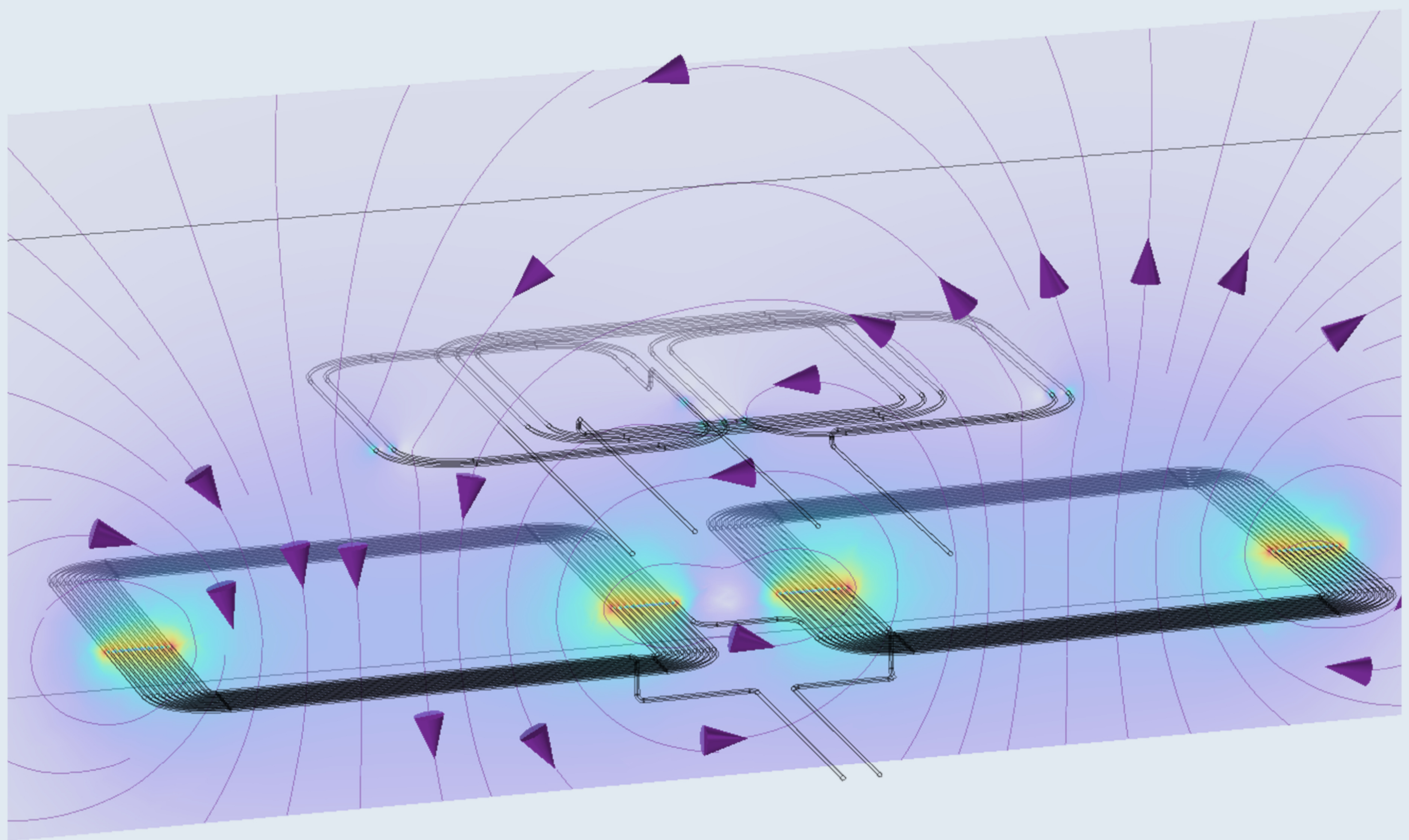

Modelling of an Electric Road System with Focus on the Inductive Power Transfer

Electric Road Systems can help to overcome the limitations of electric vehicles (e.g. short range) and thus, to further push mobility towards zero emissions.

F. Gumpert[1], J. Lohbreier[1]
1. Applied Mathematics, Physics and Humanities, Nuremberg Institute of Technology, Nuremberg, Germany

Introduction

A major transformation in the transport sector is necessary to achieve Germanys and EUs ambitious goals of CO2 neutrality (Ref 1). In this transition, fossil fuel-based engines will be replaced by sustainable technologies in which electric mobility plays an important role to reduce the CO2 footprint of the transport sector. However, currently electric vehicles have some disadvantages compared to competing technologies, especially for heavy goods transport.

