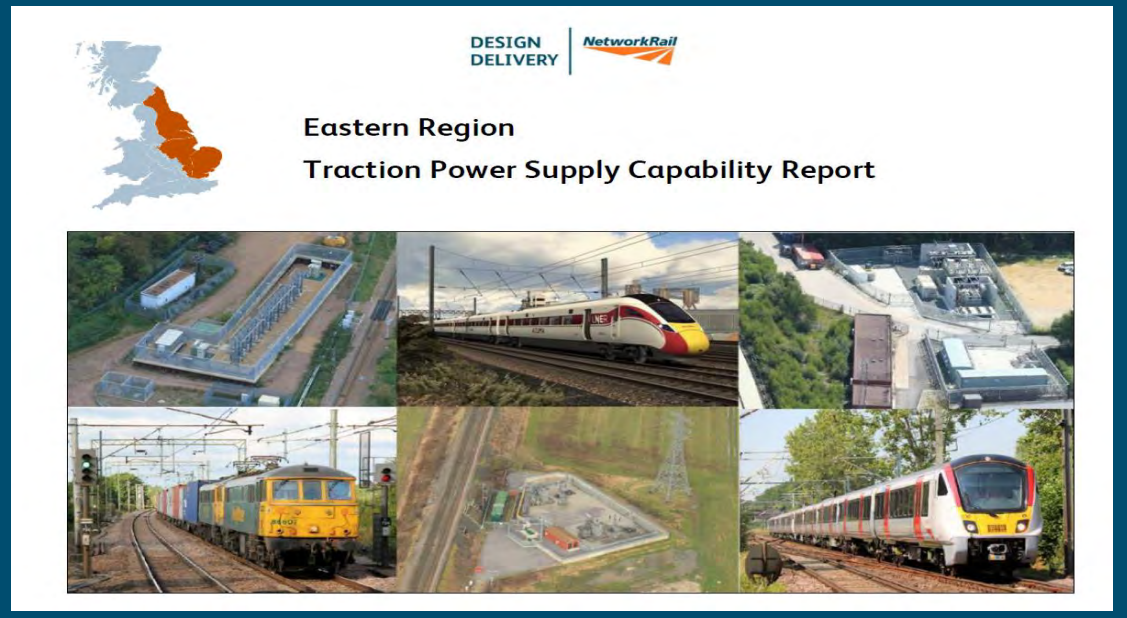
Building a regional traction power strategy approach

Moving from minimal viable product to strategic viable product

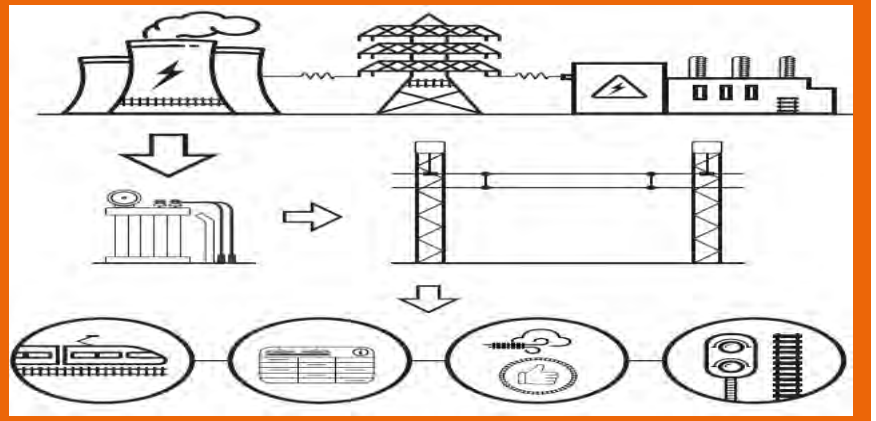


A presentation on traction power strategy in Network Rail's Eastern Region

A case study in working with specialist traction power engineering and modelling teams in Route Service's Network Rail Design Delivery (NRDD) team to develop a high-level long-term strategy, based on technical principles, based on a partnership between the Eastern regional asset management, regional functions, Routes and long-term strategy.

Aims today

1. Introductions to Kaitlyn Mair and Tom Ingrey
2. Setting the scene: need for a regional strategy (Tom)
3. Building the strategy and mindset shift (Kaitlyn)
4. Summarising the methodology and technical outputs (Kaitlyn)
5. Summarising the strategy and headlines (Tom)
6. Conclusions



Eastern Region - Industry Strategy

Eastern industry strategy team

- Part of the regional finance directorate.
- Developing strategic principles for long-term regional strategy;
- Providing regional input to the GBR transition team long term strategy for rail;
- Managing regional investment pipeline and prospectus;
- Producing regional strategic advice across industry themes.

Our vision, themes, and principles

Our vision:

A company that is on the side of passengers and freight users; that is easy to engage with and a dependable partner; a company people are proud to work for; instinctively recognised as the industry leader.

