National 5G Energy Hub

Introduction of Future-Oriented Communication Structures in Energy Technology

Garching 19.03.2019

Supported by:

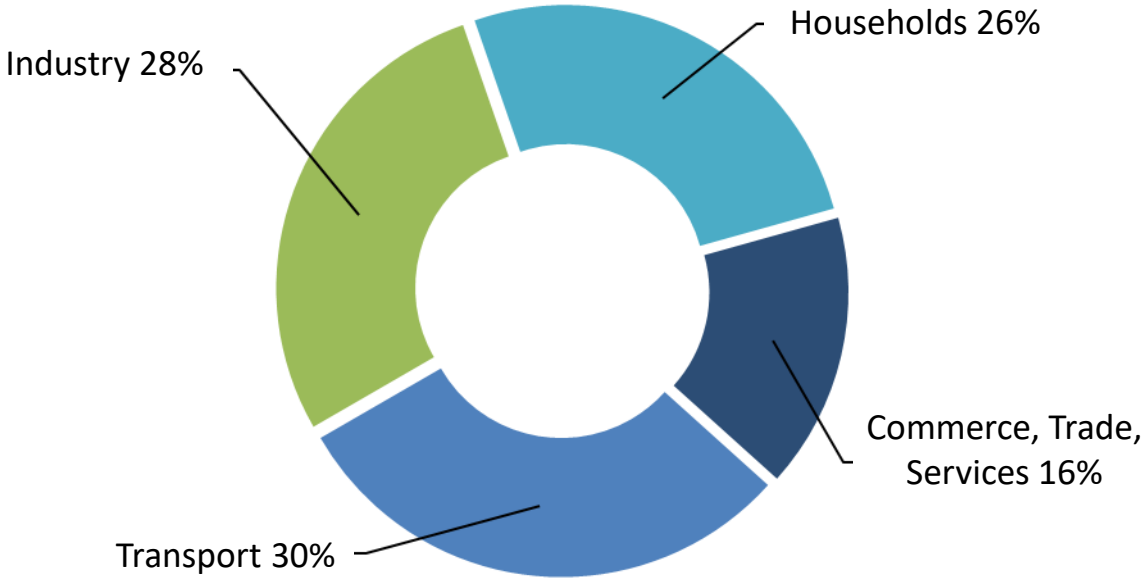
Federal Ministry of Economics and Technology

on the basis of a decision by the German Bundestag

Agenda

1. Motivation
2. National 5G Energie Hub - Project Details
3. Use Cases
    1. Regional Virtual Power Plant
    2. LV/MV-Grids: Grid Protection
    3. Building Closed Loop Control in Cloud (incl. Monitoring)
    4. LV/MV-Grids: Monitoring and Control with PMU
4. Outlook

Energy Consumption in Germany



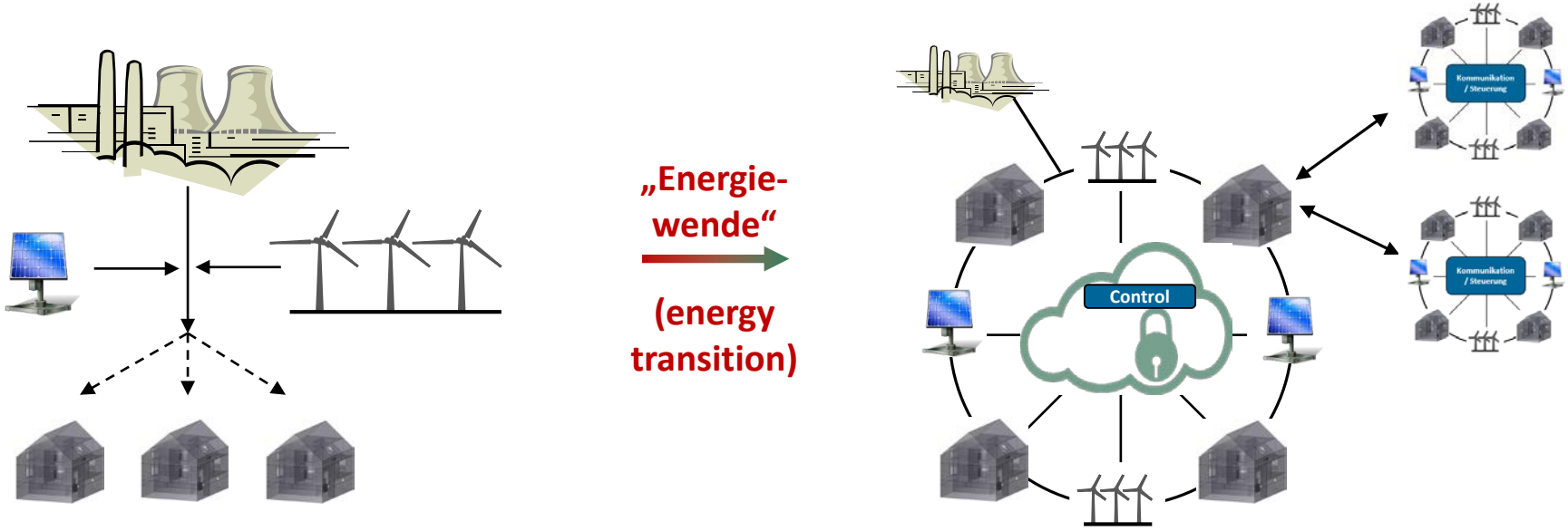
Distribution of primary energy consumption in Germany, 2017
(source: energy characteristics BMWi)

National / International Activities to Reduce Primary Energy Consumption

1. Expansion of renewable energies by 2030 (electricity - 30 % - already achieved today)
2. 55% reduction in CO2 emissions by 2030 (1990 reference)
3. Reduce energy consumption and increase energy efficiency by 2050 (reduce primary or final energy consumption by 50%)

