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Squaring the sunny circle? On balancing distributive justice of power grid costs and incentives for solar prosumers

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In cooperation with the CTI
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Increasing self-consumption – higher grid tariffs – even more solar prosumers!

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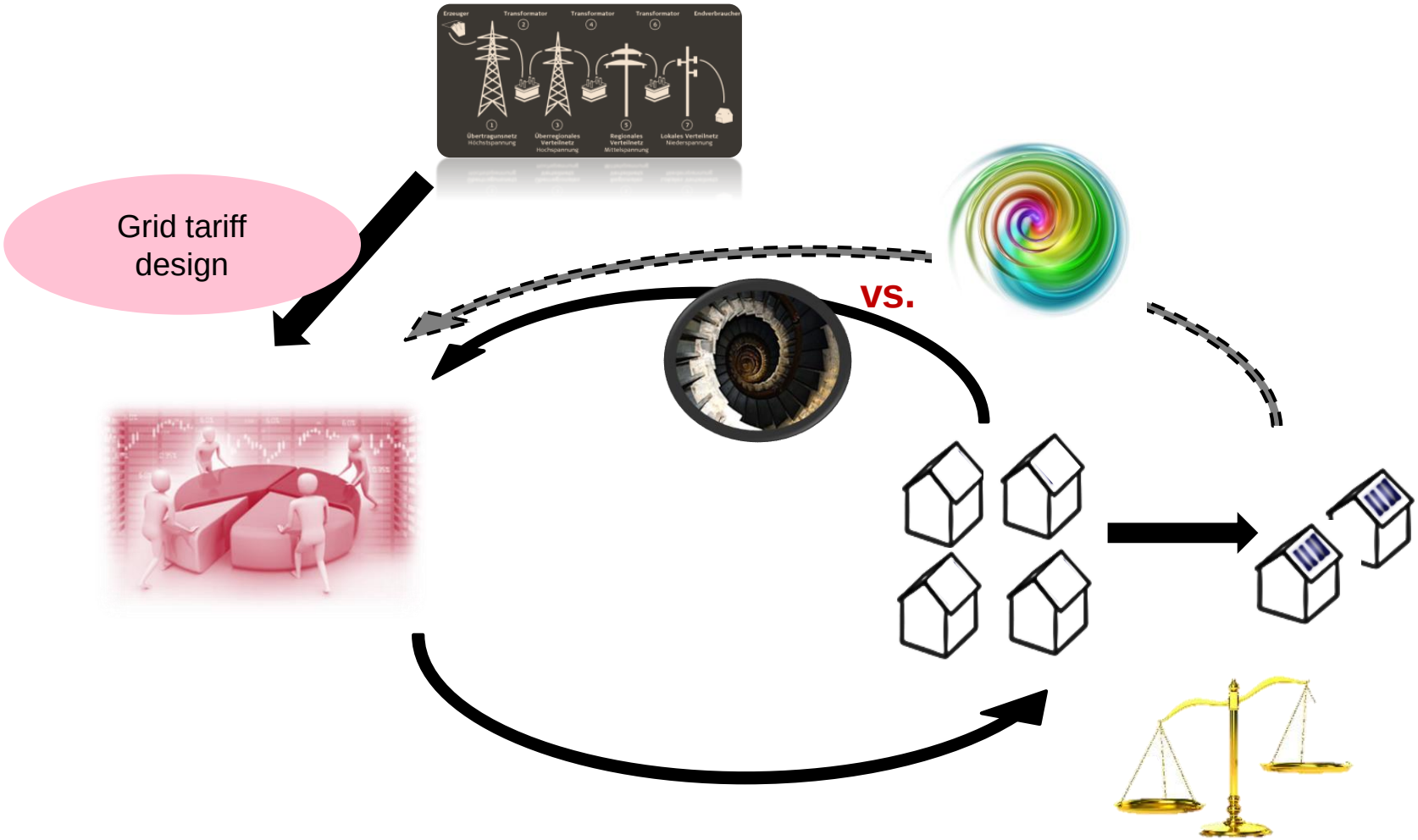

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Existing research investigates…

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… **PV bill savings** under **net-metering** (Darghouth et al., 2011, 2014, 2016a; Eid et al., 2014)

… **Cost-recovery** with an **intergrated utility regulation policy** (Darghouth et al., 2016b; Costello & Hemphill, 2014),

... **Distribution effect** with some static attempts (Eid et al., 2014)

