



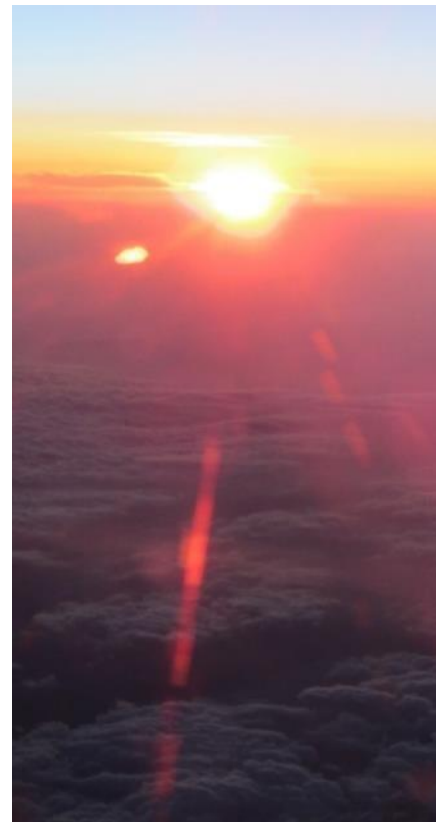
INCO_20C_10

Empower Energy Consumers through Stimuli

InterConnect Final Event 27.02.2024

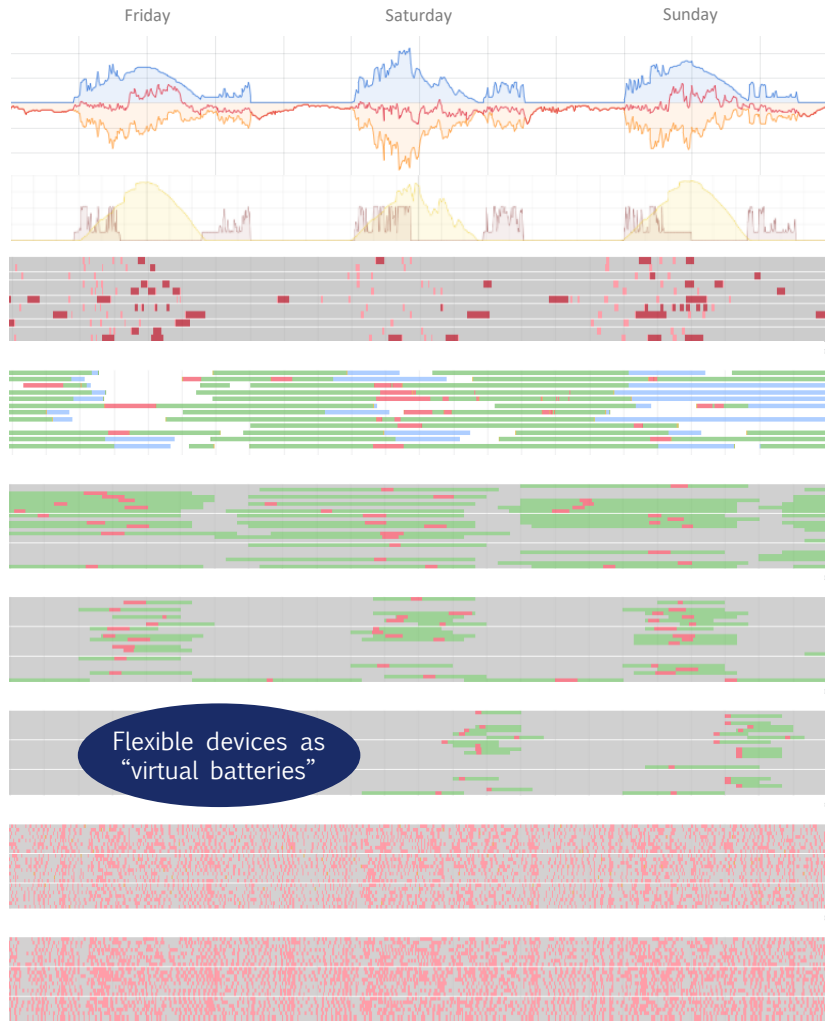


interconnect



Pilot Living Quarter „SoLAR Allensbach“

Citizens empowered to use cheaper and greener energy



- generation
— residual power → BI stimulus for local balancing
— consumption
- +1 (cheap)
 -1 (expensive)
- 15 generation units
 14 PV rooftop plants
 1 CHP, modulated
- 12 heat pumps
 warm water active
 heating active
- 13 charging stations
 car plugged
 charge time window
 charging
- 23 dishwashers
 programme time window
 operating
- 23 washing machines
 programme time window
 operating
- 23 tumble dryer
 programme time window
 operating
- 23 refrigerators
 compressor runs
- 23 freezers
 compressor runs

