Energy Innovation Summit 2024

# Flexible Railway Energy Hubs

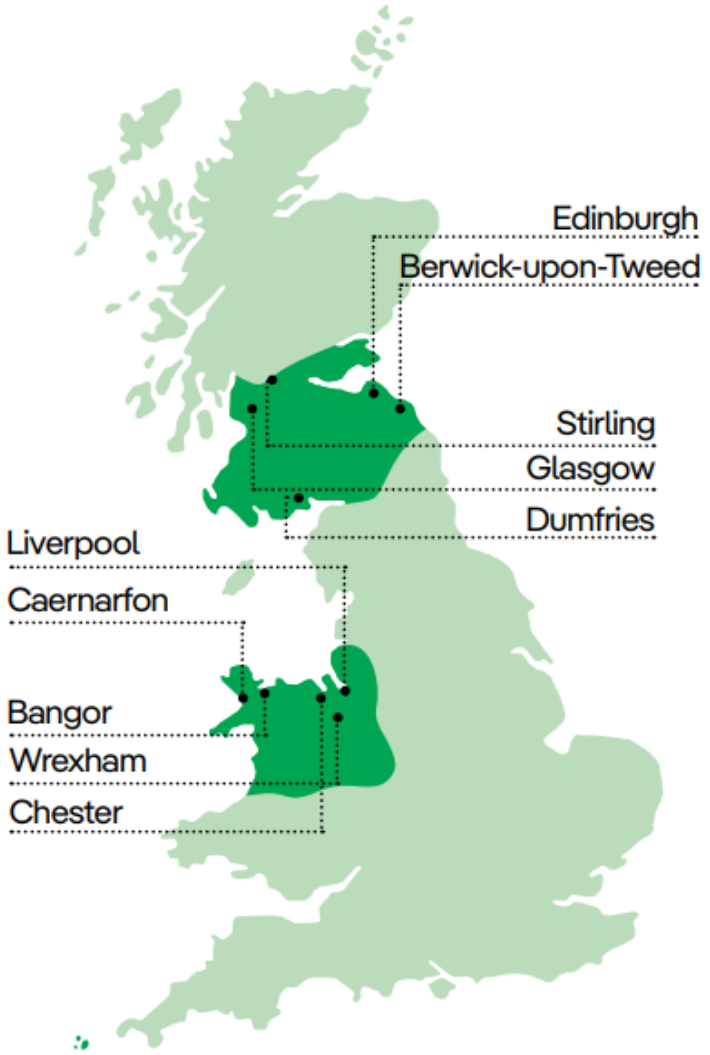
# About us

We are SP Energy Networks. As a Distribution and Transmission Network Operator we keep electricity flowing to homes and businesses throughout Central and Southern Scotland, North and Mid Wales, Merseyside, Cheshire and North Shropshire.

We do this through the network of Overhead Lines and Underground Cables which we own and maintain. No matter who you pay your bill to, we're the people to contact if you have a power cut, need a new or upgraded power connection or spot an issue with our equipment.

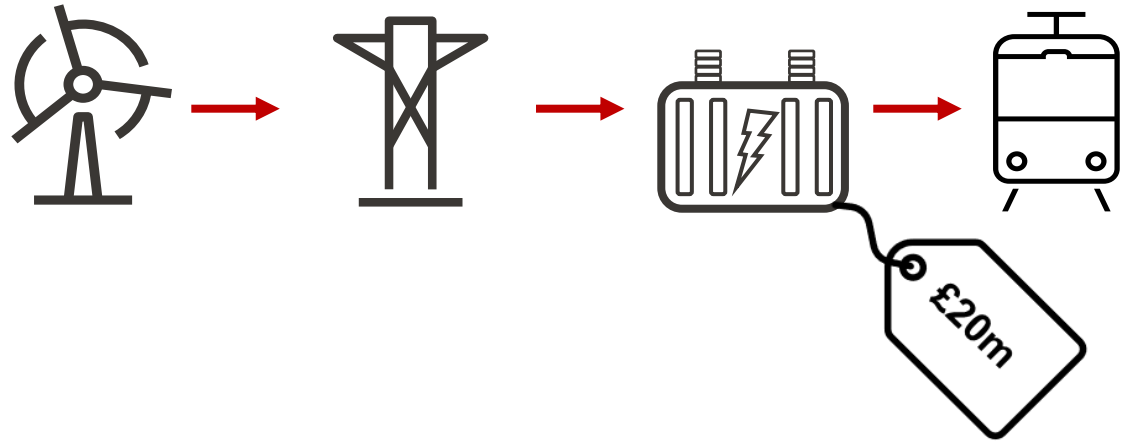
Our three regulated electricity businesses are:

