

# **Introduction of the 3Smart project: An integrated energy management system for buildings, energy grids and major city infrastructures in the Danube region**

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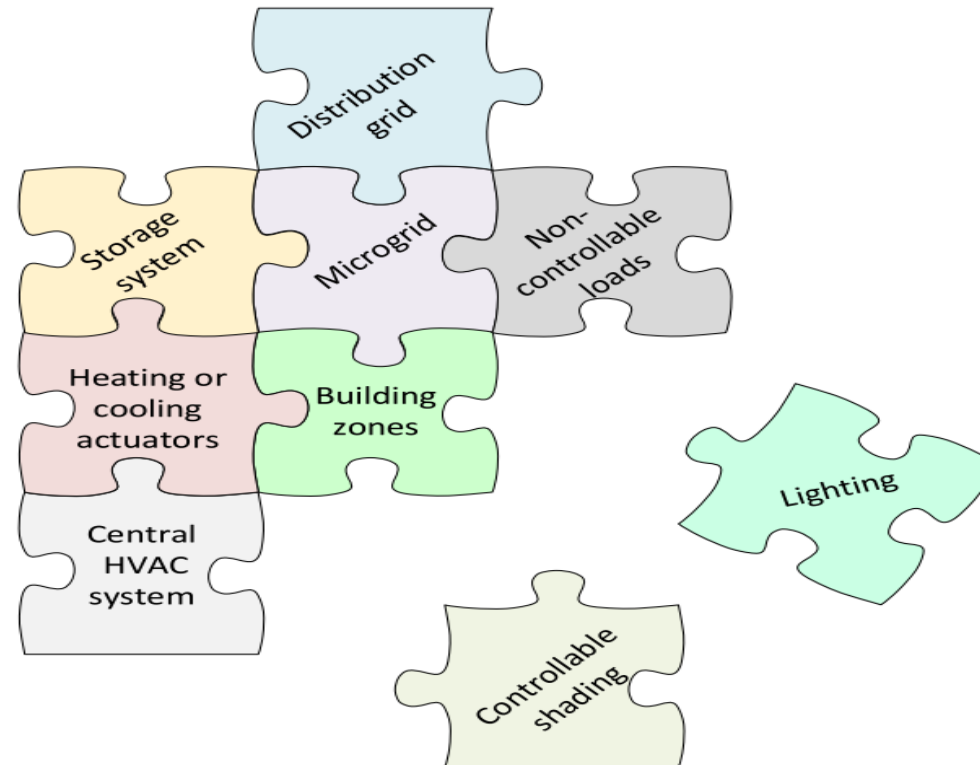
# The 3Smart project

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- Integrated real-time energy management of buildings and energy distribution grids, including demand response

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- Integrated real-time energy management of buildings and energy distribution grids, including demand response
  1. Modular software tool applicable to different buildings and grids configurations



# The 3Smart project

- Integrated real-time energy management of buildings and energy distribution grids, including demand response
  2. Pilots in 5 different countries of the Danube region comprising buildings and electricity distribution grids; CBAs and tool demonstration



# Pilot buildings and grids



UNIZGFER skyscraper on  
HEP grid (HR)



HEP building on HEP grid  
(HR)



EON building on EON grid  
(HU)



School and sports centre in  
Idrija on ElektroP grid (SI)



Retirement and care center  
Strem on EnergyG grid (AT)



School in Strem on EnergyG  
grid (AT)



EPHZHB building  
Tomislavgrad on EPHZHB  
grid (BIH)

# The 3Smart project

- Integrated real-time energy management of buildings and energy distribution grids, including demand response
  3. Strategy for removal of regulatory and other barriers related to real-time integrated energy management of buildings and grids including demand response
  4. Smart city upscale (including water distribution system, smart transport, etc.)





# 3Smart basic facts

- Lead partner: University of Zagreb Faculty of Electrical Engineering and Computing
- 9 ERDF partners (from Croatia, Slovenia, Austria, Hungary)
- 3 IPA partners (from Serbia and Bosnia and Herzegovina)
- 5 ASPs (from Croatia, Slovenia, Bosnia and Herzegovina, Hungary)
- 1/1/2017-31/12/2019
- Budget: 3.79 M€
- EU funds: 3.21 M€  
(through Danube Transnational Programme)

 University of Zagreb Faculty of Electrical Engineering and Computing	ERDF	 University of Belgrade Faculty of Mechanical Engineering	IPA
 Hrvatska elektroprivreda d.d.	ERDF	 JP Elektroprivreda Hrvatske Zajednice Herceg Bosne	IPA
 E 3, ENERGETIKA, EKOLOGIJA, EKONOMIJA, d.o.o.	ERDF	 University of Mostar Faculty of Mechanical Engineering, Computing and Electrical Engineering	IPA
 Municipality Idrija	ERDF		
 Elektro Primorska d.d.	ERDF		
 European Centre for Renewable Energy Güssing Ltd.	ERDF	 Croatian Energy Regulatory Agency	ASP
 Municipality of Strem	ERDF	 Jožef Stefan Institute	ASP
 Energy Güssing Ltd.	ERDF	 Goriška Local Energy Agency	ASP
 University of Debrecen	ERDF	 Regulatory Commission for Energy in Federation of Bosnia and Herzegovina	ASP
 E.ON Tiszántúli Áramhálózati Zrt.	ERDF	 Hungarian Energy and Public Utility Regulatory Authority	ASP

# Overview

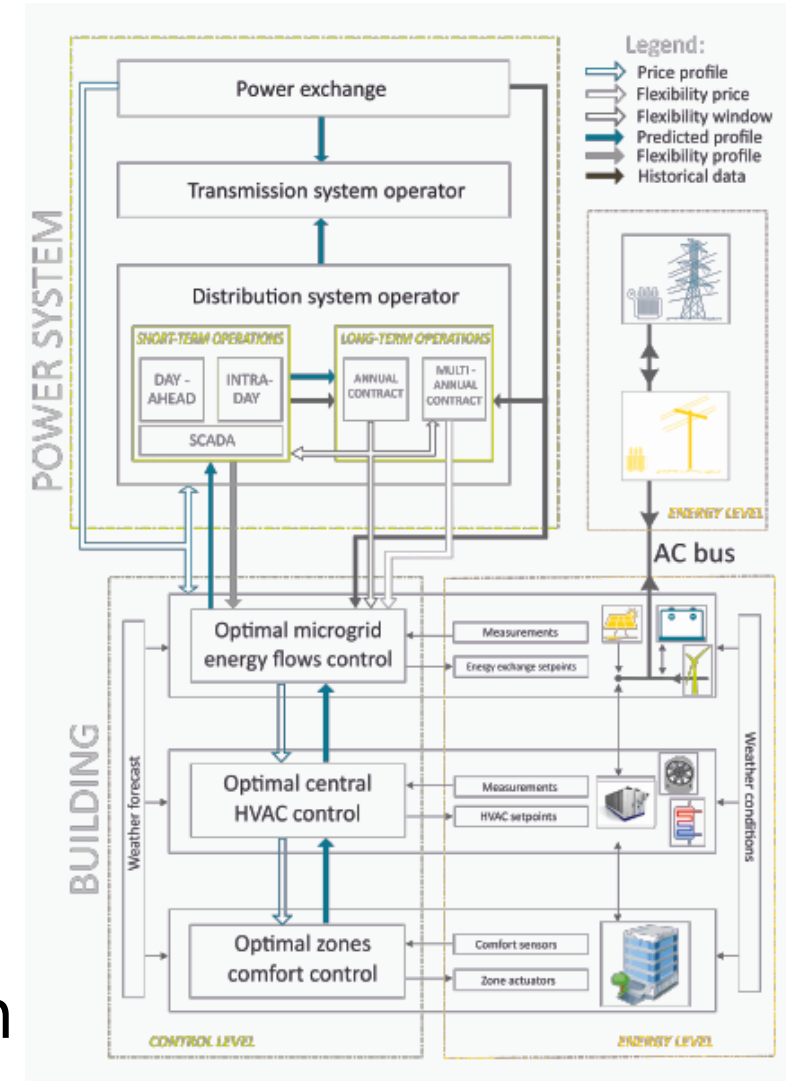
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- Technical part of 3Smart
- Regulatory Analysis and proposals



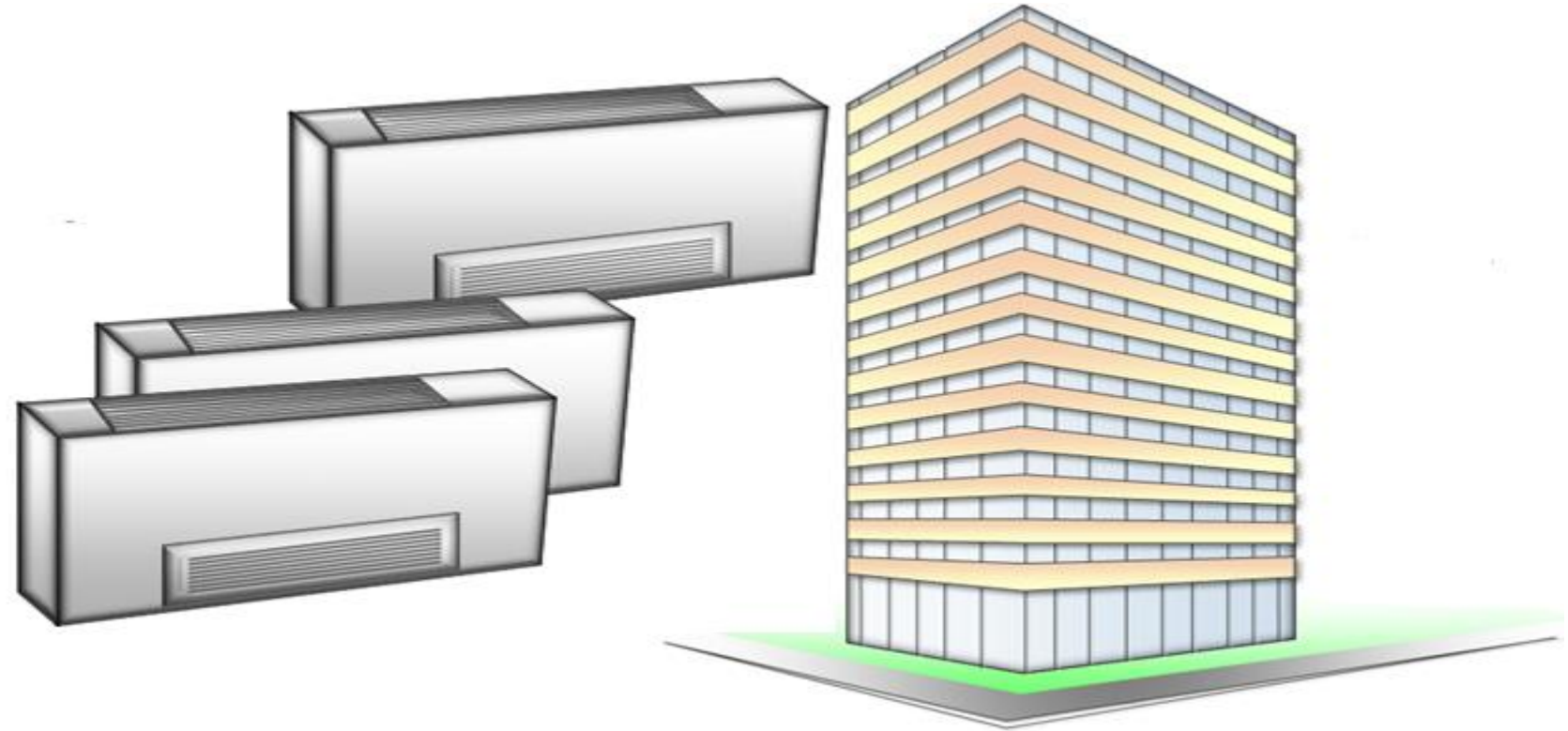
# Overall outlook of the 3Smart platform