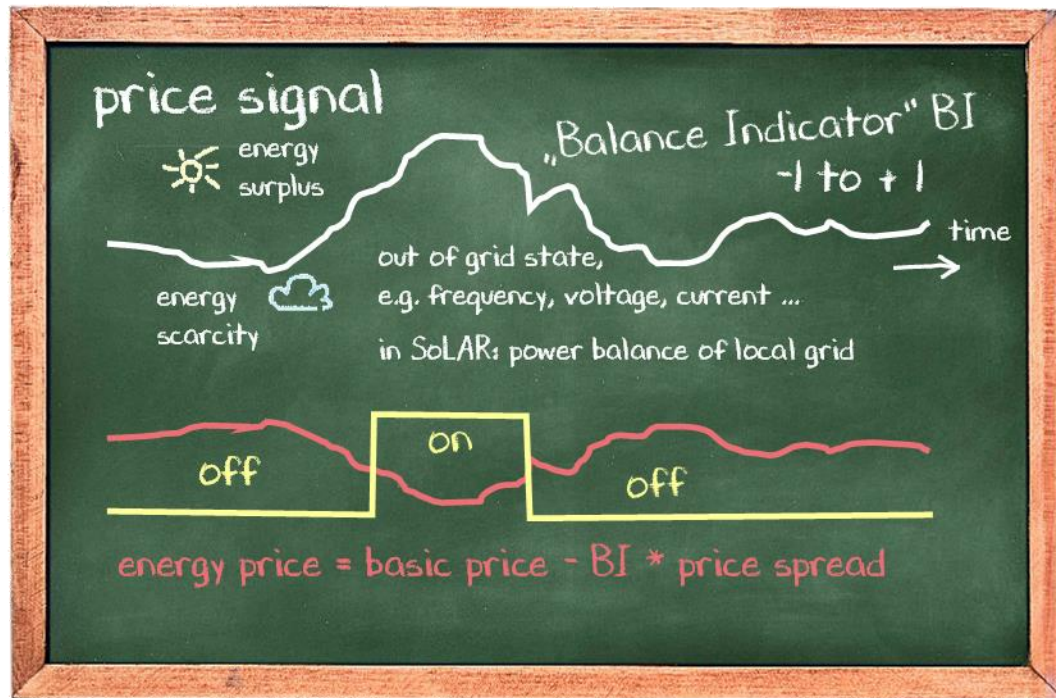


- Real estate with 12 semi-detached houses and 13 flats
- Intelligent sector coupling with dynamic price signal (stimulus)
- Stimulus (Balance Indicator, BI) out of residual power measurement
- Automatic responses by individual device software agents



Easy Smart Grid Method

Price Stimulus Signal and Automated Device Response

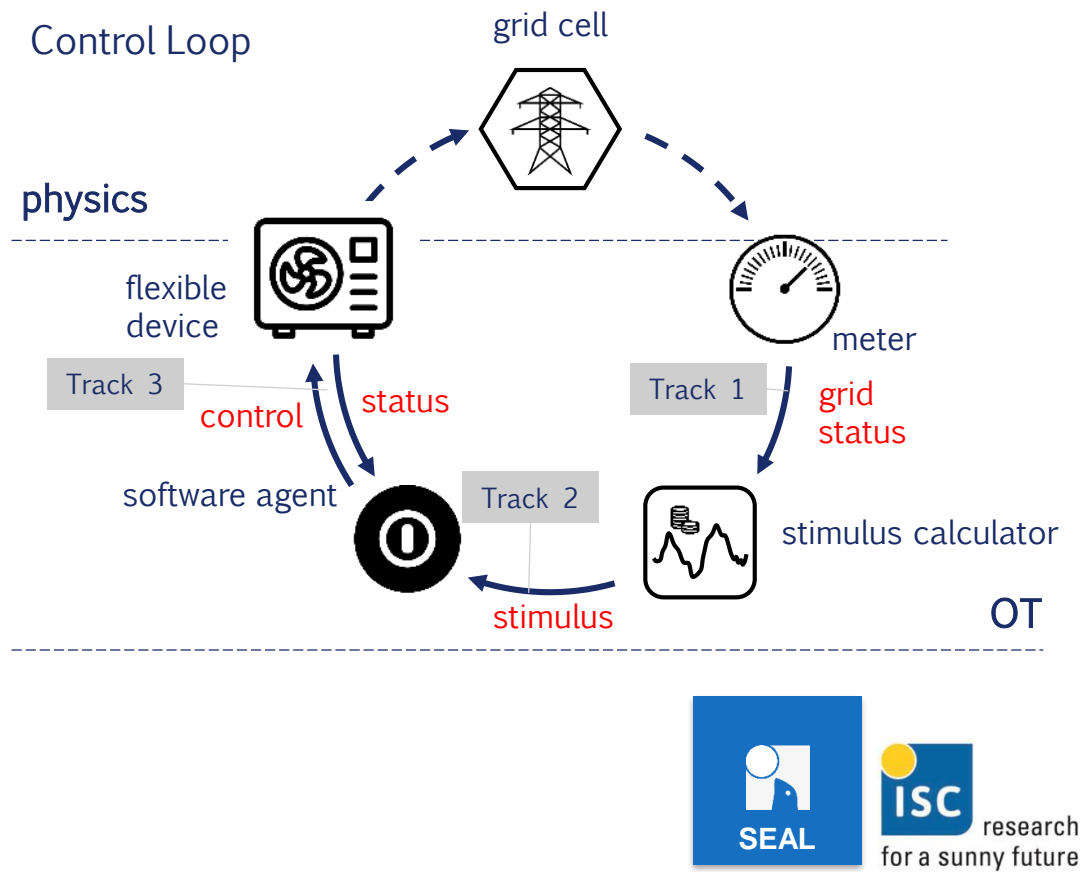


„Smart Meter 2.0“



Easy Smart Grid Method

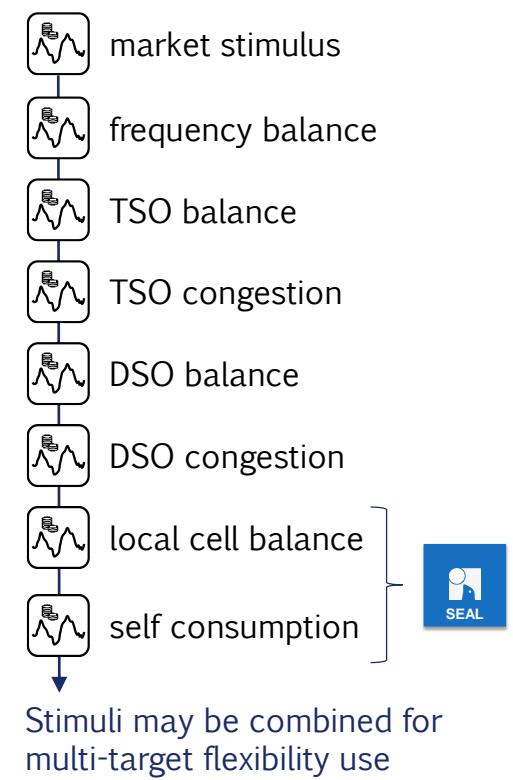
Grid and market form a closed control loop



