NetworkRail

Network RUS Electrification 'Refresh'

Working Group 4
16 January 2015

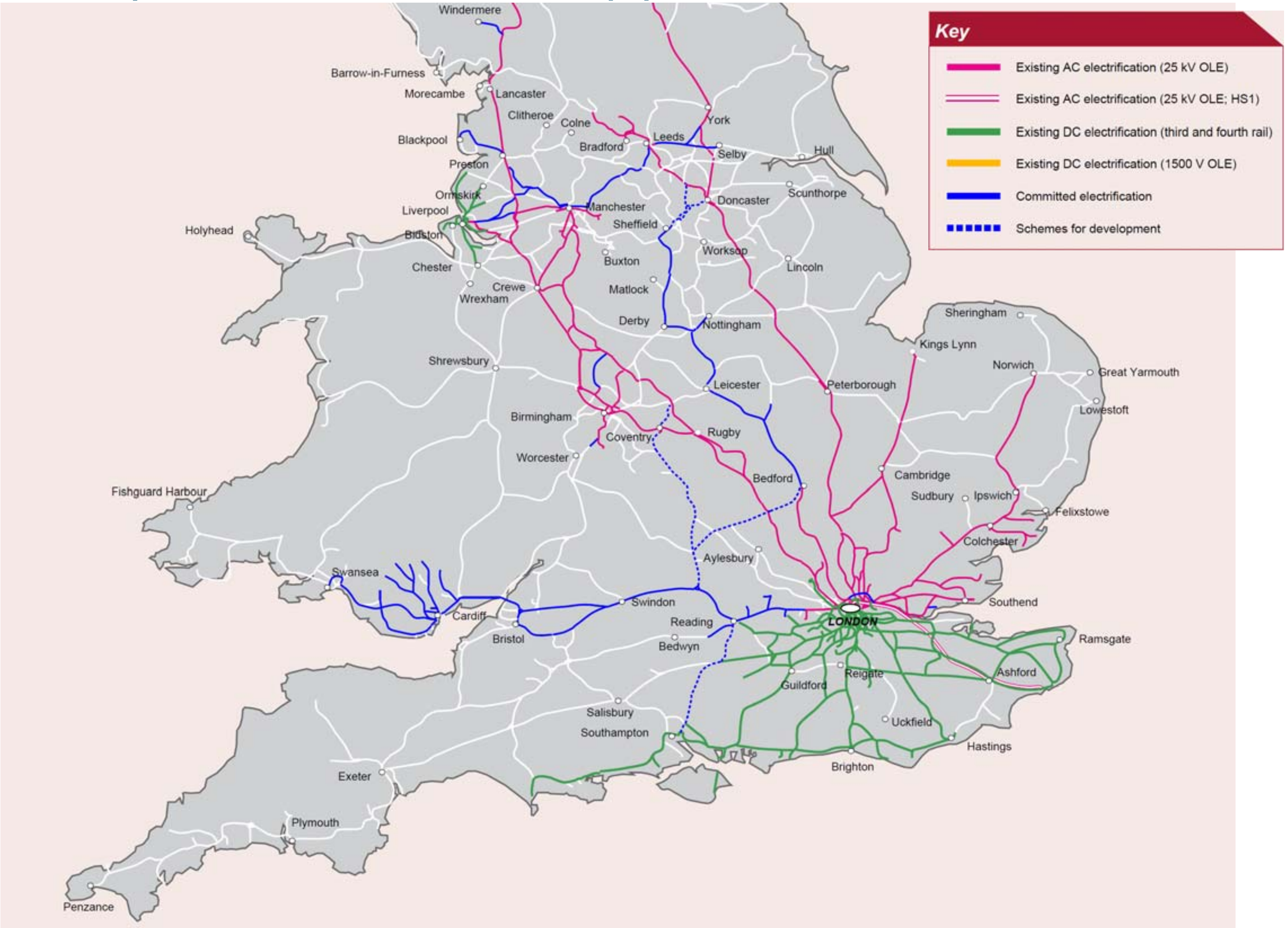
Agenda

- Introduction
- Baseline
- Drivers of Change
- Gaps
- Options
- Next steps

