Smart Building – Smart Grid – Smart City

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Project drivers – buildings (1)

- Buildings – static objects?
- Labelled according to kWh/m^2/year consumption
  - likewise it is estimated the amount of energy saved by building renovation, or
  - the amount gained with renewable energy setup on the building
- What happens with the building hour to hour, minute to minute?

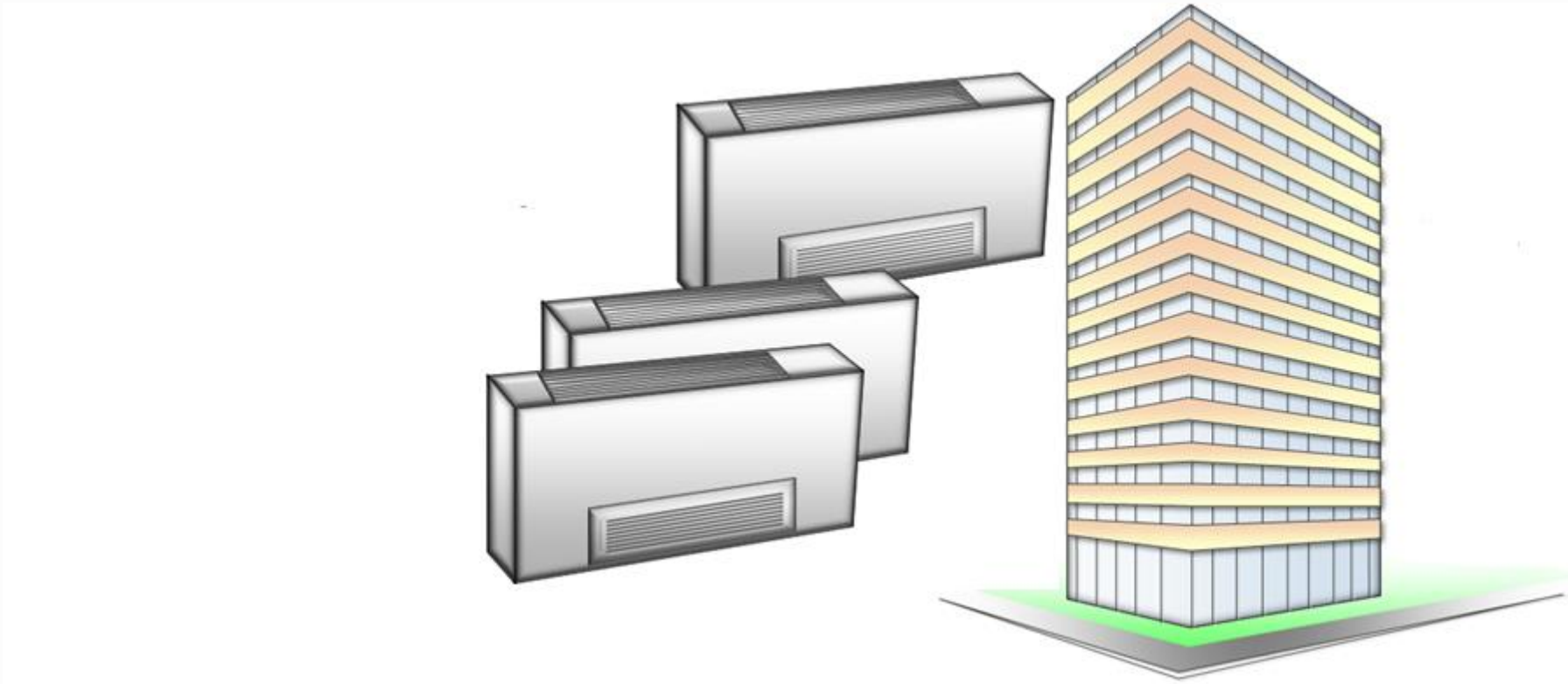
Project drivers – buildings (2)

- Smart meters can show substantial changes in the building consumption even in such small time intervals
  - electricity
  - heat
  - gas
  - water
- Why should we care about it?
- Are yearly considerations enough?

Project drivers – buildings (3)

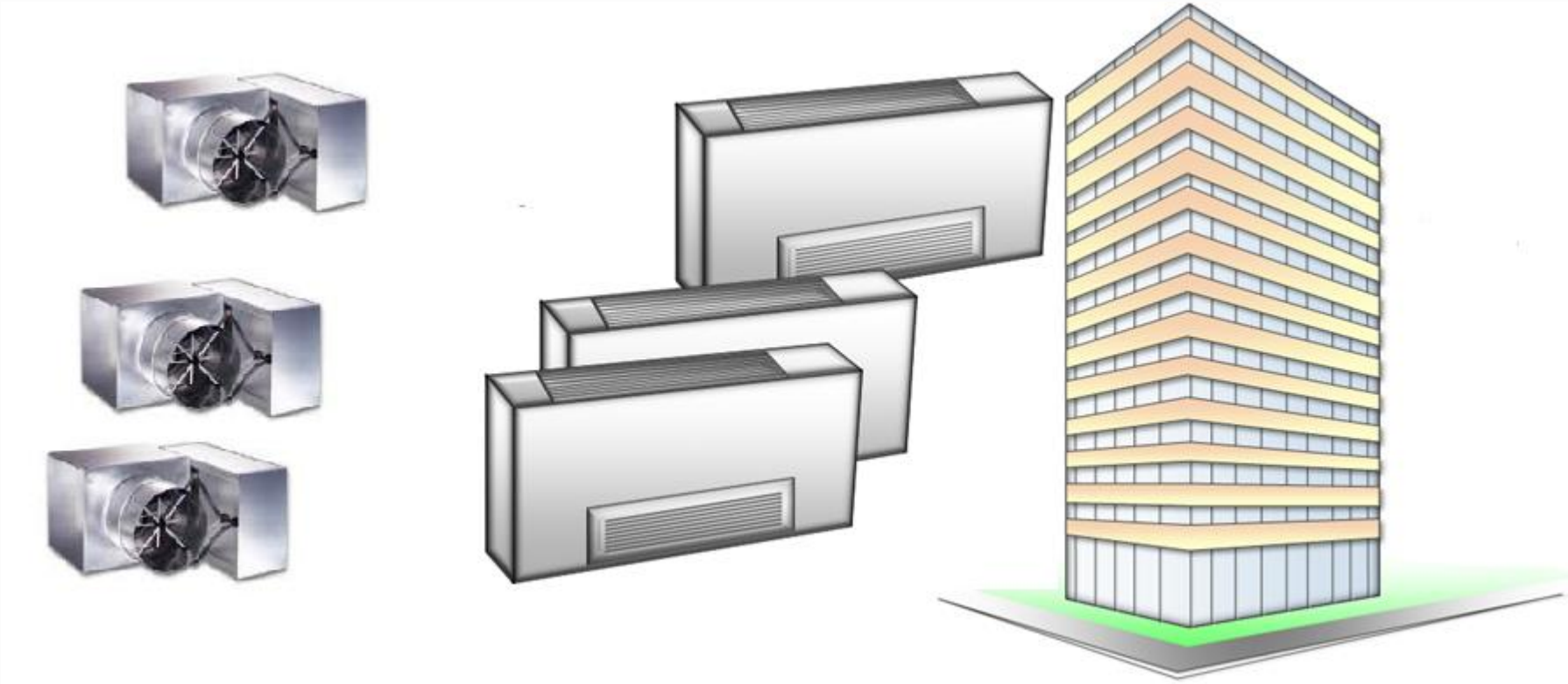
- To keep comfort, each room of a building requires energy brought to it with a medium (air or water)
  - when and how much energy do we extract from the medium to the zone?
  - when and how much energy do we use to prepare the medium?
  - when and how much energy do we draw from the utility grid to enable the medium preparation?
- The answers are not unique

