SCCER - FURIES
Shaping the FUtuRe SwIss Electrical InfraStructure

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HOW TO BOOST PV DEVELOPMENT WHILE MITIGATING GRID IMPACT USING ADVANCED ELECTRICITY TARIFFS

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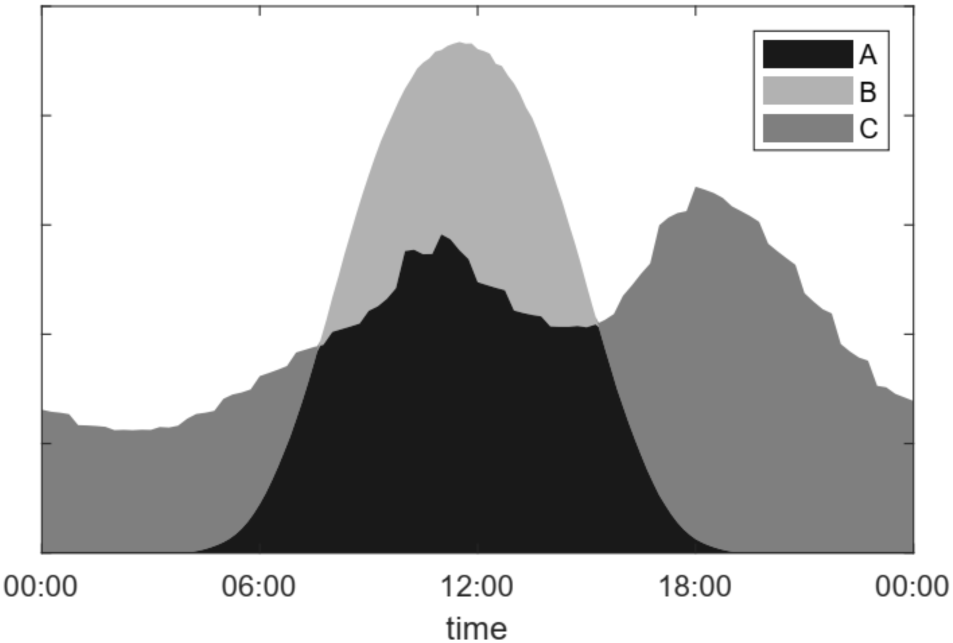
Self-consumption and system profitability



self-consumption : $\mathrm{SC} = \dfrac{A}{A+B}$

$$\mathrm{SC}_{\mathsf{min}} = \mathrm{SC}\Big|_{\mathsf{profit}>0} = \frac{\mathrm{LCOE} - t^{\mathsf{exp}}}{t^{\mathsf{imp}} - t^{\mathsf{exp}}}$$

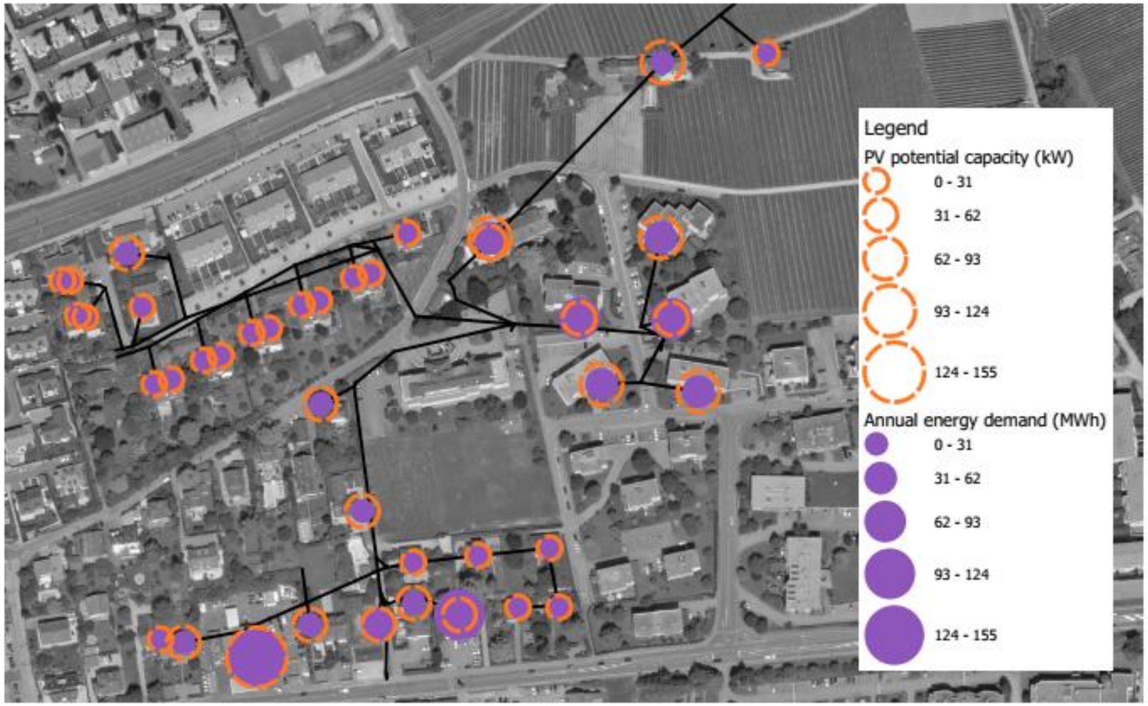
LCOE : Levelized cost of PV electricity
t^{imp} : import tariff (retail electricity price)
t^{exp} : export tariff (feed-in tariff)

- System profitability is given by SC and strongly depends on electricity tariffs (import and export)
- Batteries can increase self-consumption

Questions

- How tariffs influence investments in decentralized PV and storage?
- How tariffs impact grid operation ?
- Can advanced tariffs help mitigate impact of large PV penetration on the grid?
- How to allow long term and profitable PV penetration ?

