# Micro Substation with Power Voltage Transformers for EV charging

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## SUMMARY

The increasing demand of EV charging stations is a reality, and this need is growing with more electric vehicles coming into the market. According to the Global EV Outlook 2022 from the International Energy Agency, it is required more than 4,5 million new fast chargers by 2030 in the world. This is because there are expected more than 200 million of EVs to be circulating by 2030. Without the development of the charging infrastructure this growth will not be possible. We see is that there is still a lack of EV charging stations in many areas, mainly in remote areas when we do not have low voltage available. There is a real need to accelerate the infrastructure of EV charging stations, and these stations should be available in different areas, not only in the cities but also along the roads to make the usage of the EV possible also for long travels and transportation goods with trucks.
What should be considered is that there is not always all the infrastructure available to have the charging stations installed, sometimes we have high voltage transmission lines available, but the voltage level on these lines is not suitable for the connection of the chargers as they cannot be connected directly to high voltage. Sometimes, we have low voltage available, but the power available is not enough for fast charging stations, as in these areas fast charging will be needed because people traveling with the EVs will not be wiling to wait for hours for the battery of the car to be charged. Also charging trucks will need more power and fast chargers will be the solution.
In many cases, we have high voltage transmission lines nearby roads, so now we need to find a way to transform the high voltage available to low voltage values that can be used in the charging stations. About the power availability, this will not be a problem because the power that high voltage transmission lines can carry are much bigger than the power needed for EV charging stations.
This paper describes some alternatives how the power VTs can be used to build a micro substation in remote areas and connect the secondary of the power VT to EV charging

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stations. Making EV charging available even on remote areas. It is also possible to use this solution in urban areas, where the medium voltage grid has limitation on the power supply. As this solution takes the power directly from the transmission line there is no need to upgrade existing medium voltage grids. These transformers can be used to build a “Micro substation” at any place where we have a high voltage transmission line. Areas where medium or low voltage are not available, now can have access to power with a simple connection.

**KEYWORDS**

Power Voltage Transformers, Station Service Transformers, Micro substation, EV Charging

1. Introduction

Power Voltage Transformers also called Station Service Transformers can be connected to the high voltage on the primary side and provide power at low voltage on the secondary. This solution can be used for voltage levels from 72,5 kV up to 550 kV. The reliability this solution is very high, as they are not dependent on distribution lines that are more susceptible to outages. Power VTs are designed as single-phase line to ground transformers. By using three devices a "three-phase power supply" with accumulated output power is also possible.
If more power is needed more power VTs can be connected to the transmission line in a modular way, to increase the power supply as per below example on figure 1 and 2.

