SmartNet

Smart TSO-DSO interaction schemes, market architectures and ICT Solutions for the integration of ancillary services from demand side management and distributed generation

TSO-DSO interaction; the H2020 SmartNet project

The Path to the Intelligent Grid – NTU-DTU Workshop, Singapore, October 2016

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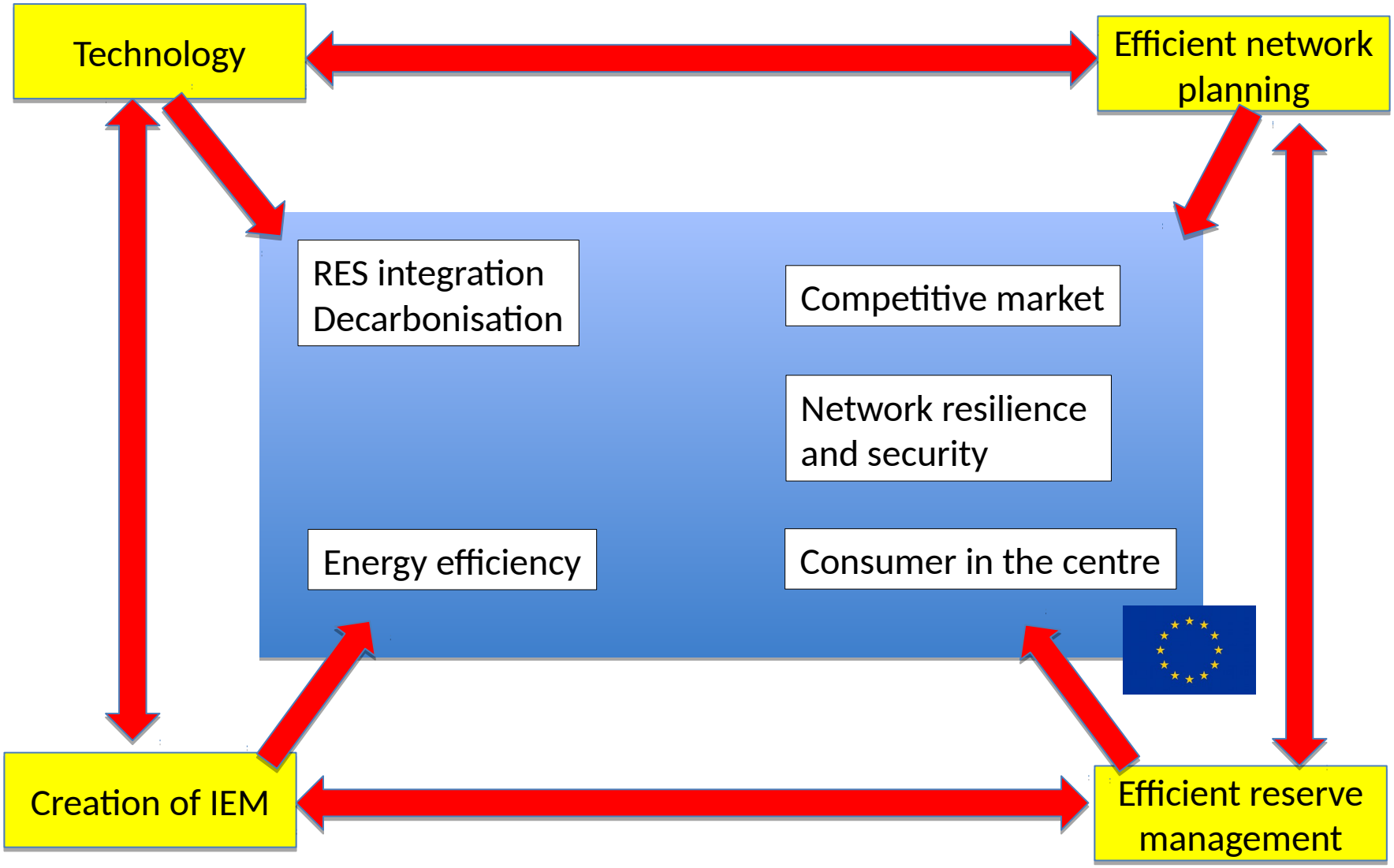
Why do we need an “intelligent grid”?