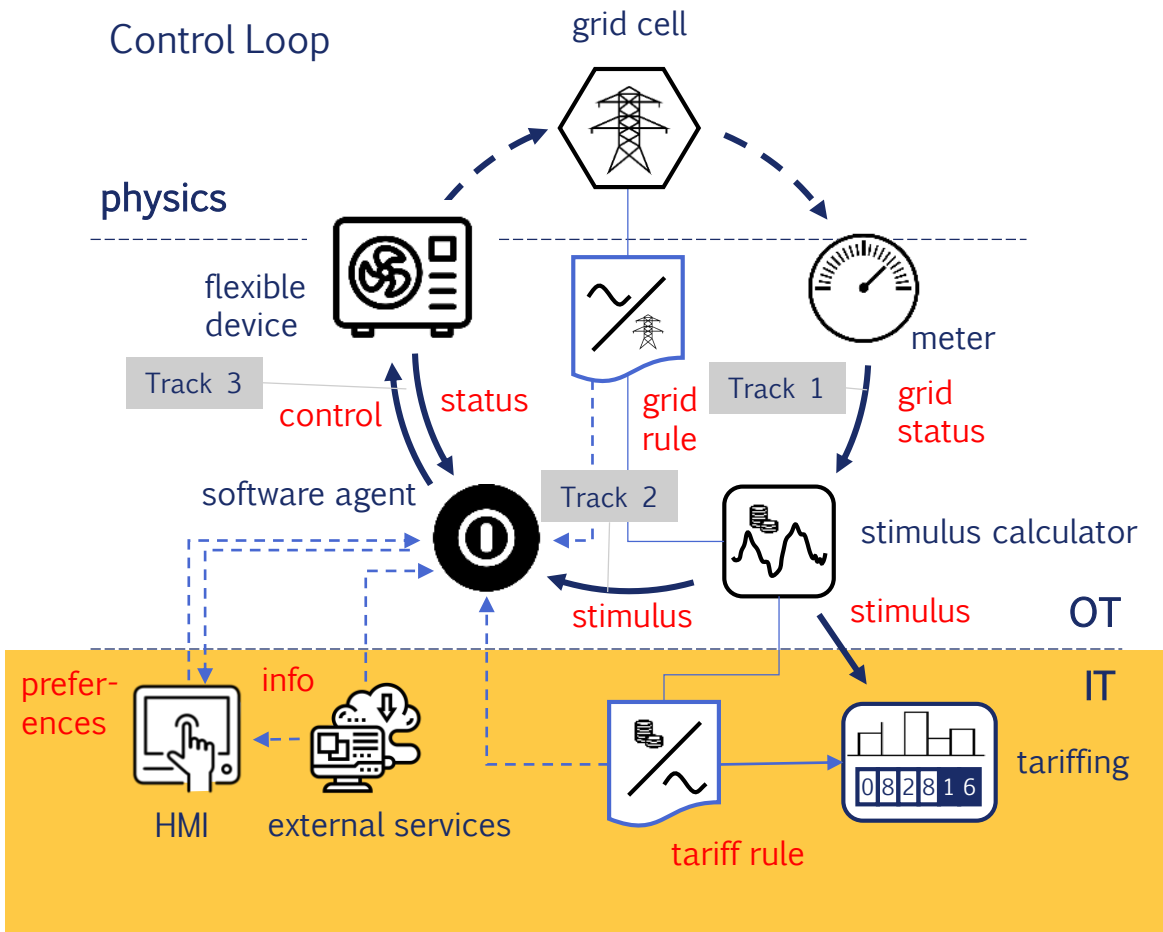
SAREFisation

Track 1	Track 2	Track 3
meter	stimulus calculator	software agent
SSA	SSA	SSA
SIF	SIF	SIF
SSA	SSA	SSA
stimulus calculator	software agent	flexible device

Stimuli types











Easy Smart Grid and InterConnect SAREFisation gives access to rich IT functionalities



SAREFisation

Track 1	Track 2	Track 3
meter	stimulus calculator	software agent
SSA	SSA	SSA
SIF	SIF	SIF
SSA	SSA	SSA
stimulus calculator	software agent	flexible device

Stimuli types

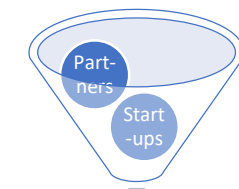
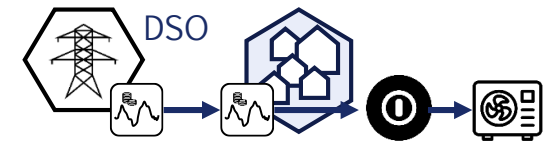
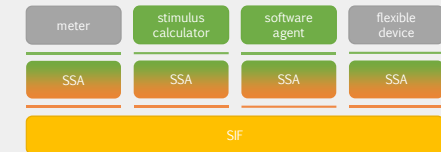
-  market stimulus
 -  frequency balance
 -  TSO balance
 -  TSO congestion
 -  DSO balance
 -  DSO congestion
 -  local cell balance
 -  self consumption
- Stimuli may be combined for multi-target flexibility use

interconnect

Stages and Tasks

Tasks Title	Project months					
	Stage 2			Stage 3		
	2	3	4	5	6	7
T1 SAREFisation of existing functions						
T1.1 Implement parameter mapping for existing functions		M1				
T1.2 Integration of existing endpoint protocol functionalities					M2	
T2 Definition and implementation of an external DSO stimulus						
T2.1 Define an external DSO stimulus and exemplary tariff scheme			M3			
T2.2 Integrate and verify endpoint protocol function for the DSO stimulus					M4	
T3 Definition and implementation of validation and demonstration approach						
T3.1 Specification of performance criteria and validation scenarios			M5			
T3.2 Performance evaluation and presentation						M6
T4 Business development						
T4.1 Identification of synergies with InterConnect partners			M7			
T4.2 Exploitation of synergies with InterConnect partners						M8