Classical commercial buildings



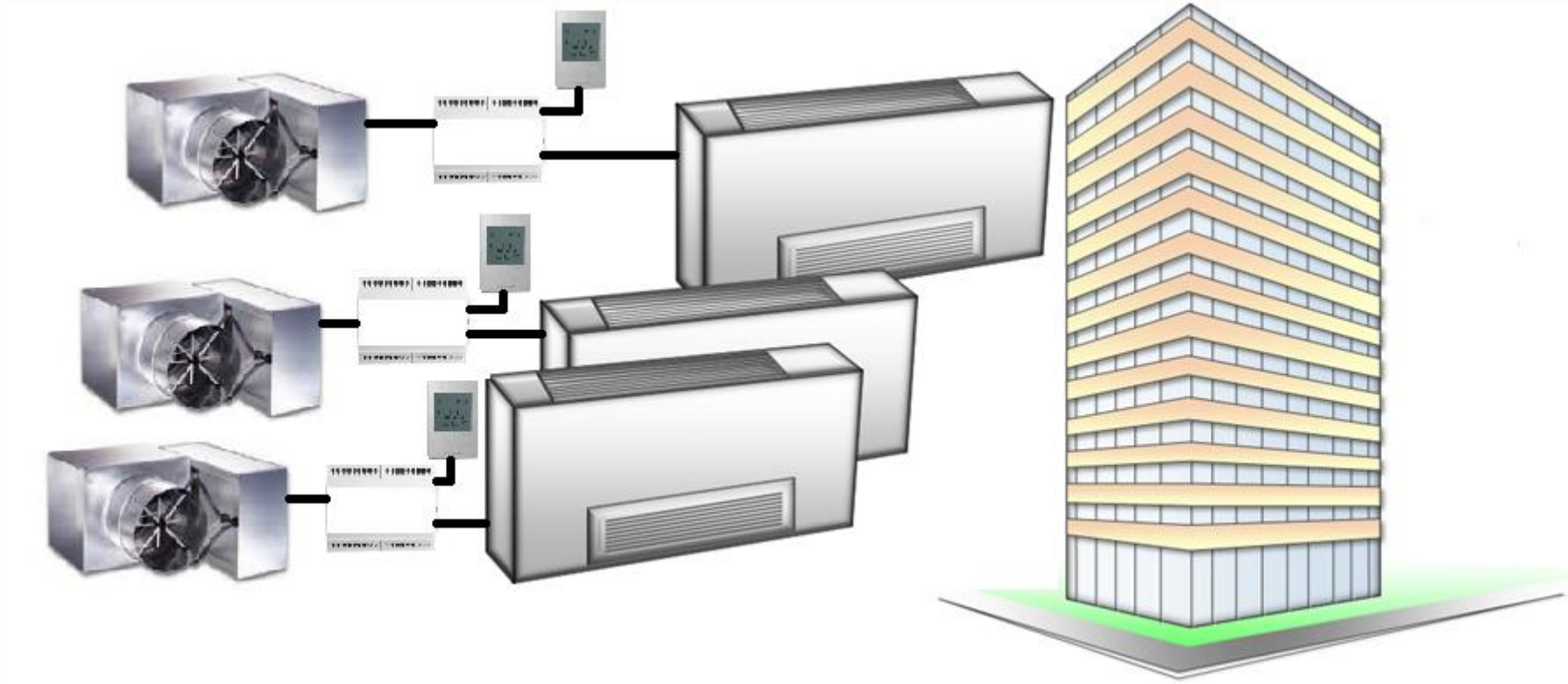
Comfort actuators in rooms: fan coils

Classical commercial buildings



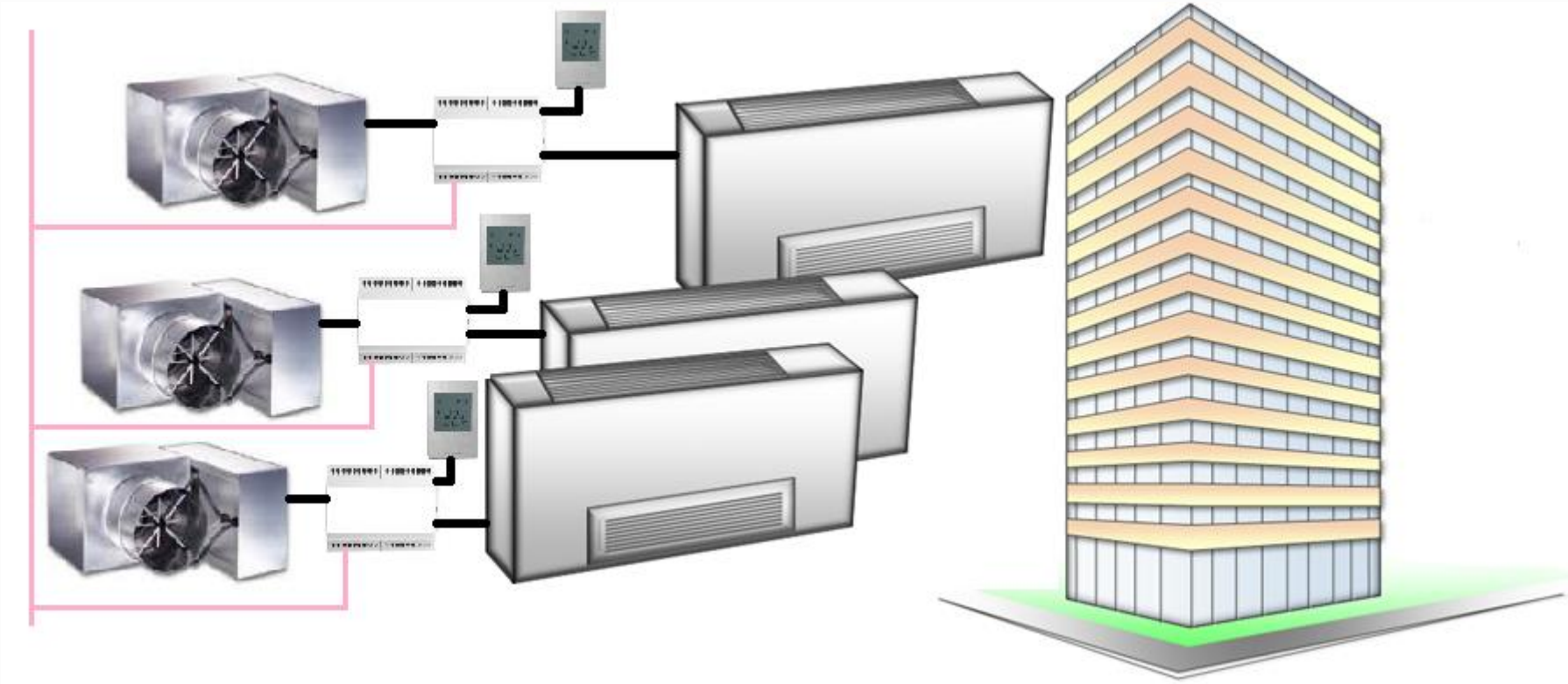
Comfort actuators in rooms: fan coils, VAV boxes or both