- Software modules
- Add-on to the existing automation systems in buildings and grids
- Operate building and grid elements to minimize costs, including exploitation of demand response opportunities
- Respect comfort and equipment constraints
- Operable in different configurations which can be selected based on projected costs of needed interventions and expected benefits in operation



# Typical commercial buildings

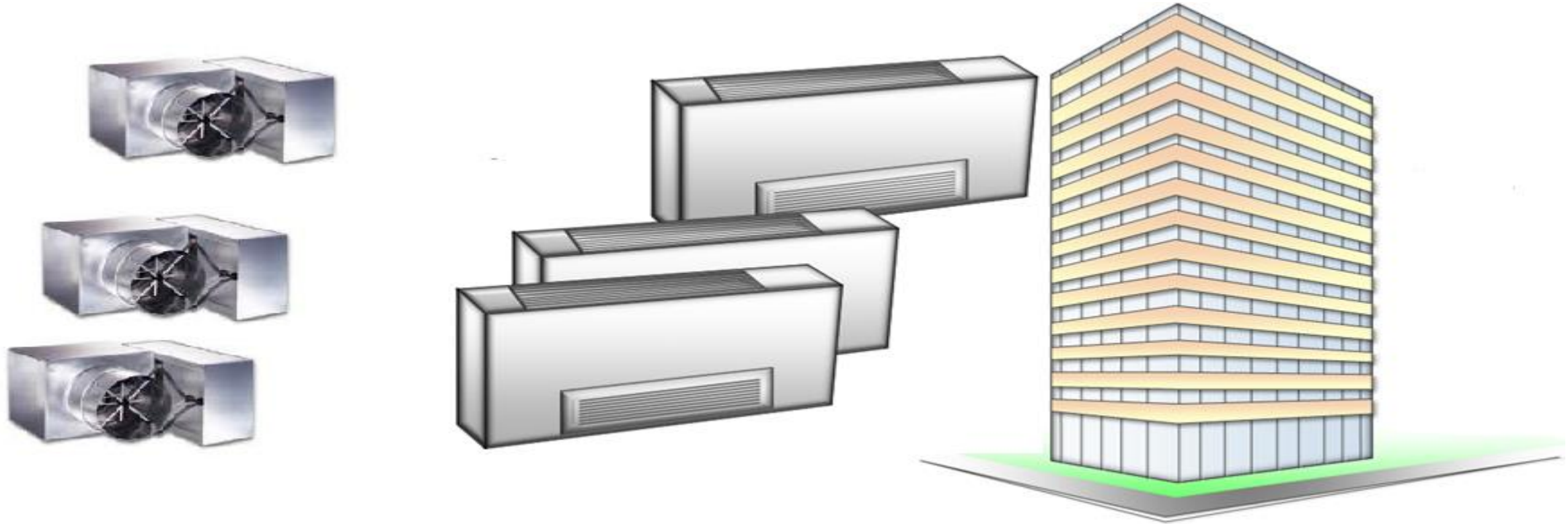
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Comfort actuators in rooms: fan coils

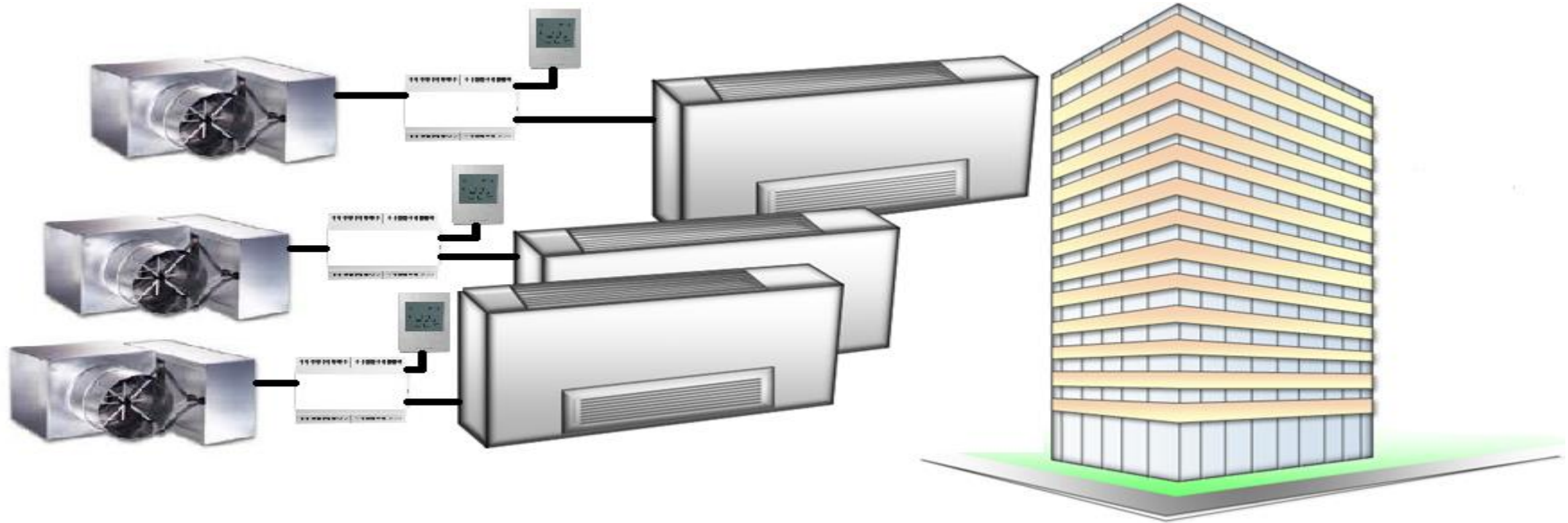
# Typical commercial buildings

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Comfort actuators in rooms: fan coils, VAV boxes or both

