Transport Decarbonisation Options and the Cambrian

A briefing paper for SARPA.

1.0 Precis: *Should Cambrian rail users be concerned about the transport decarbonisation option being chosen for their line and how it effects their services? In short, the answer is most definitely yes, exploration of the subject reveals that choices could be made that would be to the detriment of services to current users of the line, damage the prospect of freight returning to the line and increase its operational costs. In addition, there are several loose ends around the subject of Transport Decarbonisation per se. How they will play out in the real world that the current narrative of "it will be all right on the night as technology will provide answers" - is not actually answering.*

1.1 Sources: firstly, to be clear social media was not consulted in the compilation of this briefing! Secondly no individual comment or figure has been referenced as this is meant to be short internal briefing document not a forensic document. Trade magazine such as "Modern Railways" and "RAIL" have been consulted, industry websites of various companies including International Union of Railways a body which shares best practice across Europe was particularly enlightening and mainstream media articles. The subject matter is constantly evolving and what is beneath is where the author believes were current a few weeks before the COP26 summit in Glasgow. - (November 2021).

2.0 Background:

We are all familiar now with the target to reduce greenhouse gas emitting pollution to net zero by 2050. Whilst other sectors have made significant progress in reducing their emissions over the last couple of decades transport has lagged badly behind, **notably road transport**. It should be noted that pre pandemic rail accounted for 10% of all passenger Km and 10% of all freight tonne Km in the UK but just 1.4% of the transport sectors total emissions. Simply moving traffic off the roads and onto to rail would go a long way to reach targets. A shift of 1% of passenger road trips to rail is equal to a 18% increase in passenger rail usage and a 12% increase in passenger rail Km. However, the rail sector has to be rid of diesel propulsion by 2040 (an aspiration) and be carbon net zero by 2050 (legally binding), despite this Transport for Wales has procured and has continued to proceed with introducing brand new Diesel Multiple Units for our line (and others in Wales and the Borders) due in service in December 2022.

Network Rail has produced a draft Network Decarbonisation Plan (2020) that has not been signed off or funded by the Westminster Government yet (rail infrastructure is not devolved to Wales). As alluded to above the Welsh Government procured the replacement Wales and Border franchise (awarded 2018) not taking transport decarbonisation into account. With the budget due on

27th October 2021 setting out a 3 year funding window and whole slew of delayed financial announcements are expected.

Network Rail identified three options for rail decarbonisation. Electric power, hydrogen power and battery power (plus combinations of electric/battery & hydrogen/battery). Whilst a large percentage of the UK train services are already electrified (but not as great as our continental neighbours in Europe), a further c13,000 single track Km needs to be done at a rate of c450 Km per year by 2050. Around c1,300 Km are identified as being earmarked for Hydrogen power and c800 Km for battery. Some c2,000 single track Km earmarked to be electrified are used by TfW services, c360 single track Km by hydrogen and c35 single track Km by battery. This is a Network Rail plan which it has made based on existing pre covid traffic patterns, with no change in demand brought about by decarbonisation of the road sector or long term impact of Covid/Brexit. Whilst on the roads the official Government line is that we will all have electric cars, and the technology will develop for decarbonized HGV's (which currently does not exist).

There is strong support for widespread electrification within the rail industry, stakeholders and lobby groups whilst it is known the DfT are keen on a greater proportion of hydrogen powered lines. The Scottish Government has pinned its colours to a rolling programme of electrification with hydrogen power solely for its long remote rural lines with frequencies of less than 1 tph in the West of Scotland and the Far North. The new term (elected May 2021) Labour Welsh Government announced in its programme of action a rather limp wristed commitment to lobby for the electrification of the North Wales Mainline and an aspirational target that 45% of all journeys are active travel or by public transport by 2040, up from 32% today.

