Summary

With the ELISA test track on the Bundesautobahn A5 between Frankfurt and Darmstadt the first German eHighway, based on a contract given by Hessen Mobil, was installed on a public road. This project has shown, that a successful homologation of well-known railway components to a public road system during the normal operation phase is possible on schedule with minimized intervention of the traffic. This article presents the main aspects of system design and the successful solved challenges in the construction phase.

1 Starting conditions

Before the design and executive phase of the project ELISA eHighway Hesse started, the most important question was to find the best location for the future eHighway track on the German Autobahn A5. Therefore the stretch, designated by the customer Hessen Mobil, between the exits “Zeppelinheim” in the north and “Weiterstadt” in the south had to be evaluated under technological and economical conditions. The selection of the track was particularly influenced by the following criteria:

1. Accessibility and discontinuity on the stretch
2. Optimization of the position and number of substations
3. General conditions made by the customer Hessen Mobil

Under consideration of these starting conditions the best track location was identified between the exit “Langen-Mörfelden” and the bridge “Wixhäuser Straße” with a total length of 5 km as shown in Figure 1.
2 System Design

To fulfill all requirements the test track is designed with two substations transforming the 3AC 20 kV medium voltage to DC 670 V to supply the electric trucks. In total the substation is designed to deliver a nominal power of 1000 kVA with load class VI regarding EN 50329 [1]. The first substation is situated at the parking lot “Bornbruch” at the end of the test track in the north. It’s feeding both driving directions. The second substation is situated on the highway service area “Gräfenhausen West”. At this location the double-sided feeding of the catenary system is ensured in the north direction. In the other direction a stretch can be supplied which ends in front of the bridge “Wixhäuser Straße” in the south.

![Plant design at rest area Gräfenhausen](image1)

*Figure 2: Plant design at rest area Gräfenhausen*

To transfer the electrical energy to the electric trucks the typical eHighway bipolar catenary system with one pole serving as electric return circuit was chosen [1]. The system based on proven technology and know-how from electric railway systems which was also used in earlier eHighway test tracks. This system is characterized by specialized materials for reduced wear and high power transfer capabilities to serve also high traffic demands. It is an opposed staggered catenary system in curves for operating those eHighway systems based on proven standard components of Sicat contact line systems from Siemens. The major components of the catenary system are shown in figure 3.

![Design of the eHighway-contact line system in Hesse](image2)

*Figure 3: Design of the eHighway-contact line system in Hesse*
The highway service area “Gräfenhausen” is characterized by a gas station on each side and big parking lots for passenger cars and trucks with no space for the pole placement between road and parking area. However, the economical design demands the electrification of the whole 5km-stretch without interruption. Due to that fact, also the electrification of the highway service area “Gräfenhausen” is necessary. The solution is to place the poles in the middle strip of both driving directions.

In addition, two high-voltage transmission lines are crossing the highway with restrictive requirements regarding construction works in the area of the lines. In due to that fact it was necessary to design poles with a lower length to avoid electrical interferences.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
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<tbody>
<tr>
<td>Medium Voltage</td>
<td>20 kV</td>
</tr>
<tr>
<td>Nominal DC-Voltage</td>
<td>670 V</td>
</tr>
<tr>
<td>Nominal power per substation</td>
<td>1000 kVA</td>
</tr>
<tr>
<td>Number of substations</td>
<td>2</td>
</tr>
<tr>
<td>Track length per direction</td>
<td>5 km</td>
</tr>
<tr>
<td>Number of poles</td>
<td>223 + 6 poles in the middle strip</td>
</tr>
</tbody>
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*Table 1: Technical main parameters of ELISA*
3 Site works

After finishing the design and before starting the construction phase, the environmental and geological conditions had to be evaluated and proved. The site works itself began in March 2018.

One of the main tasks during the construction phase was the minimization of the impact on the traffic. Therefore the traffic safety of the site works was divided into two parts: The permanent traffic safety was installed for the work outside of the highway. In this case, no lane space was taken away, instead the existing lanes were narrowed a bit. The temporary installed traffic safety was installed for actions for work in the right lane and outside of the peak hours (e.g. Figure 5). The other lanes were only affected for the erection of the poles and cantilevers in the middle strip.

The installation of the catenary system was divided into the following parts:

- Digging up to check for cables and channels
- Bring in the steel tubes as foundation
- Setting up the poles
- Installation of the cantilever
- Pulling the messenger and contact wire (Figure 4)

The poles in the middle strip were erected during one night. Afterwards the installation of cantilevers was executed as planned in two nights over one weekend. Due to the length of these cantilevers (across all lanes) the traffic on the entire highway had to be stopped for a few minutes at each of the poles to ensure safe fixation (Figure 5).

Figure 4: Pulling of the catenary wire
Figure 5: Installation of one of the poles in the middle strip

The substations was constructed as a turnkey system in the factory so that only the commissioning had to be done on site. Therefore the installation of the substation was synchronized with the connection of the medium voltage to ensure an efficient and rapid energizing of the track. Each substation has the dimensions 8,40 m x 2,95 m x 3,10 m and is surrounded by a fence (Figure 6).

Figure 6: Substation Bornbruch (in the north)
4 Results

After completion of the works, the first electrical connection of pantograph to the overhead contact line system and test drives of an eHighway truck was successfully done in the end of November 2018 on the ELISA eHighway as shown in Figure 7. The work has shown that the installation of the eHighway system during the normal operation of the highway is possible. The challenges arisen in the design and construction phase required individual solutions which could be implemented right on schedule. This first installation of such a long track under these conditions shows, that in future longer distances could be electrified.

Figure 7: Test drives
References


Authors

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