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# EVOLUTION OF SELF-SUPPLY WITH DIFFERENT NETWORK-CHARGING SCHEMES

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# AGENDA

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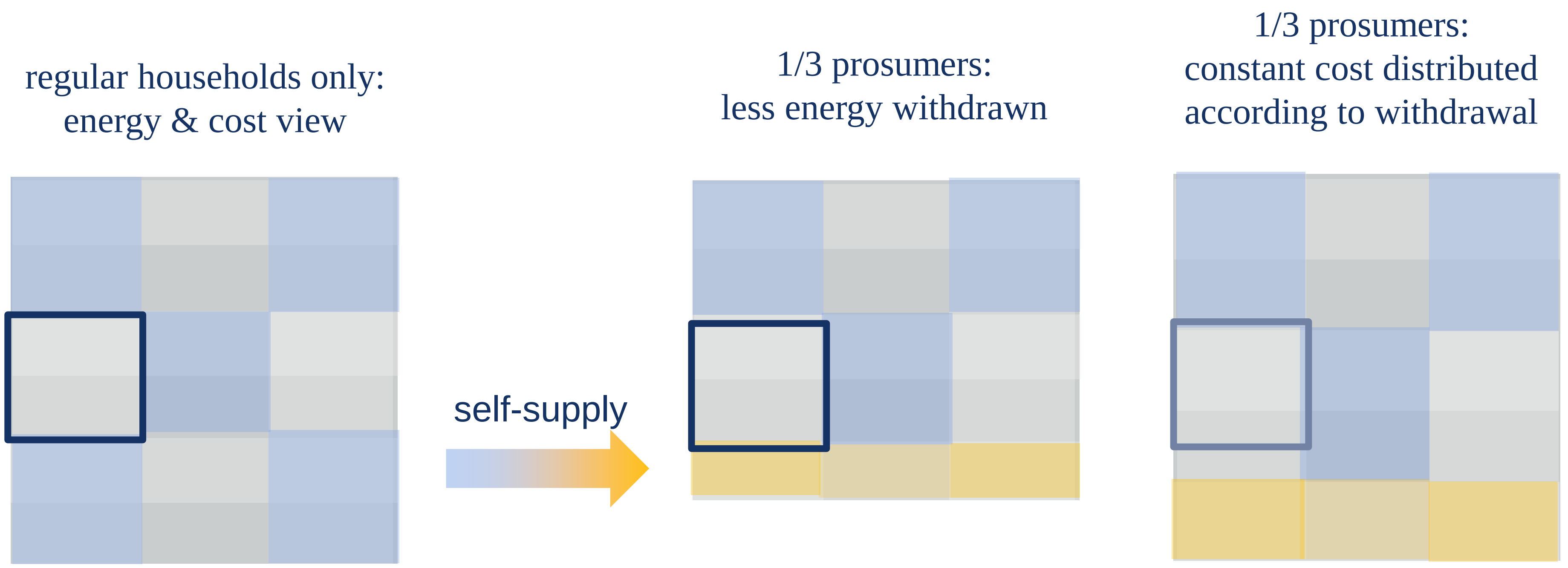
1. Background
2. Aim
3. Model
4. General Analysis
5. Case Study
6. Conclusions

# BACKGROUND

- decentralized generation and growing self supply
- incentives for self supply among others from network charges
- self-reinforcing growth of prosumer shares
- ➢ cost increase due to rising shares of prosumers



# AIM



- Which network tariffs and circumstances lead to stabilization of self supply share on a sustainable level?

objective:

- simulate investment in self-supply over time
- vary network tariff schemes
- identify conditions for stabilization of self-supply shares

# MODEL FRAMEWORK

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- one network level populated with two types of users
  - regular households
  - prosumer households

- users pay network charges based on
  - energy withdrawal (e) and /or
  - peak load (1-e)

$$p_{N,u} = E_u \cdot \frac{C \cdot e}{\sum_n E(x)} + L_u \cdot \frac{C \cdot (1-e)}{\sum_n L}$$

- prosumers withdraw less energy than they consume (d),
  but utilize the same peak load as regular users