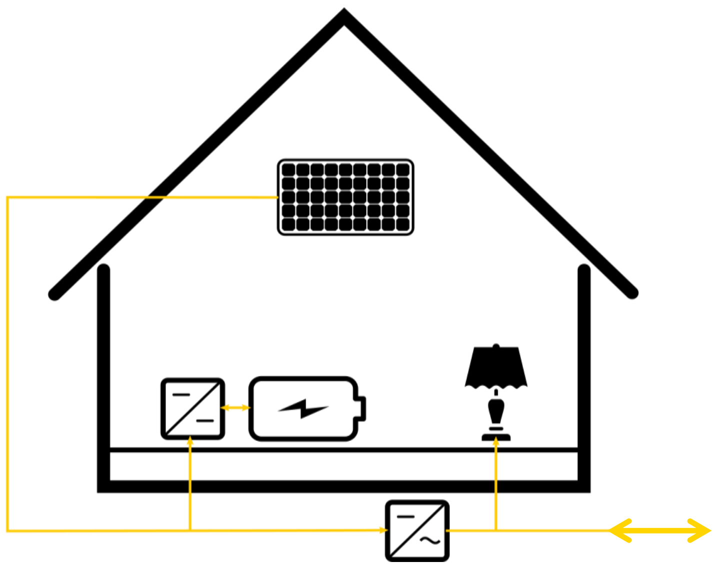
Case study



RE Rolle demo site : low-voltage grid TR3716

- Data : 1 year @ 15 minutes, LCOE calculated on 25 years
- Operation : PV and battery operation (1 year)

Optimal building design and operation



Inputs

- Electrical demand
- Irradiance
- PV, battery cost functions
- Tariffs
- Interest rate, lifetime

MILP

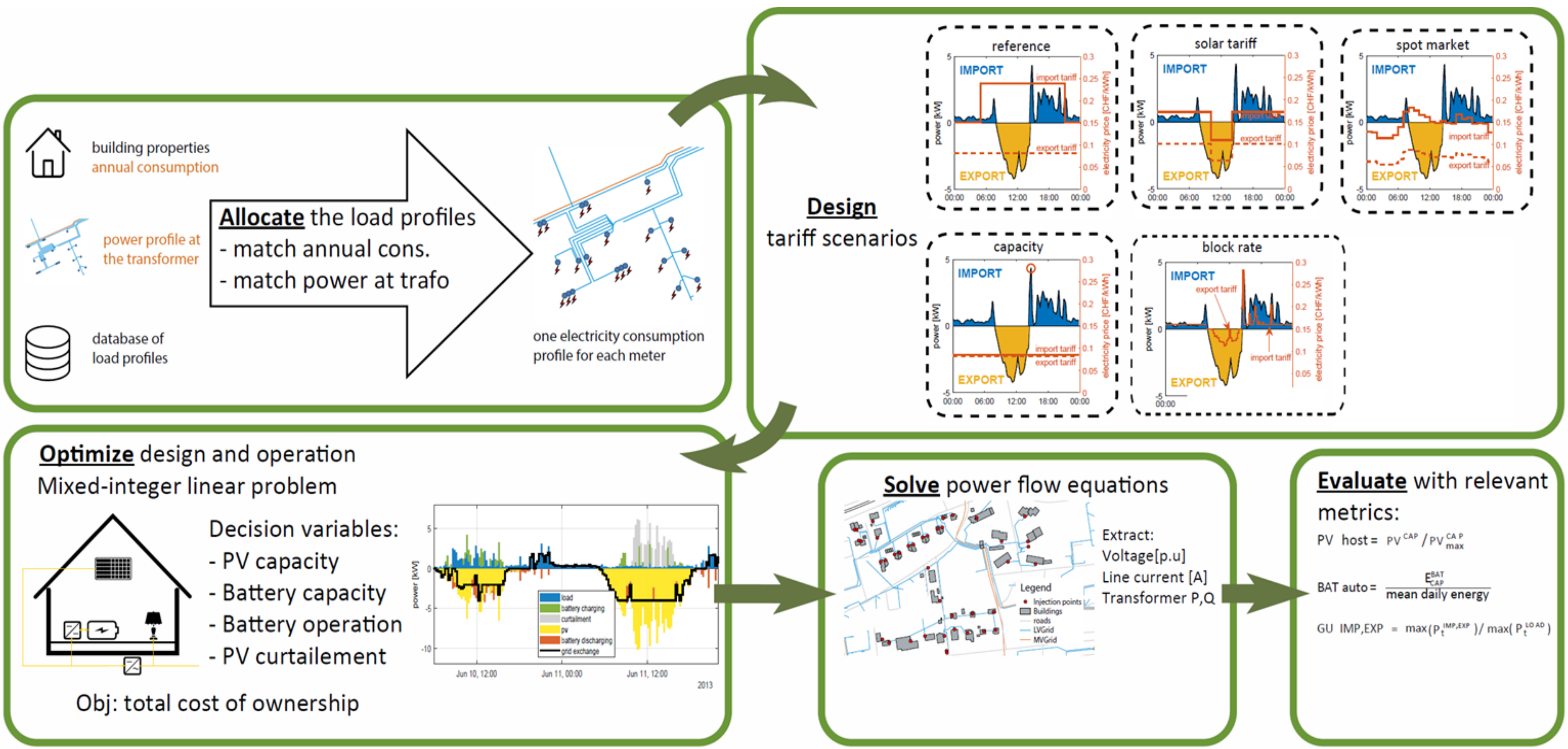
Outputs

- PV and battery capacity
- Charging and discharging power
- PV generation, curtailment

