The electric railway. Part 1, Why do it anyway?

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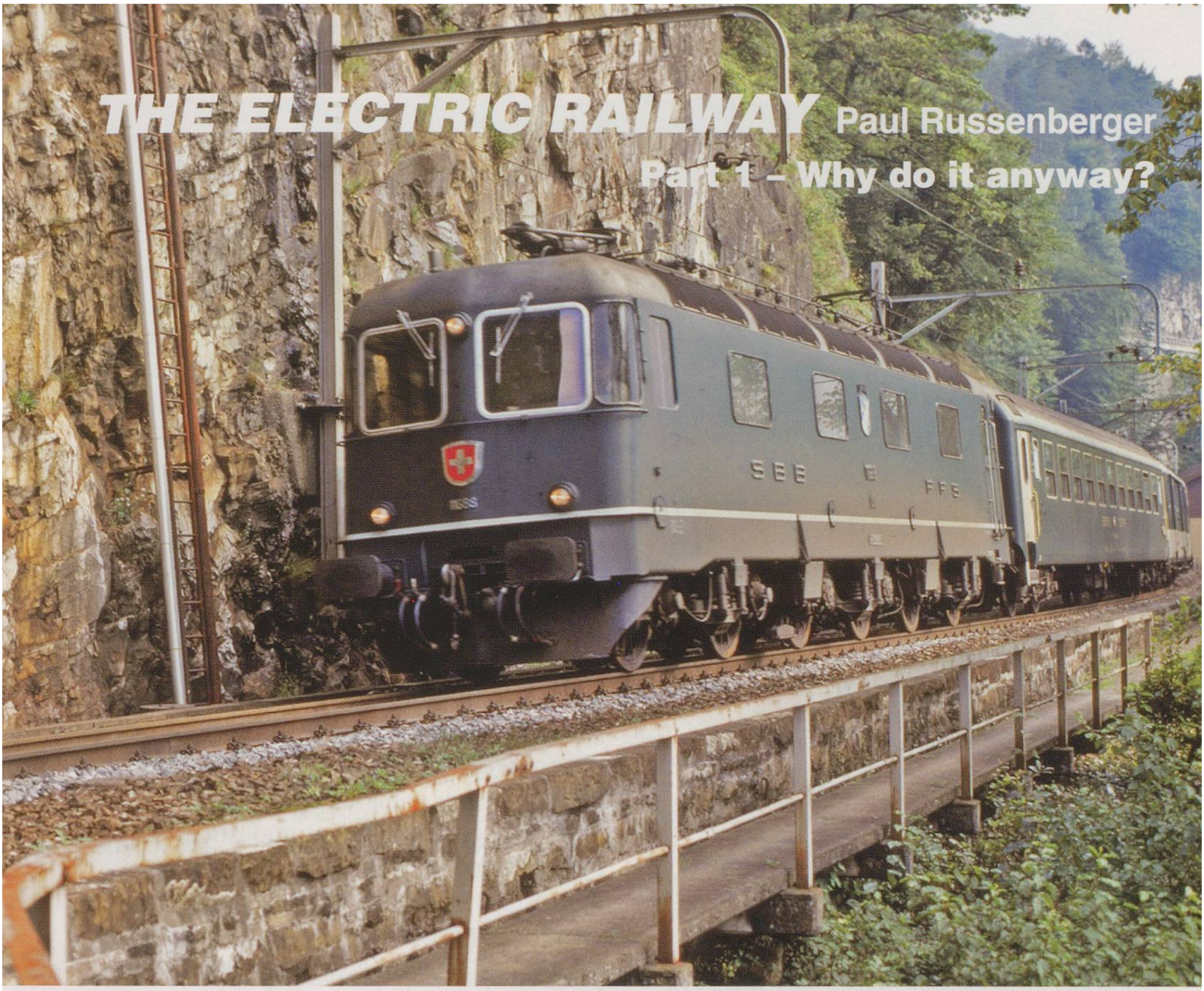
THE ELECTRIC RAILWAY

Paul Russenberger

Part 1 – Why do it anyway?



Re6/6 11688 'Linthal' approaches Brunnen on a Chiasso – Schaffhausen working. Electrification increased speed on the Gotthard line to bring its timings closer to those of other European main lines of the time, September 1989. ALL PHOTOS: *Paul Russenberger*

In reality there remains only one reason for electrifying a railway: to improve the financial balance sheet – to enable it to make more money, or, perhaps being a little more realistic, to reduce the operating loss and need for income apart from the fare-box.