3.0 What do we know?

3.1 Current Plan (as best we can surmise from what is published already) –in Network Rail's draft plan the Cambrian Lines(Shrewsbury to Aberystwyth and Machynlleth to Pwllheli) are earmarked for hydrogen powered trains as are the Heart of Wales line (Craven Arms to Llanelli) the other lines into Shrewsbury are all earmarked for electrification. There is no indication on timescale aside from the elimination of diesel haulage by 2040, however the line between Wolverhampton (Oxley Junction) and Shrewsbury (c28 miles) would appear to be an early candidate to be electrified as plans for the West Coast Mainline post HS2 construction have consistently included an hourly frequency Euston to Shrewsbury InterCity service that would need wires and the Midland Engine proposals have been repeatedly floated and campaigned for including it.

A CAF Civity Diesel Unit in Transport for Wales livery. (Wikiampyx/Wikipedia)

When tackled about ordering diesel powered trains the stock answer from TfW has been that the CAF “Civitys” (the units to be used on the Cambrian) can be converted to alternative traction. Which method of traction, how, cost, timescale and implications are not mentioned. The CAF Civity platform is a standard off the shelf product in service across Europe predominantly using electric power it might be relatively easier to convert DMU to EMU but other traction options are an unknown. However, we do know that 5 Northern EMU Civitysare planned to be made into hybrid electric/battery trains so they can run down the 11 mile Windermere branch from Oxenholme on battery power and maintain through services to Manchester using electric overhead wires at a cost of £3 million per unit. The same cost as buying c. 2 new EMU carriages, though it’s understood the Northern CAF Civitys will increase from 3 car to 4 car in length as part of this project.

It would be safe to assume given what is in the public domain that TfW are hoping that the yet to be introduced CAF Civitys(which should have a service life of 30 to 35 years) can have a midlife refit and be converted to hydrogen power at some point before 2040.

The UK rail industry's track record on converting traction type on older units is not good. A May 2018 announced project to convert a 1980s Electric Multiple Unit – a Class 321 to hydrogen power has yet (September 2021) to be seen running. It is understood that due to the volume of space needed to store hydrogen fuel a section of the passenger compartment is being given over to store hydrogen with 3 car 321s being proposed as replacements for 2 car DMUs in the North East of England to have the same seating capacity. TfW has already had a bad experience with conversions with redundant Thameslink EMUs being converted to diesel power, ordered in July 2017 and supposed to be operational before the ATW franchise expired in Oct 2018; they have only in the last few months run in fleet strength in S. Wales. The conversion of redundant London Underground tube stock (D Trains) as a supposed low cost quick alternative to new stock for use in the regions has also taken years to get a working train function in fleet service.

There would seem to be inherent risks in assuming units can easily be converted from one type of traction to another and there is a cost /opportunity cost implication of going down this approach.

Also perhaps even more pertinent to the Cambrian is the associated loss of passenger accommodation to store hydrogen in conversions. How many seats will be left once you covert a 2 car DMU?

3.2 Implications to Services- Cambrian services currently run through to Birmingham International and form a complex operational circuit with trains running from Holyhead to Birmingham via Gobowen. With that route earmarked to be electrified it seems unlikely that the current integrated service pattern can survive, for a start there is no example we can find of hydrogen and electric powered trains being able to operate coupled together. Choices will have to be made as to who has priority to run to Birmingham.

From an operational point of view, terminating hydrogen trains at Shrewsbury and allowing electric ones from Chester and North Wales to continue to run to Birmingham is a less complicated option. With hydrogen trains earmarked to run over the Heart of Wales line, some degree of operational integration with units running this line seems a likely option. This option would also cut down the number of units that need to be converted to hydrogen power if they weren't needed to run through to Birmingham International (and reduce cost).

There could be a change of traction gap with the wires reaching Shrewsbury from Wolverhampton maybe a decade before the Cambrian conversion from diesel traction. Will "smelly polluting Welsh diesels" be welcome in the West Midlands? Shropshire Stakeholders have already expressed a preference for direct services to the East Midlands over Cambrian services.

Cambrian trains seem likely to be terminating at Shrewsbury in the future.

4.0 Rail Decarbonisation Options.

Its perhaps a good point to compare what electric, hydrogen, battery traction can and cannot do for rail compared with diesel. Fundamentally the broad headlines have not changed since the article in July 2018's SARPA Newsletter - despite the DfT's blind adherence at the altar, that technology will overcome limitations.

