This is Ian Walmsley's article for his regular "Pan Up" column in Modern Railways *magazine, March 2026 and his follow-up in the April issue.*

Ian, and MR *editor, Richard Clinnick, have kindly given us permission to host this on our website.*

Stealing From the Next Generation

Time to stop pretending that discontinuous electrification is a clever innovation when it is actually a millstone around the neck of the next generation

The idea of discontinuous/disingenuous electrification (DE) is seen in some places as a great piece of innovation, and the railway loves to look innovative.

I was at a Railfuture event with the two Derby MPs recently and it seems that electrification can't be mentioned without "discontinuous" preceding it. We're in trouble now - disingenuous electrification is becoming a starting point. It impresses politicians and Treasury mandarins, for whom five years is long term. We are lucky the railway engineers of old didn't have a similarly parsimonious attitude. There is a rolling stock strategy coming soon and you can be sure it will be full of diesel substitutes. You can also be sure there will be no whole life cost/benefit analysis.

GOOD IN PARTS

Such a clever idea, not electrifying branch lines but running a battery train instead. Every now and again we run a battery train up a branch and hale the achievement that it made it. Motors are not fussy where their amps come from - battery or wire - so of course it works. Take the power from a hydrogen fuel cell, a stack of batteries, a genset or a wire - motors aren't bothered - but the disingenuous bit is pretending the system is the same as proper electrification. It isn't, and the initial savings soon go flat like a bike lamp left on overnight. Batteries to Greenford has avoided electrifying 2½ miles of railway, not exactly the East Coast main line. Then there is the even more embarrassing extension of Merseyrail to Headbolt Lane - one mile, although the trains will do more given the chance. In the latter case, the only reason the trains will be carrying around an extra six tonnes all day every day is the ORR's 'presumption against' extending the third-rail. This is not innovation; it is waste driven by an organisation which prefers zero risk to economy or CO_2 reduction. its half-hearted attempt to justify its position in MR (September 2025) was just laughable.

As I described in MR August 2024 in 'The Charge of the Battery Brigade the economics soon turn around when battery changes, weight and maintenance take their toll. I must avoid repeating that article, but the strong vested interests of all involved need repeating.

GOVERNMENT WINS

- Possible improvement within election cycle
- Less capital spend now, replaced by private capital on train cost
- Innovation box ticked

MANUFACTURER WINS

- Build trains now, no waiting for wires
- Higher train prices
- Battery change revenue through life

ROSCO WINS

- Higher prices mean more return (% of capital)
- Higher risk premium (less flexibility)
- Green box ticked

OPERATOR WINS

- Less disruption for wiring
- Quicker introduction of new trains
- Reduced maintenance compared to diesel

These are all valid points in the short term, but it is customer demand which governs things, and the customer is not always right, especially if it is the DfT (see Roger's IEP story).

LOSERS

From all the above it is clear to see why batteries are the thing while electrification is grinding to a halt in England. Sadly, the losers won't be aware they are losing for some years - the perfect crime - by which time the perpetrators will be sitting pretty on big pensions. Bi-mode trains are now common, but that doesn't make them the right choice. Class 80x depots I've visited are always changing loads of engines. They look like DMU depots, testimony to what we already knew, which is that diesels need more maintenance, especially if thrashed to try to meet electric performance. Track takes more of a beating from the increased weight, but it is difficult to measure as the pre-Class 80x baseline is confused by service frequency and technical bogie factors. Also, | suspect Network Rail doesn't want to know and wouldn't say anything if it did. The Class 800 business case also included journey time reductions which never happened. It is quite easy to avoid speeding up services and pocket any time saved for 'resilience' or locking in inefficiency. This 'slack' has enabled, routine running with failed engines (generator units). For longer wire gaps, freight or high-speed operation, diesel is the only option while batteries are okay for shorter gaps, however neither offers the same performance improvement as electrification. More trains out of service for maintenance or charging knocks down availability, typically from 90% to 85%, although 75% is not uncommon so I've used 83% in the table.