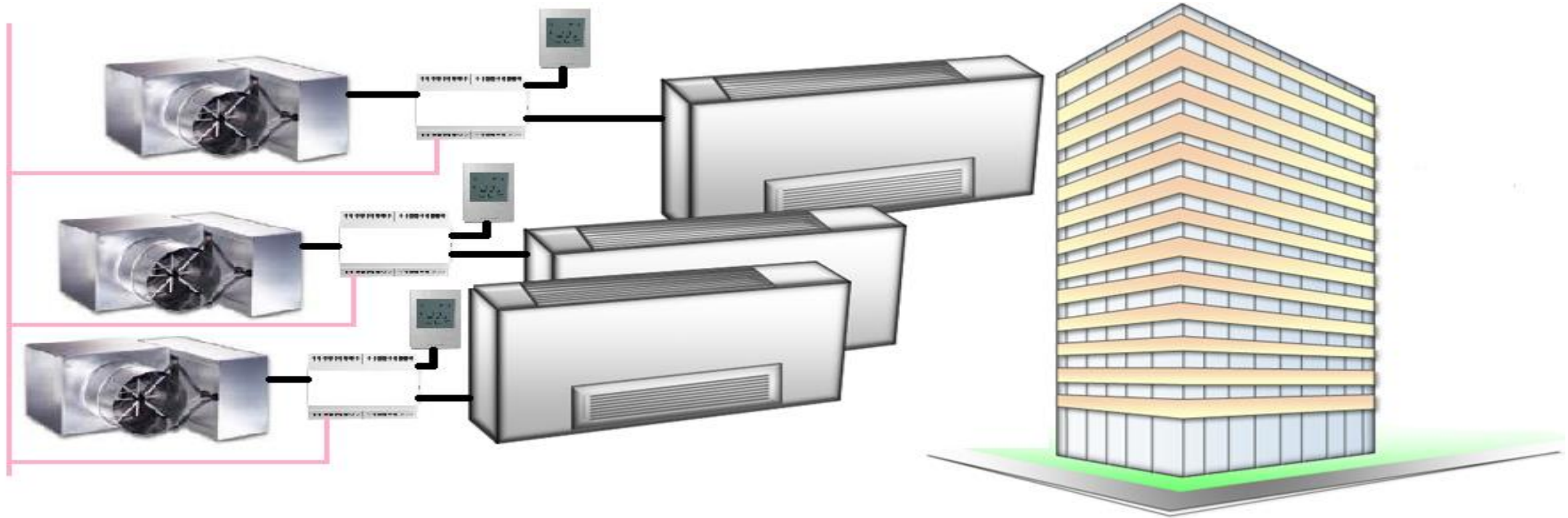
# Typical commercial buildings



Local digital room controllers perform comfort control

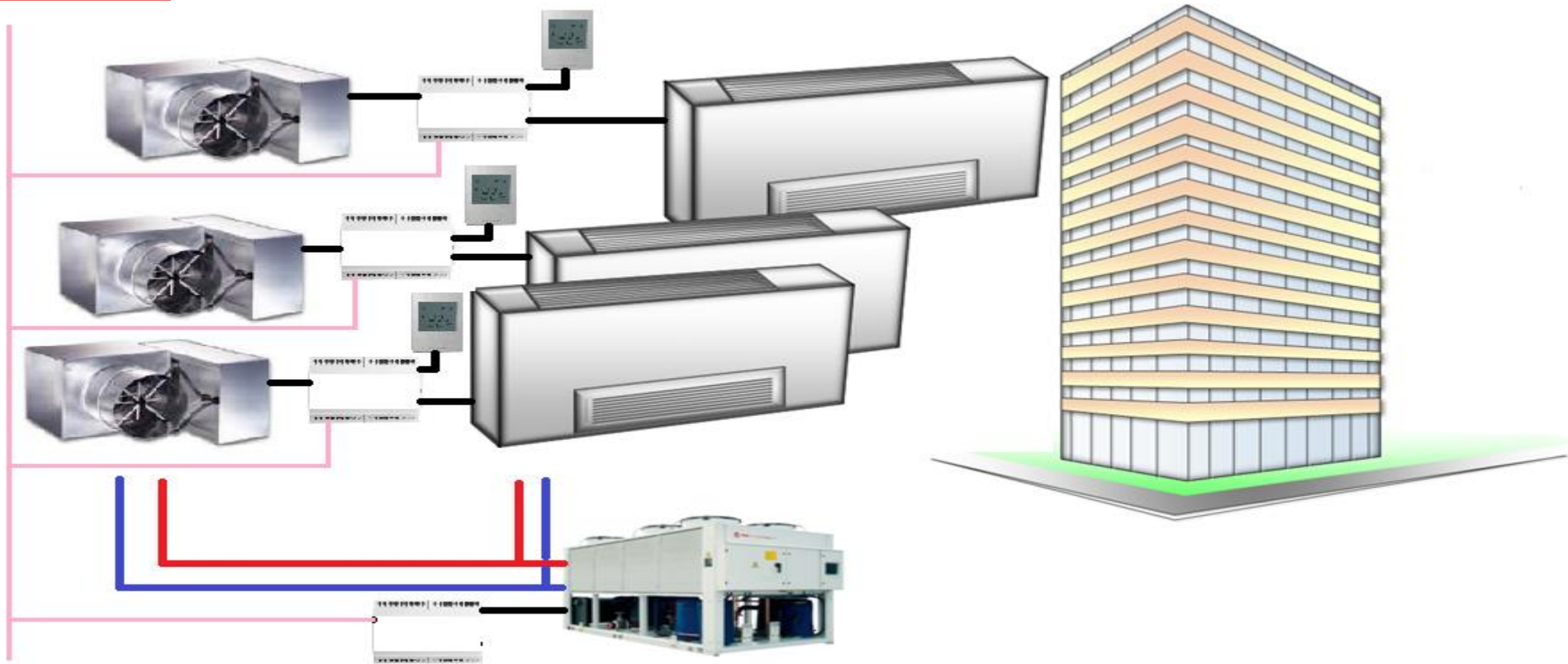


# Typical commercial buildings



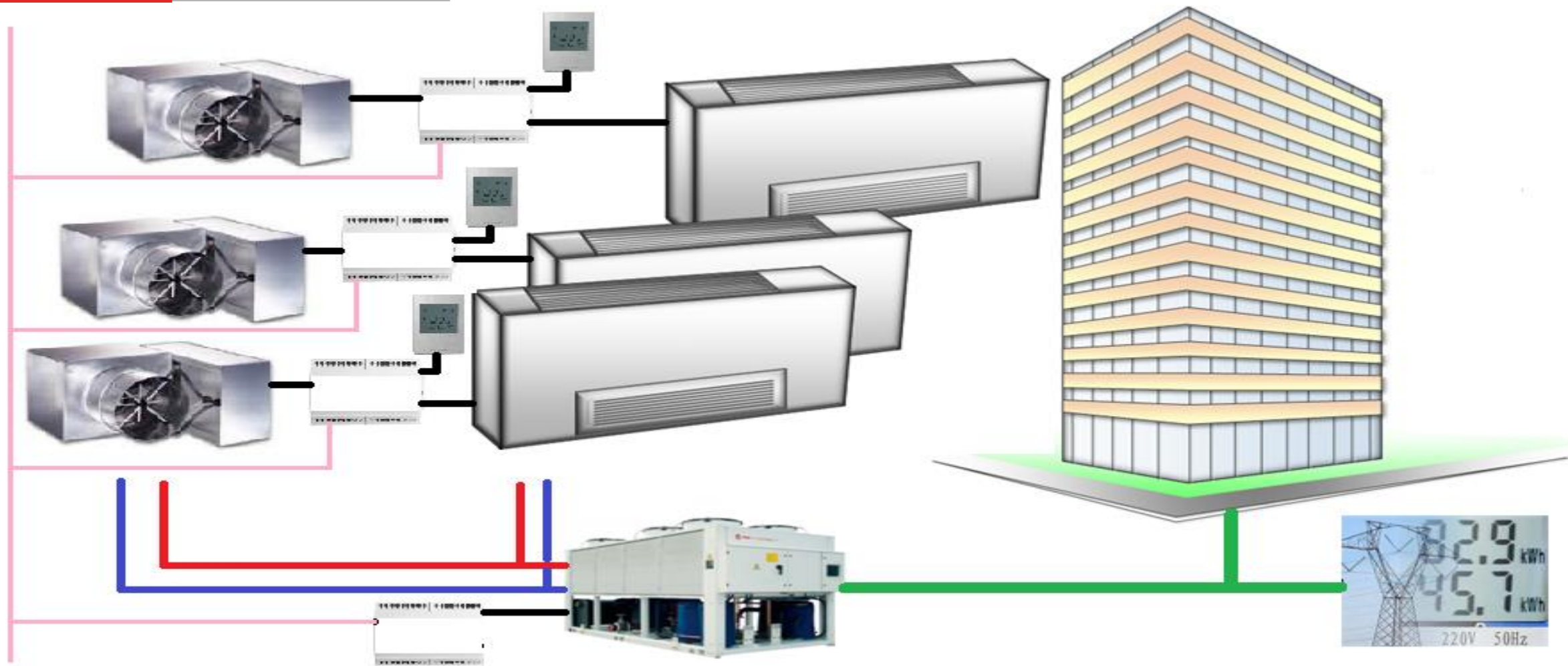
Local digital room controllers perform comfort control  
Networked for enabling central data acquisition

# Typical commercial buildings



Controlled units for production of conditioning media...