Our themes and principles:

Cost and efficiency
- Cost all our investment programmes on a whole life basis
- Deliver better value for our customers and the taxpayer by working with the wider industry as 'one team'
- Maximise opportunities for cost savings through the SPEED initiative

Customer experience
- Create a more consistent high-quality rail offer across the network
- Deliver better value for our customers by using resources more effectively

Infrastructure, enhancements, and renewals
- Deliver enhancements through renewals
- Modernise our approach to infrastructure management
- Build longevity, resilience, and flexibility into our infrastructure

Rolling stock
- Innovative rolling stock
- Unified fleet management

Timetable development and performance
- Improve connectivity through a 'Hub & Spoke' service structure
- A more intelligent and resilient timetable for our passengers and freight users

Partnerships
- Work more collaboratively for improved operational outcomes
- Establish partnerships that further the region's strategic interests
- Establish partnerships that encourage more investment in the rail network

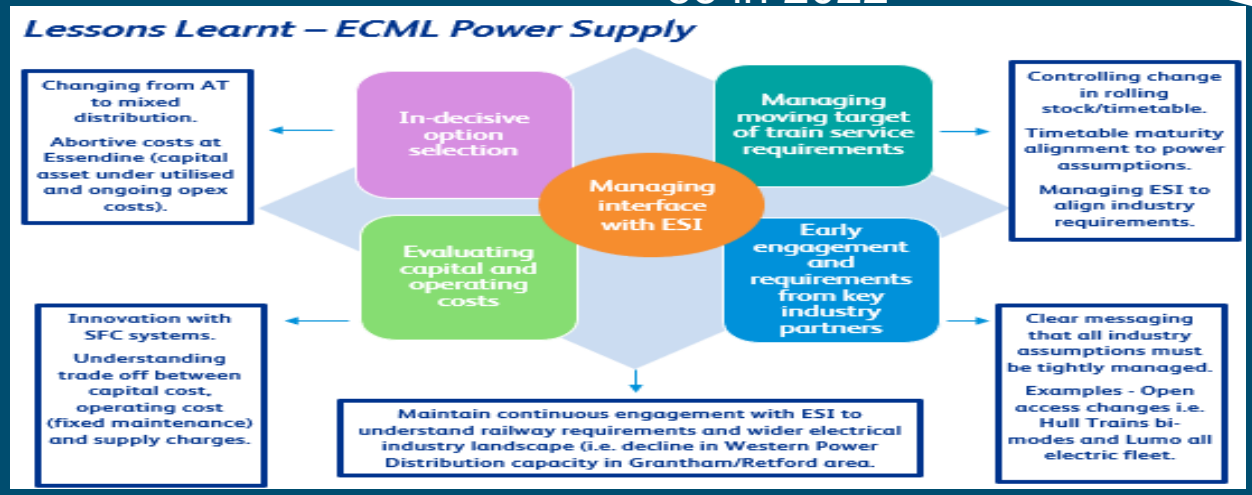
Safety
- Create a safer working environment
- Promote an open and honest health and safety culture
- Empower teams to put employee health and wellbeing first

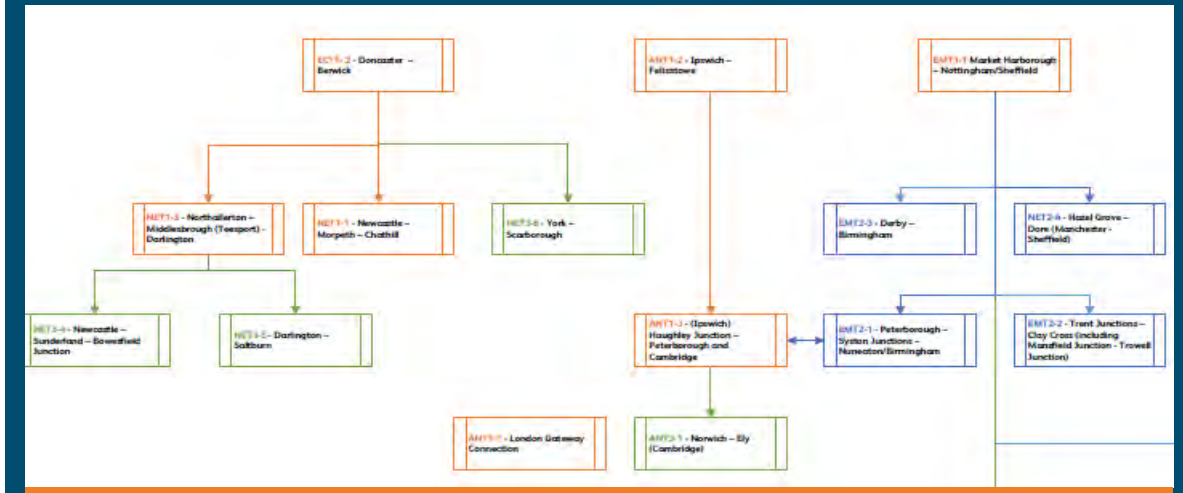
Sustainability and decarbonisation
- Introduce new lineside initiatives to improve biodiversity
- Minimise our use of fossil fuels to deliver a low emission railway
- Develop the railway to be resilient to climate change
- Reduce the amount of waste we produce by using materials more sustainability

Freight
- Support the freight market through improved capacity and capability
- Deconflict passenger and freight services
- Deliver an integrated freight estate

