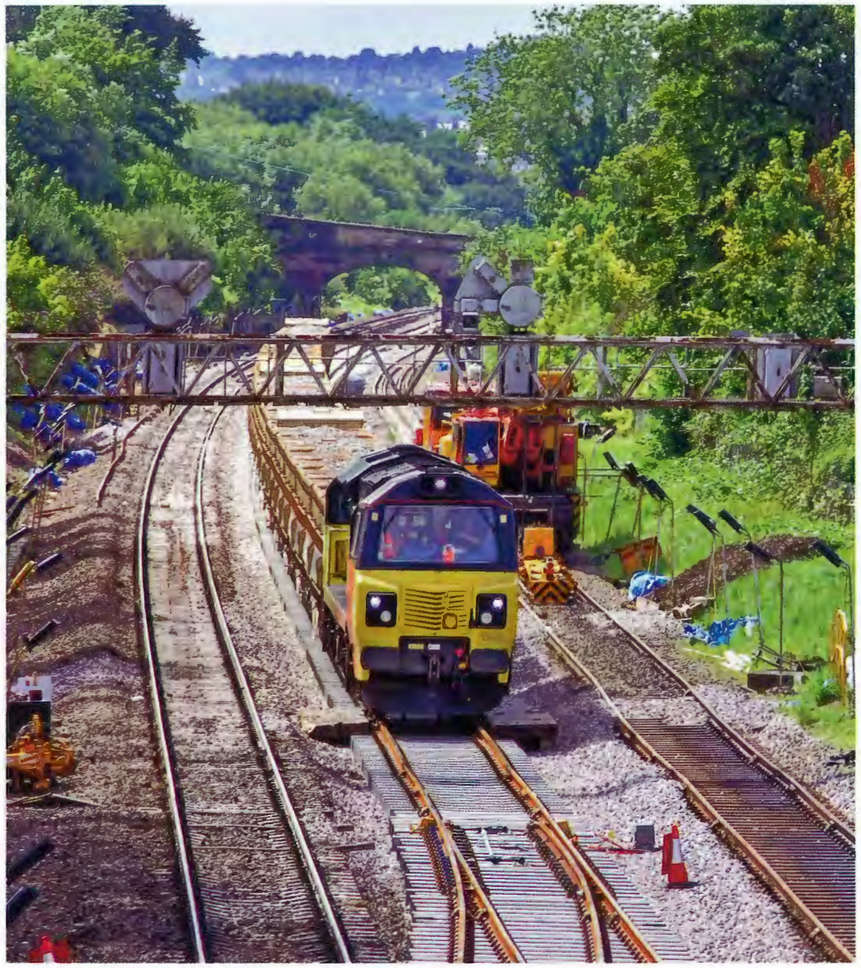
Roger Ford

NOW IT'S £3 BILLION
GW ELECTRIFICATION COST SOARS

That's six times the cost per single track kilometre of the East Coast electrification



Great Western modernisation: No 70807 heads a consist of ballast side-tippers at Bathampton on 12 August 2015. M. John Stretton

It was the nearest thing to a 1930s Soviet show trial you are likely to see in 21st century Britain. All that was missing was the 'wreckers' – Network Rail Chief Executive Mark Carne, Office of Rail & Road Chief Executive Richard Price and Department for Transport Permanent Secretary Philip Rutnam – being forced to shuffle in with no laces in their shoes and clutching their beltless trousers.

And while it would be a parallel too far to link Stalin's Prosecutor General Andrey Vyshinsky with the Commons Public Accounts Committee (PAC) Chair Meg Hillier, the questioning was at times brutal. It is not every day that the ORR Chief Executive is asked three times why he has not resigned yet.

But the PAC had every reason to be on the attack. Just two hours before the hearing on 21 October, Ms Hillier had received a letter from Mark Carne revealing that the forecast cost of the Great Western Electrification Programme (GWEP) was now put at between £2.5 billion and £2.8 billion at 2012 prices.

And note that '2012 prices'. Inflated to current prices that is £3 billion. Pause the narrative while we consider the enormity of that sum, which the 'witnesses' seemed to think merely disappointing.

That £3 billion pays for just the electrification. Project Director Don Heath delivered British Rail's modernisation of the East Coast main line (ECML) on time and on budget for just under £2 billion at today's prices. That £2 billion covered electrification, resignalling – including new Integrated Electronic Control Centres (IECC) at York and Newcastle – plus a fleet of 140mph tilt-upgradable electric trains.

