Data Life Cycles in Future Residential Multi-Commodity Energy Management Systems

Fabian Rigoll, Christian Gitte, and Hartmut Schmeck

Karlsruhe Institute of Technology (KIT), Germany

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Picture: "Turbines" by Steven Feather via flickr, 8 Sept 2014

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Karlsruhe Institute of Technology: The Merger of National Research Center Karlsruhe and Karlsruhe University

Source: KIT, 01/2014

Employees

9,254

Students

24,582

359

Professors

785

Annual Budget in Million Euros

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Energiewende – A Large Project for Future Generations

Political Agenda in Germany

- Ambitious goals
  - 30% renewables by 2020,
  - 50% by 2030,
  - 80% by 2050
- Nuclear phase out

Technical Implementation

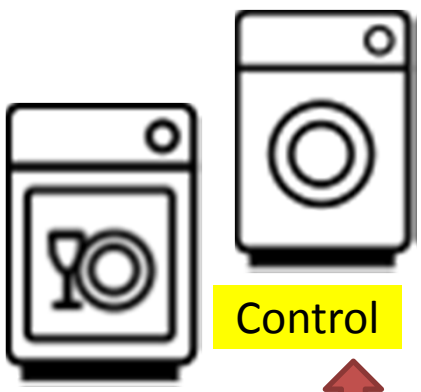
- More renewables
  → Load shifting necessary
    → More storage
    → Flexible gas-fired power plants
    → Demand side management
- Decentralized generation