Classical commercial buildings



Local digital room controllers perform comfort control

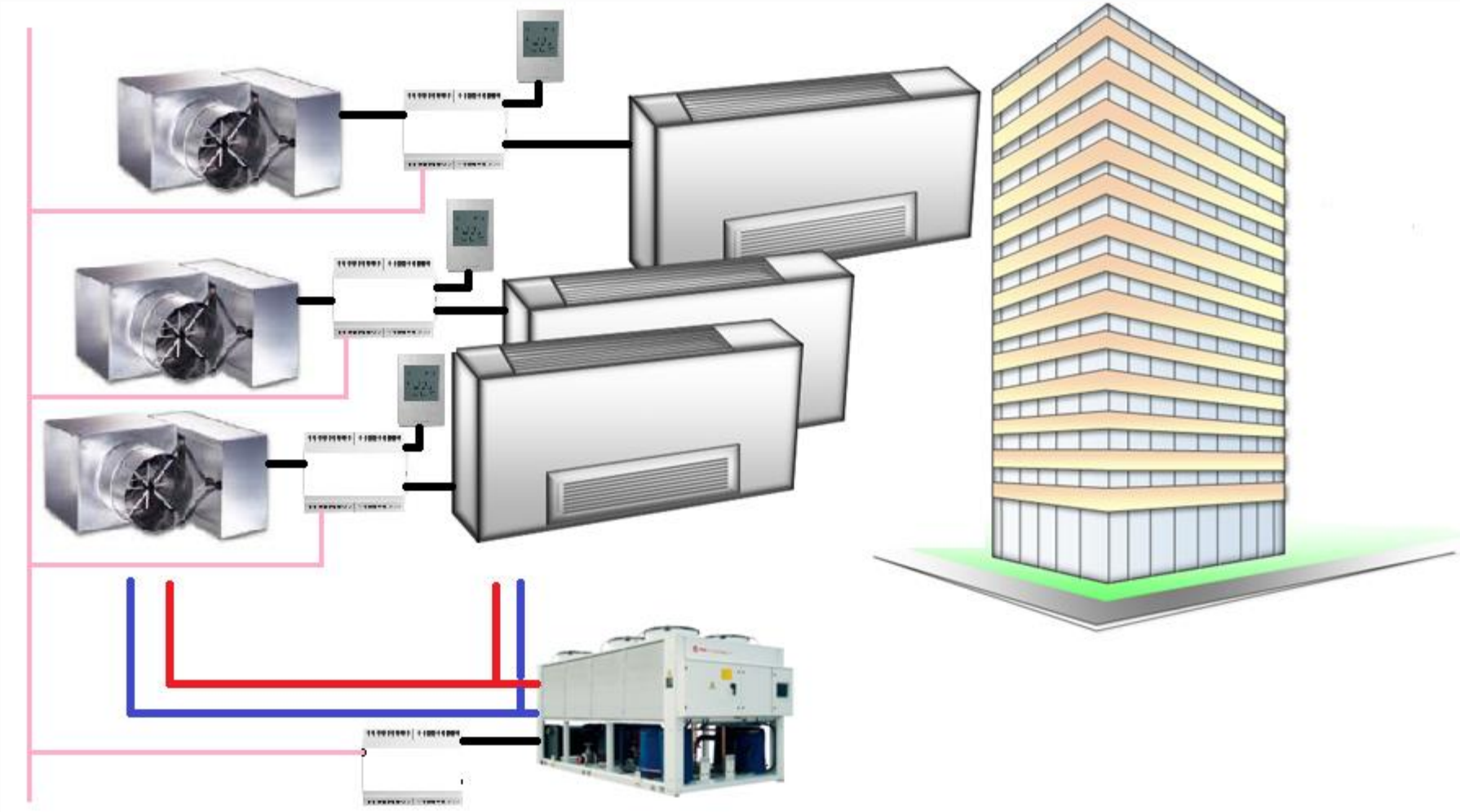
Classical commercial buildings



Local digital room controllers perform comfort control

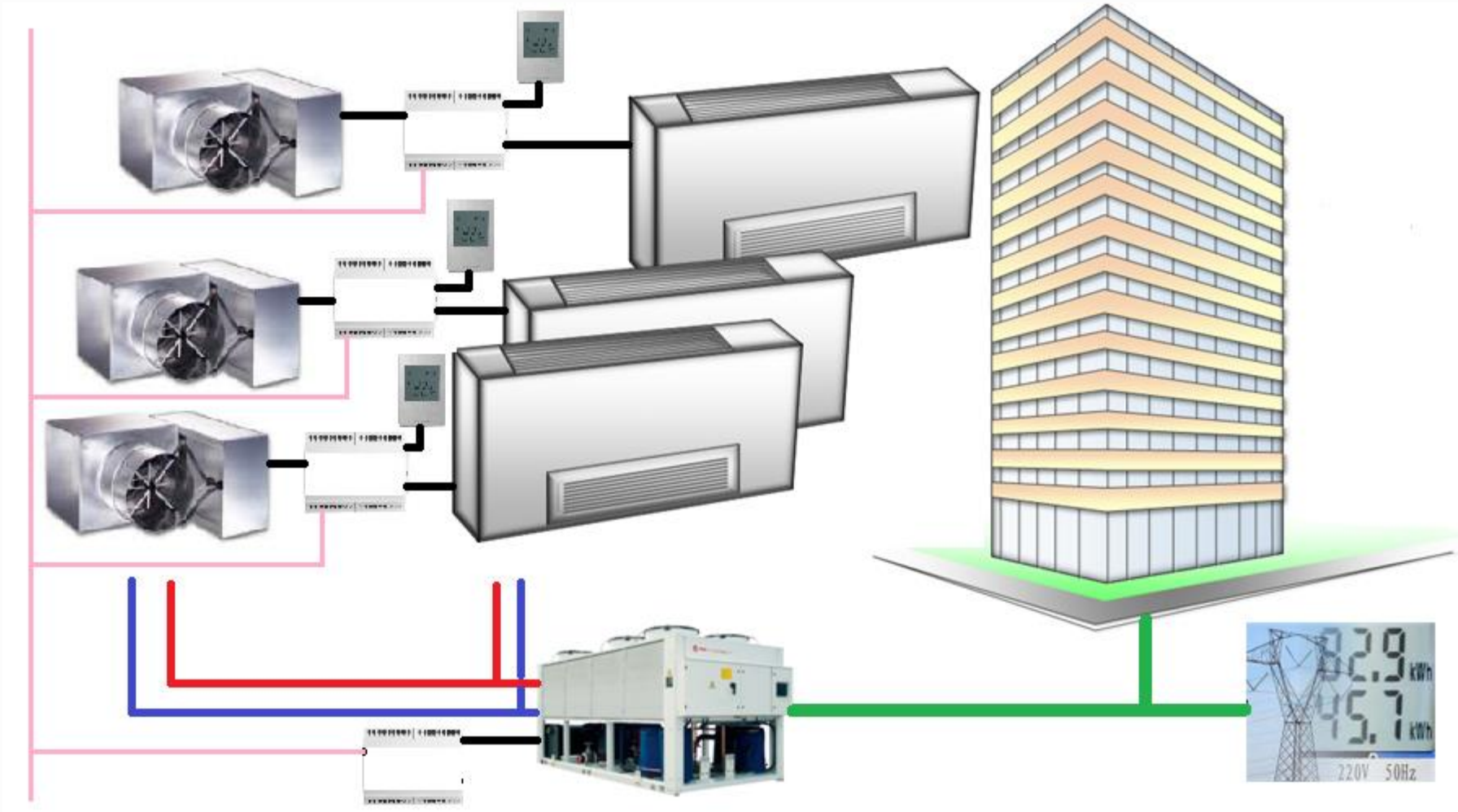
Networked for enabling central data acquisition