Baseline

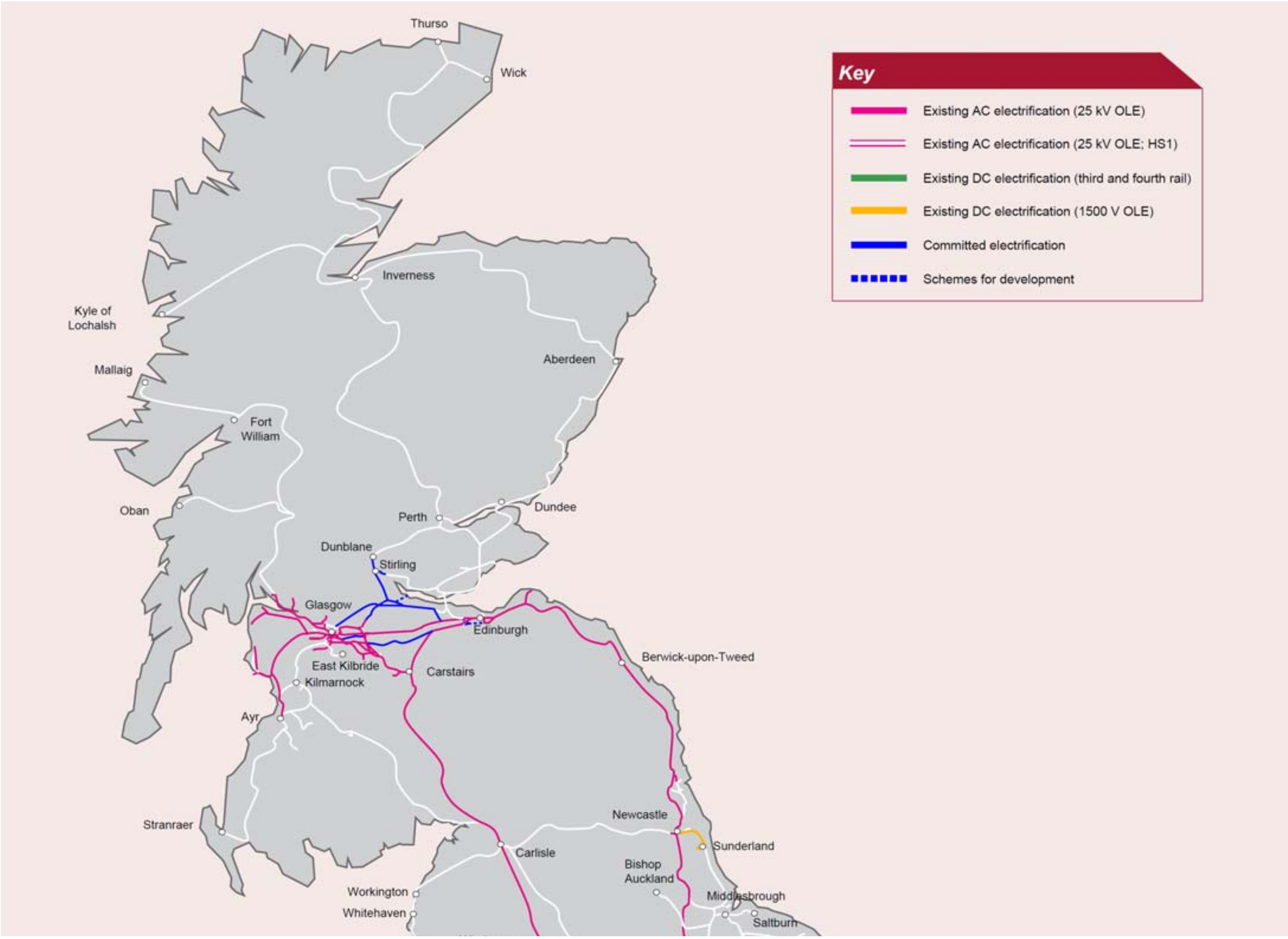
Baseline

Current and planned electrification (S)



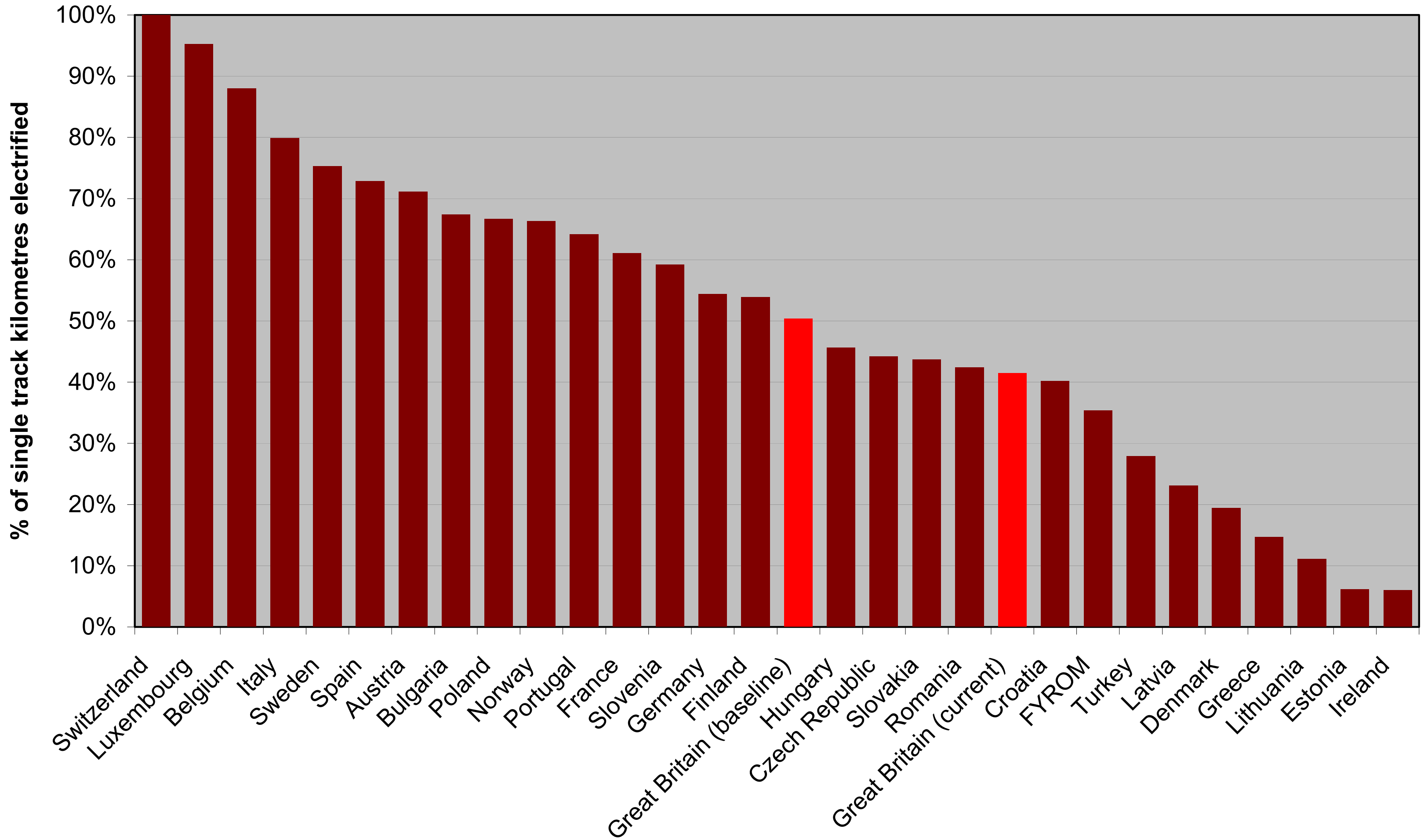
Baseline

Current and planned electrification (N)