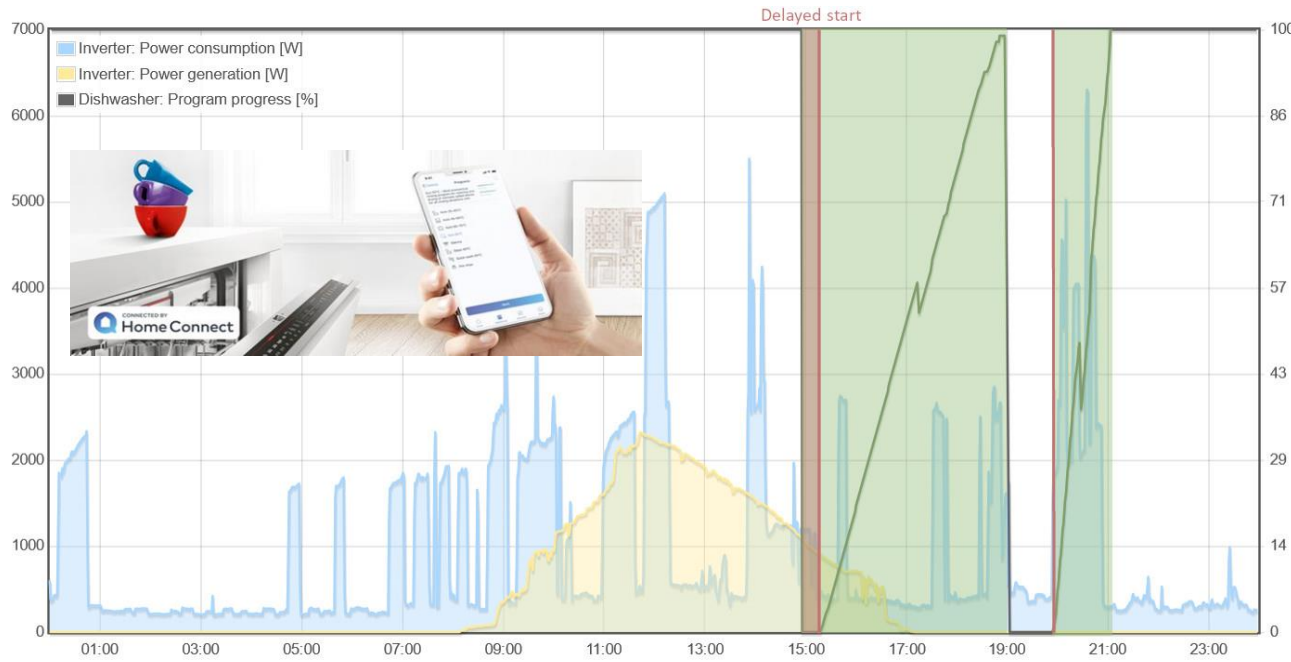
STADTWERKE KONSTANZ 



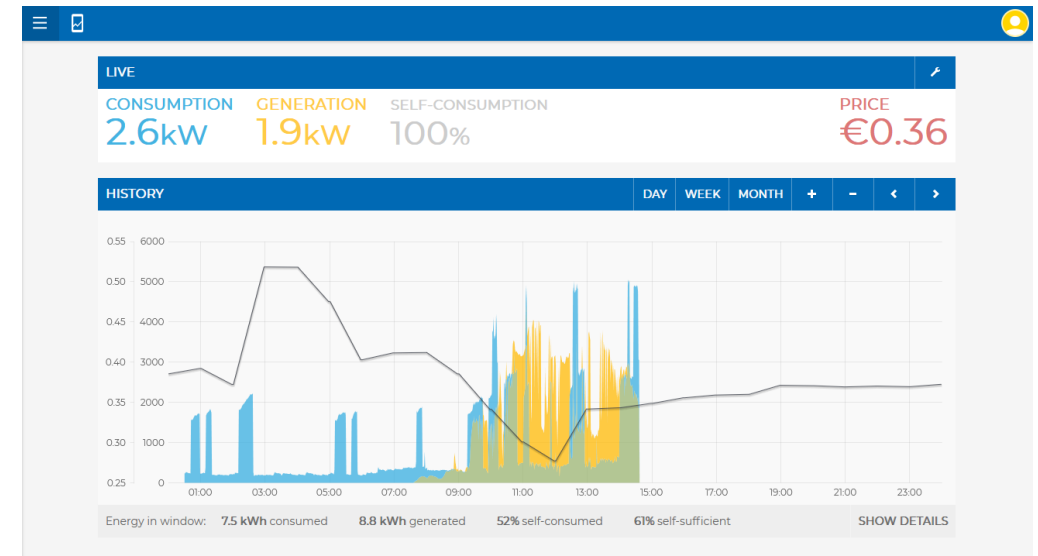
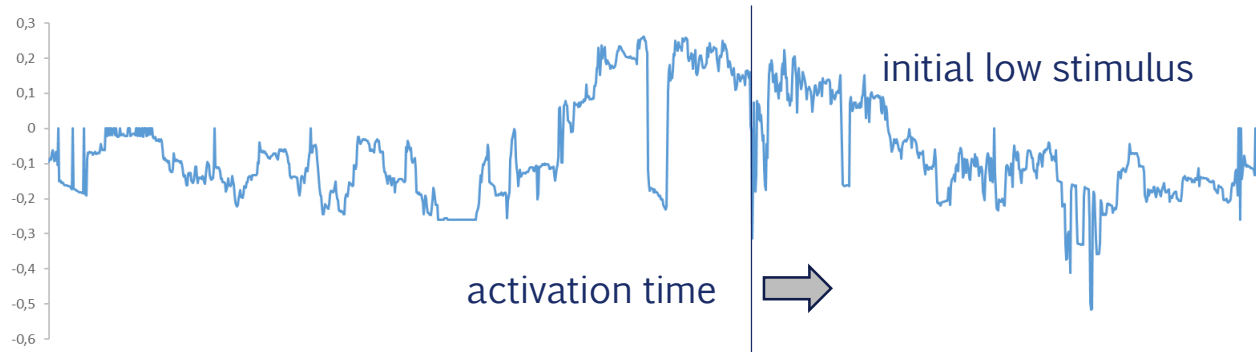
Develop Synergies



