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Enabling EV Charging by introducing LVDC Backbones in LV Distribution Networks

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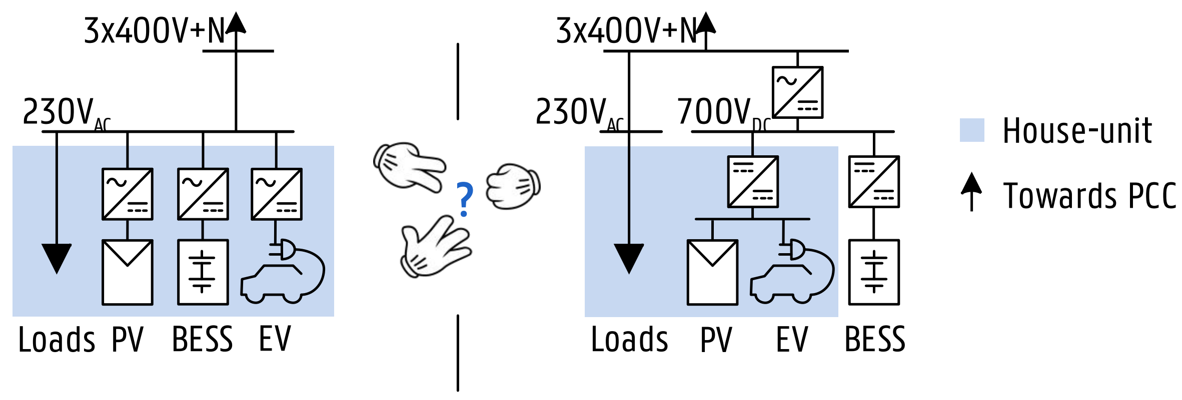
Objectives

Charging EVs through traditional AC low-voltage distribution networks involve numerous conversion stages, leading to energy losses and power quality (PQ) issues. Therefore:

- A novel approach to charge EVs is presented
- An energy loss comparison is executed
- A power quality assessment is performed

Results are obtained through power flow analysis on a representative distribution network



Traditional AC vs. **LVDC backone approach**

Methodology

Traditional AC approach:

- All house-units are single-phase connected
- House-units do all have their individual SDGEs†
- All SDGEs have a separate (DC/AC) convertor

Novel LVDC backone approach:

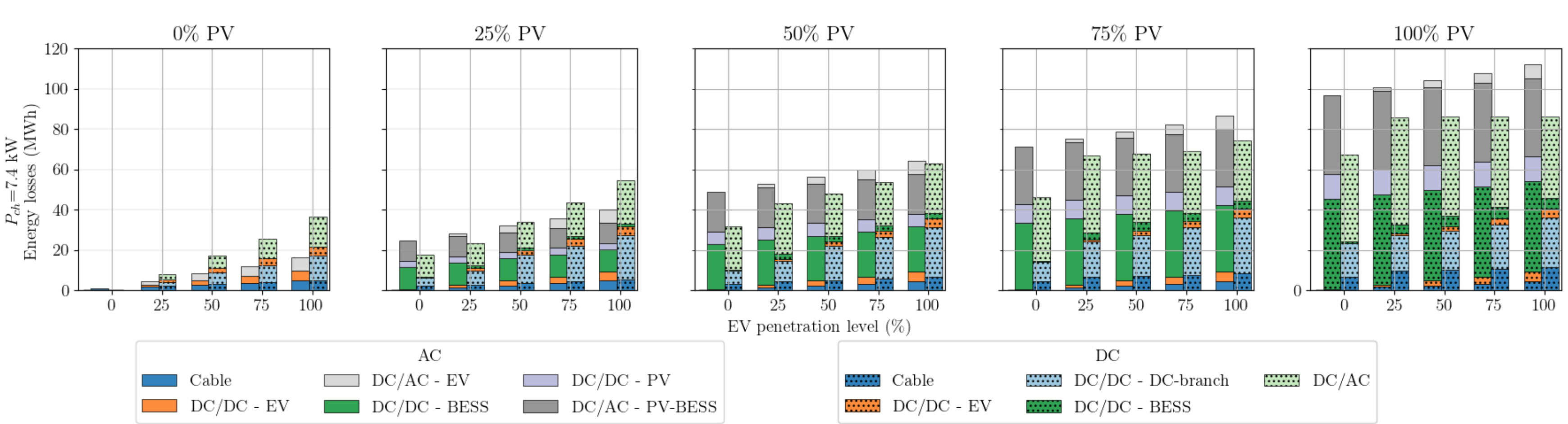
- 1 DC/DC convertor connects SDGEs to LVDC backbone
- EVs directly connected via internal DC/DC convertor
- PV systems directly connected via centralized MPPT
- Community BESS is required for the LVDC backbone

Scenarios:

