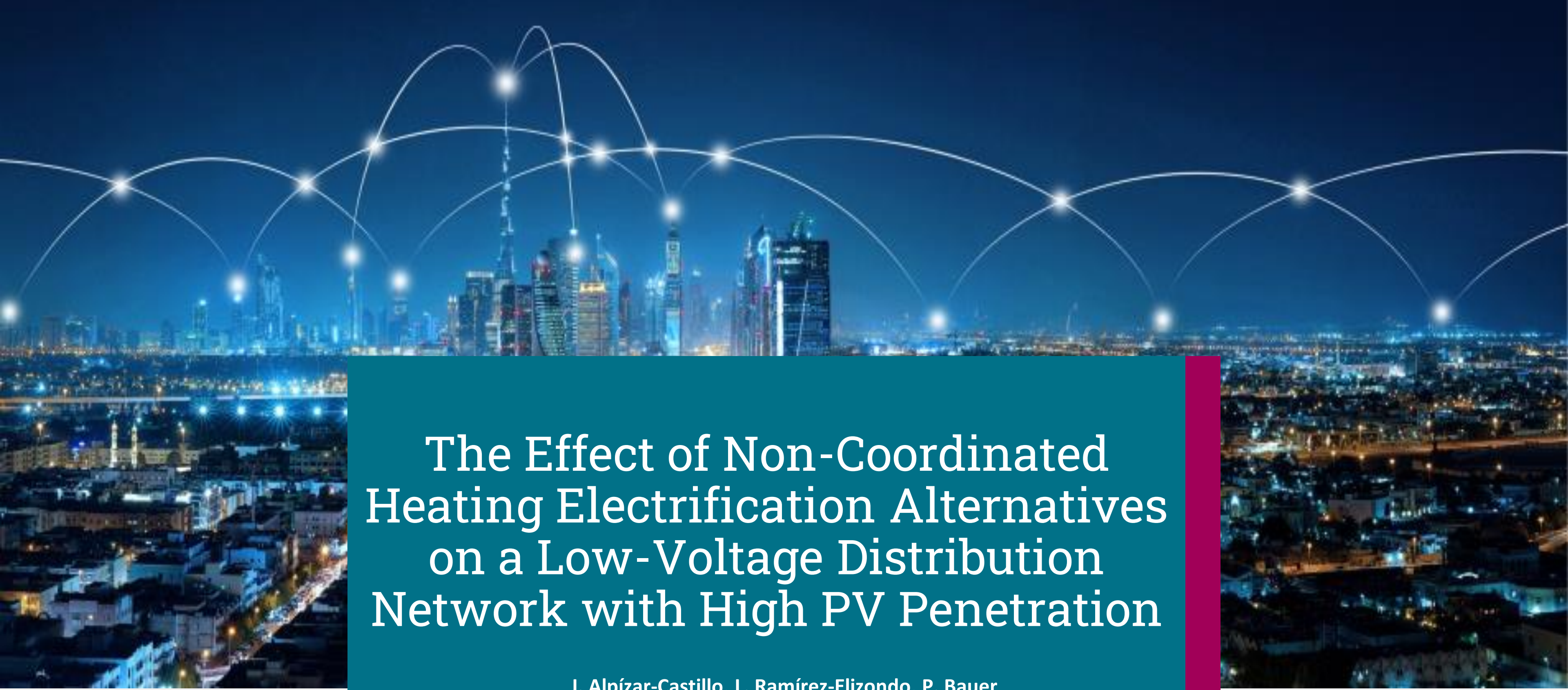


The Effect of Non-Coordinated Heating Electrification Alternatives on a Low-Voltage Distribution Network with High PV Penetration