Electric road systems (ERS) are a promising approach to overcome these problems. The ERS can be separated into two sides, the primary side (integrated into the road) and the secondary side (integrated into the electric vehicle). The coil on the primary side transfers energy by induction to the secondary coil, which receive up the energy. The received energy can be used to charge the batteries during parking (static charging) or during driving (dynamic charging). The implementation of an ERS on an Autobahn section is the scope of the third-party funded project E|MPOWER (Ref 2).

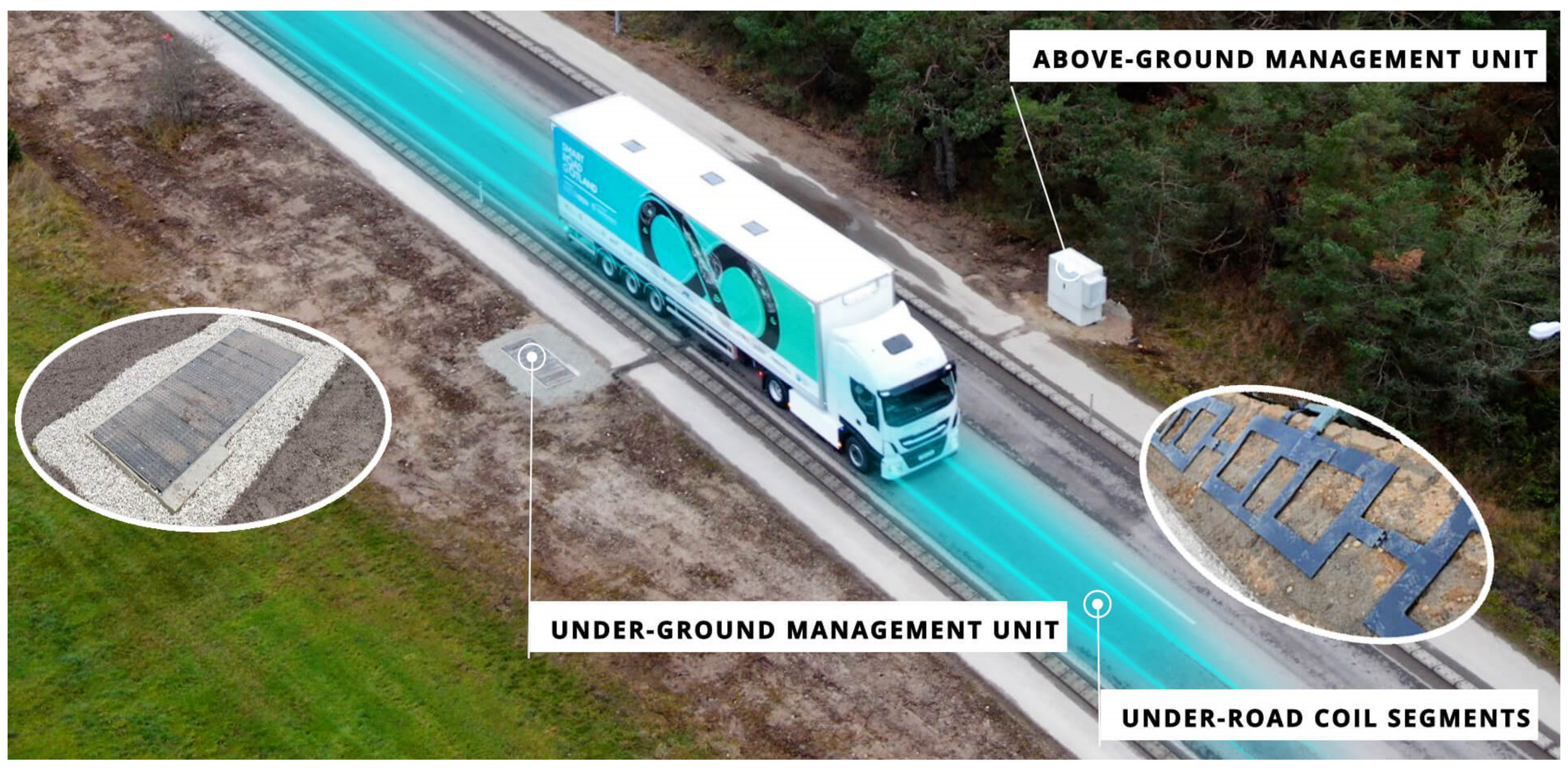

FIGURE 1. Vision of ERS to dynamically charge vehicles and to further boost electric mobility (Ref 3).

Methodology

To study the power transfer efficiency of the ERS, the voltage and current signals over time at the primary coils are modelled via an equivalent circuit of the ERS. A Fourier Transformation (FT) is applied to the transient current signal of the primary coil.

A 3D FEM model of both coils is implemented to study the inductive power transfer. The results of the FT are used as input for frequency dependent studies in the numerical model, where frequencies up to 10 MHz are considered.

