Techno-Economic Assessment of Local Electricity Communities (CELs): Flexibility and Pricing Impacts

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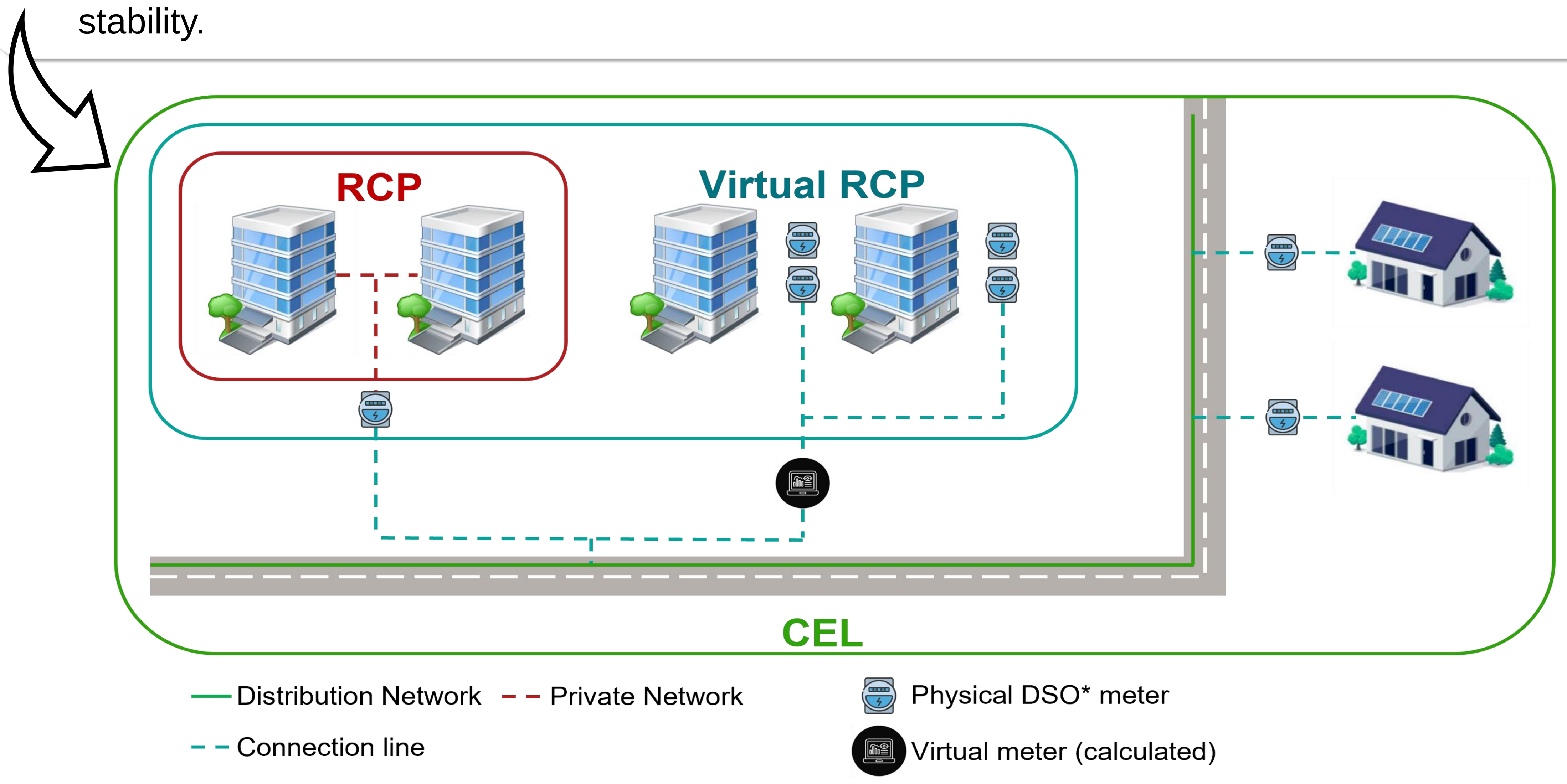
1. Introduction