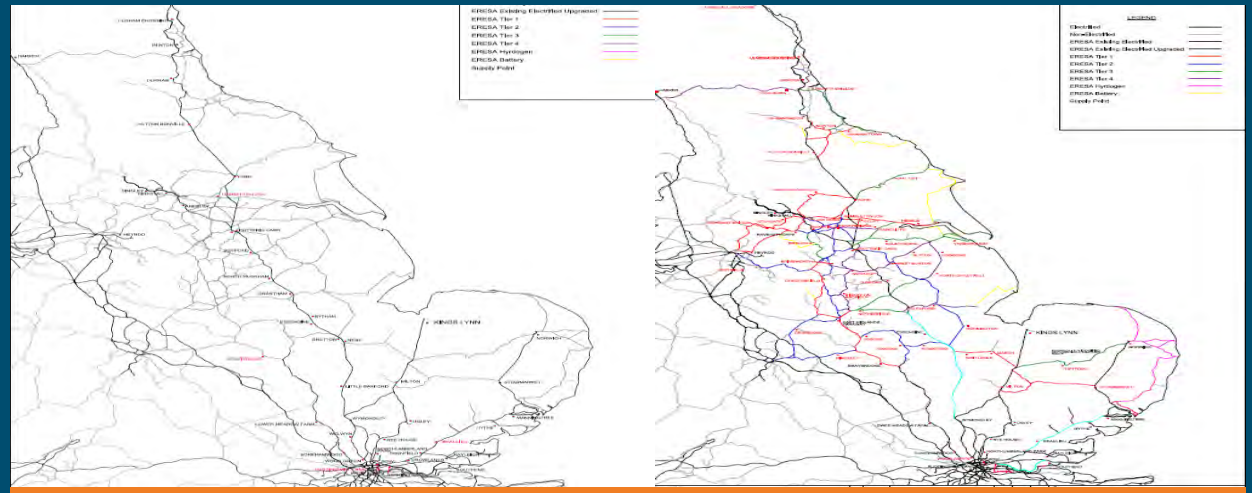
Traction Power Strategy - summary

32 Trains in 1991 – 85 in 2022





The above image represents the case for taking a strategic perspective in all traction power scoping decisions, accounting for the electrical system interrelationship with anticipated later phases of electrification to support UK govt net zero 2050 policy.



From a base of 46 power supplies today (middle image above), 35-38 new traction power supplies are required across the Eastern Region, in addition to capacity upgrades to a further 15 current supplies (image to the right above).

Case for change

- It should never be assumed that just because a route is already electrified, that it can power a given increase in electric services. Each timetable change can impact the power-draw required at specific locations due to the times trains pass in both directions.
- Historic power supply infrastructure may be decades old, and built for lower power-drawing trains or fewer services.
- Also recent interventions and upgrades may be specified to only give the minimum required increase for specific services
- Industry access rights processes are not designed to allocate rail capacity based on power supply constraints.
- BI-Mode technology, the purchase of new electric rolling stock and availability of cascaded rolling stock is allowing operators to switch existing diesel services to electric operation
- Potential increased electric freight and the future of freight on the railway increases loading
- Future rolling stock energy consumption efficiencies (such as regenerative braking improvements) are uncertain.
- Traction power requirements were typically based on a specific scheme or timetable – historically not including the headroom and flexibility for a changing railway.
- Changes in timetable, electric rolling stock and changing status of enhancements have not been integrated
- Changes in Electric Rolling Stock, service patterns and infrastructure are prevalent on all 4 routes of Eastern Region

Today – Understanding the impact of specific timetable changes on power supply, joining up traction power capability with train services to optimise power supply and identifying any non-compliances. Managing day to day service changes that affect traction power.

Tomorrow – Primacy given to power supply modelling as part of enhancements development to support fleet transitions, new electrification, provide resilience and unlock further opportunities in the future. Joined up approach to asset renewal. Aim to is allow incremental supply increases.

Future – A long term Eastern Traction Power Strategy to allow collaborative working with Electricity Supply Industry. Clarity on future connection requirements building on the National Traction Decarbonisation Network Strategy and Eastern's phased Electrification Strategic Advice timeline.

Traction Power Strategy – and beyond…

National policy (Net-Zero) and railway industry strategy (TDNS)

