A Year in Industry at Network Rail

Matt Winterbottom

Providing technical leadership

About Me

- Study at Newcastle University
- Completed Stage 2 of a Bachelors in Mechanical Engineering, I'll be going back in September to start (and hopefully finish) Stage 3
- My primary career aspiration would be to work in Formula 1 as part of a pit crew/engineer team
- Wasn't very interested in trains before I started at NR, now I'm a bit of a fanatic

My time at Network Rail so far

- Work with the Contact Systems team in Technical Authority – predominantly OLE
- Met lots of new people
- Been on some very interesting trips, such as visiting an HS2 site (Old Oak Common) and the largest mechanical signal box in the country (Severn Bridge Junction)

Some things I've been working/worked on

- Walsall OLE Bespoke training
- NP Electrical Safety Training Material
- Design for Reliability
- Enginuity 2025
- Carbon Cost of Electrification

Areas	Sections	Module A (kgCO2e)				Module B (kgCO2e)					Module C (kgCO2e)				Total EC (kgCO2e)
		[illegible]	[A1-A3] Production Aggregated	[A4] Transport	[A5] Construction	[B1] Use	[B2] Maintenance	[B3] Repair	[B4] Replacement	[B5] Refurbishment	[C1] Demolition	[C2] Transport	[C3] Waste Processing	[C4] Disposal	
Distribution	Feeder Station	0.0	376,309.1	7,435.0	102,709.7	0.0	0.0	0.0	192,449.4	0.0	0.0	2,188.4	61.6	1,465.2	682,618.5
	Mid Point Track Sectioning Station	0.0	123,672.0	2,915.5	41,598.1	0.0	0.0	0.0	67,755.2	0.0	0.0	1,218.1	21.0	404.8	237,584.7
	Track Section Station	0.0	336,563.6	8,034.4	113,983.4	0.0	0.0	0.0	190,104.2	0.0	0.0	3,422.4	56.2	1,160.3	653,324.5
	Subtotals	1,113,220.9				450,308.8					9,998.1				1,573,527.7
OLE	OLE Supporting Structures	0.0	8,081,173.5	113,835.0	1,697,806.1	0.0	0.0	0.0	4,543,356.3	0.0	0.0	27,998.1	11,238.9	2,726.9	14,477,934.8
	OLE - Wiring	0.0	1,638,392.5	11,901.1	331,343.2	0.0	0.0	0.0	48,314.3	0.0	0.0	2,050.8	2,846.9	1,577.1	2,036,425.9
	Booster Transformers	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.0	0.0	0.0
	Earthing/Bonding	0.0	23,190.3	3,681.6	4,750.8	0.0	0.0	0.0	0.0	0.0	0.0	634.4	1,140.3	318.7	33,716.2
	Switches	0.0	164,138.9	1,214.5	33,393.4	0.0	0.0	0.0	4,023.5	0.0	0.0	307.9	61.0	26.7	203,165.8
	Subtotals	12,104,621.0				4,595,694.1					50,927.7				16,751,242.8
Route clearance	Track lowering	N/A	3,347,362.9	1,418,208.8	3,107,790.9	N/A	N/A	N/A	2,299,697.7	N/A	N/A	548,976.2	506,953.7	183,561.4	11,412,551.6
	Track fence	N/A	2,575,776.8	57,932.2	810,751.5	N/A	N/A	N/A	1,764,419.3	N/A	N/A	6,654.3	985.3	223.3	5,216,742.7
	Parapets	N/A	24,996.8	1,529.6	8,436.9	N/A	N/A	N/A	0.0	N/A	N/A	530.8	418.9	272.4	36,185.4
	4 lane road bridge raising	N/A	981,241.6	61,728.9	332,054.7	N/A	N/A	N/A	0.0	N/A	N/A	11,955.0	20,162.6	5,036.9	1,412,179.7
	2 lane road bridge raising	N/A	658,617.2	30,220.4	347,302.4	N/A	N/A	N/A	122,964.8	N/A	N/A	10,939.2	1,353.7	6,697.4	1,178,095.2
	Footbridge	N/A	470,648.6	6,651.1	130,715.0	N/A	N/A	N/A	0.0	N/A	N/A	683.2	101.2	22.9	608,826.1
	Farm user bridge	N/A	379,516.9	16,447.4	180,497.1	N/A	N/A	N/A	48,718.8	N/A	N/A	5,417.4	1,303.9	2,783.6	634,685.2
	Subtotals	14,948,431.9				4,235,800.6					1,315,033.4				20,499,265.9
Total embodied carbon per module (kgCO2e)		28,166,273.8				9,281,803.5					1,375,959.2				38,824,036.4
Total embodied carbon per module (TCO2e)		28,166.3				9,281.8					1,376.0				38,824.0

