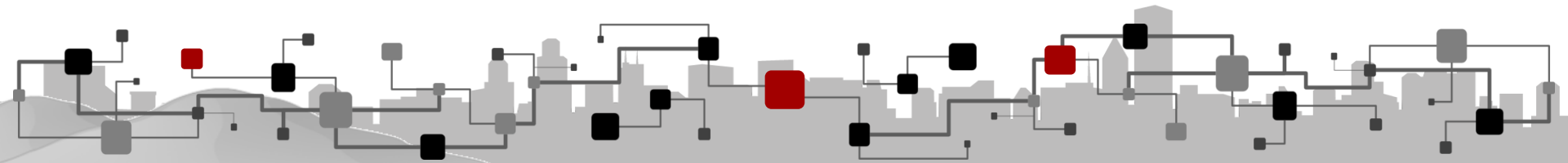
Digitalisierung im Elektrizitäts-Verteilnetz

22. März 2019

Philipp Heer - Leader ehub

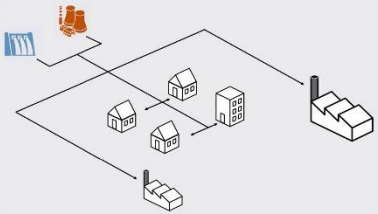
Urban Energy Systems Laboratory



Motivation

STATUS QUO

CENTRAL GENERATION

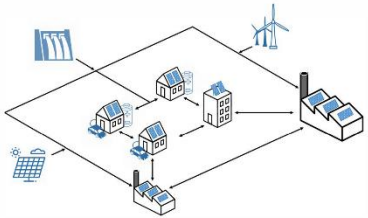


STATUS QUO

DOMINATING FOSSILE ENERGY CARRIERS

2050

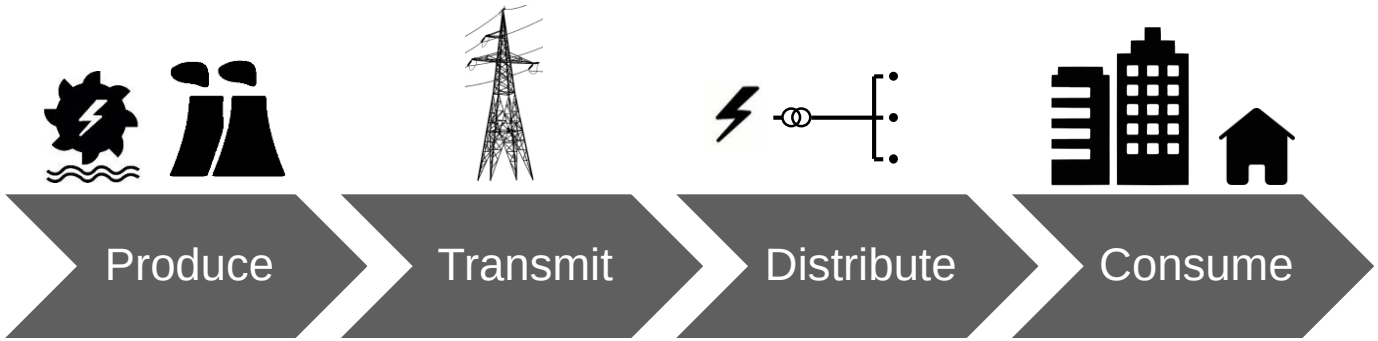
DECENTRAL GENERATION

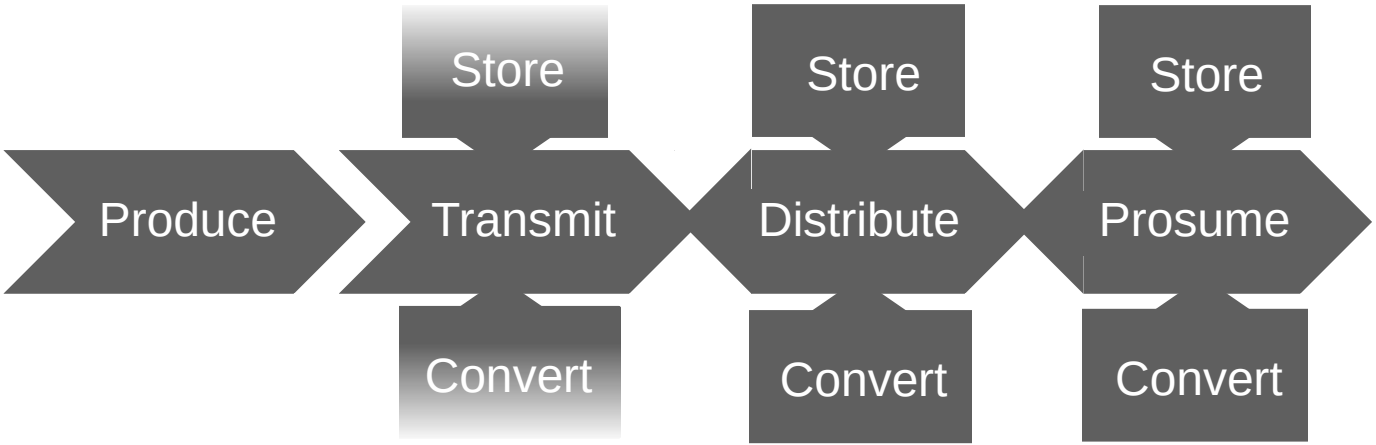


2050

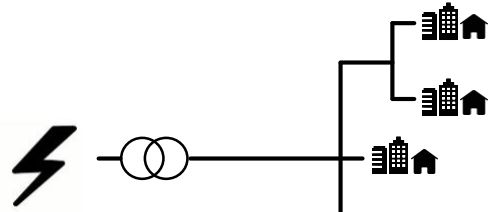
DOMINATING ELECTRICITY AS ENERGY CARRIER

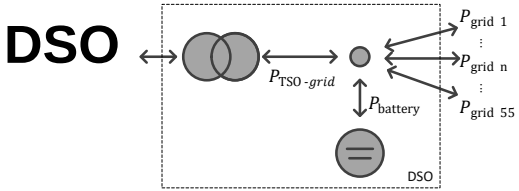
Supply Chain

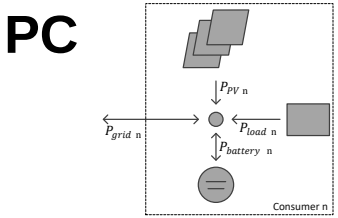




Modelling







$$P_{TSO-grid} = P_{battery} + \sum_n P_{grid\ n}$$

$$P_{grid\ n} = P_{battery\ n} + P_{load\ n} - P_{PV\ n}$$

$$\min\{|\mathrm{Cost_{kw}} * \mathrm{P_{month}}|_\infty + \varepsilon * |\mathrm{Cost_{kw}} * \mathrm{P_{month}}|_2\}$$

$$\text{s.t } |\mathrm{Cost_{kw}} * \mathrm{P_{month}}|_\infty \Leftrightarrow \min\{\max\{\mathrm{Cost_{kw}} * \mathrm{P_{month}}\}\}$$

$$\mathrm{P_{month}} = [P_{TSO-grid}(\mathrm{t} = \mathrm{t_{start\ month}}) \ldots P_{TSO-grid}(\mathrm{t} = \mathrm{t_{end\ month}})]$$

