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# Hyperloop, the electrification of mobility and the future of rail travel

Predicting the future. That's much more dark art than science and one that has to be treated with caution. There. That is my disclaimer before attempting to speculate how we will travel by rail as the 21<sup>st</sup> century advances.

## Urban Mobility

We live in an urbanised world. The engine of our economy and way of life is based in the city. Transport is the key essential facilitator of such activities and it will continue to be so for the foreseeable future. Mobility, therefore, plays a fundamental role in the shaping of urban areas. This is particularly relevant in the new crop of polycentric megapolis where the ability to move efficiently and rapidly across them is vital. With the advent of electromobility and driverless vehicles, it is fair to ask what role could the railways play in this 21<sup>st</sup> century mobility landscape? The answer is not easy of course, but it lays at railway's core advantage of mass-transit and reduced land-use. This should position urban railways as the backbone of the mobility chain.

Urban railways have traditionally and will continue to be electrified. The evolution of electrification solutions will play an important part in having transit systems that are efficient and reliable. The introduction of energy efficiency measures such as reversible substations and energy storage systems are but two technological developments that will underpin the advancement of electrification. There are also some urban/suburban electrification solutions that are ripe for upgrading. Third rail is one that springs to mind. This system can still be found in large parts of London and the South. As Prof. Rod Smith from Imperial College pointed out in one of his brilliant papers<sup>1</sup>, a letter to The Times on 08 October 1904 read

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<sup>1</sup> Energy for Railways in *Energy, Transport, & the Environment: Addressing the Sustainable Mobility Paradigm*, 1 December 2012, Pages 561-575

*"[...] The "live rail" is itself already an obsolete device, discarded in the latest types of electric railway. In ten years time there will probably be no 'live rail' left...it is an engineering blunder."*

In other words, third rail was declared obsolete over a 100 years ago and still being used! There is definitely an electrification challenge there.

Cost, you might be thinking...All of this will not mean anything if the railways cannot achieve high levels of patronage that will justify the higher upfront investment cost.

### **Long distance**

Long distance rail travel in the 21<sup>st</sup> century will be dominated by speed. Stephenson's Rocket won the 1829 Rainhill competition achieving the world speed record in the process, almost 58 km/h. fast forward 135 years, the modern era of high speed rail was established by the Japanese with the inauguration in 1964 of the Tokaido Shinkansen commercial service, reaching a maximum speed of 210 km/h. Since then, the pursuit of faster and reliable high speed services has grown rapidly across the globe. Service speeds of 300 km/h are common in modern networks e.g. Spain's AVE, the French TGV or Germany's ICE and in the very near future in-service speeds of 320-360 km/h will be routinely achieved. The technological and operational challenges that this poses are not trivial though. Finding a balance between the level of safety required while maximising capacity and optimising the energy usage is one of the biggest dilemmas faced and the cornerstone of future rail travel. Rail needs to utilise its energy efficiency endowment to good effect and is uniquely positioned to do this. Again, electrification already is at the heart of the systems that make this possible. 25kV AC power supply is, and will continue to be, the chosen approach for this.

Of course, the imagination of engineers has created many alternatives to the steel-on-steel principle that defines railways since its birth. Maglev and the Hyperloop are regarded as the most relevant future alternatives. Magnetic levitation (Maglev) uses powerful magnets to propel the train along dedicated, as straight as possible, infrastructure. With roots in Germany and

Japan, the technology is currently in service in China, linking Shanghai airport with the city centre at speeds of 430km/h. However, Maglev is intrinsically associated with Japan. The nation that established the modern era of high speed travel is also attempting to define the next chapter. Superconducting magnetic levitation (SCMaglev) has been in development for decades and recently was approved to start service operation on the Tokyo-Osaka line. While Maglev is technically viable as demonstrated by the numerous tests carried out, questions remain about its suitability for commercial application. Particularly, the extremely high initial cost that requires dedicated infrastructure. This in turn also highlights its lack of connectivity and integration with existing rail networks as well as the phenomenal energy demand (during construction and operation) casting concerns about its true potential as an alternative to conventional high speed technology which still has enormous development potential.

Hyperloop is an elegant idea. Travelling seamlessly at 1,220 km/h in gracefully designed pods with frequencies averaging 2 min dropping to 30s during peak time (no more waiting!) is very appealing. Technically, it is a challenging design but it is proving to have captured the imagination of entrepreneurs and engineers. However this is not rail travel. As Mr. Elon Musk puts it, it is a fifth transport mode. It is designed to link cities that are around 1,500 km apart. In fact, it is proposed to link Los Angeles and San Francisco where it is possible to have uninterrupted straight-line construction without coming across any built areas of significant topographic challenges. This is not the case in many other parts of the world. Ultimately, even if it sees the light given the uniqueness of its principle it probably will be a stand-alone complementing system rather than one that could be seamlessly integrated with other existing modes. It is no substitute for rail.

In practice, the vast majority of us will continue to travel on trains that are on the surface at least not dissimilar to what we know today. For instance, in the UK we are about to take delivery of 122 train sets (class 800 for those interested in this sort of thing...) in the coming 18 months. These trains will be the workhorses of intercity travel for the coming decades. If the trains they

are replacing are anything to go by, we will still be using the new ones in 2050.

Modern state-of-the-art railway investment around the globe is based on the steel-on-steel principle and there is no reason to doubt this is, by and large the rail travel of the future...as it was nearly 200 years ago. Electrification will continue to play a significant role as it always has done, more so with the drive to reduce green house gas (GHG) emissions and the likelihood of the diesel engine death. This will provide a fresh opportunity to advance electrification systems around the world, which hopefully will make them more attractive financially. On other fronts, flexibility and adaptability of the passenger needs as part of solving the conundrum posed by the tension between capacity, energy use and service level will be the driver for more innovation. Physical and virtual connectivity will be at the heart of how we will be travelling in the future, not just by rail.