Structural effects on energy supply in Germany

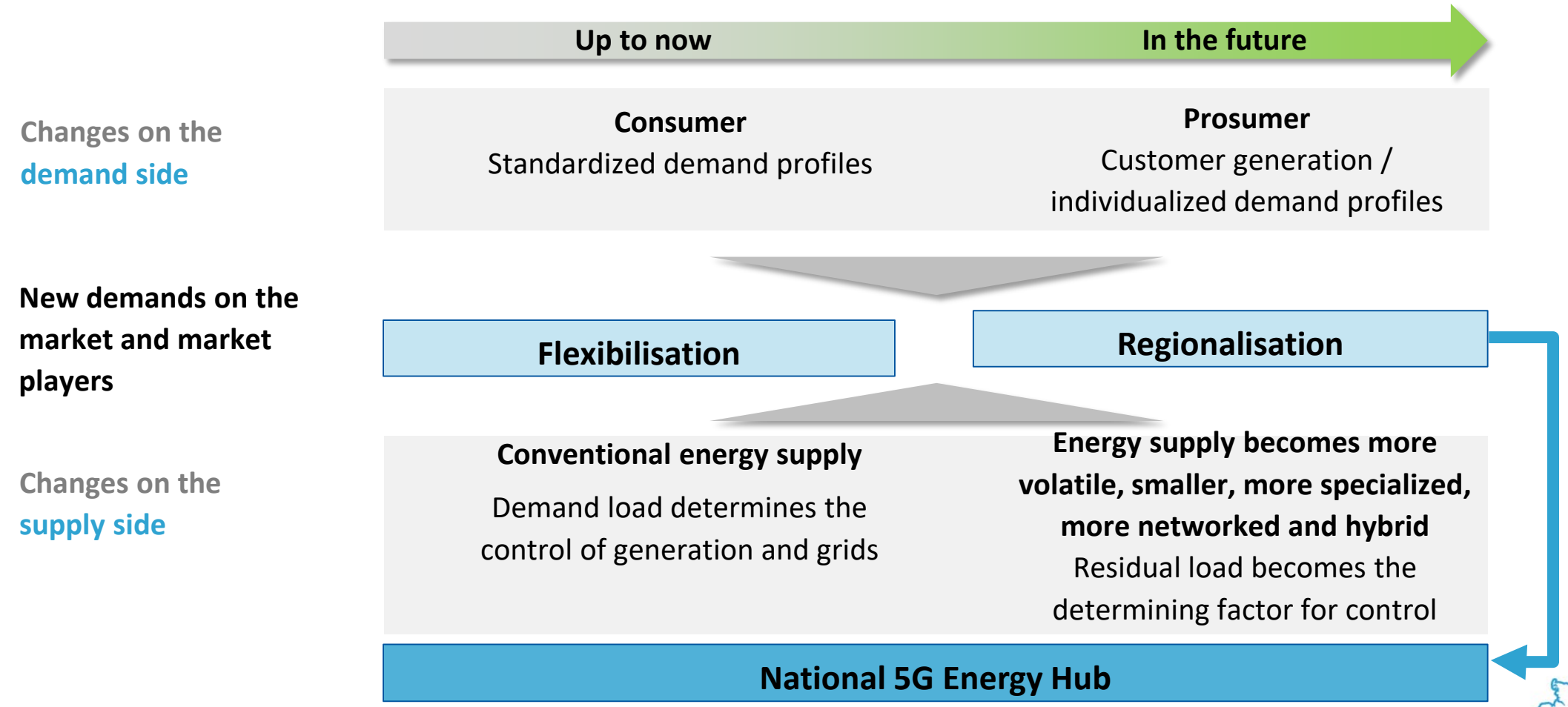
Structural Change of the Energy System: Centralised to Decentralised



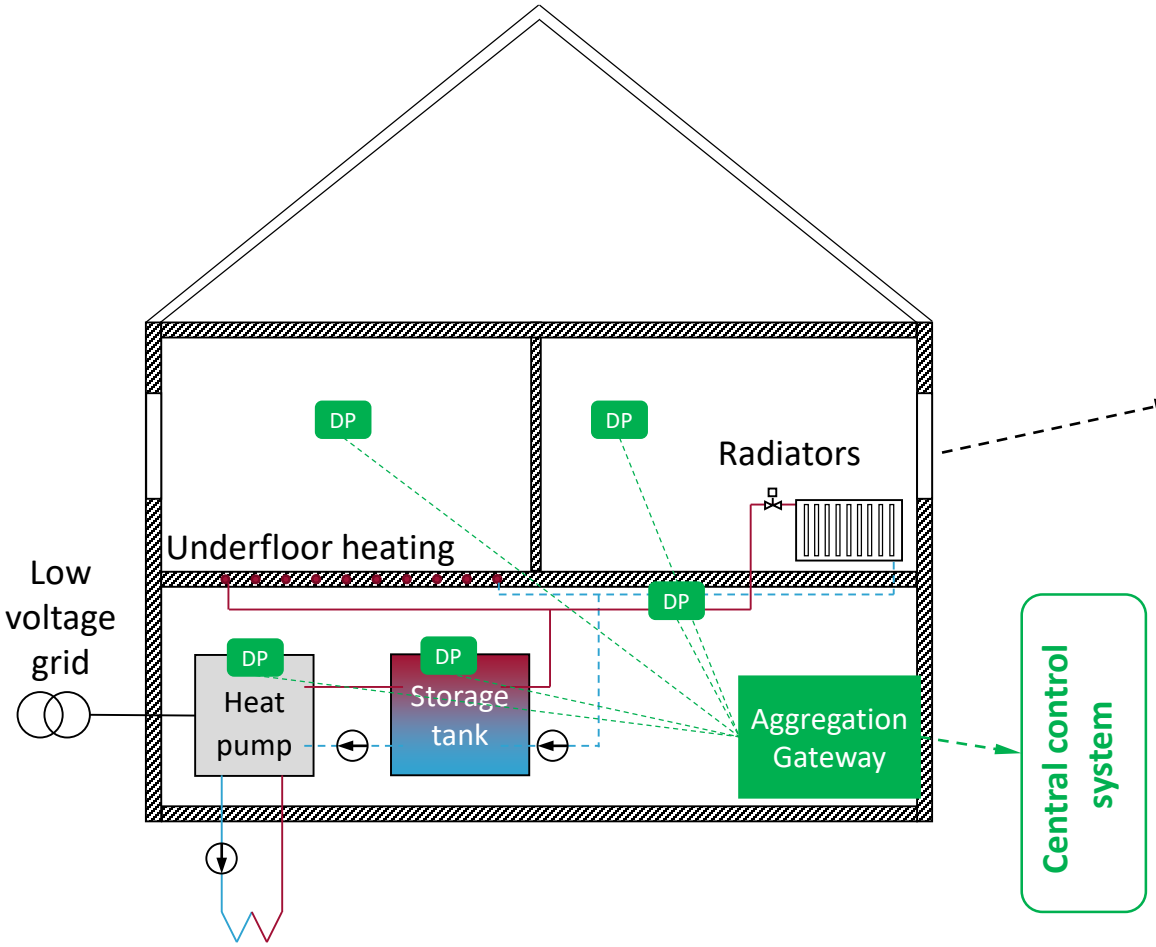
Challenges:

1. Linking of different domains (stationary / mobile applications)
2. Control and operation of the systems
3. Communication structures / security / reliability of energy supply

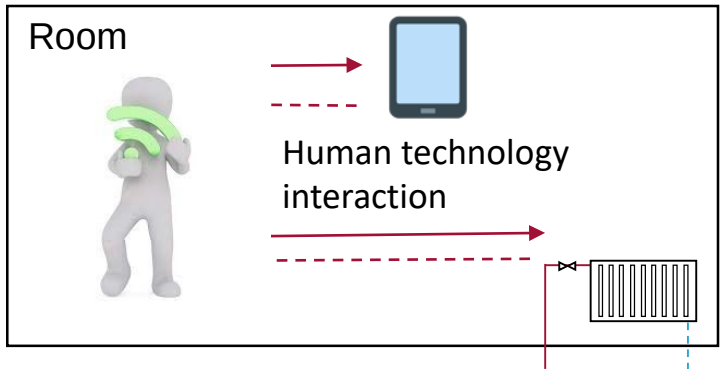
Flexibilisation and Regionalisation in the Energy Sector



Building Sector: Actual Situation and Possibilities

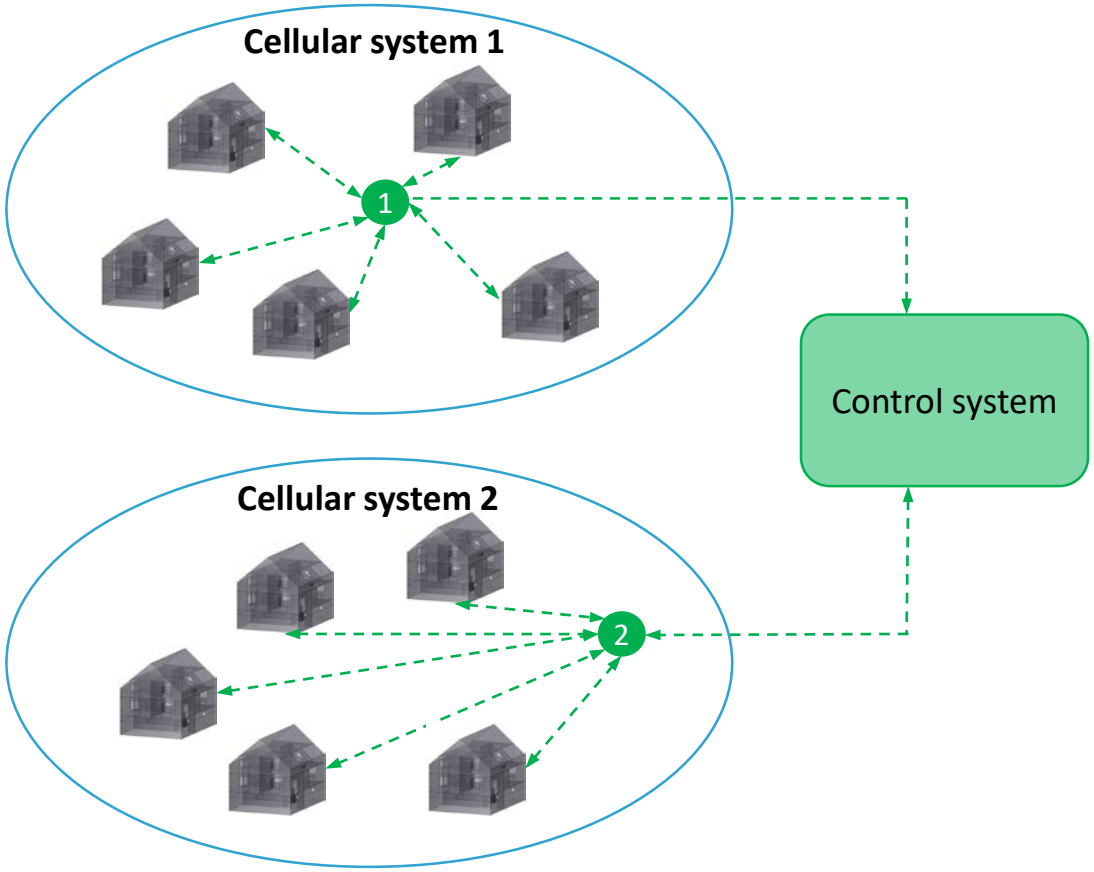


- Non-communication-capable control devices



- Control of the systems according to different aspects (heat physiological / energetic)
- Building as flexibility potential for the previous systems