Research questions:

1. What is the impact of **variants in grid tariff designs** on the **diffusion of solar prosumers**?

2. What is the **distribution effect** arising from solar prosumers?

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Solar prosumer concepts

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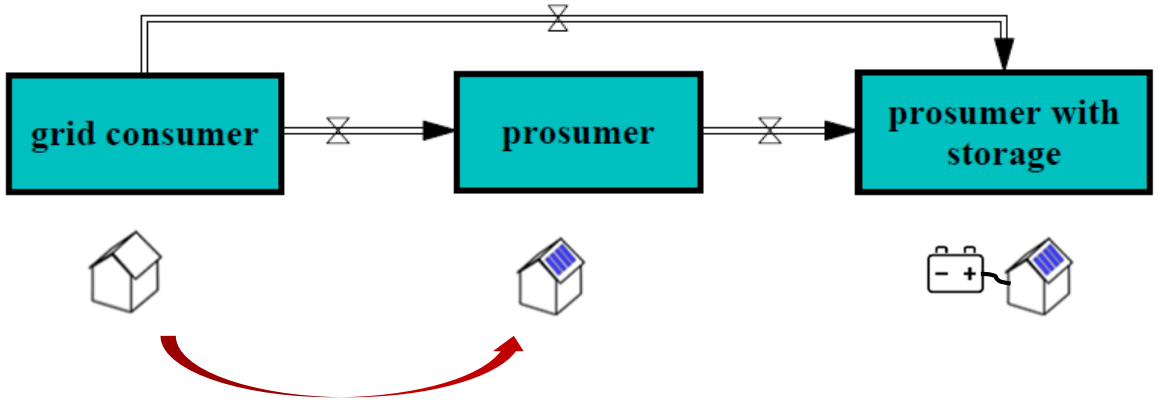


Prosumers
Self-consumption: 30-35% [1]
Peak demand: No reduction [2]

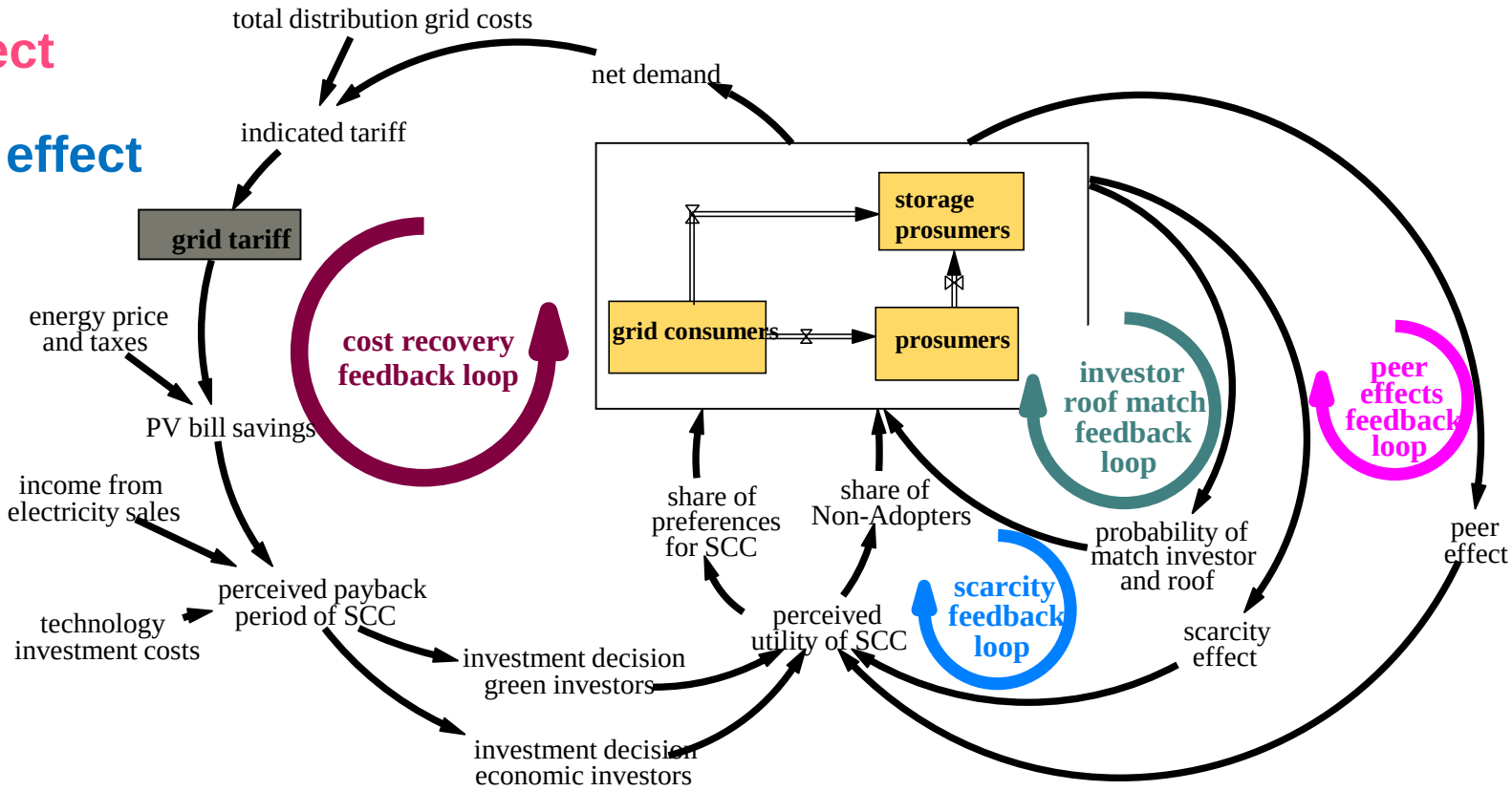
Storage prosumers
Self-consumption: 35-75%[1]
Peak demand: 30% peak reduction

