



# Network charges for distribution systems with growing prosumer share

CoNDyNet Industry-Conference-Day

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Christine Brandstät, M.Sc.

# Agenda

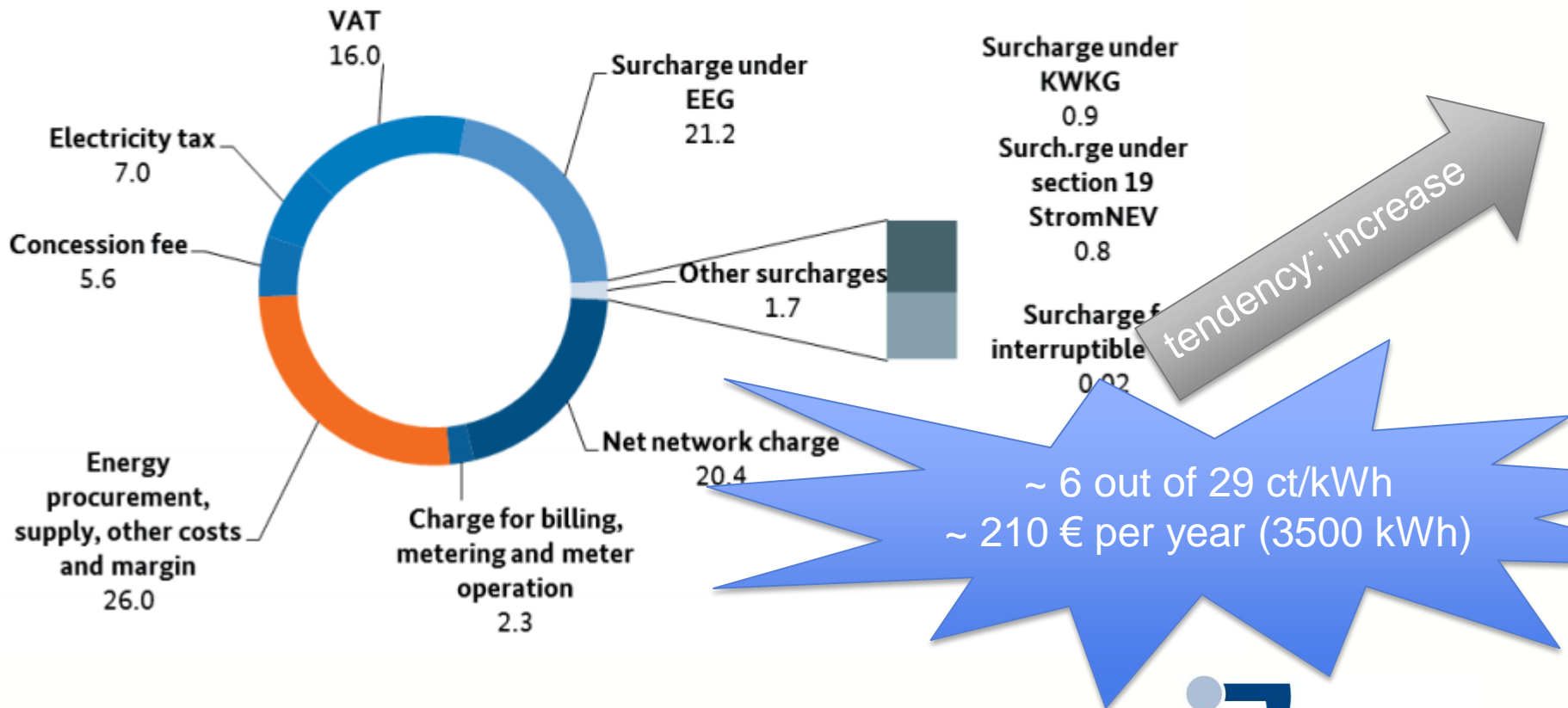
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1. Prosumers and network charges
2. Network charging schemes
3. Modelling network charges
4. Comparison of charging schemes
5. Conclusions and outlook

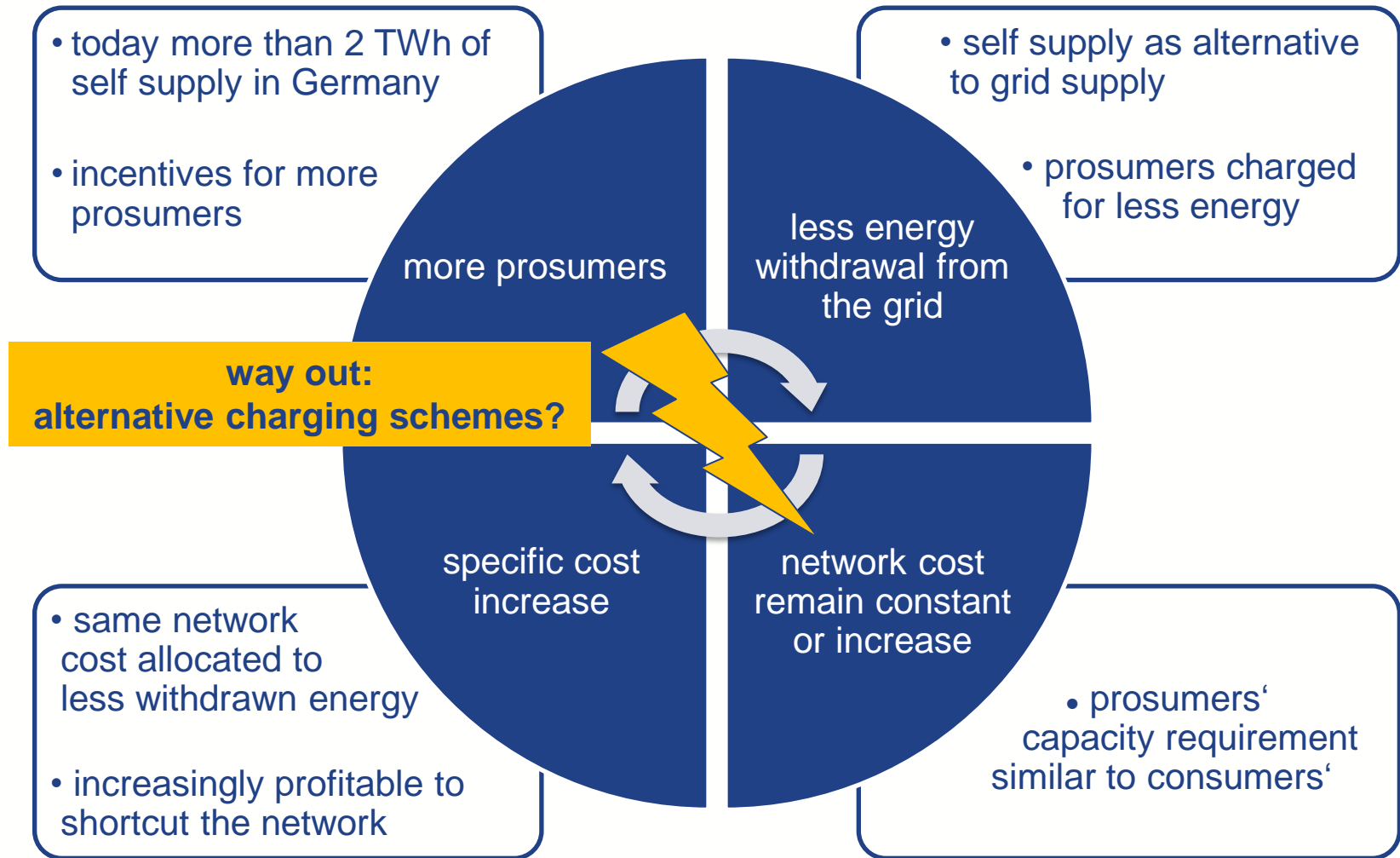
# Significance of network charges

Breakdown of the retail price for household customers with annual consumption of 3,500 kWh as at 1 April 2015 (across all tariffs volume weighted average)