4.1 Diesel

Advantages – go anywhere, carries own fuel, good range typically can travel c500 miles without needing refuelling, relatively good power to weight ratio, top speeds 70 to 100mph. Can handle all types of traffic including freight except very High Speed.

Weaknesses – environmentally damaging, noisy, increases weight of trains therefore more track wear.

4.2 Electric

A Class 323 EMU at Birmingham New Street (Hugh Llewelyn/Wikimedia Commons)

Advantages – high power to weight ratio, range only limited by presence of bespoke infrastructure. Excellent acceleration, Top speeds can easily be in excess of 100 mph. Can handle all traffic including High Speed and freight. Lighter trains meaning lower track wear. Quiet. Well proven technology substantially more reliable than diesel. Can be powered by green electricity.

Weaknesses- needs bespoke trackside infrastructure to operate. There is a cost to installing this.

4.3 Hydrogen

Unveiling the Hydrogen powered Alstom Coradia iLint Unit. (FelixM/Wikimedia Commons)

Advantages- go anywhere, quiet, hydrogen can be produced using green electricity. Relatively good power to weight ratio, top speeds 70 to 100mph. Can handle passenger traffic up to 4/5 coach Inter Regional size trains and light freight trains. No bespoke lineside infrastructure.

Weaknesses- limited range due to ability to store enough fuel (for producing the same performance you need three times the storage space for hydrogen than diesel) – a freight hydrogen locomotive will only travel just over 200 miles before needing refuelling, thermal inefficiency of green hydrogen production means two thirds of power initially generated is lost in making, storing, and converting hydrogen before a rail wheel is turned - meaning cost/opportunity cost implications. Reliability versus other power modes currently an unknown. Safety is currently an unknown – historically, carrying substantial quantities of highly inflammable gas around on passenger trains does not have a good record.

4.4 Battery

Stadler Class 777 on Battery Electric Trials in Liverpool (Ross McCall/Wikimedia Commons)

Advantages – go anywhere, quiet, can be recharged by green electricity. No bespoke continuous lineside infrastructure.

Weaknesses- limited top speed c70 mph, limited range c60 miles maximum for battery multiple units, can only power low speed low frequency smaller regional trains, a freight battery locomotive will only travel just over 100 miles before needing recharging, similar in weight to diesel power so continued higher track wear, needs bespoke recharging facilities. Batteries only have life of c 5 years then need replacing. Cost implication in train with typical expected service life of 30/35 years. Reliability versus other power modes currently an unknown.

There are limitations to both hydrogen and battery technology (as they exist - not what it is hoped it would be). The rail freight sector is crystal clear to power decarbonised freight trains you need electric power and the piffling ranges and power available from battery and hydrogen simply don't cut the mustard for heavy trains.

4.5 Engineering Train Conundrum – engineering trains are essentially freight trains that carry materials for Network Rail. The Cambrian (and other long lines in rural/peripheral areas) are earmarked for hydrogen power but it's clear that an engineering train (or indeed freight) won't have the range to run onto the Cambrian and get back from depots in England i.e Bescot, Crewe etc. Taking the recent ballast trains running in association with work on the Black Bridge the

locomotives were running from Crewe to Machynlleth every night which is on the absolute limit for hydrogen locomotives and well beyond batteries range…and we have not got to the coast! Will we have to expensively preposition multiple locomotives to swap over and pull the wagons like horses and stagecoaches? We do know the official line of "technological advances will overcome this" is still being peddled. But what if this does not happen?

5.0 Wishful thinking?

5.1 DfT's (and their predecessors') not so magic crystal ball that doesn't predict the future - lets take a ride back in a time machine to the early 1990s and speak to the inhabitants of Marsham St (DfT HQ). They were clear they thought railways were a declining Victorian mode of transport whose discussion in any future planning was how to manage their decline. There was some concern about pollution from motor vehicles but DfT had been reassured by the motor vehicle/oil industries that a technological solution was just around the corner and anything nasty would be caught and dealt with in the exhaust systems of motor vehicles. Wind the clock forward 30 years and DfT officials are snowed under by rail reopening proposals, station reopening proposals, are overseeing building a High Speed railway connecting 80% of Britain's major cities to London, rail use had more than doubled to the start of the pandemic and that magic pollution solving bit of technology promised for motor vehicles -what happened to that?