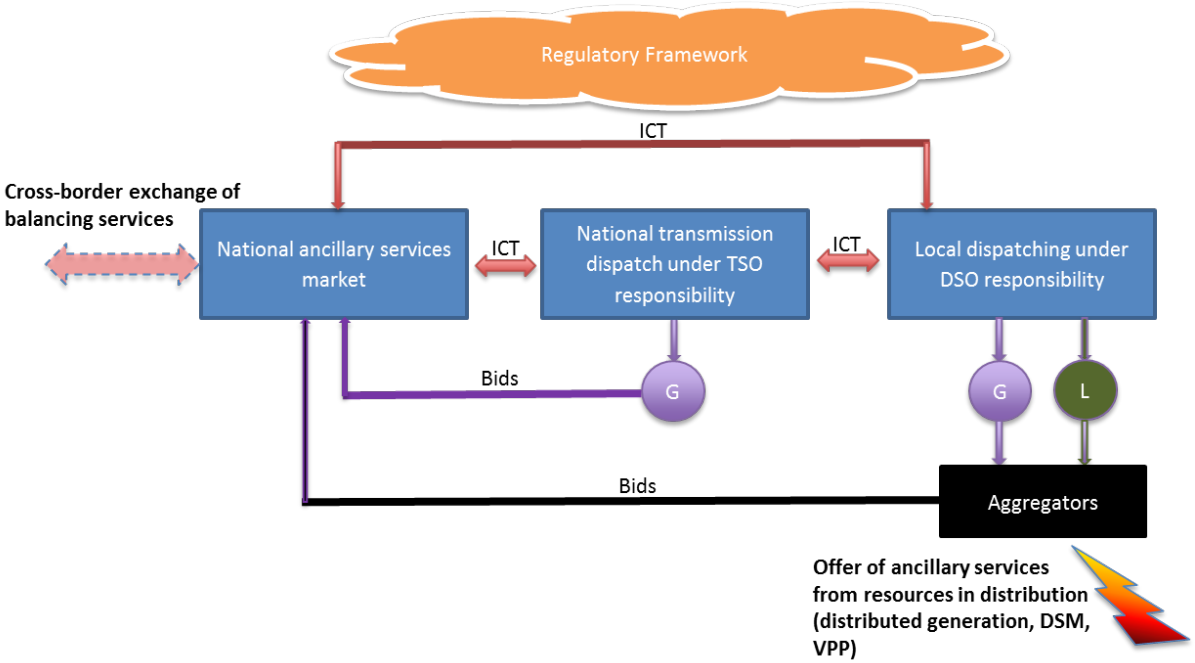
Why investigating TSO-DSO interaction?

- **In the future, distributed generation could be managed together with demand response and storage connected to distribution grids for providing services to the whole power system.**
- **Getting AS markets more efficient and enlarging the basis for AS purchase could make the system more resilient and reduce need for local reserve to compensate RES**
- **Operation of these Distributed Energy Resources (DERs) requires coordinated interfacing between TSOs and DSOs for efficient transmission and distribution grid management.**
- **DSOs, could EITHER play the role of an active subject activating DERs for the provision of local services (e.g. voltage support, congestion management) OR they could operate as facilitators for the provision of services for the whole system, being balancing markets still in TSO hands.**
- **An in-depth revision of AS market architectures is key for efficiency improvement**
- **ICT requirement should also be investigated**
- **Coupling between AS markets is the ultimate goal fixed in the NCEB by ENTSO-E for the long term.**

The SmartNet project

http://SmartNet-Project.eu

- The project SmartNet aims at comparing different **architectures for optimized interaction between TSOs and DSOs** in managing the purchase of ancillary services from subjects located in distribution.
- An *ad hoc* simulation platform is built (physical network, market and ICT) around **three national cases** (Italy, Denmark, Spain); a **CBA** is performed to assess which TSO-DSO coordination scheme is optimal for the three countries. The simulation platform is then implemented in a **full replica lab** to test performance of real controller devices.
- **Three physical pilots** are also developed to demonstrate capability to monitoring and control distribution by the TSO and flexibility services that can be offered by distribution (thermal inertia of indoor swimming pools, distributed storage of radio-base stations).



SmartNet Pilot B

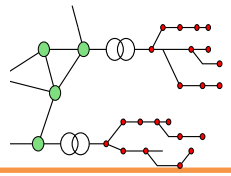
Control of Power Consumption to Summer Houses with a Pool

Services

Balancing

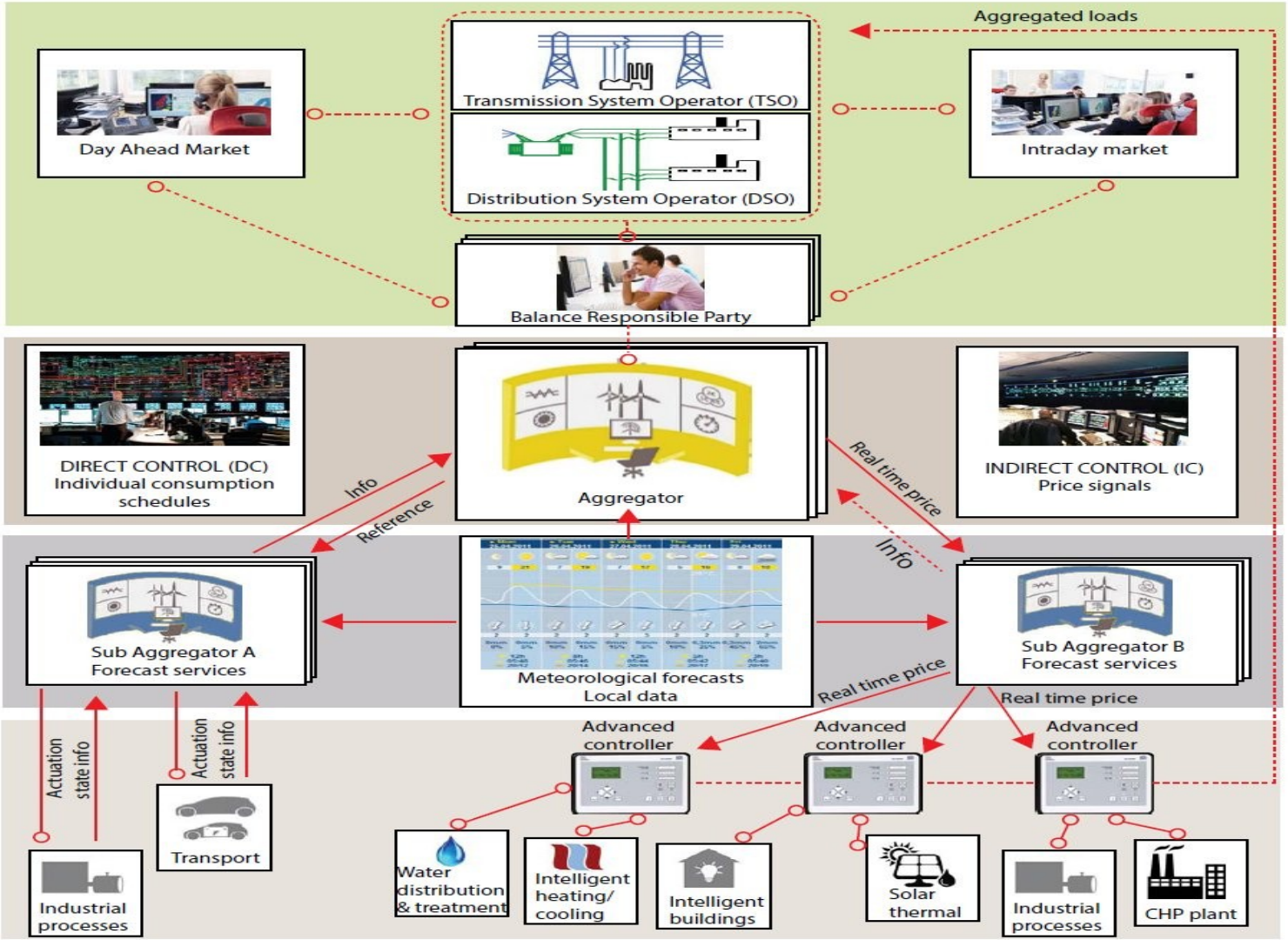
Voltage regulation (DSO)