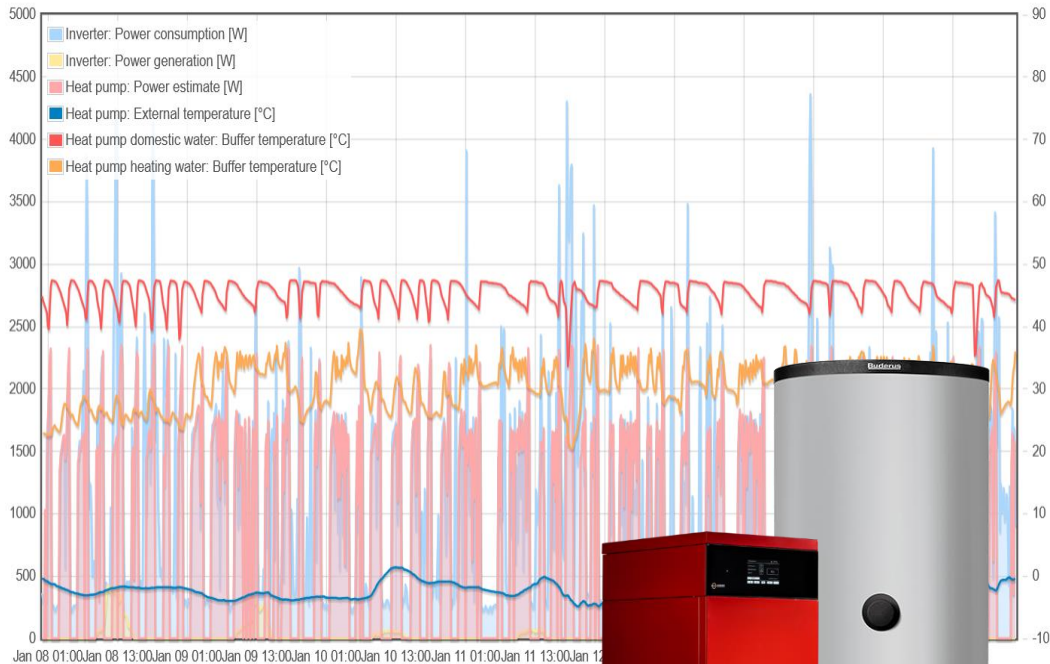
User Report Consumer Engagement and Life Test



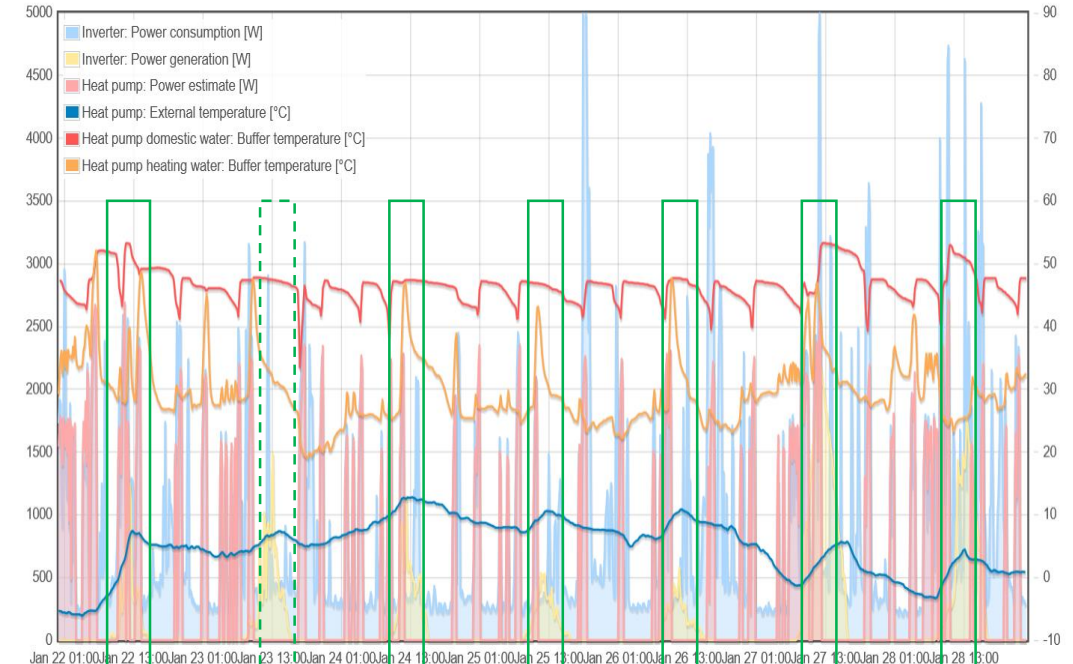
prototype
user app



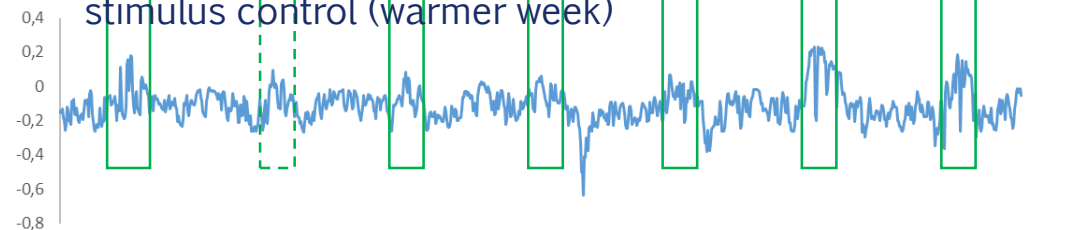
Field Test Household with PV and heat pump



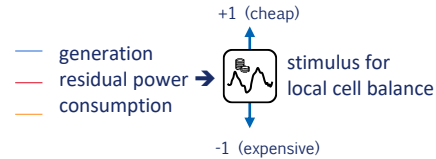
standard control (cold week)



stimulus control (warmer week)



Local Stimulus (Balance Indicator) Reaction of Flexibility in Virtual Twin Test



- 15 generation units
- 14 PV rooftop plants
- 1 CHP, modulated

3 weeks in February

- 23 households
- fix consumption

- 12 heat pumps
- warm water active
- heating active

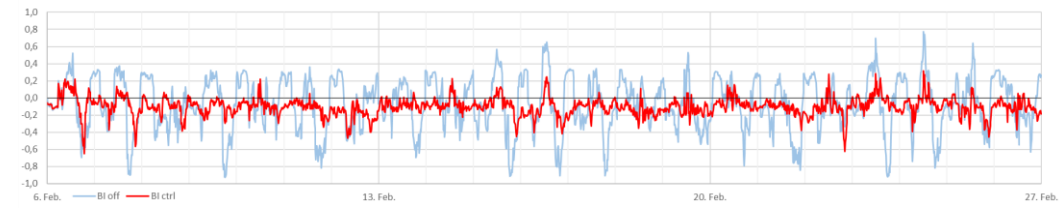
- 13 charging stations
- car plugged
- charge time window
- charging