Back in the 1960s the Reshaping Britain 's Railways Report confidently predicted that long distance internal UK travel would be undertaken by aeroplane and 75% of adults would own a motor vehicle by 1984. Both things that have never happened, only recently responding to criticism that the rebuilt East to West railway is not being electrified the Transport Secretary claimed by the time it was built there would be no need to electrify it as some unspecified all singing and dancing new fuel source without the limitations of current hydrogen and battery technology would be available. Back in 2006 when DfT took over leadership of the project to replace the venerable BR HST it dismissed electrification for the very same reason. Future self powered technology is just around the corner, the DfT confidently proclaimed in 2006 (15 years ago and still no sign of it). Every IET (the replacement train for HST) has a pantograph and runs all if not part of its journey under overhead wires drawing power from them. The largest ever single infrastructure project in UK history- HS2 is being powered by guess what – that's right overhead electric wires.

King Canute had more luck with holding the sea back than DfT has had with predicting the future. Would you bet your house on DfT being right about future technology overcoming limitations or even bet your cat's basket?

5.2 What are the real reasons behind DfT's feet dragging on electrification? The current Westminster administration was elected in December 2019 with no firm commitment toward decarbonising in its manifesto instead "the largest road building programme since the Romans" was promised. However transport decarbonisation is legally binding and the reality is state owned Network Rail would either have to be funded from Government to electrify its network or add to Government borrowing and or cancel other projects to fund it. Saying diesel traction will be banned by 2040 and then promoting alternative self-powered trains pushes the problem of expenditure on decarbonisation at least partly onto the private sector through the Rolling Stock Leasing Companies – though Government will eventually have to pay a proportion through support to Great British Railways. In addition, its long been the Holy Grail of the Civil Service to "transfer risk to the private sector" so not wanting to spend money allocated for other things fits in with the mind set of civil servants. The DfT has also had a long-standing aversion to rail electrification dating back to the "good old days" when investment in the railways was to be avoided at all costs. There's still huge push back about moving away from the "roads are god" mind set. Big Oil has been lobbying aggressively for blue hydrogen seeing it as the way it keeps making profits using brown assets with promises of carbon offset and has seemingly been rewarded with Government's Hydrogen strategy where turning fossil fuel gas into hydrogen is now the new shiny policy. Ministers are also using hydrogen technology to claim that post Brexit Britain is world leading.

"Hydrogen hype" should be taken with a huge pinch of salt.

5.3 But isn't the cost of rail electrification prohibitive? Network Rail badly let everyone down with its cost overruns on Great Western Mainline electrification but since then lessons have been learnt and recent projects such as Bedford to Corby and in Scotland have come in at less than half the cost of GWML. The Rail Industry has forensically gone through what went wrong with GWML electrification and knows what the drivers of the cost increases were and how they can be brought down and are confident a long-term rolling programme will see costs reduced even further than "stop go" projects where expertise and economies of scale are lost. The current thinking is that dependent on complexity the cost of electrification ranges from £750K per Km for simple work to £2 million a Km in more complex areas.

Therefore 13,000 single track Km over 30 years is going to cost between £9.75 Billion and £26 Billion. As the plan is to do this over nearly 30 years to 2050 then per annum the cost is going to range from c£325 million a year to c£800 million a year. Assuming an average of £600 million a year (£1.4 million a Single-Track Km per year average/ £18 Billion total) what does that compare with?

The greatest road building programme since the Romans was pledged to be over £5 Billion a year during this current Parliament, so roughly 8.5 times the annual amount to electrify.

In Wales, Welsh Labour pledged in its 2021 election manifesto it would complete the dualling of the remaining section of the Head of the Valleys road- a 14km

stretch between Hirwuan and Dowlais in a PFI deal where the construction costs were suppose to be c £600 million and then a staggering £38 million a year supposedly to maintain it over the next 30 years. Which makes the cost of converting a single track road into a dual carriageway over a £100 million a Km! This project is now on hold as are all new road construction projects not started pending a review taking into account decarbonisation and future demand factoring in Covid/Brexit.