Baseline

International comparisons



Drivers of change

Drivers of Change

Passenger diesel services

- Improving affordability and value for money by:
  - Reducing rolling stock operating costs
  - Improving rolling stock reliability
- Enhancing capacity and connectivity by:
  - Reducing journey times
  - Providing more capacity for unelectrified routes
  - Improving network availability
- Reducing environmental impacts through:
  - Lower emissions
  - Reduced noise
  - Compliance with environmental policy legislation
- Alternative approaches deliver benefits with lower costs
  - Low cost electrification using conventional electric rolling stock
  - Discrete / discontinuous OHL with onboard independent traction

Drivers of Change

Freight diesel services

- Enhancing capacity and connectivity by:
  - Allowing greater trailing weights with less speed penalty and shorter journey times
  - Releasing capacity for other services
- Improving affordability and value for money by:
  - Reduced locomotive requirement arising from journey time savings
  - Shorter routings
  - Reducing FOC operating costs
- Subject to the following enabling factors:
  - New electric locomotives
  - Investment in terminals to accept electrically hauled longer intermodal trains
  - Investment in new electrification infrastructure, including power supply strengthening on existing electrified routes

Drivers of Change

Existing DC routes

- Enhancing workforce and public safety
- Improving affordability and value for money by:
  - Reducing infrastructure maintenance and renewals costs
  - Reducing infrastructure operating costs
  - Reducing losses of power in transmission
  - Enhancing infrastructure reliability and resilience
- Enhancing capacity and connectivity by:
  - Increasing infrastructure capacity through higher levels of installed traction power
  - Reducing journey times through better acceleration
- Subject to costs of:
  - Infrastructure conversion
  - Rolling stock conversion

Drivers of Change

Existing AC routes

- Further electrification is likely to increase the usage of the existing electrified network in terms of:
  - Additional rolling stock movements on the existing network
  - The usage of existing National Grid supply points to provide power for newly electrified routes
- Additional services may require an upgrade to the existing supply in order to support both current and future demand

Gaps

Gaps

Gap types

- Gaps between the baseline and a future network which could exploit the benefits of modern AC electrification can be identified in 3 key areas:
  - Unelectrified sections of the network
  - Sections of the network equipped with third rail DC electrification which could be converted to AC overhead
  - Sections of the network already equipped with overhead AC electrification for which renewal or enhancement might be justified

Options

Options

Matrix of gaps and options

	Option →							
	Voltage	AC OHL	AC OHL	DC third rail	AC OHL	AC OHL	DC third rail	Unelectrified
	Continuity	Continuous	Continuous	Continuous	Discrete	Discrete	Discrete	-
	Contact system / clearances	GB Master Series	Lower specification	Conventional	GB Master Series	Lower specification	Conventional	-
	Rolling stock	AC	AC	DC	IPEMU	IPEMU	IPEMU	IPEMU
Gap ↓	**Unelectrified**	✓	✓	✓	✓	✓	✓	✓
	Existing DC	✓	✓	✓	✓	✓	-	-
	Existing AC	✓	-	-	-	-	-	-

Options

Drivers and assessment criteria

Strategic goal	Supported by selecting options which ensure	Assessed by	
Improving affordability and value for money	Maximum value for money for passenger and freight operators	A	Passenger and freight 'Conversion ratio'
	More efficient deployment of diesel traction	B	Reduction in diesel passenger traffic on the existing electrified network
		C	Passenger diesel island fleets targeted
Enhancing capacity and connectivity	Exploitation of synergies with passenger rolling stock procurement	D	Diesel passenger vehicles released for cascade to unelectrified routes, adjusted for age
	Improved network availability	E	Passenger diversionary route capability
Reducing environmental impacts	Impacts not route-specific		