Subgroups for:
SFH: Single-family house
MFH: Multi-family house
CC: Commercial customer

[1] Weniger et al., 2014
[2] Santos et al. (2014, p. 259)
[3] Veldman et al. (2013

System Dynamics model with feedback loops for...

- **Cost recovery**
- **Investor-roof match**
- **Peer effect**
- **Scarcity effect**



Based on Kubli & Ulli-Beer (2016)

Empirically based investment decision

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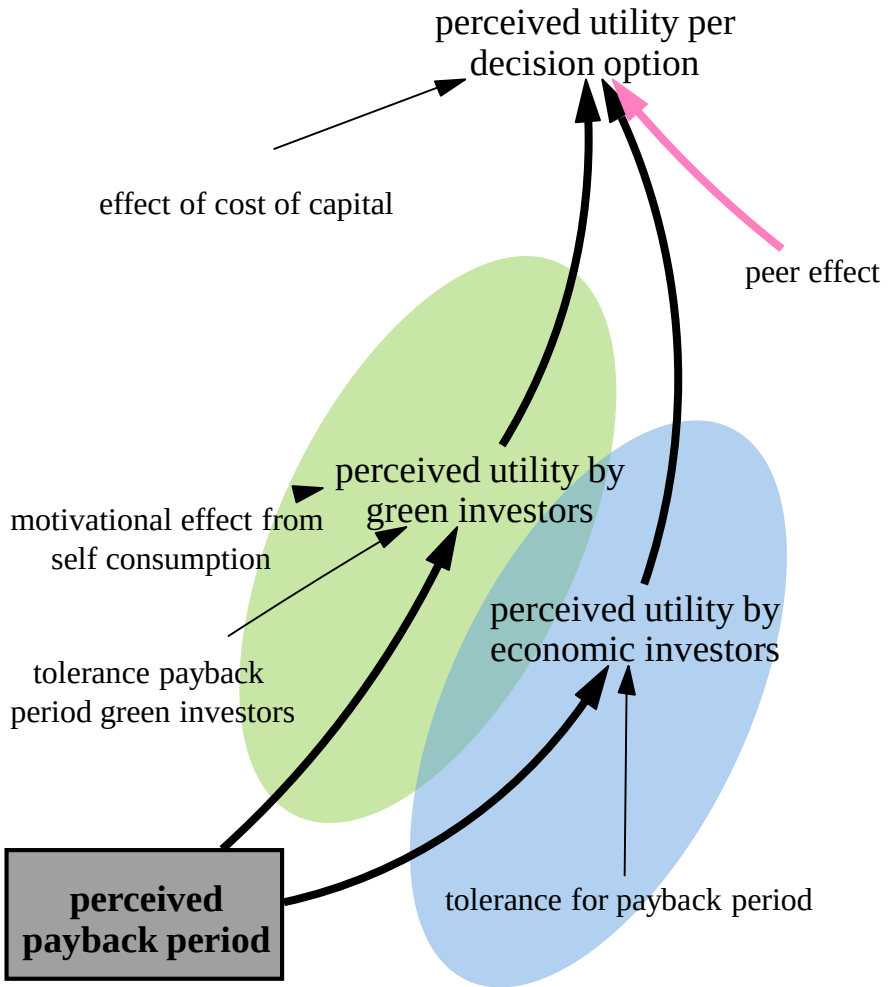