Congestion management



- The large inertia of pools allows for shift of electricity consumption by several hours.
- Via active coordination of the flexibility below a critical node on the DSO grid.
- Active load management to help finding an optimal routing of the power.

Smart-Energy OS



Step-response function: From Price to Load

(Other alternatives exists)

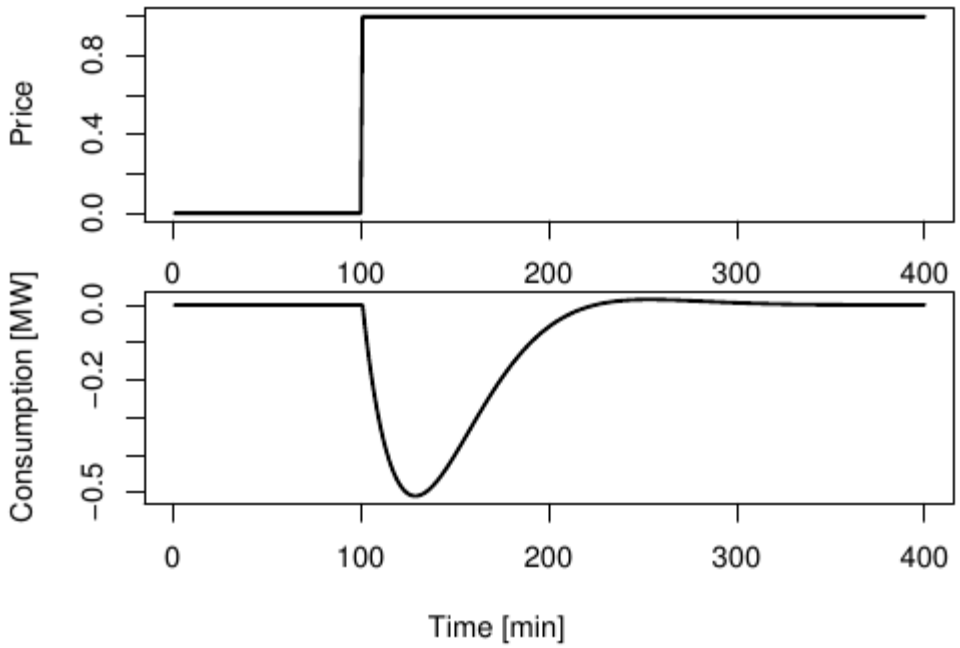


Fig. 3. Price step response in IC. The controller emitting a price signal is able to influence an aggregate of price-responsive simulated DERs.

