Arguments for railway electrification

– towards a railway sustainable in terms of the local and global environment, physical resources and efficient, economic operation, that will provide an attractive alternative to future road transport and will promote good growth

This paper is intended to support a campaign by groups spanning the Pennines, calling for a rolling programme of rail electrification across Northern England, pursuing the Northern Electrification Task Force (March 2015) recommendations which gave highest ranking to the Calder Valley Line.

J Stephen Waring, Chair, HADRAG: The Halifax & District Rail Action Group: js.waring@hotmail.co.uk

Summary:

In July 2017 three electrification schemes were cancelled: Cardiff-Swansea, the Midland Main Line (Kettering to Sheffield) and the Windermere branch. Further comments cast doubt on aspects of The Great North Rail Project, including additional platforms at Manchester Piccadilly station designed as part of the "Northern Hub" to maximise advantages of the new Ordsall Chord railway, and electrification (continuous or discontinuous) of the Stalybridge-Huddersfield-Leeds route as part of the TransPennine Route Upgrade (TRU), with related capacity improvements. We believe the capacity projects should proceed and the TRU should deliver a clean, sustainable electrified railway. Earlier commitments should be honoured and a rolling programme should move forward, not least in the North of England based on Northern Electrification Task Force (NETF) recommendations.

The arguments for electrification remain clear and enduring:

- **Economic and business case –** compared with diesels, electric trains are cheaper to build, more reliable requiring less maintenance, cheaper to operate and longer-lasting. Lighter weight means more passengers can be carried, acceleration is better and journey times can be shorter even with relatively frequent stops. The passenger experience is improved in terms of cleanliness, air quality and noise levels both in stations and on trains (particularly in comparison with diesel/bi-mode units that have under-floor engines). The "sparks effect" means electrification invariably increases demand for travel on the line, promoting good growth.
- **Environment and resources** – to improve air quality, reduce noise, combat climate change and reduce wastage of resources, objectives that can only ever be partially achieved with diesel traction. Even with non-renewable electricity generation, electric trains have 20-30% lower carbon emissions than diesel, an advantage that is already being exceeded with the current renewables mix. As electricity generation moves towards zero-carbon, so will electric transport. The move towards zero-emission, zero carbon road transport by mid-century must be matched by a commitment to a zero-carbon, zero-emission railway over a similar or shorter timescale.
- **Consideration of alternatives** – bimode trains carrying both diesel and electric traction equipment are heavier, more complex and materials-hungry, less energy-efficient and more expensive to procure and operate than pure electrics. Reliability is unproven and performance unlikely to match that of pure electrics. Diesel bimodes commit the railway for a generation to polluting technology. Prospects for hydrogen as a fuel on rail may turn out to be limited. On sections of discontinuous electrification where wiring is difficult, the gaps may be bridged by using electric trains with moderate battery or other energy-storage, perhaps including sustainably produced hydrogen. But the use of inherently "dirty" diesels and other fossil-derived sources must end.

Comparisons of electric, diesel and bimode trains

Much of the information in this table is summarised from written evidence submitted by Roger Ford to House of Commons Welsh Affairs select committee, November 2017, on cancellation of electrification in South Wales[1]. By profession a mechanical engineer, Roger Ford CEng, IRSE, FCILT is industry and technical editor at Modern Railways magazine and founding editor of Rail Business Intelligence.