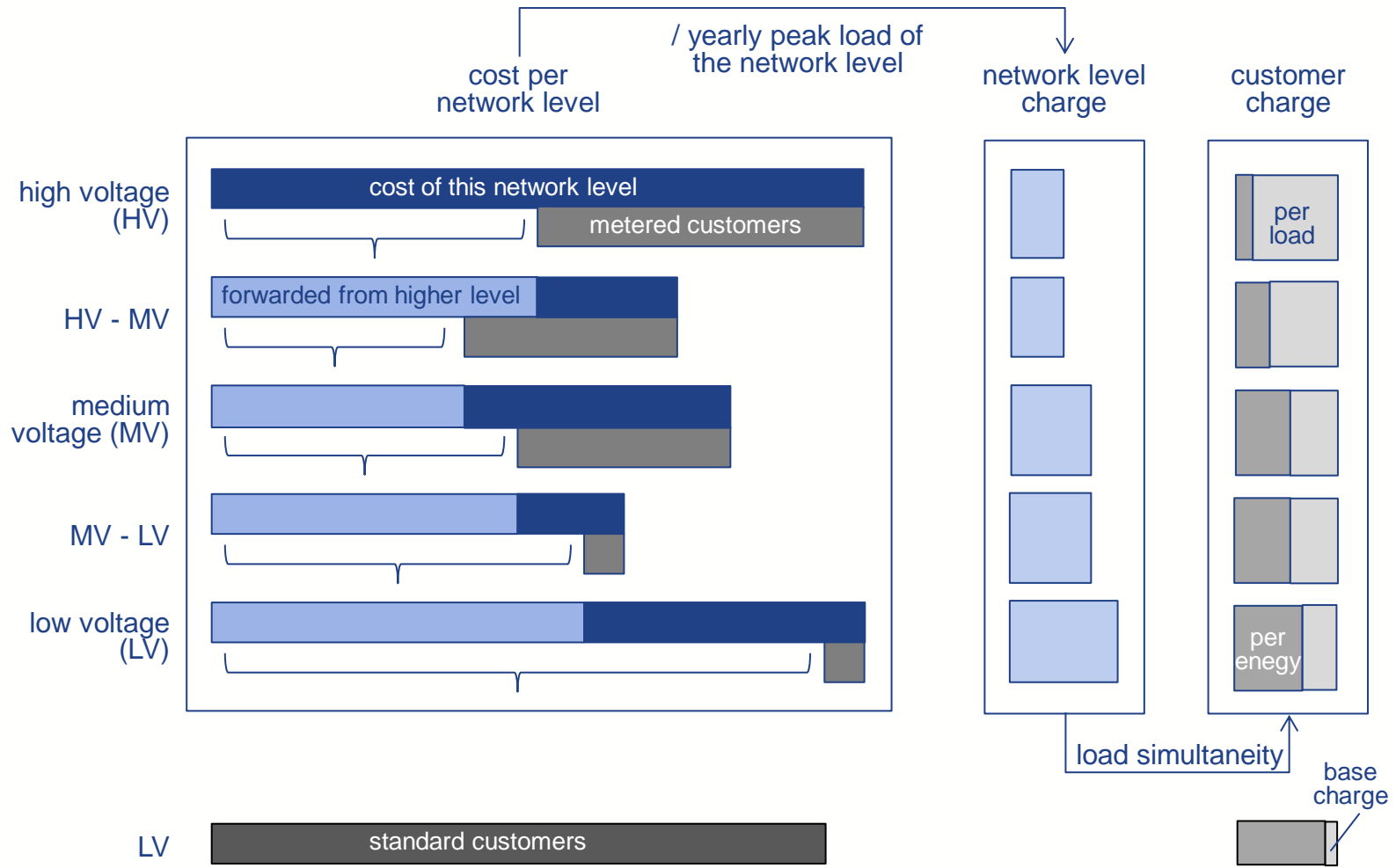
in %



# Prosumers' vicious circle



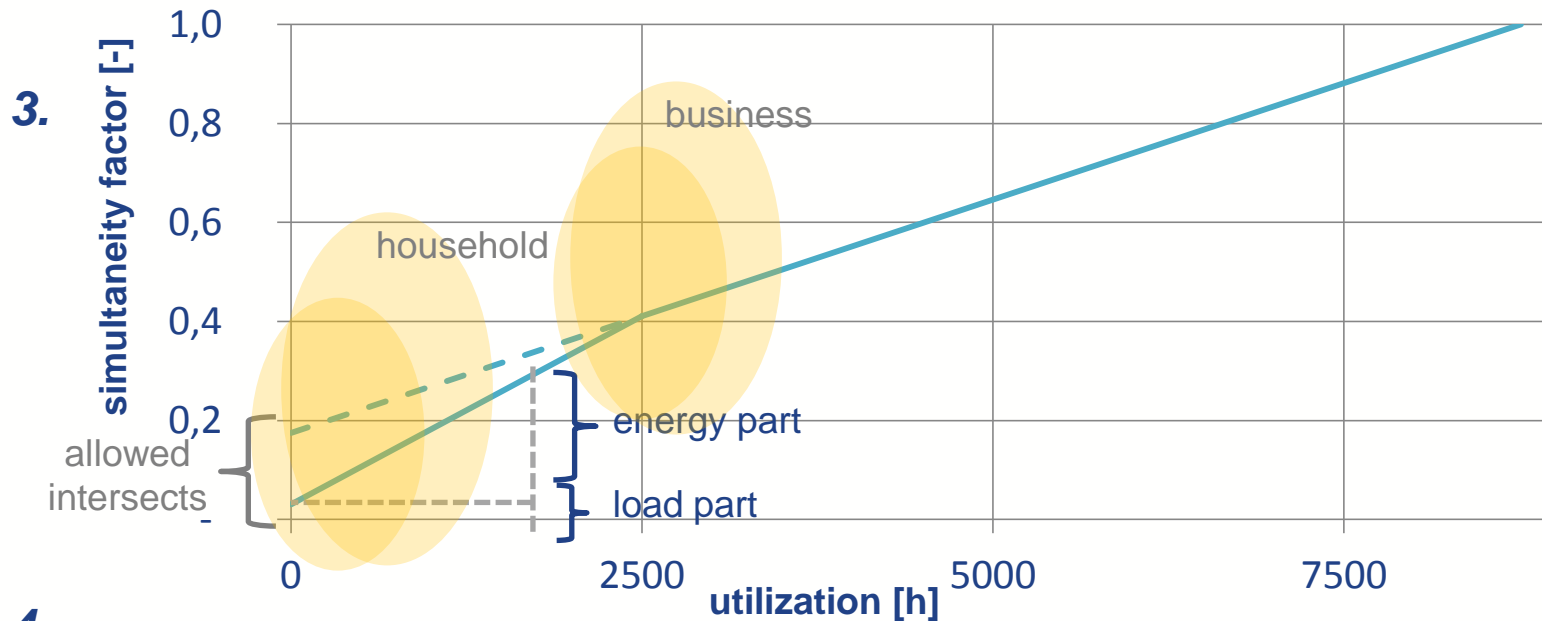
# Current charging scheme in Germany (StromNEV)



# Current charging scheme in Germany (StromNEV) II

1.  $charge_{level} = \frac{cost_{level}}{peak\ load_{level}}$

2.  $payment_{user} = charge_{level} \cdot simultaneity\ factor_{user} \cdot peak\ load_{user}$



4. a.  $Leistungsentgelt_{Nutzer} = Lastteil \cdot Entgelt_{Ebene}$

b.  $Arbeitsentgelt_{Nutzer} = Energieteil \cdot Entgelt_{Ebene}$

# Alternative charging schemes

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Current network charges are based on utilization-approximated peak simultaneity.

Alternative approaches simulated with the model are:

- flat charges based on
  - the user's peak load's share in the sum of all peak loads,
  - the user's capacity's share in the sum of all connected capacity,
  - the user's peak load at the time of peak of withdrawal from the network,
  - the user's peak load at the time of overall network peak adjusted for simultaneous generation,
- volume charges based on
  - the user's energy withdrawal from the network
  - the user's energy withdrawal from the network adjusted for the user's injections into the network throughout the same year

# Modelling network charges

## Inputs

### network structure

- network level cost
- users per network level (number, type, consumption, capacity, ...)

