Electric traction power

UKRRIN
UK RAIL RESEARCH AND INNOVATION NETWORK

1. Lowering and raising pantographs at speed

Identifying blockers to faster pantograph lowering, suggest possible design improvements, and test prototypes that at least half the change over time.

2. Leading power factor on rolling stock

Developing and evaluating electronic system architectures capable of delivering stable and reliable Leading Power Factor operation.

3. Protecting pantographs against bird strikes

Exploring solutions that reduce the frequency and / or mitigate the consequences of bird strikes on pantographs.

4. Comparability of rolling stock traction battery sizing and modelling tools

Developing a common framework to enable consistent, like-for-like comparisons of outputs from modelling tools for battery sizing and loading.

Lowering and raising pantographs at speed

Workstream: Electric traction power

What is the challenge / opportunity?

- *Introduction of multi-mode trains requires dynamic Power Changeover (PCO) between supplies.*
- *BS EN 50206-1:2010 sets pantograph response time limits:*
  - *≤ 3s to achieve electrical separation at standstill and up to the maximum speed (Clause 4.7, Clause 6.3.2)*
  - *≤ 10s for raising and lowering during routine system checks (Clause 6.3.2)*
- *So, design and assumptions are bases on the 10s limit.*
- *Evidence suggests actual pantograph lowering times can be significantly shorter.*

Benefits of shorter lowering and raising time limits

Improved infrastructure use: Faster lowering decreases the electrified track needed for transitions, cutting costs and making better use of existing Overhead Line Equipment.

For example, at a speed of 160 km/h → while lowering the pantograph in 10s a train travels ~450m + additional 450m to accommodate potential driver error → min gap size of ~1km.

What output(s) are expected?

- *The design and validation of a novel approach to power changeovers that can reliably happen in at least half of the time.*
- *Proposal should cover the full journey to develop and assess the proposed novel approach. Work would involve:*
  - *Identify requirements, blockers & opportunities including:*
    - *Operational processes and requirements (potentially extending the total time)*
    - *Dependencies and or required changes to electrical equipment and infrastructure*
  - *Develop specifications for rapid pantograph lowering that meet the above challenge*
  - *Build and test prototype(s)*

What is needed from a good proposal?

- *Involvement and contributions in-kind from relevant industrial partners (pantograph manufacturers and train OEMs) are required.*
- *Depending on in-kind and cash contribution by other parties, we will consider proposals in which the international exploitation of IPs rest with other funders and RSSB and NR are granted royalty free use of the IPs for the GB rail network.*

Funding size

Up to £500k funding one proposal

Funding source

Opportunity set and funded by NR & RSSB jointly

Useful links and background info

[T1356 Improving Power Changeover Practices]

Leading power factors on rolling stock

Workstream: *Electric traction power*

What is the challenge / opportunity?

Under stressed feeding conditions, significant voltage oscillations can emerge from the interaction of:

- *Rolling-stock power electronics and control loops (e.g. current limitation and voltage regulation)*
- *High network impedance (long feeding distances, outages)*
- *Multiple trains responding simultaneously through the shared energy system*

Static Var Compensators (SVC) have been used to enhance line voltages on 25 kV lines (ie High Voltage Booster project). Modern rolling stock has advanced power electronics capable of achieving similar benefits but has historically been discouraged due to concerns about power supply stability.

The new EN 50388-1:2022 permits leading power factors but, as yet, no railway has taken advantage of this.

The opportunity is to identify onboard power electronics and control architectures that can operate at a leading power factor and improve line voltage, network capacity, and power-supply stability.

What output(s) are expected?

- *Define enhanced on-board electronics and control architectures*
- *Define interactions between enhanced on-board electronics and control architectures and supply system*
- *Build integrated rolling stock - traction models that incorporate the enhancement*
- *Validate/ test models for instability with real data.*
- *Assess of the case to progressing beyond the proof of concept by characterizing:*
    - *capex and opex costs*
    - *benefits (e.g. avoiding infrastructure interventions and unlocking capacity)*

What is needed from a good proposal?

- *Expertise in power electronics and rolling stock*
- *Involvement and contribution in kind from OEMs and other relevant parties will enhance the attractiveness of proposals*

Funding size

Up to £250k potentially covering multiple proposals

Funding source

Opportunity set and funded by NR & RSSB jointly

Useful links and background info

Routes with line voltage limitations from NR, e.g. East Coast

Protecting pantograph against bird strikes

Workstream: *Electric traction power*

What is the challenge / opportunity?

- *Bird strikes on a pantograph/ contact wire at speed can cause significant damage and disruption*
- *This has led to significant recent events resulting on route disruption and rolling stock taken out of service*
- *Reliability of AC electrified routes can be improved if bird strike incidents can be reduced and/or consequences limited*

What output(s) are expected?

- *Identification and evaluation of the range of options that could improve resilience*
- *Options to cover a range of different timescales, complexity and implementation costs*

What is needed from a good proposal?

- *Expertise in pantograph and OLE failure modes*
- *Demonstrable awareness of bird strikes prevention related studies*
- *Involvement and contribution in kind from OEMs and pantograph manufacturers will enhance the attractiveness of proposals*

Funding size

Up to £50k funding one proposal

Funding source

Opportunity set and funded by RSSB with support and co-funding from NR

Useful links and background info

Guidance - Assessment and mitigation of impacts of power lines and guyed meteorological masts on birds | NatureScot

Norwich train passengers stuck three hours after bird strike - BBC News

Comparability of modelling tools for traction battery sizing and loading

Workstream: *Electric traction power*

What is the challenge / opportunity?

- *At present, there is no common framework to enable consistent, like-for-like comparisons of outputs from modelling tools for battery sizing and loading.*
- *These tools typically involve dynamic simulation, route profiling, and power consumption analysis to determine the optimal battery capacity, power rating, and charging strategy.*
- *They include assumptions that are not always transparent and make reliable like-for-like comparisons between different solutions difficult.*

What output(s) are expected?

- *Establish that key modelling relationships and assumptions that should be provided / met to enable comparison of models results.*
- *Standardised operational scenario definitions to use for results to be comparable (inputs, boundaries, constraints).*
- *Parameter sensitivity maps showing dominant drivers of battery sizing.*
- *Case study application(s) to demonstrate how it will enable more meaningful results and comparison.*

What is needed from a good proposal?

- *Expertise in both traction modelling capabilities and operational railway are needed*
- *Involvement and contribution in kind from OEM, ROSCOs and other relevant parties will enhance the attractiveness of proposals*

Funding size

Up to £250k for one proposal

Funding source

Opportunity set and funded by RSSB with support and co-funding from NR

Useful links and background info

Compatibility and optimisation considerations for rolling stock traction batteries and battery charging (T1272)

Battery powered trains: Route to enter into service (T1195)