Eastern Region
Electrification Strategic Advice

Strategic Framework

Eastern Region
Traction Power Strategy

RNEP &
Investment
Directorate

Operating Model

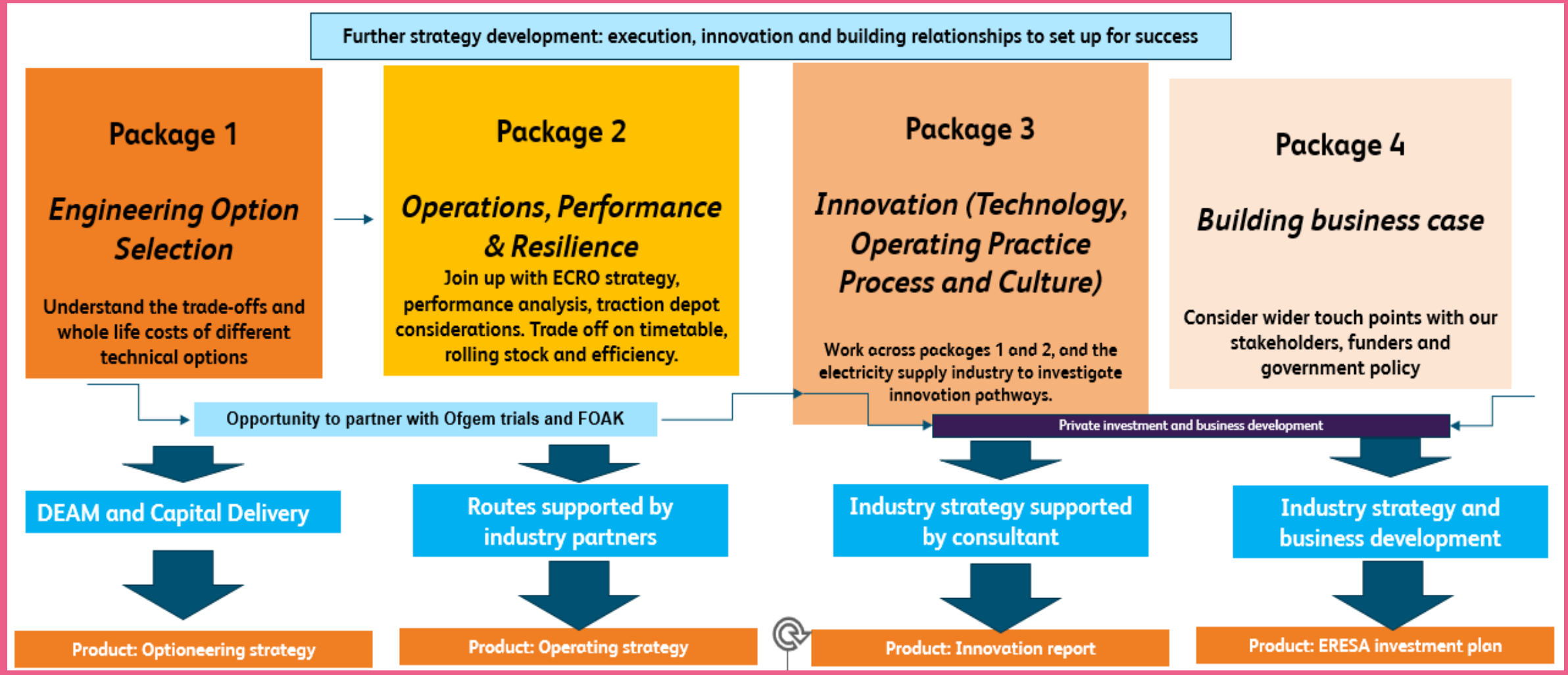
Traction Power Management Steering Group

Embedding BAU
and regional
plans

Instinctive industry leader: Continuous improvement

Further strategy development: execution, innovation and building relationships to set up for success

Further areas for study



Who am I?