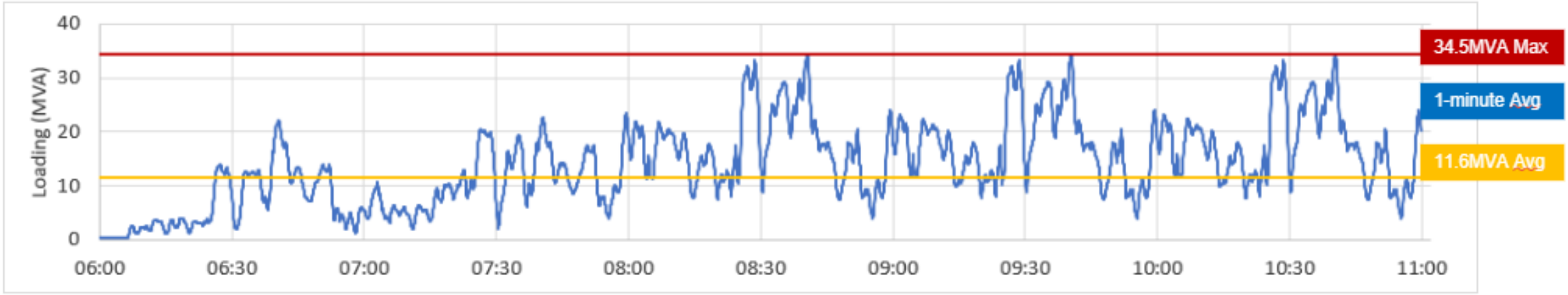
- SP Transmission PLC (SPT)
- SP Distribution PLC (SPD)
- SP Manweb PLC (SPM)



# Problem Statement

- **Network Rail** is the largest electricity consumer in the UK, consuming over ~4TWh annually (1.5m homes)
- "**Inflexible**" – Demand driven by rail timetables
- **Rail Traction Decarbonisation** will necessitate a further 3TWh demand increase over the next 20 years, regardless of whether electric, battery or hydrogen is selected
- **Wind Constraints** – Around 3.5TWh of wind generation is constrained annually, which could bridge this gap
- **New connection lead times** range from 5 to 15 years, and the process is heavily regulated – on both sides



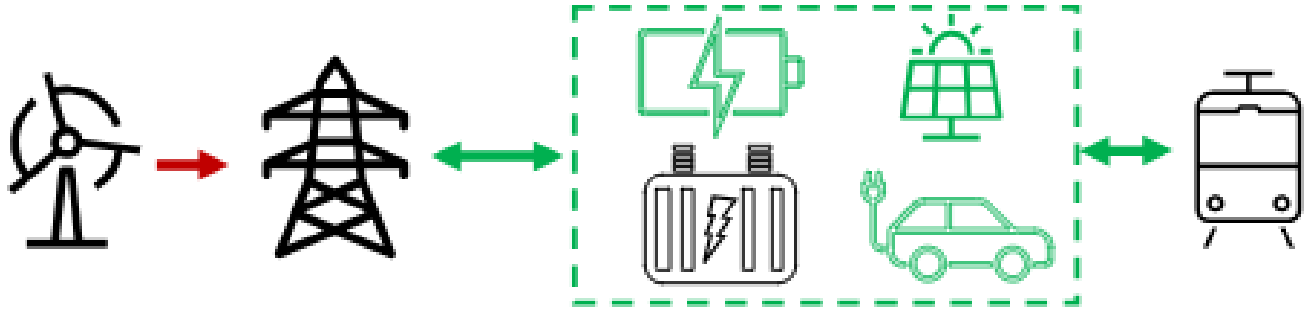
# Solution and Benefits

## The Solution

- First microgrid technology to interface cross-sector with both railway network and power grid,
- Configurable, flexible, controllable