- regular users can become prosumers via investment

- investments depend on savings and cost which correlate with the prosumer share (x)
  - profitability of investment into self-supply:

$$\pi(x) = s_N(x) + s_S(x) + s_E - c_I(x)$$

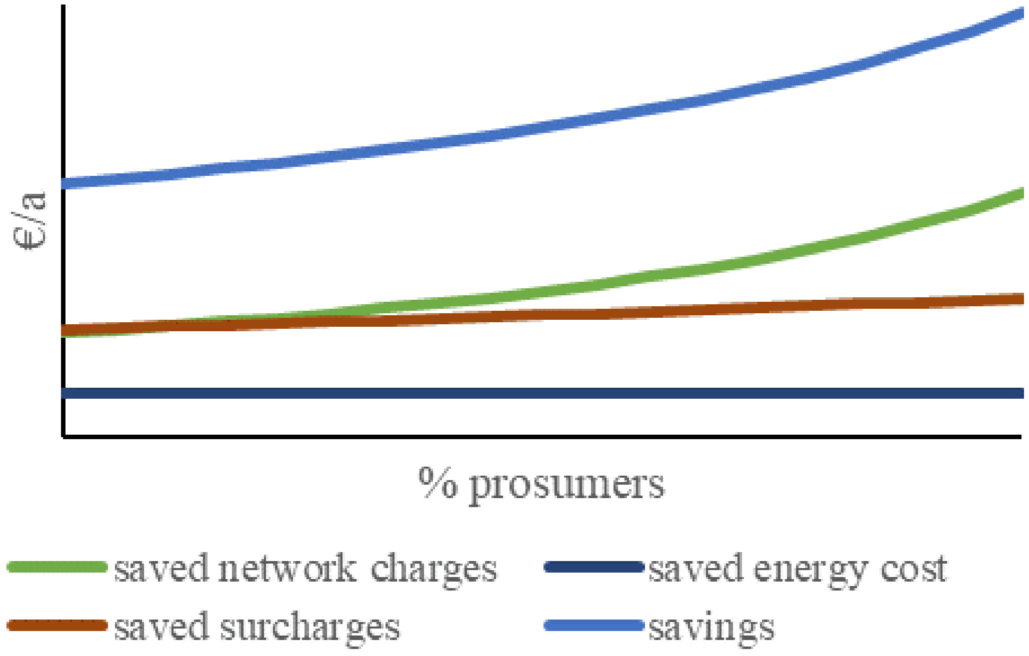
- drivers (savings – cost) :
  - saved network charges: $s_N(x) = \frac{C \cdot e \cdot (1-d)}{n(1-x+d \cdot x)}$
  - other drivers
    - saved energy cost and surcharges:

$$s_E(x) + s_S(x) = E \cdot d \cdot p_E + E \cdot d \cdot s \cdot a^{(v \cdot x)}$$

    - investment cost:

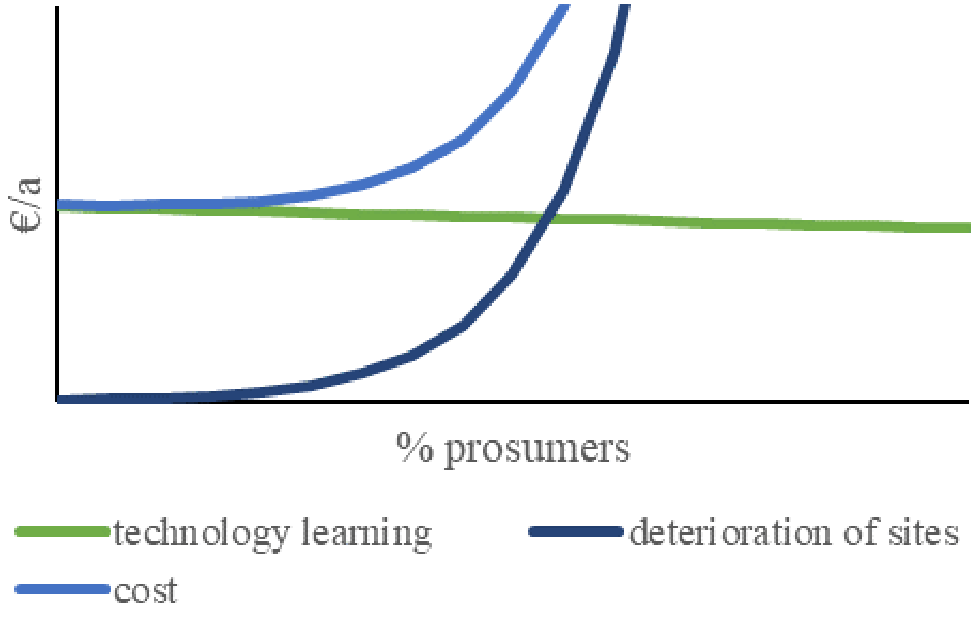
$$c_I(x) = \frac{p_{PV} \cdot L_{PV}}{t} - x \cdot l + b^{(x \cdot z)}$$