40 DIAGRAM EXAMPLE

Lots of estimating here, but Table 1 indicates some of the hidden costs of disingenuous electrification and doesn't account for the fact that performance, reliability and track damage are all worse. Base assumptions are 7% better availability for electric, maintenance cost same as build and 30% higher for diesel. Seven tonnes on 40 trains for 10 years adds about £20 million to running costs, which obviously repeats indefinitely, as does the maintenance cost. In the absence of data, I have assumed the savings from track damage with pure electric will cancel out with the maintenance of the overhead line. I'd love to be more accurate, but the most expensive part of the railway, the infrastructure, is not easily granulated. Also, discontinuous electrification is more expensive per kilometre because of the additional terminations and changeover arrangements, again, not included. Journey time reductions and the improved reliability which normally come with electrification have a value, but they vary widely. There is a crying need for research to update the figures in the British Rail Passenger Demand Forecasting Handbook but research with a genuine use is very unfashionable. Also, it grieves me to come up with high values of speed when we could achieve them just by scrapping the ceremony of the doors. Anyway, I sense you are getting bored, so let's go with £1.3 billion additional cost for going bi-mode over 30 years (Table 1). The change to bi-mode on the Great Western rolling stock cost £1.3 billion so I'm in the right shed road (no, I didn't fiddle it). I'm sure that if Hitachi knew then what it knows now the cost would be higher. £1.4 billion would electrify just about 700 single track-km so about 350 miles of railway, (slightly less for difficult bits) but there are other major downsides. The more trains there are, the worse DE looks. Here comes a fuller picture. Accountants will have noticed some sleight of hand here, because I haven't discounted the values. Inflation reduces the value of money over time so Discounted Cash Flow (DCF) is used to compensate for that. The result is that anything which takes over about 10 years to pay back doesn't happen, but in reality, the electrification is as useful as ever.

OTHER DOWNSIDES - CARBON PENALTY

This is insignificant, but since carbon reduction is foolishly pedalled as the reason for electrification, I'll include it. Electrification is to produce a better railway, the emissions reduction is by the way, and selling it to Reform, the Conservatives or even Labour based on emission reduction is never going to work. The only way the railway can make a measurable reduction to the UK's carbon emissions is by large scale modal transfer, which is achieved by a better service, not by batteries and diesels. Like it or not, carbon reduction is no longer a useful sales pitch. Planetary survival is now a side issue.

OTHER DOWNSIDES - FREIGHT

HGVs have no viable alternative to diesel, although you might think back to the idea of overhead wiring on motorways. Interesting the difference in comments I heard about that: retired engineer -"It was a stupid idea" compared to still employed engineer ("There are significant challenges').

We now have a work-around for rail freight with the Class 93s and 99s, but neither can perform as well as a pure electric. Make a realistic assessment of the whole life cost and we would be electrifying Felixstowe, London Gateway etc. In the short term we need the '93s' and' 99s't o get doing some serious work. It's tragic that'93s'find employment taking electric trains for scrap.

Bear in mind that by the time my grandkids have grown up we will still be diesel hauling freight around because we failed to do a proper job, and they will be paying the penalties. One day Disingenuous Electrification will be seen like Tony Blair's rush for diesel cars to help the environment. As my dad used to say - it'd be funny if it wasn't tragic.

OTHER DOWNSIDES - SPEED

The first big application of DE in the UK is the Core Valley Lines and all being well that will give us some idea of reliability. But we already know performance will be reduced by the long battery stretches. When I first proposed tram-trains for the valleys (MR, Nov 2013) I had timings done for Alstom's Istanbul tram train which showed a saving of 20 minutes between Barry and the heads of the valleys. About half of that was performance and the other half reduced dwell times (half a minute at all stations). The batteries have seen off the performance advantage while the agreement to keep the ceremony of the doors does the rest. In the end, the time saving will be minimal, although the service will be better. Siemens, marketing its new Desiro Verve, offers 110mph on the wires, down to 100mph on batteries — but it doesn't say how long it will take to get there. Time has a value, although it tends to be played down these days. Battery trams are a better bet than main line since the power demand is less, but they are still not as good as proper wiring.