Classical commercial buildings



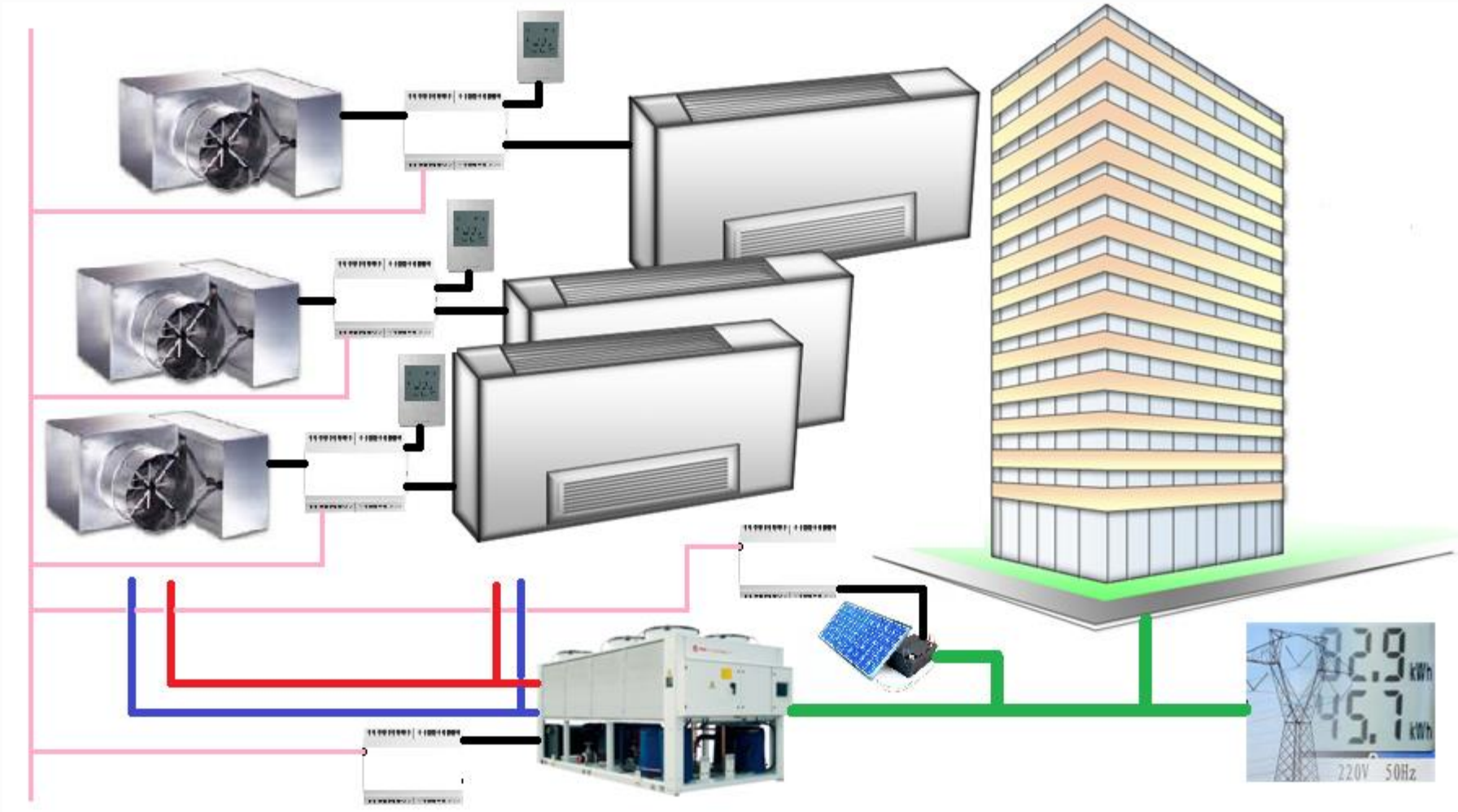
Controlled units for production of conditioning media...