# MODEL INPUT: SAVINGS FROM SELF-SUPPLY




- savings from network charges increase with prosumer shares per network
  - volume-based network charges are lower for prosumers than for others
  - rise for all as network cost is distributed over fewer usage
- RES support, taxes and other surcharges decline as less energy is consumed from the system (national effect, not per network)
- saved energy price constant with prosumer share

# MODEL INPUT: COST OF SELF-SUPPLY

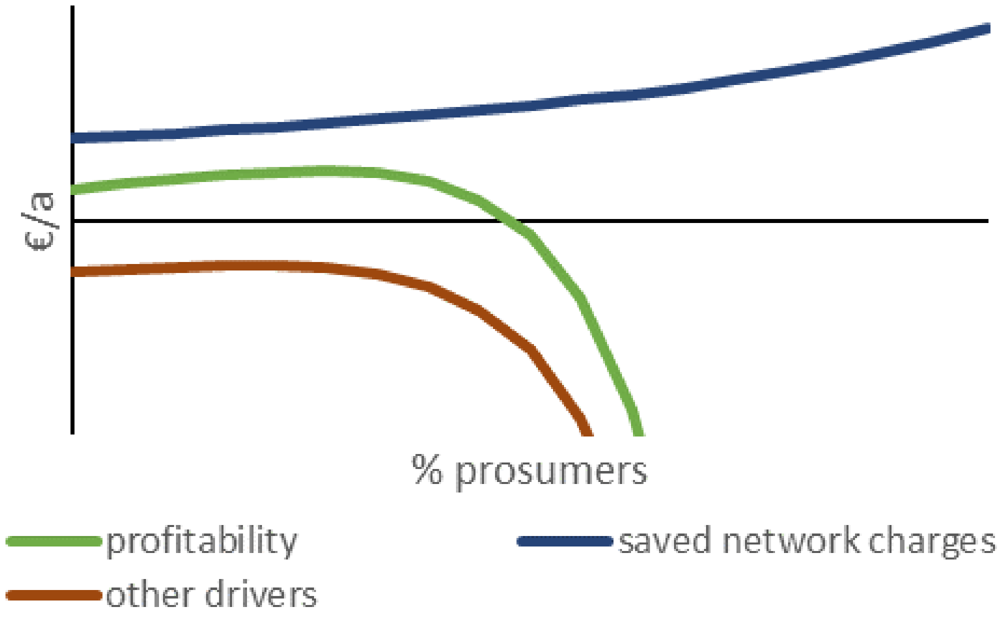



- slight decrease of investment due to technology learning,
  - global effect
  - not driven by prosumers in one network

- deterioration of available sites due to
  - limited number of rooftops for PV
  - lower electricity yield for less suitable sites