Our Focus

- Demand side management in residential buildings

Motivation: Future Multi-Commodity Residential Homes

Classic Independent Mode of Device Control



Control

White goods
Consume power
Optional hot water connection

Control

µCHP
Heat and power
Heat storage

AC

Control

Control

Renewable power

Cooling → Heat → Power

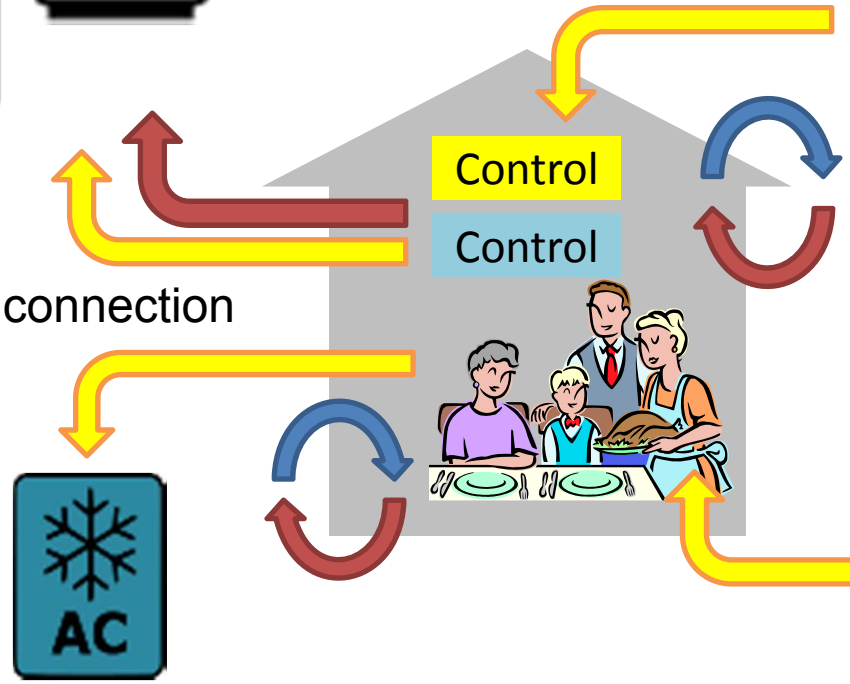
Picture: µCHP by Senertec, Germany

Motivation: Future Multi-Commodity Residential Homes

Single-Commodity Optimization Mode of Device Control

White goods
Consume power
Optional hot water connection

µCHP
Heat and power
Heat storage



Renewable power

Cooling Heat Power

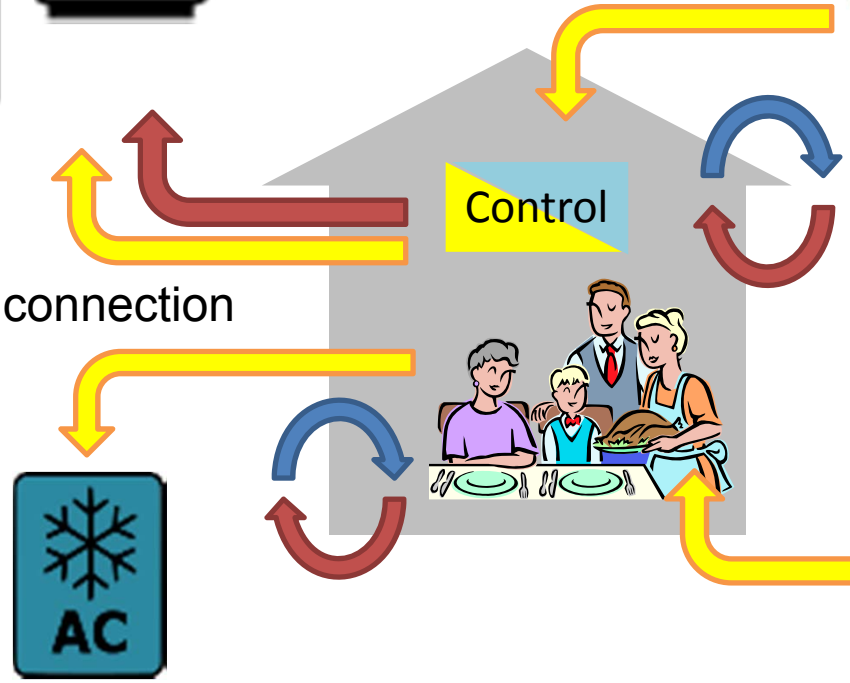
Picture: µCHP by Senertec, Germany

Motivation: Future Multi-Commodity Residential Homes

Multi-Commodity Optimization Mode of Device Control

White goods
Consume power
Optional hot water connection

µCHP
Heat and power
Heat storage



Renewable power

Cooling Heat Power

Picture: µCHP by Senertec, Germany

Multi-Commodity Optimization in Residential Homes

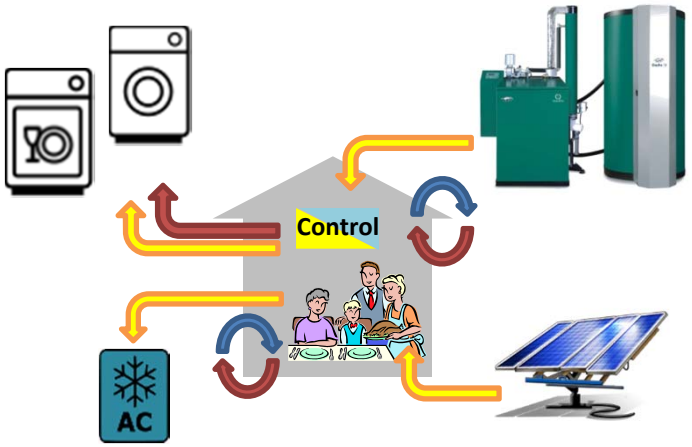
Problems
- Various data sources and data sinks
- Interleaved data flows
- Complex control and optimization tasks

Exemplary use case: “Senertec Dachs”
- Residential home
- Micro combined heat and power
  - Otto generator using natural gas
  - Cogeneration of heat and electricity
  - Warm water storage