Interaction with the previous energetic systems



National 5G Energy Hub

- Coupling of thermal/ electrical energy technology + communication technology
- Covering the entire transmission path from the sensor to a central backend (cloud)
- Development of control algorithms for local and regional energy optimization

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Project Details

- **Project partners:** RWTH Aachen / TU Dresden / Ericsson

- **Project runtime:** 01.05.2018 – 30.04.2020 (Projekt phase I)
  01.05.2020 – 30.04.2024 (Projekt phase II)
  01.05.2024 – 30.04.2028 (Projekt phase III)

- **Funding:** BMWi

- **Associated partners:** E.ON SE, Landeshauptstadt Dresden
  Techem GmbH
  VdZ – Forum for Energy Efficiency in Building Technology e.V.

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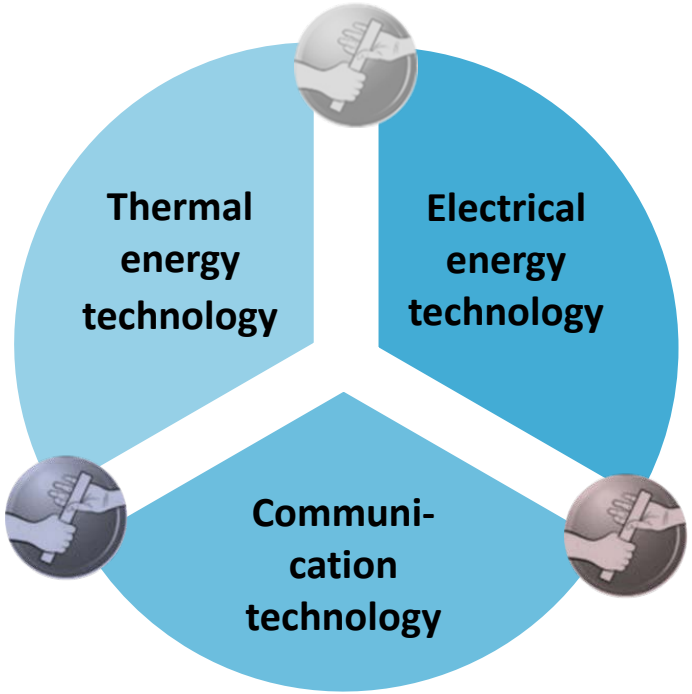
Main Project Tasks

National 5G Energy Hub



1. Development of a Communication - Open Source Platform for Energy Systems

- Creation of a system architecture for thermal and electrical systems

2. Development of a Cloud Solution for Energetic Applications

- Database Systems / good scalability / Flexibility / easy configurability

3. Development of Gateway Systems (Edge Controller)

- Development of the application gateway hardware / software

4. Sensors and Actuators

- Development and testing of actuator- and sensor-systems using wireless technologies

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User Story: „Smart Grid“ and „Smart Building“

User Story

Smart Grid	Smart Building
Intelligent and *robust operation* of electrical power supply systems to enable *improvement of energy efficiency* and flexibility while maintaining reliability.	Control of energy systems in buildings, aiming for energy efficiency, reduction of CO_2 emissions and a high proportion of energy consumption covered by renewable energies.

Use Case

Regional

PQ-Monitoring
Latency: not relevant — Data points: 3x25x300

Voltage Regulation MV-grid
Latency: < 1 s — Data points: approx. 3x300

Building-Monitoring
Latency: < 30 s — Data points: < 8000

Regional Virtual Power Plant (Regional-VPP)
Latency: < 350 ms — Data points: < 150.000