J. Alpízar-Castillo, L. Ramírez-Elizondo, P. Bauer

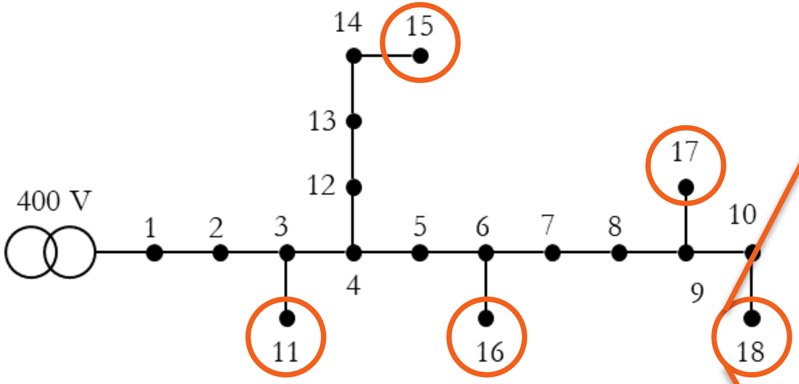
TU Delft

Introduction

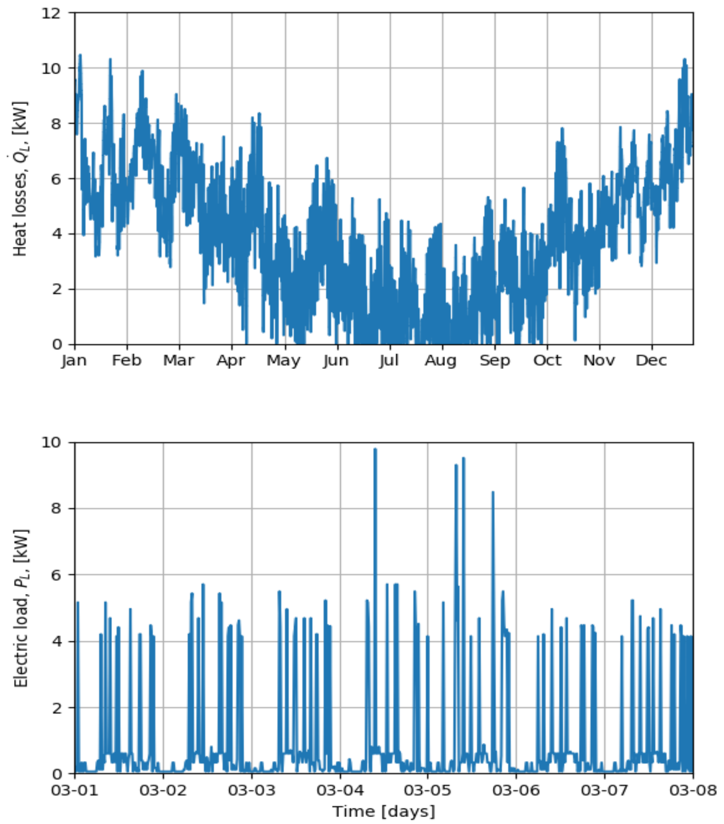
- DRES can cause stability issues, grid congestion, and overvoltages on the distribution networks.
- Electric heating alternatives consume considerable amounts of power.
- Including energy storage systems on the grid can help the DSOs to address the issues