Objectives

TOTEX = OPEX + R * CAPEX

Effect of tariffs on the design and operation



L. Bloch et al., Energy Informatics 2,2019, doi:s42162-019-0085-z.

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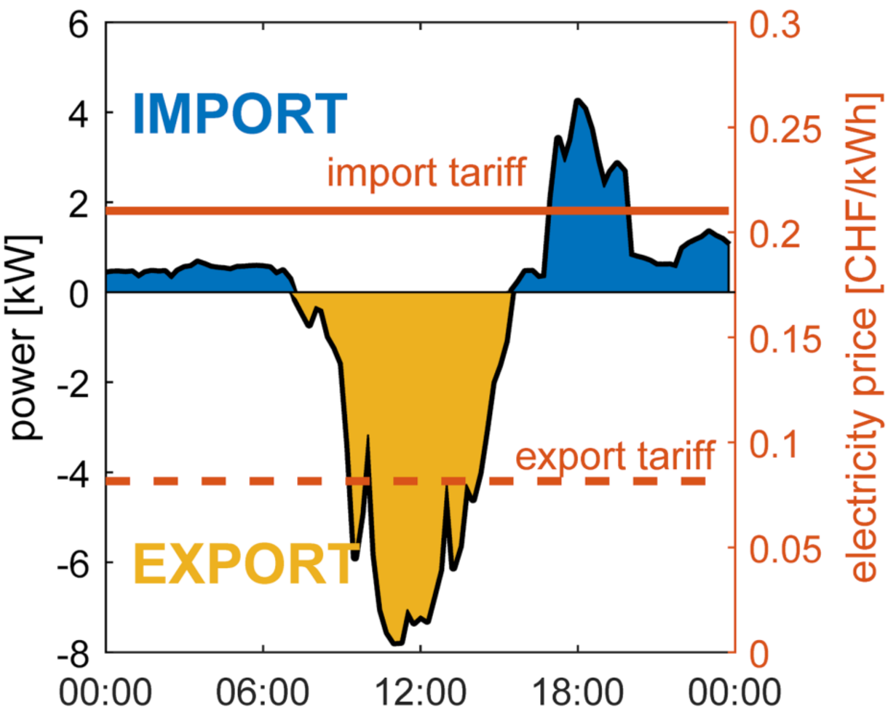
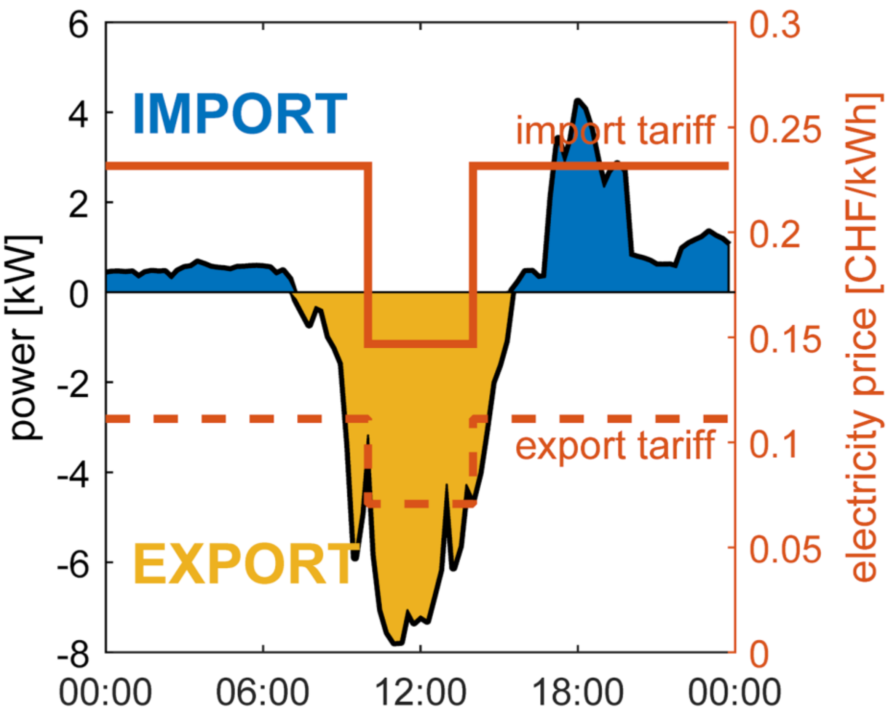
Reference tariff



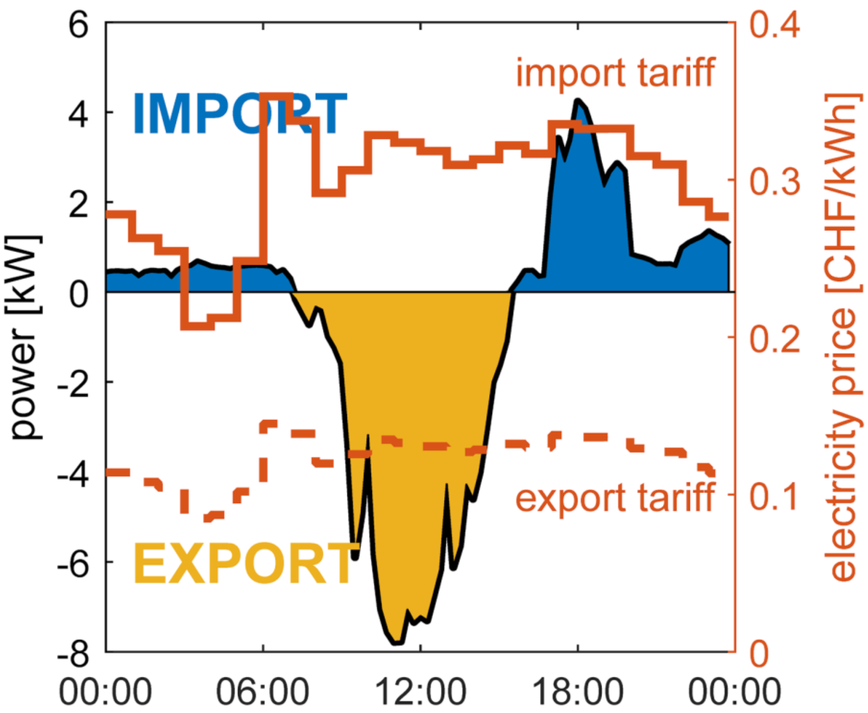
- Import: 21.02 cts/kWh
- Export: 8.16 cts/kWh