### load profiles

- quarter hourly load profiles
- randomly individualized standard profiles for consumers, PV and storage

### charging schemes

based on

- energy withdrawal / injection
- peak load (simultaneity with network consumption / net peak)
- regression / fixed load-energy split

## Outputs

### network load

- quarter hourly sum of user loads to obtain
  - network load profile
  - Network (net) peak load
  - user simultaneity



### network charges

- load and energy charges / yearly payments per user group



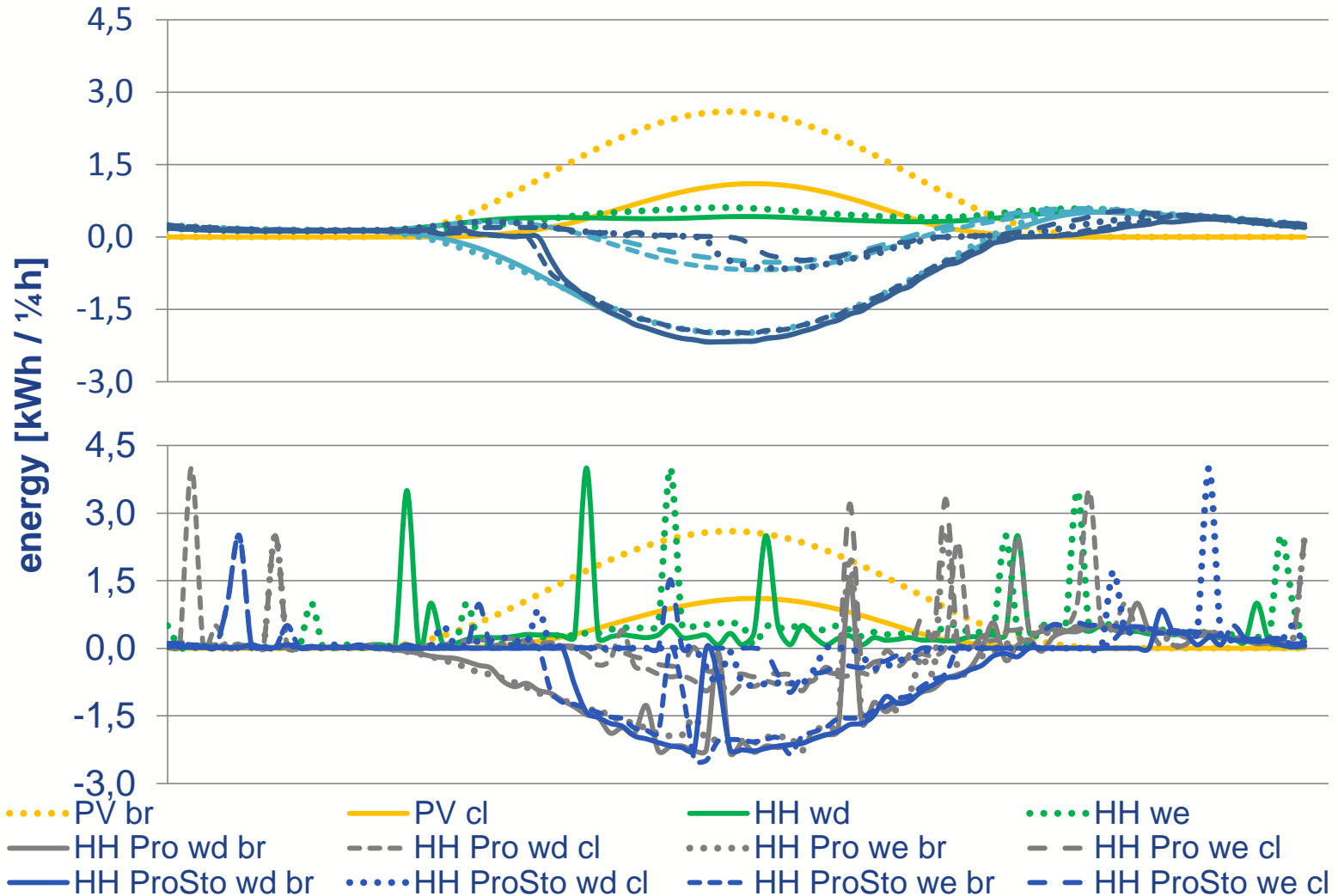
# Model network

## Input data for low voltage level

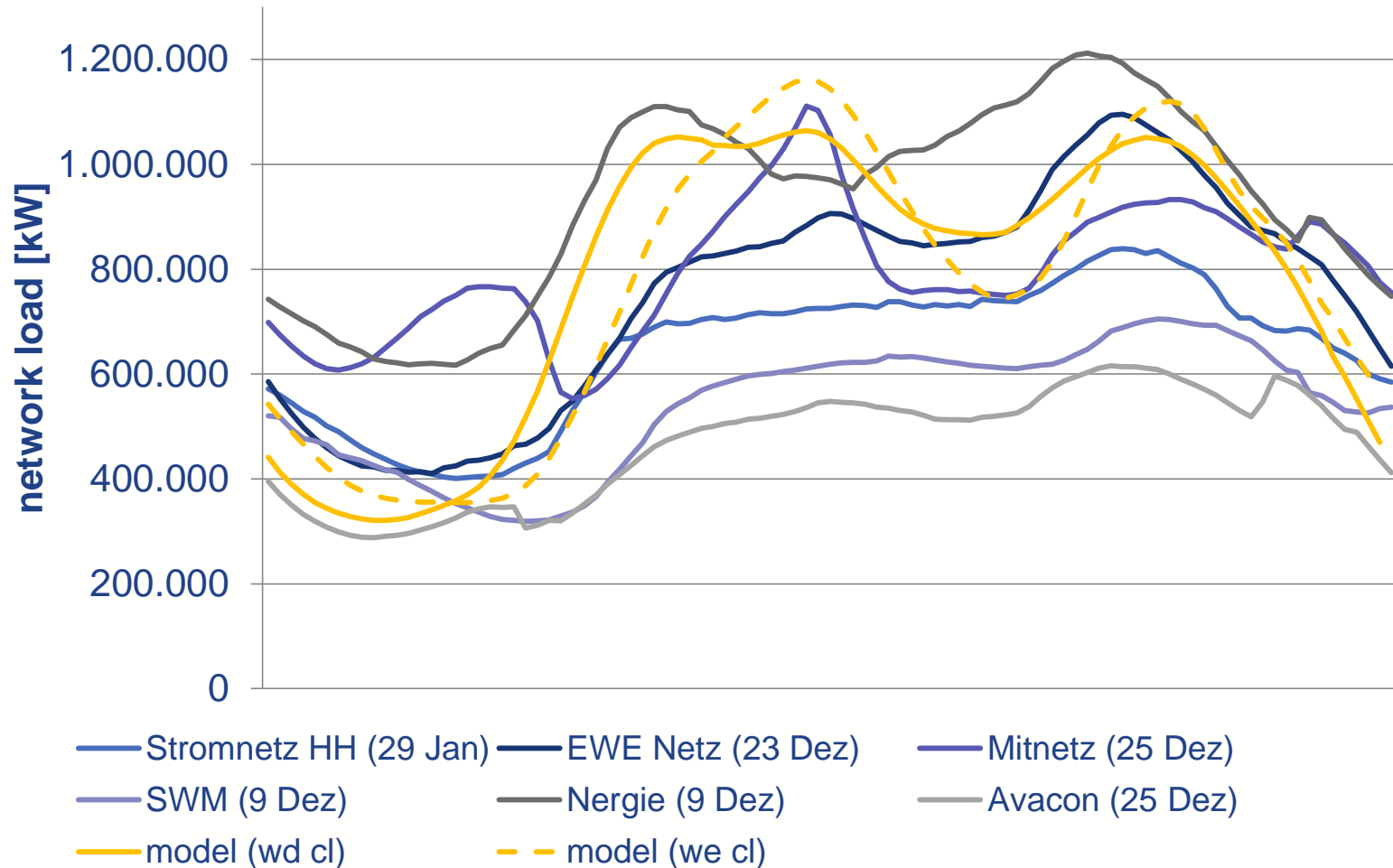
	<b>model network</b>	<b>Stromnetz Hamburg</b>	<b>EWE Netz</b>	<b>Mitnetz</b>	<b>Stadtwerke München</b>	<b>Avacon</b>
network level cost	300 Mio. €	?	?	?	?	?
number of users	1.600.000	1.130.828	1.121.496	1.612.699	949.669	1.119.193
Local generation	6%	1,64%	15,24%	7,57%	1,89%	13,91%

	<b>B</b>	<b>HH</b>	<b>B Pro</b>	<b>HH Pro</b>	<b>B ProSto</b>	<b>HH ProSto</b>
share (%)	1,4	93,6	2,5	2,5	0,04	0,04
yearly energy (kWh)	100.000	3.000	1.389	76.255	76,184	1.115
peak load (kW)	30	4	29,7	3,6	29,6	3,5
capacity (kW)	75	25	75	25	75	25