- **Base share of investors:** 57% (Balcome, 2014)
- **Payback period** as financial criteria & Tolerance for payback period (Ebers & Wüstenhagen, 2015)
- **2 types of investors:** green (31%) and economic investors (69%) (Ebers & Wüstenhagen, 2015)
- Motivational **effect from self-consumption** (Korcaj et al., 2015)
- Effect from **investment volume** (Ebers & Wüstenhagen, 2015)

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Model assumptions

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- **Increase of grid costs after 2016:** 3%/a (Swiss Federal Council, Botschaft zur ES 2050, 2013: Increase of grid costs: 3-10%/a).
- **Retail electricity price after 2016:** 9.78 Rp./kWh
- **Feed-in tariff for PV after 2016:** 9 Rp./kWh (+ 5 Rp./kWh for certificate of origin)
- **Technology learning curves:** PV 4,4%/a (Agora, 2015), batteries drop to 140 CHF/kWh in 2030, then constant (IRENA, 2015)
- **Population and consumption:** Model assumption no growth

Validation

- **Model development** as part of a project with BKW (Swiss utility company)
- **Structural and behavioral validation** with experts from BKW and the participants of the TREES workshop series @ZHAW
- **Statistical validation and calibration with 5 cases**:
  BKW supply area, Frutigen (rural area), Wohlen (agglomeration), Ostermundigen (urban area), Bavaria (different policy setting).

TREES Workshop series: Ulli-Beer, Kubli, Zapata et al. (2017)

Scenario overview

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Application context: BKW supply area		
Scenarios	(1) “Switzerland”	(2) “Capacity tariff”
Grid tariff design	Volumetric	Capacity
Metering design	Net purchase and sale	Net purchase and sale
PV subsidy	Investment grant for PV of 30%	Investment grant for PV of 30%

If you are interested in the effects of:
- Net-metering
- Flat grid tariff
- or consumer group specific results
- or adjustments of prosumers’ optimization behavior

… read my paper ☺.

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Results: Prosumer vs. storage prosumer

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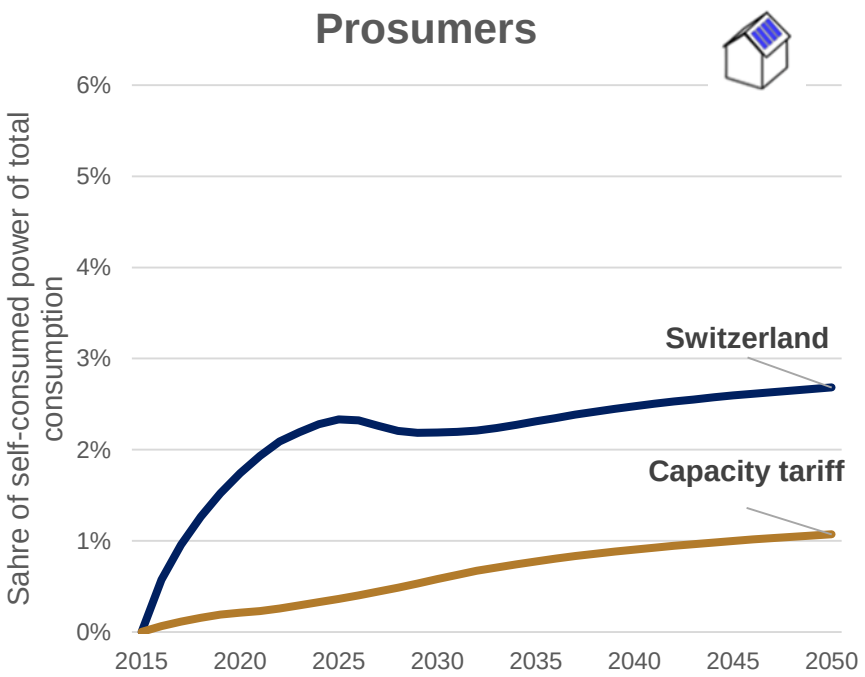

