Cover Story

The frequency of the railways

100 years of 16 2/3 Hertz Railway Electricity

PHOTO: DB AG/WOLFGANG KLEE

This year New Yorkers are talking about their Grand Central Terminal. And they are not the only ones, because after all, the world's most famous train station is celebrating its anniversary. It opened a hundred years ago, on 2 February 1913, the main reason for its construction being the desire for a clean railway, an end to steam and gases. And this was a wish that not only existed in the United States. When Grand Central opened its gates, a new railway age also began in Germany.

67 tracks, 44 platforms – Grand Central in Manhattan is the world's largest train station. But it is not just its size that makes it so important for the history of railways. It is also, and above all, the first metropolitan station built exclusively for electric trains. The age of steam locomotives was inexorably coming to a close by the second decade of the last century. Both in America and on the European continent. As well as in Germany.

Born 1912/13

In 1879, Siemens & Halske presented the first direct-current electric locomotive. In 1905, the Münchner Lokalbahn AG started to run the first scheduled transport with electric trains on German soil between Murnau and Oberammergau. Electric trains had thus already existed for some time when the New Yorkers inaugurated their new giant station. But what did not yet exist was a uniform railway electricity supply. And in terms of traction power, history was

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not written in the US, but in Germany, at the turn of 1912/13.
"The electrical work is supplied to the tractive units from an overhead contact wire by means of a pantograph as a single-phase alternating current". This is what is written in Article 1, Paragraph 1 of the "Übereinkommen betreffend die Ausführung elektrischer Zugförderung" (Agreement relating to the implementation of electric traction). Its participants: the Prussian-Hessian, Bavarian and Baden State Railways. In the third paragraph, they state: "The periodic frequency in seconds is 16 2/3". The uniform railway frequency had been born.
On 12 November 1912 it was signed by Lorenz von Seidlein, the Bavarian Minister of State for Transport. The Prussian Minister of Public Works, Paul von Breitenbach, signed on 28 December 1912. On 18 January 1913 the Minister of Finance of Baden, Josef von Rheinboldt, finally sealed the agreement. Among other reasons, they justified their decision to harmonise their approval with the perspective of the railway in Germany. A farsighted decision.

A standard in many countries

What began with the agreement 100 years ago continues to be the standard, not only in our country but also in Austria, Switzerland, Sweden and Norway. In all of these countries trains run using a single-phase alternating current with a frequency of 16.7 hertz (Hz). This term began to be used in the mid-1920s in Germany. Nowadays, frequency is measured in hertz worldwide.
Today almost 60 per cent of the German rail network is electrified, i.e. about 20,000 kilometres. According to the Verband Allianz pro Schiene (Pro-Rail Alliance Association), it should be much more. "We believe that an electrification rate of at least 70 per cent of the Federal rail network by 2020 would be appropriate", explains the Association's CEO, Dirk Flege.
In fact, 76 or 85 per cent of the network is connected electrically in much smaller neighbouring countries like the Netherlands and Belgium. In Switzerland, even more than 99 per cent of all rail lines. The proportion of electricity in France, a country similar in size to Germany, is however just over 52 per cent.

Better environmental performance

Nevertheless, the importance of rail electricity is made clear less by the length of the electrified grid than by traffic capacity. Thus, according to Allianz pro Schiene, 90 per cent of the service already operates on electrical power today. Fleges conclusion: „Everything points to a further expansion of electric rail mobility."
From an environmental perspective, too, because no public means of transport has a better environmental performance than rail. It would be even more attractive if electricity did not come from fossil fuels or even nuclear power, but from renewable energy sources.
Deutsche Bahn AG therefore has ambitious goals. By 2020, more than a third of its annual consumption is to be covered by about twelve billion kilowatt hours of green power.

DB Energie supplies railways

The protagonist of railway electricity management is the Deutsche Bahn subsidiary DB Energie. Its current electricity turnover is higher by far than the needs of DB. It thus also supplies numerous railway companies and urban and regional rail transport companies. "Our customers receive about ten terawatt hours (TWh) of electricity for electric railway operation", claims the company. The company owns dozens of power, inverter and transformer facilities. A staff of more than 1,600 people is employed by Germany's fifth largest energy supplier. The annual turnover: € 2.3 billion.
Its electricity supply grid is approximately 7,754 km long, according to DB Energie. This is where the electricity flows as part of DB Energie's full supply. "Reliable, trouble-free, cost-effective", says the company. The former railway power monopolist is, however, also required to transport electricity from competing energy companies. This has been emphasised by the Bundesnetzagentur (Federal Network Agency) several times.

External procurement uneconomical

Theoretically, since 2004 railway companies have been free to choose their electricity supplier. According to the industry associations Mofair and Network of European Railways, however, no company makes use of this opportunity. The reason: the normal 50-hertz electricity has to be transformed to the 16.7-hertz frequency. A significant cost factor. Additionally, there is the network compensation charged by the Bundesneztagentur. Both together make external procurement of railway electricity technically uneconomic for the foreseeable future, according to both industry associations.
The technical requirements of railway electricity are also disruptive in other ways. Keyword: cross-border traffic. There are five different railway electricity networks in Europe. In Germany, Austria, Switzerland, Norway and Sweden, trains run at 16 kV and 16.7 Hz. In Northern France, Great Britain, Portugal and several other countries, 50 kV and 50 hertz are the rule. In Southern England it is 750 volts, while Poland, Spain and Italy have 3 kV in their lines.
Harmonised railway traffic is something different altogether. Even in the German-speaking countries, harmonisation took a long time to arrive: at exactly noon on 16 October 1995, Germany, Austria and Switzerland switched their railway electricity networks to a uniform 16.7 hertz. More than 80 years after the historic agreement between Baden, Bavaria and Prussia. The main reason for the use of the 16.7-Hz current is now almost insignificant: at the beginning of the 20th century, traction motors were unable to use 50-hertz electricity, which led to damages. Therefore, the frequency was reduced to a third. Today, it is no problem at all, as proven by other European railway networks. Will Europe eventually agree on a uniform network? *tok*