A modular switching system as a flexible charging solution for a logistics terminal

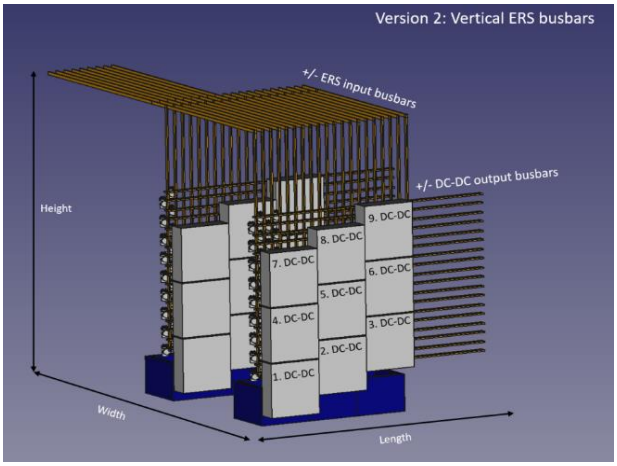

Figure 1: Part full scale model of a modular switch matrix charger

The ambition to move road transport from fossil fuels to electric energy is a large undertaking. One of the biggest challenges with making the trucks fully electric is to charge them. They are usually operated daytime, and the operations gives very little time for charging resulting in the power needed for daytime charging being in the high 100s of kW. A desired system implemented at the terminal would be a flexible system which provides charging in different power levels at different charging spots, matching the charging power needed of each individual truck charging at any given time.

This thesis investigates a modular switch matrix charger, using Elonroad's electric road system (ERS) as stationary charging ports, as a solution to charge a larger logistics fleet and compares it in flexibility, robustness, and costs to a more conventional fast charger model. The modularity stems from the charger being built with several dc-dc converters where each is connected via a switch matrix to each charging port. This enables the charger to divert as many converters as needed to every charging port in a flexible way providing each charging spot with the unique power level each truck desires when charging. The structure thus needs less converters installed as opposed to if conventional fast chargers would be used at every charging spot. The increased robustness the switch charger provides is availability. For example, if one of the chargers break and three vehicles want to charge at the same time one must wait while the other two are charging. With the switch matrix charger however, the converters can be rerouted between the charging spots. Thus, allowing all charging spots to function but with a lower output such that instead of one vehicle needing to wait a long time for a spot to be free, all can charge but with a slightly longer charge time. The total cost of the system is also lower for a switch charger as the amount of dc-dc converters is significantly reduced compared to a conventional charger structure.

Figure 1 shows one of two charger models constructed in the thesis. The converters are placed in racks with current carrying busbars going horizontally (converter outputs) and vertically (ERS inputs). At each busbar intersection there is a switch connecting the vertical and horizontal busbar which allows each converter to be connected to each ERS rail by opening and closing of the switches as the user desires.

Table 1 shows a cost comparison between two configurations of the switch model charger with one configuration of conventional fast chargers at a terminal with 55 charging spots. The comparison is made between placing conventional 350kW fast chargers at every charging spot and two versions of the switch matrix charger with a total installed power of 3MW. The 3MW switch matrix charger is the necessary installed power calculated in the thesis which can charge the whole truck fleet at the terminal. The chargers are built modular with converters ranging in size from 25kW to 150kW. As can be seen from the table, both versions of the switch matrix charger are a less costly alternative when compared to the conventional charger system, mainly due to the reduced number of converters needed.

Converter size	Conventional	Model version 1	Model version 2
25kW	€$1944 \cdot 10^3$	€$808 \cdot 10^3$	€$818 \cdot 10^3$
50kW	€$1315 \cdot 10^3$	€$456 \cdot 10^3$	€$461 \cdot 10^3$
100kW	€$928 \cdot 10^3$	€$268 \cdot 10^3$	€$272 \cdot 10^3$
150kW	€$749 \cdot 10^3$	€$339 \cdot 10^3$	€$342 \cdot 10^3$

Table 1: Cost comparison

The transition from conventional vehicles to EVs is well underway and will require huge new infrastructure projects to be able to facilitate enough charge to provide the EVs with the same or even longer driving range. I hope with this thesis to have opened for more possible solutions mainly when it comes to electrify the transport of goods sector but also questions of which way is best to go when it comes to charging for all types of EVs.

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