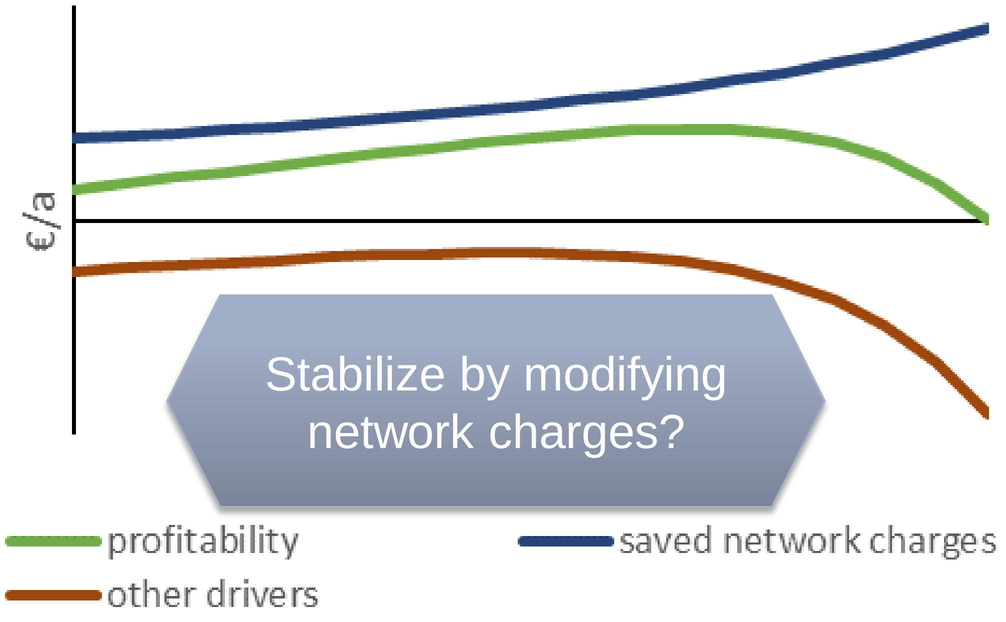
# GENERAL ANALYSIS: REFERENCE SCENARIO

- exponential course for other drivers



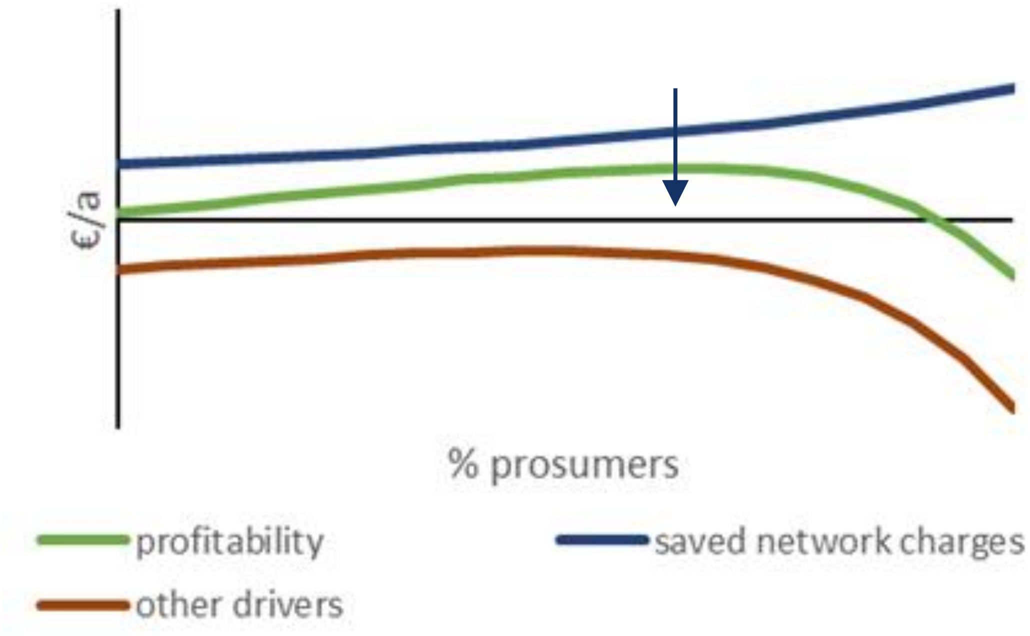

- profitability decreases and eventually becomes negative
- increase in prosumer shares is contained, system stabilizes at a higher prosumer share

- moderate course for other drivers (higher propensity for self-supply




- increase in prosumer shares over time reinforces itself
- the system does not stabilize until all users are prosumers