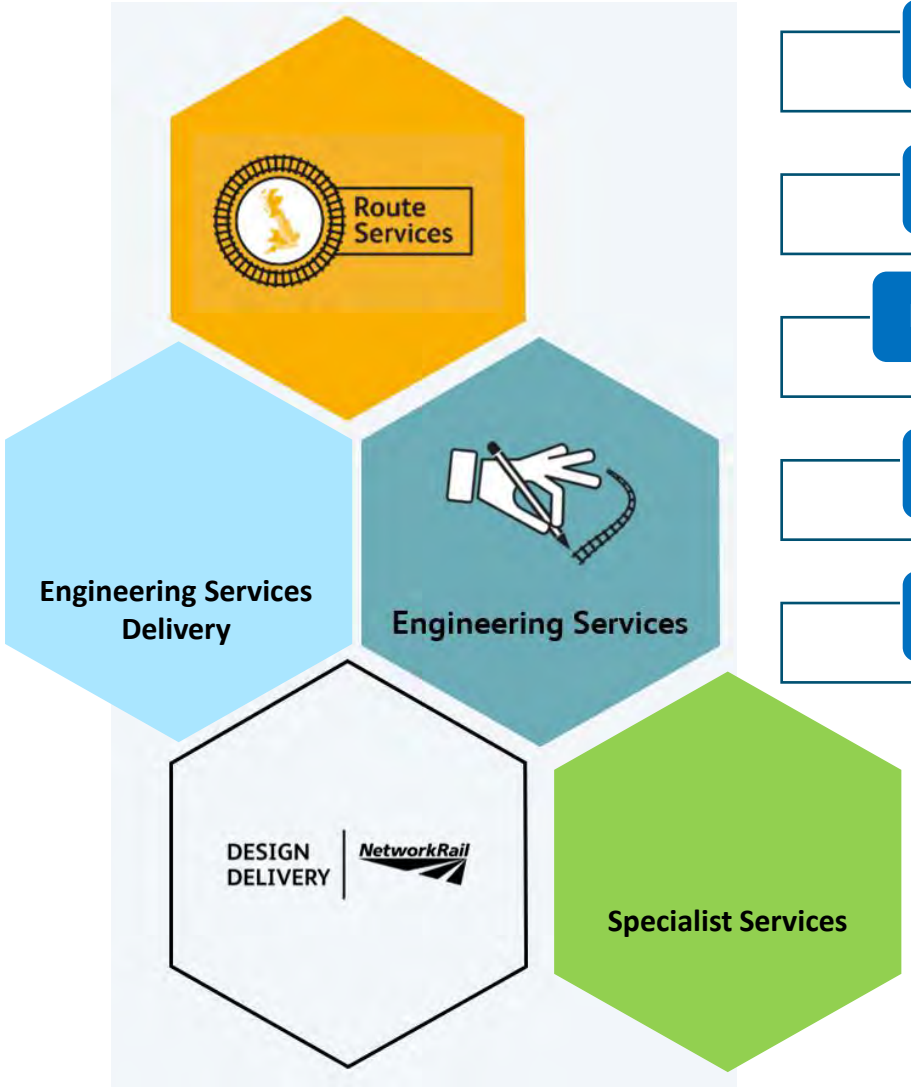
Kaitlyn Mair

Principal Design Engineer – Traction Power

Worked with NR for 15 years, nearly always doing Traction Power Design.

Engineering Services

We deliver multi-disciplinary design services and technical support



- Specialist Engineering and Consultancy – Innovation and technology development
- Design (early concept to detail)
- Project and Engineering Management
- System Modelling, Analysis and Engineering
- Testing and Commissioning

How to make a Regional Power Strategy?

1. Assumptions, lots of assumptions!
    - HS2 to Leeds and North
    - Northern Powerhouse rail
    - Passenger service growth
    - Freight Modal Shift
    - East West Rail
    - Crossrail 2
    - Rolling stock!!!!!
        - Hydrogen – a bit but not much
        - Battery Trains
2. We needed to shift mindsets
3. We needed to approach the problem from as if it were a blank canvas and ignore existing constraints

Mindset Shift

A successful strategy needs a mindset

- Normally to do traction power modelling we want
    - An exact timetable
    - All the rolling stock details:- Weight, Length, Power, Rolling resistance, Speed……..
    - Locations and electrical details of all feeder stations, conductors, sections locations ……
- Needed a flexible and adaptive otherwise we'd take years to answer the question and it wouldn't work as soon as something changed

NOT GOING TO WORK

A Blank Canvas Approach

What could we do differently?

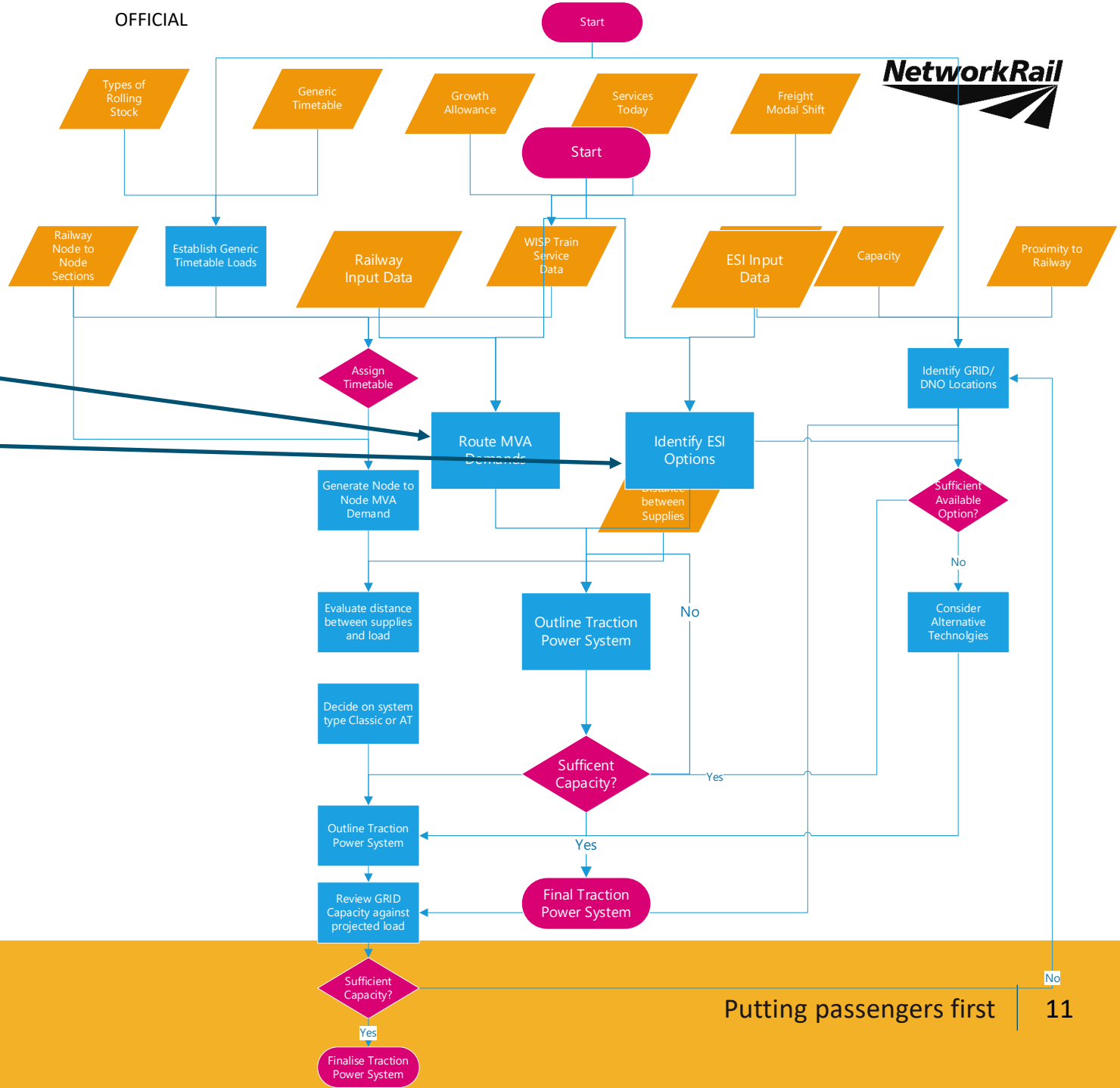
- High fault current classic systems
- Alternative traction supplies – Scott/ Le-Blanc Transformers
- Lineside Energy Storage
- HV Links