State Estimation LV-grid
Latency: 100 ms adressed — Data points: 3x300

Cloud Control of Energetic Systems
Latency: < 200 ms — Data points: < 8000

Local

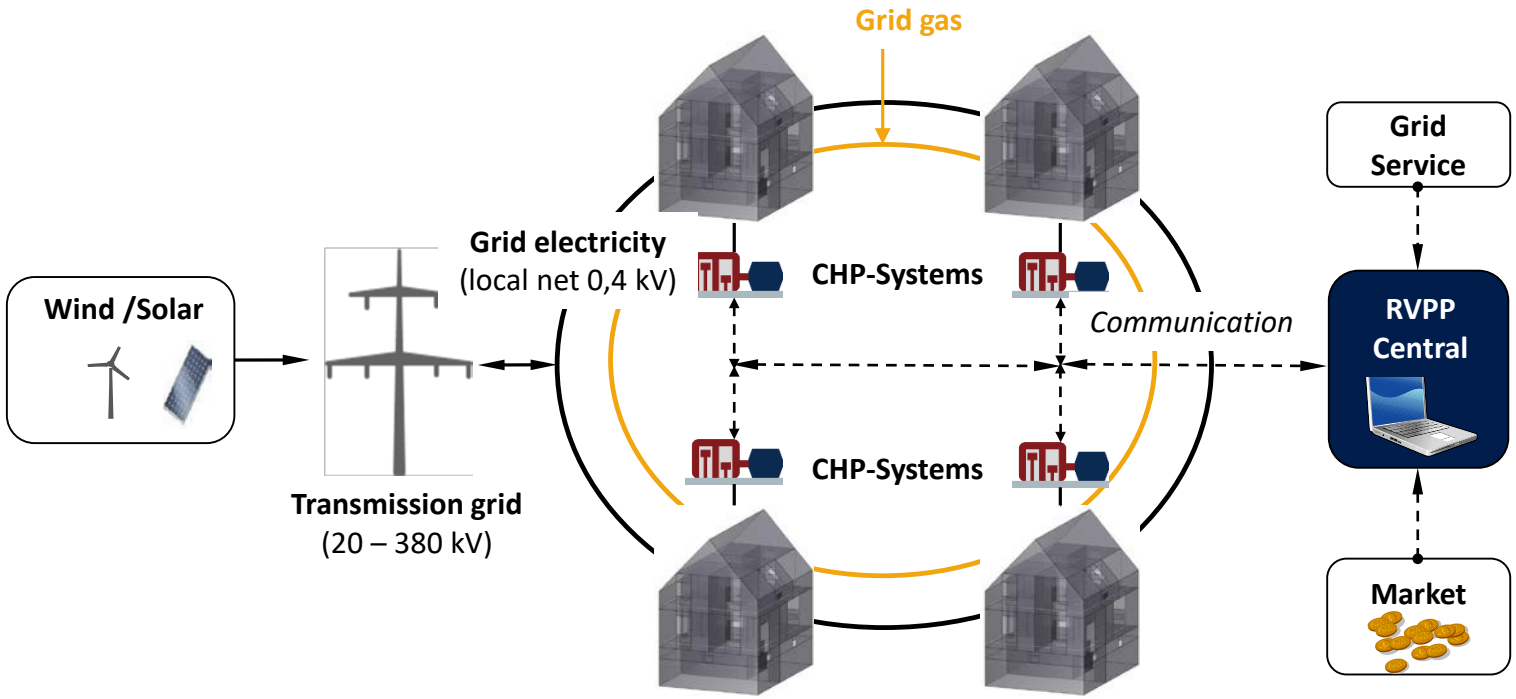
Grid Protection Support (Fault Detection)
Latency: 1 ms adressed — Data points: 3x300

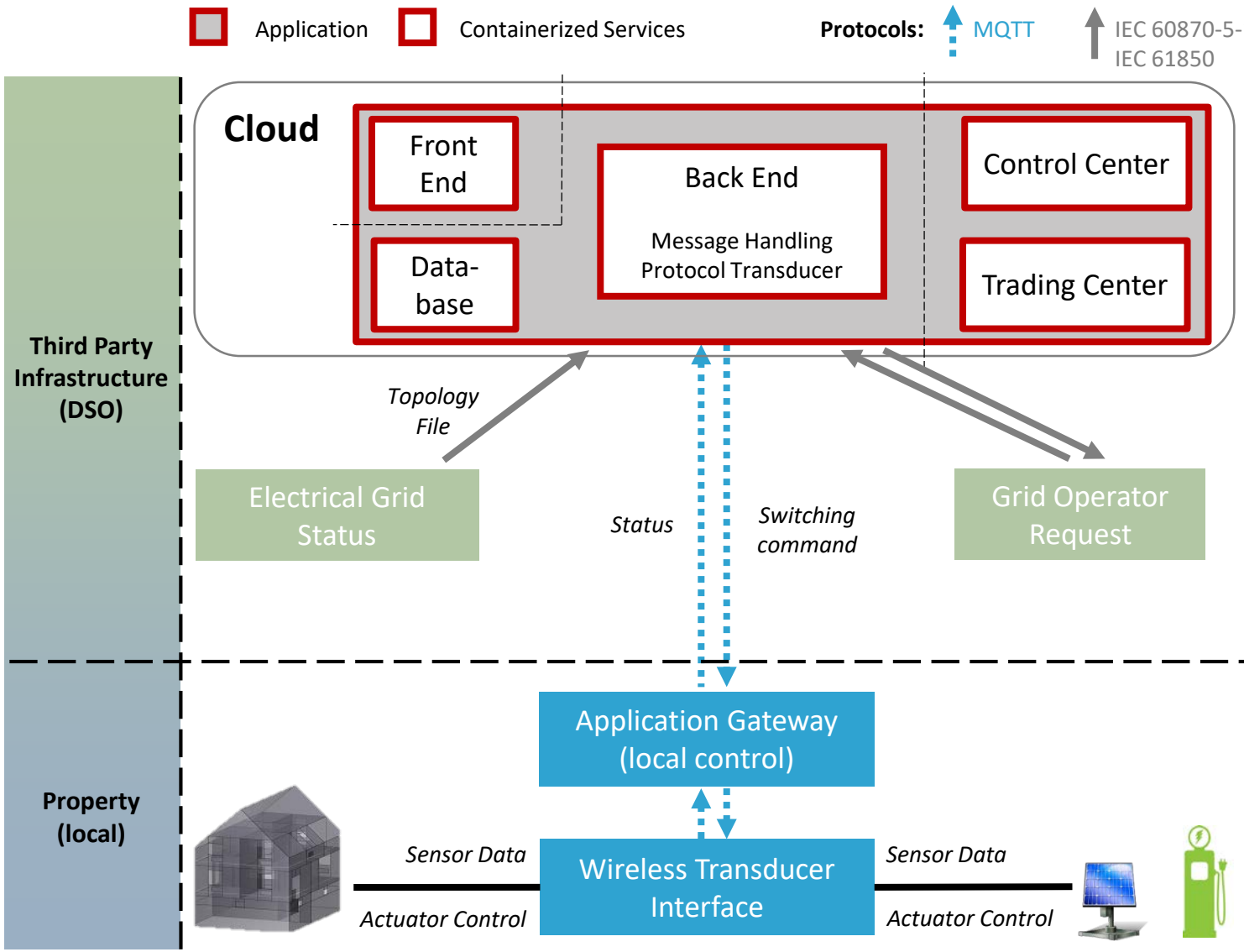
Motivation:

- Grid-compatible operation of the decentralised producers - use of thermal flexibilities (sector coupling)
- Participation in energy trading possible through pooling