# Input load profiles



# Validation of modelled network load

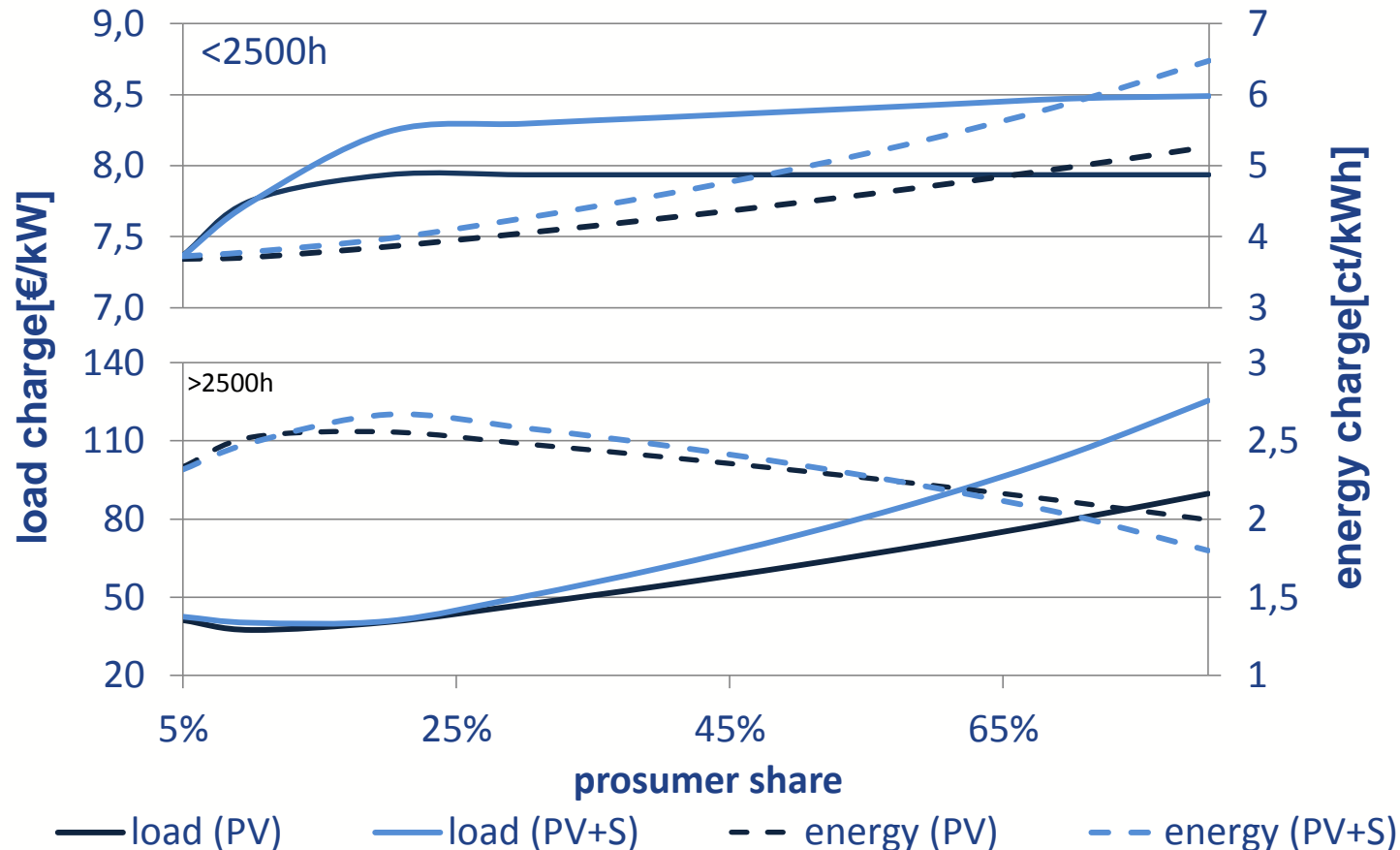


# Validation of modelled network charges

network charges at low voltage

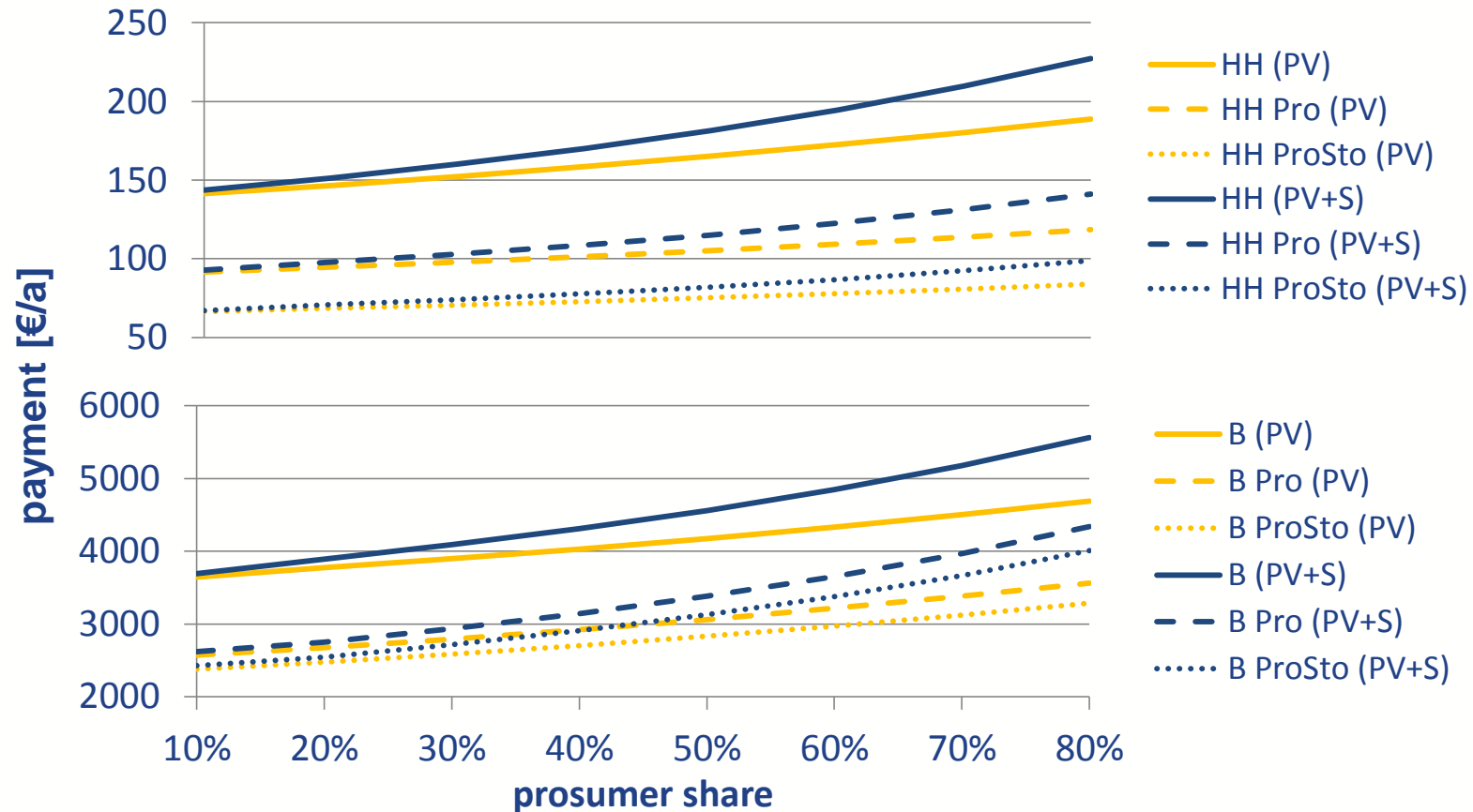
		<b>model network</b>	<b>Stromnetz Hamburg</b>	<b>EWE Netz</b>	<b>Mitnetz</b>	<b>Stadtwerke München</b>	<b>Avacon</b>
Load charge >2500h	€/kW	41,84	41,63	46,75	116,98	105,74	103,32
Energy charge >2500h	ct/kWh	2,33	2,22	2,43	1,16	0,42	1,70
Load charge <2500h	€/kW	7,37	12,98	12,99	43,73	12,81	9,84
Energy charge <2500h	ct/kWh	3,70	3,37	3,78	4,09	4,13	5,44

# Effects of increasing prosumption I: charges



- no strict proportional increase of network charges with rising prosumer share
- increasing importance of load part