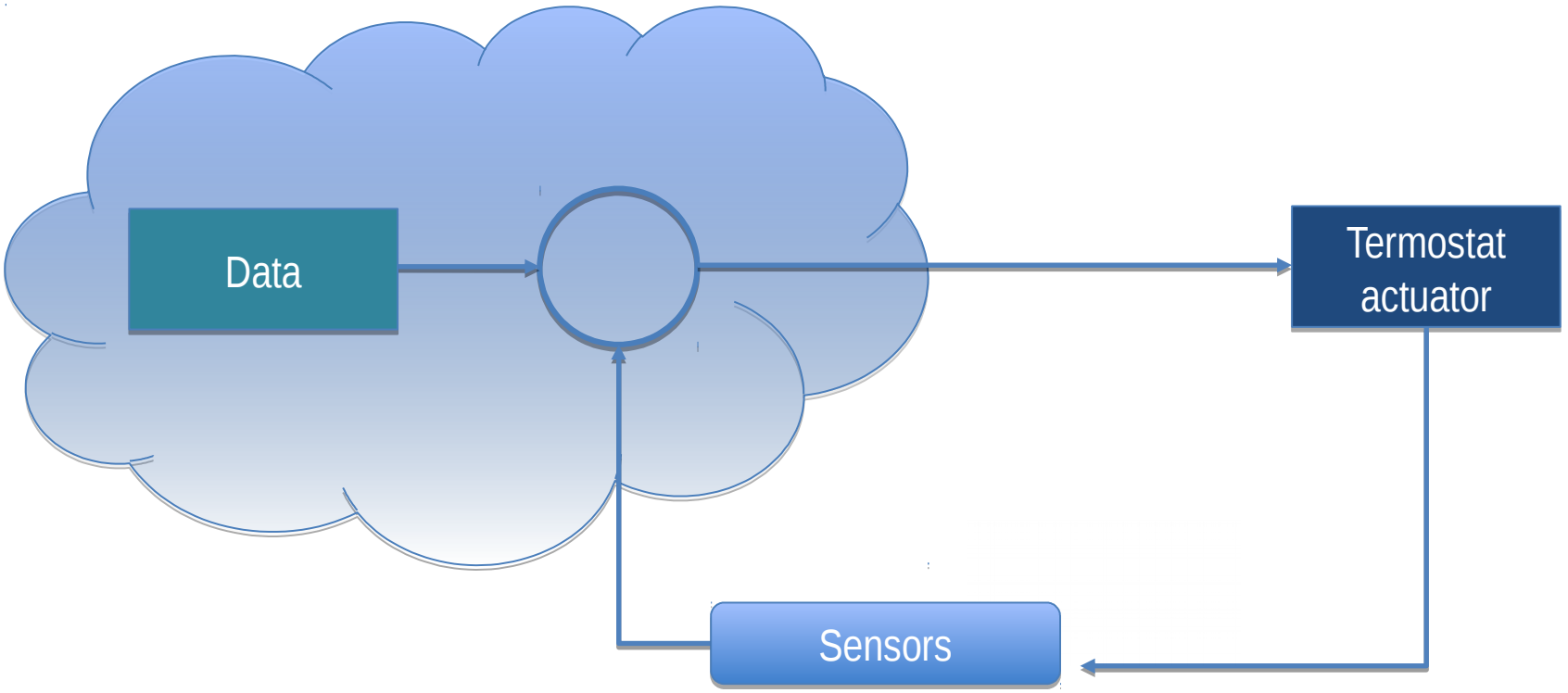
Sub-aggregator object function for Load Balancing

(Easy to change if the goal is different – eg to reduce peak load)

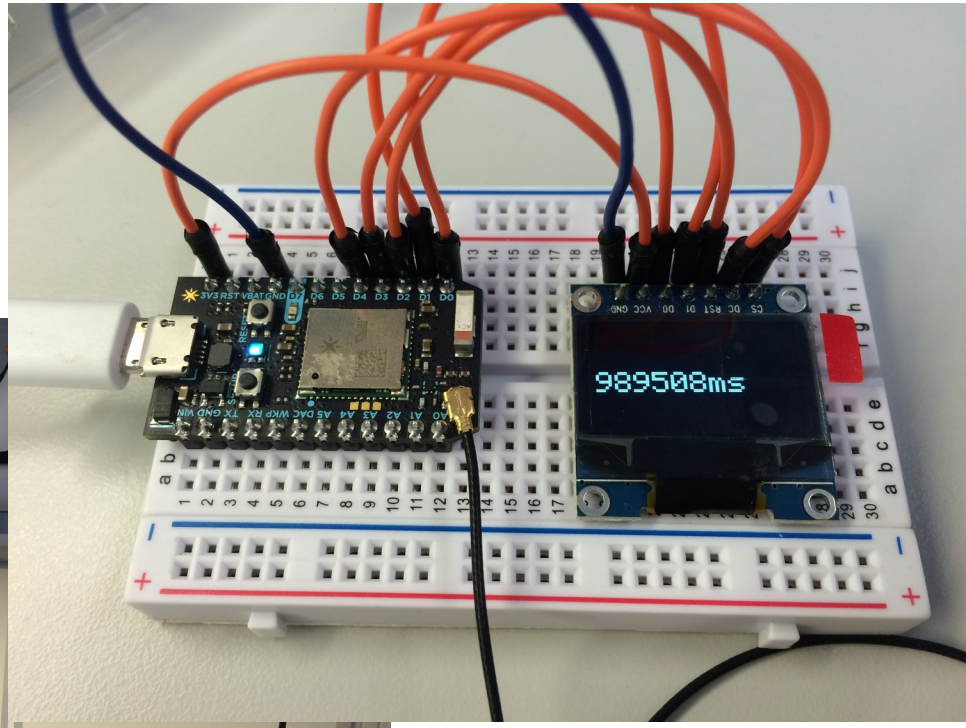
$$\min_{p,z} \quad \frac{1}{2}\sum_{k=0}^{N-1} ||z_k - z_k^{ref}||_Q^2 + ||\Delta p_k||_R^2 \qquad (5a)$$