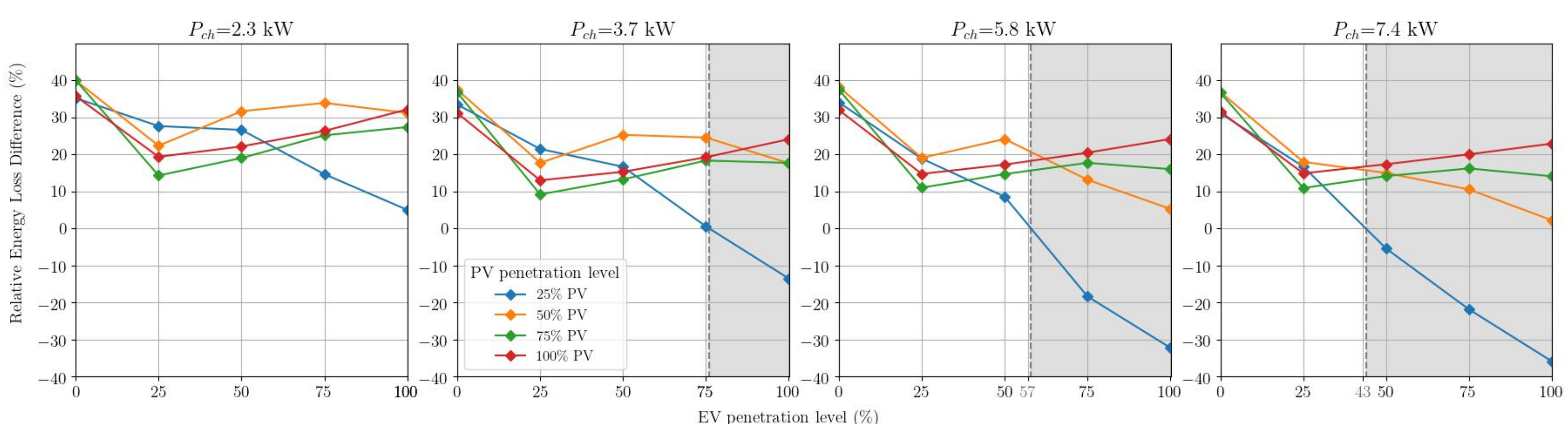
- EV charging rates studied: {2.3 ; 3.7 ; 5.8 ; 7.4} kW
- EV and PV degrees: 0 … 100% in increments of 25%

†SDGEs : Stochastic Distribution Grid Exchangers – i.e.: EVs, PV systems and Battery Energy Storage Systems (BESS)

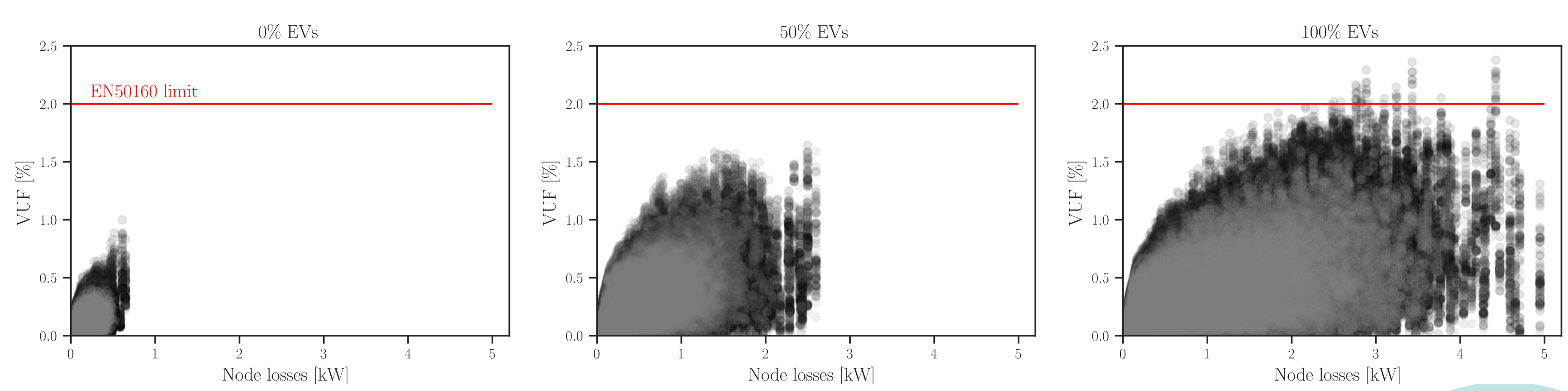
Results



- Higher P_{charge} : PV cannot cover demand → conversion losses ↗
- Leads to stagnating losses at high PV and increasing EV degree



- LVDC backbone with EV: non-beneficial for low PV degrees
- Benefit threshold ↘ at lower charging rates when PV degree is 25%



- VUF > 2% recorded for EV penetration levels of 75%.. onwards (7.4 kW)
- No limits are exceeded in the proposed LVDC backbone approach

Conclusions

▲ PQ issues (Voltage rise/drop and voltage unbalance) do not occur in the LVDC backbone approach
▲ LVDC backbone is beneficial in terms of efficiency at high PV penetration levels

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