SPURIOUS

Asked by Ms Hillier whether the range indicated continuing uncertainty over the final cost, Mark Carne came up with an incredible excuse. GWEP 'is far from completed', he explained, adding, 'we are about a third of the way through this project at the moment, so of course there are still a range of costs – as there would be in any project of this scale and complexity'. The spread reflects the uncertainty around the delivery of the programme compared with the 'frankly spurious accuracy of a single number'.

Note that 'of course'. Mr Carne's career with Shell included responsibility for the company's North Sea oil and gas platforms. When Shell was building those complex platforms did contractors come up with 'a range of costs' a third of the way through the project?

I very much doubt it. More likely Shell placed fixed price contracts with delivery dates backed by bonuses and penalties.

To get Department of Transport and Treasury approval for the ECML upgrade back in 1984, British Rail had to come up with a business case based on a tight budget in which the revenue boost from the timely start to the new electric services played an important part.

SOMETIME?

Talking of delivery, when the interrogation switched to Philip Rutnam he replied 'I'm afraid I'm not in a position to give you a schedule for Great Western electrification'. Quoting the original schedule, with London Paddington to Bristol Parkway, Newbury and Oxford wired in 2016, followed by Cardiff in 2017 and Swansea in 2018, he added that 'it is clearly highly likely that there will be delays against that schedule'.

Mark Carne added that 'at this moment in time it would be unwise for me to give a more precise timeframe'. This will emerge when NR Chairman Sir Peter Hendy completes his enhancements review, 'I hope, in November or December'.

Yet in March this year, no doubt quoting the brief provided by his Permanent Secretary, Transport Secretary Patrick McLoughlin had told the Transport Select Committee that while there was a 'huge amount of work' to do, 'once the roll-out starts' he hoped that 'further acceleration will take place and that the project will be completed within the timelines'. Oddly, I was getting the same message from a senior Great Western chum when I suggested that the lack of progress – including signalling schemes still at GRIP3 – meant the upgrade was at least a year late.

DISAPPOINTMENT

'Let me first say that obviously such a material increase in cost is a significant disappointment to me, my company and, most importantly, to taxpayers and the millions of passengers who are going to benefit from this upgrade to the railway when it is completed'
Mark Carne, Chief Executive, Network Rail – 21 October 2015

PRICE OF MILK

Central to the hearing was the lack of awareness of what electrification should cost. And I will confess again to being a boiling frog until I produced my comparison between GWEP and the ECML electrification (*Modern Railways* September 2015).

Table 1 shows the rising cost of GWEP, but also includes a boiling frog indicator comparing the cost per single track km with that of the ECML electrification. Which brings in the quart of milk test.

A quart of skimmed milk costs £1.10 in our local Sainsbury's. The question is, how much would it have to cost before you thought 'hell's teeth, that's ridiculous'?

Well, the GWEP scheme was meant to have better kit all round than the ECML so £1.50 for full fat organic Jersey might have got by. But over £2.00 would have been in 'you've got to be joking' territory.

Now here is ORR Chief Executive Richard Price being questioned by the PAC:

Meg Hillier: 'Mr Price, you signed this off a year ago at the original price and it has now nearly doubled. What have you got to say for yourself?'

Richard Price: 'Our role was what the project, once its scope had been established, ought to cost, delivered in an efficient way by an efficient company. What we have to do is hold Network Rail to account for its efficient delivery and that is what we have been doing. We established the cost of £1.6 billion for this programme last year and we stand by that as the cost of what it would take to deliver the project efficiently.'

Mr Bacon: 'So you stand by the £1.6 billion?'

Richard Price: 'We stand by that as what the project ought to cost if it was delivered in an efficient way. Two principal things have changed since then. First, Network Rail has understood more about the conditions in which it is doing the work. Its plan was to use high output equipment to conduct the electrification work; actually, in the circumstances on its network it has found it difficult to do that without, for instance, digging into signalling.'

Pause the narrative again. Mr Price is adamant that £4 is a reasonable price for a quart of milk.

This confirms my view that no one in Network Rail, ORR or the DfT has the first idea of what electrification ought to cost. Or, I suspect, any other railway investment for that matter. The price for each diagrammed IEP and the refusal to reveal the cost of the Thameslink fleet suggests that this equally applies to rolling stock.