Lots of ideas for the R&D pot but actually as far as we are concerned, a **technology agnostic approach** was the best as it leaves all paths available

From A → B

We needed to consider two main questions:-

- How Much Power Do we need?
- Where can we get the power from?



From A → B – Part 1

How much Power do we need?

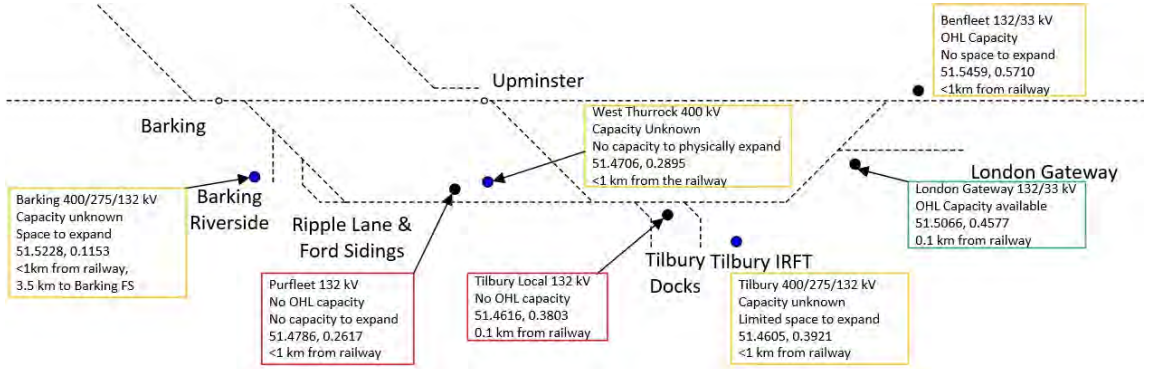
- We developed 14 Generic timetable scenarios and modelled them to develop load per km
- Battery Trains = double the power of a standard electric train
- Eastern route broken down into 222 route segments
    - Junction to Junction or station to junction etc
- Used long term planning data for 2050 to match each route section to a timetable scenario

Scenario	Route characterisation	Commuter		Inter Urban		LDHS	Freight		RTK Load (MVA)
		TPH	Length	TPH	Length	TPH	TPH	Weight	
Very High	Inner Inter-Urban with LDHS	8	12	6	12	6	1	1800	1.52
Very High + Freight	Very High + Additional Freight	8	12	6	12	6	2	2400	1.56
High	High Outer Inter-Urban with LDHS	4	12	4	10	6	1	1800	0.99
High + Freight	High + Additional Freight	4	12	4	10	6	2	2400	1.05
Medium High	Inner Inter-Urban with LDHS + Freight	6	10	4	12	2	1	1800	0.94
Medium	Commuter with Inter-Urban + Freight	4	12	2	12		1	1800	0.63
Medium/Low	Commuter + Freight	4	8				2	2400	0.43
Long Distance	Primarily long-distance services					4	1	1800	0.37
Low	Locals + Freight	4	8				1	1800	0.33
Very Low	Rural	2	8						0.1
Heavy Freight	Heavy Freight + Locals	2	8				4	2400	0.5
Very Heavy Freight	Very Heavy Freight + Locals	2	8				4	3000	0.59
Freight Only	Freight						2	2400	0.16
Very Low + Freight	Locals + Low Freight	2	8				0.5	2400	0.28

From A → B – Part 1

Where can we get power from?