# Effects of increasing prosumption II: payments



- yearly total payments rise with prosumer shares for all customers
- less impact of storage for businesses than for households (blue lines)

# Comparison of alternative charging schemes

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## requirements for charges in view of prosumption

### stable charges

- charges should not increase for some customer groups due to other customers' behaviour

### contained incentives for prosumption

- promote a certain, efficient level of prosumption without self-enforcing price spirals

### equal and fair charges

- charge similarly for similar customers

### incentives for network friendly prosumption

- steer prosumption (and general network use) to make efficient use of the network

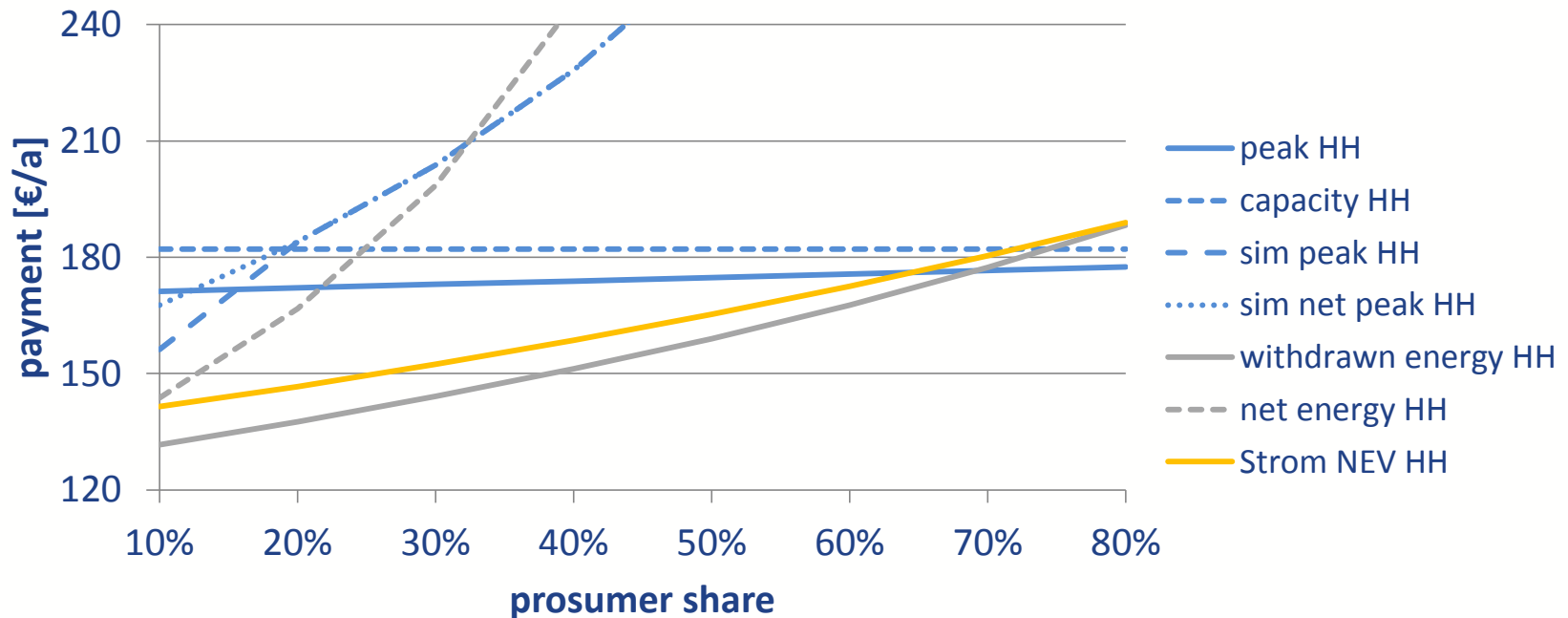
### ex-ante transparency of incentives and charges

- enable network users to anticipate their charges and adapt their behaviour

### easily billing

- contain the effort of calculating charges and billing network users

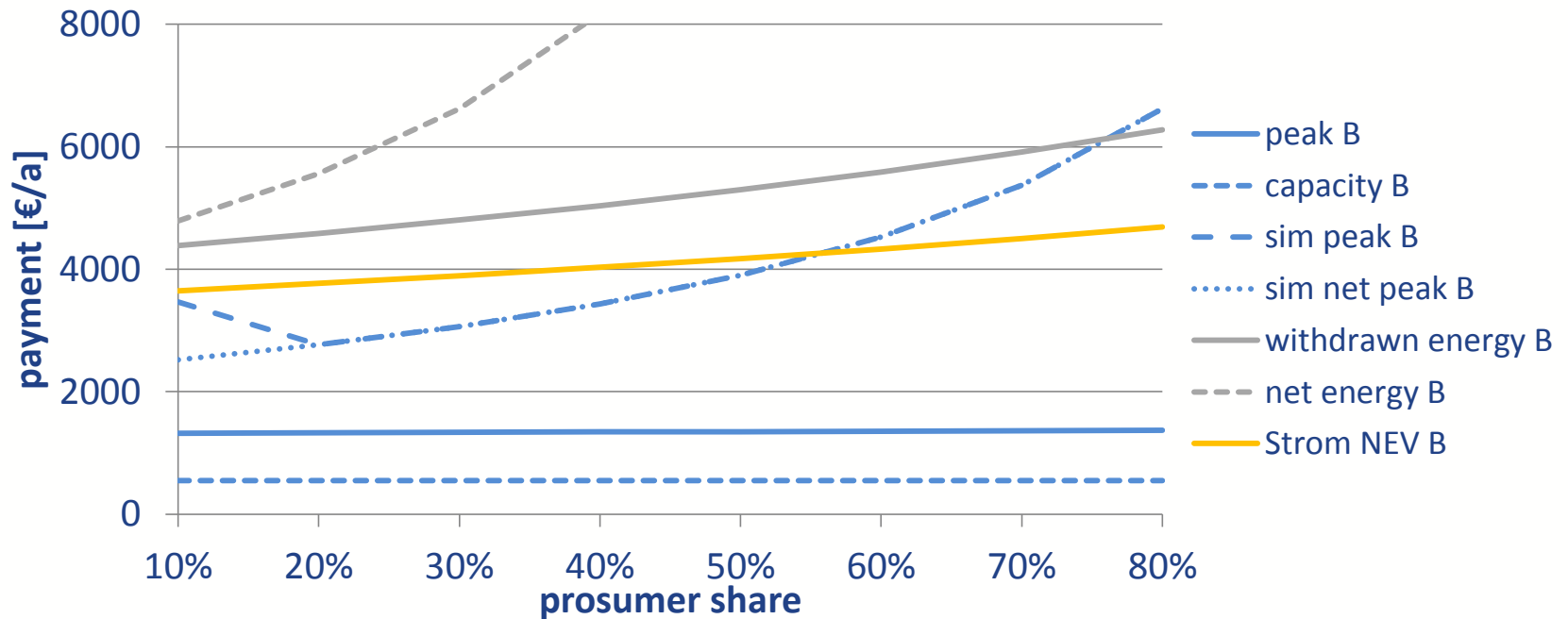
# Payments for regular households



- regular customers' payments increase strongest for net metering and charging based on actual simultaneity
- StromNEV resembles charges based on withdrawn energy