Solar tariff

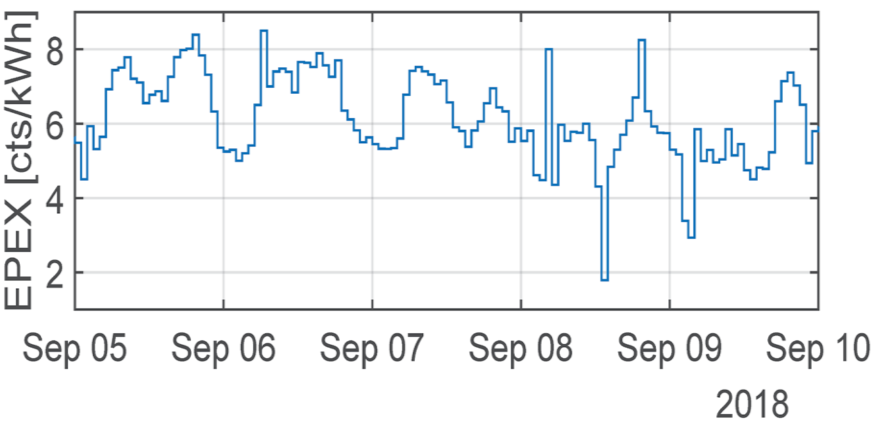


- Cheaper at midday

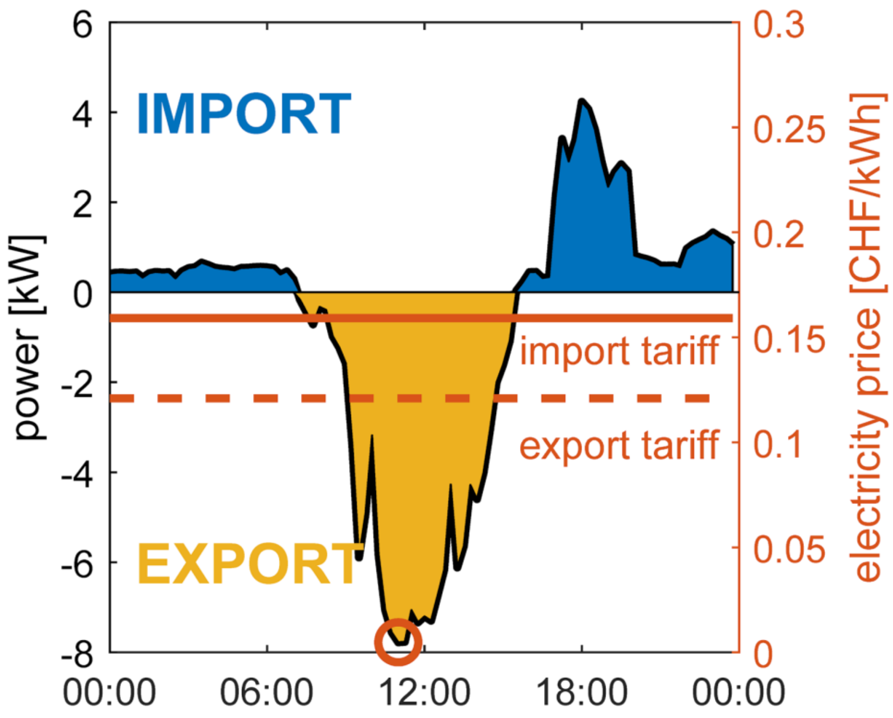
Spotmarket tariff



- Mirror of the EPEX
- Scaled to ensure same DSO revenues



Capacity tariff



- Mix of a flat volumetric tariff and a capacity component
  - Import : 15.91 cts/kWh
  - Export : 12.09 cts/kWh
  - Power : 5.02 CHF/kW/month

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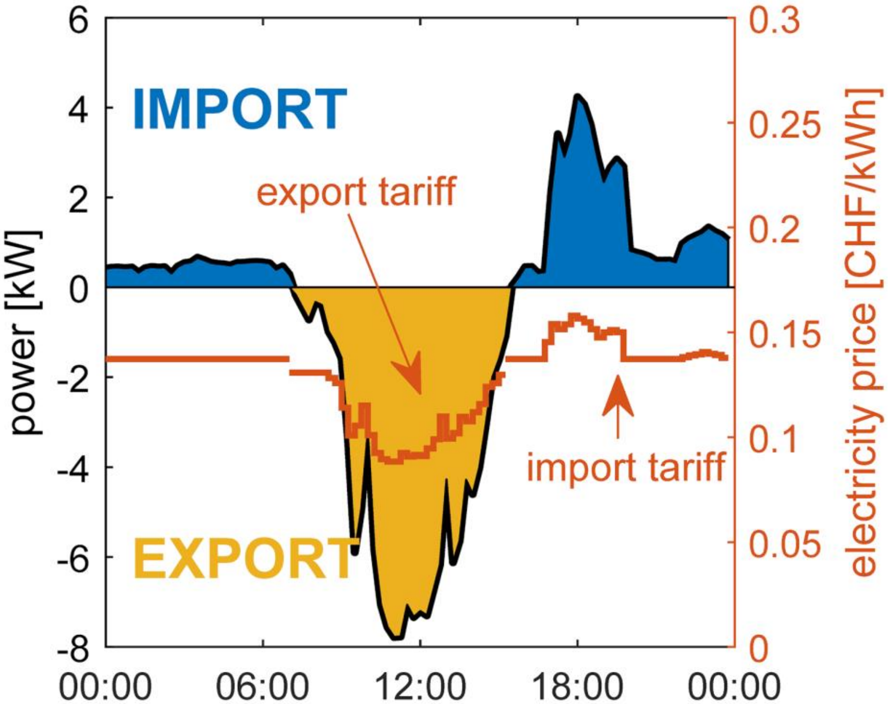
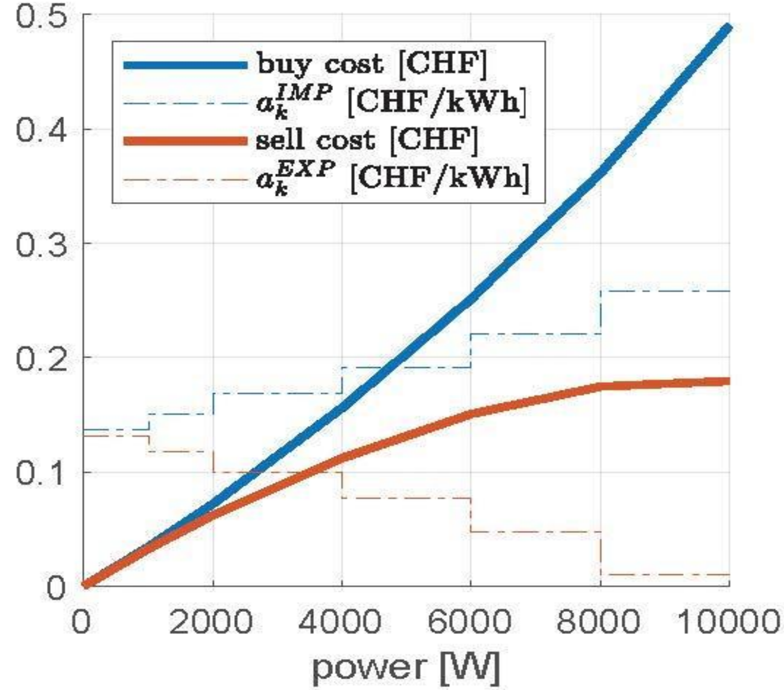
Block rate tariff





- Import tariff increasing with power consumption while export tariff decreasing with power injection