Overview of the Carbon Cost of Electrification

- As the UK approaches its net-zero goal of 2050, reduction of railway emissions play a crucial role.
- The railway emits:
  - 1.4% of UK transport emissions,
  - And 0.5% of total UK emissions.

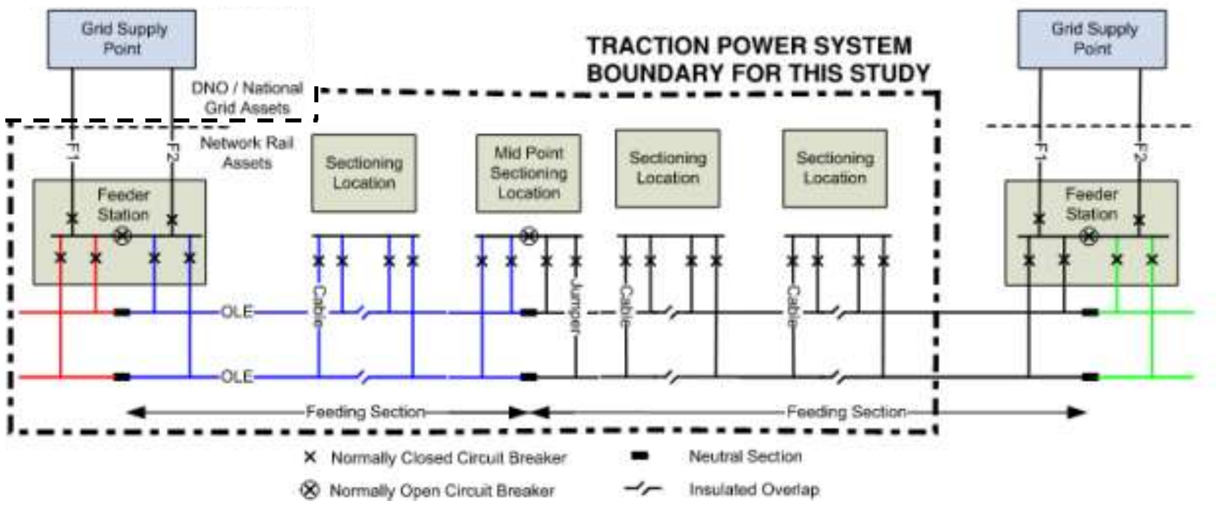
- Travelling by train emits 3-5 times less carbon than driving (pp/km),
- Around 6 times less carbon than flying (pp/km),
- And a single freight train may be able to remove up to 70 HGVs from the roads.
- Electrification could be a real solution to this net-zero goal.
- Objective of study is to analyse current carbon emissions of electrification and explore opportunities to reduce this.

Plans of Institutes and Organisations

- Initially, I researched the plans and strategies of rail-based institutions and organisations
- All are committed to net-zero and have action plans to achieve this by 2050
- All institutions mention electrification as a primary contributor to net-zero
- Some mention hydrogen power, the complete removal of diesel trains by 2050, and battery power to achieve multi-modal optimisation

Scope of Project

- 80 stk total length
- 80 stk open route OLE (UKMS)
- All assets included in diagram
- 40km vegetation clearance
- 40km ethernet fibre optic cabling
- 33 bridges,
  - 11 need no work
  - 11 need track lowering
  - 11 need rebuilding (1x 4-lane, 2x 2-lane, 4x footbridge, 4x farm user bridge)
- Grid connections are not included



PAS2080

- Gives a whole life carbon management strategy.
- Carbon emissions are split into modules.
- Module A – before use (A1-A3: production aggregated, A4: transport to site, A5: construction on site)
- Module B – in use (B1-B5: use, maintenance, repair, replacement, refurbishment)
- Module C – after use/end of life (C1-C4: demolition, transport, waste processing, disposal)
- Emitted carbon for each module is calculated through the WLC Baseline Tool.