$$\min\{|\mathrm{P_{a,b}}|_\infty + \varepsilon * |\mathrm{P_{a,b}}|_2\}$$

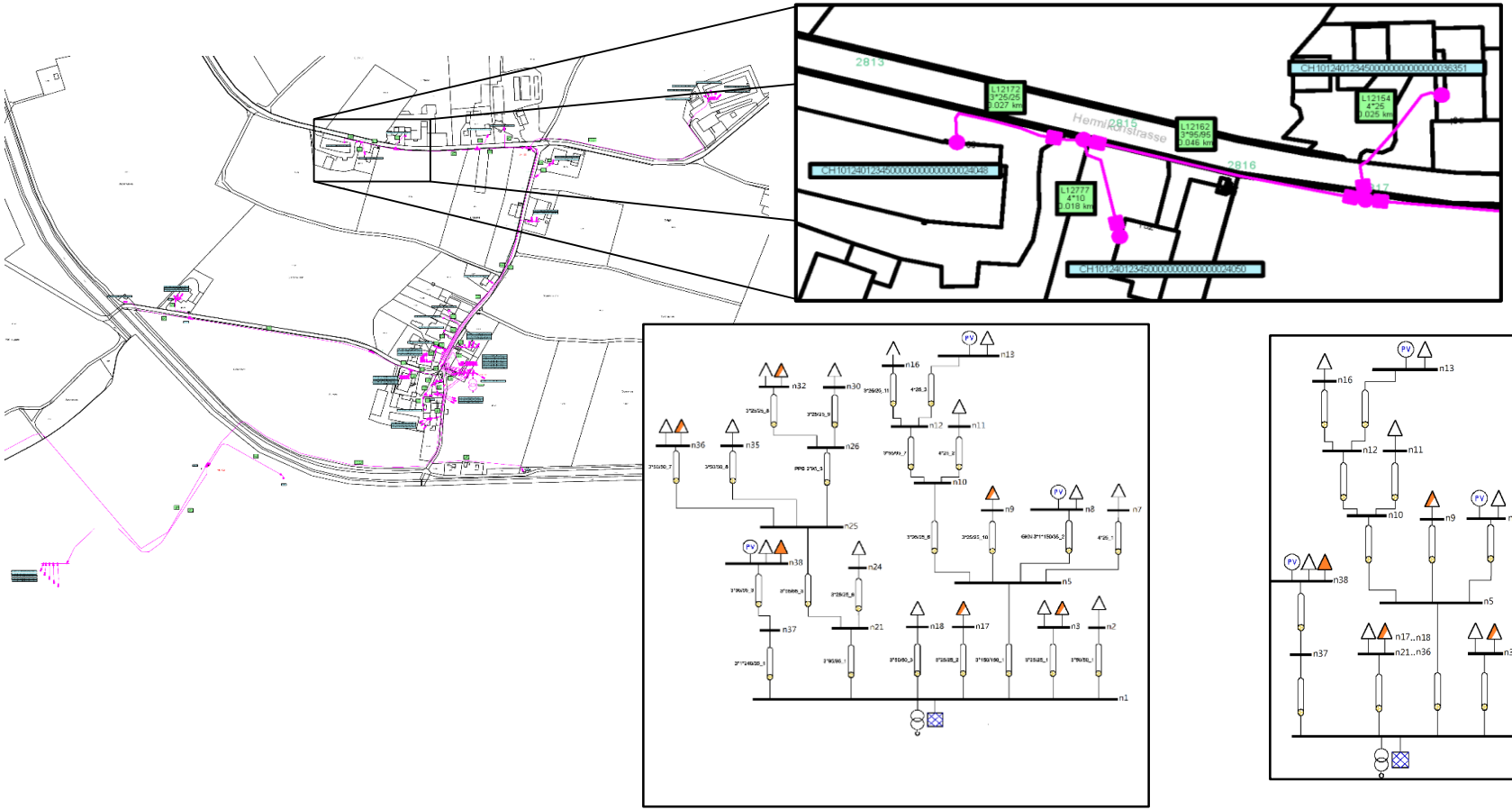
$$\text{s.t } |\mathrm{P_{a,b}}|_\infty \Leftrightarrow \min\{\max\{\mathrm{P_{a,b}}\}\}\ \forall\ (a,b) \in (n,n)$$

$$|\mathrm{P_{a,b}}| \leq \mathrm{P_{a,b\ grid\_max}}$$