- 23 dishwashers
- programme time window
- Operating

+ other flexible household appliances



Comparison of balance
 ■ no control with stimulus
 ■ optimized by reaction to stimulus



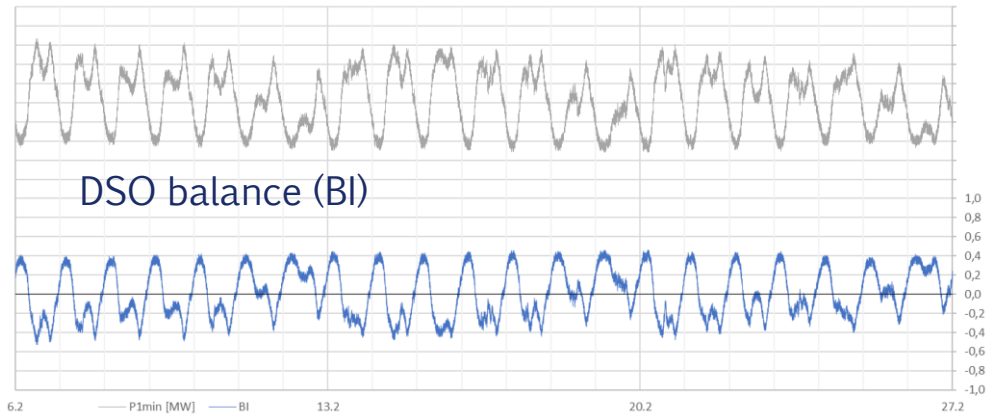
root mean square deviation
 stimulus without control $\sigma \Delta BI_{off} = 0.302$
 stimulus with control $\sigma \Delta BI_{ctrl} = 0.105$



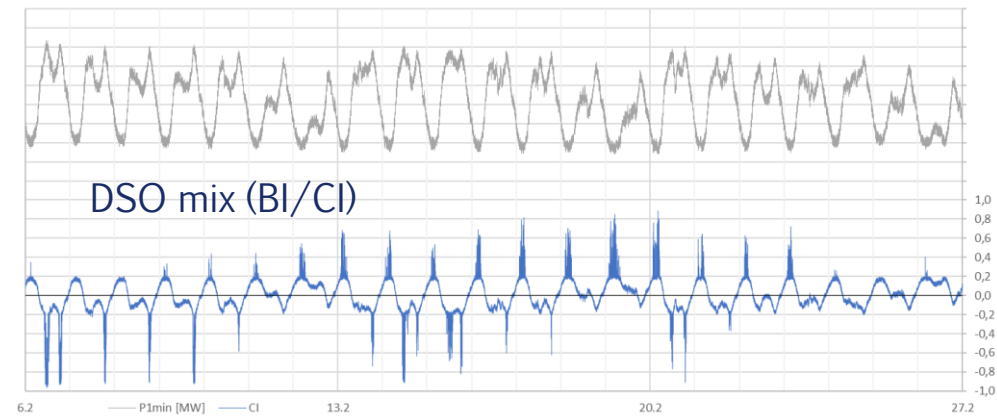
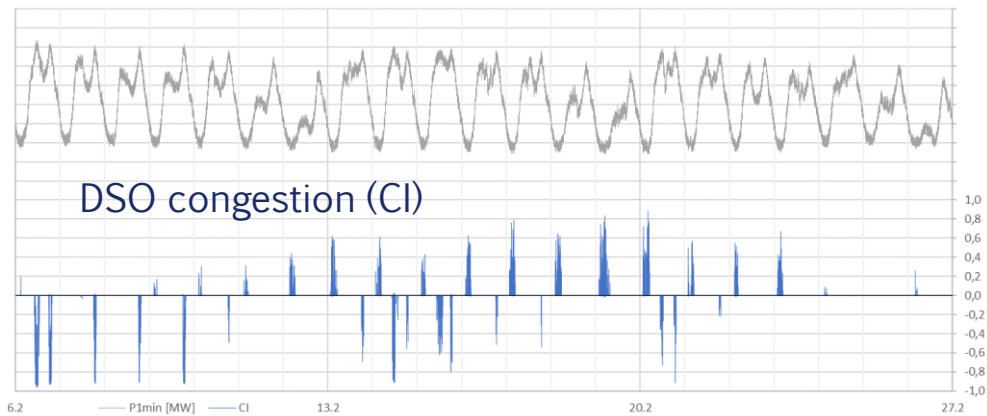
External stimuli

Stimuli types from DSO and TSO sources

risk evaluation	risk level	stimulus (CI)
decrease	very high (4)	-0.5
decrease	high (3)	-0.375
decrease	medium (2)	-0.25
decrease	low (1)	-0.125
healthy	healthy (0)	0
increase	low (1)	0.125
increase	medium (2)	0.25
increase	high (3)	0.375
increase	very high (4)	0.5