  with additional electrical heating

→ **Hybrid heating by natural gas or electricity**

Approach
- Data life cycle analysis
- Role model of acting entities

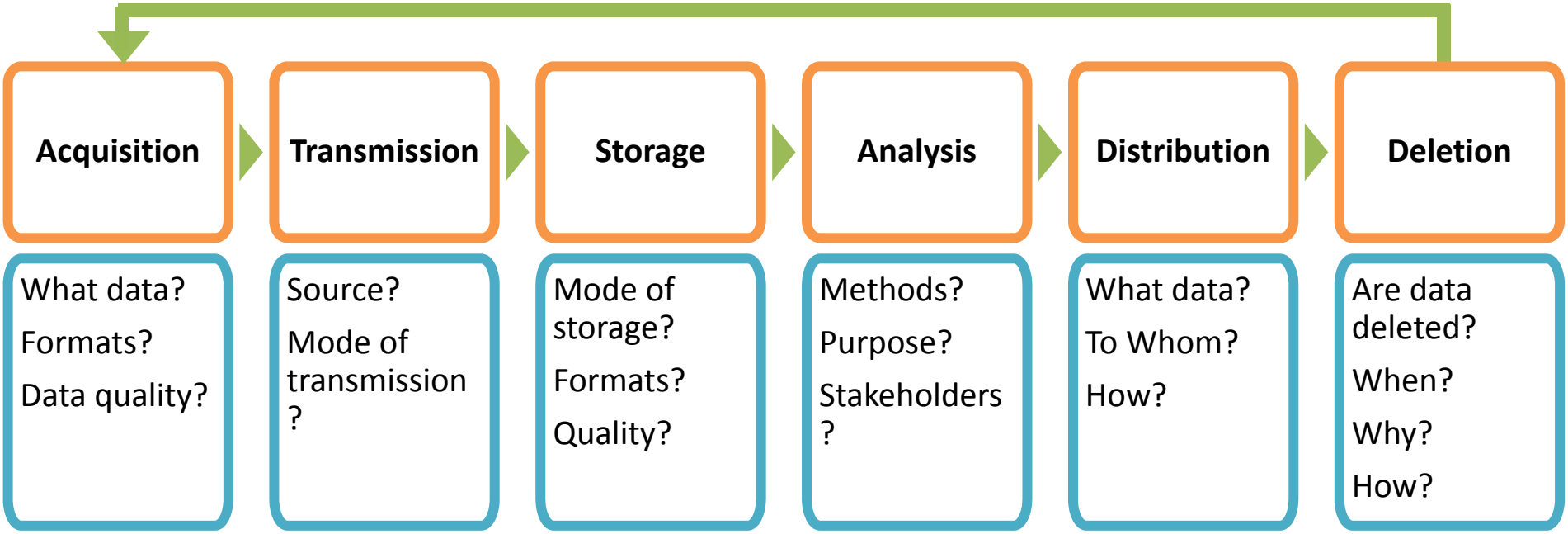


Add-On Heating Element

Picture: µCHP by Senertec, Germany

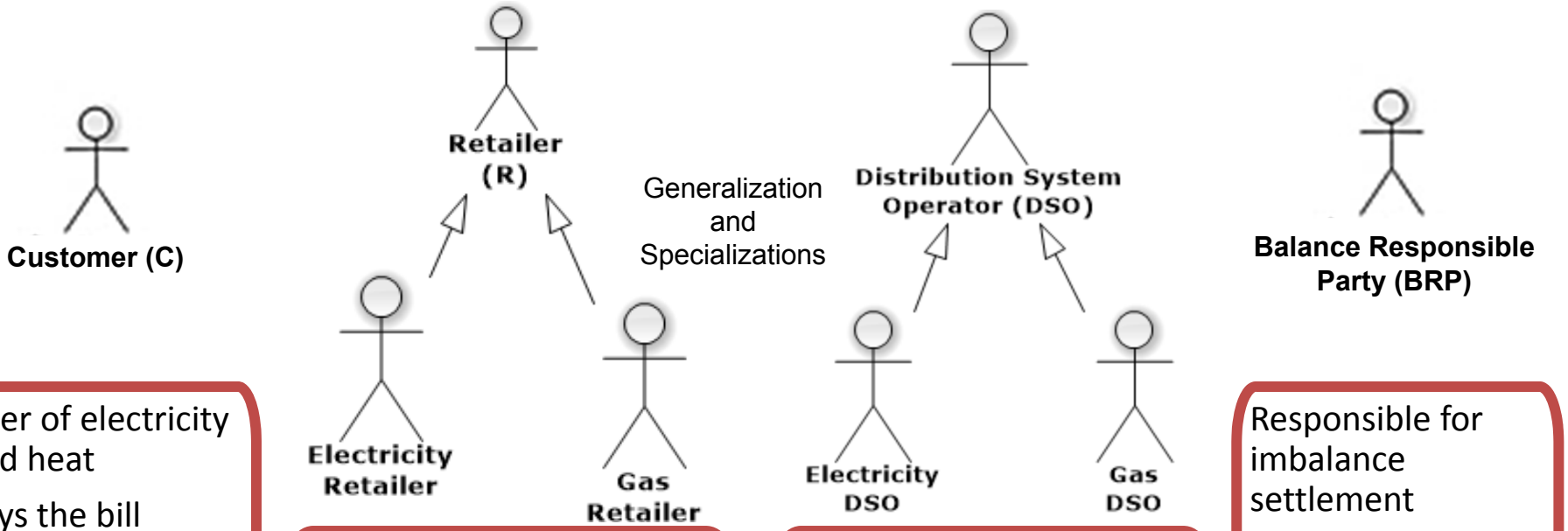
Data Life Cycle Analysis

A Prototype Data Life Cycle



- A tool to gain better understanding of data life cycles
- Not necessarily a straight-forward cycle

Role Model Based on European Energy Legislation



User of electricity and heat