# Typical commercial buildings

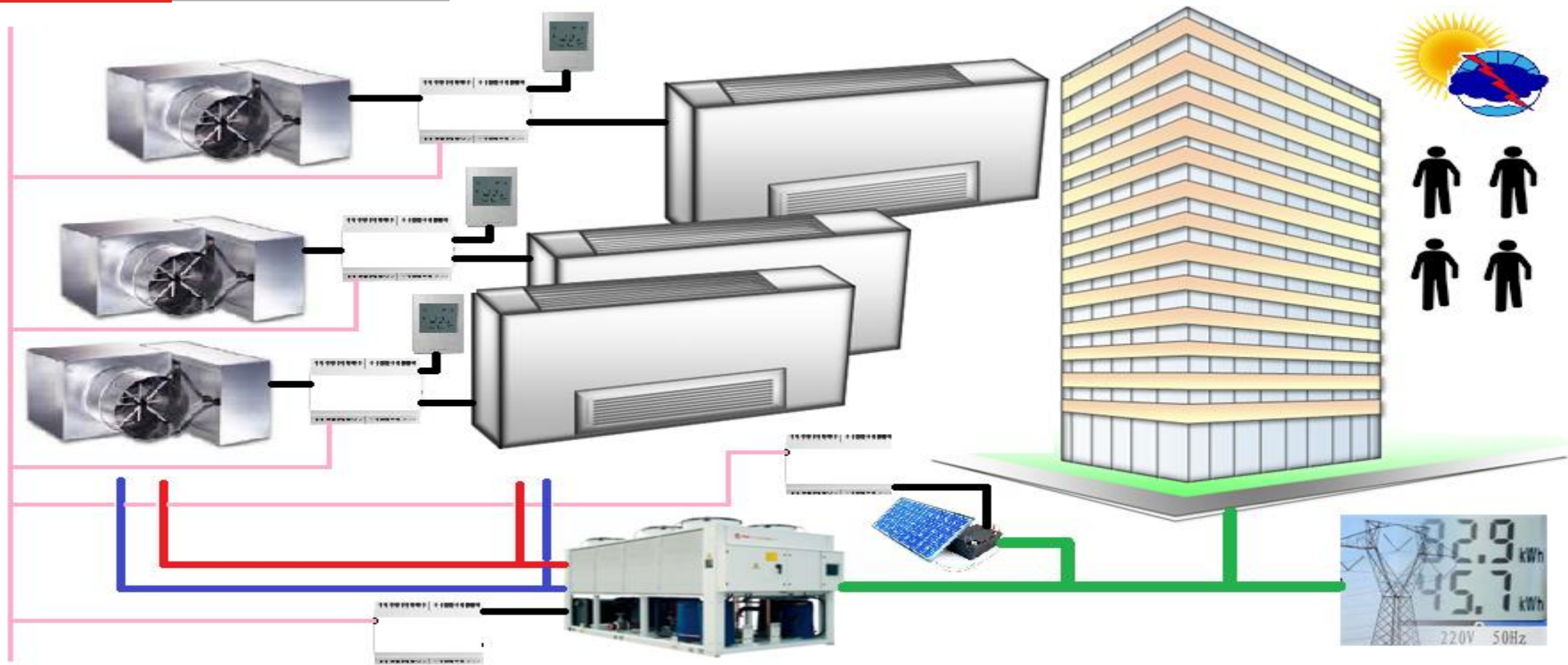


Connected to energy distribution grids





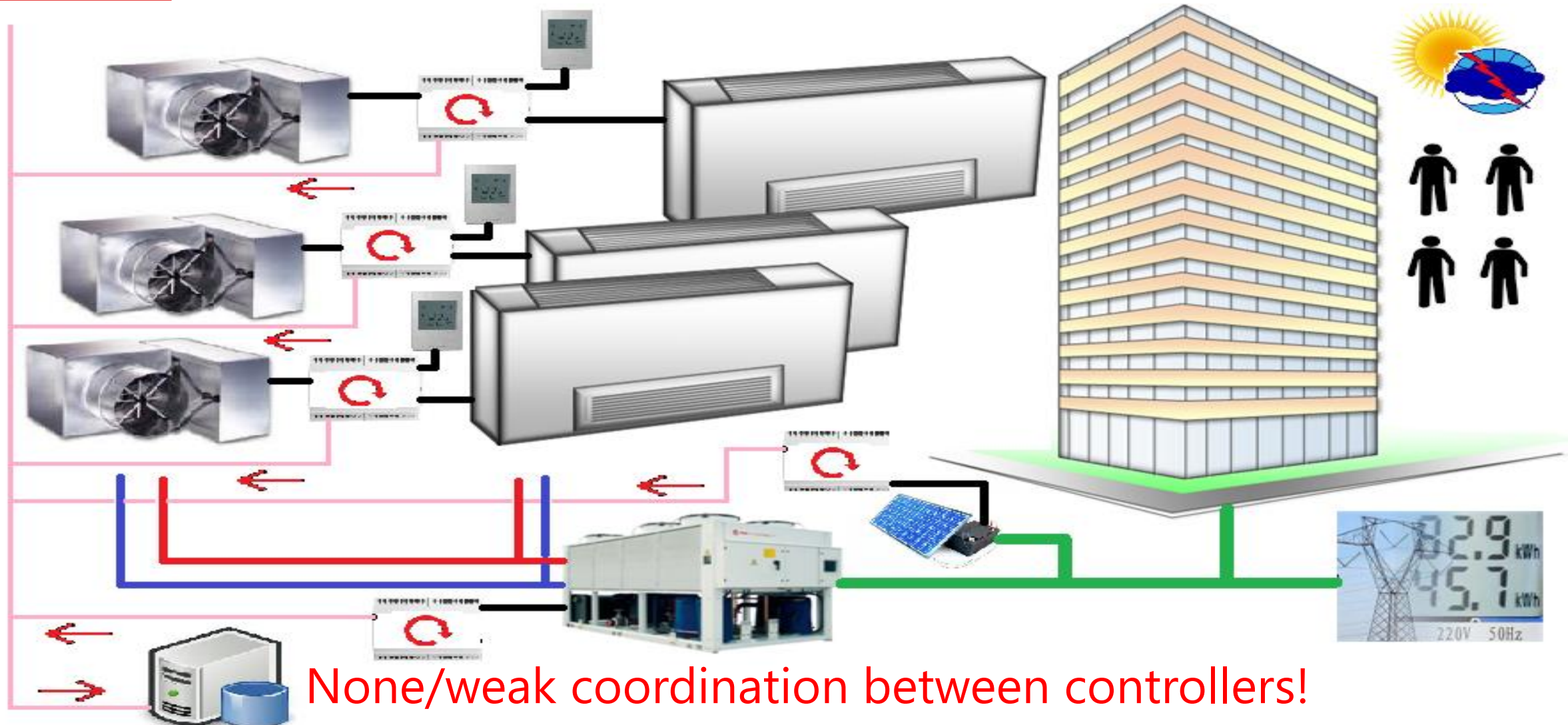
# Typical commercial buildings



Weather and occupants

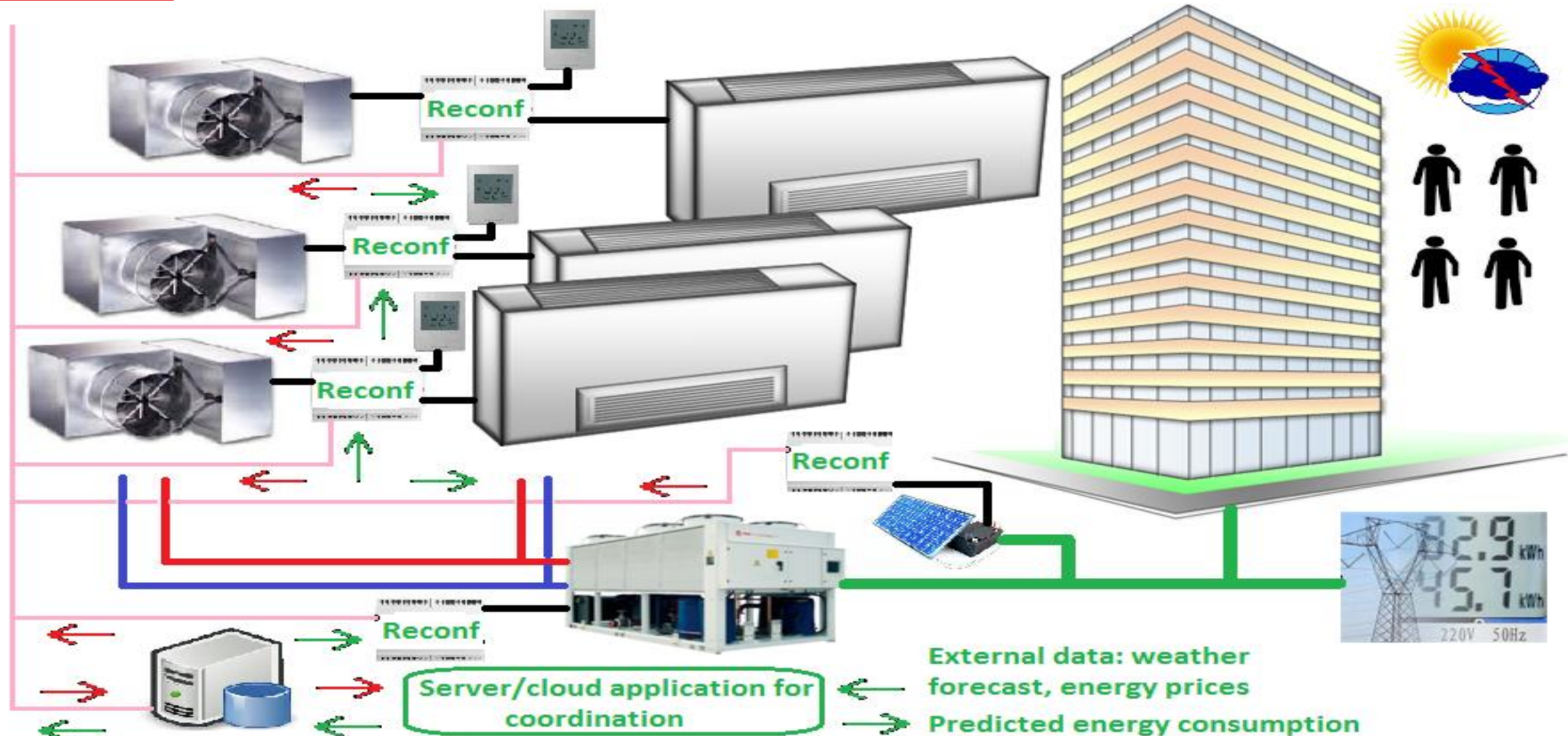


# Typical commercial buildings



None/weak coordination between controllers!  
Oversized energy costs !

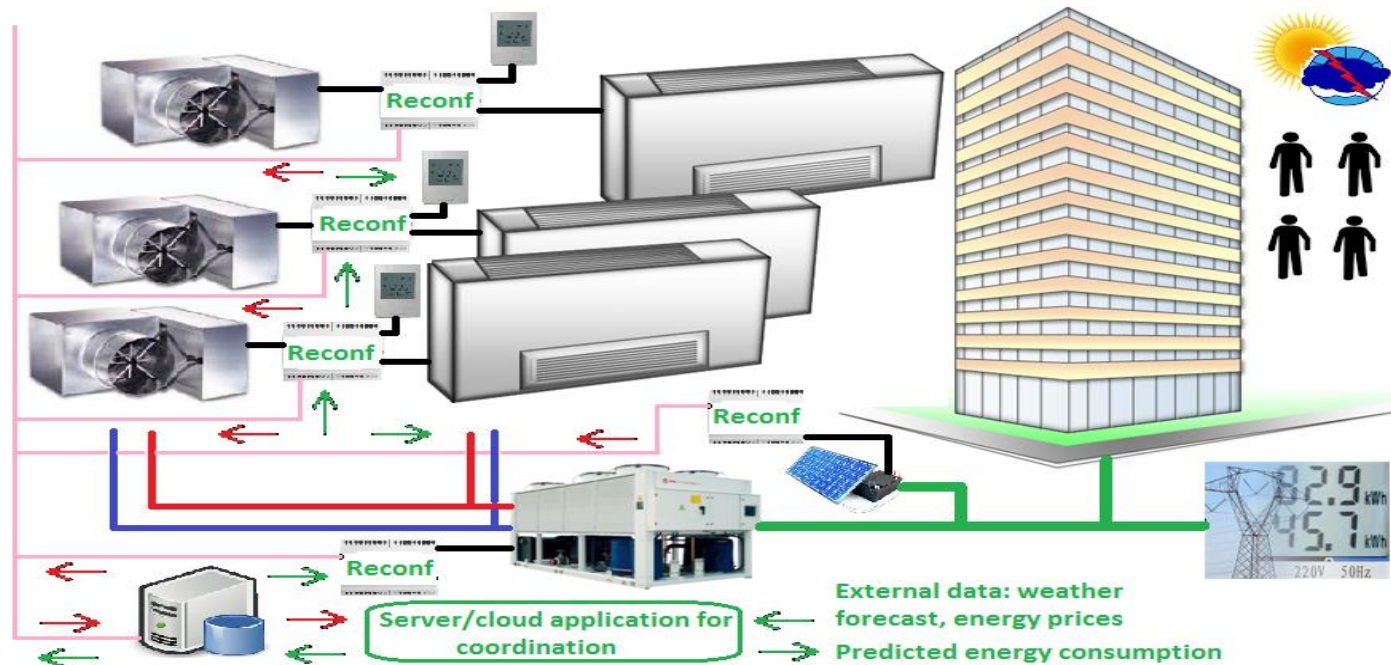
# Real-time building energy management (1)





# Real-time building energy management (2)

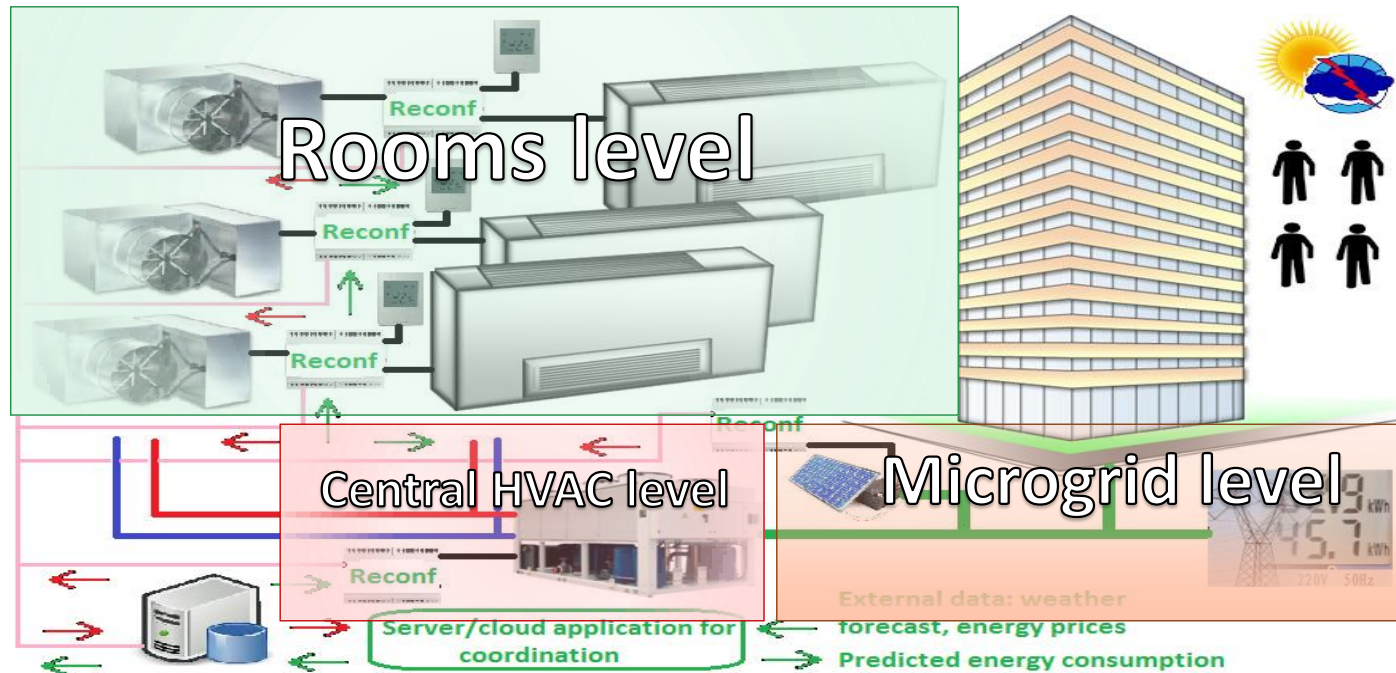
- Modularity of the coordination service
  - Separate modules for different building levels



- Mutually coordinated in any configuration

# Real-time building energy management (1)

- Modularity of the coordination service
  - Separate modules for different building levels



- Mutually coordinated in any configuration

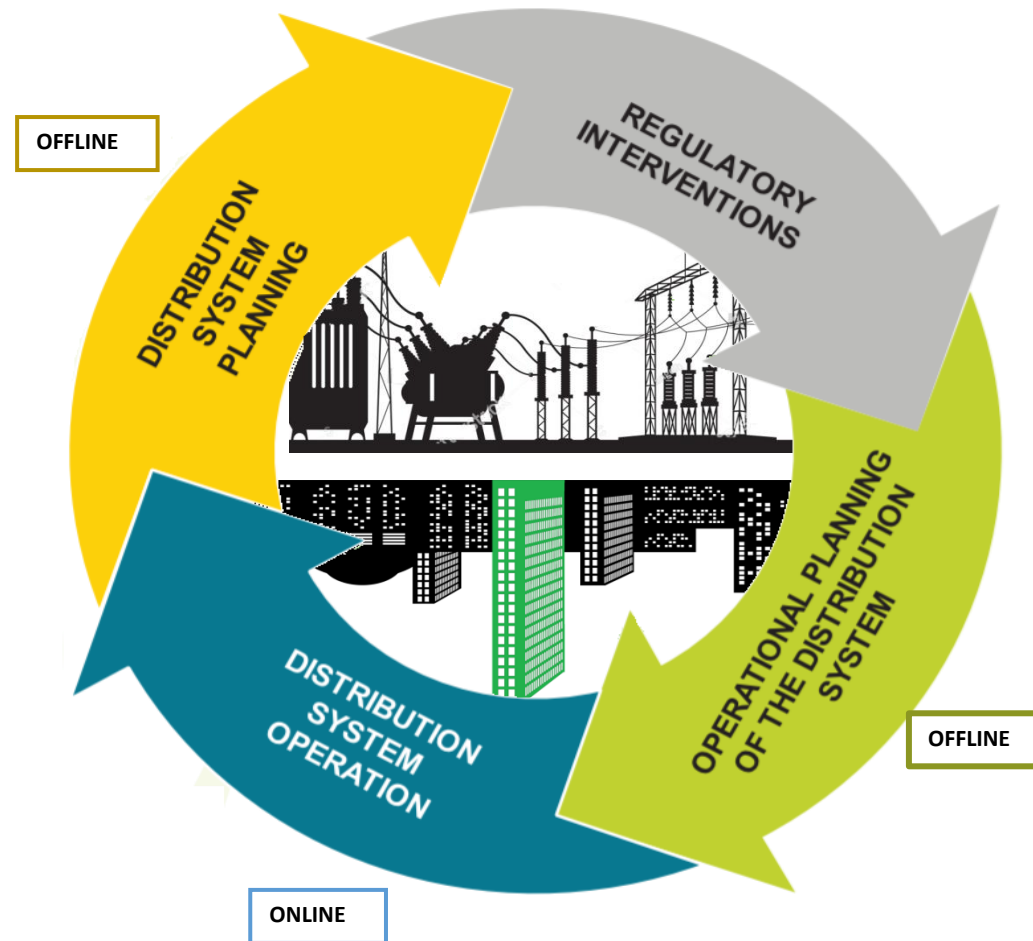
# Grid-side concept

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- **Long-term (off-line)** → determination of needs for flexibility from end-customers for the period ahead (week, month, year, multi-year)
  - determined potential time intervals and financial parameters for flexibility engagement from flexibility providers
  - furnishing **contracts** with flexibility providers
- **Short-term (on-line)** → determination of activations of flexibility by end-customers according to the established contracts (day-ahead, 15-30 minutes ahead)
  - determined **time intervals** from the contract when flexibility is called