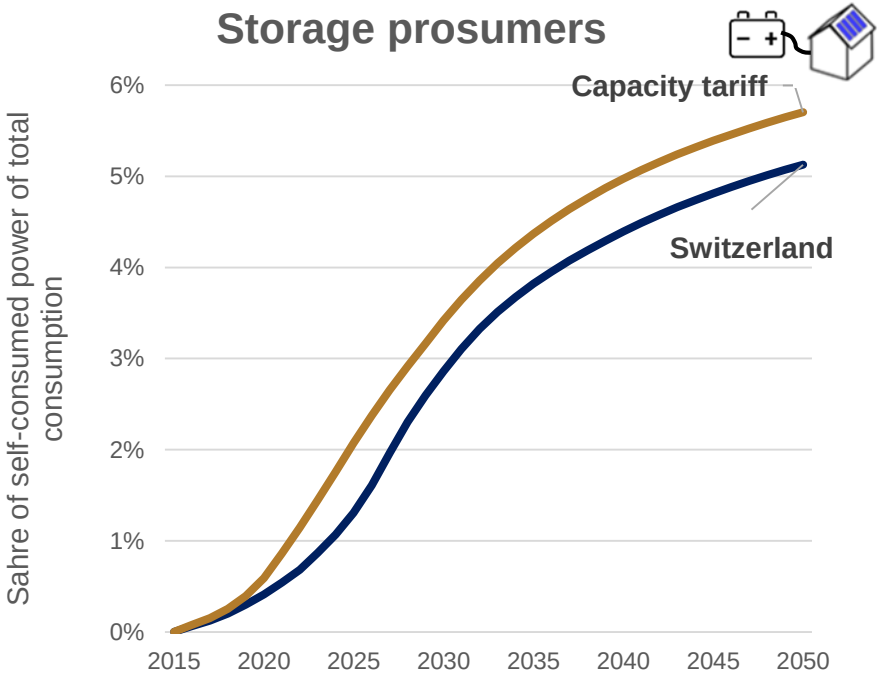

Clearly less PV installations under the capacity tariff and also the total self-consumed power is lower, despite additional storage.

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Results: Distribution effect in 2050

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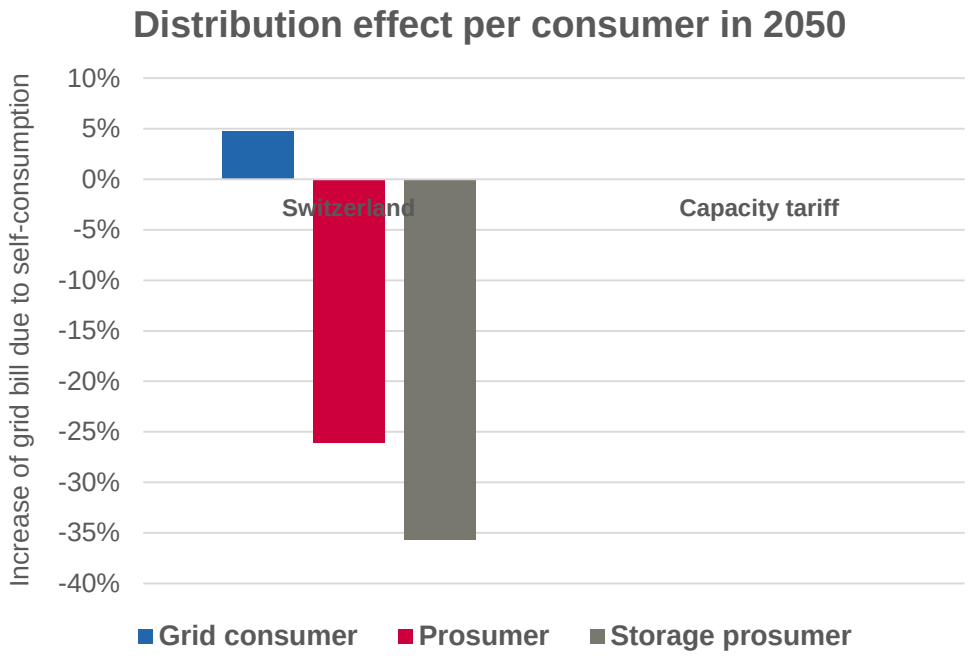