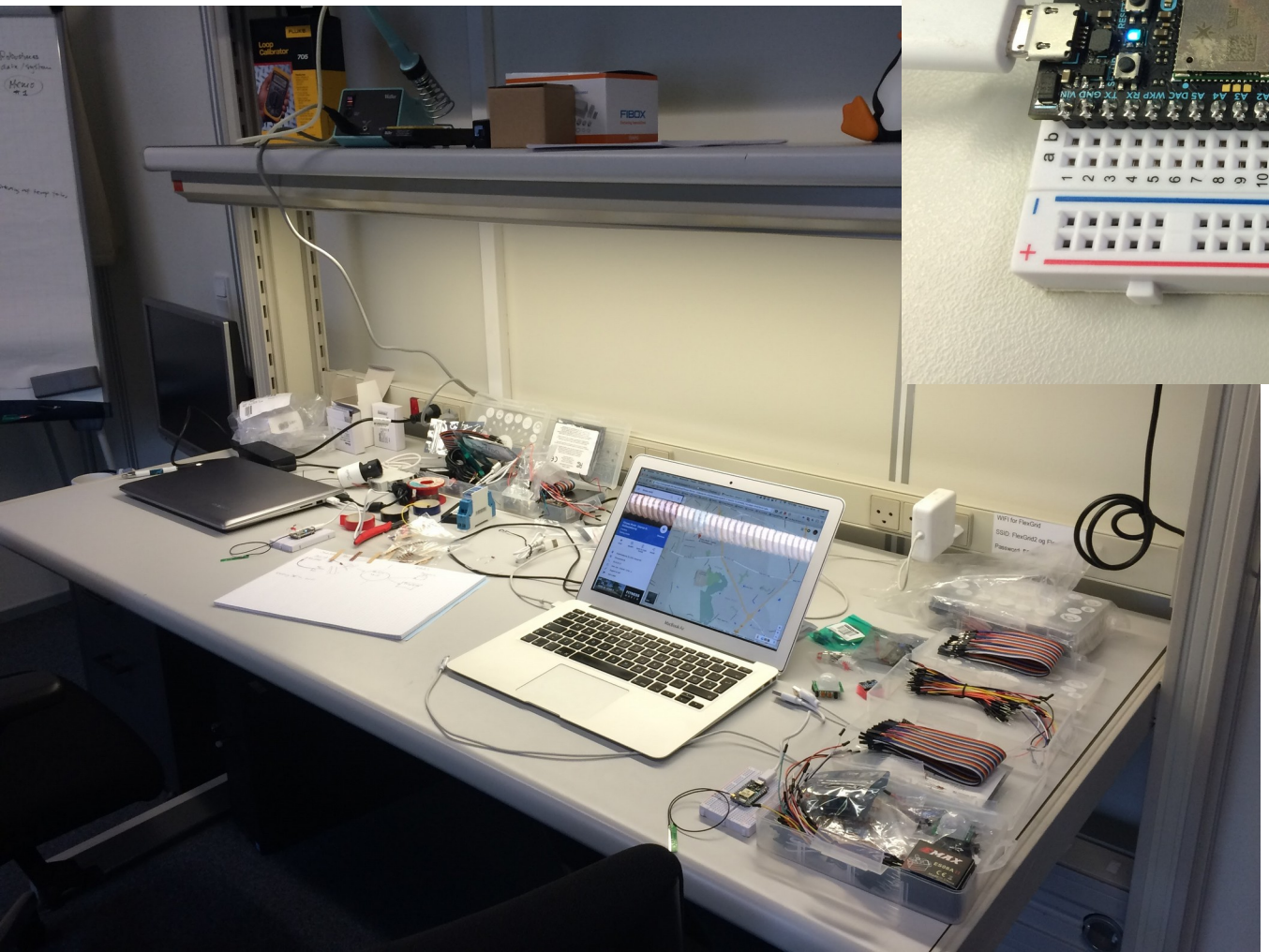
$$\text{Subject to} \quad z_{k+1} = z_k(p_k, d_k) + g_k(z_k, d_k) \qquad (5b)$$