- Switzerland will implement Local Electricity Communities (CELs) in January 2026, following the latest federal ordinances (February 2025).
- Declining feed-in tariffs make local energy use more profitable than exporting excess PV energy to the grid.
- CELs aim to offer a new option to consume PV surplus locally, reducing reliance on feed-in tariffs.
- Grid constraints highlight the need for energy management.
- **Tariff structures impact energy-sharing incentives and cost distribution.**
- Flexibility solutions (batteries, demand-side management) optimize local consumption and grid stability.



2. Goals

- Investigate the effects of **different tariff structures, CEL sizes, and configurations** on combining local energy production and consumption to ensure economic benefits.
- Evaluate the role of **flexibility solutions** (storage, demand-side management) in maximizing self and local consumption and reducing grid dependence.
- Assess the **impact of CELs with flexibility** on the distribution network, focusing on energy flows, congestion risks, and grid stability, and explore cost-sharing models among CEL members.

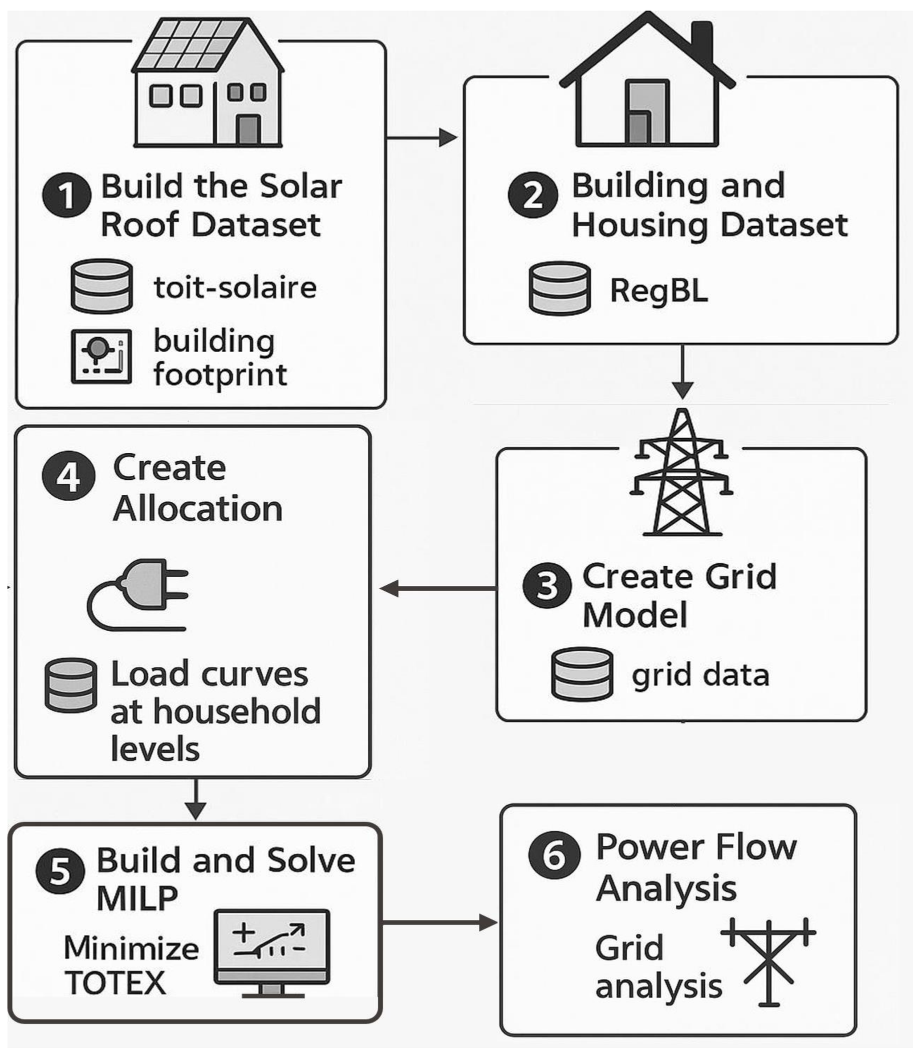
3. Scenarios

- CEL sizes: 30% of the buildings; 60% of the buildings
- PV penetration sensitivity
- Participant distribution: End-of-line; Random; Ideal
- Centralized battery presence and location
- Decentralized batteries
- Addition of large Consumers / Producers
- Tariff Models

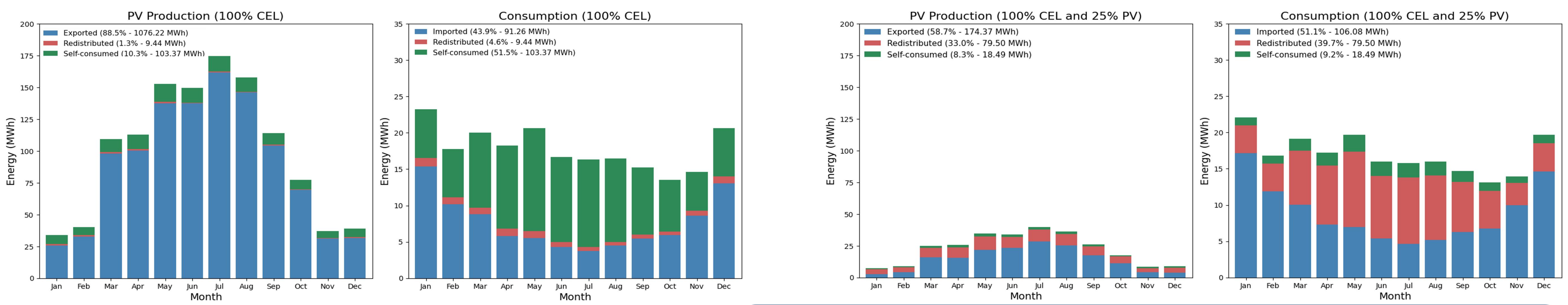
4. Methodology

Six key steps for analysis:

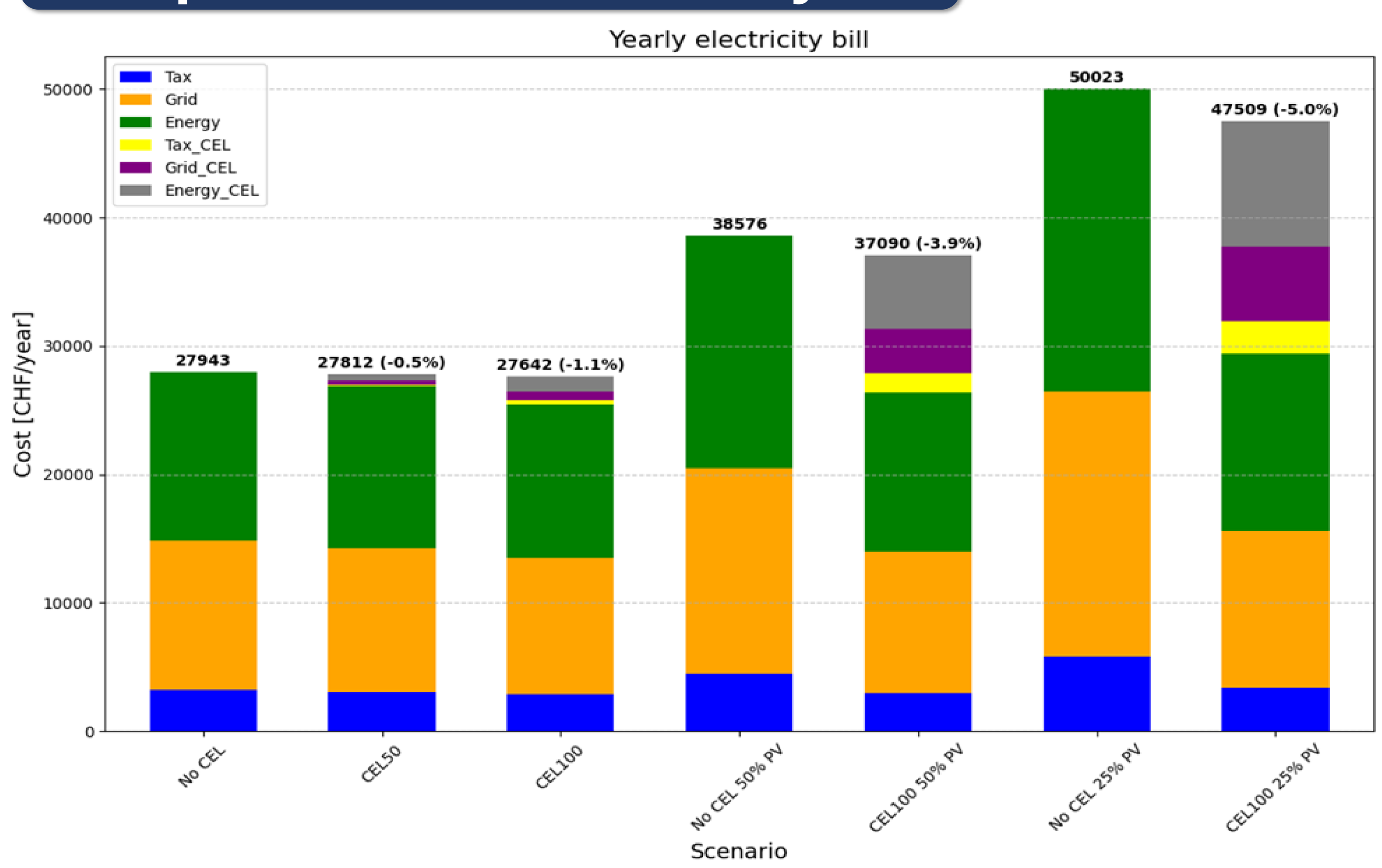
1. **Solar Roof Dataset** – Using *toit-solaire* and building footprint data, we evaluate roof suitability for PV installations based on orientation and tilt.
2. **Building and Housing Dataset** – Data from *RegBL* provides household- and building-level information.
3. **Grid Model** – A network graph is created using the housing dataset and real grid data from the DSO.
4. **Load Allocation** – A two-step optimization assigns realistic load curves to buildings, ensuring consistency with transformer-level demand.
5. **MILP Optimization** – A Mixed-Integer Linear Program (MILP) minimizes **Total Expenditures (TOTEX)** by optimizing PV, battery, heat pump, and EV investments under different tariff schemes.
6. **Power Flow Analysis** – The grid impact is evaluated, analyzing voltage levels, line overloads, and transformer performance.



5. PV sensitivity impact



6. Impact on the electricity bill



- Lower PV penetration increases distributed energy sharing within the CEL because, at higher PV levels, prosumers consume during peak production, limiting local energy trading.
- Self-consumption is limited due to production-consumption mismatch without storage.

- Without a CEL, PV integration increases energy costs due to grid dependency.
- CELs mitigate cost increases by enabling local energy redistribution.
- The most cost-effective scenario, where all buildings are included in the CEL (CEL100), is with 25% PV due to shared local generation and self-consumption.

7. Conclusions & Outlook

- Enhancing local and self consumption
- Reducing electricity costs
- Minimizing excess PV exports
- Supporting grid stability
- Encouraging sustainable energy practices

- Scenario development
- Grid impact analysis
- Distribution keys for participants
- Quantification & optimization of CEL benefits

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