- Electrical Supply Industry
  - Proximity to the railway
  - Available Capacity / Voltage Level
  - Land Availability
  - Red Amber Green assessment on the above
- Options when there's no viable ESI connection?
  - Traction Alternatives
    - Batteries
    - Hydrogen
    - Bi-Mode
  - Embedded Generation/ Lineside Energy storage



Standard Design Principles

Considerations

- Route Independence
    - Primary Routes to have direct connection to ESI
    - Secondary routes direct supply from ESI or a primary route
- Minimum of N-1 Redundancy
- Autotransformer is the system of choice for high power routes
- Idealised electrical sectioning
- 12 kA Fault levels & no Booster Transformers!
- Maximum BEMU journey of 100 km round trip

Supply type	Capacity	Feeding distances from Feeder Station
132 kV Single Phase	10 – 20 mega-volt amps (MVA)	25 – 30 km
33 – 132 kV Three Phase (SFC) in island mode	20 – 100 MVA	~40 km
275/400 kV Single Phase (Classic)	20 – 40 MVA	30 – 40 km
275/400 kV Single Phase (AT)	40 – 100 MVA	50 – 60 km

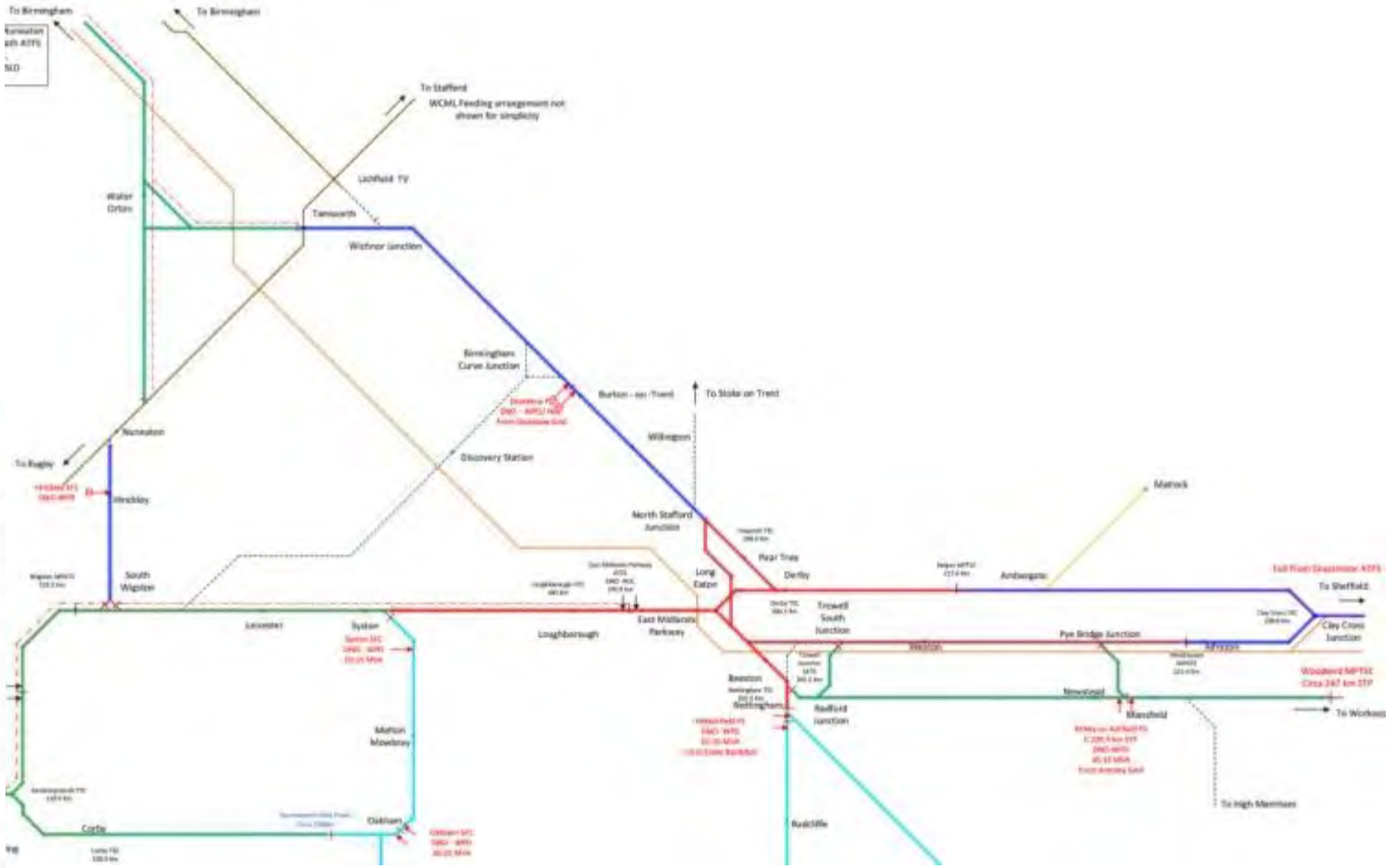
Exclusions

- No consideration of battery charging at terminus stations

An engineers outputs

- Single Line Diagrams for four routes
  - Anglia, East Coast & East Midlands South, Yorkshire & North East
- Projected loads every 10 years
- Feeder station locations
- System types

North East SLD			
Option: Scenario B			
Substation	DNO	Status	Future Load
York	NGC	Existing - Upgrade	42.72
Hutton Bonville	NPG	Existing - Upgrade	33.90
Spennymoor	NGC	New	27.85
Benton	NPG	Existing - Upgrade	18.82
Marshal Meadows	SPEN	Existing	19.54
Ulgham Crossing	NPG	Existing - Upgrade	11.95
Hexham	NPG	New	11.09
South Shields	NGC	New	10.15
Norton	NGC	New	8.72
Bowesfield	NPG	New	29.08
Harker	NGC	Existing	3.81
Durham	NPG	Redundant	