Classical commercial buildings



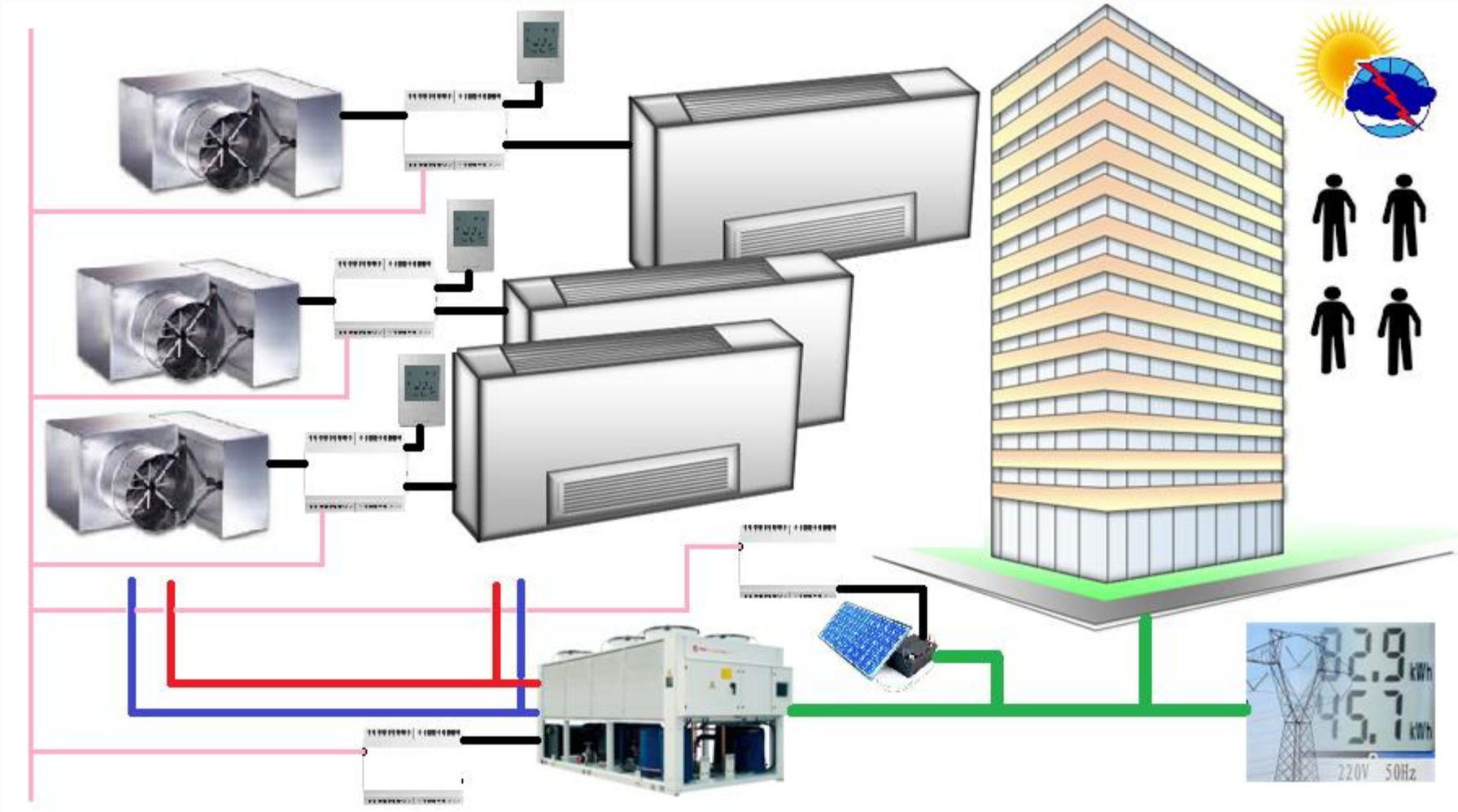
Connected to energy distribution grids

Classical commercial buildings



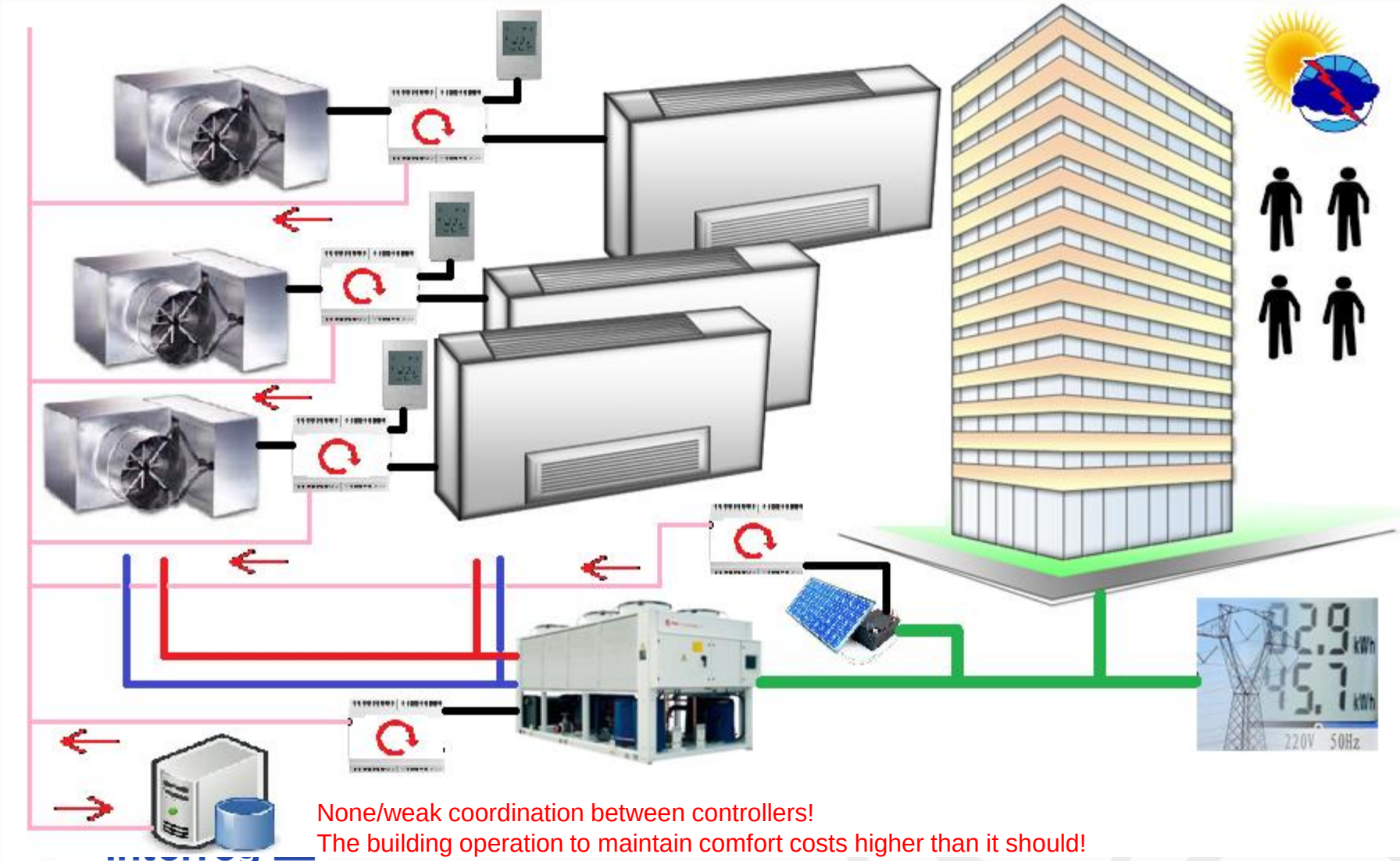
Local energy production and controllable storage

Classical commercial buildings



Weather and occupants

Classical commercial buildings



None/weak coordination between controllers!
The building operation to maintain comfort costs higher than it should!

Project drivers – buildings (4)

- Buildings are an orchestra of many individual technical systems
  - in buildings without coordination all those systems are simply reactive to local variables or time-programmed
    - e.g., heating in the zone is on/off when thresholds are reached
    - batteries are filled in the night and discharged during the day

      → the shape of energy exchange with utility grids is coincidental and non-controllable

Project drivers – utility grid (5)

- Many such non-controllable buildings coincidentally produce large peaks and sags of energy consumption on the grid
  - peaks result in progressively higher losses in the grid and may overload the grid equipment
  - high variance of energy consumption makes it difficult to assure proper supply conditions (voltage)
  - distributed generation may induce overvoltage

  → increased expenses for the grid, reluctance to renewable energy integration

What if?

- ...if we can orchestrate the building subsystems
  - such that energy consumption is reduced and energy exchange with the grids becomes controllable while the comfort remains intact

Example 1 – Predicted sunshine during heating

- No coordination: The room is heated up to the moment when together with sunshine effect overheating and discomfort occurs

  →non-necessarily spent heating energy

- With coordination: Predictive controller reduces/stops heating well before the sunshine event and remains permanently within comfort temperature bounds

  →well exploited free energy from the Sun

Example 2 – Peak consumption

- No coordination: Cooling is turned on at 7:00 in the morning, cooling elements in all zones start at the same time and produce a huge power consumption peak from the grid

  →high power peak can significantly increase energy costs for the building

- With coordination: Cooling elements in zones are synchronized in energy draw such that power peaking is avoided

  → power peaking kept under the prescribed limit

What if…

- …if the grid assigns different energy costs to different times of consumption and communicates it to the building in advance
  - … and the building through the coordination mechanism adapts to these prices by selecting the one energy exchange profile that keeps the comfort intact and has the lowest cost
- …and in this way by summing up many buildings the grid reshapes its load profile
  - … and reduces energy losses while increases its equipment lifetime