WLC Baseline Tool

- Worked to the 80 stk scope.
- Analyses each asset by module to calculate total carbon emitted.
- Each module has been calculated based on well-rounded assumptions.
- Can be used to obtain a total emitted carbon value for 80 stk.
- 38,824,036.4kgCO_2e

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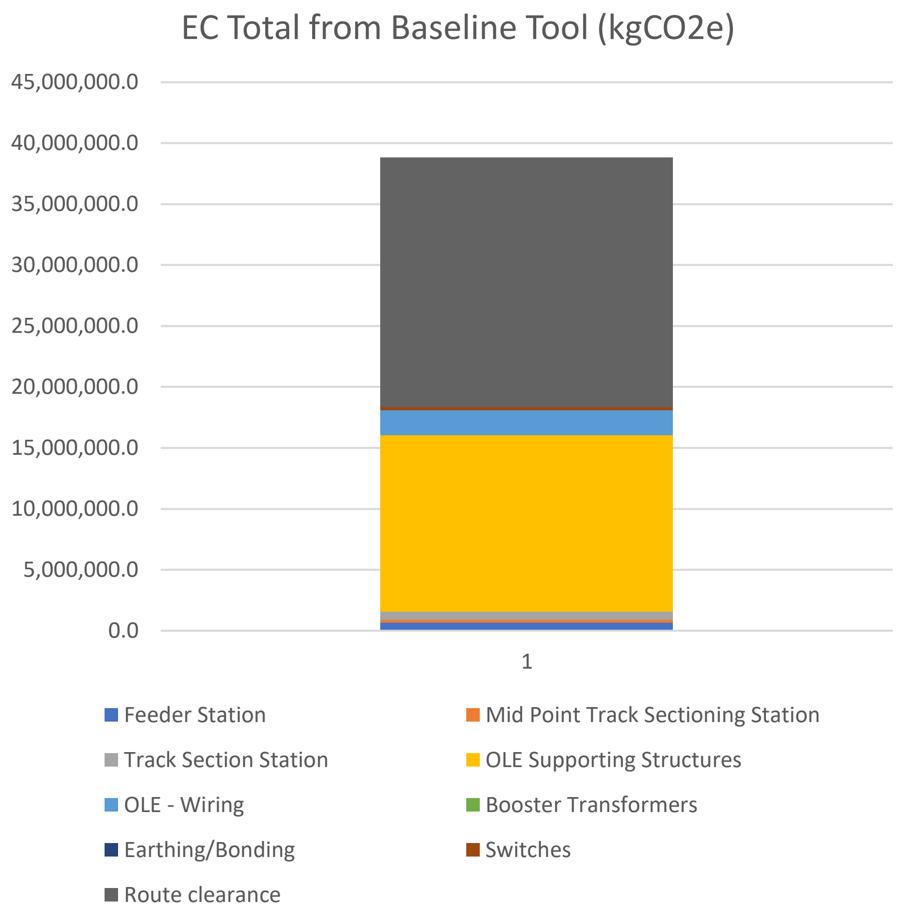
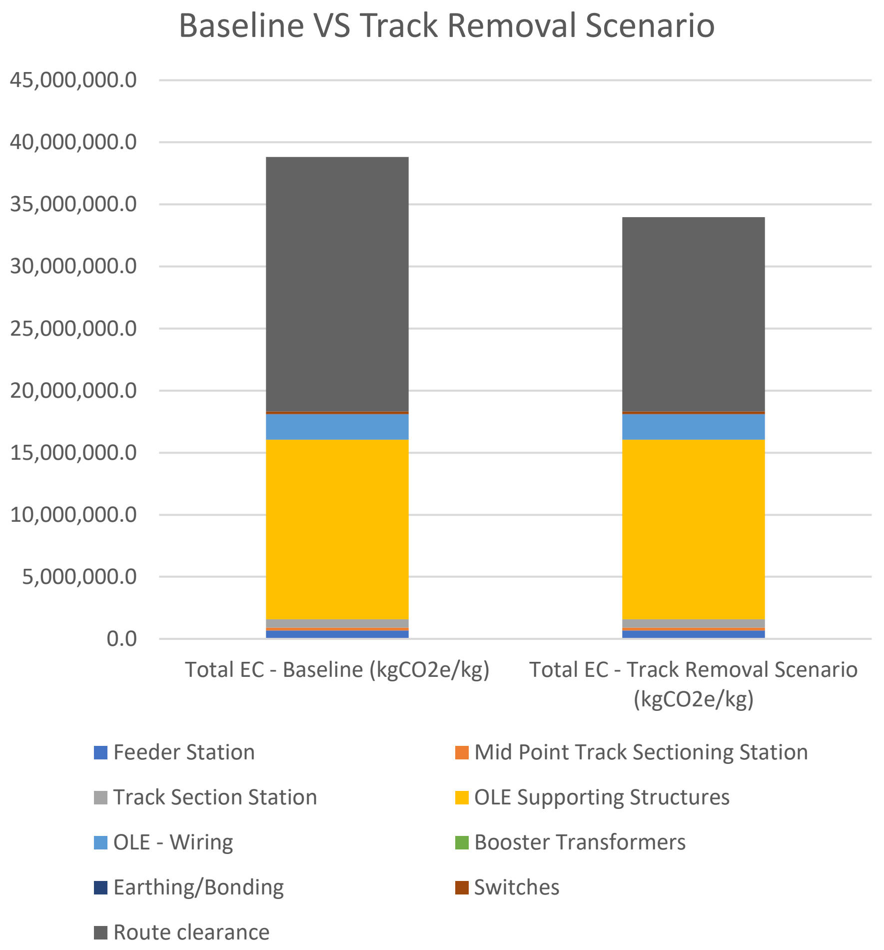
Baseline Analysis