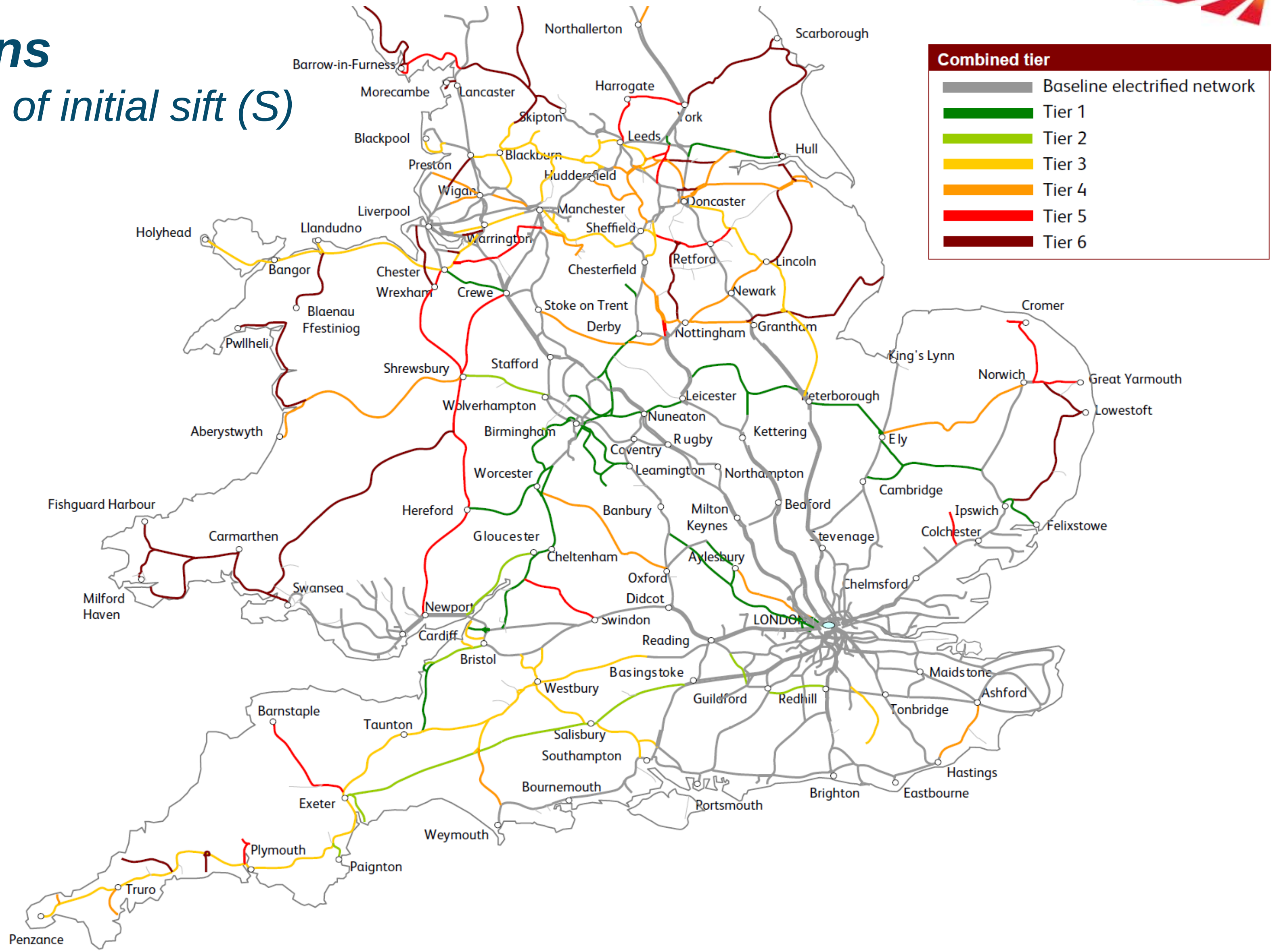
Options

The initial sift

- Key measure of likely business case is traffic converted to length of route electrified (the ‘conversion ratio’)
- For each remaining diesel passenger service and intermodal freight flow (following completion of committed projects) calculate the length of electrification required for it to convert to electric
- Look at where service groups overlap and combine options where the conversion ratio can be improved (with a limit on option size)
- Consider requirements for diversionary routes, and add these to the most appropriate options
- Order the options by their conversion ratio, and consider how the case for each would be affected by the earlier higher-priority schemes

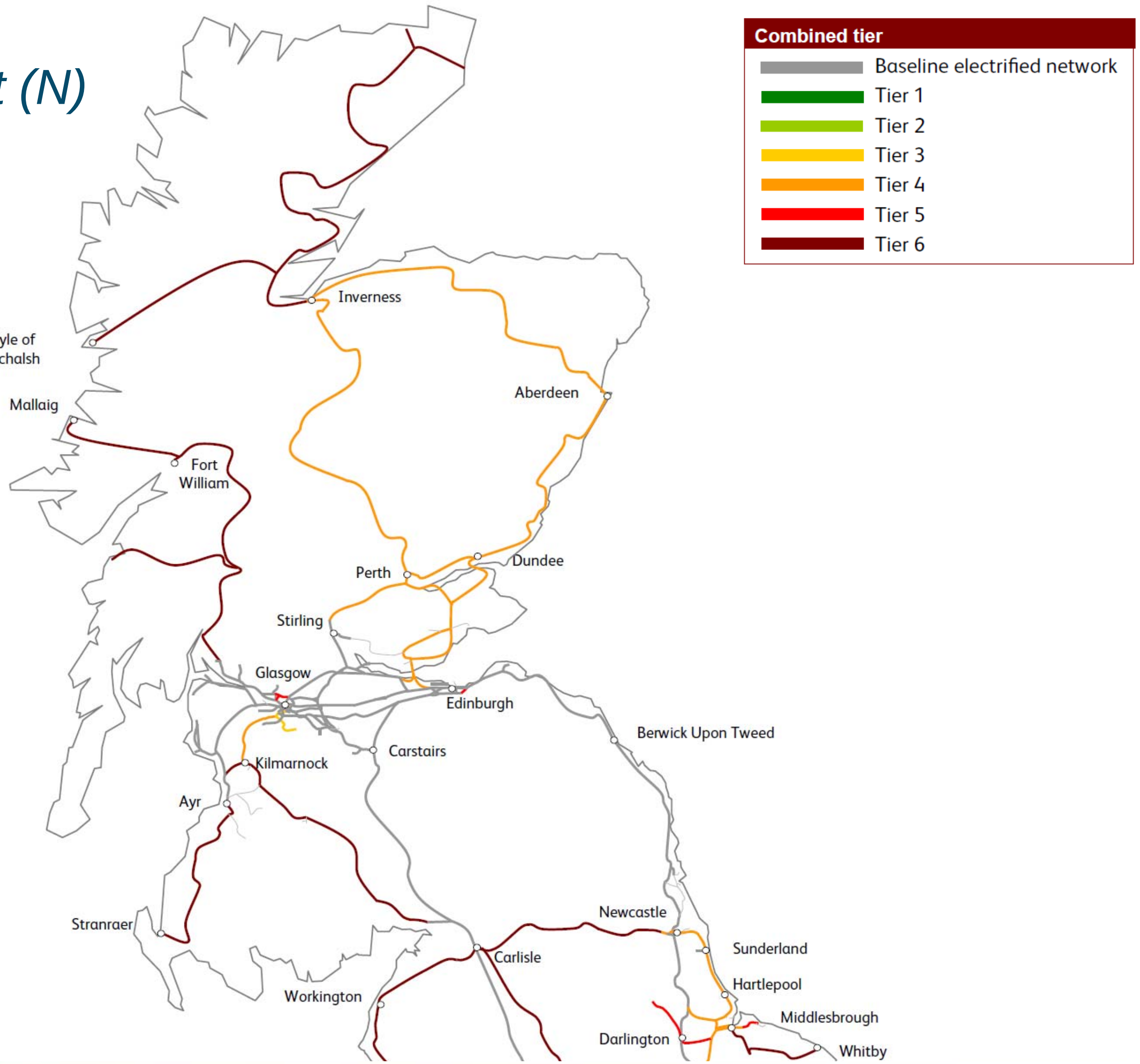
Options

Results of initial sift (S)