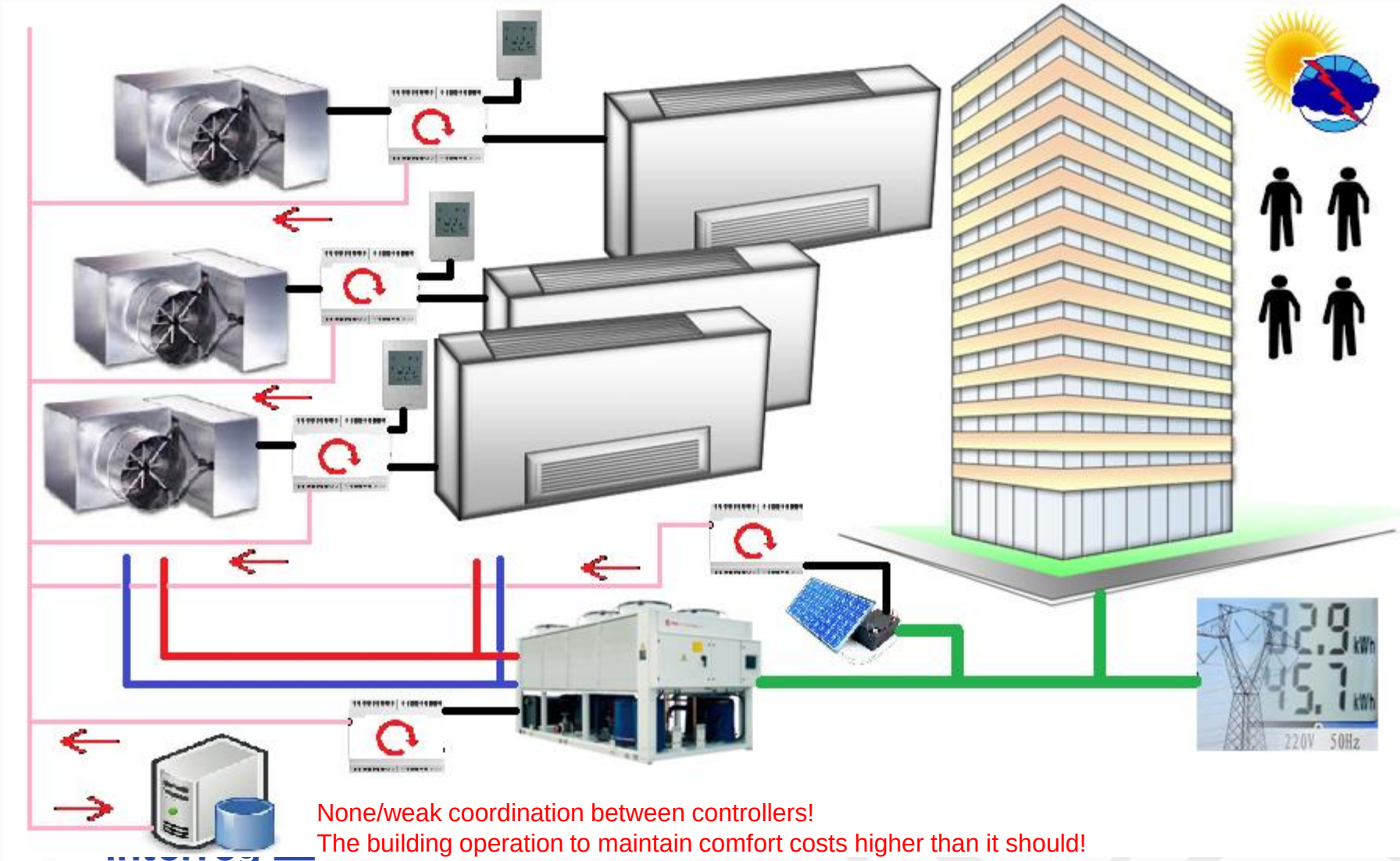
Grid-building coordination (1)

- Coordination within the building, within the grid and between the building and the grid **is technically possible**
- …how we do it?
  - Predictive control and mathematical optimizations
  - Exploiting their naturally featured market-based mechanisms for correlating prices and consumptions

Grid-building coordination (2)

- …but
- …can we make it economically viable?
  - If we can easily impose coordination over the existing systems in their variety, yes! → needed energy management tool adaptable to different building configurations
- …are we allowed to do it?
  - If we can align with regulatory framework and remove barriers → need to influence the regulatory framework on technically sound basis

Classical commercial buildings



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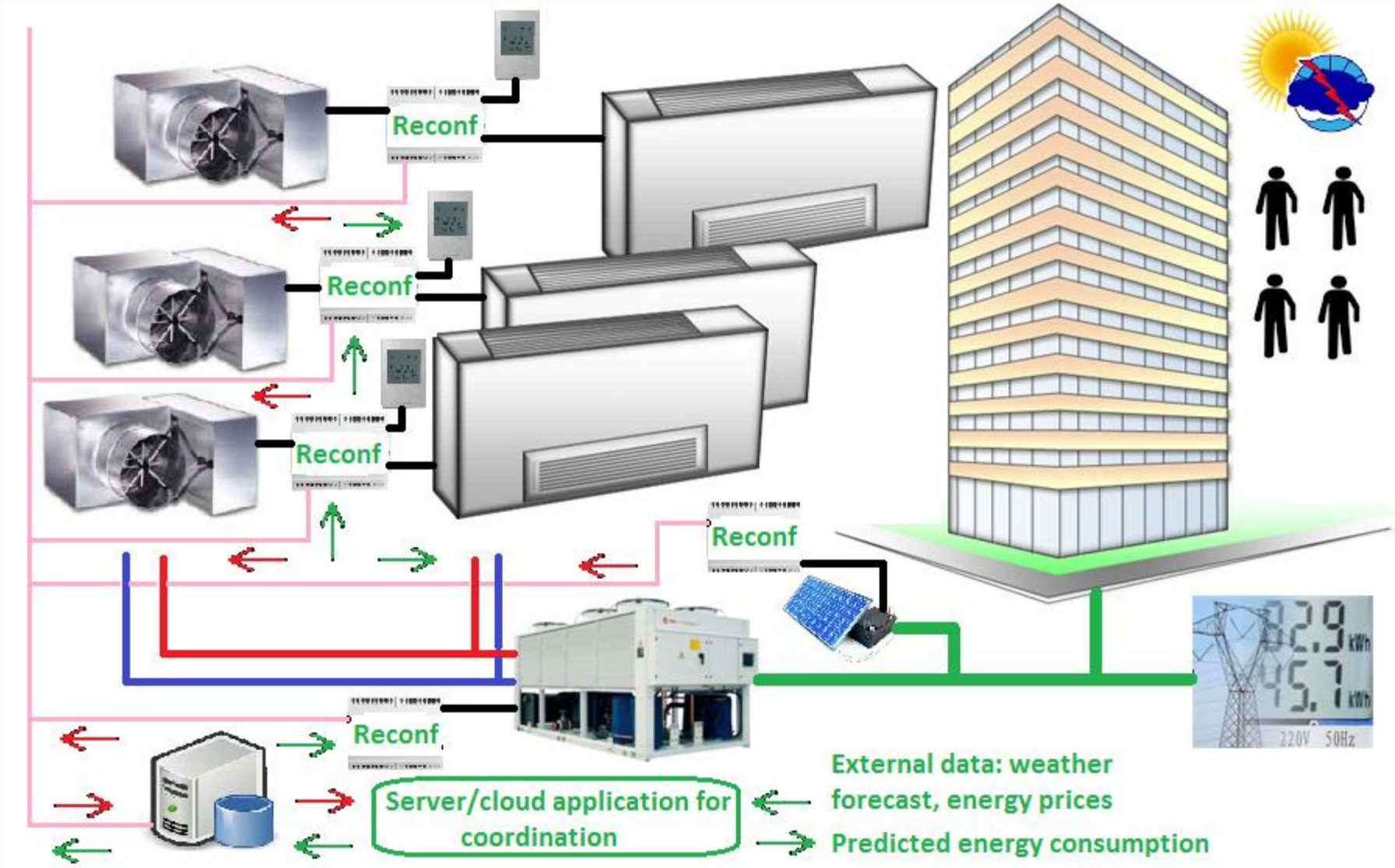
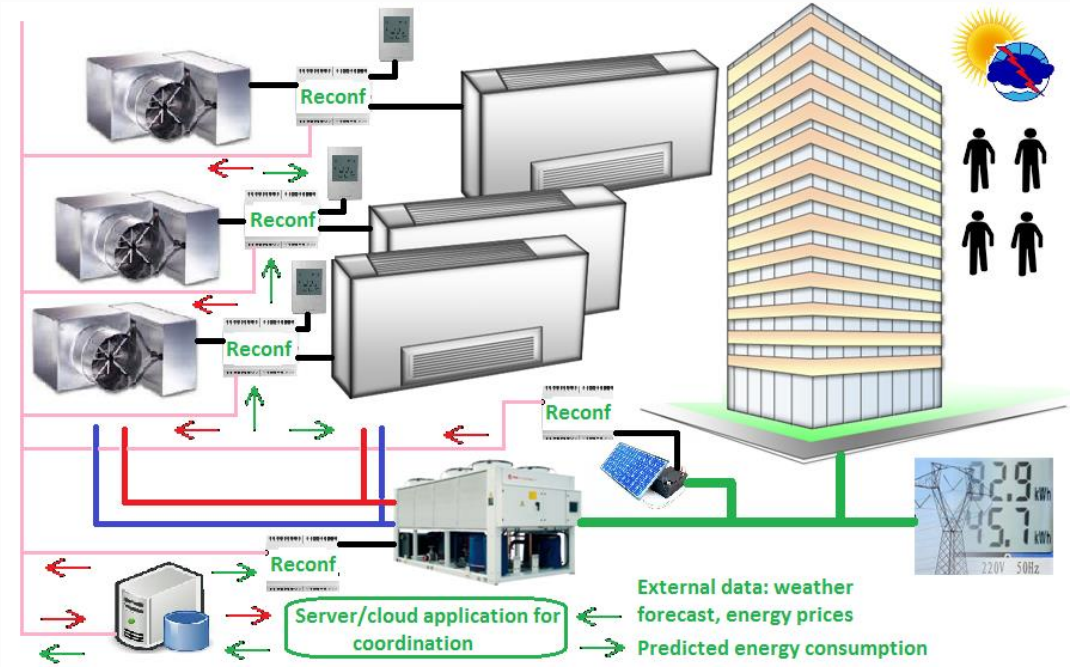
The building operation to maintain comfort costs higher than it should!