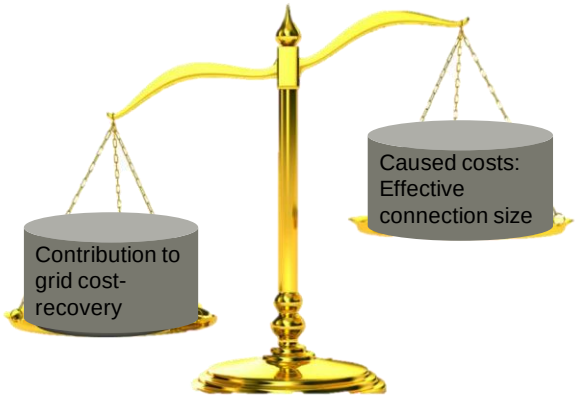

In money terms: For one **grid consumers** in the year 2050 this makes:

- "Switzerland": **13 CHF/year**
- "Capacity tariff": **0 CHF/year**

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Results: Increase in grid tariff due to self-consumption

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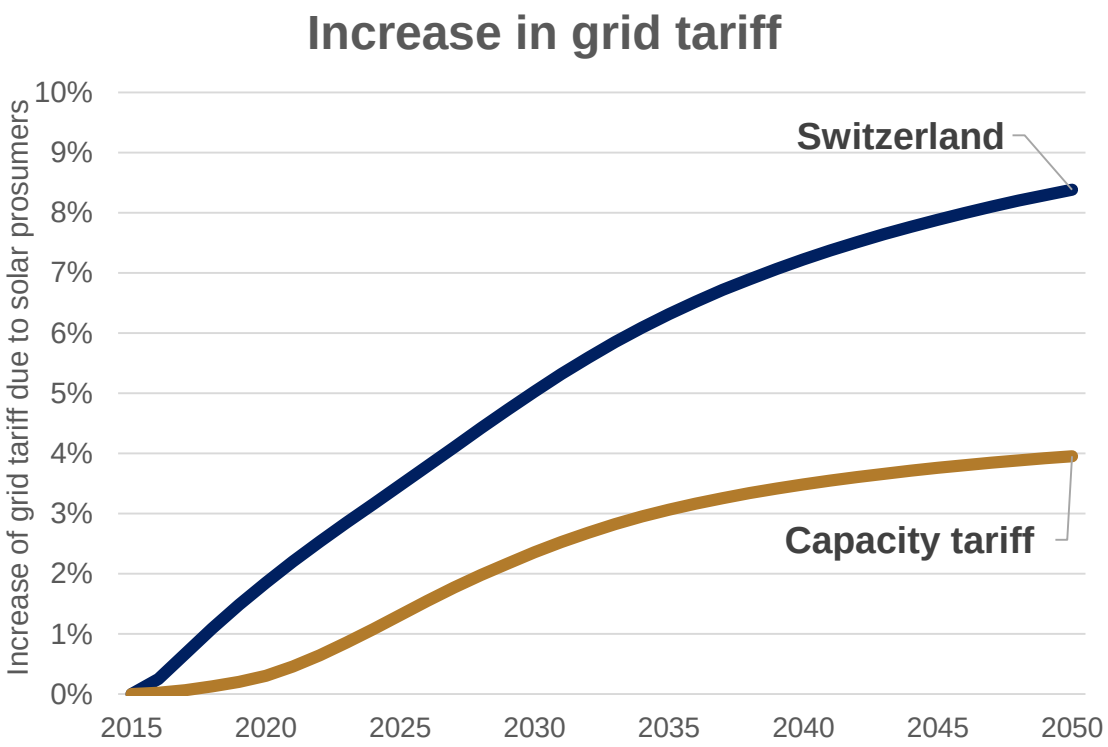

"Capacity tariff": Despite perfect cost-causation, the grid charge increases as storage prosumers reduce their peak demand.

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Policy implications

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1. **Distribution effect** is only **moderate** (for the policy setting of Switzerland). The distribution effect should not overly dominate discussions!
2. Emphasis should rather be on whether the grid tariff design **incentivizes** an **efficient** and **sustainable power system,** such as investments into solar power, low connection size.
3. **Vision:** Grid tariffs should consider which grid infrastructure is needed to transfer the power to the consumer.

Thank you for your attention!

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Own papers

Kubli, M. (2017, forthcoming). Squaring the sunny circle? On balancing distributive justice of power grid costs and incentives for solar prosumers. *Under review at Energy Policy*.

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