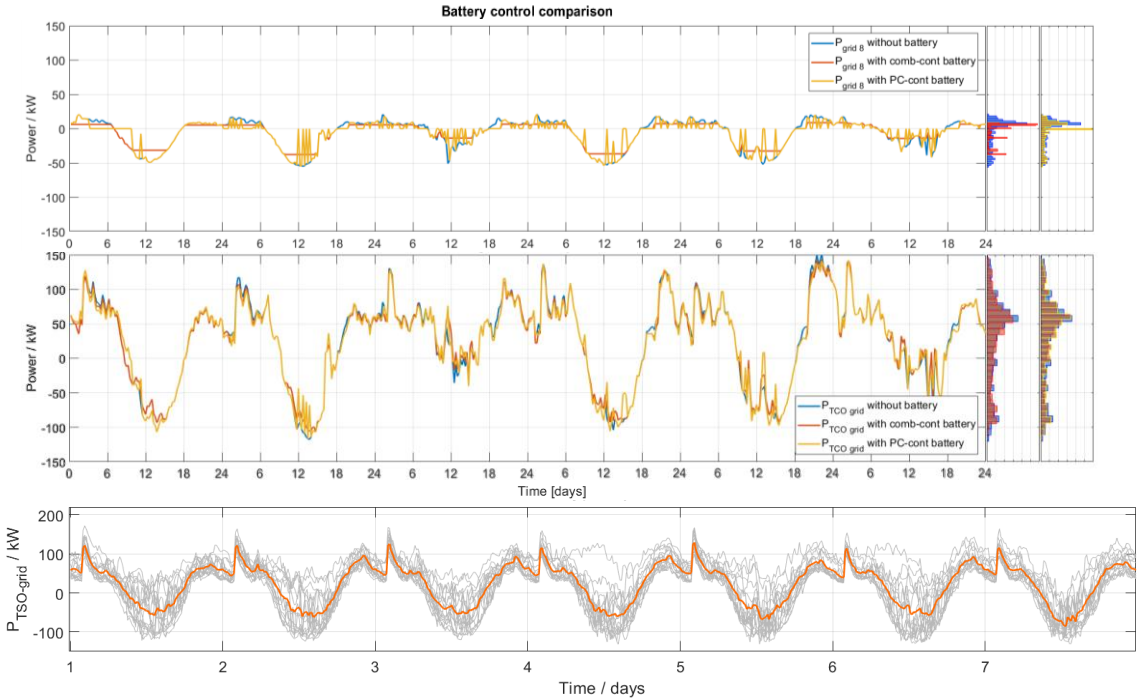
$$\min\{\mathrm{E_{cons\ cost\ n}}\} \Leftrightarrow \min\left\{\sum \begin{matrix} \mathrm{E_{grid\ n}}(t) * \mathrm{C_{feed-in}}, & \forall\ \mathrm{P_{grid\ n}}(t) \leq 0 \\ \mathrm{E_{grid\ n}}(t) * \mathrm{C_{HT/LT}}(t), & \forall\ \mathrm{P_{grid\ n}}(t) > 0 \end{matrix}\right\}$$