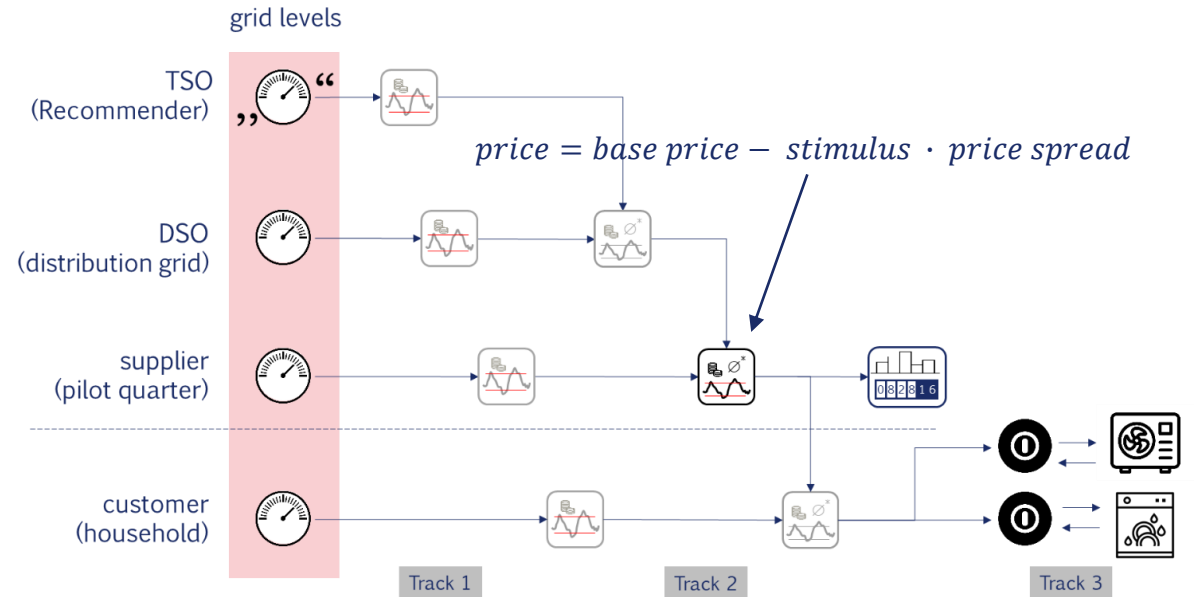
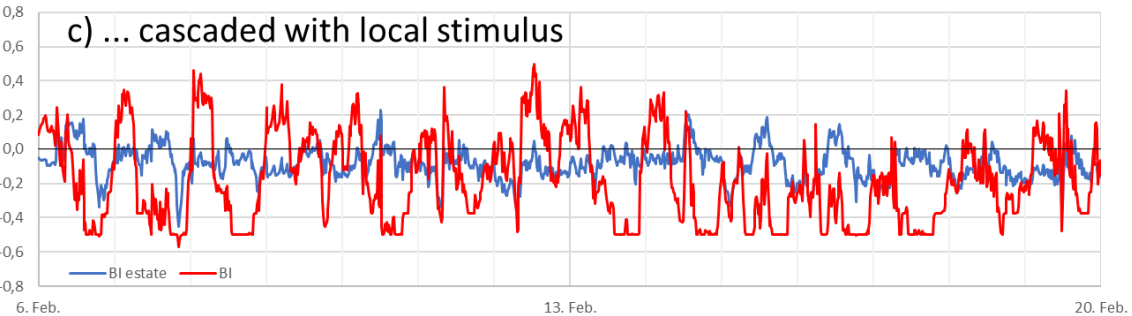
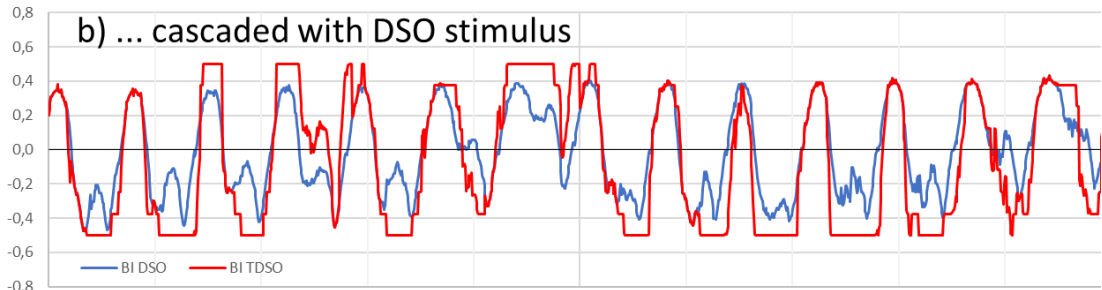
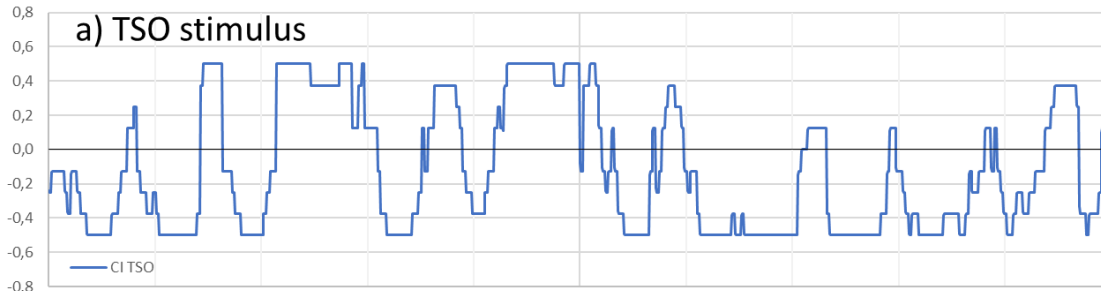


TSO recommendation (CI)



Cascading of stimuli

Weighting of grid levels, adding of prices



price stimuli are added

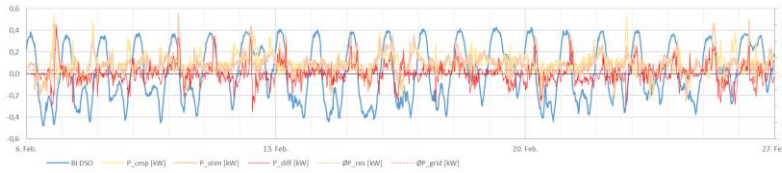
normalized stimuli are merged

- Same direction → max. abs. value
- Opposite direction → lower level weighted higher