In order to obtain the necessary experimental data, a novel, tailor-made measurement device is currently under development.

Results

The open circuit current of the secondary coil is compared for a set of lateral displacements of the two coils with respect to one another. Thus, the transmission efficiency during the dynamical charging process is investigated. As one would expect, maximum transmission efficiencies are reached if the car (and the therefore the secondary coil) is perfectly aligned.

The car passes three efficiency peaks during the passage over the primary coil. When the car is in perfect alignment with the primary coil, the peaks have efficiencies of more than 96%. For a non-ideal overlap of the coils, the efficiencies drops.

In practice, the secondary coil will be equipped with a ferrit core (not included here) to further optimize transmission efficiency.

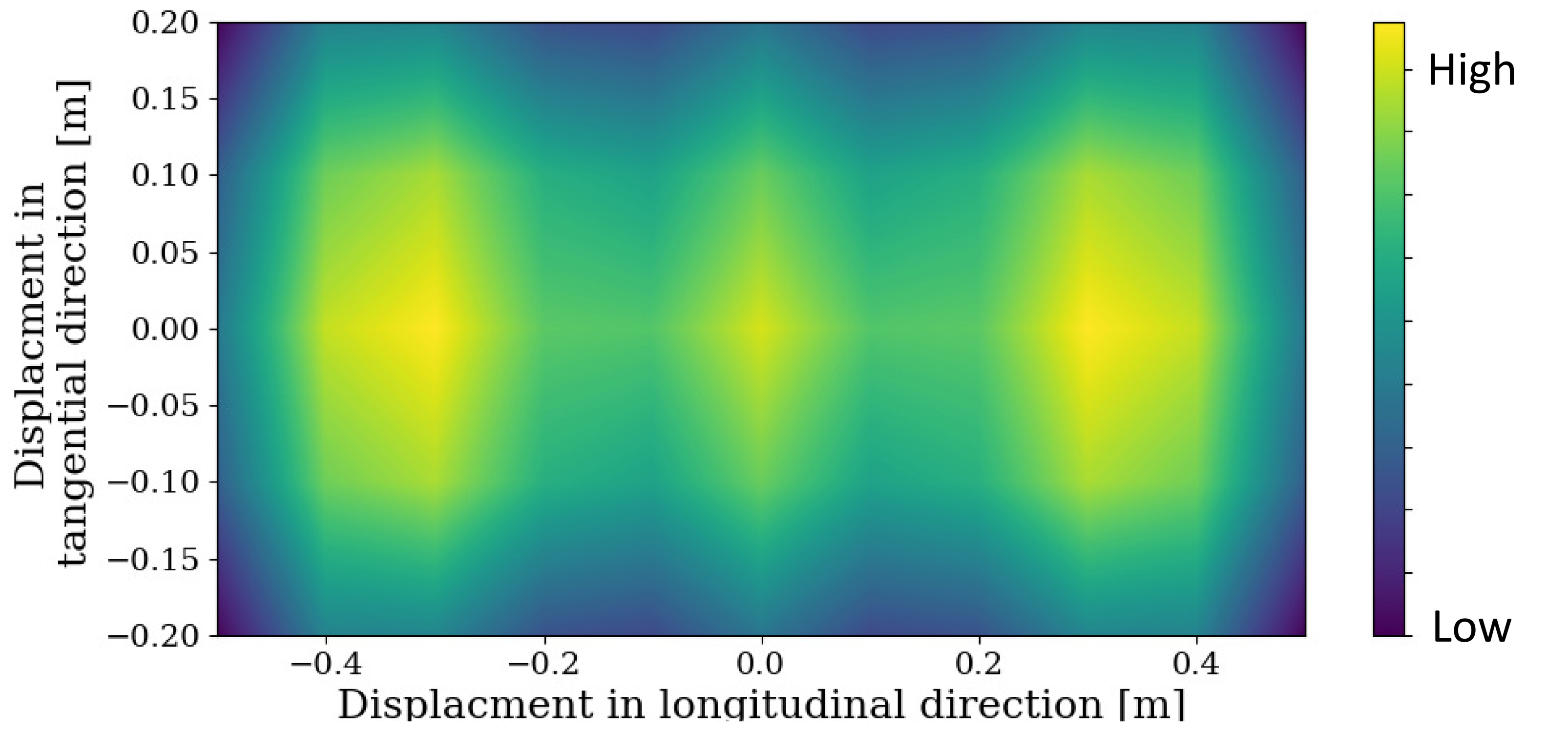

FIGURE 2. Normalized open circuit current of the secondary coils if the secondary coil is laterally displaced.

REFERENCES

1. Statistisches Bundesamt
2. https://www.fau.de/2023/01/news/wissenschaft/eine-strasse-unter-strom/
3. https://electreon.com/media-kite

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages