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Rail Infrastructure

HIGHLIGHTS

■ **TECHNOLOGY STATUS –** There is a vast range of rail infrastructure in use today, with a whole spectrum of possible energy consumption and efficiency performance. The most significant contributor to the life-cycle of rail infrastructure energy consumption is its construction phase. Naturally this depends on the size of stations, quantity of track and whether or not the rolling stock will be run on electricity or diesel. Electrified and high speed track is becoming more and more popular, partly because of their greater energy efficiency compared to diesel. This does however lead to greater infrastructure requirements and energy consumption, specifically in the form of overhead line equipment and larger, airport style termini.

■ **PERFORMANCE AND COSTS –** Infrastructure construction, maintenance and operation together contribute 13.5% to the total lifecycle emissions of electrified rail based on an EU average electricity generation mix. Operation of the rolling stock accounts for 82% and the remaining 4.5% is construction and maintenance of rolling stock. Maintenance energy consumption of electrified track is dominated by the railway itself and supporting substructure, at 39% and 38% respectively; stations contribute 12%. In terms of costs, the rail driveway can cost between €56,800 and €472,700 per track km, and a typical high speed rail station costs around €100m and takes two years to build. High speed rail infrastructure is leading the way in terms of performance efficiency and is attracting the latest technologies, but it is also the most costly. Substructures of gravel are only operational 79% of the time due to maintenance and substantiating of the ballast. This can be increased to 99% with ballastless track, although this is uncommon at the moment.

■ **POTENTIAL AND BARRIERS –** France, China and the UK are making steps towards sustainable stations, with plans and targets particularly focusing around installing solar photovoltaic cells on station roofs. Other options for reducing energy consumption mirror any commercial building, such as thermal insulation and low-energy lighting. Barriers to such developments are high capital costs, and in the case of upgrading existing stations, whether or not the structure is able to support renewable energy devices or new waste and water systems. In terms of the life cycle, transporting materials to the construction site by river or rail can also cut energy consumption, though this is restricted by the location of the infrastructure development. Improved signalling and communications technology claims to be able to save around 5% of in use traction energy, achieved by smoothing speed profiles and reducing conflicts.

TECHNOLOGY STATUS – Rail transport infrastructure may offer unexploited potential for energy efficiency improvement, such as the reduction of energy consumption of large railway stations, signalling equipment and electricity transmission for electrified rail. Further, considering life cycle emissions opens up more areas for improvement, such as the energy consumed in constructing rail substructures, tunnels or bridges, or process emissions from the materials used in the various components of a railway line. To provide context, Figure 1 shows the relative contributions of various components to the lifecycle GHG emissions from a railway. The figures are based on the carbon footprint assessment of the Eastern branch of the Rhine-Rhone LGV [1], adjusted to the EU electricity mix. The following subsections provide a discussion of the current status of each component of the rail infrastructure.

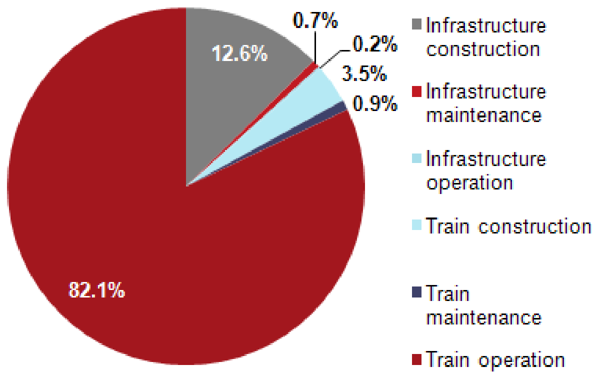

Figure 1: Life-cycle emissions from electric rail transport based on EU grid electricity mix [1]

■ **Permanent way and borders** involve earth works to support the track, drainage systems for water dispersion and perimeter barriers. Typical energy consumption (including earth works and energy embedded in materials from extraction and processing) ranges from 5,150 to 6,779 GJ / track km [2]. Junctions typically include a kilometre of track, and related land and earthworks. Rail in a rural environment simply requires bordering by post and wire fencing to stop trespassing, while urban routes often have acoustic side barriers [3].

■ **Ballast** is the support for the rail track, and is composed of tightly interlocked gravel pieces. Gravel ballast requires regular maintenance as pieces fall away under vibrations, and the support for the track needs substantiating. For high speed trains, greater quantities of ballast are normally required with larger stone sizes [4]. High speed trains may also require banked curves or super-elevation due to their maximum required curvature. Conventional trains however already employ tilting technology (e.g. Pendolino rolling stock in the UK) so banking would be avoided. **Ballastless track** or slab-track uses a continuous concrete bed with entrenched rails instead of interlocked gravel pieces and sleepers. This has specific uses in road crossings and tunnels, and has also been tried for continual stretches of rail but remains relatively uncommon.

■ **Track gauge** is the term given for the width between rails. Many countries have a combination of gauges

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