Grid-building coordination (3)



Grid-building coordination (4)

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



  - Mutually coordinated in any configuration

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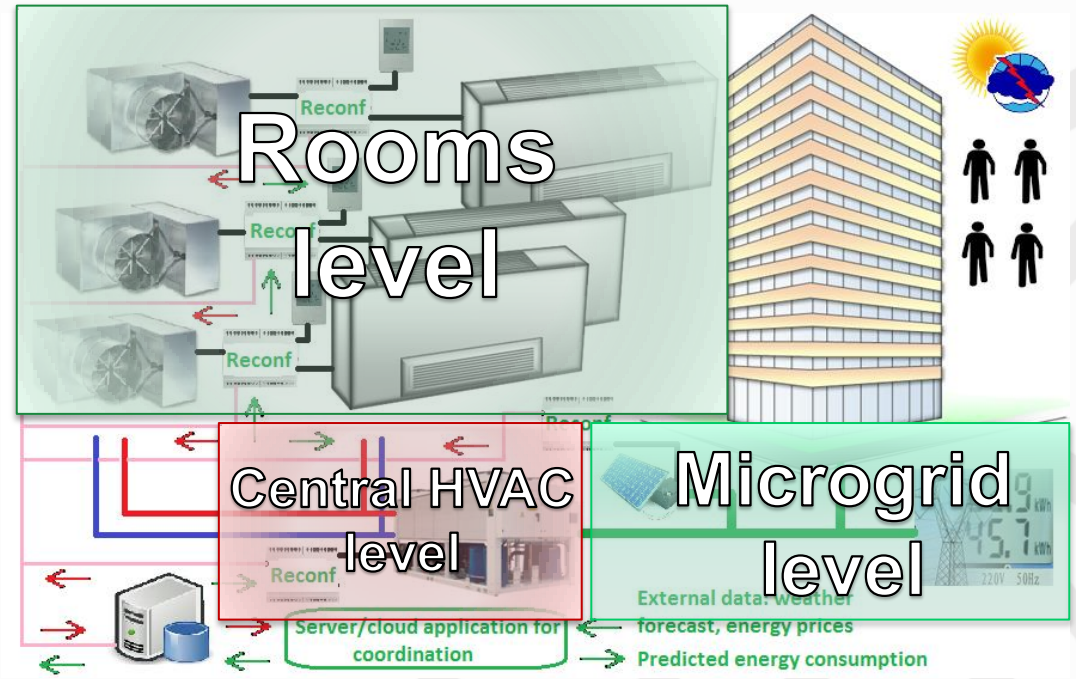


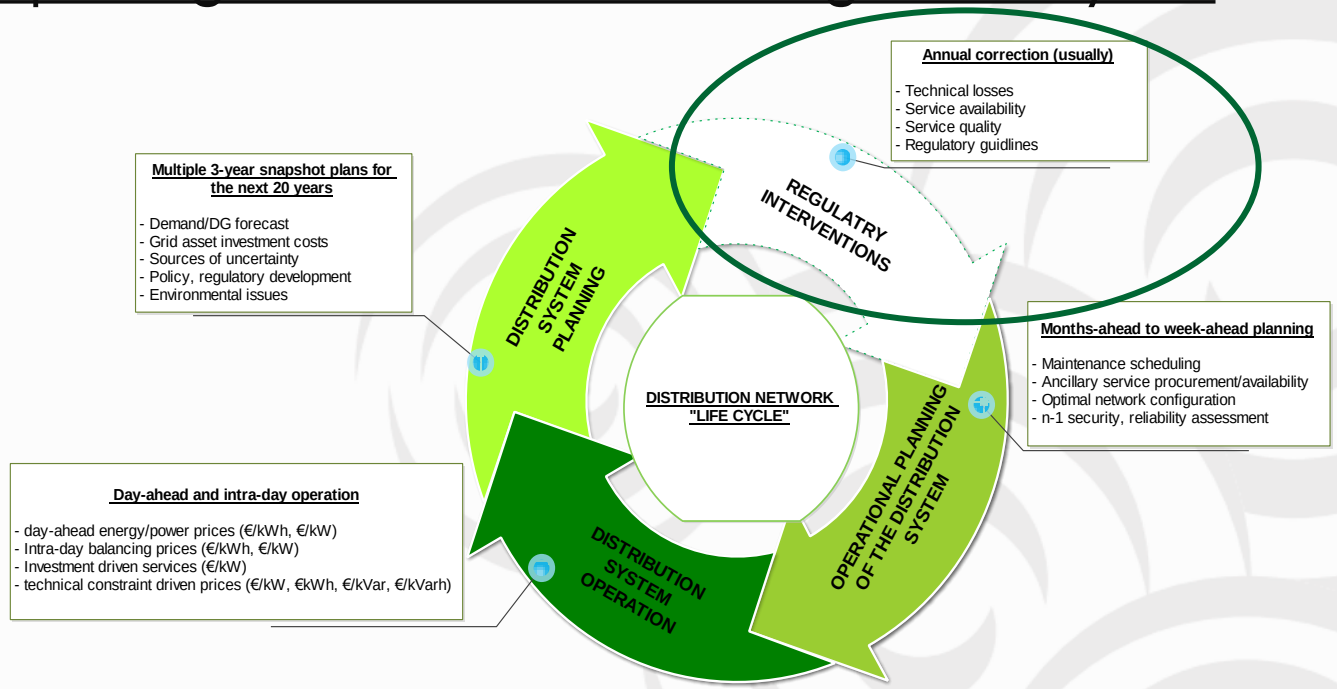
  - Mutually coordinated in any configuration

Grid-building coordination (6)

- How does the „grid see" consumers/producers?
  - Passive new load → reinforce the grid!
  - Distributed generator → voltage issues (compensations), congestion (more copper), security of supply (more copper)
  - Electric vehicles are coming → high peak load if no control in EV charging!
- Active distribution management – but what does it mean?