- Main areas of carbon dioxide emissions are Route Clearance and the OLE supporting structures.
- Over 90% of total emissions within electrification come from these two areas.
- These areas have the highest potential in reduction of carbon emissions.



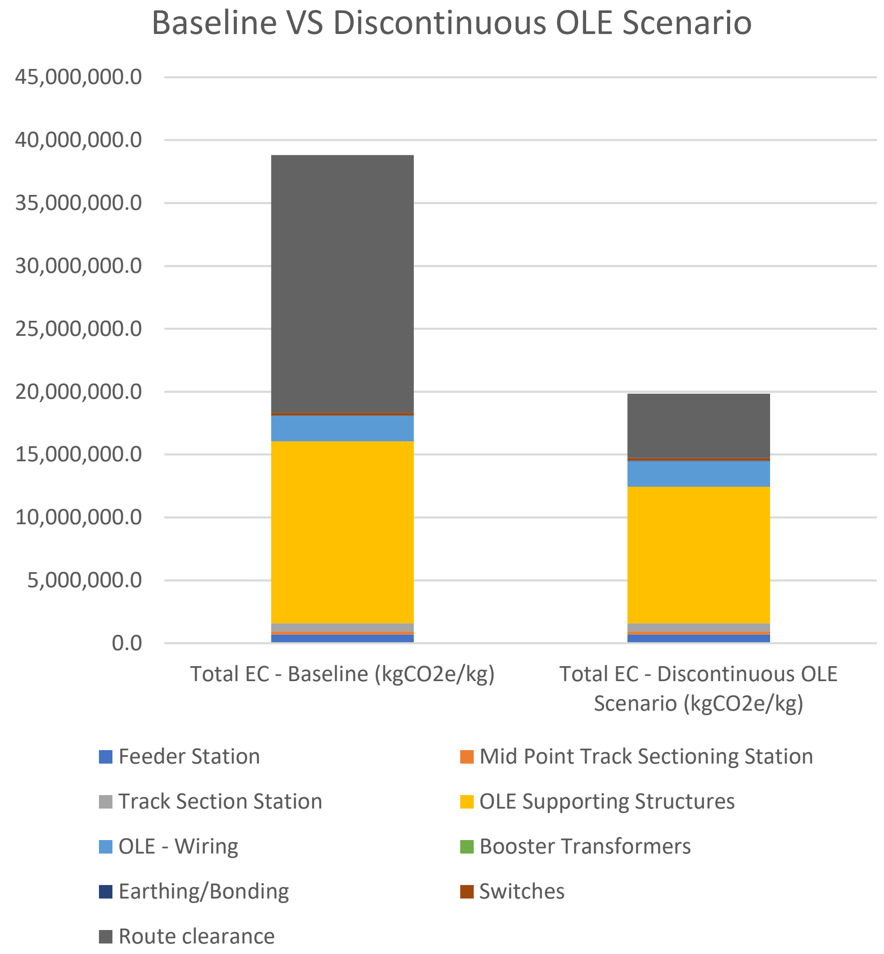
Scenario 1: Need for Track Removal

- Route clearance is the biggest carbon cost of electrification.
- In the baseline, it is assumed that tracks are renewed when lowered.
- If tracks are reused instead of renewed, there is an estimated carbon reduction of around 2.9 million kgCO_2e.
- This is approximately 25% of all carbon emitted by route clearance.



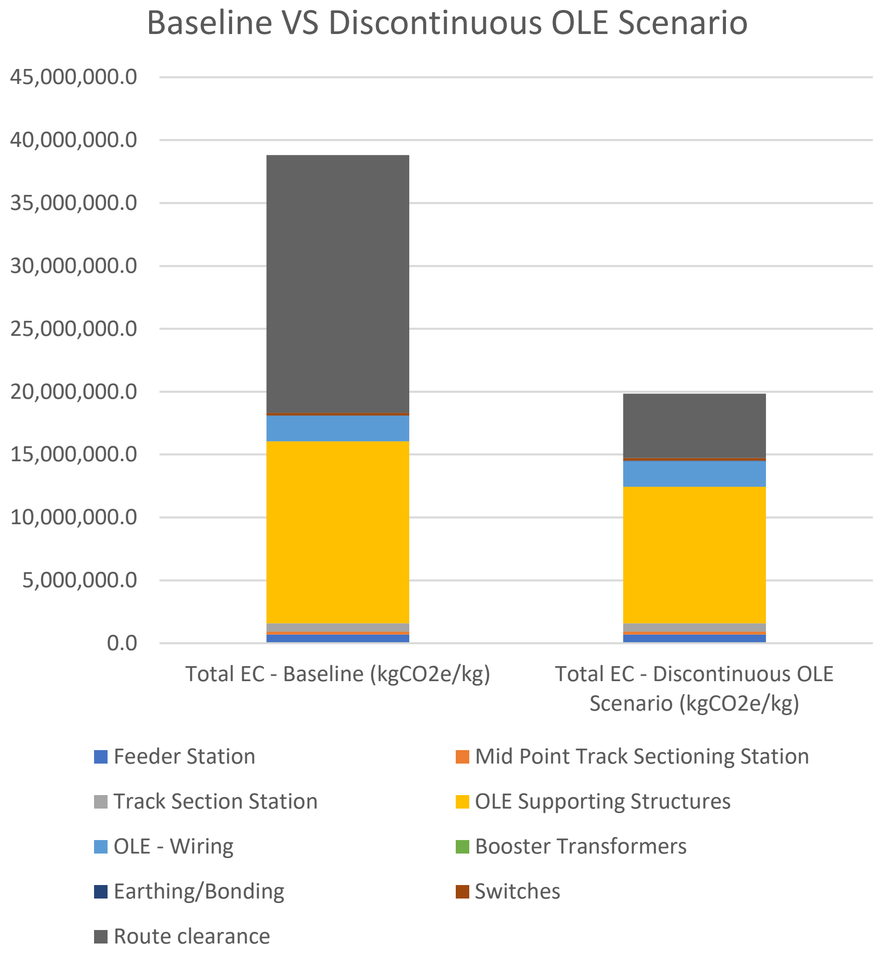
Scenario 2: Discontinuous OLE

- If discontinuous OLE is used in a ratio of 3:1 electrified:non-electrified, 25% of supporting structures can be removed.
- This gives a decrease of around 4.1 million kgCO_2e in the area of OLE.
- ‘Properly planned’ discontinuous electrification assumes that the need for route clearance can be avoided in 75% of cases.
- This causes a huge reduction in carbon savings, roughly 15.4 million kgCO_2e.