SE-OS
Control loop design – **logical drawing**

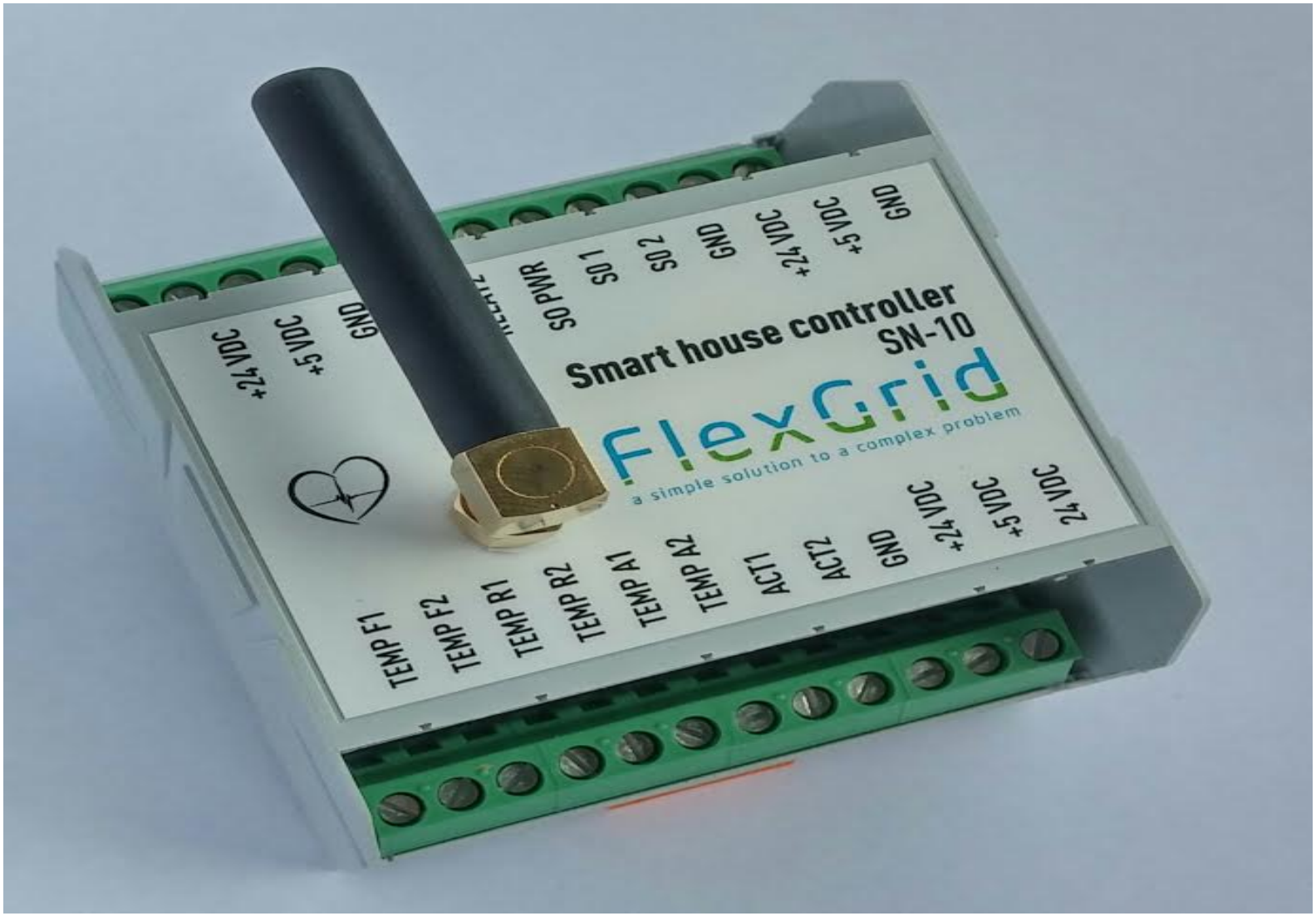


Lab testing ….





