Smarter, more Efficient Electrification

What is the situation?

Electrical power demand on the railway continues to increase as a result of expanding electrification and longer, more frequent and more power intensive trains.

Approximately 40 % of the British railway network is electrified, comprising 25 kV a.c. (two-thirds) and 750 V d.c. (one-third) systems supplying traction power to trains. The benefits of expanding the electrified network will be realised as part of a rolling electrification programme. However, the business justification for electrifying less frequently used lines hangs in the balance, leaving nearly half of the railway network reliant on self-powered trains.

In 2015-16, the UK railway traction electricity demand was 3.4 TW/h, making us one of the largest single consumers of electricity in the UK.

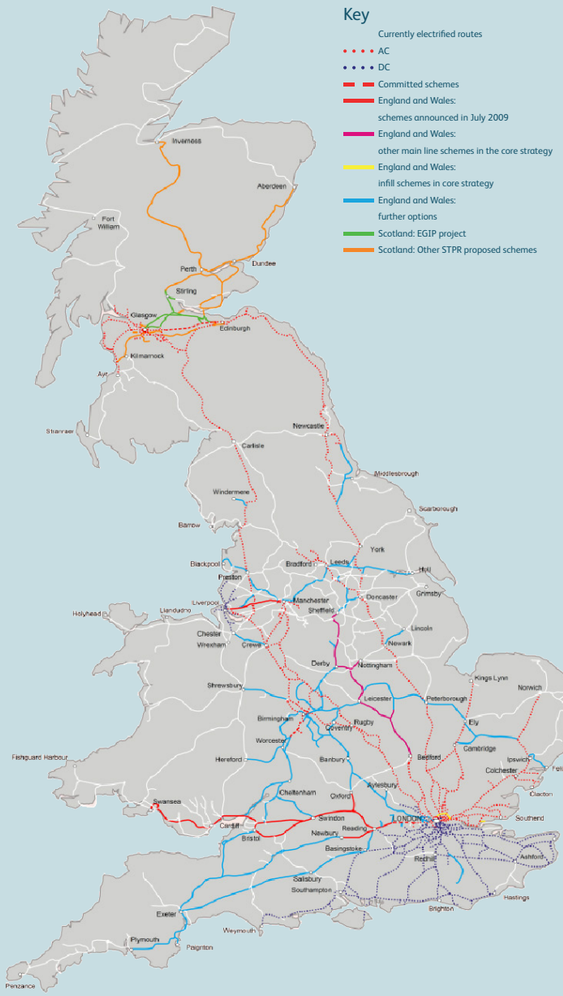
We are progressing Smart Grid technologies (such as IEC 61850) as well as energy harvesting, storage and recycling (regen. braking) to reduce costs and demand.

R&D activities are required to further unlock the following ambitions:

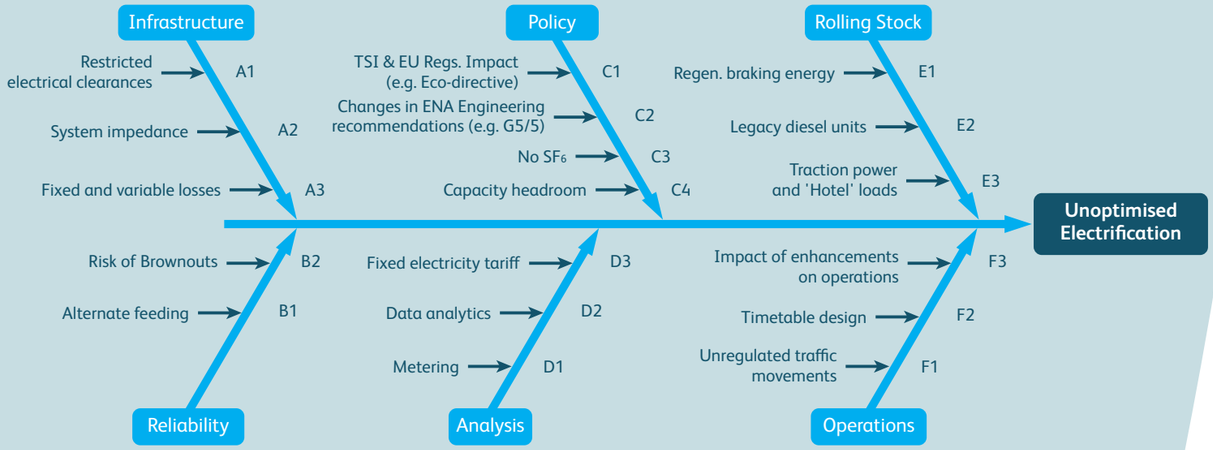
- To reduce the cost of electric traction infrastructure.
- To grow the capability to increase the proportion of electric traction use.
- To improve the management of electrical energy demand.
- To improve the efficiency of electrical energy.

Our challenge is to improve the electrification infrastructure operation, economically and efficiently, keeping sufficient capacity headroom maintained. An enabler to achieving this objective, and satisfying our licence condition, is further development and implementation of smarter, more efficient electrification systems. This includes new electrification, as well as, modifications to legacy infrastructure where appropriate.

Appendix 7 - Core and further options



Analysis of causes



Scope

The overall scope of the challenge is to investigate the potential for new technologies and techniques to support the ambition of smarter, more efficient electrification. The enablers for this are:

- Optimised design and performance of electrification equipment and systems.
- Real-time understanding and control of how electrical energy flows in the network.
- Electrical distribution assets which utilise modern materials and methods to reduce electrical losses.

Priority problems

Specific priority problems	Related goals	Benefits
• Development of new tools, techniques, equipment and understanding to reduce the cost of electrification.	• Design and development of Compact Substations (e.g. replacement of Sulphur hexafluoride (SF6) with alternative gases in Gas Insulated Switchgear and progression of Solid Insulated Switchgear utilising disconnectors with sufficient air-clearance). • Improve the industry's understanding of optimising Discontinuous Electrification (e.g. onboard storage, charging, pantograph raising/lowering) to avoid expensive civil alterations associated with accommodating the contact system in areas of restricted electrical clearances (e.g. bridges and tunnels). • Development of automated Overhead Line Equipment design tools, i.e. efficient allocation design tools with integrated survey platform in order to minimise data processing.	• Greater capability to increase the proportion of electric traction on the network, including freight services. • Better value for the taxpayer and better for the environment.
• Development of technologies which facilitate and improve the management of electrical energy demand.	• Development of Power Quality and Smart Metering technologies for the industry, including linear transducers and harmonic monitoring capability for high-frequency harmonics. • Development of Smart Network components, including power electronic technologies, Automatic Voltage Control and energy harvesting, storage and recycling (regen. braking).	• Compliant electricity supply industry connections and greater alignment with electricity supply industry best practice. • Cost-efficient acquisition and smarter use of electricity.
• Development of equipment to improve the efficiency of electrical energy distribution.	• Design and development of high-efficiency Auxiliary and Rectifier Transformers to meet (auxiliary) or be designed to the equivalent standard of (rectifier) the EU Eco-directive; investigations to include the robustness of transformers built to high-efficiency designs and special measures for cooling circuits to increase efficiency. • Research into the use of composite materials for conductor rail to reduce wear rates (linked to impedance) and extend asset life.	• Greater compliance with EU Regulations and alignment with electricity supply industry best practice. • Reduced electricity bill and greater green credentials for the rail industry.

Expected impact & benefits

- Reduced cost of electrical traction infrastructure.
- Greater capability to increase the proportion of electric traction.
- Improved management of electrical energy demand.
- Improved efficiency of electrical energy distribution.