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Soil physical investigations for the optimisation of the cable plough procedure for the burial of 380 kV power cables (Miboka-project)

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The extension of the power grid is crucial for the success of the German energy transition (Heimann, 2015). In the past, companies rarely buried high voltage power cables in the ground due to high prices and construction limitations (Kroener et al., 2014). High prices are largely related to the conventional installation technique, the open construction, as it requires the movement of tonnes of soil. Even replacement of soils by filling substrates in the cables´ vicinity can be necessary, if heat conductivities (HCs) of soils are insufficient (Amprion, 2017). Current flow generates heat loss in power cables. If HCs are low, soils trap this heat, which potentially causes harmful temperatures that will reduce the cable´s ampacity and its longevity (Kroener et al., 2014). Therefore, high HCs are favoured, which are soil specific and determined by the soil´s bulk density (de Vries, 1963), whereby denser soils result in higher HCs.

Frank Föckersperger GmbH had developed a multiple cable plough (MCP) by which the protection pipes of power cables can directly be ploughed to required soil depths. This technique is promising to reduce the amounts of excavated soil and to shorten construction times (TenneT, 2019a). In a cooperative project, the TU Berlin scientifically accompanies Frank Föckersperger GmbH to identify what effect the MCP has onto soil properties and to evaluate if natural soils **can** meet the requirements that the cable bed of the open construction technique **needs** to meet. These requirements consist of a cavity-free cable bed, minimum bulk densities of 80 percent of the reference soil´s bulk density, and HCs of 0.4 W m^{-1} K^{-1} for dry and of 1.0 W m^{-1} K^{-1} for moist soil conditions (Schneider, 2019).

In course of their Wahle-Mecklar project, TenneT TSO GmbH is going to construct a 13 km long underground powerline between Wahle and Lamspringe, Lower Saxony, Germany (TenneT, 2019b). On a test field near the community Wartjenstedt, TenneT TSO GmbH and Frank Föckersperger GmbH tested the MCP on a 200 m strech in July 2019. After the operation, the TU Berlin sampled three trenches regarding their disturbed and undisturbed realms, and investigated the following parameters in the laboratory: soil texture, bulk density, HC, and water retention.

During the MCP procedure, soil layers were drastically mixed causing changes in soil texture. In contrast, the procedure´s effect onto the water retention did not indicate general trends. We found that results for bulk density and HC complied with the requirements. However, a cavity-free cable bed was not present and bulk densities were mostly lower than their references. Concerningly, we detected some of the lowest bulk densities in the cable bed or in close vicinity.

Therefore, Frank Föckersperger GmbH recently carries out modifications on the MCP to ensure cavity-free cable beds with more homogeneous and denser bulk densities to facilitate sufficient HCs thereby. Currently, we run simulations to identify the real impact of the results onto the heat and water transport in power cable containing soils. In the future, we are going to evaluate the MCP modifications after their implementation.

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