO_2 emissions, transport is a major culprit in climate change, and as such, there is a great onus on transport leaders and stakeholders to propose and deploy solutions that reduce their environmental impact despite a growing demand for mobility. Rail transport meets 9% of the passenger kilometre/freight tonne kilometre demand worldwide while only emitting 0.7% of global energy-related CO_2 emissions, while the other modes (notably road, aviation, and maritime) emit 22% of global energy-related CO_2 emissions. It is obvious that rail is the most carbon-conscious and environmentally friendly mode of transport.

Transportation emissions account for roughly 1/4 of emissions worldwide, and are even more important in terms of impact in developed nations. Modes of mass transportation such as light rail and long-distance rail are the most energy efficient means of transport for passengers. Modern energy efficient technologies, such as plug-in hybrid electric vehicles help to reduce the consumption of petroleum, land use changes and CO_2 emissions. Utilisation of rail transport, especially electric rail, over the far less efficient air transport and truck transport, significantly reduces emissions.

2.3 CO2 emissions reduction target

Environmental issues receive increased attention of policy makers at both national and European levels. To achieve the ambitious objective of a 60% reduction in CO_2 emissions in the transport sector by 2050 set out in the 2011 Transport White Paper, the European transport system must undergo step changes [3]. For instance, it has to use less and cleaner energy and make efforts to reduce its negative impact on the environment and key natural assets. The railway sector can significantly contribute to this effort through cutting-edge low-carbon solutions that tackle climate change and urbanisation-related challenges. It is important to enable the sustainable growth of mobility based on rail as the backbone of an intermodal transport system.

Notably, the Trans-European Transport Network (TEN-T) is a major tool to foster economic competitiveness and sustainable development of the European Union. According to the European Commission, the completion of the TEN-T Core Network by 2030 will have positive effect for the European economy in terms of GDP level increase, fostering employment, time savings on travelling and a reduction in greenhouse gases emissions.

Although rail technologies are already 3 to 4 times cleaner than road or air transport in terms of CO_2 emissions, efforts need to be intensified to tackle climate change in the upcoming decades. The rail supply industry is therefore committed to further progress over the whole life cycle of our products – from production to operation to end of life – such as emissions reduction, increases in energy efficiency and material recyclability, and noise and vibrations reduction, among others.

Moreover, the European Rail Traffic Management System (ERTMS) is a key technical solution to achieve interoperability on the European railway network, but also to respond to a growing transport demand. Not only does ERTMS will enable full interoperability along the European railway network, but it will also help to improve capacity on railway lines as a high-performance signalling system.

2.4 Modal shift barriers

Rail systems have to face several obstacles before reaching full interoperability. Railways have greater or lesser interoperability depending on their conformity to standards of track gauge, couplings, brakes, signalling, communications, loading gauge, operating rules, etc. Furthermore, there is a persistence of redundant national rules or in conflict with EU TSIs, as well as a heterogeneous level of competence of conformity assessment bodies. In order to overcome these interoperability challenges, the full implementation of the Technical Pillar of the Fourth Railway Package it is vital.

The different modes of transport have often been developed independently in the Member States, often without taking into account inter-modal competition. As a result, the current situation of the transport market is characterized by severe distortions of competition and a high taxation burden on rail transport. The removal of the present taxation inequalities would favour the establishment of a level-playing field between the different modes of transport and therefore a modal shift towards the least polluting modes of transport.

The current situation displays an unequal treatment of infrastructure charging, being rail transport indeed the only mode to be heavily regulated at EU level for charging of infrastructure. The currently ongoing revision of the Eurovignette Directive could be an opportunity to create a fairer level playing field applied to all modes introducing the principle of distance-based charging in road transport and taking into account the costs of all externalities.

Rail infrastructure is facing a twofold challenge. On the one hand, ageing rail infrastructure needs to be modernised and upgraded in order to meet the demands of growing transport flows. On the other hand, new infrastructure will have to be constructed in order to meet capacity demand in certain regions as well as to better link up European Member States. Rail will only be able to compete with other modes of transport and unfold its environmental benefits if a modern infrastructure is provided.

2.5 The role of the rail supply industry

Even with a past environmental performance record better than any other major mode, the rail sector is committed to further reducing its GHG emissions. In particular, the European rail industry, representing 46% of the global market for rail supplies, is actively focused on continual innovation of rail system technology in order to further improve energy efficiency and reduce GHG emissions while at the same time boosting the attractiveness of rail transport and thus eliciting a modal shift from more polluting transport modes to rail.

Over the past two decades, the European rail industry has provided considerably more energy efficient products to its customers. In 2010, an estimated 20% energy reduction had already been obtained compared to 1990 vehicles. On certain types of vehicles, the savings could represent as much as 50%. Regenerative braking or energy storage technologies have contributed to these results. Nevertheless, further gains in energy efficiency are still possible to reduce the energy consumption and carbon footprint of the railway system, and the industry is committed to achieving this long term goal.

Over the past two decades, the Czech rail industry has significantly improved the environmental performances of its products, be it on energy efficiency, noise and vibrations or recyclability of materials. Regenerative braking, energy storage or lighter materials are already game changers – and more work is being carried out to mitigate the impact of climate change.

3 CONSIDERABLE INOVATIVIE PROJECTS

3.1 VEHICLES

What will be the future products? It will be dual-mode vehicles with traction batteries powered by a trolley and high-energy or high-power electric buses. Optimised hybrid locomotives and train sets enable the provision of seamless services between electrified and non-electrified parts of the network both for freight and regional passenger services. The support of efficient last mile services will improve the competitiveness of rail freight services, especially in the intermodal industry as well as for private sidings.

An automatic coupling together with continuous electric wire, facilitate efficient shunting operations and new production schemes. Electronically controlled braking and automated brake tests are innovations which are creating step changes especially in rail freight services. Instant electronic braking reduces derailment risks and improves the general safety and security of the train operation. This is especially important for longer, heavier, commercially faster trains which will be an important pillar of future rail freight services.

The development also focuses on enhancing effective utilization of applied materials, eg. fiber composites or aluminium alloys. Advanced technologies also include laser welding, a higher use of extracts and castings thanks to the latest production methods or improved methods of material bonding. These approaches deliver primarily lower weight of vehicles which leads in its turn to more efficient transport from the point of view of energy consumption.

In accordance with requirements for the sustainable development, Škoda Transportation develops systems which cause less pollution and noise, show higher energy efficiency and have lower operating costs. One of the many examples is the use of electric traction or energy recovery technology. The Škoda Electric company made use of an electric drive employing the possibility of an integrated diesel generator and supercapacitators in 45 trolleybuses in the Italian city of Rome, and this ranks it again among the technological leaders in the field of trolleybus supply.

Hybrid cars represent an important intermediate step on the way to an electric bus. Škoda Electric works on this technology with the aim to take full advantage of the current leading-edge technology in electrical engineering (the most advanced semiconductors, a traction motor with high efficiency and a high-capacity traction battery) and to optimize the properties of a thus powered bus (range of vehicles, seating capacity, weight per axle) [7].

3.2 COMPONENTS

BON*AXLE*® is innovative induction-hardened axle. It is solution to the requirements of increased safety and reliability. It also brings significant decrease of life-cycle costs (LCC). BON*AXLE*® is likely to bring paradigmatic change in railways across Europe and beyond. GHH-BONATRANS achieved to improve the technology already well established in Japan by adapting it to the conventional European geometry and steel grades.

BONA*STAR*® is a family of new wheel materials for all types of passenger, locomotive and freight wheelsets. In comparison with the wheels made of standard EN grades, BONA*STAR*® ensures 30% greater life in mileage by increasing the fatigue limit in the wheel web significantly and by providing greater hardness and strength of the rim (while preserving its high-level plastic properties). BONA*STAR*® also ultimately reduces the wheelset LCC [8].

3.3 ERTMS

The European Rail Traffic Management System (ERTMS) is a key technical solution to achieve interoperability on the European railway network, but also to respond to a growing transport demand. Not only does ERTMS will enable full interoperability along the European railway network, but it will also help to improve capacity on railway lines as a high-performance signaling system. More specifically, ERTMS will bring the following benefits to the rail system making modal shift considerably more attractive:

- Increased capacity on existing lines and a greater ability to respond to growing transport demands: ERTMS reduces the headway between trains enabling up to 40% more capacity on currently existing infrastructure;
- Higher speeds: ERTMS allows for a maximum speed up to 500 km/h;
- Higher reliability rates: ERTMS may significantly increase reliability and punctuality, which are crucial for both passenger and freight transport;
- Lower production costs: one proven, harmonised system is easier to install, maintain and manufacture, making railway systems more competitive;
- Reduced maintenance costs: With ERTMS level 2, trackside signalling is no longer required, which considerably reduces maintenance costs;

- An opened supply market: customers will be able to purchase equipment for installation anywhere in Europe and all suppliers will be able to bid for any opportunity;
- Reduced contract lead time due to the reduction of process engineering;
- Improved safety for passengers

The ETCS L2 has been piloted within the Czech Republic in the section Kolín – Poříčany. Based on the experience of the application of the ETCS L2 on the pilot section, the technical specifications for the implementation were defined. The main characteristic of these specifications is the implementation of the ETCS L2 respecting mixed, it means operation of rail vehicles equipped and not equipped with OBU ETCS.

Presently has been completed the first commercial project of installation the ETCS L2 on a section Kolin - Břeclav – state border of the Czech Republic with Slovak Republic and Austria. Under the realization is a project ETCS L2 on a section Petrovice u Karviné – Břeclav, and the newly launched work is the realization of the section Čecká Třebová – Přerov. The further development of the ERTMS system, which includes ETCS is defined by an ERTMS national implementation. This plan defines the basic parameters for the development of the ETCS in the framework of the railway infrastructure of the Czech Republic [9].

3.4 RESEARCH PROJECT

The FINE 1 project aims to reduce operational costs of railways by a reduction of energy use and noise related to rail traffic. The project results are expected to enable an increase of traffic in Europe and to enhance the attractiveness of railway in relation to other modes of transport.

The project activities will support the innovation process within the S2R Technical Demonstrators (TDs) by providing methodology and know-how to enable development of low noise and low energy TDs. The project is fully in line with the EU objectives with eight technical work packages (WPs) addressing technologies to support these objectives. The reduction of energy use for rail vehicles is as addressed in WP 3 and WP4 and will indirectly lead to reduced green-house gas emissions, also with most rail transport powered with electricity. Further, reducing energy use will lower the life cycle cost and the costs of vehicle operation. The project also aims at development of practical methods for predicting noise and vibration performance on system level including both rolling stock, infrastructure and its environment. Prediction of interior vehicle noise is addressed in WP 7 and source modelling for interior and exterior noise in WP 8. With an accurate characterization of each contributing source, it will be possible to optimize cost benefit scenarios, as addressed in WP 6, as well as take exposure and comfort into account. Finally, the auralisation and visualisation techniques of traffic noise scenarios and the noise control techniques developed in WP 9, support the reduction of noise exposure for residents by efficient traffic planning and novel mitigation techniques.

In summary, the expected FINE 1 advances of the state-of-the-art in noise modelling and control as well as in energy management and control methodology, will improve the competitiveness of the European railway system compared to other modes of transportation and thus promoting a modal shift to rail.

4 CONCLUSION

Rail is the most environmentally-friendly transport mode contributing to only 0.7% of global energy-related CO_2 emissions while meeting 9% of the global mobility demand compared to 22% of global energy-related emissions emitted by all other transport modes: road, aviation and maritime [10].

A modal shift to rail (as the most sustainable mode of transport) should be at the backbone of any transport sector strategy to reduce CO_2 emissions [11].

The European rail industry is fully committed to developing technology for rail that is even more energy efficient and environmentally-friendly which will continue the decades-long trend of declining rail transport emissions [12].

Much of rail transport relies on electric energy which allows for even further CO_2 emissions reductions as the energy sector shifts to renewable, low-carbon energy generation. This technology and infrastructure has already been deployed in many parts of the world, whereas the other major transport modes are almost entirely reliant on fossil fuels.

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