OTHER DOWNSIDES - STOCK COMPETITION

DE routes need new battery trains — great for manufacturers, but less so for ROSCOs with stock going begging. There are perfectly serviceable Class 323s and 350s looking for work and numerous units being scrapped which could have operated new electric services if wiring plans not been axed after the tragedy of Great Western. The spare trains are no use for DE routes as the spend required to fit batteries doesn't have sufficient life to pay it off. ROSCOs no longer trust the DfT forecasts. The very best rolling stock deals come from desperate ROSCOs, especially when there is a choice of stock. Rental figures could be expected to be as low as 10% of a new build bi-mode and rolling stock is typically 15% of the cost of running a service. The actual figure varies dramatically but say 20x4-car units were needed, then the old stock cost at £200 per vehicle per month (pvpm) over 10 years costs nearly £2 million while the new bi-mode at £1,000 pvpm is £9.6 million - before we start on the penalties already listed. Assuming the old stock is replaced after 10 years, all the additional costs above will apply, all for the want of a few miles of wire.

OTHER DOWNSIDES- SYSTEM LOADS

Even if the battery was 100% efficient (which it isn't) then the train on the juice needs to draw power to run itself and almost as much on top for charging the battery. This is not insignificant and means beefing

up the DE system to accommodate it with a consequent increase in cost. To get a meaningful charge it also means reasonably long electrified sections of beefed-up power supply, with automated arrangements for coming off and back on the juice, all of which have a cost.

The electrical 'water tower' at the end of a branch line installed to allow fast charging is usually made of recycled batteries and so of limited life. Fast charging from the overhead is not possible as it would melt the wire. On the third-rail voltages in busy areas gets very low, so the SWR idea of charging batteries '' between Waterloo and Basingstoke is not feasible. A while ago | set out a scheme which was feasible with longer electrified sections, but it still isn't financially viable over the long term. Waterloo-Exeter is a better home for IEP units replaced by pure electric by electrifying to Bristol Temple Meads and Swansea. The IEPs would of course need shoegear, but the DC input would be no problem - they are basically Class 395s.

South Eastern Railway is looking for Networker replacements, which will be heavier and need power for air-conditioning, hence the power supply needs upgrading. Unfortunately, that got cut from the budget so the battery idea is meant to spread the load — even though it will also increase the load due to the extra weight. For the Treasury the appeal is not the fishy physics, it's the batteries being paid for by private capital while the supply upgrade would be public money. All money is not the same.

OTHER DOWNSIDES - THE N MINUS 2 FACTOR

Bear with —'N'stands for normal, in the sense of the power supply from the grid. A 25kV system would have supply points 20-odd miles apart, possibly closer for DE to cope with the load mentioned above and gaps. There is a neutral section between, that bit where the power breakers clunk out and the air-con goes quiet. The next section is fed from the next sub-station, in normal operation. But say a connection is lost, which does happen and is increasingly likely as the grid runs closer to the edge on renewables. No problem, we go to N (minus) 1 and feed from the next section by bridging out the neutral section. Voltage drops a bit, but everybody gets home.

But then there is a fault on another system, taking us to N-2, which gets a bit hairy but can still be cross-fed because all the sections can be linked. A fault at Tottenham once meant Liverpool Street was being fed from Colchester. The volts were so low that drivers were selecting the old units' disused 6.25kV setting to get going.

With DE, cross-feeding is impossible unless all the sections are linked by power cables, in which case you might as well have done the job properly. So, make no mistake, DE will be less reliable since while battery units can keep going, a fault on the next powered section means they can't recharge. It is also a myth that certain bridges and tunnels can't be wired, disproved by proper engineers doing proper research.

OTHER DOWNSIDES - KILLING BUSINESS CASES

Even when it is realised that full electrification was the best option, if DE has been installed already conversion is very difficult to make a case for. The bi-mode trains are already there, and the lease cost is in the budget, along with the track and maintenance costs of the new normal. Performance gains would be at the outer ends of the system, fairly marginal and difficult to place a value on. An opportunity for redemption comes if the stock can be reallocated, but other than that DE gets established like Japanese knotweed. It may have been the wrong answer, but you can't afford to fix it. That is why it is so important to stop it seeding anywhere else. The aversion to capital spend is understandable given the hash made of recent projects, but the money men should consider that the interest on the loans from ROSCOs is higher than Government borrowing. It is a bit like the Tony Blair (again!) dash for PFI funding of hospitals — a 2019 report concluded that for an investment of £13 billion the NHS then had a bill of £80 billion. A few months ago, it was revealed that Scottish taxpayers will have paid £14.8 billion for schools worth just over £3 billion. Leasing means the debt is never paid and just starts again with new bi-modes. To quote Stagecoach's tagline — "We've got you".