Pays the bill

Owns personalized data

Operator of the distribution grid

Design of tariffs

Billing

<u>Specialisation</u>:

Operator of electricity distribution grid

Operator of natural gas distribution grid

Supplier of energy

Voltage Control

Congestion Management

<u>Specialisation:</u>

Supplier of electricity

Supplier of natural gas

Responsible for imbalance settlement

Application of Demand Side Management

(electricity only)

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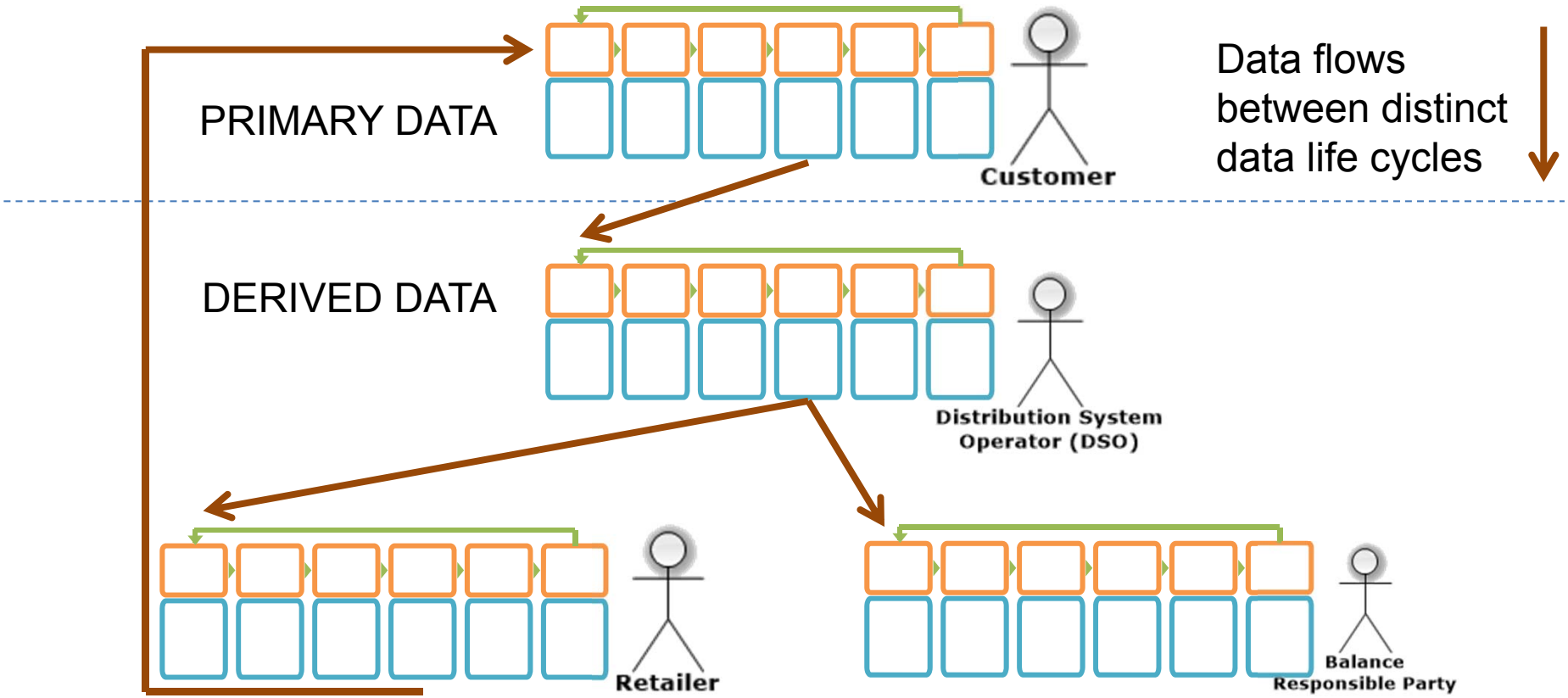
Role Model