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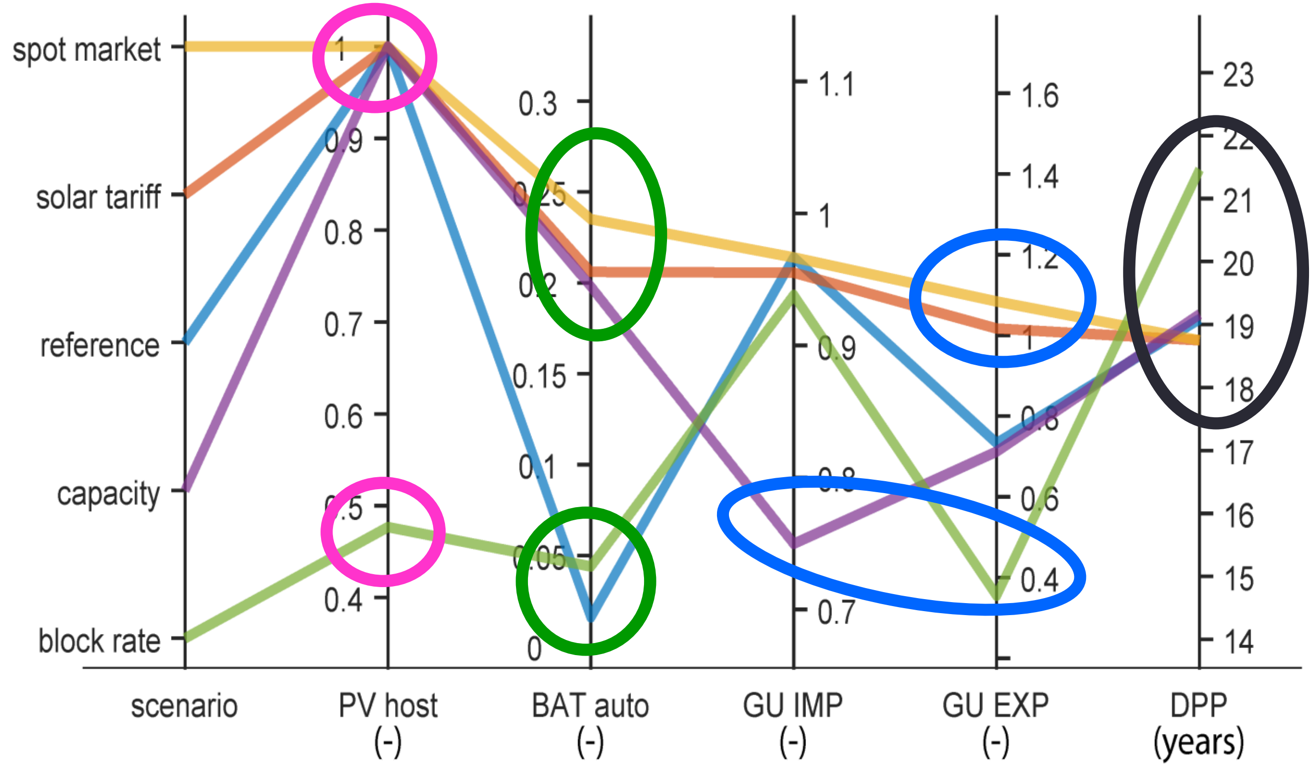
Effects of advanced tariffs