The £ saved by not ploughing ahead with the A465 project alone is equivalent to £58 million a year. This could be ploughed into Welsh decarbonisation projects beyond what Network Rail/ Westminster will be funding.

6.0 Decarbonisation on the roads.

Meanwhile Westminster believes it can decarbonise the road sector without any hard choices having to be made on using road vehicles less despite recognising this when decarbonisation was originally looked at seriously, indeed future road traffic growth is still being predicted by the DfT. However there is a lot scepticism from outside Government whether this position is tenable for a variety of reasons, some of it is genuine concern on various issues, some of it is being stoked by sources previously noted for their climate change denial who now rail against cost and implied negative impact on economic development of action, whilst others see policy driven by political considerations of wanting to look to do something but not wanting to upset core voters or rock the status quo pandering to vested interests.

6.1 Private Vehicles – without doubt the technology is here already to have private cars powered by batteries that perform similar to those powered by the internal combustion engine. The top concerns are as follows:

1. Range Anxiety.
2. Cost.
3. Charging Infrastructure.
4. Can the National Grid cope with all those cars that need charging up?
5. Does the planet have the resources for all those rare metals in batteries?
6. How will the Treasury replace fuel duty?

Issue 1 is an area where technology has advanced: 20 years ago a battery car could barely do 20 miles without recharging today 200 miles is the norm. It's pointed out that 60% of all UK car journeys are under 5 miles and less than 3% involve driving more than 100 miles in one day. Is the range anxiety issue largely a red herring whipped up by climate delayers? So is Issue 2: once we move to mass production costs will come down as have windfarm construction costs and most believe that the cost of charging your vehicle overnight by electric will be cheaper than buying fuel at the pump (This brings its own set of issues of course!).

Boris Johnson promised we would all be charging our electric vehicles overnight outside our own homes allegedly ticking off issues 3 & 4, with home chargers on all driveways and using cheap overnight electricity when the grid is used less. However a cursory examination of the subject reveals problems for a start, with 28% of all UK households terraced houses the bulk dating from before 1919 and a further 20% flats there's clearly millions of households that don't have access to secure off road parking outside the front door. Whilst most will not need to charge their vehicle every day or even every week the reality is a large number of vehicles may have to be charged away from home and not during the night for obvious security reasons. This of course draws on the national grid in peak hours increasing demand on it and the charge will cost more than those that can charge overnight. Inevitably this will impact more on those in older properties and those on lower incomes. Affluent middle-aged voters with detached/semi detached houses in the suburbs and non-urban areas would appear to be OK.

Issues 5&6 are the big elephants in the room - the consensus with rare metal consumption is clear – there's a finite amount of them and all the pointers are we need to think long term and use them wisely perhaps even ration them – completely at odds with DfT traffic growth predictions of 40 million road vehicles by 2050. The Treasury holds the real big key. Whilst fuel tax is a blunt "one size fits all" tool it's now possible with modern technology and road charging to devise a progressive tax system that doesn't penalise road users in deep rural areas with no / poor alternatives but penalises say the school run journeys of less than a mile in urban areas. However taxing motoring generates close on £30 Billion per annum and the Treasury will want to find a way to keep this sort of revenue.

The UK currently has 32 million private vehicles which spend 95% of their time stationary on average. Issues 3-5 are by default ameliorated by having fewer of them and using them less. Unfortunately the Treasury might not see it this way.

The Government's plan for carrying on as now with private vehicle ownership and usage growing forevermore doesn't survive any rational analysis. A change however belated will have to be made when reality bites and baby boomers addicted to driving are no longer the core voting cohort.

6.2 Commercial Vehicles.

The we can carry on as before mantra is here also however the post Brexit/Covid crisis in HGV Drivers mean there's other issues at play also.

Light Commercial Vehicles up to 3.5 tonne aka the transit van- yes these can be powered by battery like the car however with a similar range (c200 miles) before charging the issue is centred around how we use them: range and charging means it can't be like before.

Class 2 Large Good Vehicles (rigid body) – the Swiss are trialling Japanese made hydrogen powered lorries that can do 250 miles before needing to refuel. These have smaller payloads than articulated HGV's

Class 1 Large Goods Vehicles (articulated) aka HGVs – so far no one has developed a decarbonised HGV. Battery and hydrogen have the problem that the weight of batteries/ space needed for hydrogen to move such large vehicles means they have to severely compromise payload, research continues. Meanwhile reflecting this reality, we've seen proposals for "e roads" with lorries having a pantograph to draw power on Motorways/ A roads and then allegedly using battery power off them though all the trials to date see them reverting to diesel!

HGV Driver shortage – this has been rumbling under the surface for a long time with the cracks papered over by cheap EU drivers who are no longer in the UK. It's an issue that's deeper seated and more multi-faceted than can be rectified with some marginal pay increases. Road freight has very small margins and any cost increases will affect commercial competitiveness

Unless something magically happens, technology wise the pointers are that Inland freight is going to have to see massive changes to how it operates with transporting heavier loads and loads over longer distances by road no longer as easy nor as cheap.

Though not Government policy the road sector will inevitably have to move away from longer distance delivery to a more localised hub and spoke model concentrating on "last mile" delivery. This dovetails with the driver shortages crisis as a more local focus requires fewer drivers who can work more convenient hours.

The shores of Cardigan Bay are 200 Km plus from the national and regional distribution centres in the West Midlands that currently serve them, Newtown 120 Km and are therefore given the distances involved likely to be the sort of places most effected by any change in the provision of long distance logistics.

7.0 Conclusions

It would be fair to say the current Westminster Government is placing faith in technology partly as a means to avoid making hard choices that would be unpopular with sections of its core voters, sections of its own party and the mainstream right-wing press.

The issue is when not if the penny drops that those hard choices need to be made, the history of relying on technological advances suggests that they are not going to come through in the way hoped for it.

There's an underpinning generational divide in UK politics and by 2030 the numbers, power and influence of the "baby boom" generation will be weakened and younger voters who have different priorities and are far more amendable to environmental issues will start to outnumber them.

Whatever is decided now it will not be a forever policy.

Choices made at Cardiff Bay don't seem constrained by the same factors as by the UK Government, the money to do things differently has been there all along- the roads' budget yet it remains unclear whether Welsh Labour who seem to like the rhetoric over addressing climate change have truly made the leap away from road building and into action yet. Scotland will no doubt be further ahead and an example to follow once the Green/SNP deal is fleshed out and implemented.

7.1 Questions about Impact on the Cambrian – issues to be concerned about are as follows-

Early 2030s

1. Termination of Cambrian services at Shrewsbury.

Late 2030s onward

2. Costly and disruptive conversion of DMUs to HMUs.
3. Unknown operating costs of hydrogen v electrification.
4. Loss of passenger accommodation on trains to accommodate hydrogen conversion.
5. Increased cost of running Network Rail trains and any bespoke heavy freight/excursion traffic.

The long-term nature of the plan means SARPA has time to react, formulate policy and lobby. In addition, answers will emerge to wider issues over time that will inform debate/policy/choices.

8.0 Priorities for SARPA

Number one priority has to be to fight to retain through services to Birmingham.

By the mid 2020s the costs of converting existing rolling stock to hydrogen and the cost of running hydrogen trains in service versus wiring and cheap green electric without the thermal loss of making green hydrogen will become clear once current trials come to fruition. The answer could be that wires or a combination of overhead wires/battery running turn out to be cheaper whole life cycle option than hydrogen.

Number Two priority is to make sure the best decarbonisation choice is made for the Cambrian not the choice that is the current political flavour of the month. On past form by 2050 we will have gone through at least another dozen Westminster transport secretaries.

8.1 Modal Shift- freight.

Even a relatively slight change in how we do things now can have a potentially big impact on the Cambrian. If we can't develop a genuinely decarbonised Heavy Goods Vehicle the logistics of UK inland freight will have to radically change. Even if we can get a battery or hydrogen powered HGV it is likely that the payload able to be carried and range will be smaller than today's vehicles

and with an industry that has deep seated long term problems recruiting drivers needing more of them to carry the same is not credible.

Smaller payloads, less range and recruitment problems all point toward longer distance freight movements in the UK needing to move to rail over time with a hub and spoke model adopted. The Cambrian has not been in a fit state to handle genuine mixed traffic since the mid 1980's and a lot of investment would be needed to make it capable once more. In the shorter term moving parcel/letter traffic back onto rail on the Cambrian only needs secure space on passenger trains.

Number Three priority whilst we are a Rail Passenger Association is to have a freight policy and does this involve trade offs? i.e fewer passenger trains to allow freight

8.2 Modal shift- passenger.

The disparity in usage figures between road and rail trips is often used to try and justify further investment in roads over rail. However as noted above even small changes brought about by decarbonisation can lead to a massive increase in rail usage. If current road users undertake more local trips by sustainable means as originally intended by the DfT's Transport Carbonisation paper then they will be more amenable to rail trips over longer distances rather than automatically choosing the road vehicle. The frequency we fly may also reduce and therefore demand for foreign holidays as we are a holiday area the shift could see much more enhanced seasonal demand.

Number Four priority should be to continue the themes we already campaign on; through trains to West Midlands, capacity including hourly service and quality of rolling stock.

Annex 1 – Electrifying the Cambrian.

The length of the Cambrian is always going to make this a "non-cheap" option but it's important we have an idea of what it involves and cost so we can compare other alternatives if nothing else. This is a desk exercise with some base assumptions but the authors do have local knowledge of the line unlike many consultants who charge big £ for their thoughts and then drop school boy errors in their reports as they don't have local knowledge.

The good news is that 95% of the Cambrian should be relatively easy and cheap to wire up. The big mistakes made on the Great Western Mainline that saw costs

balloon centred around inappropriate over specificized catenary, overhead clearance and buried cables. Needless to say we would prefer catenary appropriate for our line and not for withstanding earthquakes on very high speed lines as was put on the GWML. The Cambrian has no buried cables to worry about as we went from mechanical signalling to RETB and now ERTMS. We know where we have our cables and there are not miles of buried fibre optic to worry about. Overhead structures become fewer and further in between the further west you go, the Aberystwyth and Welch Coast Railway went out its way to avoid building them and we have fewer per route Km than the national average. Some bridges look OK to put wires under to a Mark 1 eyeball inspection whilst others don't. For instance, the new bypass bridge at the Welshpool end of Newtown has great clearance but the station footbridge doesn't.

The big issue is probably the tunnels either side of Penhelig Halt and whether you want the aesthetic of wiring on Barmouth Bridge. Using NR current estimate of £750 milion per single track Km for simple works and up to £2 million for more complicated works a ballpark figure the Cambrian is as follows. Assumed cost of £750K per STKm for 95% and £2 million per STKm for 5%.

- Cambrian Mainline Shrewsbury (Sutton Bridge Junction) to Aberystwyth – 135 STKm - c£120 million
- Cambrian Coast Dyfi Junction to Pwllheli 85 STKm - c£80 million.

If £200 million is a bit steep what about Ancillary Electrification? This is a combination of electric overhead wires and unelectrified sections or islands using bimodal trains with batteries for unelectrified sections that charge up whilst under the wires.

- Cambrian Mainline wired section from Newtown to Machynlleth – 50 STKm - £40 million
- Cambrian Coast wired section from Barmouth to Porthmadog 25 STKm - £20 million.

At £60 million this avoids wires on Barmouth bridge, getting wires through the Penhelig tunnels, avoids wiring under the more numerous bridges between Newtown and Shrewsbury and provides direct power for the steep climbs to Talerddig and Minfordd. Engineering, excursion and freight movements are then cheaper and easier. Though the cost of replacing train batteries every 5 years needs to be factored into whole life costs comparisons.

Annex 2 – a vision for what a decarbonised transport system looks like in Mid Wales.

Aim – a vision of what it could look like is a useful campaign tool to garner action and give the populace and politicians in Mid Wales an objective for their transport system, the local authorities in Mid Wales are already confused/ lost by the Welsh Government's moratorium on road building lets fill the vacuum.

Let's build on what's happening all ready.