	Electric	**Diesel/bimode**	**Remarks**
Average cost per vehicle	**£1.2M** (Recent EMU orders)	**£2.36M** (Hitachi bimodes ordered for TPExpress)	Reflected in leasing costs of train operating companies (TOCs)
Performance	Best due to low mass; higher power can be installed; higher efficiency.	Bimode is worst of both worlds – underpowered in diesel mode, overweight in electric mode.	Reflected in TOC costs and revenue, fares, profitability, premium payments to DfT (or increased subsidy)
Availability (% of trains in fleet in service)	Best	Lower due to increased maintenance – larger fleet required compared with electric.	
Train maintenance costs.	Typically **33% lower** than diesel.		
Reliability (expressed as miles per 3 min delay)	Siemens 3 most reliable EMU types) **100,000** mile/3min delay	Siemens equivalent DMUs **26,000** mile/3min delay (Ford considers this creditable for DMU)	
	Hitachi IEP specification **50,000** mile/3min delay	Hitachi IEP specification **25,000** mile/3min delay	
Track wear – dependent on vehicle mass.	Hitachi IEP train mass per vehicle **41 tonne** electric…	… diesel bimode with engine and fuel, **50 tonne.**	Reflected in variable track access charge paid by TOCs to Network Rail.
Mass of diesel power pack (engine + generator)	0	10 tonne, approx.	
Energy costs	Typically **45% lower** than diesel.	Advantage of electric over diesel due to lower mass, increased efficiency. Regenerative braking on electric trains recovers kinetic energy and returns as electricity to grid, saving **15-20%**. Rail can use whatever source of energy supplies the grid.	
Environmental – local	**Zero emissions** due to traction at point of use. (Some brake dust emissions but see also remarks.)	NOx, particulates, brake dust etc	Modern electric trains with regenerative braking also have reduced emissions due to brake dust.
Environmental – global – combatting climate change	*Even with non-renewable primary energy for generation, electric **20-35%** lower CO_2 emissions than diesel. With current mix including renewables this improvement is thought to be significantly already greater. As electricity generation moves towards zero-carbon, so will electric trains –JSW*		
Cost of electrification work!	*Obviously electrification work has a high capital cost, but with a holistic view this is recouped by reduced operating costs later. This was the rationale for a number of earlier electrification schemes including the 1985-1991 East Coast Main Line project which was paid for (£306M) on the basis of operational cost saving and increased output. This balancing of electrification costs against future saving is further explored by Prof Stuart Cole in a further item of written evidence to the HoC Welsh Affairs Committee[2] –JSW*		

[1] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/welsh-affairs-committee/the-cancellation-of-rail-electrification-in-south-wales/written/73604.pdf

[2] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/welsh-affairs-committee/the-cancellation-of-rail-electrification-in-south-wales/written/73840.pdf

Arguments for railway electrification

Context – Summer 2017 saw the cancellation by government of planned railway electrification from Cardiff to Swansea, on the Midland Main Line from Kettering to Derby and Sheffield, and on the Oxenholme to Windermere branch (20 July statement to Parliament)[3]. These were three previously committed electrification schemes and the latter two directly affect rail development in the North of England. Midland Main Line premier inter-city trains from the early 2020s are now expected to operate on diesel power for more than half of the journey from London to Sheffield using "bi-mode" trains which will carry both diesel power packages and electric power collection equipment. The Windermere branch, including services to Manchester Airport, may be operated in the near future by still to be tested electro-diesel bi-modes converted from former Thameslink (Bedford-London-Brighton) electrics, or perhaps by new pure diesels (with internal combustion engines in operation "under the wires"), and perhaps, it is hoped, by non-polluting "alternative fuel" trains, possibly using batteries instead of diesel engines on the branch line.

Comments by Rt Hon Chris Grayling MP, Secretary of State for Transport quoted in the Financial Times[4] immediately after the 20 July announcement led to the general understanding that the **TransPennine Route Upgrade (TRU)**, including electrification of the line from Staybridge via Huddersfield to York, completing an electrified intercity route from Liverpool to Newcastle, is being reconsidered and may not be electrified along the whole length. Instead of running fully electric trains, "bi-mode" units will be used and indeed these trains are already on order for the TransPennine Express train operating franchise. Like the possible ex-Thameslink Windermere branch trains these will be electro-diesels with diesel engines for use over sections of line that are not electrified. Unlike the Windermere trains they will, at least, be brand-new. It is generally accepted that that the diesel bimodes will have an inferior performance to pure electrics on routes across the Pennines. The fear therefore is that journey time targets may only be achieved by missing out stops.