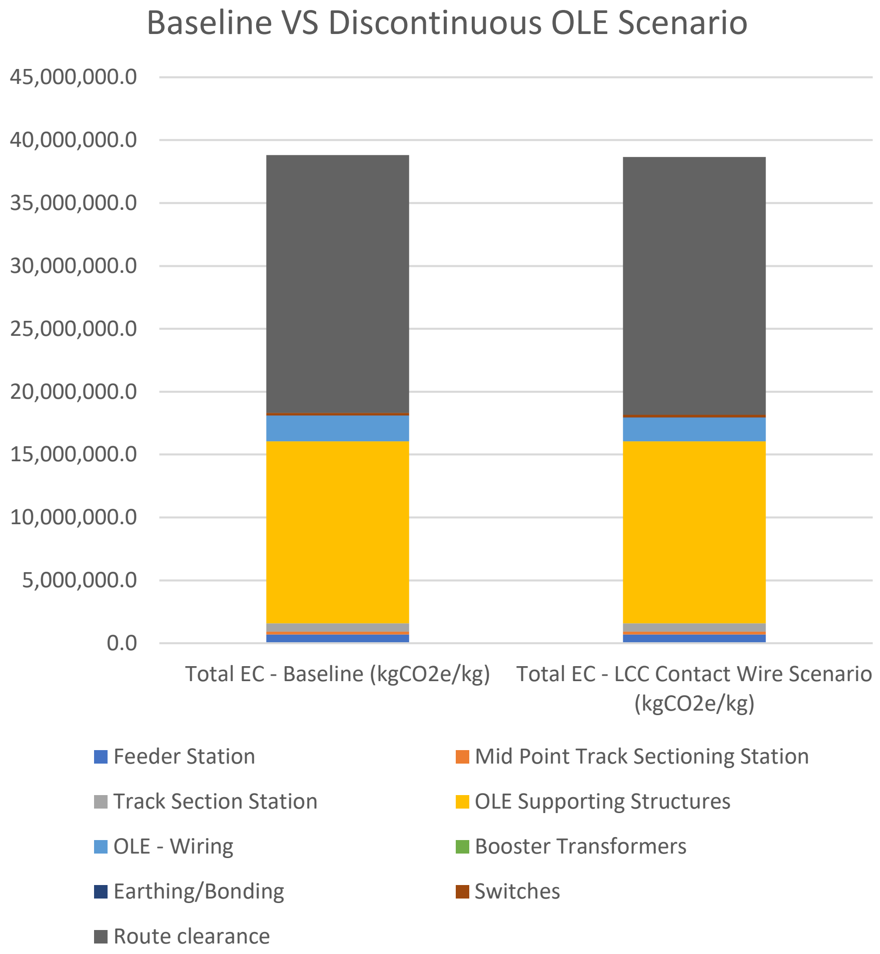
Scenario 2: Discontinuous OLE (Cont.)

- Additional carbon costs must be added:
  - Troughing and cabling to connect adjacent sections of OLE
  - Potential battery emissions, due to trains needing at least one method of power when not under OLE
- Troughing totals to 294,400.1kgCO_2e.
- Cabling data is unavailable, unlikely to come close to the reductions made.
- One 4800kWh BEMU emits 350,400kgCO_2e in its lifetime, meaning 55 diesel trains could be retrofitted from these savings.