Objective:

- Energy and cost optimal operation local/overarching





- Back End (Cloud) with coupling to systems of network operators or energy service providers
- Network operators or energy service providers can specify control conditions and receive monitoring information via standardized interfaces

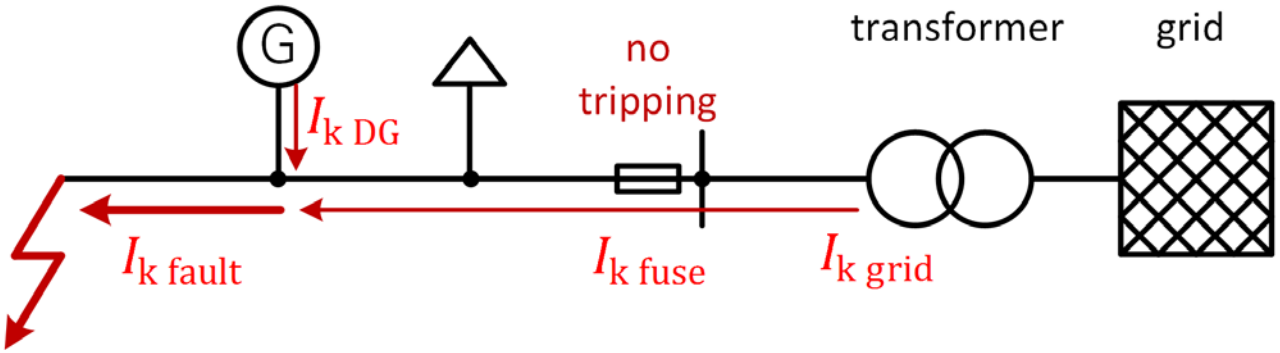
- Sensor signals are aggregated and preprocessed in Gateway
- Gateway can also take over basic control functions independently from the cloud

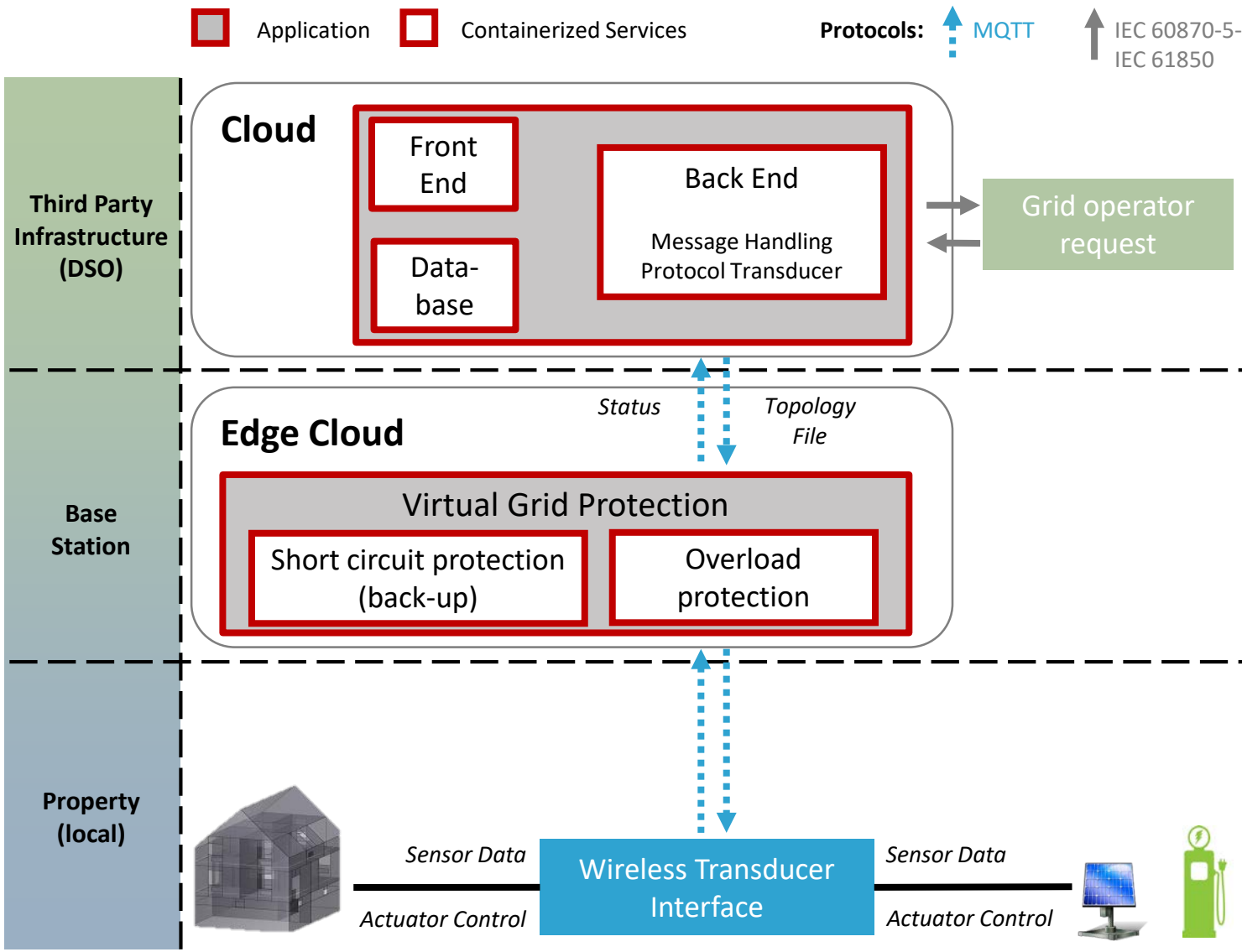
Motivation:

- More PV systems and CHPs at the LV and MV levels
- The LV and MV levels, however, have only a rudimentary protection concept

Objective:

- Reliable detection of faults through reserve protection in the LV network
  advantages: radio-supported, retrofittable, cost-effective
- Evaluation of grid states (e.g. short-term overload) as support for grid protection in the MV grid





- Back End (Cloud) with coupling to the systems of the grid operator
- Grid operator will run his own cloud resp. can hire managed cloud

- Radio network operator will provide fee-based access to Edge Cloud
- Services can be shifted to Cloud if Edge Cloud is not available
- Different protection algorithms can be deployed

- Plug‘n play sensor systems will provide instantaneous values of current
- Time synchronicity of transducers is very important
- An application gateway should not be necessary

Motivation:

- Standard sensor and actuator integration:
  - High cabling effort
  - Low interoperability of different bus systems
- Maintainability of the automation software on local controllers is difficult

→ Cloud-based building automation by using 5G

Objective:

- Thermal and electrical system monitoring
- Control and optimization of building energy systems

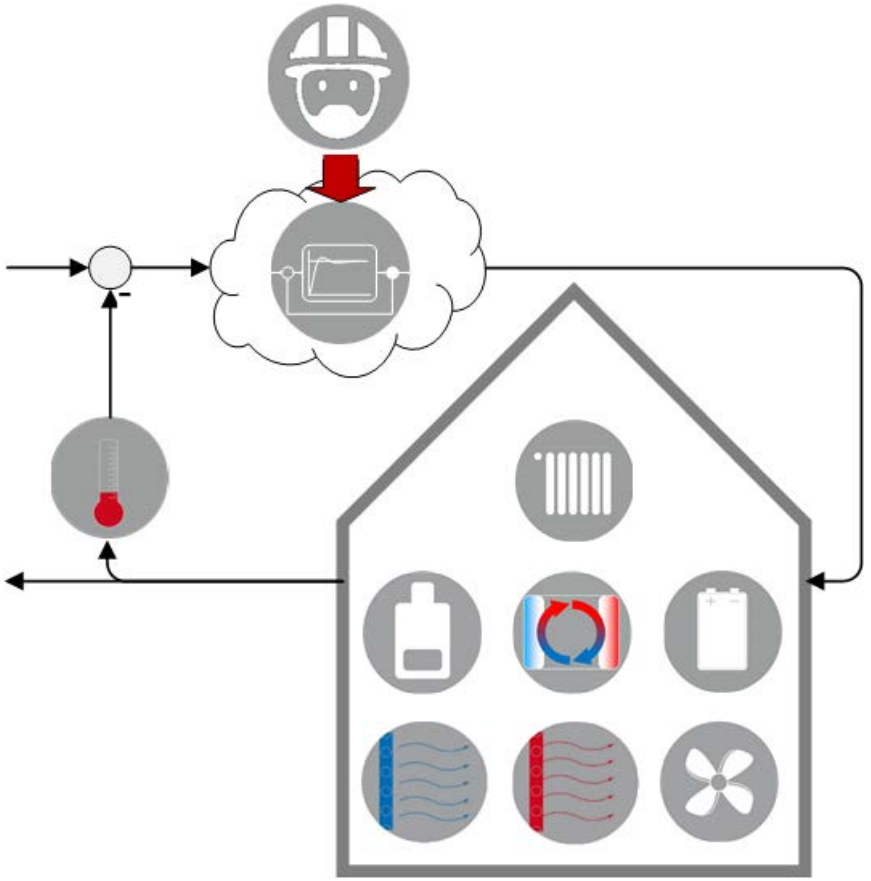
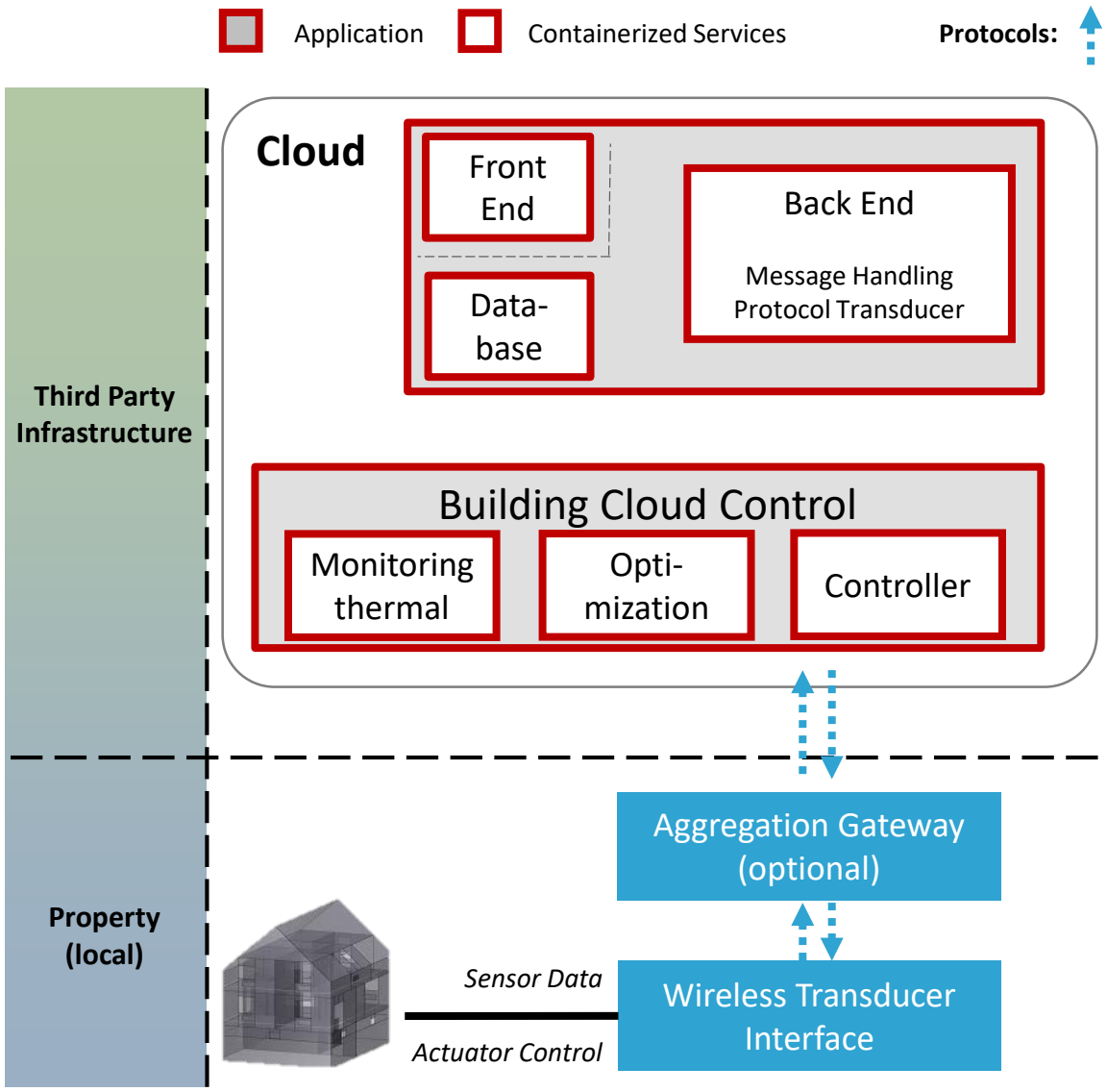