The change in the source of motive power enables the improvement to take place in different ways and classic examples can all be found in Switzerland:

- Increase in speed to increase ridership (*main lines*)
- Reduction in journey time through rapid acceleration of frequently stopping services (*suburban services, notably around conurbations such as Zürich*)
- Reduced fuel cost at point of delivery to the railway (*originally arising from difficulties in importing coal*)
- Reduced cost of traction unit maintenance (*all schemes*)
- Increased traction unit availability (*all schemes*)
- Elimination of a pocket of steam or diesel traction causing operational inflexibility and increased cost of maintaining a small fleet of different traction, especially if it operates far from its maintenance depot (*final SBB electrification of branches*)
- Tunnel working necessitating exhaust-free traction (*Jungfraubahn, Zürich S-Bahn, alpine base tunnels such as the Lötschberg*)
- Environmental compatibility (*urban tramways*)

All these reasons applied during the conversion of the Swiss railways to electric

'Swiss Standard' Bern tram 111 pauses at the Hasler stop on Route 3 to Weissenbühl. The use of electricity reduces the environmental effect of the trams on the city, August 1984.

traction, or when new lines were built with electric power from opening. Other reasons can be added today. For example, the first cost of a diesel locomotive is always more than the equivalent electric locomotive and its maintenance costs are higher. As it needs to return to a fuelling point, though not as frequently as a steam locomotive, it cannot be available to haul trains – and therefore earn its keep – for the same proportion of time as an electric loco which may run for three weeks without attention.

Another advantage of electricity over diesel fuel as the prime mover is that the electric locomotive can draw on a larger power supply than that available to a diesel. While diesel engines can be made to operate for limited periods at higher power outputs than those they can deliver continuously, diesel engines fitted to locomotives have their upper limit set to prevent their continuous rating being exceeded. An electric locomotive can be built to allow a higher power output for limited periods, particularly when starting. The constraint in each case arises from the need to limit the temperature reached by

Re450 450 020 has arrived at Dietikon from Zürich Hauptbahnhof. The greater power output of the electric engine increases the capacity of densely worked suburban services through more rapid acceleration of trains with an increased carrying capacity.

BDhe2/4 12 still carried Arth-Rigi Bahn livery in August 2001. The peace of the high mountains is not disturbed by the quiet hum of electric mountain railways.

the equipment; it is easier to cool transformers and electric motors than diesel power plant.

For Switzerland one incentive for railway electrification was the difficulty in obtaining fuel during the First World War. The front lines between the Franco-British and German armies made the coal fields of north east France inaccessible. Eventually train services were severely curtailed because fuel to power them simply was not available. Neglecting the national economic and social effects of the reduction in transport, considering the railways as commercial organisations, fuel was necessary if they were to trade at all!

Steam locomotives present a further disadvantage compared with electric engines. They have to carry their fuel and water with them. This adds to the weight and length. Even the smallest of the British Railways 'standard' tenders weighed over 36 tons – rather more than a fully laden passenger coach. Apart from needing replenishing with water every 150 km, additional fuel would have to be consumed which could otherwise be used to make money by hauling the payload.

Today in the matter of 'carbon footprint' the electric railway wins. The hydro-electric generation produces a theoretically 'zero' footprint, as does nuclear power, though the latter remains the subject of controversy for other reasons. Where steam or diesel power stations generate the electricity, there are the inevitable carbon emissions. However, the