Scenario 3: Low Carbon Copper Conductor Wire

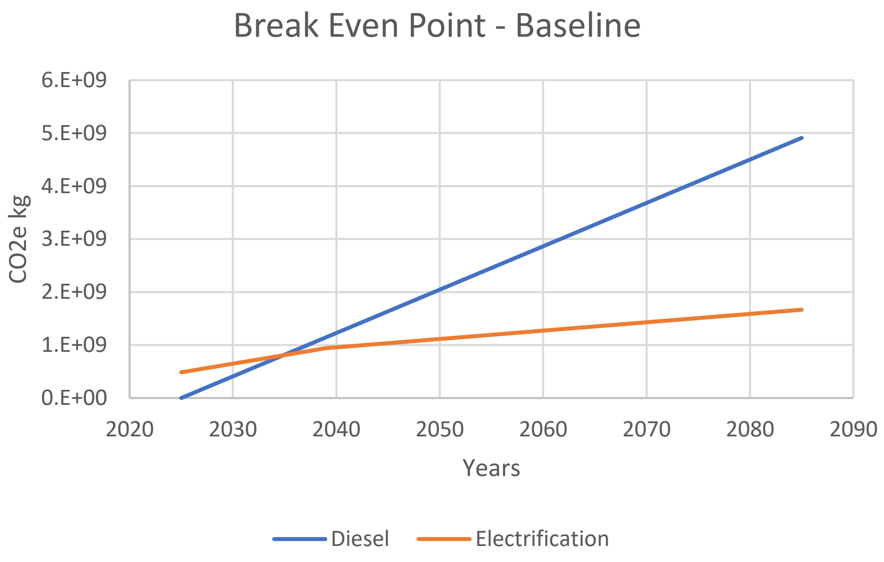
- LCC Conductor Wire may only be a small improvement, but it is an improvement nonetheless.
- This wire uses ‘very efficient ore concentration processes’ and a ‘world-class green energy mix’ to allow for a saving of 150,000kgCO_2e per 80 stk.
- While it may be less economically viable, this reduction could be as easy as just changing a supplier.