Effect of Non-Coordinated Heating Electrification on a LV Distribution Network

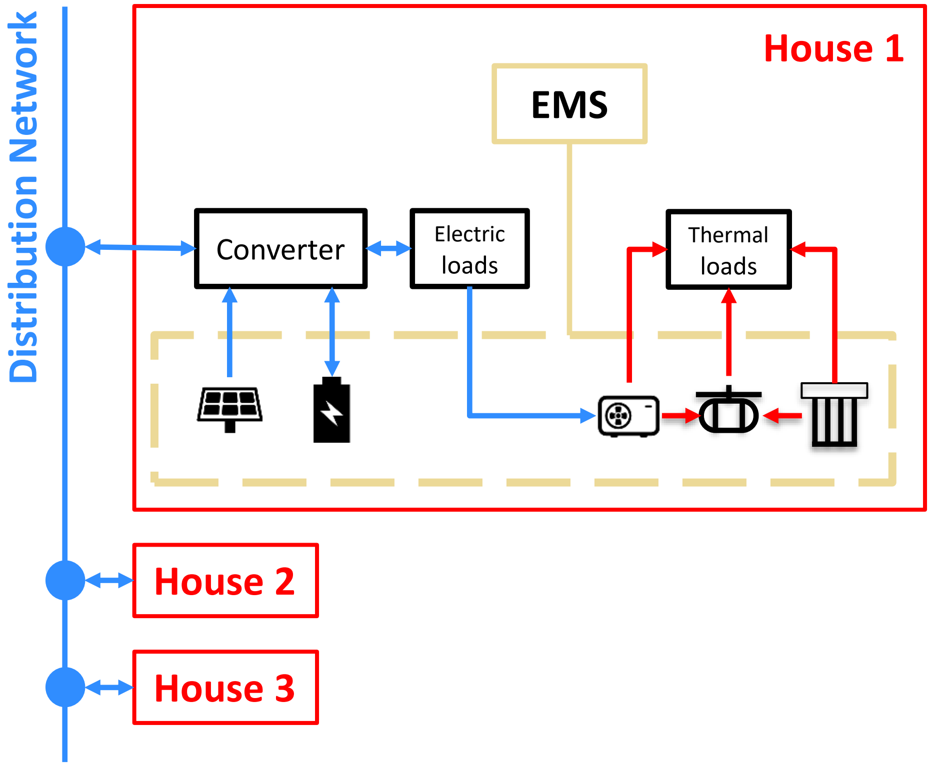
18-node CIGRE network model

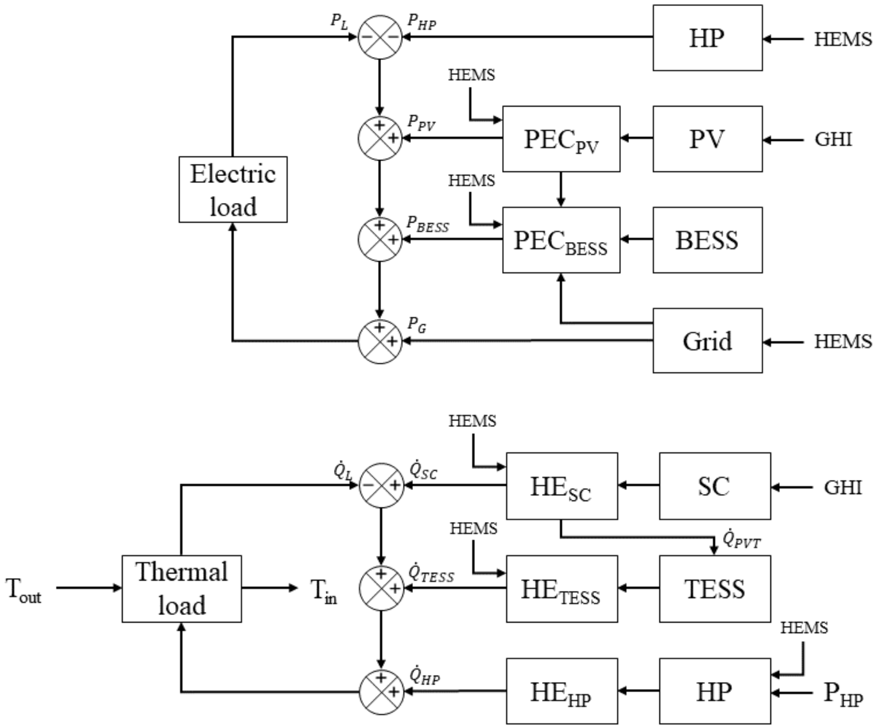


Node	Load (kVA)	Power factor	PV (kW)	BESS (kW)	BESS (kWh)	HP (kW)
11	12	0.85	6.4	8	10	5.4
15	12	0.85	9.6	9.6	15	8.1
16	12	0.85	14.4	14.4	30	16.2
17	12	0.85	19.2	19.2	30	16.2
18	12	0.85	19.2	24	30	16.2