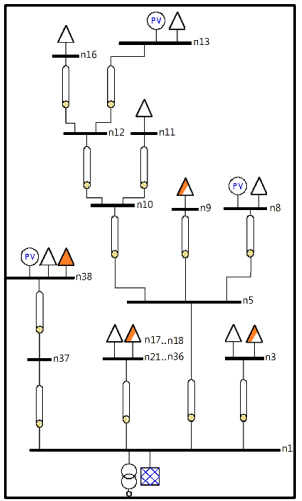
$$\mathrm{dE_{grid\ n}}(t) = \mathrm{P_{grid\ n}}(t) * dt$$

Considered grid

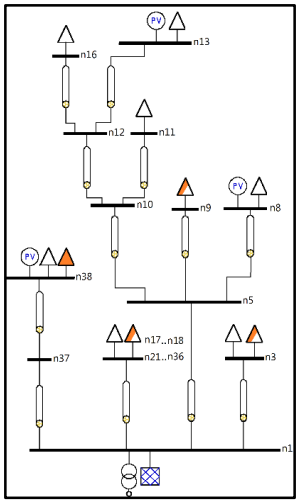


Simulation

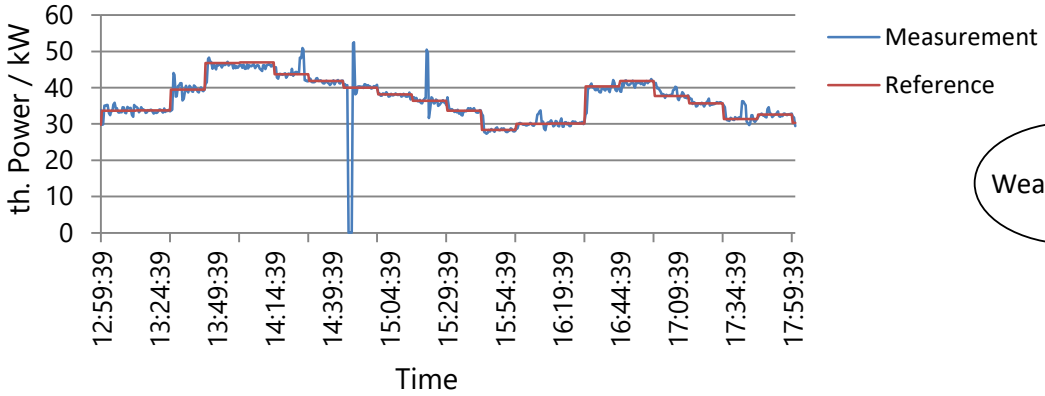

Battery control comparison
Power / kW
$P_{grid\ 8}$ without battery
$P_{grid\ 8}$ with comb-cont battery
$P_{grid\ 8}$ with PC-cont battery
$P_{TCO\ grid}$ without battery
$P_{TCO\ grid}$ with comb-cont battery
$P_{TCO\ grid}$ with PC-cont battery
Time [days]
$P_{TSO-grid}$ / kW
Time / days


