

Project Title: Optimal PV Feed-in Limits in Swiss Distribution Grids: Trading off Curtailment Remuneration against Grid Reinforcement

Project Type: Master's Thesis

Project Description: Under the revised Swiss Electricity Supply Act (Art. 17c StromVG), distribution system operators (DSOs) may curtail PV feed-in at the connection point without remuneration, up to 3% of the plant's annual energy (Art. 19c StromVV). The VSE industry guideline implements this as a static feed-in limit of $k = 70\%$ of PV nominal power. Curtailment beyond this allowance must be remunerated, while too little curtailment forces grid reinforcement, so a fixed 70% is a heuristic rather than a cost optimum.

The main objective is to develop an optimization-based planning framework that finds the optimal feed-in limit k^* . The project will address the research question: *Which k minimises the DSO's total cost of curtailment remuneration (at spot prices or distribution locational marginal prices, DLMPs) plus reinforcement capex, and is 70% cost-efficient?*

The problem will be posed as a two-stage stochastic MILP: the first stage chooses k and reinforcements, the second simulates grid operation with LinDistFlow voltage and thermal constraints. As the cap is linear in k , k is optimised jointly with investments; for endogenous DLMPs, iterative and bilevel formulations will be compared.

Key tasks during the project:

1. Literature review and problem formulation,
2. Simulation environment setup: PV/load time series and LV/MV test feeders in pandapower,
3. Mapping the 3% energy allowance to a power limit k for different PV orientations,
4. Joint optimisation of k and grid reinforcement,
5. Comparison of fixed-tariff, spot, and DLMP remuneration,
6. Performance evaluation and sensitivity (PV penetration, load growth, uniform vs. feeder-specific k).

Useful software skills:

- Good knowledge of power-system analysis and distribution grids.
- Programming experience in Python.
- Interest in optimization and electricity markets; familiarity with pandapower, Pyomo, or Gurobi is desirable.

- Basic understanding of linear/mixed-integer programming or optimal power flow is an advantage.

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Reference:

- [1]. Federal Electricity Supply Act (StromVG, SR 734.7), Art. 17c Flexibility, <https://www.fedlex.admin.ch/eli/cc/2007/418/de>
- [2]. Swissolar, 2026 – Was gilt neu für Photovoltaikanlagen? (Art. 19c StromVV), <https://www.swissolar.ch/de/news/detail/2026-was-gilt-neu-fuer-photovoltaikanlagen-80786>
- [3]. VSE, Regelung der Einspeisung von Photovoltaikanlagen (NRE-CH 2025), <https://www.strom.ch/system/files/media/documents/20250918-be-regelung-der-einspeisung-von-photovoltaikanlagen.pdf>
- [4]. A. Papavasiliou, “Analysis of distribution locational marginal prices,” IEEE Transactions on Smart Grid, vol. 9, no. 5, 2018.
- [5]. R. Gupta, F. Sossan, M. Paolone, “Countrywide PV hosting capacity and energy storage requirements for distribution networks: The case of Switzerland,” Applied Energy, 2021.