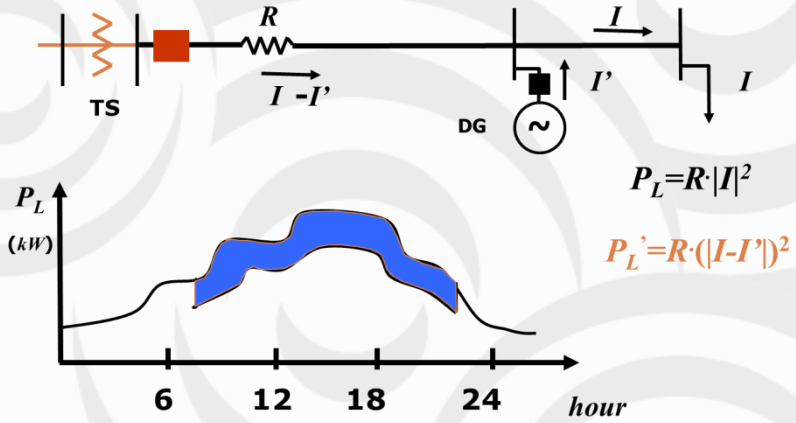
Grid-building coordination (7)

- …how do we do it?
- …can we make it economically viable?
  - coordination over different time periods → challenging task of capturing different distribution grid life cycles



Grid-building coordination (8)

- What do we want to achieve?
  - Active DSO, optimally use different resources through market mechanisms
  - Coordinate building-grid-market
  - Flexible sources in the service of the grid/system
  - Change the way of thinking and „doing business" for all power system entities



Grid-building coordination (9)

- … can we find common grounds for the grid-building energy management in the entire Danube region?

  → hopefully yes, through the **3Smart** project!

Overview of 3Smart (1)

- 3Smart overall objective:
  - provide a technological and legislative setup for cross-spanning energy management of buildings, energy grids and major city infrastructures in the Danube region

Overview of 3Smart (2)

- 3Smart specific objectives:
  - SO1. Enable energy management between buildings and distribution grids
    - →cross-spanning energy management tool
  - SO2. Demonstrate effectiveness and feasibility of modular energy management
    - → pilots in HR, SI, AT, HU and BA
  - SO3. Enable take-up of the platform in buildings, grids and infrastructures
    - → strategy to influence the regulatory framework, strategy for EMS take-up on city scale, training, stakeholders engagement, cost-benefit analyses

Overview of 3Smart (3)

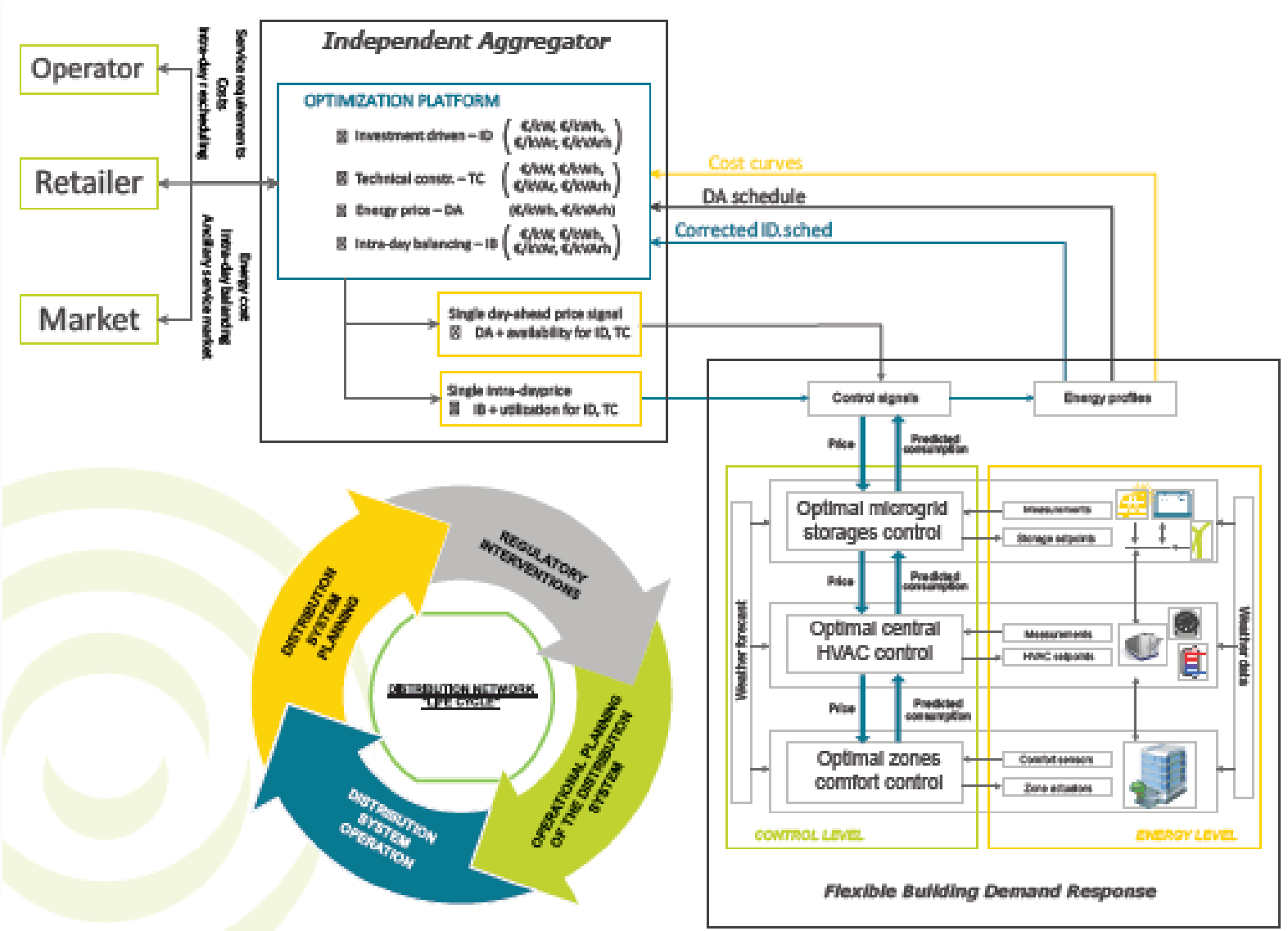
Partners

- UNIZGFER (Lead Partner), HEP (HR)
- E3, IDRIJA, ElektroP (SI)
- EEE, STREM, EnergyG (AT)
- UNIDEBTTK, EON (HU)
- UNIBGFME (RS)
- EPHZHB, SVEMOFSR (BA)

Associated Strategic Partners

- HERA (HR)
- GOLEA, JSI (SI)
- FERK (BA)
- HEA (HU)

Building-grid cross-spanning platform



Pilots

- The modular 3Smart energy management tool put in place in 5 pilots in 5 different countries of the Danube region:
  - UNIZGFER and HEP buildings in Zagreb, HR
  - school and sports hall in Idrija, SI
  - school and care retirement home in Strem, AT
  - EPHZHB headquarter building in Mostar, BA
  - EON headquarter building in Debrecen, HU

Platform, training, replication

- Platform is developed by modules and different partners contribute to it
- Pilot leaders and pilot hosts trained how to install, monitor and maintain the modules locally
- Platform operation will be presented to the public within pilots, in about 2,5 years time

3Smart vision

- Enabled economically optimal interoperation of energy efficiency measures and renewable energy sources in buildings
- Initiated installation of distributed storages to improve energy security in the Danube region
  - storages will further enhance controllability of the energy exchange profiles
- High share of renewable energy in the energy mix

Acknowledgement

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PROJECT WEB PAGE

www.interreg-danube.eu/3smart

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