Options

Results of initial sift (N)



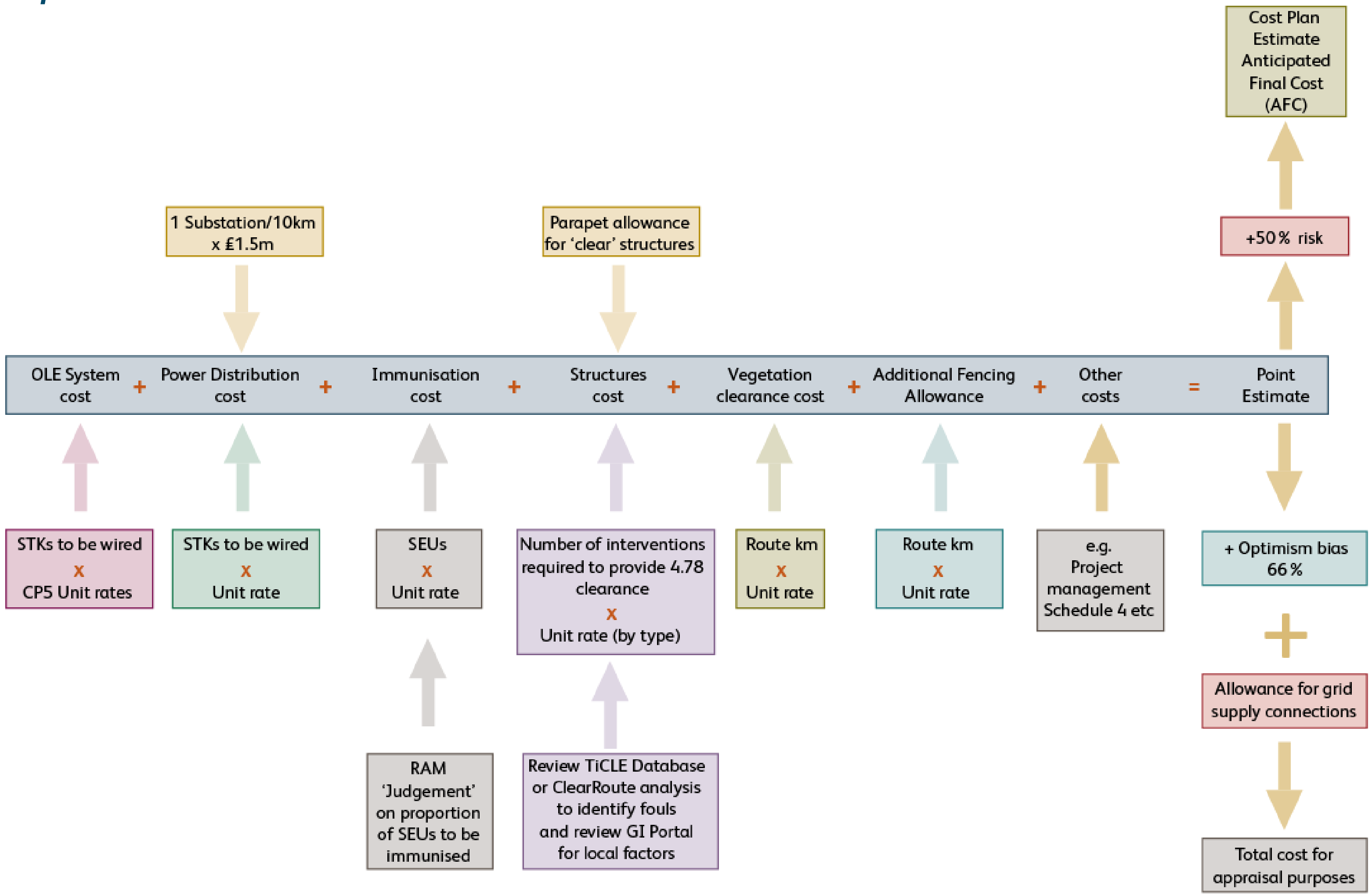
Options

Selecting options for appraisal

- Results of initial sift grouped into tiers, where 1 = highest conversion ratio and 6 = lowest
- Results for remaining measures are grouped into six categories and allocated star ratings
- 5 stars indicates a result in the top 1/6 for that measure
- The following mixed traffic routes have been selected for socio-economic appraisal (business case):
  - Options with a conversion ratio in Tiers 1 and 2
  - Options with a Tier 3 conversion ratio which score highly against at least one the other factors