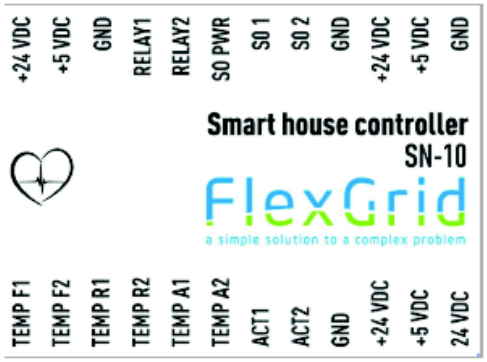
SN-10 Smart House Prototype

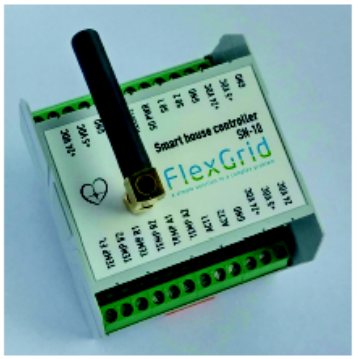


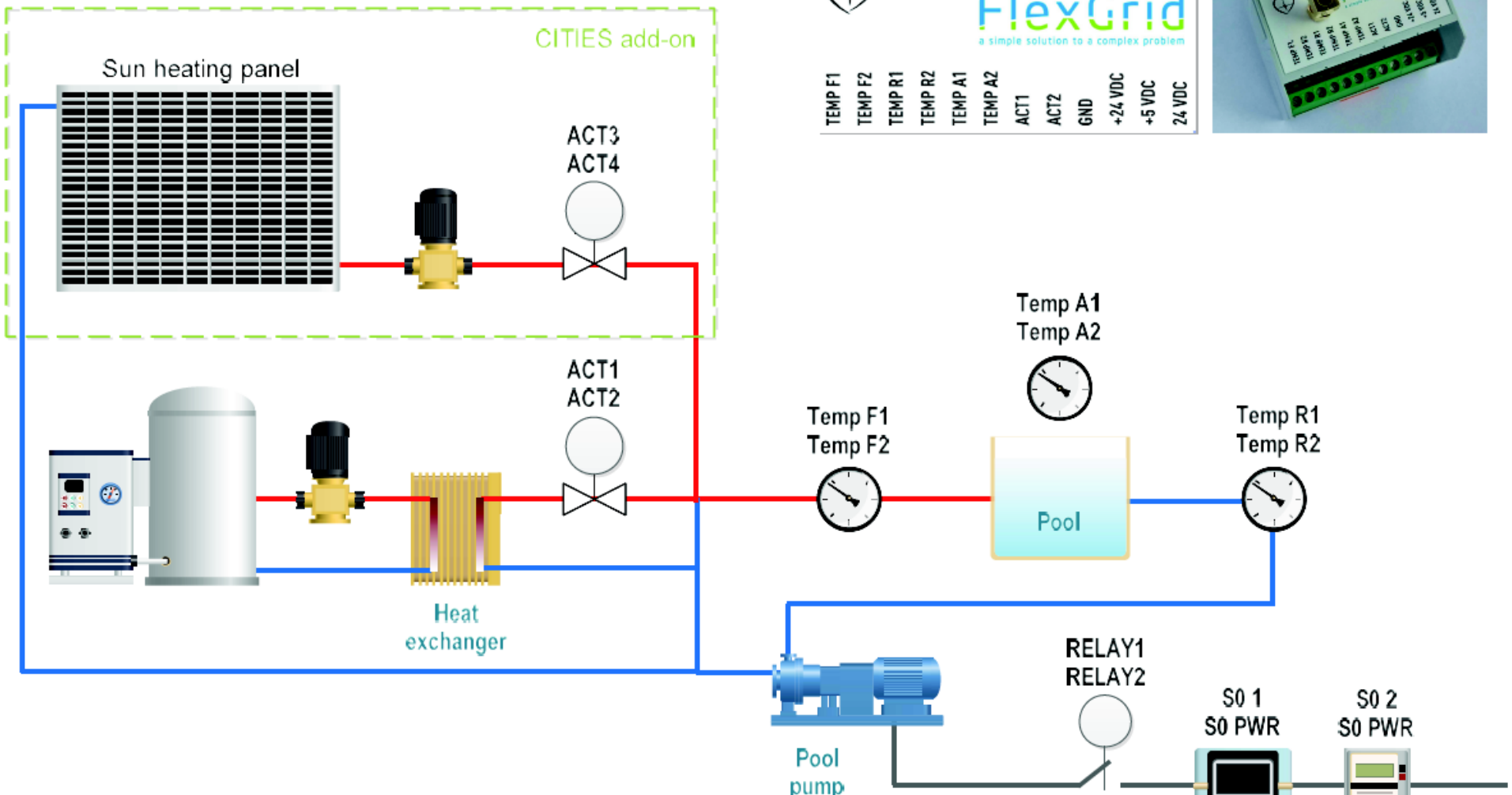
Smart Control of Houses with a Pool

PilotB SN-10 signal overview

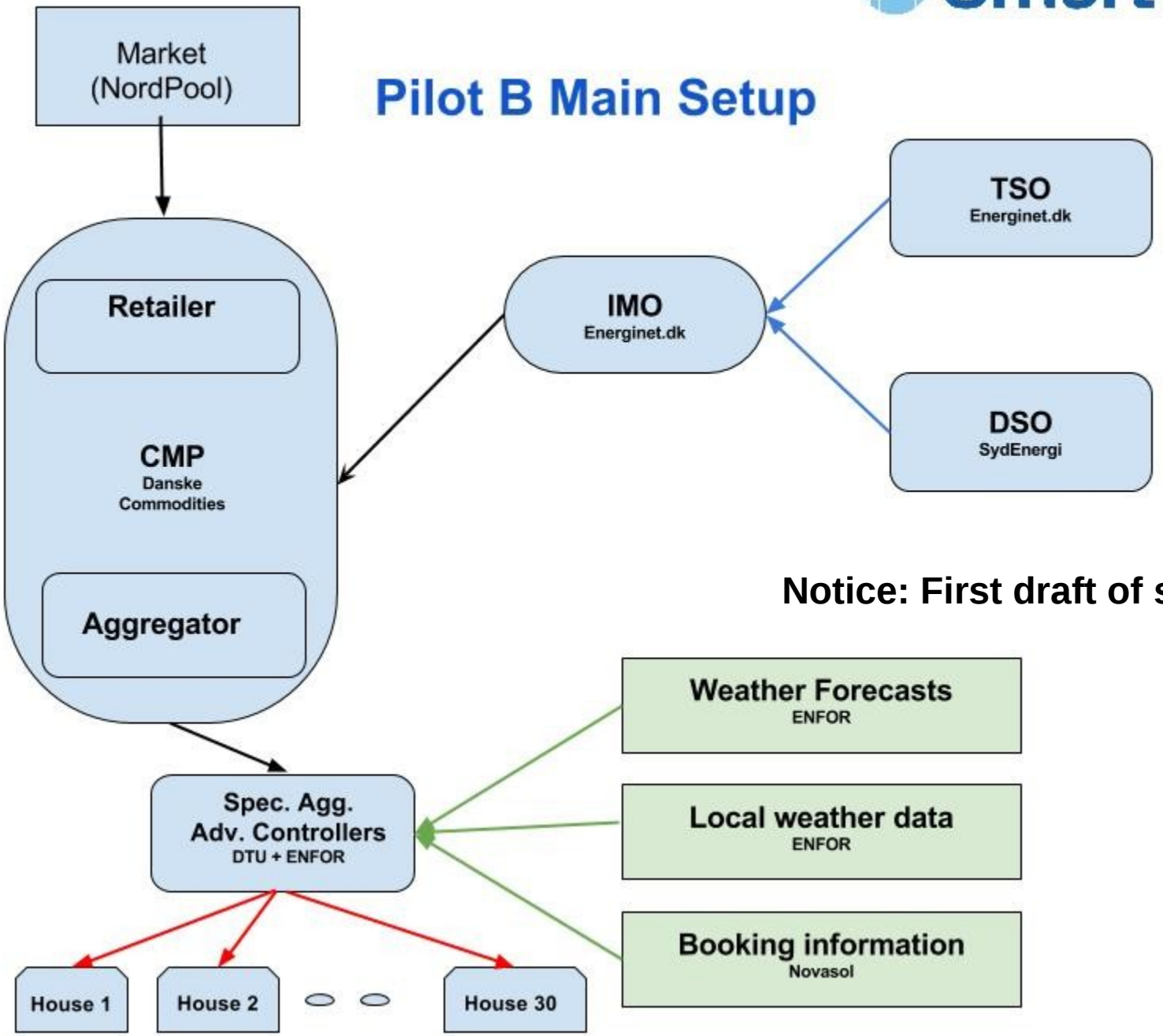
revision 1.0 (CITIES add-on)