A related issue – need for capacity works in the Great North Rail Project (Northern Hub and TRU):

(a) There seems also to be a threat to capacity works that were promised as part of the original Northern Hub project, specifically the proposed provision of two additional through platforms at Manchester Piccadilly station to handle more frequent services that will be developed via the new Ordsall Chord railway over the next few years. It is highly unlikely that "digital signalling" will be able to provide what the additional tracks platforms offer. The two additional platforms would, given necessary dwell times, allow an increased frequency measured as trains per hour through the station, enabling greater timetabling flexibility to get best value from the Ordsall curve which was physically complete in Autumn 2017. The additional platforms are necessary to allow attractive and robust timetables to be devised for train services from the Calder Valley and Huddersfield lines, through Manchester Victoria and round the new line to Manchester Piccadilly and the Airport.

(b) It is also understood that capacity enhancements are under consideration as part of the TRU in the Huddersfield-Mirfield corridor. Increased tracks (restoring 3 or 4 lines instead of 2 or 3 at present) is an obvious possibility benefitting not just TransPennine Express services via Huddersfield but also Calder Valley services via Brighouse. It is acknowledged that resources have now been committed to investigating digital signalling on this route, but this may be many years from fruition and will not provide that opportunities for parallel running that are possible with additional tracks.

It is understood that Network Rail will submit TRU options (including electrification and capacity) for decision by DfT by Spring 2018.

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[3] Statement by Chris Grayling MP, Secretary of State for Transport, 20 July 2017: https://www.gov.uk/government/speeches/rail-update-bi-mode-train-technology

[4] Financial Times article on-line 21 July 2017 available at https://www.ft.com/topics/people/Chris_Grayling

In March 2015, the Northern Electrification Taskforce, a group comprising an all-party group of MPs and local authority representatives from across the North of England, backed by professional input, published its report.[5] The conclusion, on operational, economic and business criteria, placed 12 northern routes in a top tier recommended for electrification during the "CP6" 2019-24 Network Rail control period. A further 20 routes were placed in Tiers 2 and 3, and the task force concluded that all of these routes should be electrified in due course. On the criteria used the top-ranked scheme in Tier 1 was the "full" Calder Valley Line comprising the routes from Leeds to Manchester and Preston via both Bradford and Brighouse and Hebden Bridge. Next in rank order were the second Liverpool-Manchester route via Warrington, Southport/Kirkby-Salford, Stockport-Chester, Middlesbrough, the Harrogate Line and Selby-Hull. The last of the above was an already proposed scheme but it has been cancelled recently at the behest of Government. The full list of Tier 1, 2 and 3 NETF schemes is appended to this paper.

It is conceded that delays and cost overruns in the delivery of Network Rail electrification schemes, particularly the Great Western Main Line (GWML) scheme, have led to the present electrification programme (not to mention future schemes such as the Calder Valley) being reconsidered. Even before this summer's announcement electrification to Oxford, Bath and Bristol had been indefinitely shelved. This means that Great Western "electrics" will continue to run trains on diesel power at these destinations, with negative environmental consequences for noise and air quality locally as well as increased carbon dioxide emissions.

Government statements have also referred to overhead electrification structures as being unsightly (in particular with reference to the Windermere branch through a national park), as well as to the existence of bimode technology making full electrification unnecessary. However, the aesthetic objection to overhead electrification does not seem to have held sway, for example, when Crewe to Glasgow electrification was completed through the spectacular Cumbrian fells, a project that took just four years from approval in 1970 to completion in 1974. Bimode "electro-diesel" technology is not in essence new or "state of the art" but carries its own inefficiencies and sources of waste.