NO ECAM

In a follow-up letter to the PAC on 26 October Mr Price warned that details of the costs quoted in Mark Carne's letter had not been given to ORR and had not been subjected to independent scrutiny. Mr Price added that 'some elements' of GWEP had yet to go through ORR's Enhancement Cost Adjustment Mechanism (ECAM). As if people who don't know the cost of anything adjudicating on the cost of everything would make any difference to the sheer unreality of the GWEP costs.

Adding to the confusion, Richard Price added that ORR's 'efficient cost' – a newly minted oxymoron – at £1.65 billion, applies to only Part 1 of the overall programme. This covers electrification of the routes between Maidenhead, Bristol, Cardiff and Oxford. Part 2 of the GWEP ECAM submission will include Cardiff to Swansea, the Welsh Valley Lines, Reading to Basingstoke and the Thames Valley branches.

Did Mark Carne's new estimates refer to Part 1 of GWEP or the anticipated final cost of all GWEP works? Mr Price didn't know. Couldn't he have picked up the phone and asked his mate Mark?

What I noted was the inclusion of the Valley Lines electrification within GWEP. As I understand it, Valley Lines is a separate project partly funded by Whitehall through the Welsh Assembly Government. The only link with GWEP is a possible shared National Grid power supply point.

Finally Mr Price explained why ECAM was so important. Any cost estimates should not be accepted until they have been subjected to independent verification and their efficient cost (oxymoron alert) established.

If the supply industry is presented with a cost which has not been subject to scrutiny, 'a value for money risk is created because Network Rail may work to an inefficient estimate and its supply chain may bid up to this amount', warns the ORR Chief Executive. The real value for money risk is Mr Price's acceptance of the £4 quart of milk.

TABLE 1: RISING COST OF GWML ELECTRIFICATION (2014-15 PRICES)

	Project cost (£ million)	£/single track km	ECML multiple*
July 2009	625	637,100	1.4
July 2011	850	866,460	1.9
January 2013	910	927,625	2.1
2013/2014	1,380	1,406,730	3.1
December 2014	1,700	1,732,925	3.9
October 2015	2,915	2,971,254	6.6

**Cost per single track km of GWEP divided by cost per single track km for ECML electrification at 2014-15 prices*

Check points carefully: road/rail machines at Bathampton on 12 August 2015. M. John Stretton

Roger Ford

GWEP COST EXPLOSION 'IGNORE THE HEADLINES'

Seen from the inside there are perfectly good reasons why GWEP is costing more

In his evidence to the Public Accounts Committee, Network Rail Chief Executive Mark Carne detailed the three principal reasons behind the cost increases 'across the electrification portfolio' which 'underpin the material cost changes'. In the case of GWEP the first factor was inadequate planning and scope definition of the project in the early phases. This was compounded by poor cost estimating, 'particularly on the portfolio as a whole on electrification projects'.

When it came to cost estimation, Mr Carne argued that since the railway has not carried out any electrification of any significance for 20 years, 'the cost base was out of date'. On top of that, today's railway 'bears no resemblance in some respects, to that of 20 years ago'.

Well, that argument may be comforting, but when GWEP was emerging around 2009, there were experienced estimators around who, as I did, applied ECML work rates to the GWML and produced informed ball-park figures. These gave a cost per single track km of around 50% more than the ECML.

According to informed sources, the increase centred on the Series 1 Overhead Line Equipment (OHLE) being more costly to erect, plus possession costs in today's railway.

OHLE

Despite being higher quality, the Series 1 OHLE itself costs the same per span (a span is one set of catenary and contact wire with its own support) as BR's Mk 3b equipment. While the components are more expensive, installation takes up fewer man-hours, thanks to off-site pre-fabrication. On the four-track sections costs are also about the same.

Just for the record, the last Mk 3 OHLE cost I have is around £135,000 per single track km (current prices). In round numbers this equates to £135 million for the GWML, although more demanding specifications introduced by NR may have increased that slightly.

Mr Carne's third reason for the cost increase was that the intended flexibility of the regulatory regime has changed following reclassification of NR's debt. 'Intended flexibility' refers to NR's ability to borrow against its Regulatory Asset Base (RAB).

FLEXIBLE FRIEND

This created a classic money-go-round. NR borrowed on the market to fund enhancements. When a project was completed its 'efficient cost' was added to the RAB. At each Periodic Review ORR calculated a return on the RAB and added it to NR's income. This return paid the interest on the borrowing.