PV
n16
n13
n12
n11
n10
n9
n8
n38
n5
n37
n17..n18
n21..n36
n3
n1

Conclusion



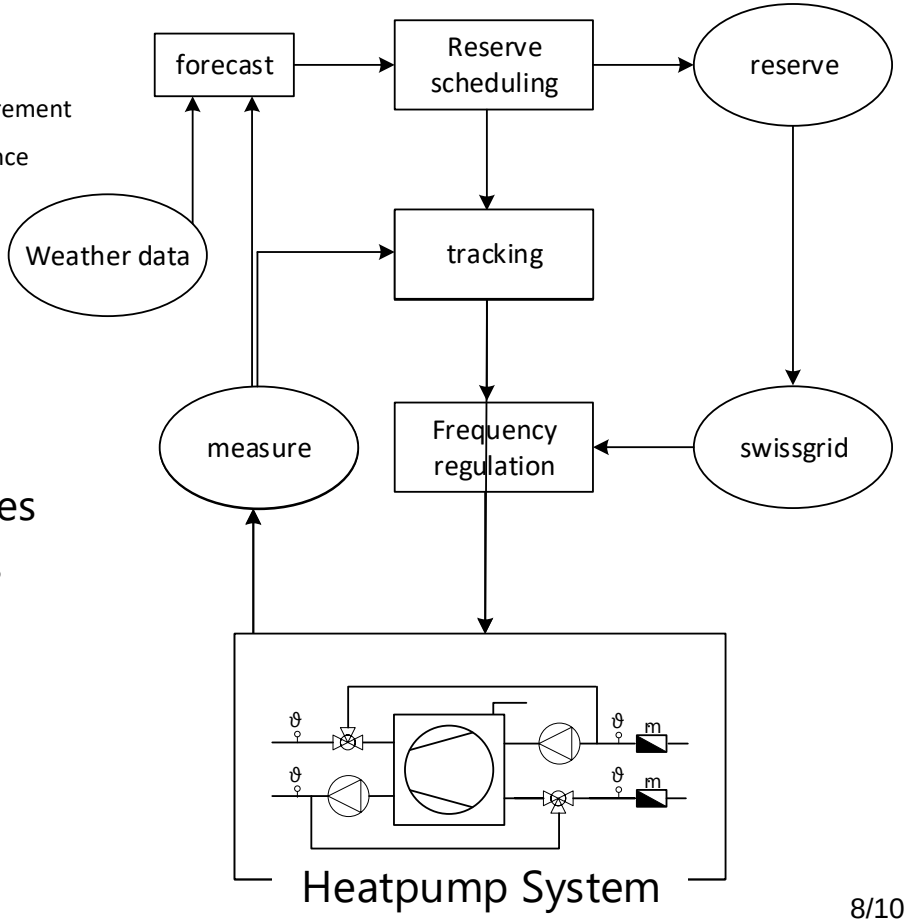
Offering grid reserves using thermal systems



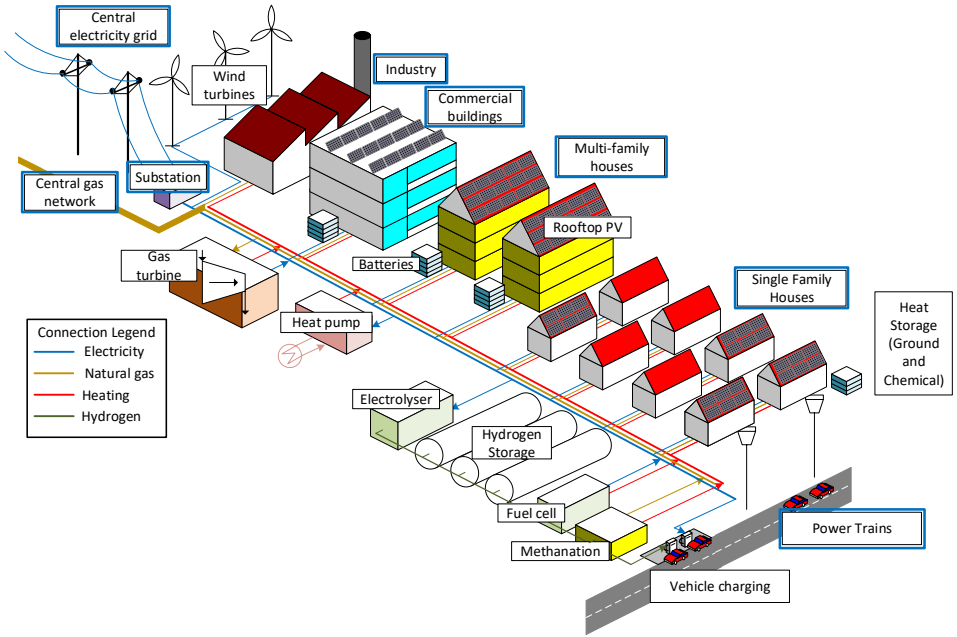
60% of HP capacity for secondary control reserves

100% of HP capacity for tertiary control reserves

- Increased income
- equal comfort
- equal energy efficiency



ehub demonstrator at Empa



Thank you for your attention!

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