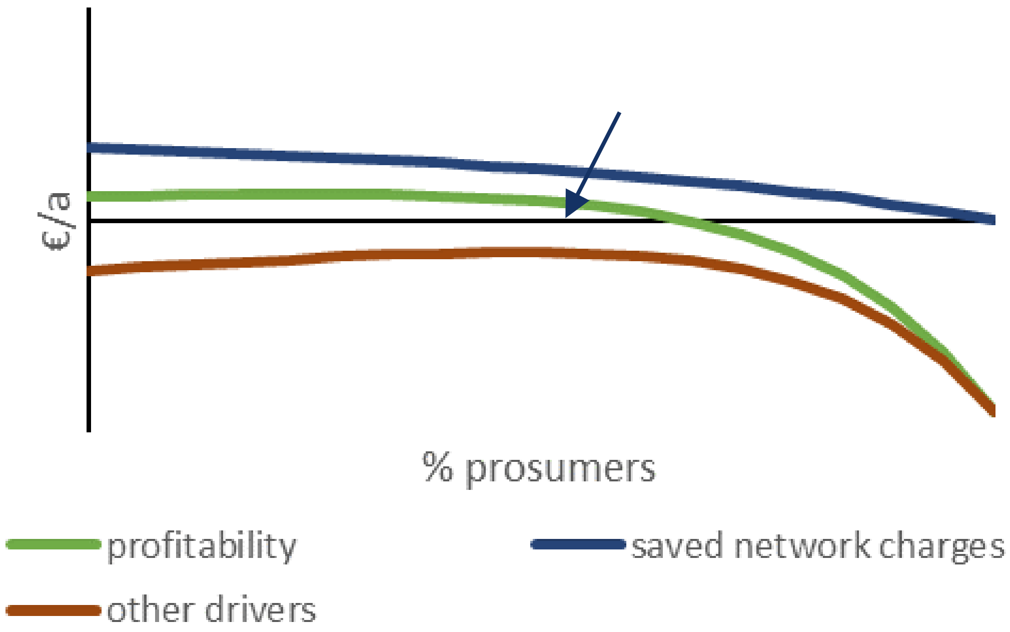
# GENERAL ANALYSIS: SHIFTING ENERGY-LOAD SPLIT




alternative 1a: higher load share

- brings down incentives from network tariffs
- correspondingly lowers profitability
- with profitability at zero or below no additional investment in self supply takes place
- self-reinforcing effect is contained
- prosumer share stabilizes at new level