I'm told that the Treasury still uses the appalling cost per stkm from Great Western electrification of £3.5 million, which inflated to today is around £6 million. Actual costs for new schemes are around £2 million, but if you didn't want to do it which would you use?

OFF RAMP

Although all this says main line DE is a stupid idea, this won't kill it off because of the vested interests above. The situation is a bit like the days of the Modernisation Plan in the 1960s where lots of diesels were built from a range of manufacturers because the planned electrification couldn't be afforded. Had the plan gone through we would have been fully electrified by 2004. Many of the locos built had a short life, which may prove to be the case with battery trains when the true cost emerges, or one catches fire.

In my fantasy world, I will imagine someone in power looked beyond their next payday and decided to do the right thing. That would be to target electrification to displace bi-modes to routes with a less good business case, thus avoiding building any more. Don't hold your breath though. All I can suggest is that the young engineers of today think how they will feel when they retire, leaving a dog's breakfast of disjointed wiring while their kids scour the globe for more Lithium.

April 2026 Follow-up article:

Discontinuous Electrification - Continuous Loss

I missed a big one

Last month I went through the many downsides of discontinuous electrification, - an innovation which is currently poisoning the well for electrification schemes. All those points are valid, and on that basis alone the idea should be stopped now, but I missed a big one. I have no excuse. as a chartered electrical engineer, I should have picked this up, but I haven't come across the issue on the railway since I graduated in 1978. The issue is transmission losses - and not the usual kind, but let's deal with them first.

CURRENT AFFAIRS

All the losses we needed to worry about in proper electrification were what is known as I^2R (current squared times resistance) losses associated with the trains drawing power. The higher the current, the greater this is - and it is the reason behind the idea some 20 years ago to convert the Southern third-rail system from 750V DC to 25kV AC. As trains got heavier and less efficient, they drew more power, and the more power drawn, the higher the transmission losses. More sub- stations are needed to support the system and that gets expensive. Third-rail systems in busy areas typically have transmission losses of around 15% to 20%. Lightly used third-rail lines have lower transmission losses. On the third- rail, the standing losses, when no trains are running, are minimal. At the higher transmission voltage, 25kV, I'R losses are significantly reduced for a given power (which is voltage times current). The resistive loss is not worth worrying about, say 2%. I say that because there is very little that can be done about it so why worry? National Grid power lines lose about the same amount, but because they are even higher voltage (275 or 400kV) the current is not the biggest problem. These cables are high up on pylons, not just for safety, but because they form a capacitor with the ground. Capacitors store electricity and discharge when the voltage drops or reverses.

HIGHER LOSSES WITH DE

So, what changed? That would be the great innovation of Disingenuous Electrification. I'm not talking about the odd dead section under a bridge, but the long sections of no electrification which need correspondingly long single phase 25kV cable runs. These cables are heavily protected or buried to avoid them being nicked or someone putting a shovel through them. The cable now has a significant capacitance, which increases with length. A DC cable, as on the third- rail network, has no problem of Capacitance, since it charges when switched on and that's it. That is why DC is used for long undersea cables. However, a 25kV AC 50 Hz cable's distributed capacitance needs to be charged - and being AC, this happens 50 times per second, so there is a significant standing load even when there is no power being drawn. This is called reactive power, which is why some of you studied imaginary numbers in sixth form. These are used for out-of-phase currents.

What it is called doesn't matter, but the operator still must pay for it because the supply must transmit it. Put the wire above the train (as is the obvious thing to do) and it is not a concern (because the capacitance of the overhead is very low) but put it down a buried cable and it is a concern - it really is.

ALL DAY AND ALL OF THE NIGHT

This is happening all the time the wire is energised, night and day, irrespective of traffic levels. Transport for Wales probably expected all the grief it is getting with changeover sections and losing the odd pantograph, although it will be wishing it had bought better balises. What it may not have expected were these capacitive losses. It looks like 25% (there are a lot of cables)! One quarter of the electricity bill is for lost power, another penalty of disingenuous electrification. Don't be fooled by claims it is 7%: that is the percentage of losses when powering trains, but of the total power, day and night, it will be about a quarter. This will continue every hour of every day, so can we please pull the plug on this mad corruption of the best thing that ever happened to railways and make electrification great again?