The costs of GWML are reported to have perhaps tripled to around £2.5 billion. To put this into historical context, between government approval in 1985 and completion to Edinburgh in 1991, British Railways electrified the East Coast Main Line (north of Hitchin) at a cost of £306M (equivalent to just under £1bn at 2017 prices). The scheme was funded internally through increased productivity.[6] Aesthetic issues were appropriately addressed; for example, the OHLE structures on the Grade 1 listed Royal Border Bridge over the Tweed were approved by the Royal Fine Art Commission.[7] The ECML electrification scheme has been criticised for having insufficiently robust OHLE (for example in high wind conditions); however there seems little obvious reason why using more robust structures need be disproportionately more expensive. Some of the structures used on the current GWML electrification do appear to be very robust and criticism on aesthetic ground is understandable. However, it does not have to be like that on every section. There are alternatives. The respected railway engineer Ian Walmsley, writing in Modern Railways magazine, argues convincingly for a continuing programme of electrification including reinstatement of the cancelled Midland Main Line scheme. Walmsley cites the example of Denmark where electrification designed for 250km/h (156mile/h) was ordered in May 2015 and is already live over 121 km[8] .

Contrasting approaches to rail and road: Also in July 2017 the government also announced, as part of a statement

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[5] http://www.railnorth.org/news/electrification-task-force-final-report-revealed/ (includes report as .pdf)

[6] GREEN, C and VINCENT, M: *The Intercity Story* (Oxford Publishing Co, 2013), page 35. See also letter from David Carter to the Guardian newspaper in https://www.theguardian.com/uk-news/2017/jul/24/uks-rail-network-suffering-from-lack-of-joined-up-thinking

[7] https://www.networkrail.co.uk/the-history-of-the-royal-border-bridge/

[8] "STOP – THINK – ELECTRIFY": Modern Railways, November 2017, page 39 (Key Publishing).

on air quality, that the sale of "conventional" petrol and diesel cars and vans (implicitly this might exclude some forms of hybrid vehicle) would cease in the UK by 2040. This was a pre-existent policy dating from 2011 which also including a commitment to making road transport almost totally zero-emission by 2050.[9] Many who campaign for the local and global environment would question whether these target dates are sufficiently ambitious. Nonetheless, the future prospect seemed to be, in around two decades time, a road transport system moving rapidly forward in terms of sustainability based on electric, perhaps driverless vehicles, whilst UK rail continues to derive a significant part of its traction power from dirty diesels.

Glut of EMUs. Returning to the present-day context, the current situation with franchise renewals where there is an incentive to provide new rolling stock on lines such as Thameslink, Anglia and South Western means there is an increasing glut of relatively modern electric multiple unit (EMU) trains. For example 86 4-car Class 319 trains have been withdrawn by Thameslink: some have come to the North, some are being converted to dieselised "Flex" units (perhaps for lines such as Windermere), but about half at time of writing, looked to be going off-lease into store. The TransPennine Express franchise is to replace express-standard Class 350 units that were built as recently as 2014 with new build. The released 350s were to go to the London Midland franchise but the new West Midlands operator has ordered new trains instead. In this situation it seems illogical not to go ahead with electrification schemes where spare trains, new or refurbished to nearly new standard, could be used.

The general arguments for railway electrification remain strong. Network Rail themselves summarise the arguments as follows on a web page headed simply "Electrification" [10]:

> **"Electrification of the railway allows for faster, greener, more reliable train journeys, improves passenger services and supports economic growth in Britain. Benefits of electric trains:**
>
> - More capacity for passengers: more seats than diesel trains of the same length.
> - Faster than diesel trains: superior braking and acceleration make journey times shorter.
> - Quieter than diesel trains: good news for people living near the railway – our lineside neighbours.
> - Better for the environment: their carbon emissions are 20 to 35 per cent lower than those from diesel trains, and there are no emissions at the point of use, improving air quality in pollution hot spots, such as city centres.
> - Lighter: less maintenance is needed because electric trains cause less wear to the track, so the railway is more reliable for passengers.
> - Good for the economy: faster trains with more seats and better connections with previously hard-to-reach areas improve access to jobs and services, and open up new business opportunities.**"**

We set out a slightly more detailed summary of these arguments below on the following pages.