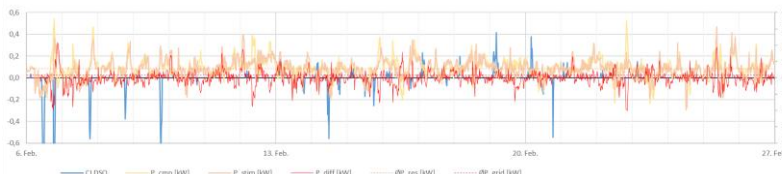
Reaction of flexibility on stimuli

Variations of external stimuli from DSO and TSO

DSO BI



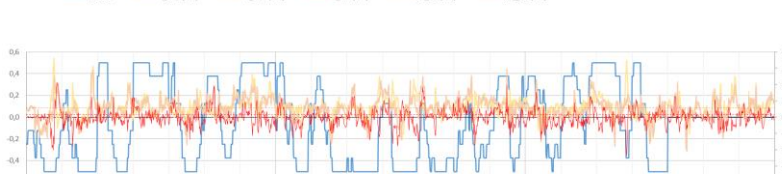
DSO CI



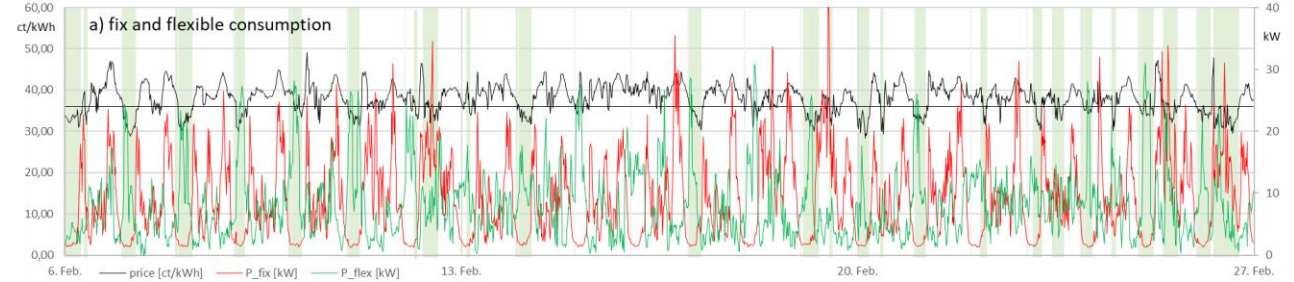
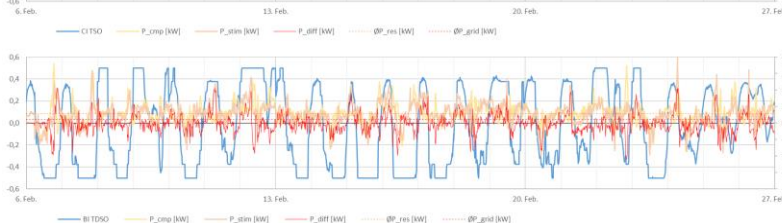
DSO BI/CI



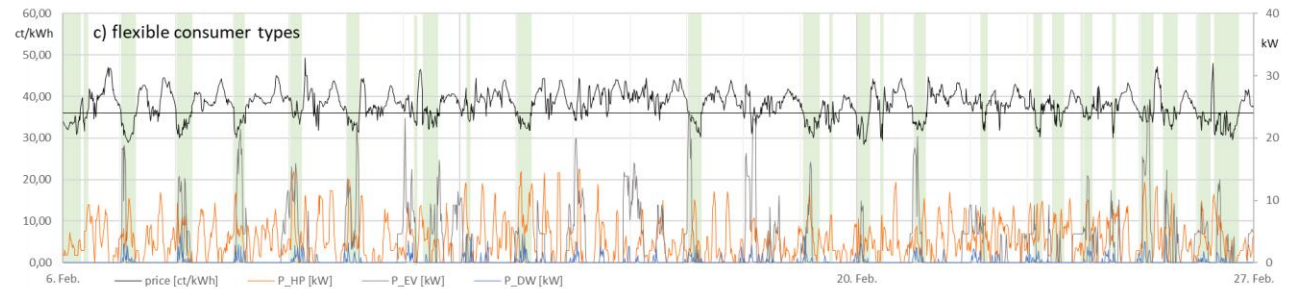
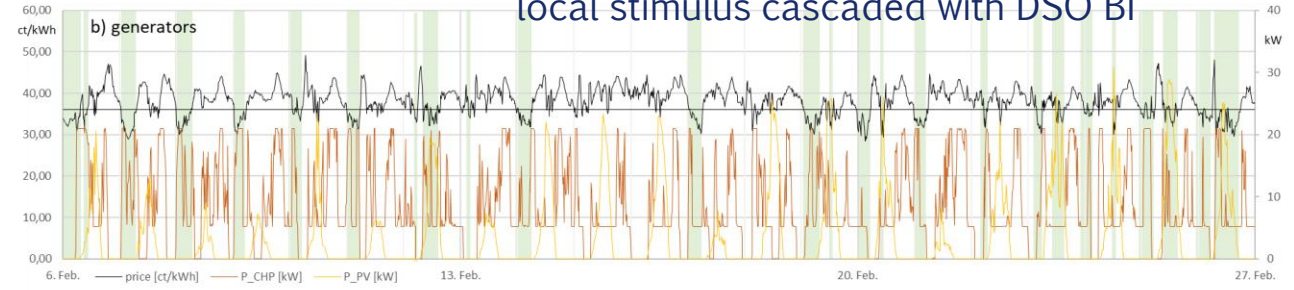
TSO CI



TSO/DSO



local stimulus cascaded with DSO BI



Reaction of flexibility on stimuli

Variations of external stimuli from DSO and TSO

	local	external stimuli				
		DSO BI	DSO CI	DSO BI/CI	TSO	DSO/TSO
Ø price [ct/kWh]						
Total consumption:	38,250	38,375	38,292	38,315	38,908	38,817
Fix consumption:	38,460	39,098	38,537	38,698	39,592	39,845
Flexible consumption:	38,017	37,564	38,017	37,876	38,126	37,652
PV generation:	36,565	36,990	36,761	36,811	37,745	37,829
CHP generation:	37,596	37,950	37,714	37,789	38,674	38,590
Heat pumps:	37,766	37,971	37,939	37,892	38,315	38,170
EV chargers:	38,508	36,548	38,425	37,874	37,387	35,971
Dishwashers:	37,687	35,921	37,406	36,832	36,526	35,393
self-consumption	95,7%	94,0%	95,4%	95,3%	93,4%	93,1%
Ø grid use [kW]	5,68	5,52	5,53	5,49	5,39	5,42
Ø stimulated power [kW]		2,28	1,89	1,00	1,33	2,10
stimulated power/grid use		41%	34%	18%	25%	39%
Ø power/price [kW/(€/kWh)]		11,38	9,43	5,02	6,65	10,51



interconnect

Thank you for your attention!



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