Image source: RWTH Aachen

Building Cloud Closed Loop Control (incl. Monitoring)

Use Case 3b



- Management, visualization and analysis of the building operation
- Control algorithm runs in the (Edge) Cloud
- Actuator signals are sent back to the building
- Transducer interface connects sensors and actuators with the cloud via 5G

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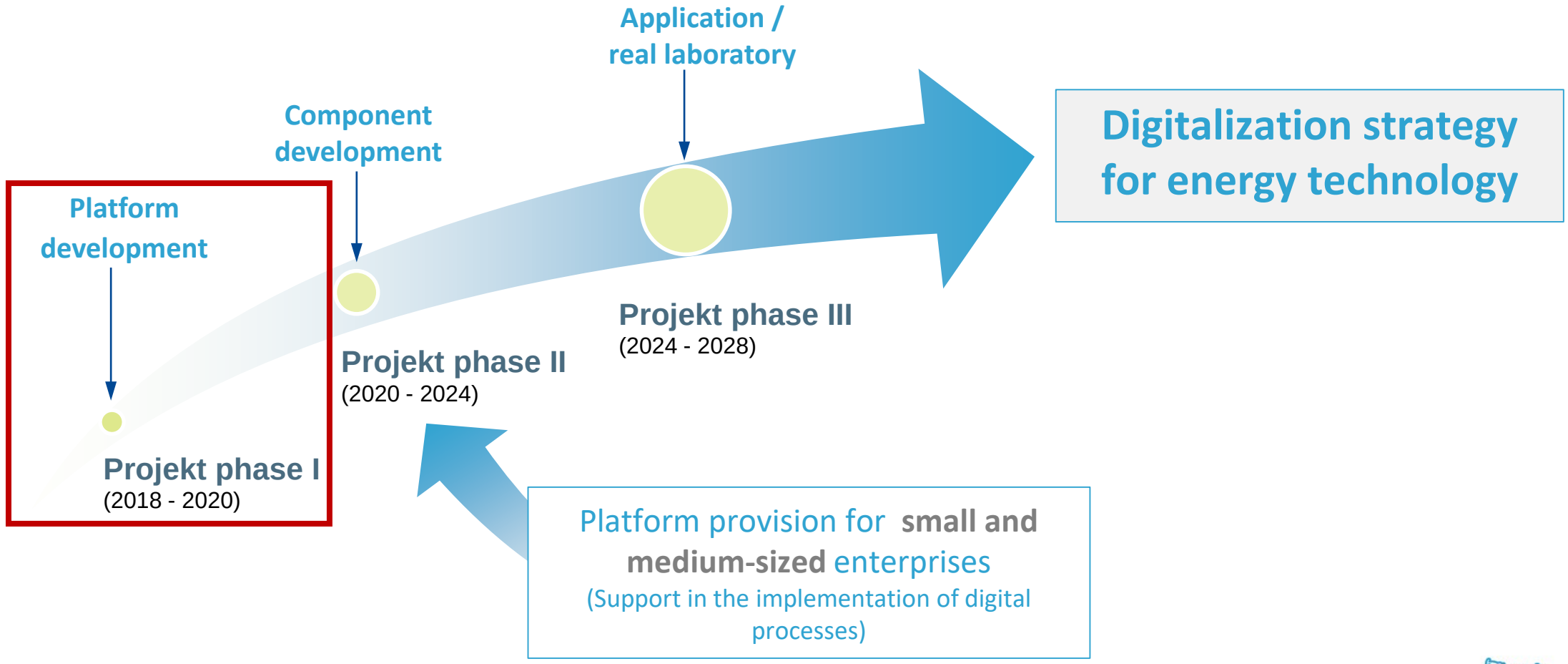
Outlook


Application /
real laboratory
Component
development
Platform
development
Digitalization strategy
for energy technology
Projekt phase III
(2024 - 2028)
Projekt phase II
(2020 - 2024)
Projekt phase I
(2018 - 2020)
Platform provision for small and
medium-sized enterprises
(Support in the implementation of digital
processes)

- Thank you for your attention -

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