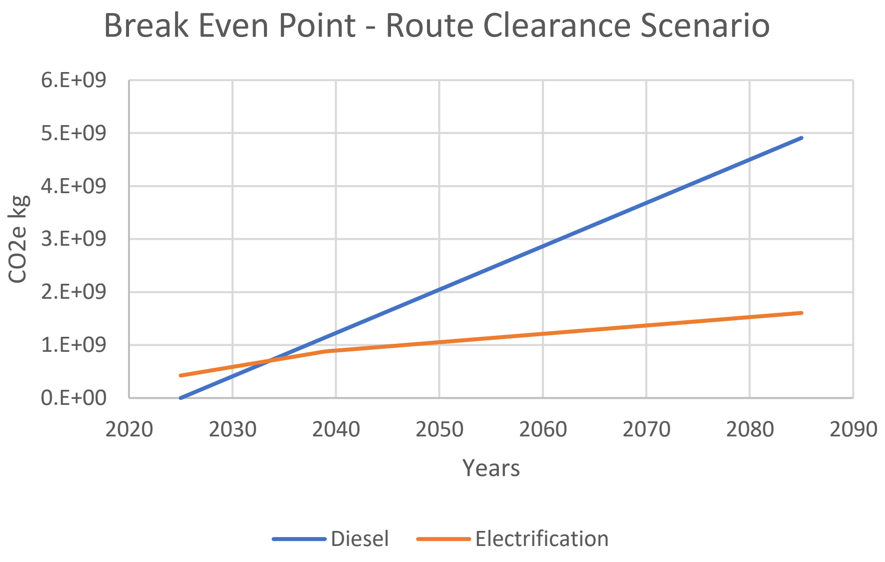


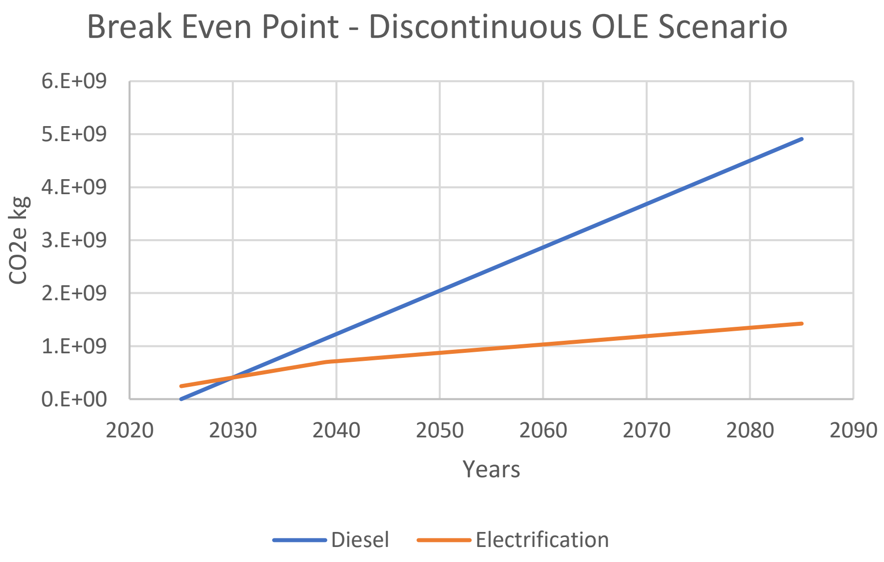
Negative Outcome Scenarios

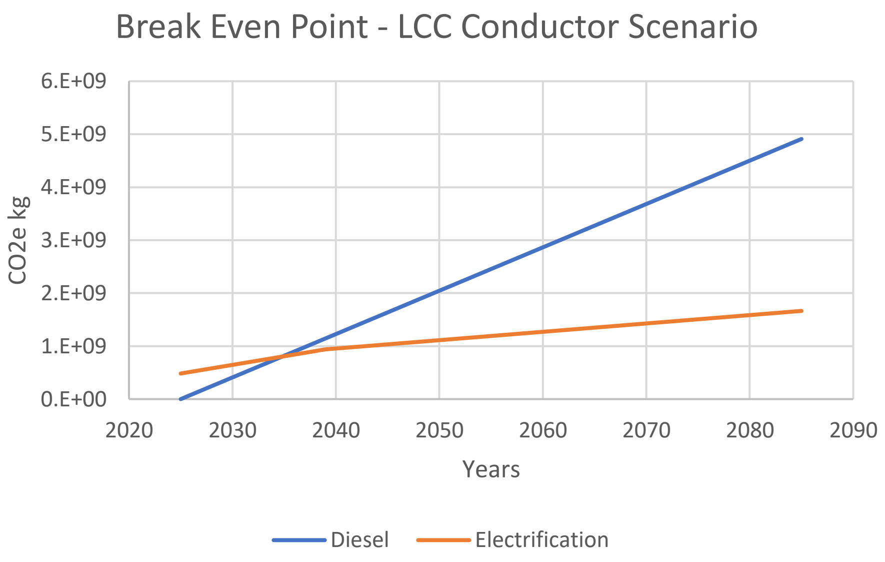
- Composite Masts (CFRP)
  - Not enough data to accurately calculate carbon – some values given as 5 times more energy intensive to process than steel, some say 15.
  - If these values are true, they would need to be 15 times lighter than steel to make it worth using them, to allow more to be transported at once and avoid transport emissions.
  - CFRP is not able to be recycled at the same extent as steel – the processes used are either far more expensive or will yield poor recyclability.
- In-house Component Manufacture
  - The materials to make components must still travel from their origin.
  - If in-house component manufacture was adopted, there would be an increase in UK emissions, therefore proving more of a detriment than a benefit.

Break Even Points









Conclusions

- Re-use track that is removed during track lowering – approx. 3 million $kgCO_2e$ saving.
- Discontinuous OLE – approx. 19 million $kgCO_2e$ saving.
- LCC Conductor Wire – approx. $150,000kgCO_2e$ saving.
- Composite masts – unable to tell, seems unlikely there will be great, if any, benefit.
- In-house component manufacture – more likely to increase carbon emissions than reduce them.

Recommendations

- The study of composite material production greenhouse gas emissions needs improvement, to define an objective value for carbon for each of the modules.
- It may also be appropriate to investigate the use of varying OLE types, such as an auto tensioning system vs a manual tensioning system.
- There should be extra study on the carbon content of lithium-ion batteries, allowing more accurate data on the exact carbon emitted by retrofitting diesel trains with battery systems.
- It is necessary for more suppliers to list carbon datasheets on their products to ensure that it is possible to keep track of emissions as the UK approaches the deadline of achieving net zero.

Thank you for listening

Any questions?

Technical Authority

everyone
home safe
every day

Technical Authority

Providing technical leadership