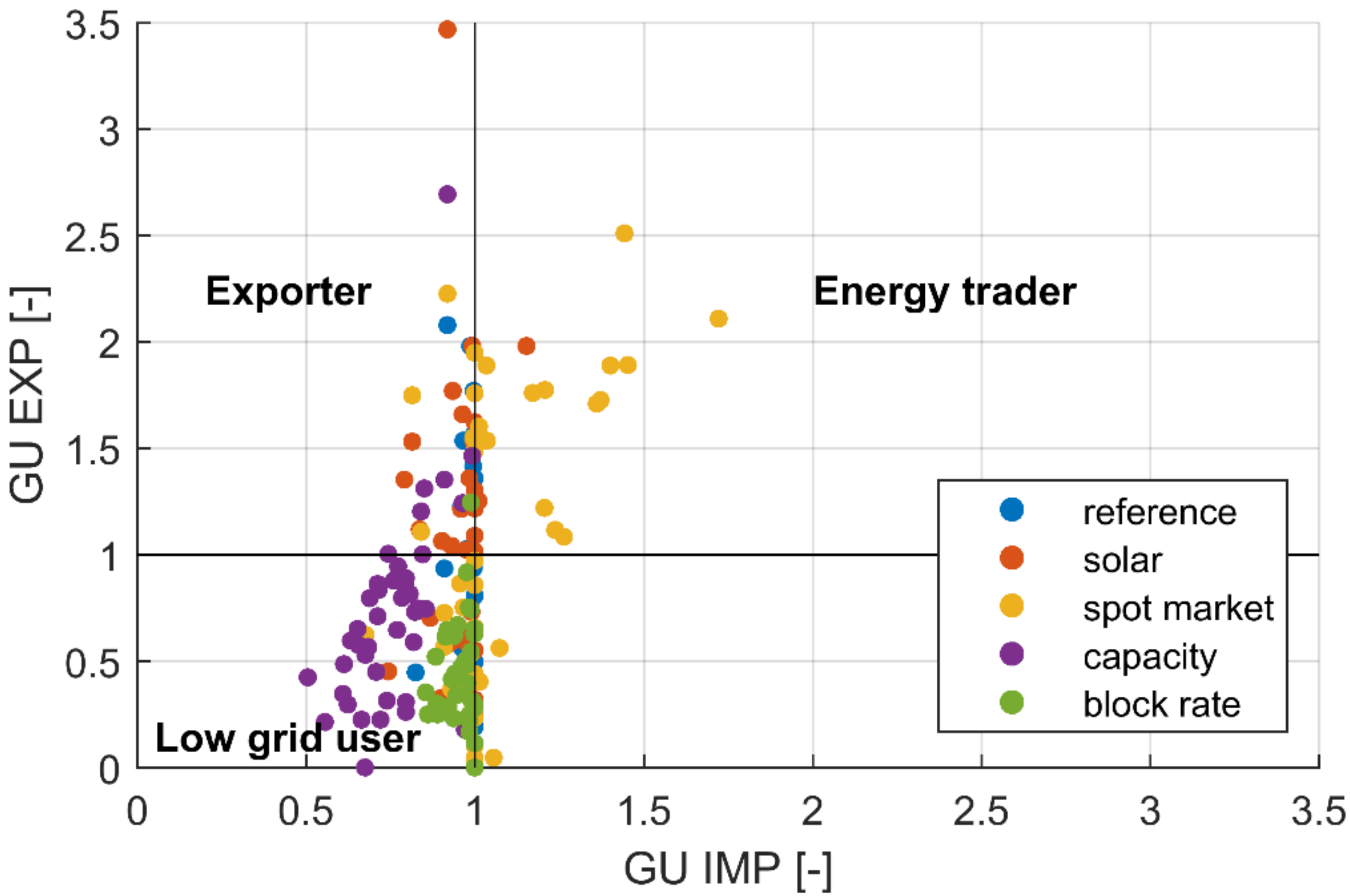


Median of 41 buildings

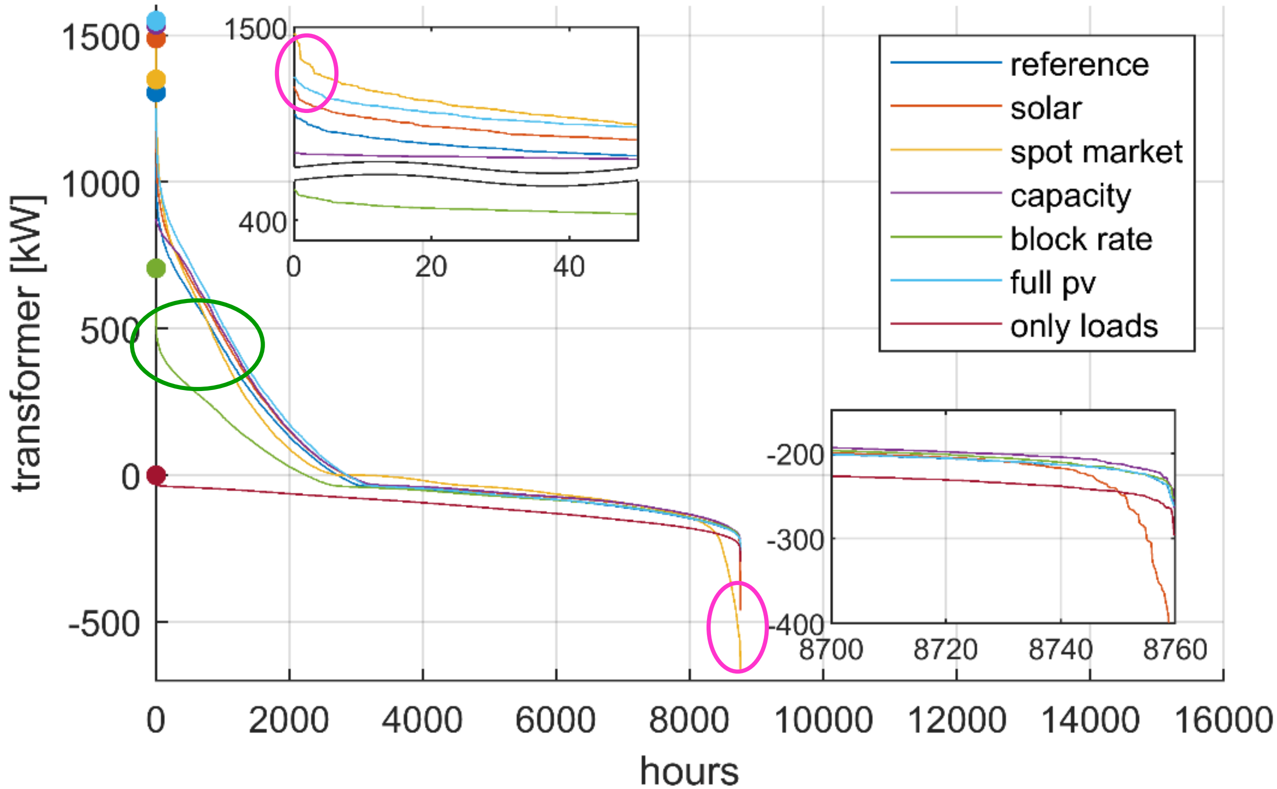
- **PV hosting** always maximum except with block rate
- Dynamic and capacity tariffs promote larger **battery size**
- Playing on the spot market can actually increases the **Grid Usage,** capacity and block rate globally decreases it
- Variance in **payback time** between systems is important

