Over the past few years, the number of PV installations in the Netherlands has grown exponentially, increasing the installed capacity from 149 MWp in 2011 to 14.4 GWp in 2021[1]. The rapid adoption by (larger) commercial customers, driven by attractive subsidy schemes, has led to voltage limit violations in the Dutch medium-voltage grid. Annual netting of generation and demand caused a short return on investment for households (over 20% has a PV systems installed), but also led to complaints about inverters switching off due to over-voltages.

Historically, the LV grids of Liander (one of the Dutch DSOs) have been designed for around 1.5 kW per household, accounting for the coincidence of the load. Nowadays, with EV charging equipment, PV systems and heat pumps being installed, the loads increase drastically. And with it, the voltage drop/rise over the LV grids. As a result, Liander has seen a significant increase in smart meter voltage events (indicating voltages outside 230 V ± 10%) and voltage related complaints.

Ideally, the DSO would be aware of the voltage limits being reached before actual under- or overvoltages occur. Knowing the grid voltages at the points of common coupling is relevant for adequate decision making. Of course, the voltages are simulated in network analysis software. When the loads and network properties are known, the voltages are a result of the calculation. However it is not uncommon that the actual voltages do not align with the simulated ones. Various reasons contribute to this. Dutch regulation does not allow the DSO to access detailed smart meter data[2]. Consequently, the (peak) load of the customer has to be assumed (e.g. based on the annual net energy use). Furthermore, details about the network itself (e.g. MV/LV transformer tap-changer settings, LV topology, cable properties) are not always well known. Finally, network models are usually based on the maximum MV voltage variation and/or assumed MV voltages rather than the actual MV voltage. So, as LV network models lack accuracy to determine the actual LV voltage, it is beneficial to introduce voltage measurements. Liander is developing these insights in LV voltages in various ways.

Currently, data is retrieved from smart meters that do not contain privacy-sensitive information. Examples hereof are smart meters used for public lighting and smart meters of public objects (such as EV charging points, bus stops, traffic control installations, garbage containers and pumping stations). Liander uses a form of distribution automation to switch public lighting on and off. This automation is present in the MV/LV substations. Requiring current and voltage measurements to determine the energy used by the public lighting, the smart meters also provide insight into the voltage on the LV rail. When voltage issues arise, this measurement can help to identify if the solution lies in the MV grid, the LV grid or the MV/LV transformer tap-changer setting. In addition, the smart meters of public objects provide insight in the voltage drop/rise over the LV feeders.

Liander aims to increase the number of locations with voltage measurements.
The insight into LV rail voltages is limited, as the public lighting distribution automation is present in a minority of Liander’s MV/LV substations only (16%). That is one of the reasons

[1] For reference: the Dutch annual peak load is around 18-19 GW.
[2] Some exceptions apply, but it is not in the interest of this publication to elaborate on that.

Liander is rolling out measurement devices on the LV switchgear of its MV/LV substations. Aside from providing insight into actual LV rail voltages on more locations, these measurement devices help to understand MV network and LV feeder loading and identify energy losses.

Smart meters currently produce overvoltage alarms when the voltage reaches 253 V. However, PV inverters often already switch off before this voltage is reached at the point of common connection because of voltage rise over the cable between the PV inverter and the point of common connection. Soon, overvoltage alarms will be changed such that it does not produce an alarm at 253 V, but a few volts before so the DSO gets an active notification that the voltage is closing in on its limits.
Additionally, discussions with the relevant authorities are ongoing to retrieve more detailed voltage data from household smart meters. As the public objects are only a small fraction of the LV connections (around 2%), the insight provided in voltages along LV feeders by these measurements is limited. To gain the desired insight it will not be necessary to know the voltage at all connections at all times. For network planning purposes, knowing the voltages at the start and end of the feeders during periods of high load/generation is sufficient. Both the absolute level of and the trend in these voltages provide insight into the need for network reinforcement.