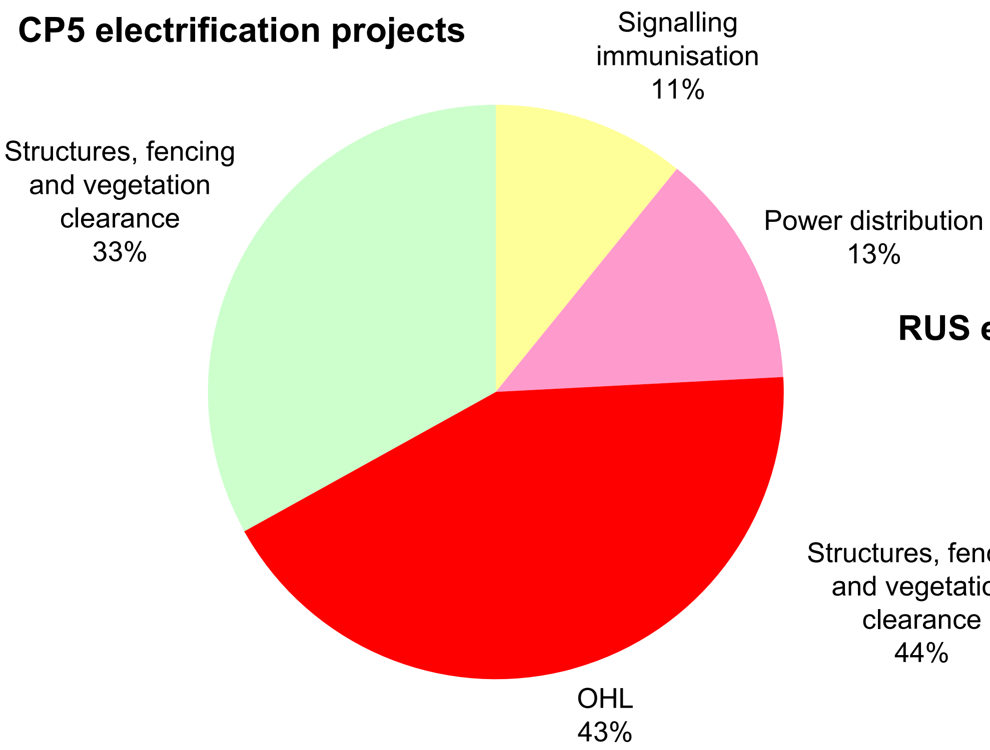
Options

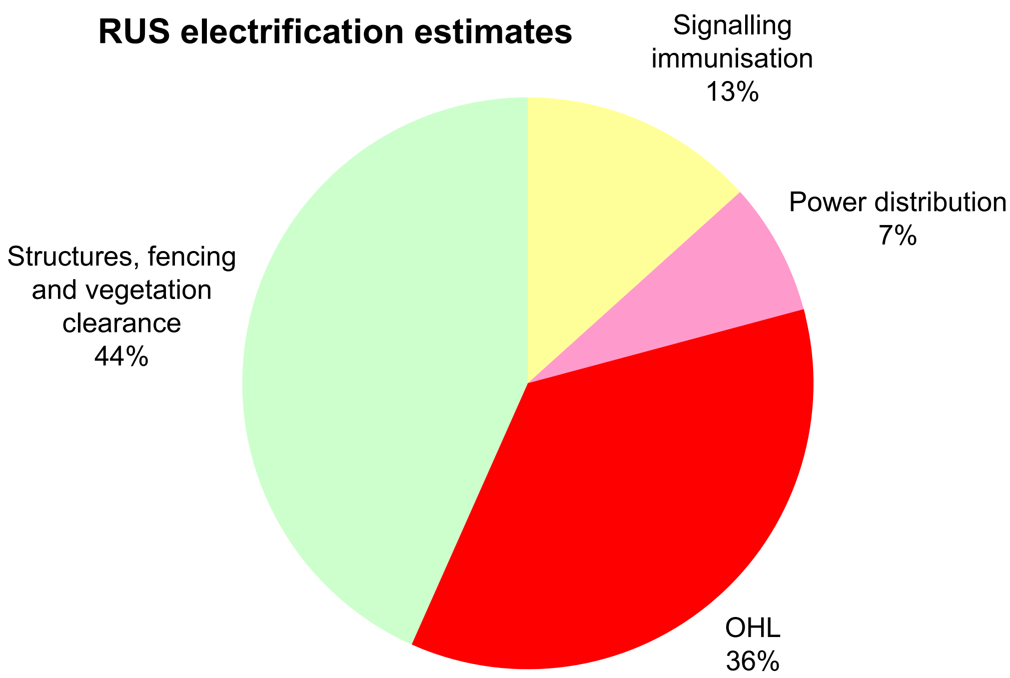
Components of electrification costs



Options

CP5 projects vs. RUS estimates





Options

Impacts reflected in business case appraisal

Cost estimates produced on the basis of engineering assessments and standard unit rates

Principal benefits comprise:

- Reduction in operational costs
- Benefits related to improved journey times & journey opportunities
- Reduced greenhouse gas emissions

Quantify vs. capture

- Some benefits captured quantitatively in economic appraisal (e.g. opex, greenhouse gases)
- Others dealt with qualitatively (e.g. improved station & on-board environment for passengers)