Legitimate Interest in Data

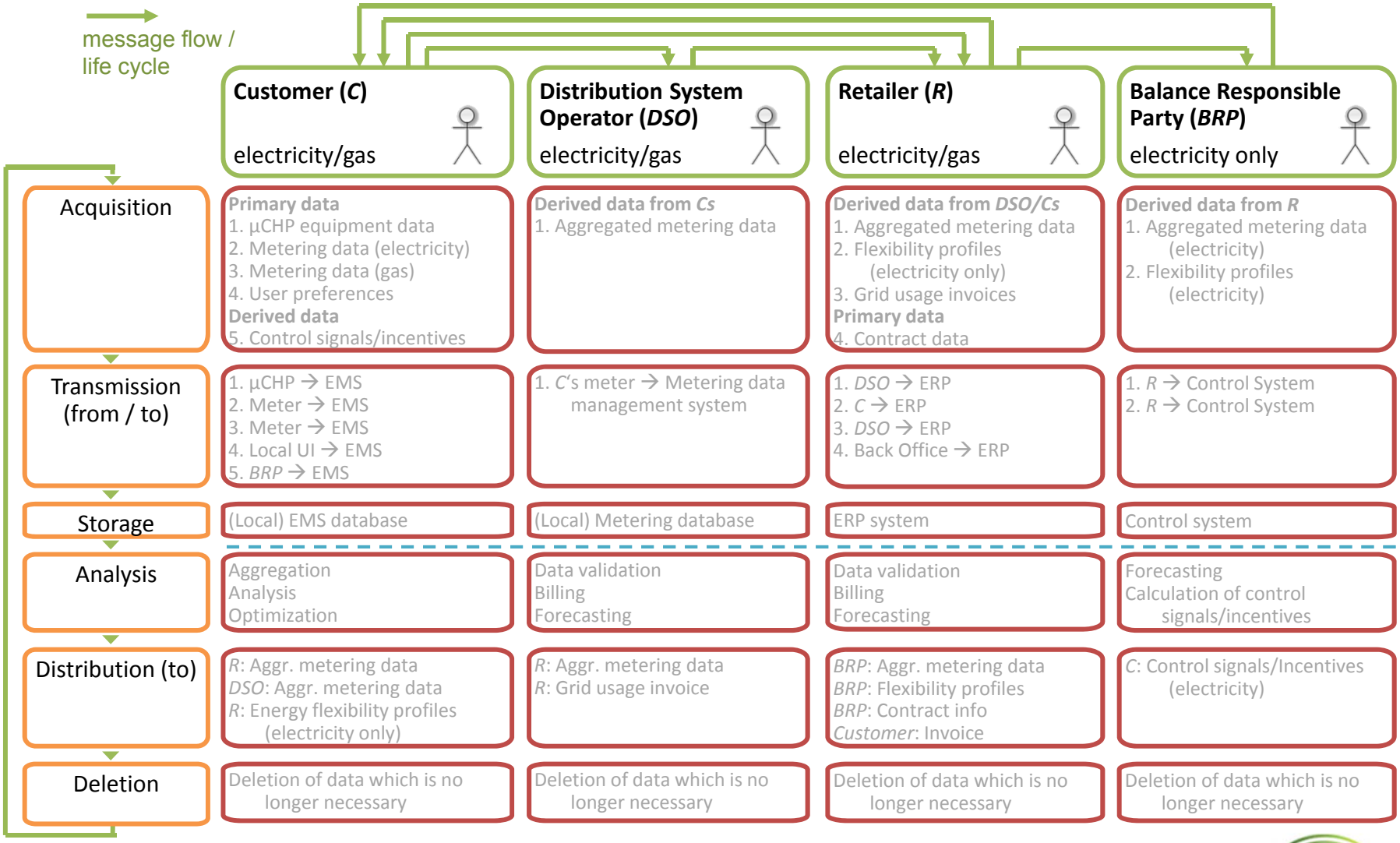
	Customer	DSO	Retailer	BRP
Metering data	X	X	X	X
Billing data	X	X	X	
Operational data	X	X		
Contractual data	X		X	X