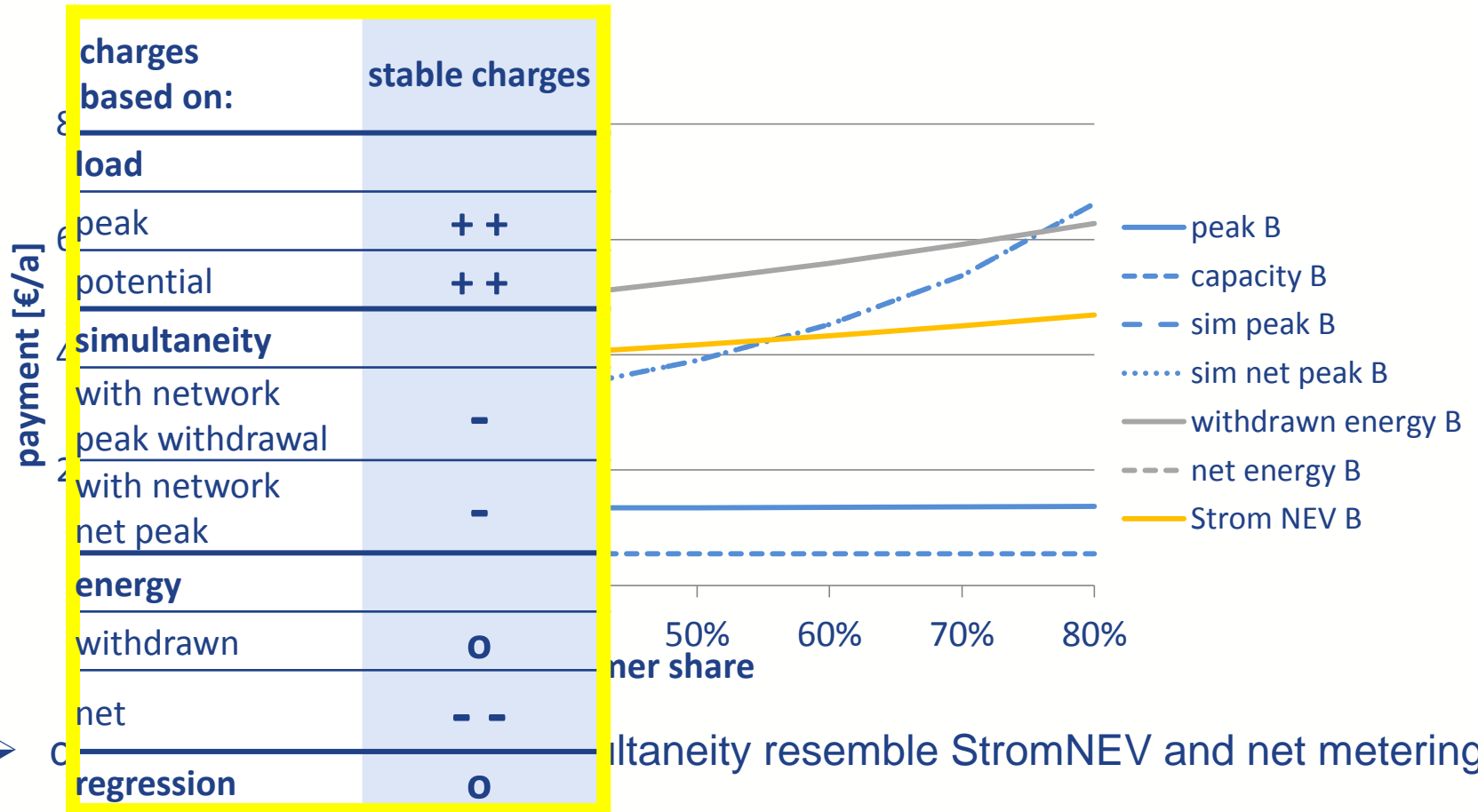


# Payments for regular businesses



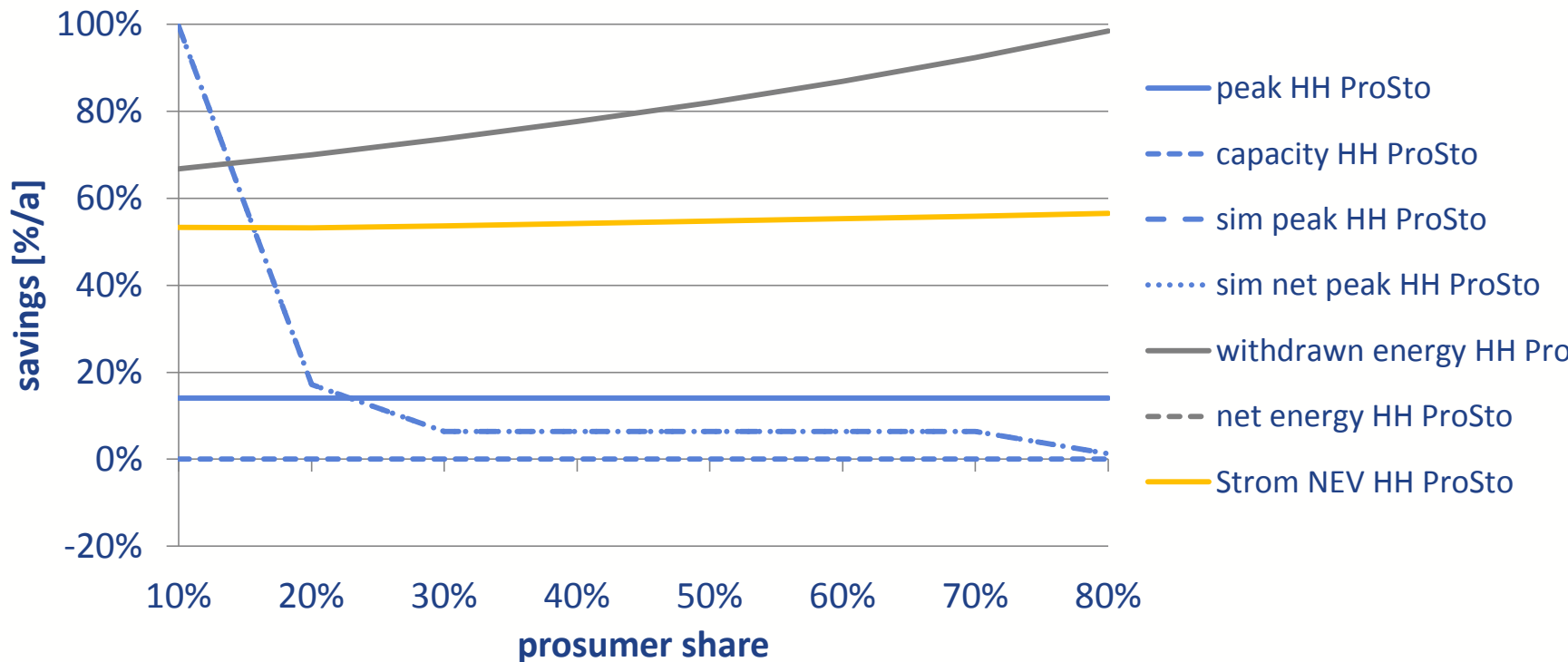
- charges based on actual simultaneity resemble StromNEV and net metering
- flat rate charges comparably low

# Payments for regular businesses



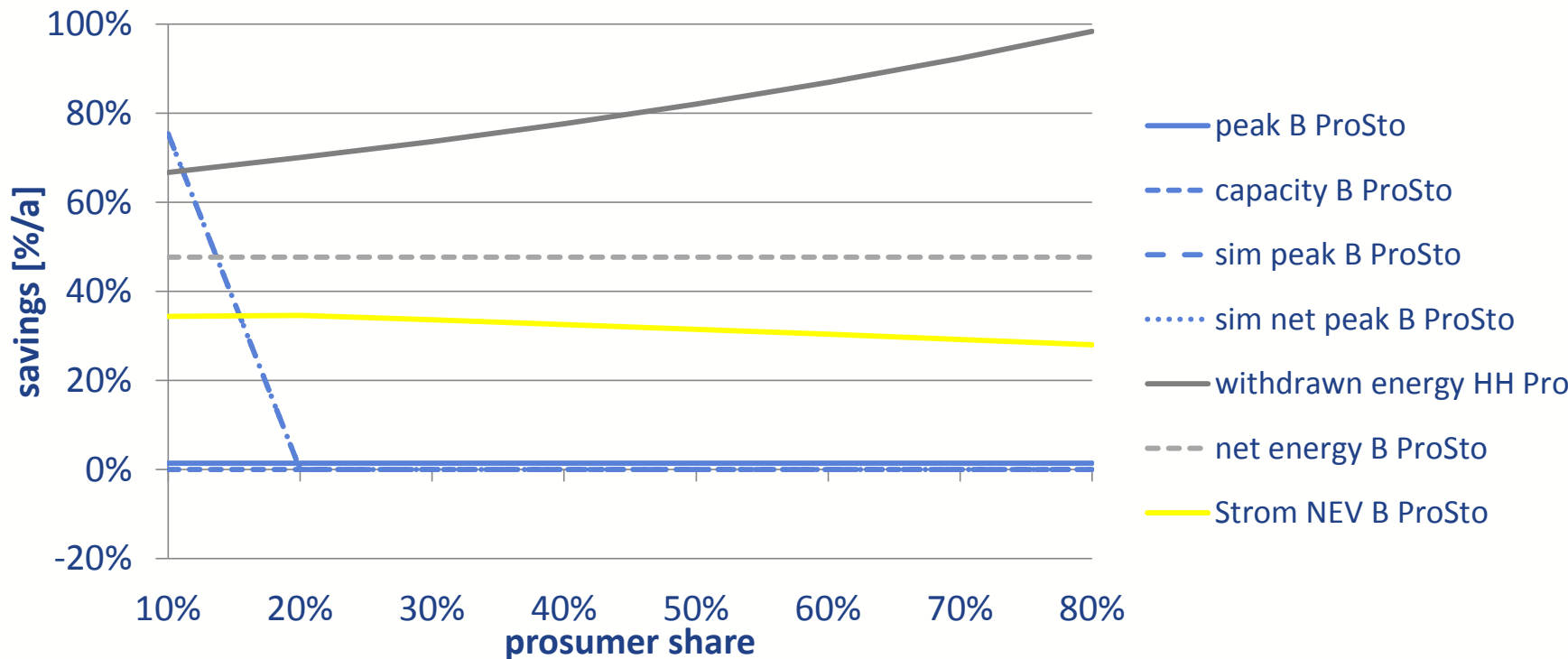
- simultaneity resemble StromNEV and net metering
- flat rate charges comparably low