# Grid-building interaction for demand response



# Grid-building interaction – off-line (long-term)

## LEGEND

### COLORS

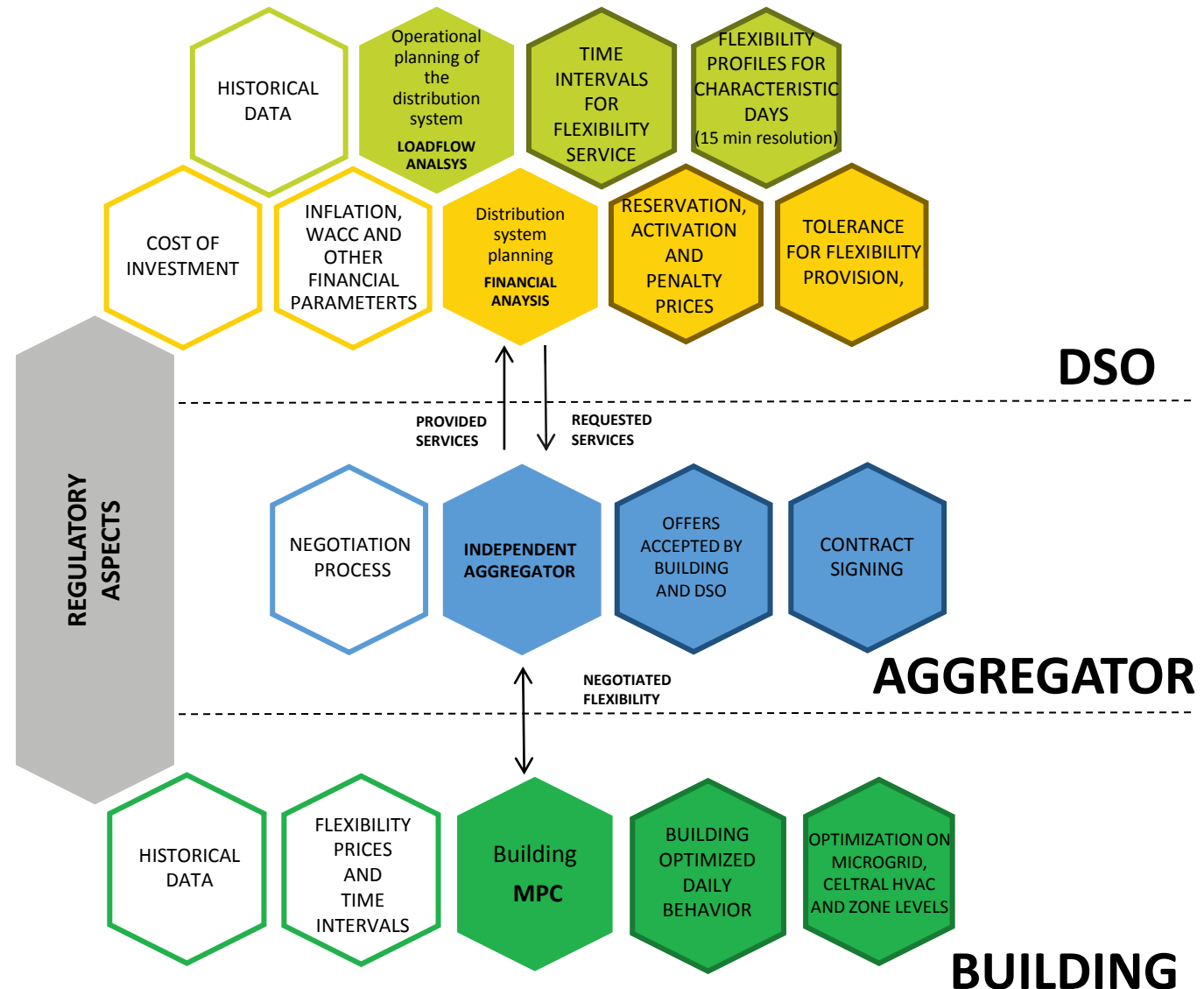
- DSO (ANNUAL)
- DSO (MULTIANNUAL)
- BUILDING
- REGULATOR
- AGGREGATOR

### SHAPES

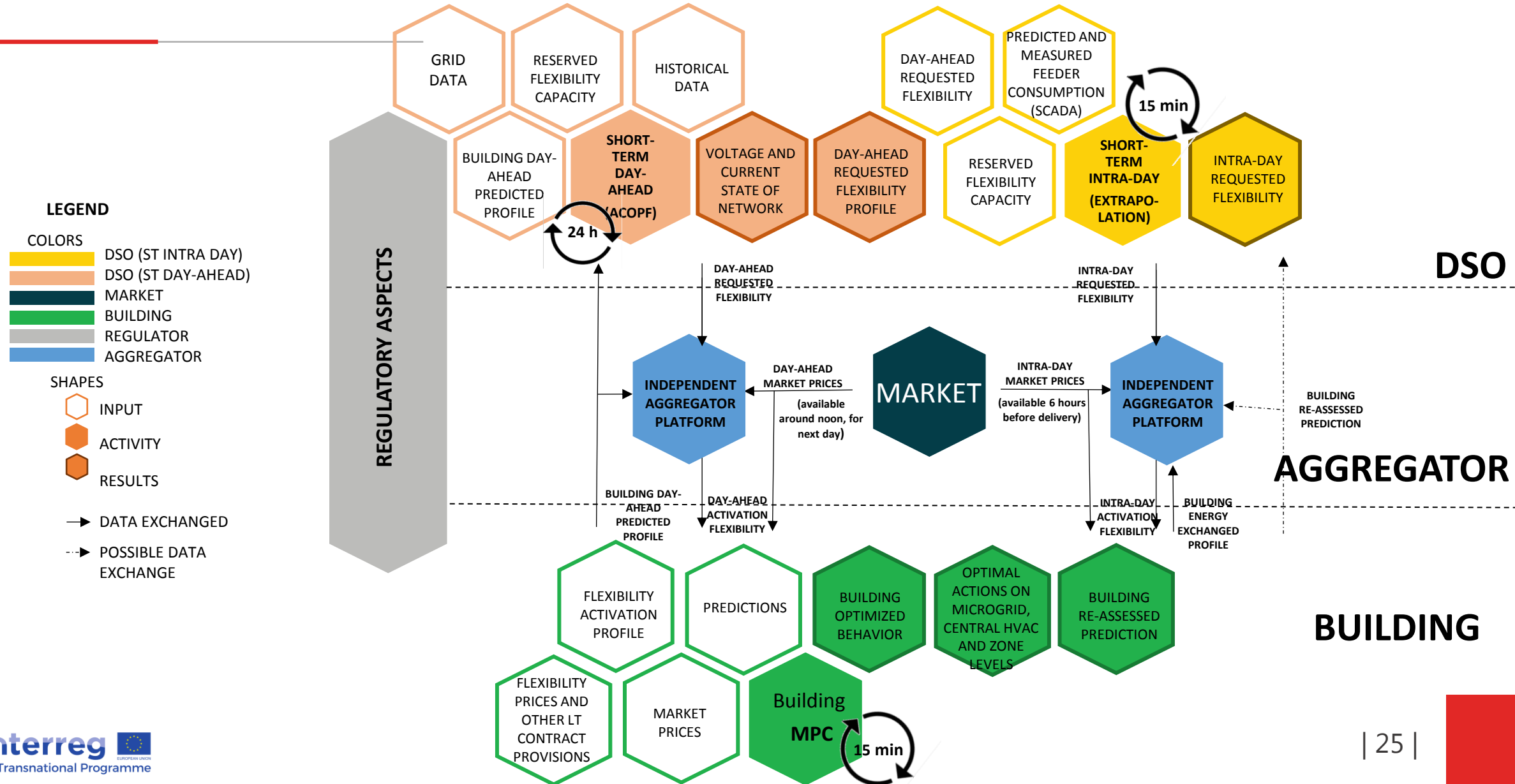
- INPUT
- ◼ ACTION
- ◼ RESULT

→ DATA EXCHANGED

Possibility to assess worst-case benefit for the building → for CBA and RoI related to the investment on the building side