For politicians, this 'Network Rail credit card' meant that they could authorise enhancements, secure in the knowledge that future generations would cover the cost. The cost of the interest, that is, because, as ORR eventually pointed out last year, the credit card was never paid off. As of April 2015, Network Rail's debt stood at £36.5 billion and the RAB at £53 billion.

Using its flexible friend NR could also borrow to fund cost over-runs. But, following reclassification, the company now has to live within its loan agreement with the Department for Transport, capped at £30 billion over Control Period 5. An initial £6.5 billion was made available in 2014, of which £2.4 billion was used to pay back existing bonds.

WRONG

'Fundamentally, the cost estimates were wrong.'
Mark Carne, Chief Executive, Network Rail, 21 October 2015

Pressing on: the scene at Langley on 7 November 2015, when the relief lines were closed for engineering work. Here the Furrer+Frey electrification design can be seen over the Class 165, with a cantilever over two tracks and back-to-back insulators. Ken Brunt

Are six bolts necessary? Base of mast mounted on pile. Ian Walmsley

GRASS ROOTS

So much for the view from the top. In a message to staff following the PAC revelations, Mike Gallop, Director Route Asset Management (Western), described how the cost increase came about, 'in particular in developing the OHLE system from an early stage to final design'.

At the start of the project NR sought to remove as many of the failings of the BR Mk 3b OHLE equipment as possible. 'With this in mind', Series 1 was developed with Swiss manufacturer Furrer+Frey. In addition to the potential for 140mph running, Series 1 is safer, simpler in design, more reliable and has a longer life span.

However, because the applications had been limited to Swiss railways, 'considerable work was required to develop the design to a standard usable on our network.' 'Despite this cost', Mike Gallop says that Series 1 was 'unquestionably' the right long term decision. 'By investing in better equipment now we reduce our dependence on public subsidy in the future.'

Well yes, but how much does it cost to adapt an existing OHLE design to make it work on the UK network? Series 1 is an elegant piece of engineering with the minimum number of components. You would be hard pushed to spend £10 million on a complete redesign, which is not even a rounding error in the GWEP cost scheme of things.

Was there any attempt at value engineering? Note Ian Walmsley's photo of the base of the mast mounted on its pile (above). Why six bolts when four would do? Actually I don't like the look of it at all, but that's just me.

PILLING

On the piling delay, Mr Gallop confirms that in many cases test pits are having to be dug by hand to ensure that the pile will not cut buried or hidden signal cables. According to informed sources, in the ECAM submission NR forecast that 80% of OHLE construction would be delivered using high output methods with a lower unit cost. Currently, 80% of the work is being carried out using conventional techniques.

ORR's ECAM assessment assumed 18 piles per shift from the purpose-built High Output Plant System (HOPS). This was based on 14 piles per shift on tests. Currently NR is achieving eight per shift. On the ECML, the purpose-built Plasser SCPV14 self-contained piling machine averaged four to five foundations an hour.

When it comes to erecting masts on the piles using the HOPS, ORR assumed 14 per shift. Over the last eight months informed sources claim an average of 16 per week (2-3 per shift).

LOCAL CONCERNS

A further source of extra cost is the consultations and consents process which has been 'much broader and more involved than planned'. Some of GWEP is outside Permitted Development Rights and NR has occasionally gone beyond normal consent duties because of the extent and impact of the work on local communities.

Individually, comments Mr Gallop, these are minor costs, but GWEP includes 'over 2,000 consents across 250 miles of track, through three areas of outstanding natural beauty, a UNESCO world heritage site plus over 150 bridges and other structures which need to be rebuilt'. In this situation 'costs mount up quickly'.

His conclusion, while clearly intended to rally the troops, may raise a few eyebrows. 'What we are building is historic and will benefit generations to come long after the work itself is complete. So ignore the headlines; we're doing the right thing with the right team. Let's press on.'

Roger Ford

BI-MODE LIMITATIONS

Inspiration delivered: the third pre-series IEP train (T2) at North Pole, as part of the IEP testing programme. Courtesy Hitachi

Lots of motored axles really won't compensate for sheer grunt

Back in 2008 ('Informed Sources', April) I displayed a generosity I now regret. At that time the full length 10-car Inter-city Express Programme (IEP) bi-mode still had a 2MW (2,700hp) diesel power-house at one end and a 2MW transformer at the other, both feeding distributed traction packages down the train.