# Incentives for household prosumers



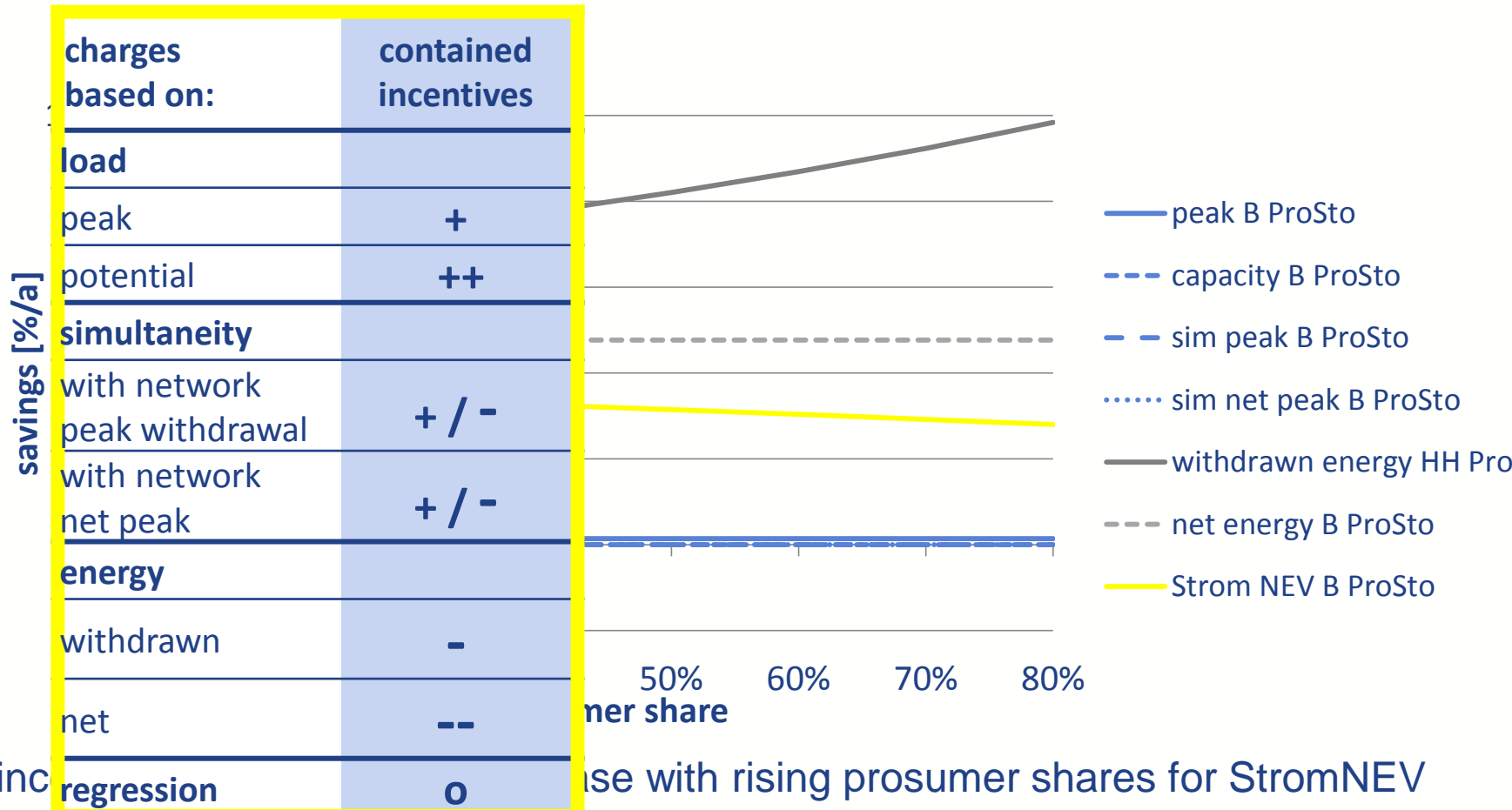
- incentives for self supply rise with prosumer share for StromNEV and net metering (>100%) but decrease for charging schemes based on actual simultaneity

# Incentives for business prosumers



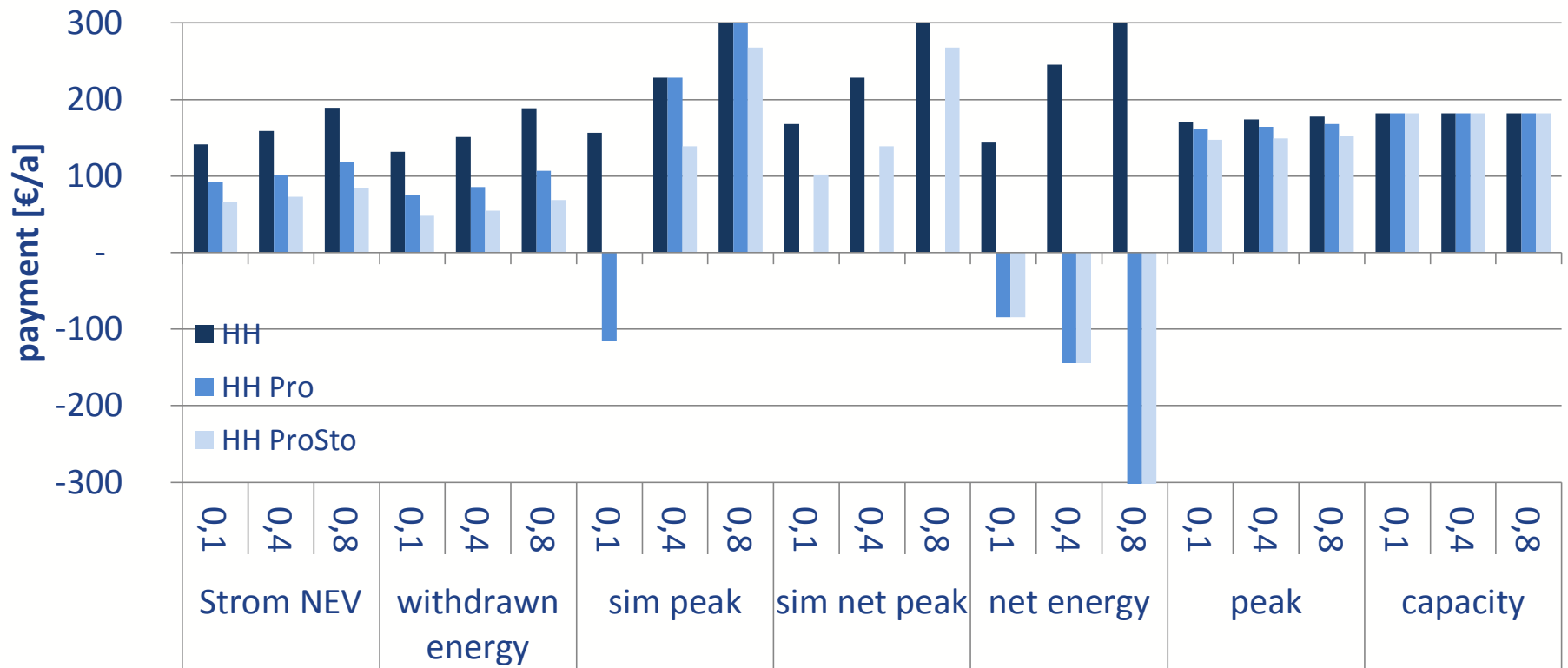
- incentives for self supply decrease with rising prosumer shares for StromNEV and rise more moderately for net metering