Data Life Cycle Analysis

Interleaved Data Life Cycles



Resulting Big Picture of Data Life Cycle Analysis



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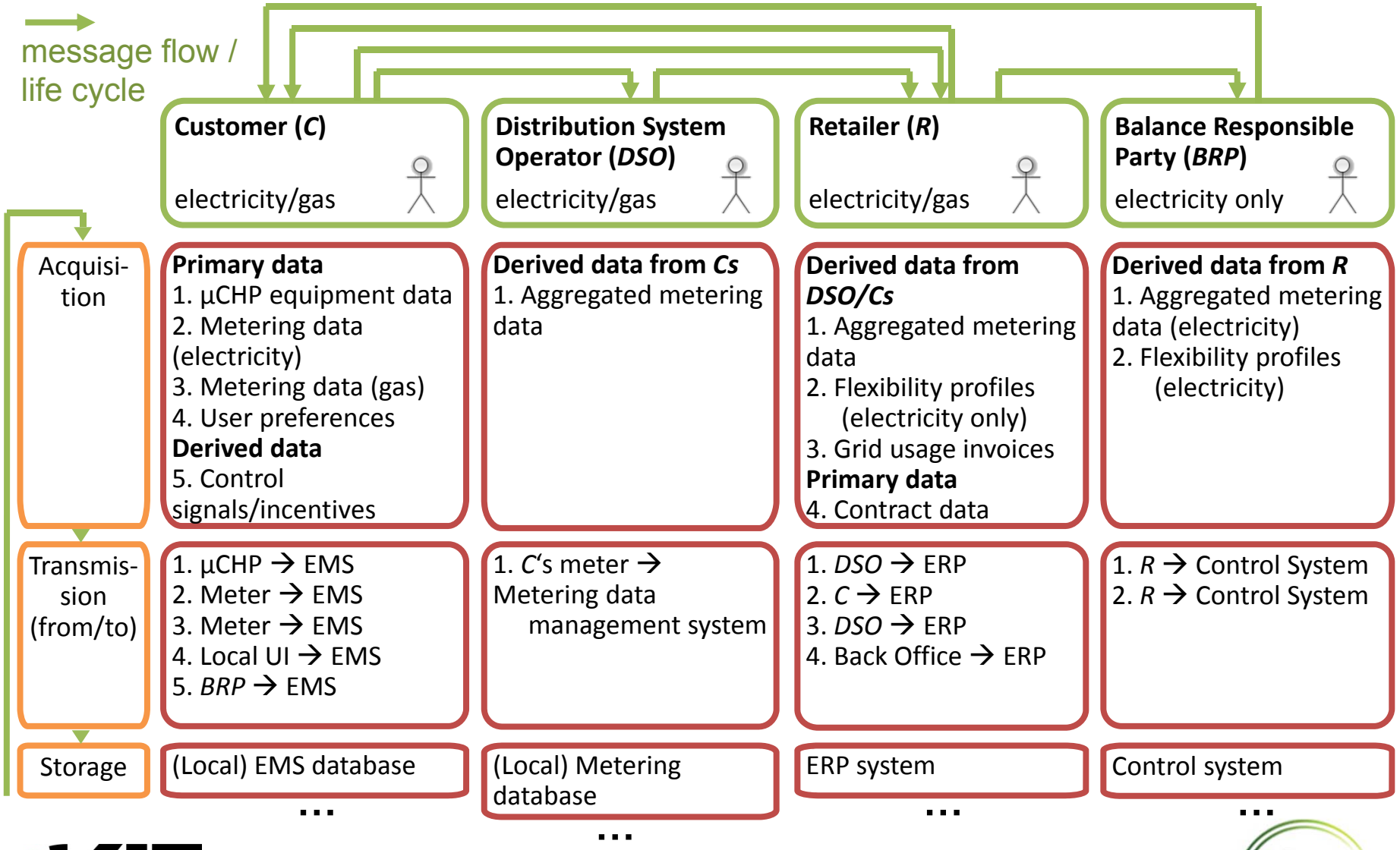
Resulting Big Picture of Data Life Cycle Analysis (Part 1)



