Concept-Study for the Development of the 2040 Electrical Grid of EW Tuggen

Student

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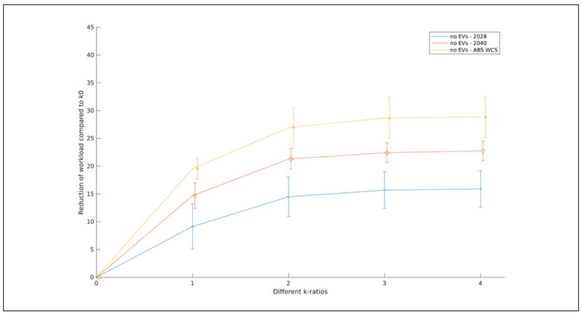
Introduction: The medium and low voltage grid will experience great level of changes with the rise of decentralized power production and as the consumption of energy increases, mostly via the use of heat pumps and electric vehicles. Switzerland is trying to become carbon-neutral by 2050, which combined with the price reduction of photovoltaic panels and the increasing interest in electric vehicles will quickly subject the grid to high amount of sporadic stress. In many places reinforcing the grid by laying down more cables may be a viable strategy, but it comes with prohibitive costs. Increasing the “intelligence” of the grid may obtain the same results since the most problematic players in the future will only episodically breach the maximum workload of the already existing grid.

Definition of Task: Tuggen (SZ) is a small town with high PV potential, and it is an interesting case study for how the future low-level grid might develop. For this project the area connected to the transformer Laui, composed of 50 households with already 266kW PV installed, was chosen to be simulated for a short term (2028) and a medium term (2040) scenario.
Based on the rapid growth of the PVs and EVs market it is assumed for the NEPLAN simulation that in 2028 Laui will have 53kW more PV and 10 houses will home-charge EVs, while in 2040 it should rise to 230kW more PV installed and 46 houses home-charging.
The PV potential of each household is determined using the website sonnendach.ch with the assumption that only 70% of the best roof area will be used by modules with 20% efficiency. The irradiance profile over the day is implemented via the weather data registered in 2020.
The model is simulated in all the different scenarios to find the weak link of the grid, verify the impact of high PV penetration and test the effectiveness of batteries in tackling the stress that the future grid will be subjected to.

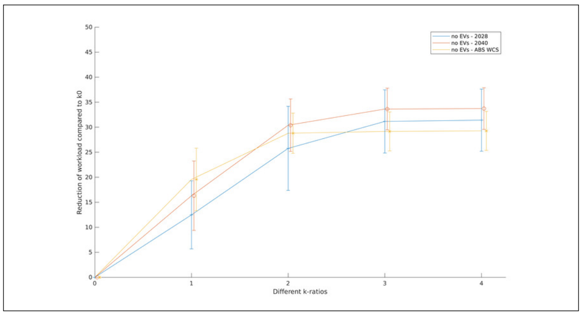
Result: The stress introduced by the PVs in the short and medium term never reached dangerous levels in the mean workload of the cables, but the maximum was nearly reached in the 2040 scenario. When all the potential PV was included, defined as Absolute Worst Case Scenario, the limit of one of the cables was breached, specifically one that acted as a bridge for three distribution boxes.
The inclusion of batteries was able to reduce the mean stress on the grid, but because of the charging strategy simulated, i.e. batteries started charging instead of letting the power flow to the grid, the maximum was never reduced. To tackle the max workload the peak-shaving strategy should be chosen, even if it will reduce the use that the owner would get from the battery.
Batteries coupled directly to a PV were only significantly effective with a capacity equal to the power of the PV (1 kWh coupled to 1 kW). Higher capacities became effective with "district batteries", i.e. batteries connected to the distribution box and not in every house. Even with this position the effectiveness is reduced with three times the capacity or higher. Coupled batteries should be chosen to better repay the investment, while district batteries should be favored to increase self consumption.

Laui's area with highlighted PV potential
Own presentment

Results of simulations with battery directly coupled to PV plants
Own presentment



Results of simulations with district battery (connected to distribution boxes)
Own presentment



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Subject Area
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