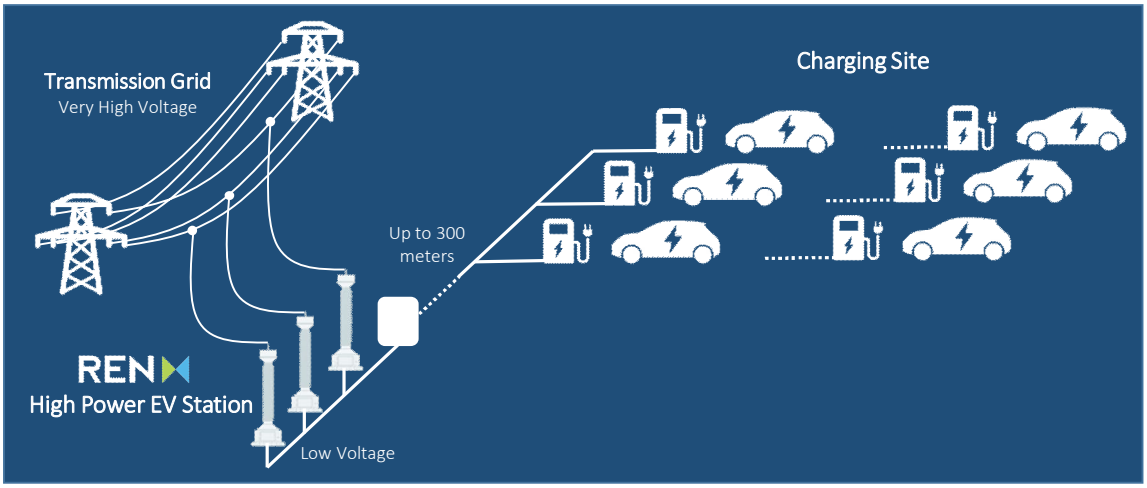

Figure 1: Example with one module

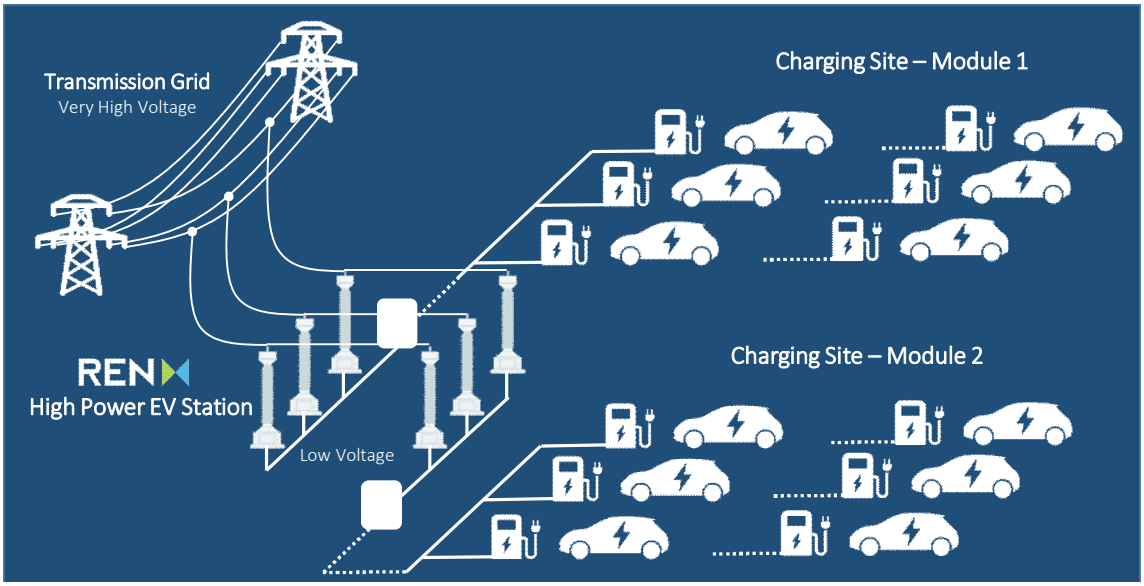

Figure 2: Example with two modules

There is a pilot project already in place in Portugal, using 3 power VTs, connected directly to a transmission line, suppling power to an EV charging station. The solution was patented by REN with the patent number: WO2019123424A1. On figure 3 we can see a picture of the installation.

Figure 3: Demonstration Project connected to a 220 kV overhead line in Lisbon area

## 2. Power VTs

Power Voltage Transformers combine the attributes of an inductive voltage transformer with the application of a power transformer.
Typical applications:
- Auxiliary power supply for substations
- Electrification of remote areas
- Power supply during substation construction works

The application is not limited to these examples.

Power VTs can be insulated with Mineral oil, SF6 and Clean air. The Power VTs insulated with Clean air (Syntetic Air (Purity 99,999% ) (20% O2 + 80% N2) , bringing a completely SF6 free solution up to 420 kV. Long term sustainability and no environmental compromise are possible with clean air insulated Power VT. Global warming potential (GWP) of Zero.

Clean Air instrument transformer are installed and in service with outstanding results, proving this innovative and eco-friendly product is highly reliable for the use in AIS and GIS switchgear applications. The Clean Air portfolio is fully compliant and tested to international standards. It provides the same electrical and insulation features as traditional insulation technologies while at the same time giving all the benefits of a SF6 free solution.
The application is suitable for low temperature applications at -50°C and below, they are also maintenance free during a long lifetime of more than 30 years. On figure 4 we can see an example of a Power VT with clean air insulation:

Figure 4: Power VT with clean air insulation

The power output of a single-phase transformer can reach 167 kVA, with a three-phase solution we will have 500 kVA. It is very simple to add more modules to this solution, bringing the possibility of supplying higher power values. Transformers with single-phase power of 333 kVA are also under development. On figure 5 we can see some details of the Power VT construction

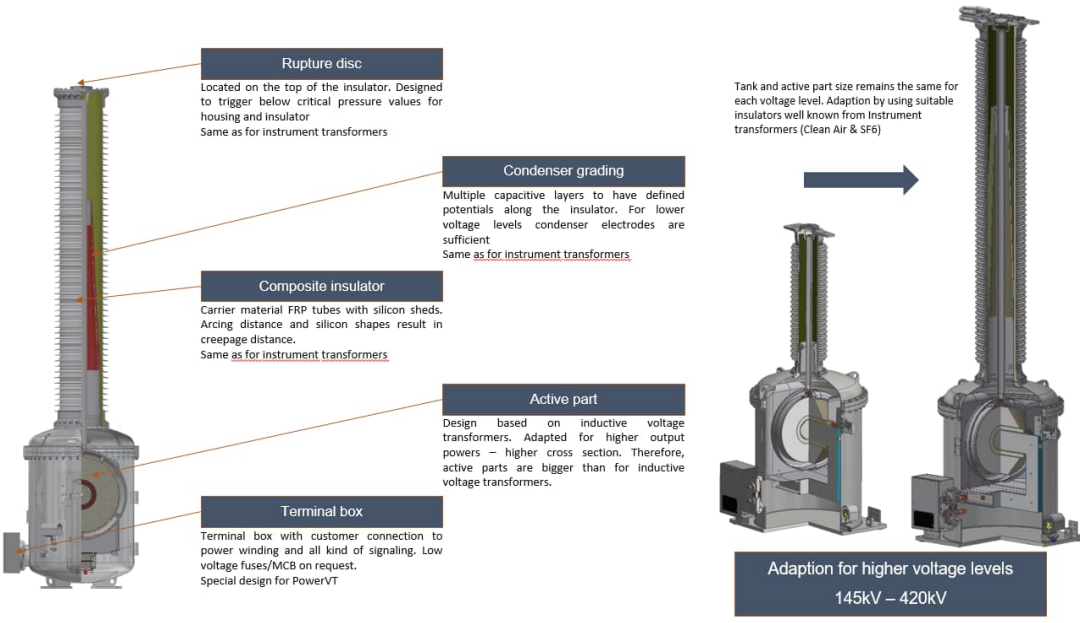


Figure 5 – Power VT construction

The Power VTs can be monitored with sensors, providing with real-time insights on the installed products, allowing optimized grid management based on a flexible and economic operation. The parameters that can be monitored are the gas density and the internal temperature of the transformer, the information can be monitored online. On Figure 6 we can see the main components for the online monitoring of the Power VTs


Figure 6 – Online monitoring components

## 3. Conclusion

The solution of the micro substation using the power VTs can we an alternative for many different applications were power is needed and we have a high voltage transmission line available. The installation can be done is a short period of time and does not require a large number of equipment.

Some of the unique benefits that the micro substation solution can bring are:

- Enables coverage for general use of electric vehicles: implementation in the outskirts of the main cities (charging hubs) or in the main roads and highways, using already available sites, whenever an overhead line crosses a main road;
- Overcome grid constraints: as the charging stations are directly connected to the transmission grid, avoiding the need for grid reinforcements, mainly in rural areas, thus boosting fast deployment;
- Virtually unlimited power availability in each site: enabling massive scalability of fast and ultra-fast chargers per site, which responds to ‘consumer anxiety’ in terms of availability (multiple chargers) and charging time (higher power required);
- Transmission service quality level: providing clients the best service level with minimal interruption time;

The solution is suitable for standard or tailor-made applications such as:

- Service areas in highways and roads
- Electrification of public transports
- Electrification of company fleets
- Large parking lots in city suburbs or intermodal parking facilities
- Highly dense suburb residential areas, for population without home charging facilities

- Heavy-duty logistic centres
- Electrification of river boats
- Mobile solution for electrification of forest machinery or special events in remote areas

## BIBLIOGRAPHY

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