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/633269/air-quality-plan-overview.pdf

[10] https://www.networkrail.co.uk/our-railway-upgrade-plan/key-projects/electrification/

Arguments for rail electrification – and against a continuing diesel (or electro-diesel) option

1 Commercial, operational and business arguments for rail electrification:

- Reduced capital cost of rolling stock compared with diesel
- Rolling stock maintenance costs reduced by simpler electric technology. Electrics are 30% cheaper to maintain than diesels.
- Track maintenance costs reduced (about 10%) because lower mass electric vehicles (compared with diesels) mean reduced track forces.
- Reduced energy consumption due to increased efficiency of supply and traction system and reduced mass of electric trains compared with diesels meaning less energy required to accelerate to given speed; potential for energy recovery in regenerative braking which is now the norm on new electric trains.
- Reliability – due to mechanical simplicity
- Capacity – potentially more seats on electric train compared with diesel of similar mass, length or power
- **Passenger benefits**
  – performance (in addition to reliability), particularly on routes with frequent station stops or gradients, due to higher power/mass ratio electric trains have higher
  – reduced noise on train, particularly now that underfloor diesel engines are the norm, and in stations
  – improved air quality in stations
  – linked to the above enhance passenger perception leading to ***sparks effect*** attracting more passengers and promoting good growth

2 Rail electrification as sustainable technology to conserve resources, preserve the environment

- reduced energy consumption of electrics as above
- local environment in stations and around the railway more generally
  – reduced noise
  – improved air quality; zero-emission at point of use compared with particulates and NOx from diesels; modern electric trains with regenerative braking also significantly reduce pollution from brake dust by making less use of friction brakes.
  – reinforces perception of railway as "green alternative" to road travel
- global environment, combatting climate change
  – even with non-renewable primary energy sources electric traction has 20-35% lower CO_2 emissions than diesel. This has already improved further given the presence of renewables in the generation mix.
  – potential to be zero carbon as electricity generation moves to renewables (or nuclear[11]).
- physical resources – materials – electric traction equipment is longer lasting and requires less replacement of parts during lifetime leading to better conservation of physical resources. Diesel-generator sets have more manufactured components and more moving parts.
- the visual/built environment – whilst overhead electrification masts may be considered visually intrusive in areas of sensitive built environment (e.g, in the city of Bath) or of natural beauty (e.g. national parks), this must be compared with the visual intrusion of modern roads and of national grid powerlines and pylons, as well as the effect of roads in terms of noise and air pollution. Consider the effect of overhead wires on the

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[11] This is not to suggest that all supporters of this statement are supporters of nuclear power.

10 mile long Windermere branch in the Lake District National Park, compared with the impact of the A590/A591 dual carriageway roads in the same area. The M6 motorway passes just outside the national park boundary through an area of spectacular scenery, alongside the electrified WCML railway: which has the greater visual impact? Not all schemes will require the heavy, apparently over-engineered structures recently installed on the Great Western Main Line; better designs are possible.

- electrifying more railways makes better use of the railways we have already. At present we have many diesel services operating “under the wires”. Our front page illustration is a panorama of a large electrified terminus station: of six trains in shot, five are diesels. This seems wasteful in business as well as environmental terms.

3 Alternatives to continuous electrification

It has been suggested that significant lengths of the main line railway network may be left unelectrified, with the gaps to filled by use of bi-mode trains.

The electro-diesel bimode alternative: a sub-optimal solution, “worst of both worlds”. The idea of an electro-diesel train is not new, although the bimode train with underfloor diesel engines as well as the electric overhead pick-up (pantograph) is relatively so. The bimode electro-diesel multiple unit trains carries fuel tanks, diesel engine and generator in addition to electric current collection equipment (visible as the familiar “pantograph” on top of the train) and transformers. It thus has greater mass or weight than either a pure electric or a pure diesel of equivalent performance. Carrying both electric and diesel-electric traction energy systems the electro-diesel bimode is the “worst of both worlds”. The following points sum up the argument, supported by some quantitative data set out in a table on the next page. Electro-diesel bimodes are:

- compared with either pure electric or pure diesel, the most expensive type of train to buy. Pure electric is least expensive.
- inherently inefficient, wasteful of energy, due to additional mass to be carried “dead” over long sections (e.g. Windermere-Manchester service carrying diesel under the wires all the way from Oxenholme to Manchester; MML Sheffield-Kettering (electric transformer dead weight), Kettering-London (diesel dead weight); etc. Additional mass causes additional energy use/fuel consumption.
- increased complexity of technology – additional maintenance requirement, unproven reliability of dual technology crammed into small space.
- unsustainable in environmental terms, e.g. noise and air pollution from diesels in stations and other unelectrified sections which are likely to be more urban areas; rail must lead in combating climate change.
- Diesels are obsolescent technology. If the East Midlands franchise is required to introduce new diesel bimodes in the early 2020s these engines will still be within their useful life when internal combustion engines are rapidly being phased out of road transport.
- The diesel bi-modes are almost certain to have reduced performance in terms of acceleration and hill climbing compared with pure electrics. This problem could be tackled by having more powerful diesel engines but this would mean either larger and heavier engines being used, or uprating the power of the existing small engines (reducing reliability), in either case further increasing fuel consumption. There would be increased pollution both climate-damaging CO_2 and also nitrogen oxide and other pollutants associated with diesels which damage air quality. In practice, bi-modes will have greater difficulty meeting journey time targets unless stops are omitted, which would damage services for local communities.
- If diesel engines are to have sufficient power to match electric schedules on heavy bi-mode trains, it will be more difficult for them to comply with ambitious emissions standards.
- Whilst modern diesel and other internal combustion engines may have reduced emissions they can never be zero emission and as long as they rely on fossil-derived hydrocarbon fuels can never be zero-carbon.

What about partial electrification with battery, Hydrogen (H_2) or alternative fuel bimodes? We take heart from aspects of the government announcement referring to the development of alternative fuel technology. The short (10 mile) Windermere branch could be ideal for battery operation, with the batteries charging in Oxenholme station or during longer runs under direct electric power between Oxenholme and Manchester Airport.

- Battery technology is moving forward driven by growth in renewables and the demand for low/zero-emission road vehicles.
- A battery/electric "independently powered electric multiple unit" (IPEMU) train has been successfully tested in Essex[12]. However it seems unlikely that a fleet of IPEMUs with sufficient capacity to operate from Kettering to Sheffield will be built for the East Midland franchise by the early 2020s.

Hydrogen (H_2) can be manufactured as a chemical store of energy using the electrolysis of water using carbon-free electricity as energy source; so trains powered by H_2 fuel cells (which use electrochemical combination of hydrogen and oxygen rather than combustion) could become zero-carbon in the future as well as zero-pollution[13]. However, rail applications in the short-medium term may be limited to short distances determined by H_2 fuel storage capacity on board the trains.

The Alstom iLint train under test in Germany is the first train to be powered by fuel cells using hydrogen gas stored in pressure tanks on the vehicle roof. The iLint also has batteries for storing recovered energy from braking and a sophisticated energy management system. By spring 2017 Alstom was able to claim letters of intent for 60 trains with four German regions.[14]

It is not immediately clear how safety issues associated with hydrogen stored on board a transport vehicle compare with those associated with other fuels. Data needs to be published on this to provide reassurance.

The future may also bring **sustainable liquid fuels** capable of being used in an internal combustion engine. This involves bio-engineering techniques akin to artificial photosynthesis to manufacture biofuels. Such an energy source could be sustainable because it absorbs CO_2 from the atmosphere in production and does not involve the use of large areas of farmland. However, the IC engine (gas, diesel or petrol) will remain inherently inefficient, and will always produce additional pollution, for example nitrogen oxides, at point of use compared with pure electric traction systems.

Bridging the gaps. We comprehend arguments against continuous electrification of routes based on the cost and disruption associated with increasing physical clearances for the high voltage equipment. We would not oppose the idea of some short sections being left "unwired". But:

- the whole point of the above argument about bi-modes is that the continuing use of diesel engines reduces efficiency, increases energy consumption and damages the local and global environment.
- We should care where our energy comes from and should start to move away from a railway, as well as other transport, dependent burning fossil-fuel derivatives in an internal combustion engine, towards the use sustainably generated and clean electricity.
- The widespread use of either sustainable biofuels or sustainably-generated hydrogen for medium to long distance transport would appears to be, at best, some years away.
- The conclusion seems to be that where sections of an electrified railway are left unwired (or not live) the gap

[12] http://www.railway-technology.com/projects/independently-powered-electric-multiple-unit-ipemu-essex/

[13] Much current H_2 production is, however, by steam reforming of hydrocarbons with CO_2 as by-product. Clearly this would only be carbon neutral if offset, or the CO_2 captured and stored without release into the atmosphere.

[14] http://www.alstom.com/press-centre/2017/03/alstoms-hydrogen-train-coradia-ilint-first-successful-run-at-80-kmh/

should be filled by trains with a moderate amount of onboard energy storage, probably provided by batteries. This is already feasible. Battery technology will continue to improve, driven by development of renewables and indeed by demand for pollution-free road transport.

Disruption in construction? The electrification work itself need not result in excessively long periods of disruption to passengers. Much work can be done at night and with effective planning, learning from experience, with teams moving on from project to project, the need for lengthy blockades minimised. Some recent electrification work has employed long blockades, perhaps to allow projects running late to be completed, but this need not be the norm, the key surely being realistic timing, effective planning and experienced project management.

Alternative approaches. Another approach to reducing the need for physical work to increase clearances could be the adoption of dual-voltage electrification, with some sections energised at 6.25kV instead of 25kV. Reducing the line voltage by a factor of four has a proportional effect on the resulting electric field strength and required distance of live conductors from physical structures. Dual voltage electric trains are a tried and tested technology and have been in service on many railways across Europe for several decades.

Further information on current electrification programme in parliamentary briefing paper SN05907 Rail Electrification, 27/07/17.

Concluding remarks

Trains are an excellent alternative to road transport in terms of their ability to carry large numbers of people over either long or short distances. Modal transfer to rail is a potentially highly effective way of reducing road congestion and improving air quality as well as reducing CO_2 emissions and will be even more effective with electric railways. It must surely be agreed to action to tackle both air pollution climate change must be a key policy objective. Rail must be perceived as modern and also good for the environment if it is attract more people from congested roads. We should be concerned about air quality in train stations as well as on city streets. This principle can be applied not just to commuting or business journeys but to a wide range of personal travel needs – leisure, personal business, local and longer distance journeys, urban and rural (issues caused by road transport including congestion, air pollution and noise are no longer restricted to urban areas).

The Northern Electrification Task Force recommendations should be the basis of a rolling programme of electrification across the North of England, starting with the top ranked schemes in Tier 1. Electrification of the full Calder Valley Line would naturally follow the completion of work on the Huddersfield Line (the TransPennine Route Upgrade). “Full” CVL electrification means both routes from Leeds, via Bradford and via Brighouse, to both Manchester and Preston. Further schemes would run alongside or closely follow, perhaps the Harrogate Line - a relatively easy scheme to do in Yorkshire - and the Southport/Kirkby lines or the Warrington Central line in the North West.

NETF said that the Tier 1 schemes should be carried out in Control Period 6 (2019-24). This may no longer be feasible, but planning should, nonetheless, start now to ensure physical works can start in about 5 years from now (Autumn 2017). This should be seen as perfectly realistic. When physical work starts it should be carried out in as smart a way as possible to minimise disruption. Where “gapped” electrification is adopted the gaps should be filled by the use of clean on-board energy storage such as batteries, not by “dirty diesels”.

The rolling programme should build on lessons learnt from recent schemes in terms of working with contractors and project management, gaining in expertise continuously. The idea of a dedicated management team working through a series of projects seems to make sense. Skills need to be retained, maintained, developed, not lost by a stop-go approach.

The initial costs of electrification may appear high. But to abandon electrification on such grounds is short sighted in both environmental and business/economic terms. Electrification costs are balanced and will in most cases be outweighed by savings for train operators later in terms of more cost-effective rolling stock. This was the principle on which the East Coast Main Line was electrified in the early 1980s. A similar approach based on the whole costs of running the railway is required by the DfT today.