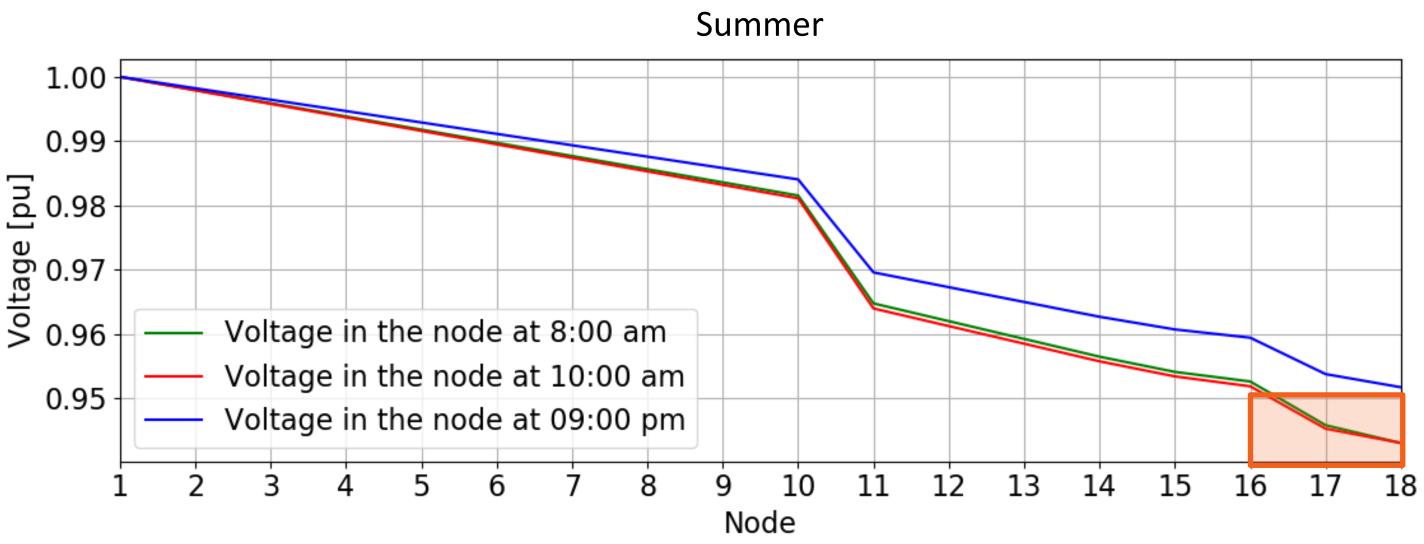
Control architecture





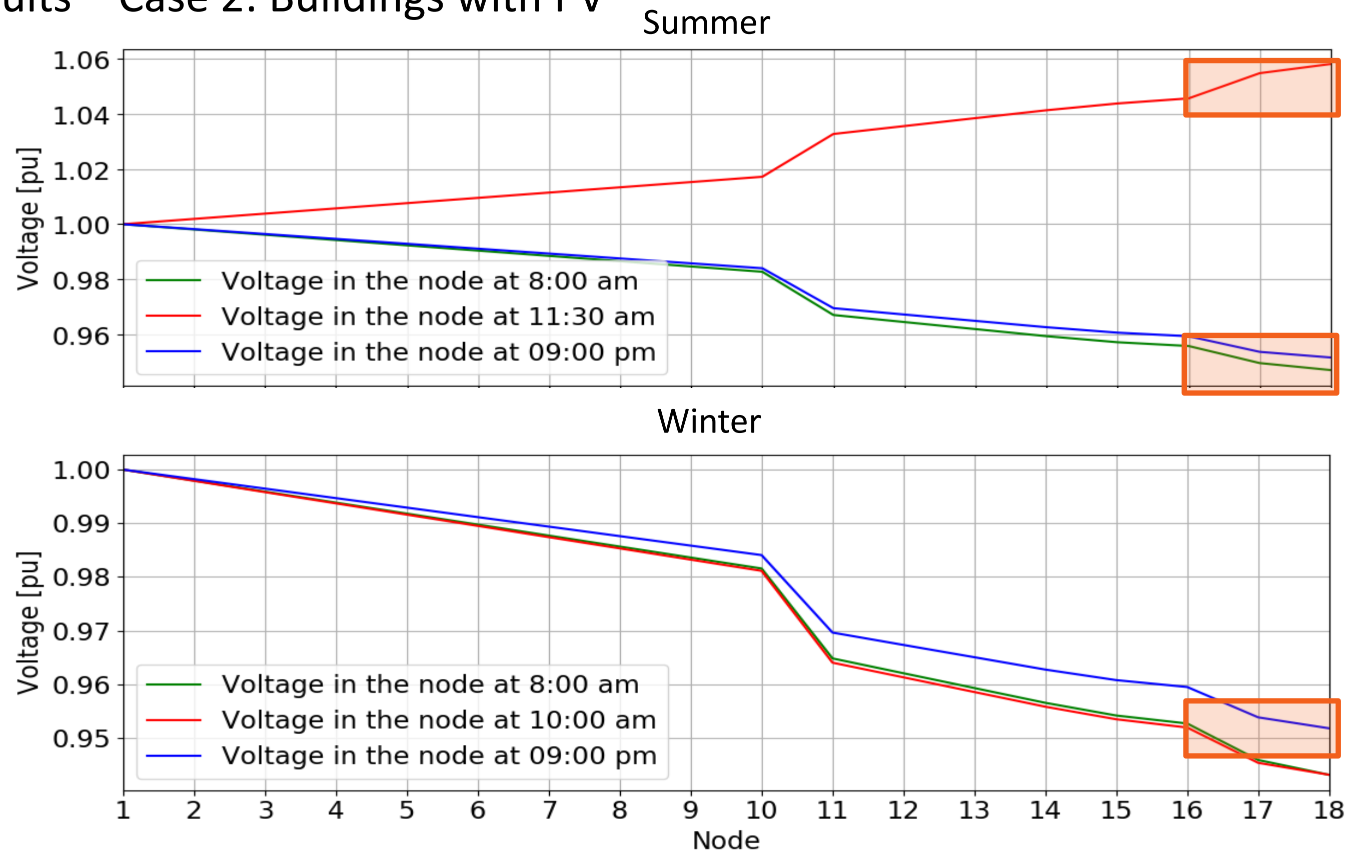
Multi-carrier coupling and system aggregation