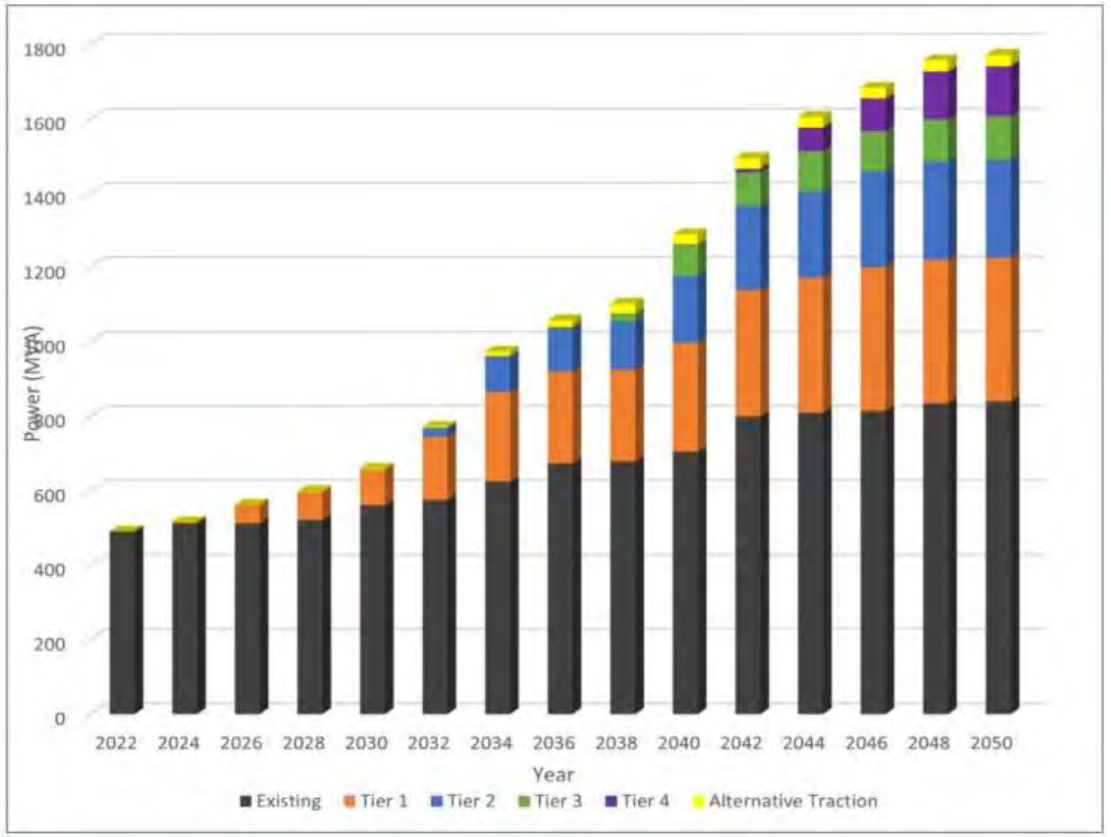


Route Services

A strategic planners outputs

		Status of supplies	No. of supplies	No. of TNO	No. of DNO	Power Demand (MVA)	Total Power Demand (MVA)
SCENARIO A	Option 1	Existing	15	6	10	422	1670
		Existing - Upgrade	15	3	12	502	
		New	37	12/14	23/25	746	
		Redundant	15	0	15	0	
	Option 2	Existing	20	7	13	448	1676
		Existing - Upgrade	14	2	12	430	
		New	36	9/11	25/27	798	
		Redundant	12	0	12	0	

	Total electrified (km)	Power supply demand FSC – MVA5	Power supply demand % increase
Electrified route miles today 2022	1577	554	-
Electrified route miles by 2050	3747	1695.5	312%
Battery power route miles by 2050	280	33.5	-



How have those assumptions survived?

- HS2 to Leeds and North - Only to East Midlands Parkway

- Northern Powerhouse rail - Merged into IRP
- Passenger service growth - Growing but not necessarily in the old peaks
- Freight Modal Shift - Lets see what Julian has to say
- East West Rail - Not planned to be electrified at present
- Crossrail 2 - Development Paused
- Rolling stock!!!!! - GBRTT Rolling Stock strategy in development
  - Hydrogen – a bit but not much
  - Battery Trains

Conclusions

Next steps

1. Annual Traction Power Statements
2. Industry integration – fleet and infrastructure
3. Alignment and integration with current programmes
4. Innovation - Further research and development looking at how can we minimise the need to upgrade the existing network?
    - How to integrate BEMUs into a traction power network
    - Lineside energy storage to manage peaks – dynamic power management
    - Integrating live network data into ECTS/Traffic Management

Final Thought

A strategy is a blueprint of a vision from a point in time, circumstances change and we need to adapt with them

everyone
home safe
every day