- Welsh Government / TfW are still publicly committed to an hourly service between Aberystwyth and Birmingham starting in May 2024 and hourly summer trains between Tywyn and Pwllheli from summer 2023 (need to confirm)- the franchise commitments attached to the introduction of new CAF rolling stock.
- Welsh Government / TfW are now reported as seriously looking at a commitment of an hourly public transport option from all villages even in rural areas to their nearest town as part of their target to increase non car journeys.
- An increase in the share of non private motor vehicle based journeys within Wales of 40% is targeted by 2040.

Making the leap to a Taktfahrplan* from here is not hard or insurmountable. There's plenty of international best practice i.e Switzerland or the Netherlands to copy and learn from.

*fully integrated regular interval pattern timetable designed to optimise connections between rail services at a national level and local bus services.

To note

- The Swiss took 7 years to plan implement, deliver infrastructure improvements and buy rolling stock etc, train trains crews etc before the launch in 1982.
- A UK wide rail Taktfahrplan should use Birmingham New St as its starting point as it's pointless starting at Cardiff.
- Light Freight (parcels traffic) is the easiest thing to get back on rail and any planning should take this into account.

Phase 1 by 2030.

- Aberystwyth and Newtown stations should be manned first train (06xx) to last train (23xx) as integrated transport hubs for rail passengers, bus passengers and parcels (drop off/ collect/ e cargo bikes/ electric van arrive/depart by train etc) traffic.
- Smaller (single shift?) hubs should be established at Porthmadog, Barmouth, Machynlleth and Welshpool.
- Full Taktfahrplan implemented? Would be dependent on UK moving toward it, no reason that non track infrastructure should not be in place first. i.e secure accommodation for staff/parcels, bus lanes, bus parking etc Timetables and connections may not be perfect.
- To start, existing rolling stock can be used on our line i.e Class 197 would need more units possible to drip feed in as other TfW lines are electrified via cascades.
- Hourly Aberystwyth to Birmingham International service all year-round 1st train from Aberystwyth 0530 as now last to Shrewsbury 2130 plus 2230 & 2330 to Machynlleth. Shrewsbury to Aberystwyth 1st departure 0630 last 2130 plus 2230 to Machynlleth.
- Two Hourly Pwllheli to Machynlleth all year round with extension to Birmingham.
- Two Hourly Pwllheli to Tywyn extras in summer to give hourly service in height of tourist season.

- By the end of this decade on rail we will know what works, the whole life costs and what is the best option to decarbonise with.
- By the end of this decade on roads we will know what works, the whole life costs and what the impact on the logistics chain will be of any changes and therefore future demand for freight and passenger growth as a consequence.

We can now definitely plan what our future railway infrastructure and furniture looks like depending on scenario achieved. There are five broad scenarios listed below in likelihood of happening from unlikely to most likely.

1. **“Bionic duck weed saves DfT’s bacon” - 2% -** some yet to be discovered power source that can power HGVs , freight trains etc.
2. **“Back to the drawing board - an explosion destroys confidence in hydrogen” -3% -** hydrogen is a pressurised explosive gas and a series of mishaps will dampen enthusiasm.
3. **“Hydrogen & battery fail to progress at all” -10% -** today’s limitations and no magic new power source is discovered.
4. **“Hydrogen is the hero” -25% -** hydrogen technology really kicks on and a way is found to power larger vehicles with it without hitting the weight/power/ quantity of fuel ceiling.
5. **“Hydrogen & battery miss long-range last-minute penalties after making progress and fall short of expectations” – 60%** - there are some improvements in today’s limitations but not enough to overcome the weight/power/quantity of fuel ceiling.

With the exception of scenarios 1 & 4 the likely hood is that we have to seriously consider the likelihood of palatalised / containerised freight being caried on the Cambrian one more. There will have to be a UK wide model shift of long distance freight to rail. This means extra sections of double track, passing places and sidings/extra platforms in key locations.

Phase 2 to 2039

- A UK wide Taktfahrplan should be in place this decade.
- The Infrastructure plan for the Cambrian is implemented based on the UK wide Taktfahrplan, decarbonisation option selected and medium/heavy freight scenario. It has to be holistic and each side of the triangle should inform the other.

Phase 3 to 2049

- A rolling stock plan is implemented based on the chosen infrastructure plan.

Gareth Marston.