Results – Case 1: Buildings without DRES or MCES



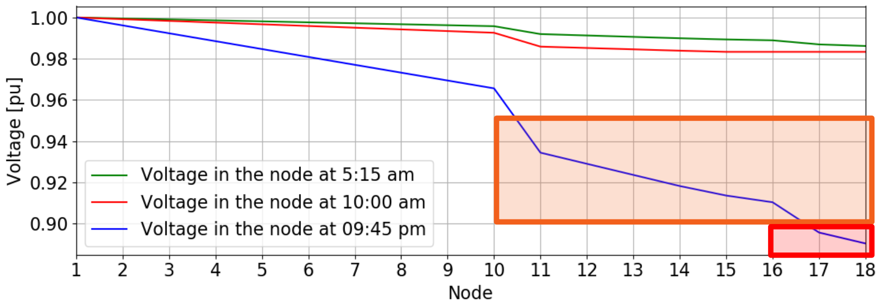
Multi-carrier coupling and system aggregation

Results – Case 2: Buildings with PV

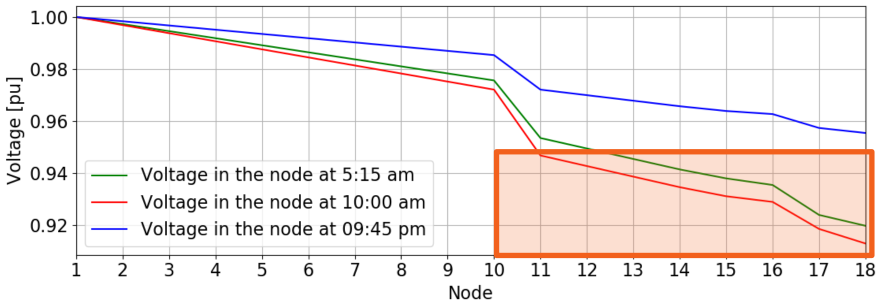


Results – Case 3: Buildings with the full MCES

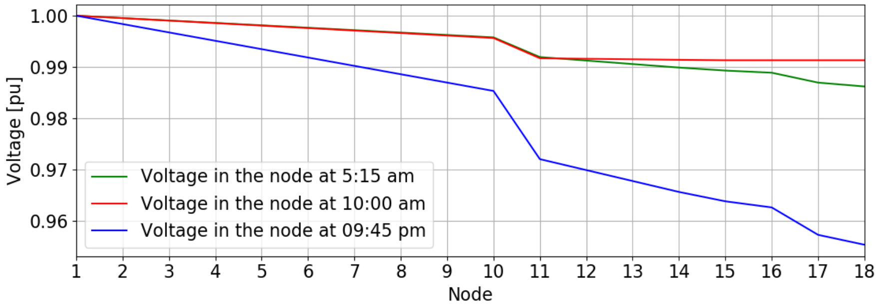
Winter – Only heat pump



Winter – Heat pump and solar collectors



Winter – Heat pump, solar collectors, and TESS



Multi-carrier coupling and system aggregation

Results

Case	Season	Maximum voltage (pu)	Minimum voltage (pu)	EN50160 compliance
1	-	1	0.943	Satisfied
2	Summer	1.058	0.943	Satisfied
2	Winter	1	0.943	Satisfied
3	Summer	1.037	0.980	Satisfied
3	Winter: HP	1	0.890	Not satisfied
3	Winter: HP, SC	1	0.912	Near limit
3	Winter: HP, SC, TESS	1	0.952	Satisfied

Multi-carrier coupling and system aggregation

Conclusions and future work

- Adding only PV increases the voltage in summer
- Replacing gas-based boilers for heat pumps as sole heat sources in most buildings can cause the voltage to drop outside the limit allowed by the technical standard EN50160
- Combining heat pumps with solar collector reduces the usage of the heat pump, but the voltage still remains near the allowed limit.
- Adding thermal storage showed the best voltage behavior in the distribution network.
- Further work is recommended in aggregating the individual MCES systems to enhance the flexibility of the network, consider aging of the batteries and including EV chargers.

Thanks

The project was carried out with a Top Sector Energy subsidy from the Ministry of Economic Affairs and Climate, carried out by the Netherlands Enterprise Agency (RVO). The specific subsidy for this project concerns the MOOI subsidy round 2020.

Discussion and contact