The percentage of the UK rail network electrified is about 33%. The majority of comparable European countries have been ahead of the UK for many years. The Netherlands, a country comparable in size with the North of England, is 70% electrified, Germany 60%.[15] On similar percentages most lines in Northern England would already be electrified.

The aim should be to eliminate diesel operation and create an ultra-low emission, zero-carbon, high technology railway including all existing main and secondary routes across the North of England within 20 years from now.

J Stephen Waring, MA (Cantab.) (Engineering),
Chair, HADRAG: The Halifax & District Rail Action Group
20 Manor Drive, Halifax HX3 0DU; js.waring@hotmail.co.uk
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Appendix on final page: →

[15] UIC Synopsis 2016: https:// https://uic.org/IMG/pdf/synopsis_2016.pdf

Appendix:

NETF Tier 1, 2 and 3 schemes, March 2015

The North of England Electrification Task Force was Chaired by Andrew Jones, MP for Harrogate and Knaresborough. In his foreword to the March 2015 task force report ***Northern Sparks*** Mr Jones concluded: "We want a railway that meets the needs of the North. A network that is expanded, efficient and electrified. This report is the Task Force's view of where the next steps start." The task force included in total three MPs (Harrogate, Bolton West, Redcar) three council leaders (Warrington, Bradford, Darlington) and senior officers from the DfT and Network Rail. In section 8.3 the report set prioritise schemes in three tiers (below) and commented: "We believe that ALL these routes need electrifying, starting with those in the first tier", based primarily on the scale of economic impact they will bring. This provides the core foundation for the remaining tiers." The separate schemes were given scores based on economic benefits (50% weighting), impact on services, costs and environment (20%) and providing capacity and quality (30%) the total weighted score for Tier 1 schemes are also shown below.[16]

Tier One	Tier Two	Tier Three
Calder Valley – Leeds to Manchester and Preston via Bradford and Brighouse	Manchester to Sheffield and south east Manchester local services	Barrow to Carnforth
Liverpool to Manchester via Warrington Central	York to Scarborough	Pontefract to Church Fenton
Southport/Kirkby to Salford Crescent	Bishop Auckland/Darlington to Saltburn and Sunderland	Hull to Scarborough
Chester to Stockport	Barnsley to Huddersfield	Ormskirk to Preston
Northallerton to Middlesbrough	Sheffield to Lincoln via Retford	Carlisle to Newcastle
Leeds to York via Harrogate	Chester to Crewe	Skipton to Carlisle
Selby to Hull	Burnley to Colne & Kirkham to Blackpool South	Barton on Humber
Sheffield (Meadowhall) to Leeds via Barnsley / Castleford & connections	Knottingley to Goole	Cumbrian Coast
Bolton to Clitheroe		Doncaster to Gilberdyke
Sheffield to Doncaster/Wakefield Westgate (Dearne Valley)		Cleethorpes to Thorne (Doncaster)
Hazel Grove to Buxton		Middlesbrough to Whitby
Warrington to Chester		Skipton to Heysham

Northern Sparks report March 2015

– NETF Tier 1 schemes *weighted scores*

- **Calder Valley "full"**: Leeds to Manchester and Preston via Bradford and Brighouse ***84***
- **Manchester-Warrington C-Liverpool:** ***80***
- **Southport/Kirkby-Salford Cr:** ***79***
- **Chester-Stockport:** ***75***
- **Northallerton-Middlesbrough:** ***73***
- **Leeds-Harrogate-York:** ***70***
- **Selby-Hull:** ***70***
- **Sheffield-Barnsley/Castleford-Leeds** and connections: ***68***
- **Bolton-Clitheroe:** ***67***
- **Sheffield-Doncaster/Wakefield** (Dearne Valley)**:** ***67***
- **Hazel Grove-Buxton:** ***66***
- **Warrington-Chester:** ***64***

[16] http://www.railnorth.org/news/electrification-task-force-final-report-revealed/ (includes report as .pdf)