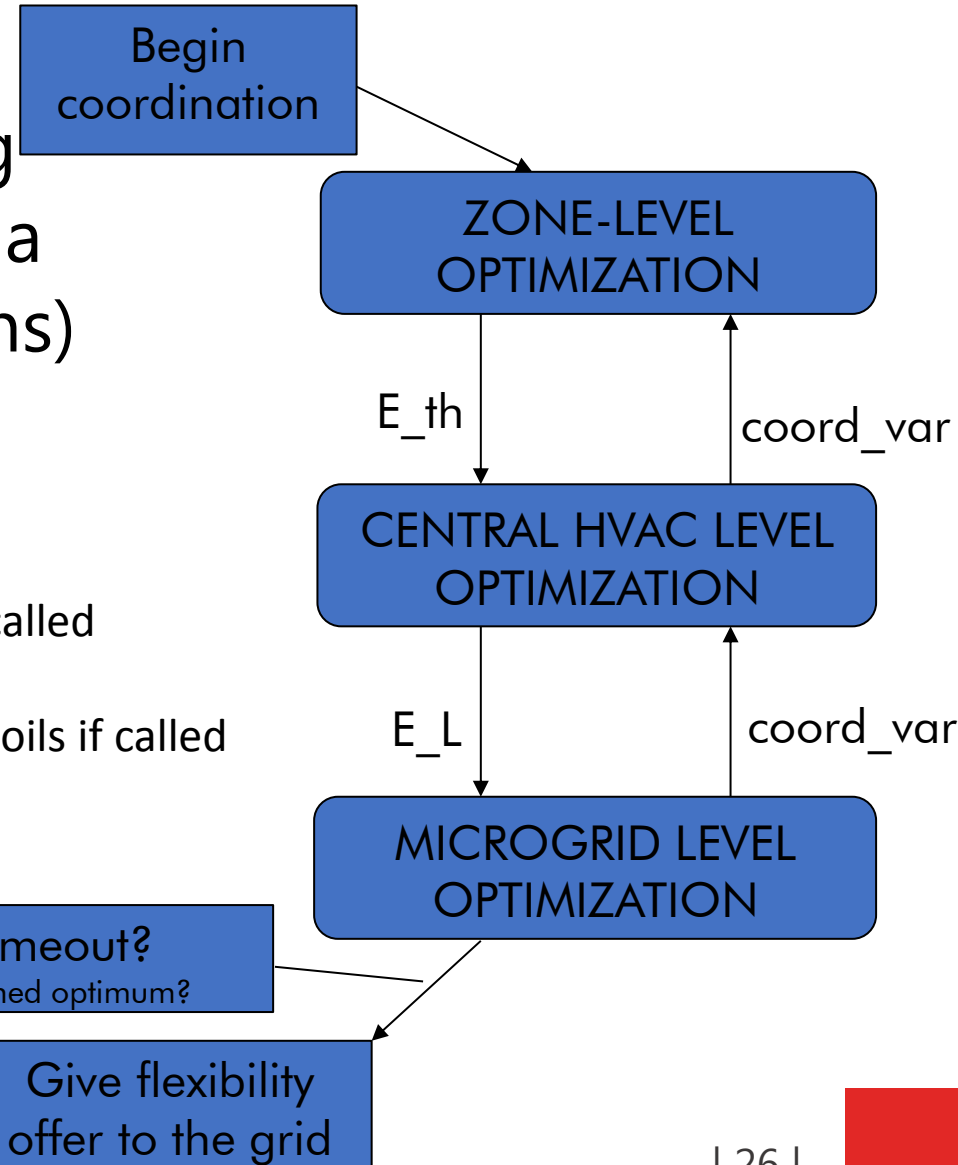
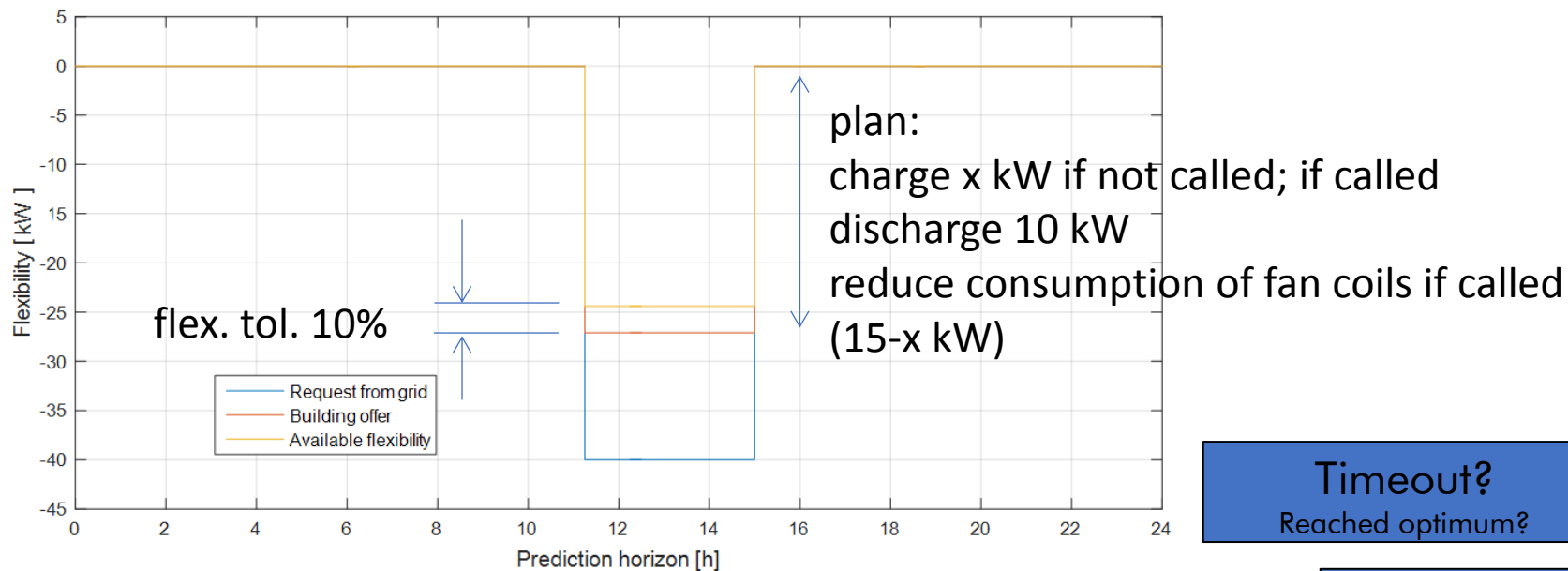


# Building-grid interaction – on-line (short-term)



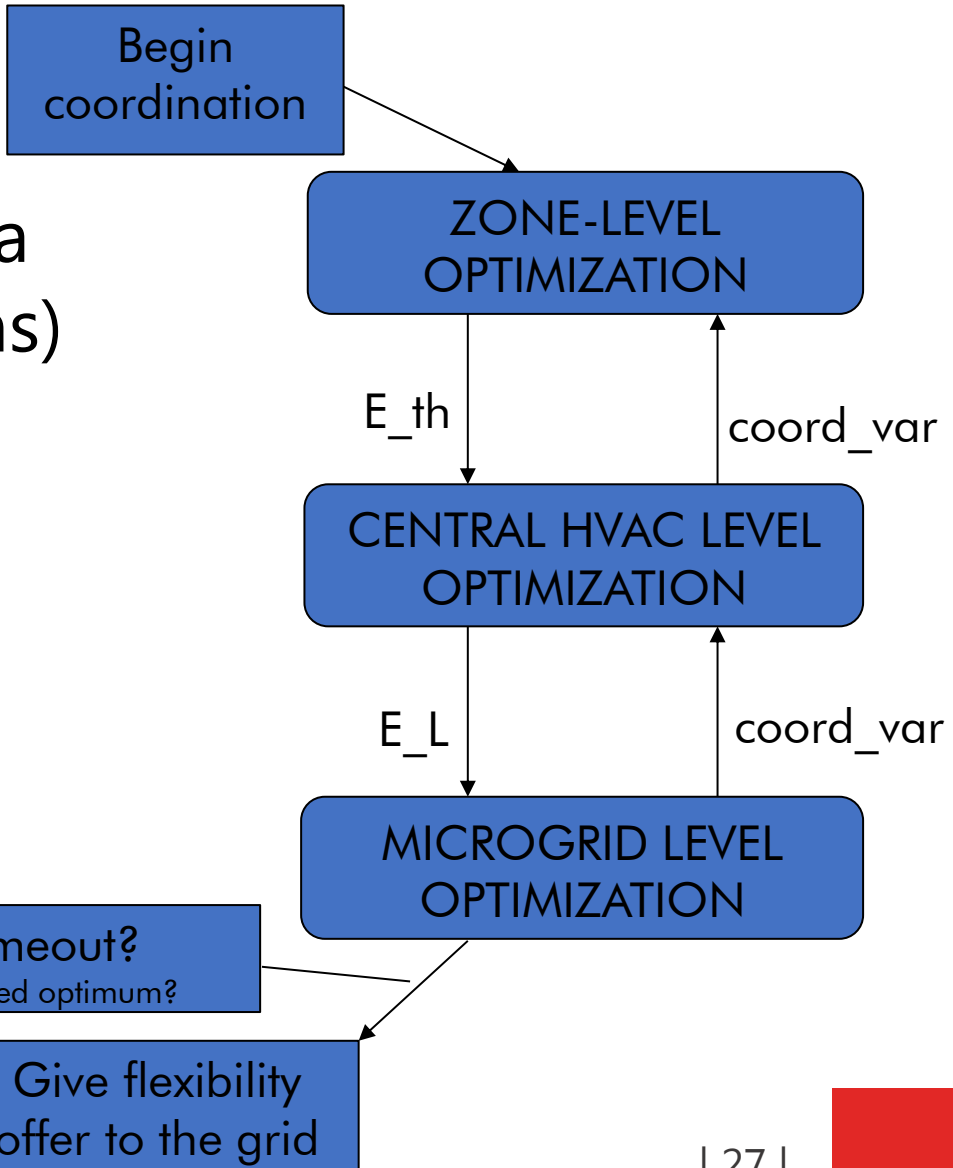
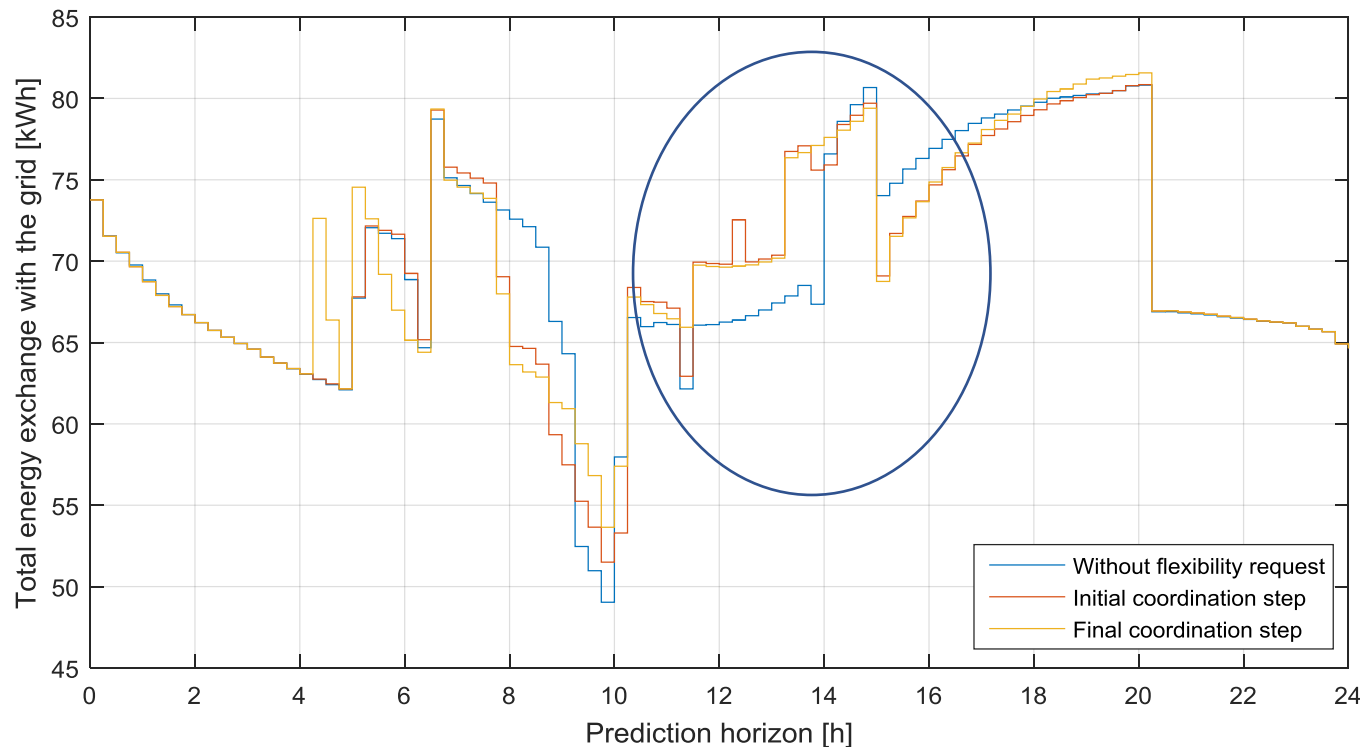
# Flexibility contracting – example

- Reservation window 11:30-15:00, building with 10 kW battery system and heating via fan coils in winter (~15 kW of fan coils fans)