# Incentives for business prosumers



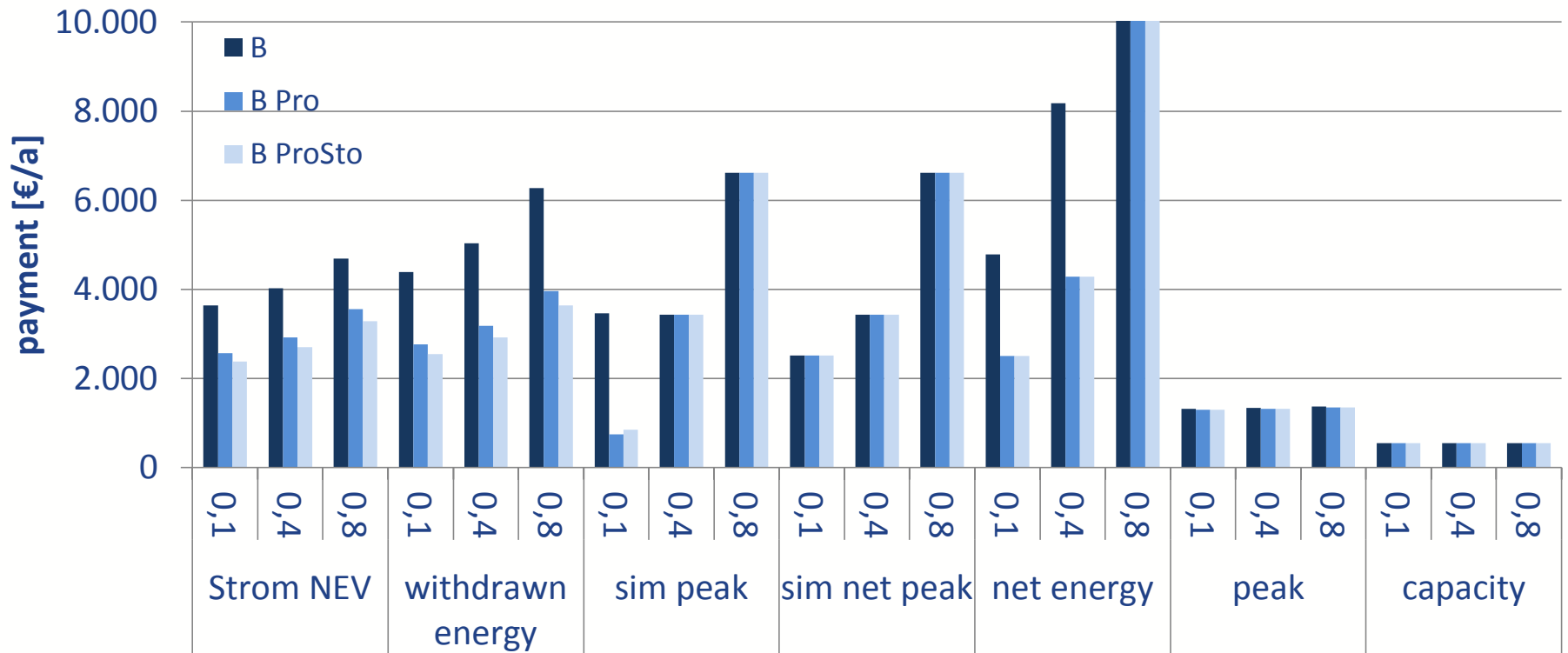
➤ increase with rising prosumer shares for StromNEV and rise more moderately for net metering

# Distributional effects for households



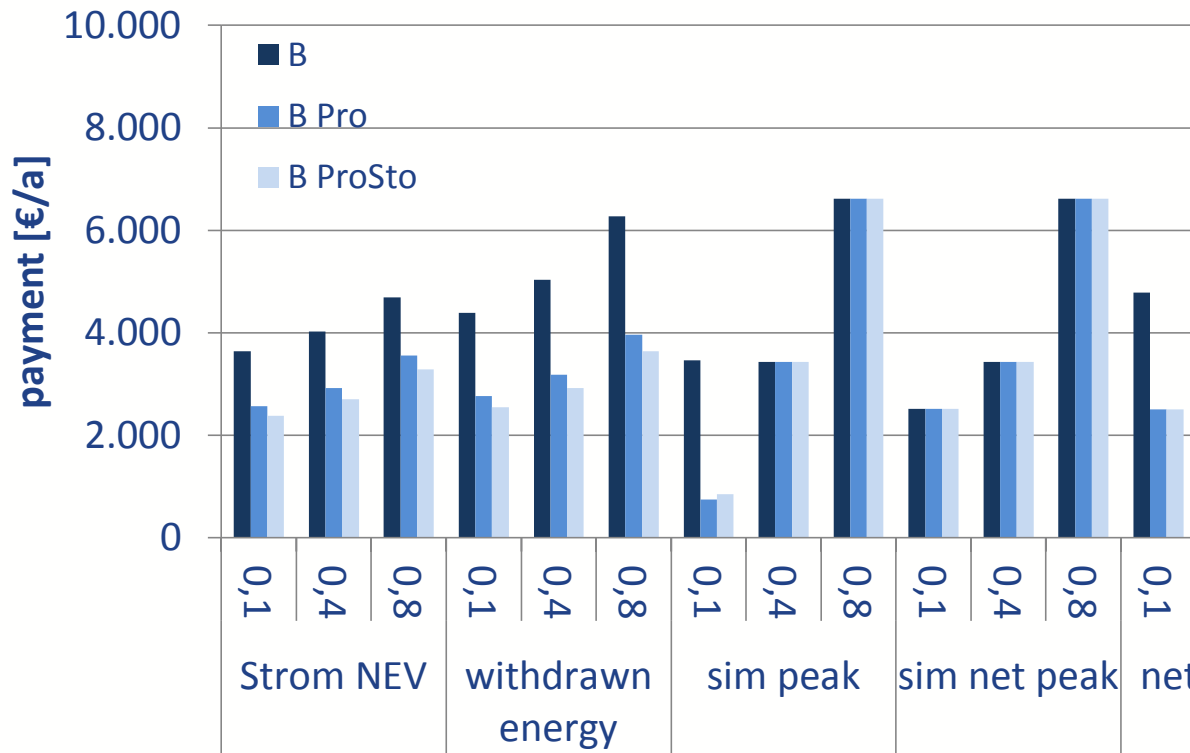
- regular customers pay more than prosumers in all schemes except capacity flat
- distributional effects strongest for net metering and simultaneous peak charging

# Distributional effects for businesses



- equal charges with/without presumption for flat rates and simultaneous peak
- less distributional effects with/without presumption than for households

# Distributional effects for businesses



charges based on:	equal charges / fairness
load	
peak	+ / -
potential	+ / -
simultaneity	
with network peak withdrawal	-
with network net peak	+ / -
energy	
withdrawn	0
net	- -
regression	+

- equal charges with/without prosumption for flat rates are
- less distributional effects with/without prosumption than



# Comparison of charging schemes

charges based on:	stable charges	contained incentives	equal / fair charges	efficient network use	ex-ante transparent charges	easy billing
<b>load</b>						
peak	++	+	+ / -	-	+	+
potential	++	++	+ / -	--	++	++
<b>simultaneity</b>						
with network peak withdrawal	-	+ / -	-	+	-	-
with network net peak	-	+ / -	+ / -	++	-	-
<b>energy</b>						
withdrawn	0	-	0	-	0	+
net	--	--	--	--	0	+
<b>regression</b>	0	0	+	0	++	-

# Conclusion & Outlook

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## Conclusions

- regular users' network payments rise with increasing prosumer share
- flat charges fall short in promoting efficient network use
- charges based on actual peak simultaneity best for efficient network use but complex

## Outlook

- other incentives for prosumers may be more substantial
  - other energy price components (taxes, RE subsidies...)
  - decreasing levelized cost of PV (grid-parity)
- 'natural' threshold for self supply
  - availability of appropriate locations and investment opportunities



JACOBS  
UNIVERSITY

Christine Brandstätt, M.Sc.

Jacobs University Bremen | Bremen Energy Research

Campus Ring 1 | 28759 Bremen | Germany

c.brandstaett@jacobs-university.de

+ 49 421 200-4866 | <http://b-e-r.user.jacobs-university.de/>

# Input load profiles