J. Holweger et al., EPSR, 189, 2020, doi: 10.1016/j.epsr.2020.106763.

Tariffs changes prosumer profiles



Impact on grid : Load duration curve

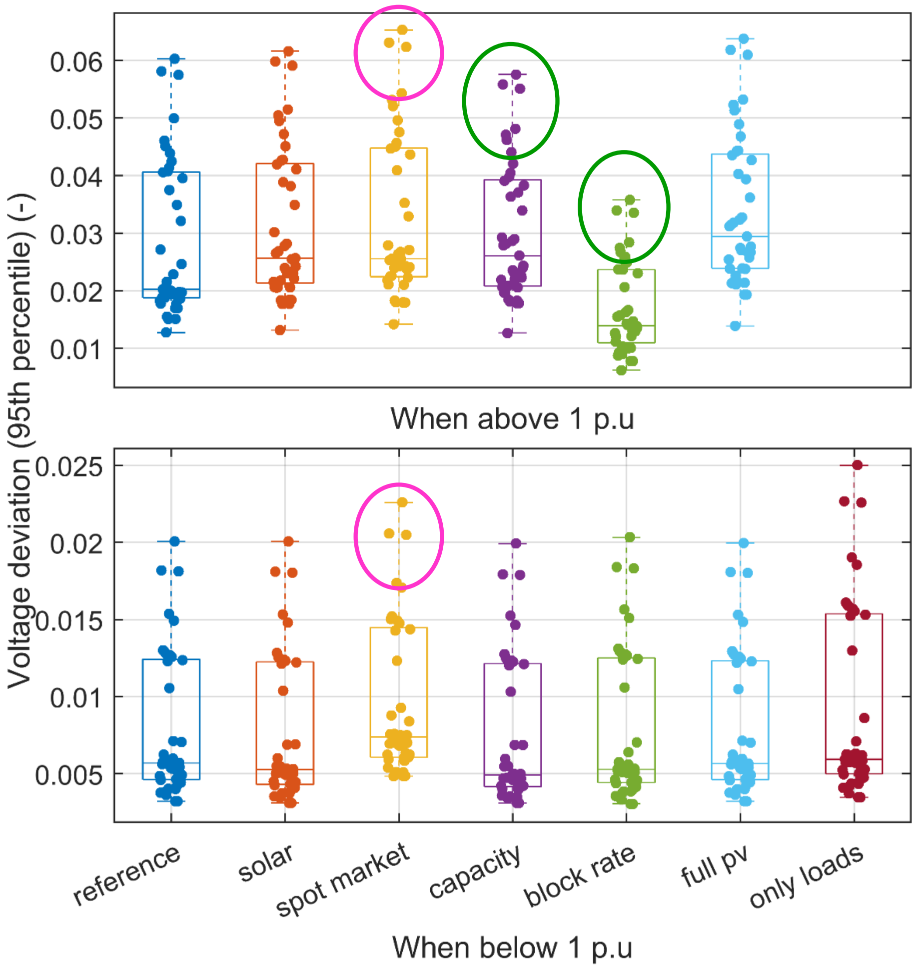


Dynamic tariffs tend to **increase the stress** on the grid

Block rate and capacity tariffs are able to **reduce the stress** on the grid

J. Holweger et al., EPSR, 189, 2020, doi: 10.1016/j.epsr.2020.106763.

Impact on grid : Voltage deviation



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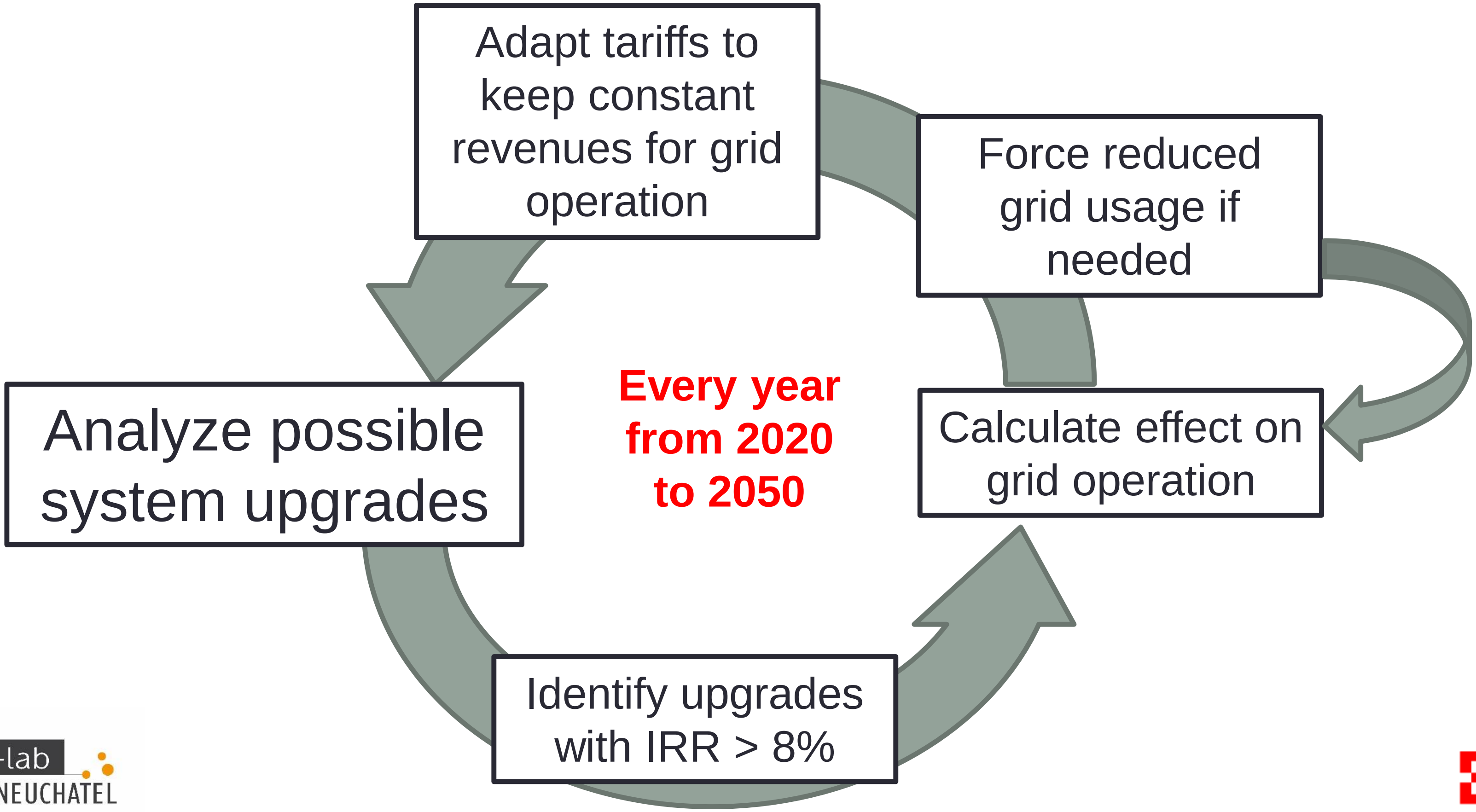
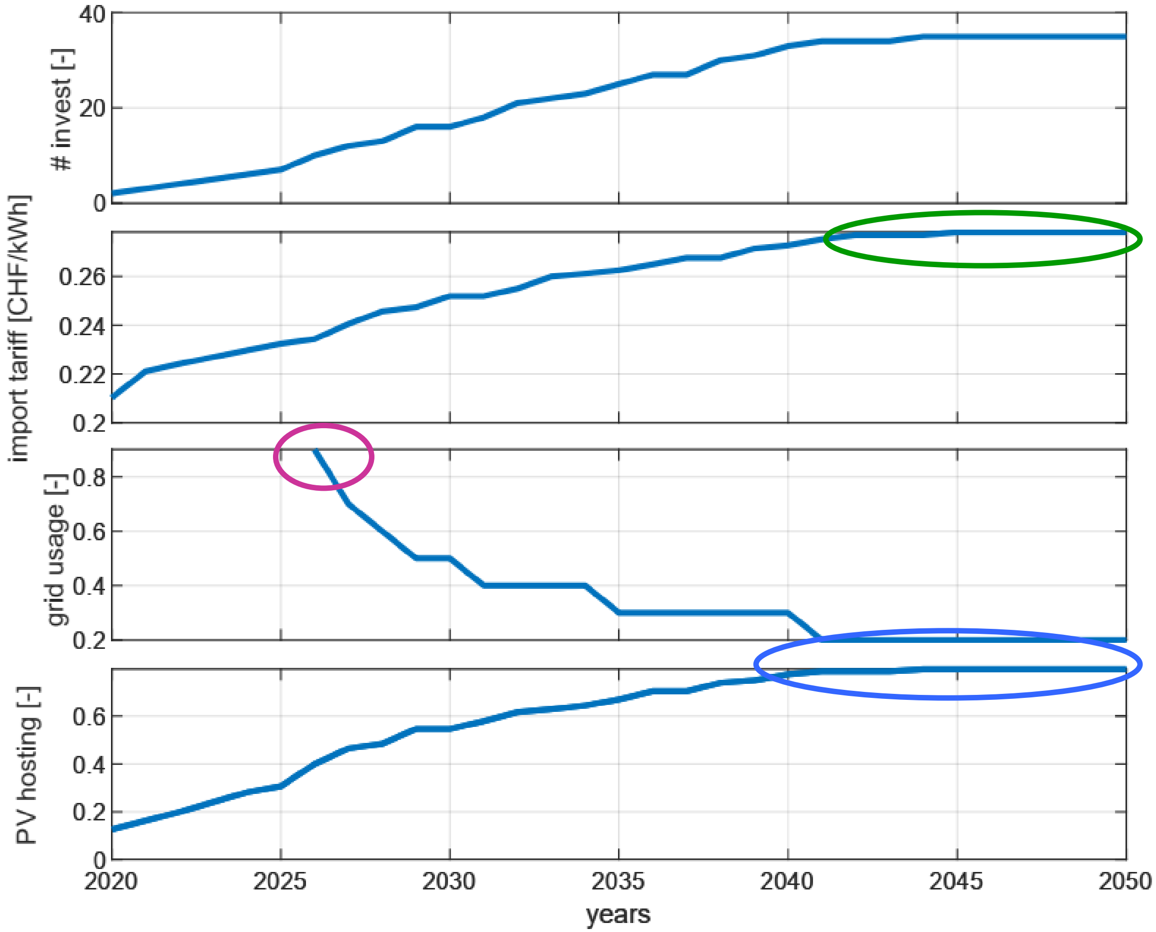
Long term evolution