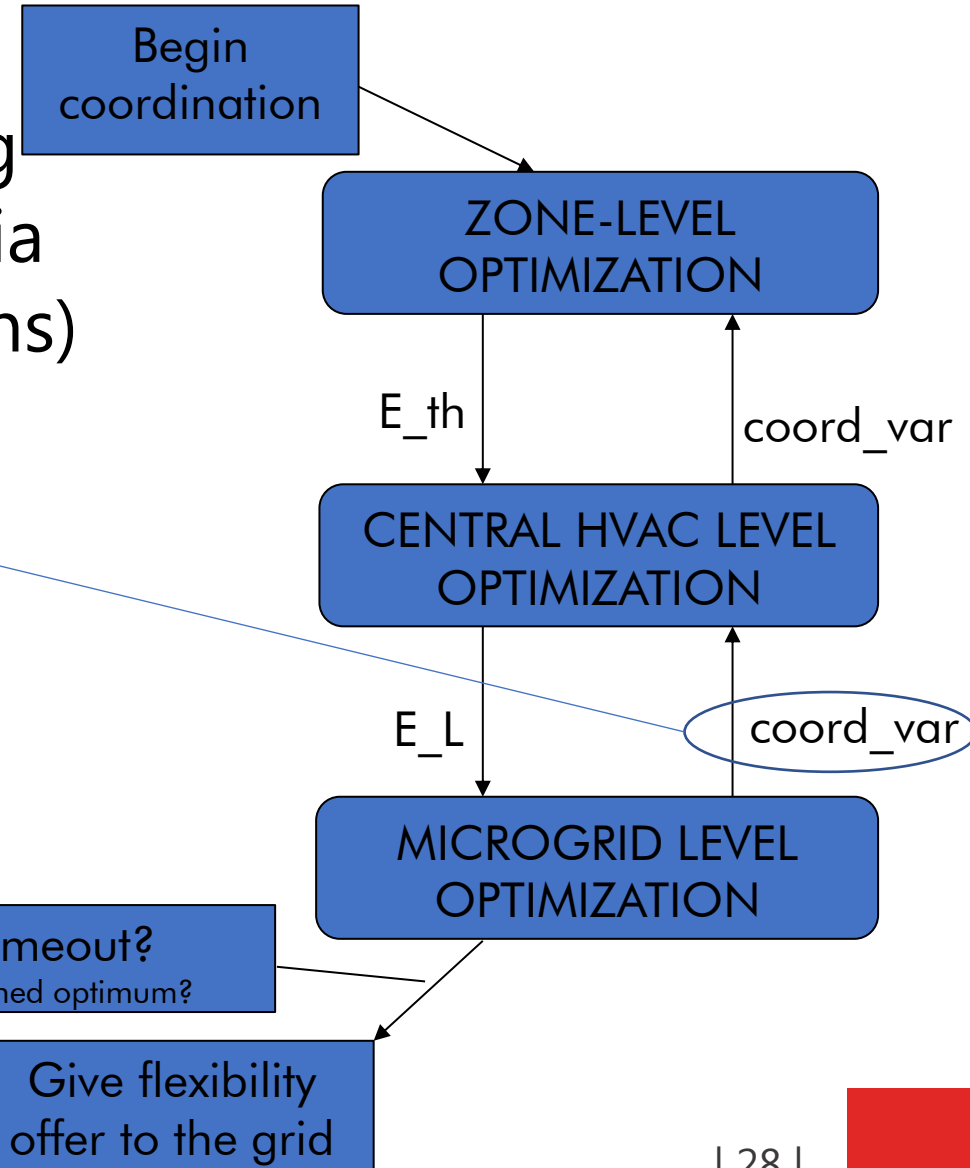
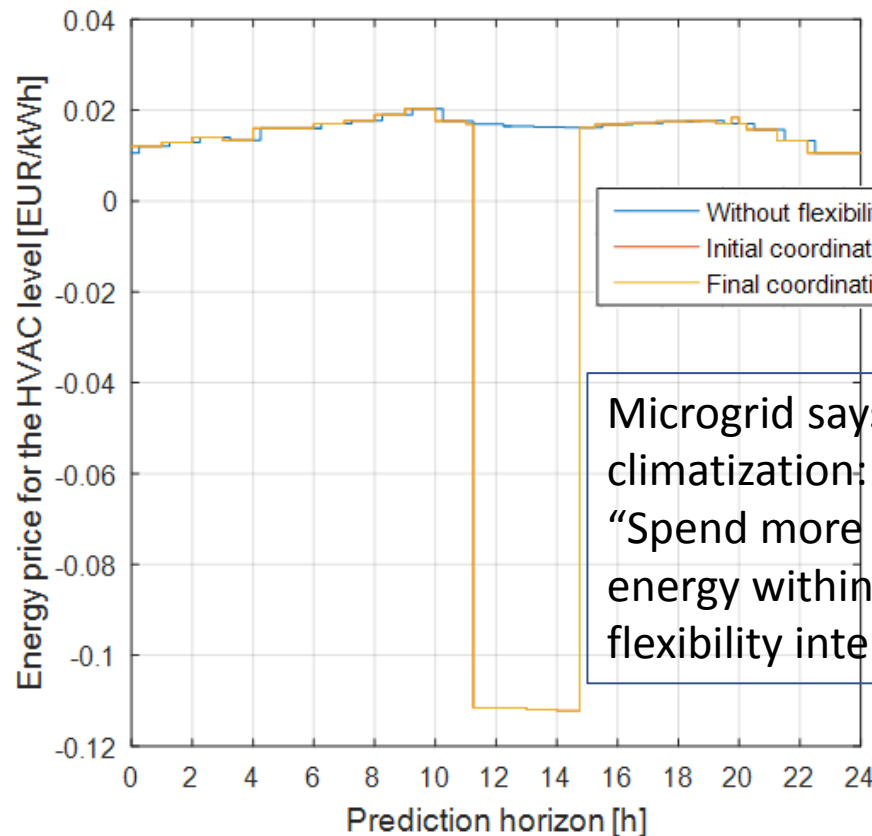
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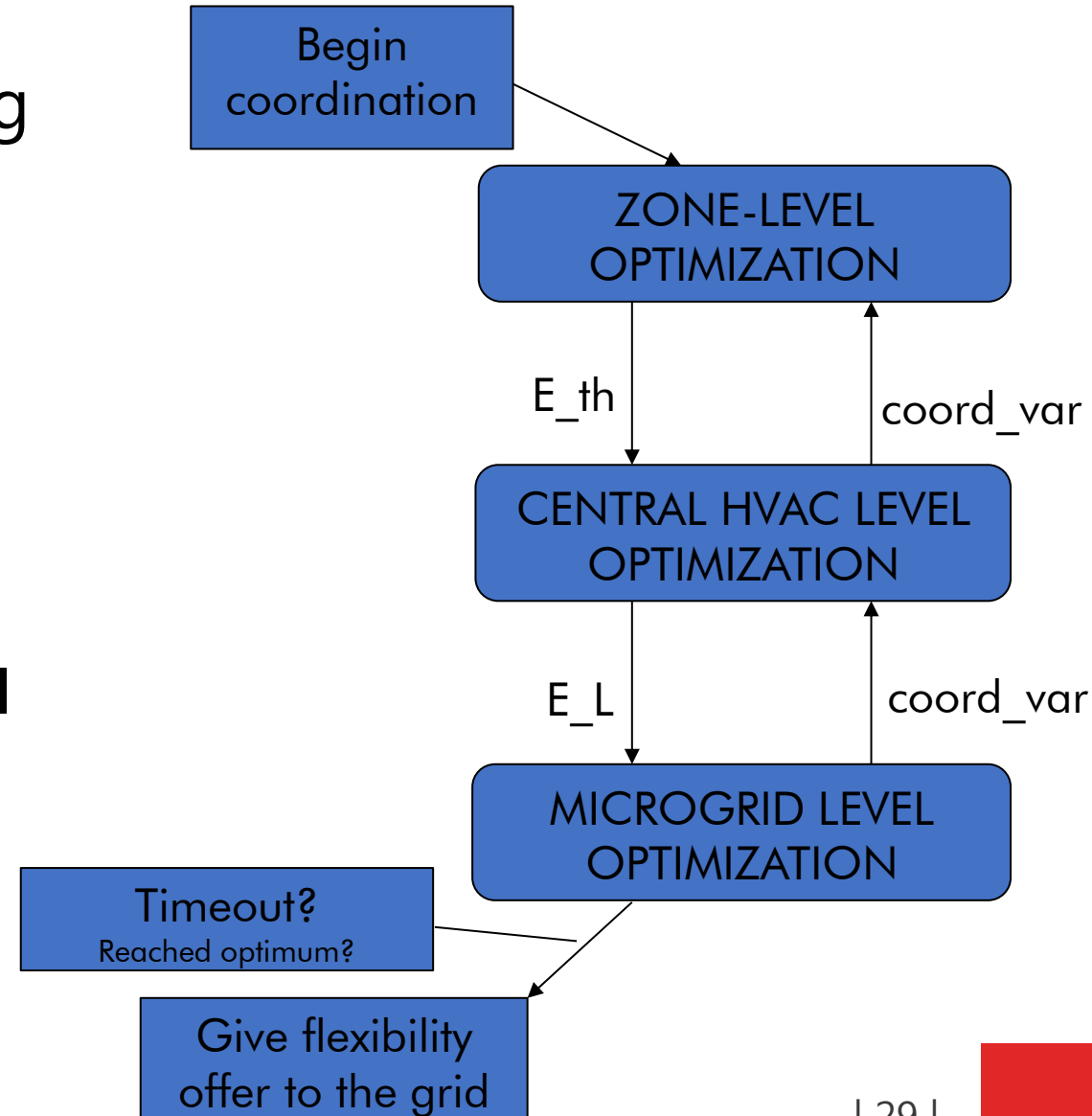
# Flexibility contracting – example

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# Flexibility contracting and on-line execution (1)

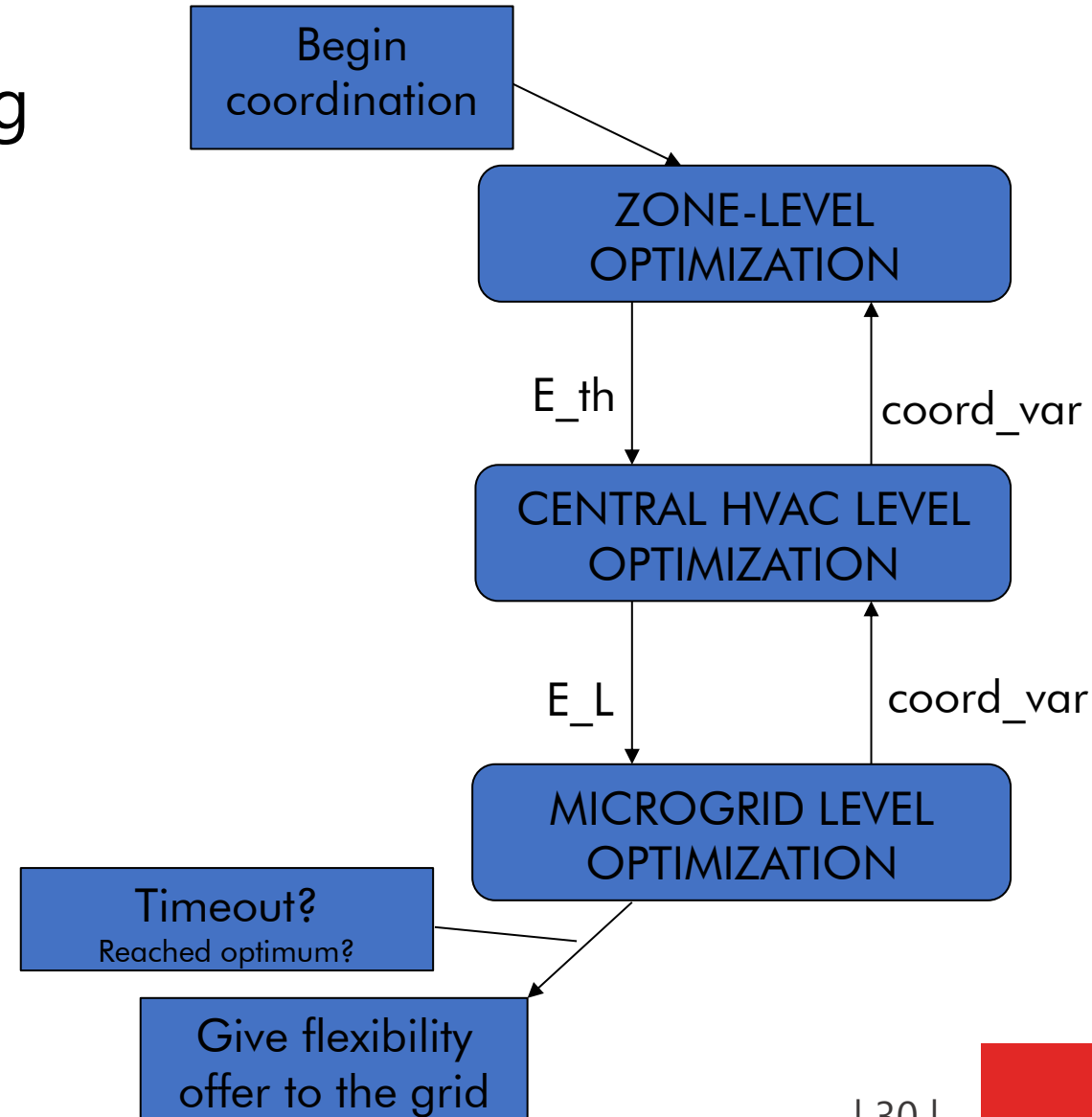
- Key points from the optimized building behaviour compared to the optimized behaviour when flexibility is not asked to be offered:
  - flexibility service provision induces a **lucrative decrease of energy-efficiency** in the building operation
  - revealing **narrow time slots for potential flexibility call** by the grid induces unwanted effect – increased declared consumption of smart buildings in that interval which forces the activation of flexibilities