Having laid my hands on the IEP technical specification I was bombarding the Department for Transport press office with so many supplementary questions that they decided to cut out the middle man. A conference call was arranged with two civil servants: Stuart Baker, Divisional Manager National Projects, the Department's sponsor for IEP; and Derek Chapman, Deputy Director Technical.

When during the call I suggested that the 10-car bi-mode IEP with one power house might struggle a bit over the climbs between Edinburgh and Aberdeen a strange conversation ensued.

I was pointed at Appendix DIII in the Invitation to Tender and asked to note the journey times specified for the 260-metre train under 'self-powered operation'. This gave an Edinburgh-Aberdeen journey time, excluding station dwell times, of 137 min against the 158 min in the current timetable.

When I continued to doubt, I was told that the usual train acceleration curve does not apply when you have a power house supplying distributed traction in an EMU. The kindness was that I did not name what I believed to be two misguided chums.

LEGEND

Which meant that what I think of as the Baker Heresy continued to flourish. When announcement of the preferred bidder appeared imminent, DfT prepared a media 'Q&A sheet' in response to 'issues raised in the national press, the rail technical press and by industry stakeholders'.

One answer explained that 'the higher number of powered axles on an IEP long bi-mode means that journey times when not under the electric wire will be comparable to HST, despite the higher installed power of the HST'. It continued 'despite the long bi-mode train (in self-powered mode) having less installed power than an existing HST, train running times will be comparable on the non-electrified sections as the bi-mode IEP train is much more capable of deploying its power at the rail during acceleration than an HST. Even the non-electrified section between Edinburgh and Aberdeen should be slightly faster'.

In vain over the ensuing years have I run mini O-Level physics tutorials explaining that the simple formula 'Power equals Speed times tractive effort' means that a good big-un will always beat a good little-un. I even got my erudite brother to model a drag race between IEP bi-mode and IC125. Yes, the IEP took off like a dose of salts but 160 seconds and just over two miles after the start the IC125 caught up and took the lead, travelling at 80mph to the bi-mode's 72mph.

But like all such comforting canards – the latest is the claim for 40% more track capacity with European Train Control System Level 3 – the low speed acceleration advantage became received wisdom.

'When the legend becomes fact, print the legend' as the newsman said in the western *The man who shot Liberty Vallance*.

SAVED

In the following years Hitachi redesigned its train to save the project. IEP is now an electric multiple-unit and the bi-mode a DEMU with underfloor engines.

DfT has allocated 36x5-car bi-modes and 21x9-car EMUs to the Great Western fleet. These will replace 58 IC125 sets following electrification.

When Great Western's order for a separate batch of Class 802 Hitachi bi-mode derivatives, known as AT300, to replace IC125 on West of England services was announced, there was a short-lived frisson of excitement. The press release revealed that the diesel engines would be uprated.

This confirmed earlier reports that the standard Class 800 bi-mode couldn't match IC125 timings over the Devon banks and led to the further revelation that the MTU V-12 engines under the Class 800 IEP units are de-rated from the nominal maximum 700kW (940hp) to 560kW (750hp) in the interests of reliability. Should a bi-mode lose an engine in service, the other two are automatically cranked up to the full 700kW.

PERFORMANCE

That the Class 800 engines are slugged wouldn't have mattered had electrification gone to plan. Entering service in 2017, they would have zipped along at 125mph under the wires, then fired up the engines to run at up to 100mph on non-electrified routes. But assuming, as we must, that energised overhead line electrification west of Airport Junction will be minimal by then, the self-powered performance of the Class 800 has become of prime importance.

This is clearly a sensitive subject. Even DfT's Train Technical Specification is unclear. On the one hand it says: 'The IEP Trains must have a maximum service speed of at least 125mph and shall be able to achieve that speed on the whole of the IEP Network'. But then it accepts that 125mph may not be achieved 'in the case of an IEP Train containing Bi-mode IEP Units operating in Self Power Mode'.

It took a series of Parliamentary questions to cut through the obfuscation and get DfT to confirm that the Class 800 could actually run at 125mph under diesel. I suspect that there may still be issues in the IEP contract, since high mileages with the little MTUs wailing their hearts out day in, day out, is not the duty cycle that Hitachi or MTU anticipated.