## Use Cases:

- Power quality issue mitigation
- Renewable Wind curtailment reduction
- Flexibility and Ancillary services
- Traction Power Voltage Regulation
- Rail Demand Balancing



### Consumers

- Making GB's largest consumer of electricity 'flexible' reduces constraint payments, avoids network upgrades, and can reduce consumer bills

### Network Operators

- Reinforcement works to cater for future railway demand can be avoided, potential savings for electricity and rail customers

### Railways

- Access flexible tariffs and time-shifting demand reduces NR energy bills
- Smooth the peaky single-phase loads on 25kV networks
- Opens option of large-scale solar PV across the railway network

# Key innovations

- **First microgrid technology to interface with both railway network and power grid**
  - Configurable, flexible, and controllable coupling components, transforming the railway system from the single largest inflexible load to the **single largest flexible demand**.
  - *Local battery storage and optional PV generation will mitigate both average and peak power demand increases, thus helping avoid the need for transmission network reinforcement due to increased railway electrification.*
- **Railway traction network as a conduit for delivering services to the electricity grid**
  - The “reach” of the traction power network gives access to a wide range of low-cost sites for battery storage and solar panel location. The traction power network also reaches regions experiencing significant wind curtailment, where Energy Hubs offer **significant wind curtailment reduction potential**.
- **Digital simulation of the Energy Hubs providing insights into bi-directional power flow**
  - Offering predictive operational control capability, supporting overall system efficiency and resilience. The simulation will be used to specify **optimal Energy Hub configurations** for roll-out.
- **Co-ordinated operation of multiple Energy Hubs via microgrid tertiary control (future roll-out)**
  - Offering potential to deliver a high-capacity distributed, reconfigurable, battery storage service for mitigation of wind curtailment.

# Programme Delivery Overview

| | **SPEN Oversight**<br>Project Management Office, Senior Sponsor, Innovation Board, Executive Board | | Deliverables |
|---|---|---|---|
| WP1 Project Management Coordination | This will be led by SPEN and will be a general task throughout the project to ensure that milestones, deliverables and stage gates are met on time and to standard. | SP Transmission | • Annual Reports<br>• Final Report |
| WP2 Design, Innovation and Simulation | To finalise the demonstrator Hub design, develop and validate a digital Hub model, and simulate further Hub Use-Cases | University of Leeds | • Technical Design Report<br>• Final Outcomes and Conclusions Report |
| WP3 Design and Build | To design the civil elements of the compound, hub power module and 25kV interface works; and build the Hub on-site | Network Rail | • Integrated AFC (Approved for Construction) design pack<br>• Completion of Hub construction |
| WP4 Hub integration and operation with the Railway | To develop Hubs' scope for testing and complete site trial with analysis feeding into output report from live trial. | Network Rail | • Safety, Assurance Strategy<br>• Entry into Service<br>• Safety Assessment Report<br>• Provide output/results of trial |
| WP5 Knowledge capture, dissemination and stakeholder engagement | Ensuring key outputs from the project are recorded and shared with the wider energy and rail industries. | SP Transmission | • Stakeholder mapping and dissemination plan |
| WP6 Commercial model, regulatory framework and rollout to BAU transition | Development of a commercialisation model for Hubs' rollout. Refining definitions throughout the project utilising project dissemination. Final models of CBA and Rollout | SP Transmission | • First definition of commercialisation and rollout<br>• Final CBA and Rollout Model<br>• Outlined BAU Transition |