- Long-term PV and battery installations
- Grid usage constrains to keep grid safe operation



2020-2050 evolution

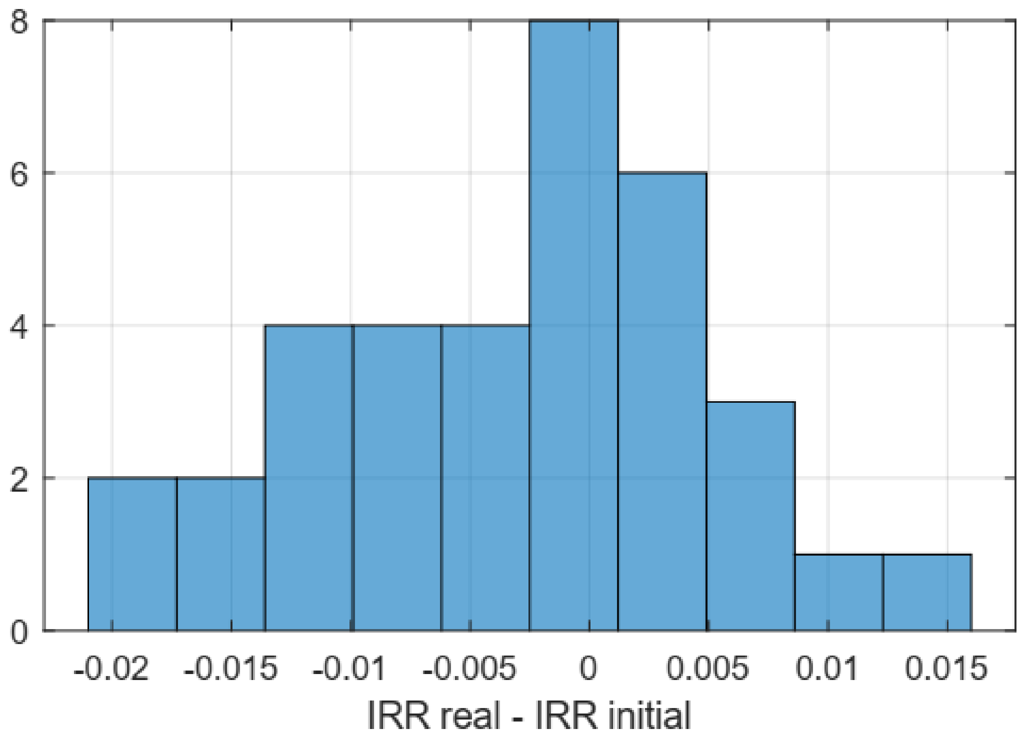


Based on RE single tariff

- **Import tariff** increases up to 0.28 CHF/kWh (+32%)
- **Grid usage** constraint starts in 2026
- **PV hosting** reaches 80% (30% higher than 50 TWh objective)

L. Bloch, EPFL PhD thesis, 2020.

Profitability for prosumers



- Import tariff ↑ ⇒ IRR ↑
- GU constrain ↓ ⇒ IRR ↓
- 2% maximum variance around an 8% profitability threshold

L. Bloch, EPFL PhD thesis, 2020.

Conclusions

- Dynamic volumetric tariffs promote investment in larger storage but increase the stress on the grid
- Capacity based tariffs change battery usage, from trading energy to reducing consumption peaks
- Block rate tariffs promote smaller installation, hence helping reducing the stress on the grid
- Long term installation of distributed PV systems can be promoted by tariffs adaptation and (possibly) operational regulations
- Adaptation of tariffs in addition to investment cost reductions ensure profitability for most prosumers

Outlook

- Analysis of
  - Effect of self-consumption communities
  - Effect of other flexible loads such as heat-pumps and EVs
  - Effect of advanced tariffs on long-term evolution
- Market opportunities for DSO
  (use of distributed ressources by both prosumers and DSOs)
- Strategies to minimize (long-term) overall investment costs

Thank you for your attention