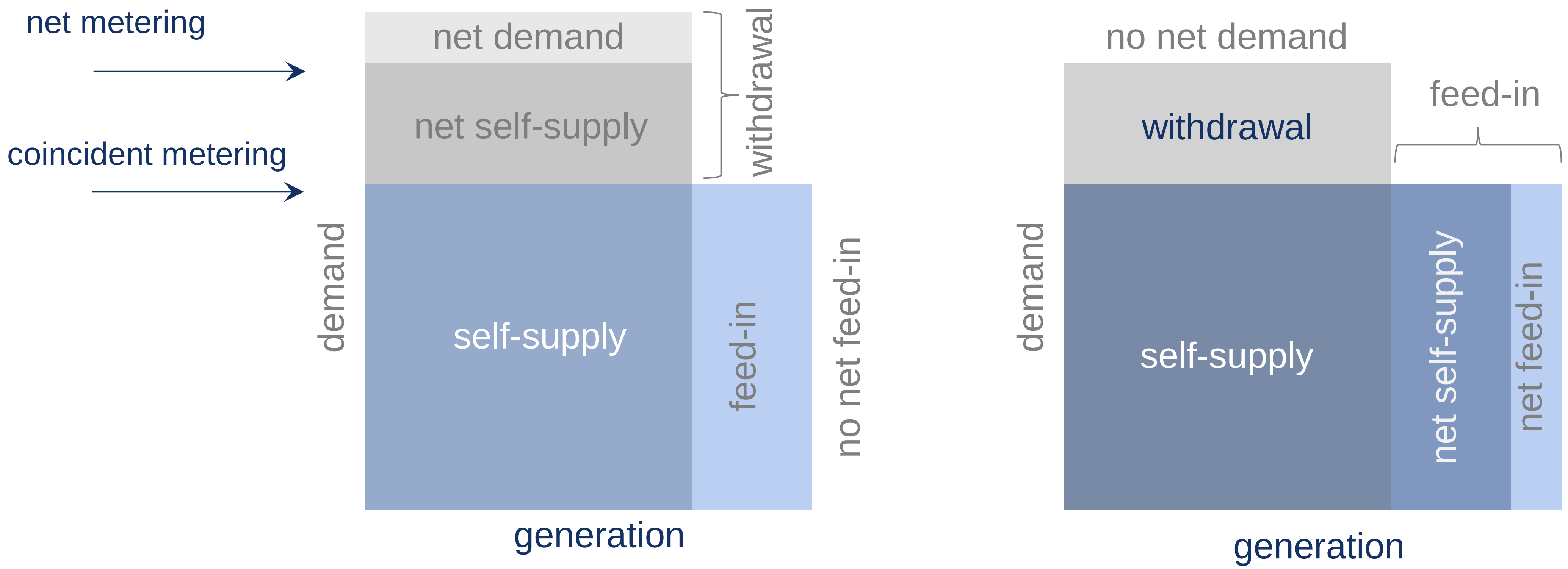
# GENERAL ANALYSIS: LINKING ENERGY-LOAD SPLIT TO PROSUMER SHARE



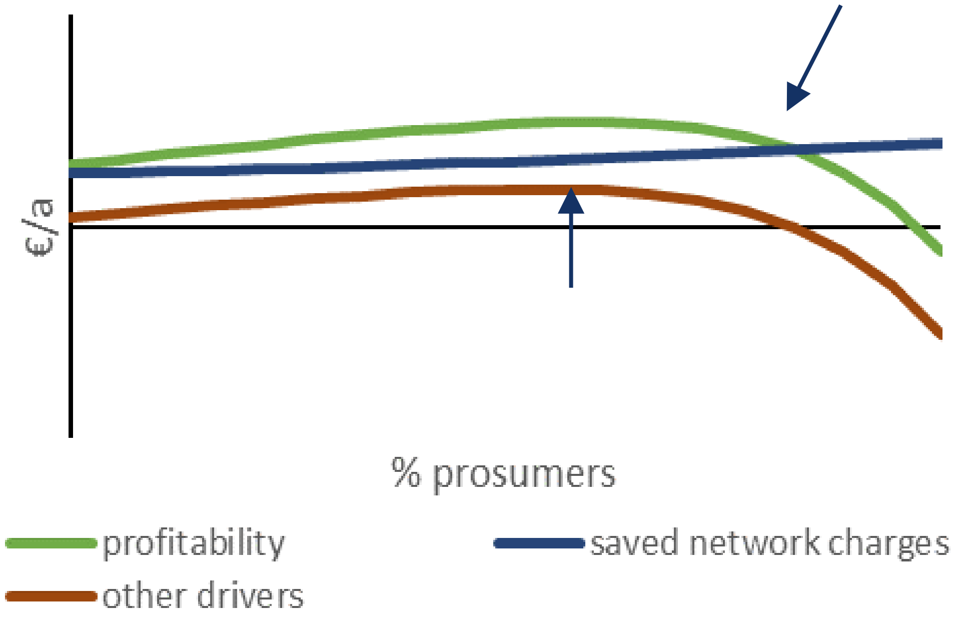

alternative 1b: load share linked to prosumer share

- increasing load share with prosumer share tilts incentives from network tariffs downwards
- correspondingly lowers profitability
- no additional investment once profitability sinks below zero
- self-reinforcing effect is contained
- prosumer share stabilizes at new level