# Business Case

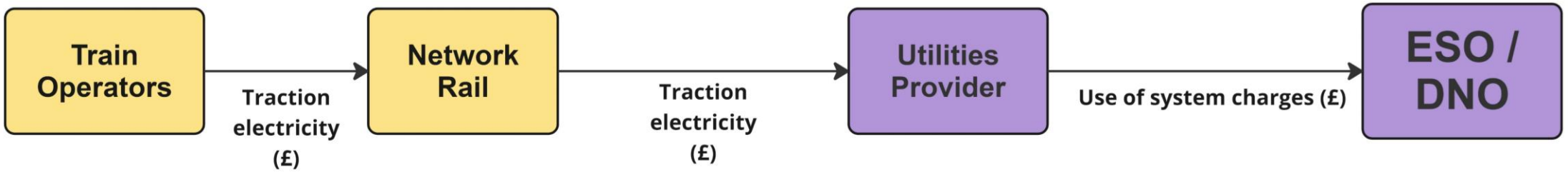
SIF Challenge
"Accelerating decarbonisation of major energy demands"

**Services to the railway**

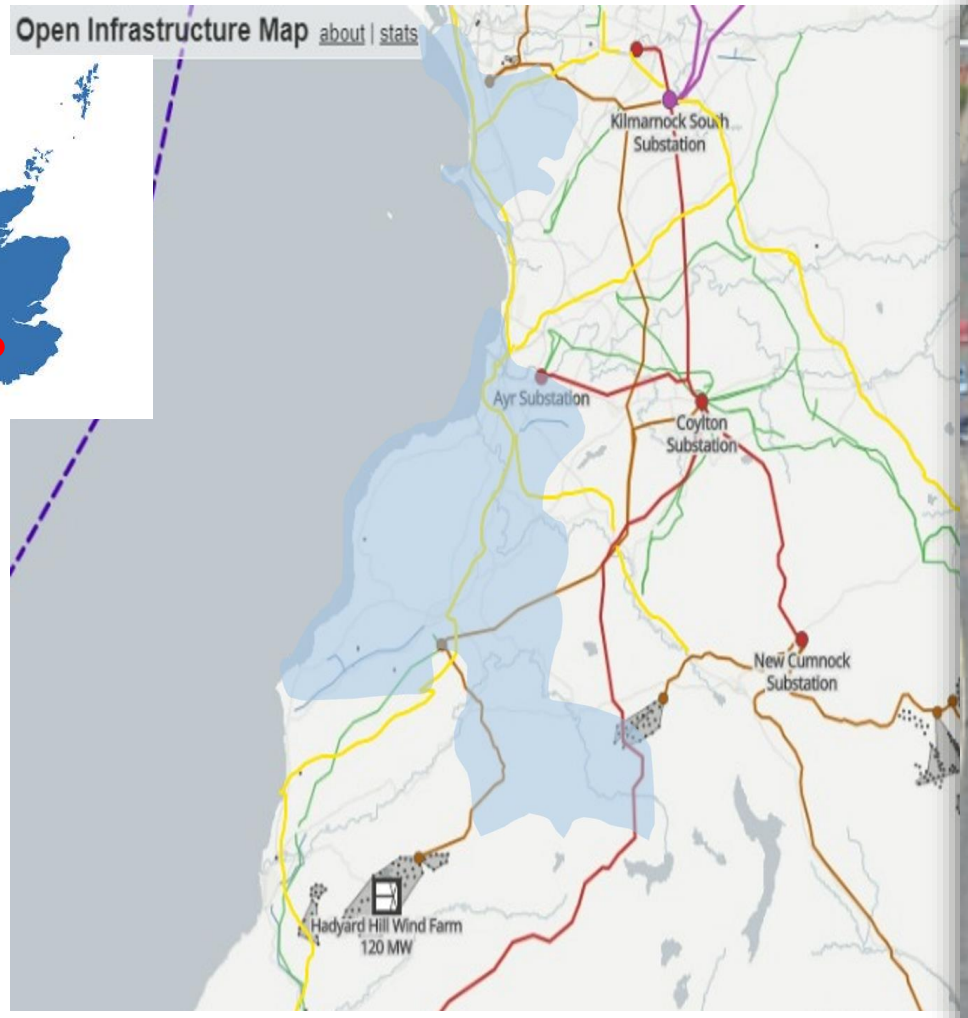
- Use of stored energy from overnight and solar PV
- Traction voltage regulation for electrified routes
- Non-traction power for stations and depots
- Backup power supply for rail depots
- Battery train charging for non-electrified routes