FORMULA

But more important is performance and the formula power equals speed times tractive effort. Here the Class 800 is a strange beast.

Because of the DfT's obsession with initial acceleration, the five-car Class 800 has a starting tractive effort of 200 kiloNewtons (kN) compared with the modest 160kN from the two power cars of the IC125.

So it will accelerate like a Class 313, but that acceleration lasts only up to 13mph when the formula cuts in and the tractive effort falls. Given that inter-city passengers don't like sudden acceleration; that, unlike a Deltic engine in a fast patrol boat, the MTUs won't go from idle to full power in a trice; and that professional driving doesn't see the power controller as an on-off switch, it is unlikely that the bi-mode will have more than a few seconds at maximum acceleration.

In the past I have used horsepower per tonne as an indicator of performance. Here a five-car Class 800 in diesel mode scores 9 against 10.8 for a 2+8 IC125.

I have recently developed a new measure, which may get me ostracised by traction engineering chums. Anyway, kN of tractive effort per tonne should give an indication of acceleration and performance on gradients.

Of course, it is a one-dimensional parameter, because as speed increases, so does resistance to motion. But it suggests that, as with my brother's analysis, the Class 800 starts the stronger, falling behind the IC125 after 37mph. In confirmation, Virgin has expressed doubts about the ability of the East Coast bi-modes to keep to current timings on services north of Edinburgh.

ALL DIESEL

As already reported, DfT has confirmed it is discussing with Hitachi the option of having the 21x9-car Class 801 EMUs for Great Western supplied as bi-modes. Since these are the last of the Great Western Railway fleet to be delivered (during the first half of 2018) this suggests that in its heart of hearts DfT suspects that GWEP is going to be really, seriously, late.

But is that a sensible move in terms of performance? Notionally, a nine-car Class 800 would have five engines. But that would mean even fewer hp/tonne and thus worse performance than a five-car.

TIMETABLE

At the beginning of November the Liberal Democrat transport spokesman in the House of Lords asked what analysis had been made of 'the impact of having diesel and electric engines fitted to the new Hitachi Great Western main line trains on journey times between Paddington and Cardiff, and between Cardiff and Swansea'. The reply confirmed that DfT 'is analysing the impact of Great Western electrification delays on the configuration of the IEP fleet. The analysis is looking at the timetable implications including journey times and capacity'. It added 'the analysis will be informed by the recommendations made by Sir Peter Hendy. No final decisions have been made'.

There's more to this than speed. Up in the Highlands there are suggestions that time lost over the long climbs could be recovered through shorter dwell times with IEPs compared to HSTs. Door opening and closing times are 4 sec and 8 sec respectively.

But on GWR station stops are likely to be longer with IEP.

When IC125 entered service 40 years ago next October, Western Region was running the fastest services in the world outside Japan. But shorter journey times extended commuting distances and over four decades an InterCity route has morphed into an outer suburban service with growing demand for and at intermediate stops.

A long thin tube with narrow doors and a vestibule at each end is not what you want for commuter traffic. And the 800 series vehicles are longer than the IC125's Mk 3 coaches.

Already, the station dwell time for a West of England IC125 at Reading can be 3 min. What GWR needs is a fleet of outer suburban 110 or 125mph EMUs with wide doors and an interior optimised for commuting.

TIMING

While we used to talk of GWR's new electric timetable starting in May 2017 it is not that straightforward. In fact it is a lot more complex.

According to the IEP Great Western Master Availability & Reliability Agreement (MARA), the first two Class 800 units become available for service on 8 June 2017. Delivery then runs at one unit a week, with two more sets being available for service at fortnightly intervals.

Note that under the IEP deal, Agility Trains guarantees to cover diagrams, so the number of sets available will be less than the number delivered. For example, the 36 Class 800s for GWR will cover 32 diagrams (89% availability).

So the 2017 'electric' timetable would have been operated with IC125 for the first month or so. With each five-car Class 800 costing £325,000 a month it is clearly in everyone's interest to replace IC125s as soon as Class 800s become available, whether the wires are up or not.

But a high-capacity GWR IC125 has 560 seats versus 309 for a five-car Class 800, hence, I imagine, the bi-modes being handed over in pairs. For reference the nine-car Class 801 will have 620 seats. These will also become available in pairs, starting on 1 March 2018.

I wonder how much it would add to the monthly £325,000 to run the GWR bi-modes at the full engine rating? And would it invalidate the reliability commitment?