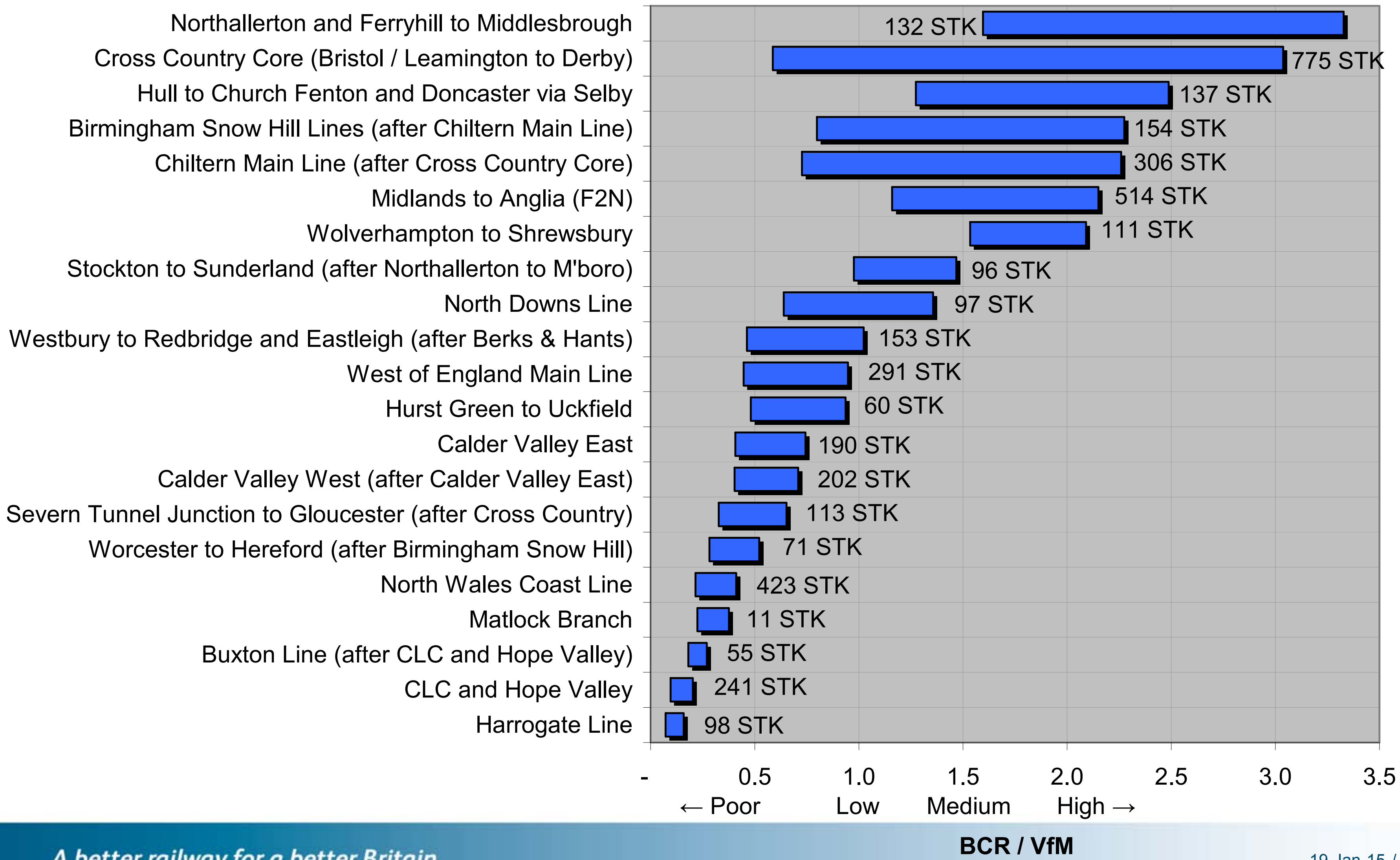
Options

Key appraisal assumptions

- The socio-economic appraisals reflect funders' guidelines and key assumptions have been discussed with DfT. However, some key points to note include:
  - In general, the scheme AFCs include a 50% allowance for risk/contingency on top of the point estimate. As these schemes are at a pre-GRIP level of development, the capital cost for appraisal purposes includes 66% optimism bias on top of the point estimate (in line with funder's appraisal guidelines, WebTAG)
  - The appraisals generally reflect the anticipated pattern of services at the end of CP5 (for example, post-Northern Hub service patterns in the north of England). The significant exception to this is HS2, the impact of which is not reflected in any of the appraisals. HS2 could reduce the value of some proposed electric services by providing direct on-rail competition
  - Freight benefits are only monetised in the F2N business case

Options

Appraisal results with +/- 20% capital cost range



Options:

F2N option: benefits

- **Freight capacity benefits**: equivalent to extra 6 paths per day. Based on 20% increase in capacity because of train lengthening due to more powerful **new** AC traction. However only on fully electrified routes which are c. 60% of all flows:
  - Diesel only F2N (48tpd CP5 Package 1) = 50% increase in Felixstowe capacity
  - F2N OLE = an additional 12% (20% of 60% of flows) increase in Felixstowe capacity relative to the 48tpd
- **Freight carbon benefits due to transfer from diesel to electric traction**: based on estimates of gross tonne kms switched from diesel rail traction to electric rail traction.
- **Benefits to passenger services**: benefits to passenger services using the F2N route (same methodology as for passenger options).

Freight benefits account for about 70% of total benefits; passenger benefits for 30%.

Options

F2N option: business case summary

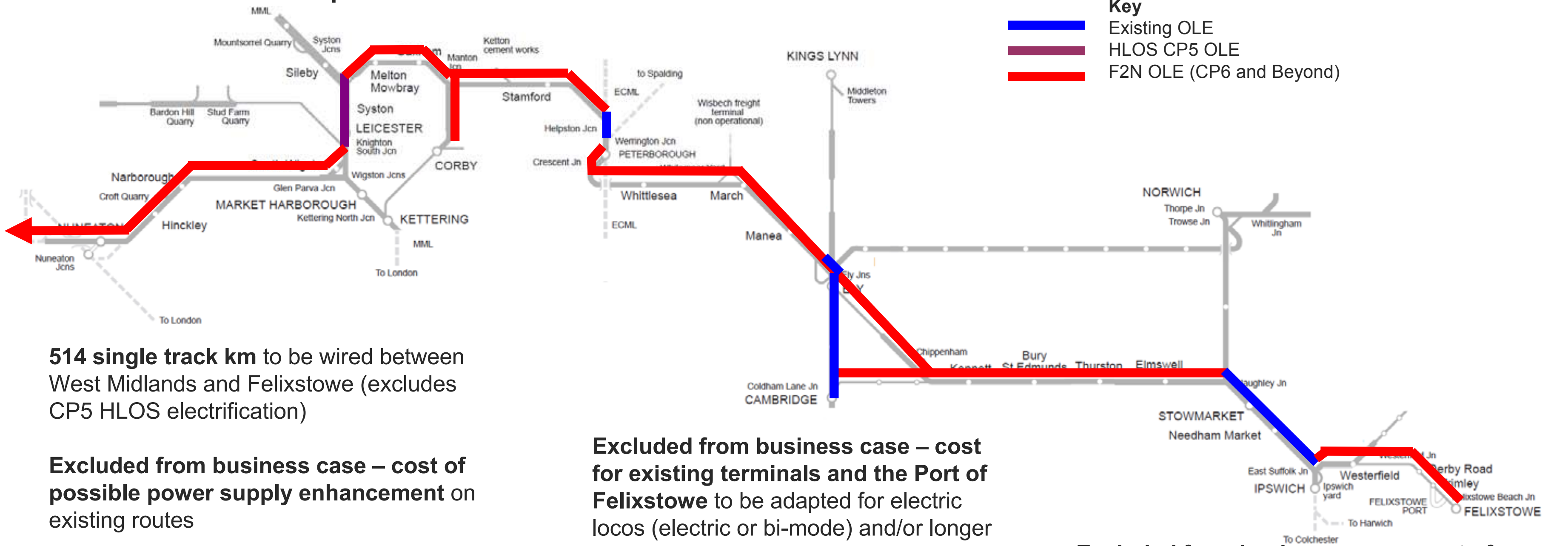
Felixstowe to Whitacre Junction electrification

Includes passenger electrification benefits and builds on F2N 48tpd capacity

BCR with capex +20%:1.2

BCR with central capex: 1.5

BCR with capex-20%: 2.1.