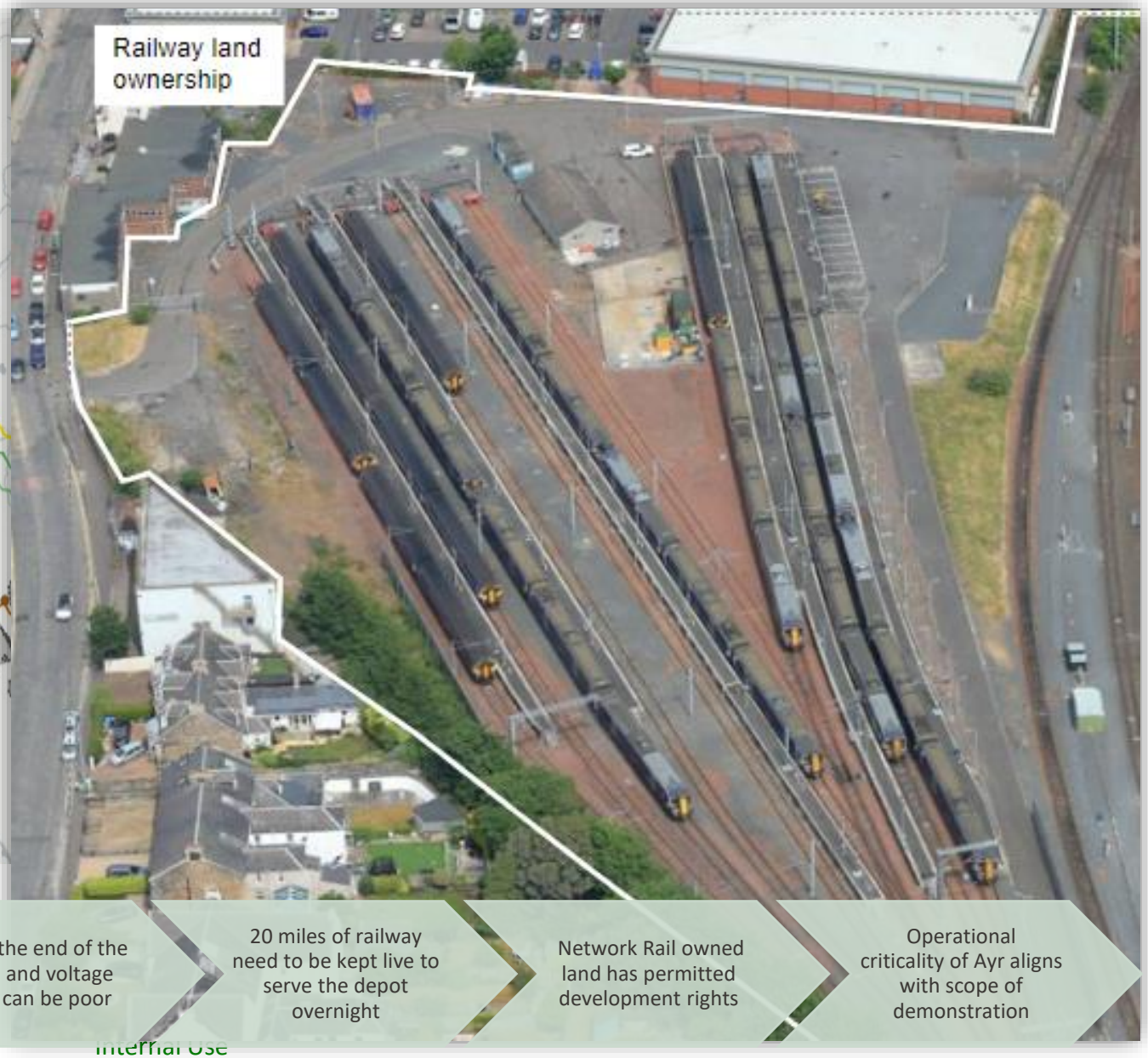
**Services to the electricity grid**

- Mitigate wind curtailment
- Demand side (load balancing) services
- Grid frequency stability services
- Grid voltage regulation services