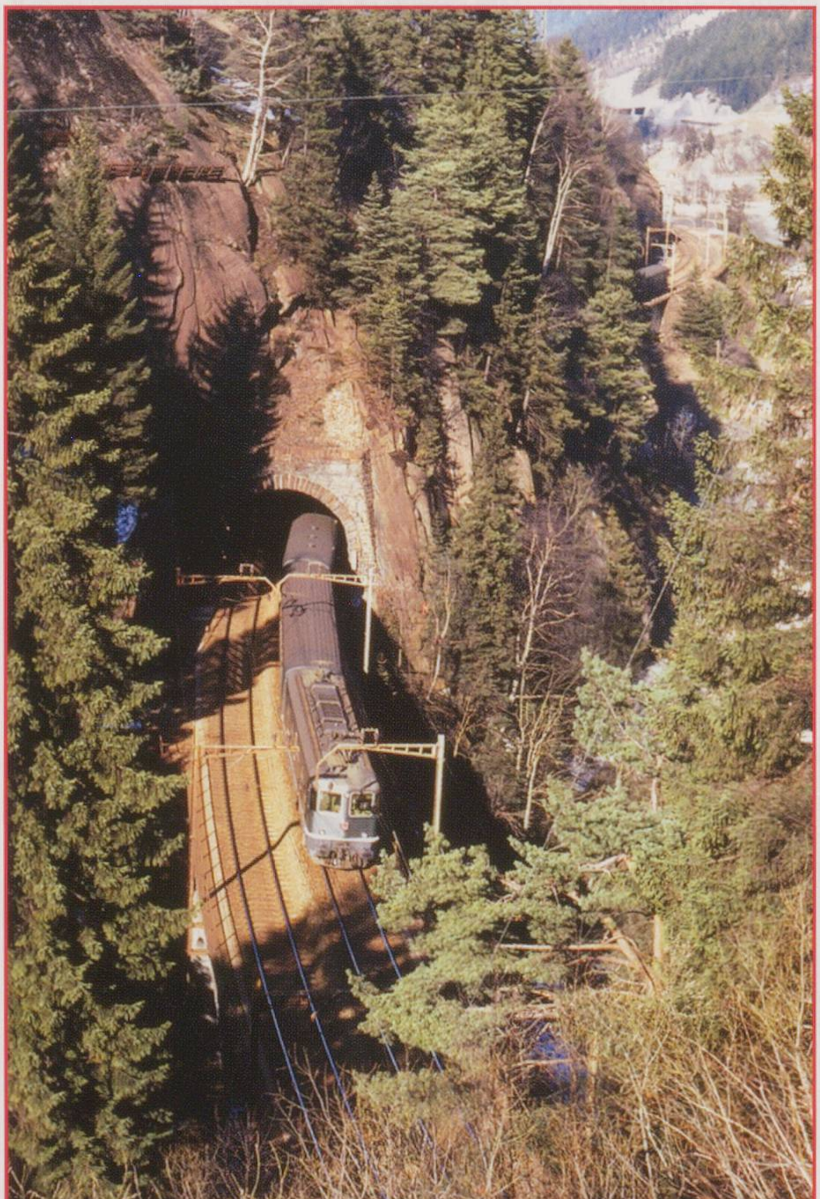
The low level platforms at Zürich Hauptbahnhof with their intensive service could not be operated other than with electric traction, February 1991.

larger the generating plant, the more efficient it is. A steam driven power station is some four times as efficient as the steam locomotive fleet it would replace. While there are power losses in the supply network and in the trains themselves of perhaps a quarter of the energy generated, the very significant reduction in the environmental effect remains.

Another environmental effect of lesser consequence is the reduced noise of an electric train compared with either a diesel or steam. This may be of little commercial significance, but anyone who has wished to enjoy the silence of the Alps from the summit of the Brienzer – Rothorn will be aware that the Kleine Scheidegg is considerably quieter!

Railways are usually electrified for a combination of reasons and because some specific facet of the railway needs replacement. Since there is always the high capital cost of installing the fixed power supply equipment there must be an improved financial performance to provide a return on investment. If money has been borrowed to pay for it, then the ensuing interest will have to be paid! (In the current financial climate, that may make schemes rather more attractive.) Altering the infrastructure to make it compatible with the newly electrified railway is not simply a matter of increasing clearances to accommodate overhead line equipment. It may be appropriate to revise track alignment to make full use of the higher speeds which the new traction can attain or the layout to take advantage of multiple unit rather than locomotive hauled working. Signalling circuits which prove the absence of a train may need altering so that they are not affected by the traction current flowing through the rails on its way back from the train to the substation.

Although a variety of reasons usually support electrification, the system actually chosen is almost always a compromise because there is a fundamental problem inherent in electricity. Electricity which is suitable for transmission from the generating station to a train is not suitable for driving its motors and vice versa. The thrust of technological development in electrification has been to minimise the effects of the compromise. During this series of articles, the intention is to explore how this development took place in Switzerland and to provide an explanation of how electric trains are powered and controlled.



An unidentified Re6/6 leaves the Mühle Tunnel below Wassen, on the Gotthard line. March 1981.