514 single track km to be wired between West Midlands and Felixstowe (excludes CP5 HLOS electrification)

Excluded from business case – cost of possible power supply enhancement on existing routes

Excluded from business case – cost for existing terminals and the Port of Felixstowe to be adapted for electric locos (electric or bi-mode) and/or longer trains (775m)

Excluded from business case – cost of new electric locomotives needed for growth in traffic and for existing diesel services

Options

Key points re. F2N option

Option was appraised relative to a Base Case – Do Minimum of Package 1. This package was based on Package 1 in the June 2014 F2N strategic business case.

- Appraisal does not include costs of electrification at Port of Felixstowe or at any other terminals (as required to enable “end to end” electrification on otherwise fully electrified routes).

- Assumed F2N electrification follows Birmingham-Derby

- Appraisal does not include FOC rolling stock costs or operating cost savings.

- Cost currently at GRIP 0. GRIP 1 cost to be confirmed Spring 2015

NetworkRail

Options

Hierarchy of AC electric traction options

Option Hierarchy	Option	Advantages	Disadvantages	Applicability
1	Diesel or DC to 25 kV AC OLE	Greatest flexibility and operating benefits supporting all types of electric rolling stock including high speed passenger and freight	Fixed cost of infrastructure of installation of OLE	► Starting for any scheme considering introducing AC electric traction ► It is the only option when considering o high speed passenger, and/or o freight electric traction.
2	Diesel or DC to reduced clearances, neutral sections and/or trolley wire contact systems	Potentially lower fixed costs of OLE infrastructure	Reduced flexibility, may need bespoke rolling stock, only lower speeds or locations where extended neutral sections are operationally feasible, and no freight benefit	Where the business case threshold is not met for 25 kV AC conventional OLE, reduced clearance or lower cost contact systems could be considered on routes: ►Passenger services less than 100mph ►No planned AC electric traction.
3	Diesel or DC to on board independent power	Reduces the need to provide new electrification infrastructure	Higher cost rolling stock with on board independent power, not suited for high speed passenger or mainline freight, re-charging time penalty and bespoke rolling stock	Where the business case threshold is not met for 25 kV AC conventional OLE, on routes less than 100mph independently powered trains could be consider where: ►Where gaps are within the capability of current energy storage ►Where it is possible to reduce the extent of OLE using energy storage.

Options

Independently Powered EMU
Trial Specification

Target Areas		
Range	→	50km, Regional Service
Acceleration, Speed	→	Similar to DMU
Operational cycles	→	30km battery – 50km overhead
Life Time	→	5 to 7 Years life
Safety	→	High level of Intrinsic Safety

IPEMU Performance Status

The diagram being used for passenger service is part of the Abellio Greater Anglia network and is a branch railway line from Manningtree to Harwich Town.

Objective Target	Objective	IPEMU current status
Safety	High level of Intrinsic with secondary safety control	Safety Case approval for passenger service. High level of Intrinsic chemical stability with secondary safety software control.
Speed	DMU operating speed (60mph)	E* design limit (100mph+)
Extreme Range	40 miles	30 miles (full performance) 48 miles (typical branch line)*
Operating Cycle (Branch)	70% (OLE) to 30% (battery)	60% (OLE) to 40% (Battery) on HAR-MAN diagram – 22 miles for a round trip. One trip uses ~25% state of charge
Battery Life	5 – 7 years	5 years (predicted)
Passenger impression	No noticeable difference	No difference reported

*Extreme range – Testing to-date has shown a total 48 miles (typical branch line duty) were covered before the batteries isolated due to low state of charge.

Options

IPEMU driver's experience

Options

IPEMU next steps

- Industry workshop day at the end of January – share the learning from the trial and seek input into next steps
- Evaluation of trial data and modelling and business cases of candidate routes (main output of the trial is a validated modelling tool based on the trial data):
  - Unelectrified routes without committed plans for full electrification
  - Routes operated by diesel services at speeds under 100mph:
    - Unelectrified branch line – charging points are at one or both ends of the line
    - The service operates on an electrified main line but begins or ends its journey on an unelectrified branch line
    - The service travels over a long distance and potentially bridges several gaps in electrification infrastructure
    - Groups of services radiating from a central electrified station or core network to serve a number of unelectrified branch lines.
- Potential to assess the amount of infrastructure that can be removed from the scope of works of an electrification scheme given the capability demonstrated by the trial

Options

Conversion of existing DC routes

- Costs and benefits of conversion of 3rd rail DC to AC overhead has been previously assessed for:
  - The route from Southampton to Basingstoke
  - The entire third rail DC network in southern England
- Conversion of a large proportion of the network is required to achieve ‘value for money’
- Improvement if providing for other capacity or renewals benefits
- An update of the costs and benefits will be undertaken

Options

DC-AC conversion principles

To be considered on a case by case basis where a business case exists

Route that maximise benefits – *cost savings, journey time savings and freight opportunity*

Capacity benefits – *an efficient alternative to other capacity requirements*

Appropriateness – *interface with other AC routes, fewer structures, existing dual voltage stock*

Timing – *Consistency with renewals dates for rolling stock, DC infrastructure, linked to other electrification schemes*

Options

Existing AC routes

Renewal of replacement of existing OHL could be considered in one of the following two instances:

- Where usage of an existing AC electrified section is expected to increase significantly following extension of the electrified network to cover additional routes
- Where the impact on performance arising from degraded or unsuitable OHL is sufficient to warrant consideration of the case for renewal or replacement

Next steps