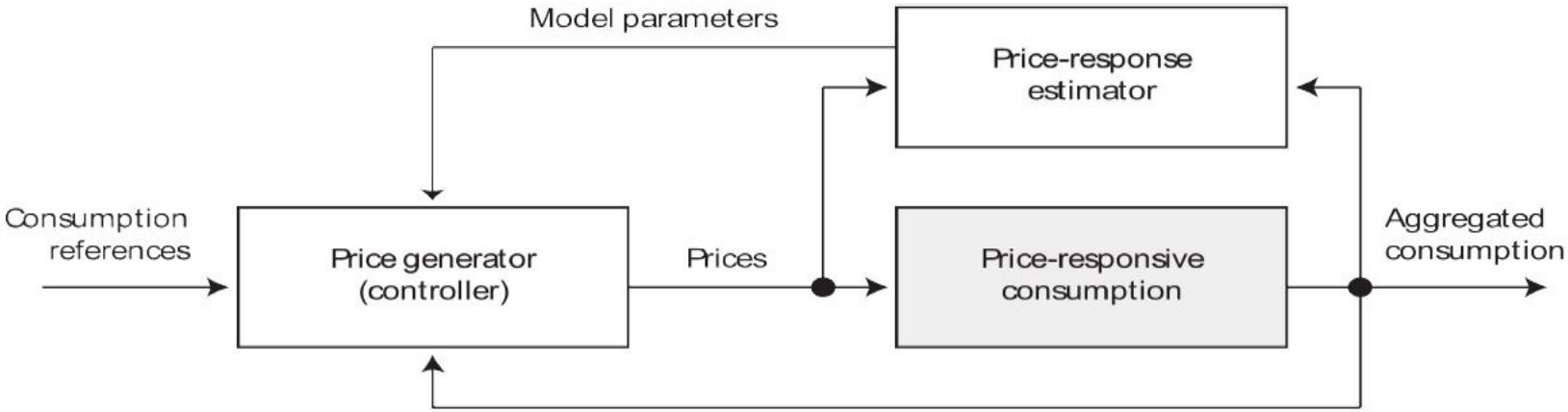


Pilot B Main Setup



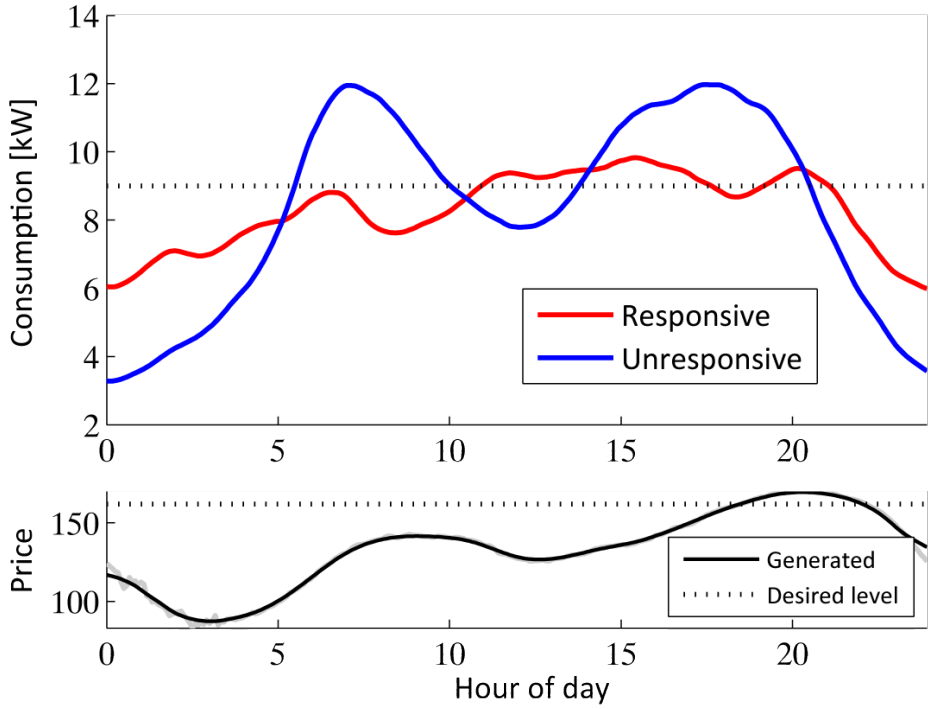
Notice: First draft of setup

Control of Power Consumption



Control performance

Considerable **reduction in peak consumption**



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