# GENERAL ANALYSIS: REBATE FOR SELF-SUPPLY



# GENERAL ANALYSIS: SHIFTING REBATE FOR SELF-SUPPLY

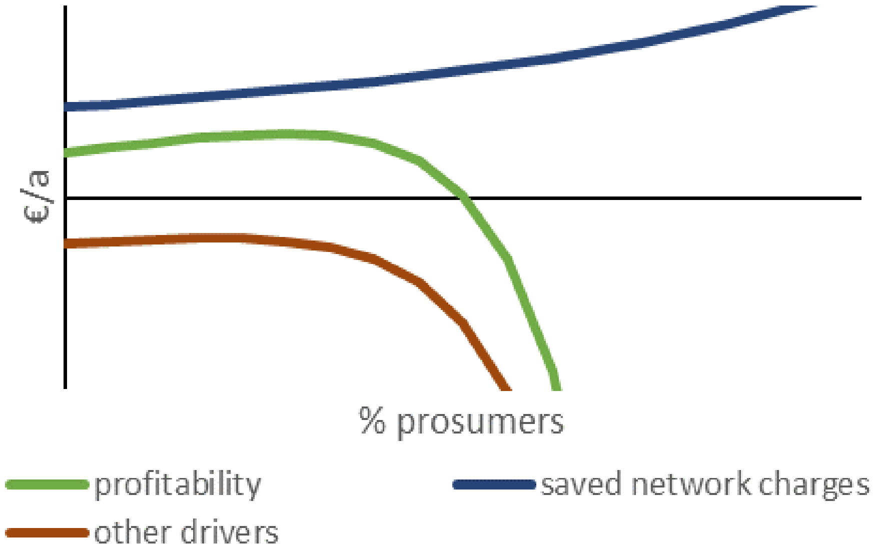



alternative 2: lower rebate for self-supply

- lowering the reduction of energy for prosumers
  - tilts incentives from network charges downwards
  - lifts savings from energy and surcharges
- profitability is still lowered
- no additional investment once profitability sinks below zero
- self-reinforcing effect is contained
- prosumer share stabilizes at new level

# GENERAL ANALYSIS: SHIFTING COST TO PARALLEL GRID WITH LOWER PROPENSITY FOR SELF-SUPPLY

parallel network with less propensity for self-supply




alternative 3: shifting cost to parallel networks

- lowering cost in one network reduces incentives from network charges
- correspondingly lowers profitability
- no additional investment once profitability sinks below zero
- self-reinforcing effect is contained
- prosumer share stabilizes at new level

# CASE STUDY WITH EXEMPLARY DATA FOR GERMANY

finds that the system stabilizes

- with an energy-load split of 40 / 60 % or less
- for a rebate for no more than 40 % self-supply (in some constellations not at all)
- if at least 50 % of network cost can be shifted

➢ maybe rather extreme cases

| parameter | unit | value | reference |
|---|---|---|---|
| prosumer share of network users | % | 0 - 100 | assumption |
| total annual network cost | €/a | 200.000.000 | assumption |
| number of network users | - | 1.000.000 | assumption |
| energy share | % | 75 | assumption |
| energy reduction factor | - | 0,4 | assumption |
| household yearly energy demand | €/a | 3.000 | assumption |
| energy price | €/kWh | 0,064 | BNetzA 2017 |
| energy-based surcharges and taxes | €/kWh | 0,166 | BNetzA 2017 |
| PV installation cost | €/$kW_p$ | 1100 | Fh ISE 2018 |
| PV lifespan | A | 25 | Fh ISE 2018 |
| PV yield | kWh/$kW_p$ | 900 | Fh ISE 2018 |
| coincidence factor PV and self-supply | % | 25 | Fh ISE 2018 |
| installed PV capacity | $kW_p$ | 8 | assumption |

# CONCLUSIONS

- (inefficient) self-reinforcing effect is possible but uncertain, depends on network charges and a set of other drivers
- in case of self-reinforcing dynamics, alternative network charging schemes can
  - stabilize the system
  - calibrate the new equilibrium prosumer level
- effective modifications of network charges are
  - shift of energy-load split
  - reduction of the rebate for self-supply
  - cost-shift between parallel networks

**policy perspective**

- regulators can select from a toolbox of tariff modification, which
  - reconcile the uncertainty of a spiral effect
  - allow to achieve other tariff goals, such as cost-reflectivity

# THANK YOU FOR YOUR TIME AND ATTENTION!

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# LITERATURE

- Network charging in general
  - Reference the reviews in Simshauser and Picciariello

- Distribution charging and self supply
  - Jagstorff et al 2014
  - Simshauser 2016
  - Hintz et al 2018
  - Picciariello et al 2015 a & b
  - Neuteleers et al 2017
  - Passey et al 2017
  - Schittekatte 2017

- Utility death spiral
  - EEI 2012
  - Costello & Hemphil 2014
  - Felder & Athawale 2014
  - Laws et al 2017