# Beta Demonstration – Ayr EMU Depot



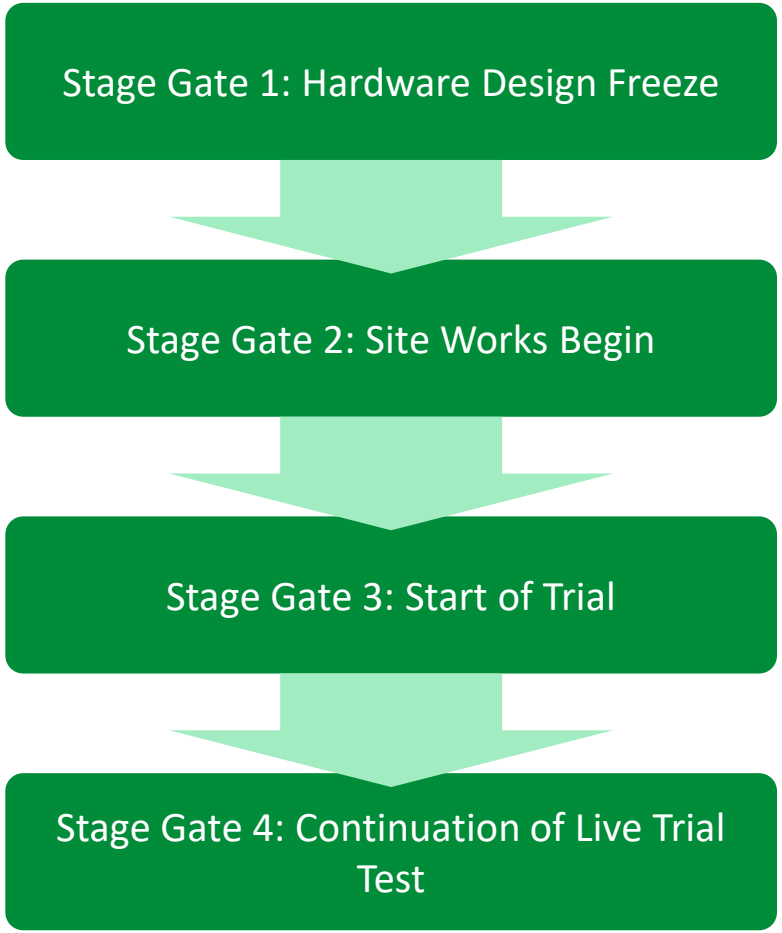




**"Beta" selection criteria**

- Constrained area of the electricity grid where SPEN are tendering flexibility
- Ayr is at the end of the rail line and voltage quality can be poor
- 20 miles of railway need to be kept live to serve the depot overnight
- Network Rail owned land has permitted development rights
- Operational criticality of Ayr aligns with scope of demonstration

# Ensuring successful delivery

***"De-risked through addition of stage gates"***




## Criteria

- Finalised specification of key equipment,
- Set approval criteria from Network Rail acceptance panel,
- Engage ORR regulation on trial acceptance criteria

- Site surveys completed
- Permitted Development confirmed
- Equipment delivered to the site

- Build on site complete
- System fully commissioned
- Testing scope defined

- Option of shortening the trial period if all the testing objectives are met ahead of schedule

# Conclusion

The Rail and Energy Networks require significant collaboration to ensure full decarbonisation.

Hubs has the potential to deliver significant value to electricity and rail customers and operators, the Strategic Innovation Fund and the wider Industry

Hubs has the potential to advance the ongoing collaboration between rail and energy, collectively minimising the impact of rail decarbonisation on the transmission network

SPEN and the project partners are fully committed to this project and willing to commit considerable resources to ensure its successful delivery.