# Flexibility contracting and on-line execution (2)

- Key points from the optimized building behaviour compared to the optimized behaviour when flexibility is not asked to be offered:
  - special attention needs to be put on the right **balance between the reservation reward and the retail electricity prices**
    - reservation reward for a certain power higher than retail price for the respective energy consumed opens space for very inefficient, but lucrative building operation, e.g. the extreme case of usage of switchable resistor banks



# Infrastructure up-scale

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- Replacing optimization of **building climatization under comfort constraints** that has:
  - electricity cost and thermal energy costwith optimization of **water distribution with pumped storage under network pressure constraints** that has:
  - electricity cost and water leakage costs
- Top-level (microgrid) interaction with the grid remains completely the same
- Other examples:
  - electrified rail transport that optimizes traction force profiles of rail vehicles under timetable/traffic constraints,
  - electric vehicles parking with chargers that optimizes charging profiles under vehicles usage and target SoCs constraints
  - ...

# Overview

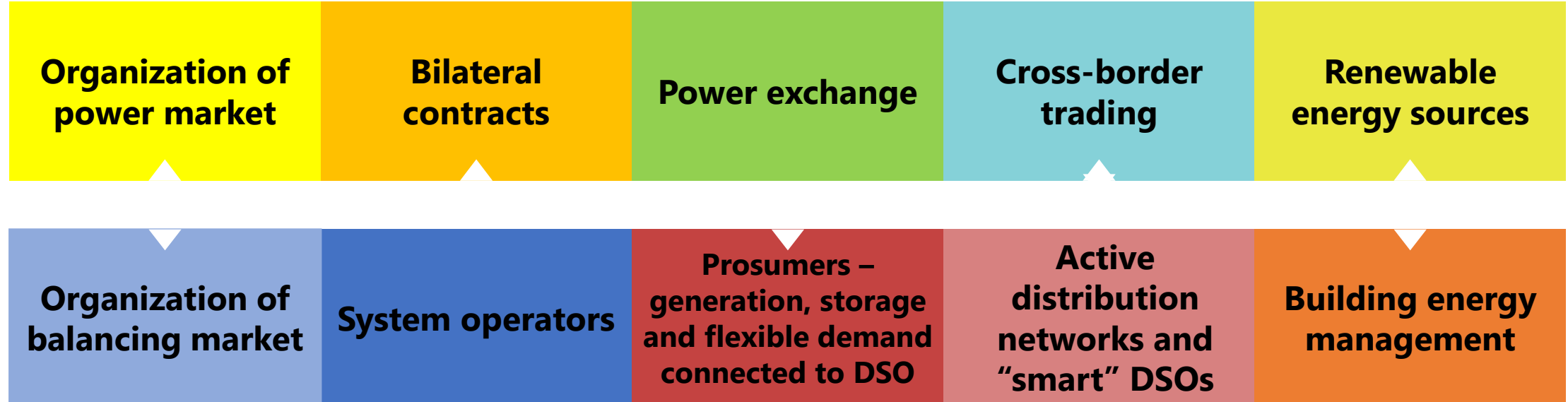
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- Technical part of 3Smart
- Regulatory Analysis and proposals

# Regulatory Analysis of the Danube Region and beyond

The aim of the Regulatory analysis primarily was to seek the **potential barriers** which hinder the real-time building-grid energy management including demand response.

A Strategy is proposed to **remove the regulatory framework barriers** for Energy Management System (EMS) adoption in the Danube Region completed with **lessons learnt** from the project, the analysis is already focused on the realized system.



# Results of the Regulatory Analysis 1.

## Barriers to participation in Demand side management:

- **Retail prices reflecting wholesale market prices** - regulated tariffs are artificially low, thus there is no incentive for Demand Response as a mean for reduction of energy costs
- **Power exchange** (dynamic pricing reflects the wholesale price at the relevant power exchange), power exchanges exist and operate in most of the countries
- **Dynamic pricing – supply contracts** - market participants may conclude such a contract without any special requirement
- **Dynamic network tariffs** - currently none of the Danube Region countries offers dynamic network tariffs; there are no general obstacles for them
- All market participants shall be treated in a non-discriminatory way - no obstacle to new market players, but *no framework that encourages/requires generators to provide any flexibility service*, except for Germany

## Results of the Regulatory Analysis 2.

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- Renewable energy sources (RES) vs. balancing and ancillary services
  - **renewable sources may not participate in the balancing and ancillary services** market in the majority of the Danube Region countries
  - renewable sources are often **subsidised** (e.g. feed-in tariff) – no incentives for balancing their own production
  - implementation of relevant Network Codes and Guidelines (inter alia Guideline on Electricity Balancing (EB))
- Smart meters roll-out shows a mixed picture
  - in certain countries there is no decision on smart meters roll-out, in other countries (e.g. Austria, Croatia) the installation is still ongoing
  - **lack of smart meters hinders the full-scale introduction of dynamic tariffs and demand response**

# Results of the Regulatory Analysis 3.

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- Building energy management
  - relatively few available regulations or strategies in the Danube Region countries
  - Serbia - as an exception from the above - has a strategy in relation to the introduction of energy management systems
  - **Technical specifications for smart meters do not cover the possibility of communication with the building energy management system**
    - **real-time reading from the billing meter needed, with sampling time at the level of 1 min, for the usually applied 15-min settlement period**



# Strategy to remove barriers

Barrier Cluster	Short Description
Smart metering CBA and possible roll-out	In many countries the CBA analyses indicate the full roll-out as economically non-viable, with CBA methodology that is not accounting for benefits from unlocked energy management potential, dynamic tariffs and flexibility, meanwhile <b>smart metering is a prerequisite for flexibility</b>
Interoperability of smart meter (gateway) and energy management systems (HEMS, BEMS)	<b>Standardization of interoperability</b> is lacking in terms of <b>smart metering</b> system with home energy management system ( <b>HEMS</b> ) and building energy management system ( <b>BEMS</b> ). The standardization would make the spread of flexibility usage significantly easier.
Lacking market and rules for flexibility	There is no market for flexibility, in some countries the Day-Ahead and Intra-Day markets are missing.
Possible contradiction between local (DSO) and global (TSO) interests with respect to flexibility	There is a <b>contradiction</b> between <b>local interest</b> (e.g congestion management by DSO) and <b>global interests</b> (e.g ancillary services for TSO, tertiary reserves), thus communication platform and rules are necessary

# Strategy to remove barriers

Barrier Cluster	Short Description
Vague future roles of future energy system where flexibility trading is a central point	The future roles and players are not yet defined (e.g aggregator) which are necessary for the flexibility market
Administrative and financial barriers in case of entering into DA, ID market by smaller entities	There are certain administrative and financial requirements for new entrants which only large market players can comply with and can enter DA and ID markets
Poor market liquidity	In case of ID market mostly all countries face a poor market liquidity, some of them also face a DA liquidity problem
Lacking power exchange market	Some countries face poor or completely lack power exchange
Dynamic tariff system is not yet managed	In the majority of the analysed countries there is <b>no dynamic tariff system</b> which could catalyse flexibility. However, in several countries DSO tariffs are maximised tariffs thus DSOs can give discounts from its tariffs for predefined services offered by network users, which can be an incentive for flexibility offers
Low price and strict retail price regulation	In some cases it is recognised that the low electricity costs and low regulated retail end-user prices hinder the use of flexibility

# Proposals to remove regulatory barriers

Barrier Cluster	Proposal for the removal of the barrier
Smart metering CBA and possible roll-out	The revised CBA should care more about the <b>benefit</b> part – demand response and dynamic tariffs enabled by smart meters, the prescribed frequency of analyses should be reviewed
Interoperability of smart meter (gateway) and energy management systems (HEMS, BEMS)	In terms of technology standardization the <b>interoperability</b> and its <b>standardisation of HEMS</b> (Home energy management system) and <b>BEMS</b> (Building energy management system) with the <b>smart metering system</b> is a prerequisite of the future exploitation of flexibility. <b>Clear regulation is needed that allows the billing meter read access with proper frequency to the end-customer (real-time metering enables control).</b>
Lacking marketplace and rules for flexibility	The future <b>role of aggregator</b> has to be clearly defined in order to prevent the possible contradictions between the parties (aggregator vs. DSO, supplier, etc.) Clear <b>definition of flexibility service procurement procedure</b> is needed

# Proposals to remove regulatory barriers

Barrier Cluster	Proposal for the removal of the barrier
Possible contradiction between local (DSO) and global (TSO) interests with respect to flexibility	In order to resolve the possible contradiction between local (network congestion management by DSO) and global (system balancing by TSO) interests, <b>data exchange should be developed/regulated between TSOs and DSOs.</b>
Vague future roles of future energy system where flexibility trading is a central point.	Questions to be answered: Estimated operational cost of the flexibility market, expected effect on the network tariffs and energy prices, responsibilities/rights of TSOs and DSOs in balancing and activating flexibility services, expected effect on the liquidity of existing ID and DA markets, data exchange needs and interface solutions
Administrative and financial barriers in case of entering the DA and ID market by smaller entities	Administrative and financial requirements should be made less strict by the national regulator ( <b>lower entry costs to the ID and DA market</b> ), new incentives should be elaborated by the Power Exchange/Regulator in order to boost the participation of smaller entities

# Proposals to remove regulatory barriers

Barrier Cluster	Proposal for the removal of the barrier
Poor market liquidity	Ensure liquidity of the domestic electricity markets by appropriate regulatory measures such as contract reviews, capacity releases, virtual power plants, etc. Coupling of organised day-ahead electricity markets with neighbouring countries.
Lack of power exchange market	Remove major legal and contractual obstacles to establish organized electricity markets and market coupling
Dynamic tariff system is not yet managed	Promotion and implementation of dynamic tariff systems which stimulates the demand response system on both building and grid sides
Low price and strict retail price regulation	Remove major legal obstacles, otherwise only a small portion has an interest to be involved into flexibility market and to implement energy management systems.

# Main proposals to remove regulatory barriers

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- Smart meter roll-out where it is needed, benefits in the CBA
- Grid-building interface standardization, allow smart meter read access with proper frequency by end-customer
- Market for flexibility trading
- Clear rules of using flexibility (e.g. data exchange between TSOs and DSOs, aggregators)
- Administrative and financial requirements should be less in relation to DA and ID markets
- Advanced, dynamic tariff system



# THANK YOU FOR YOUR ATTENTION!

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## PROJECT WEB PAGE

[www.interreg-danube.eu/3smart](http://www.interreg-danube.eu/3smart)

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