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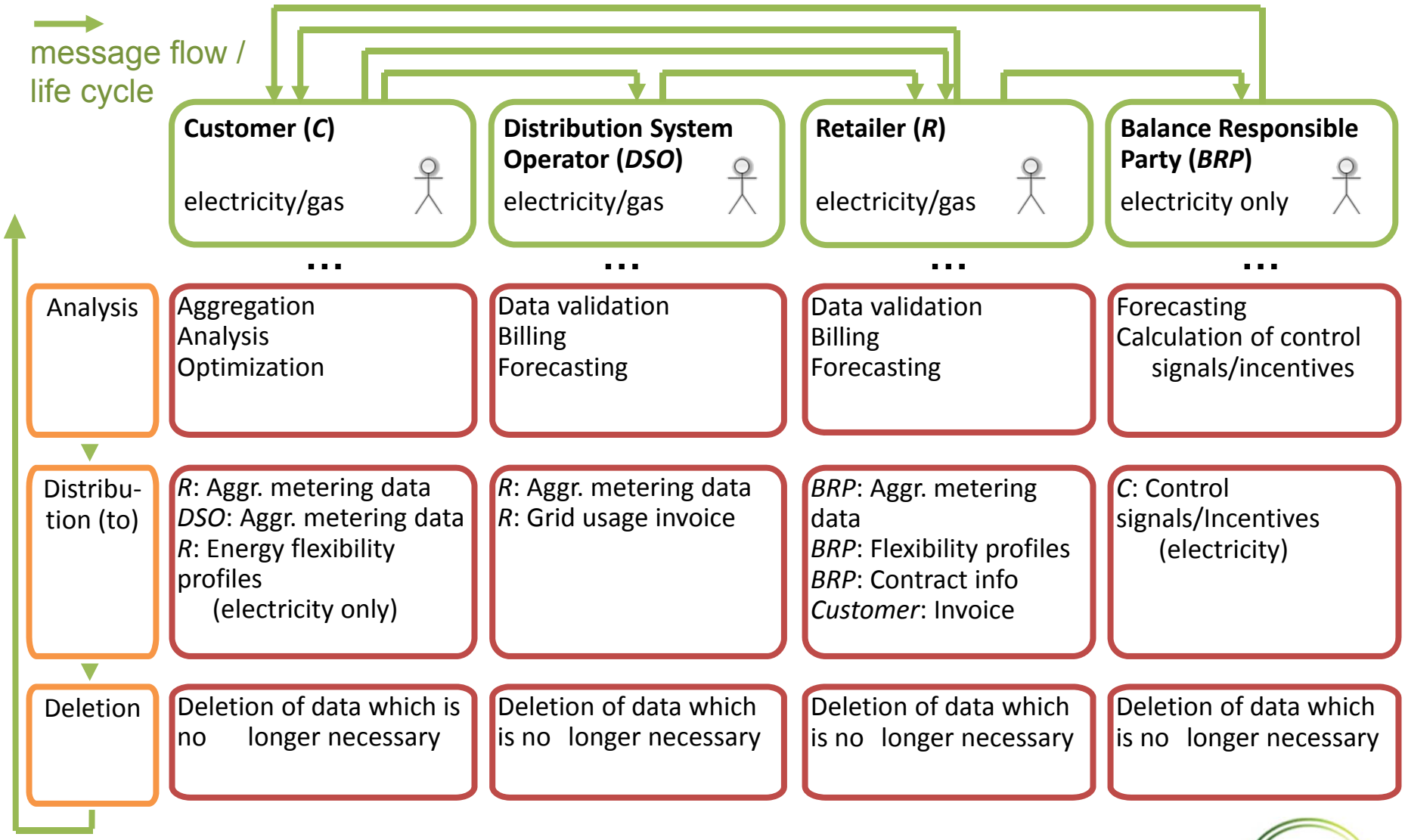
Resulting Big Picture of Data Life Cycle Analysis (Part 2)



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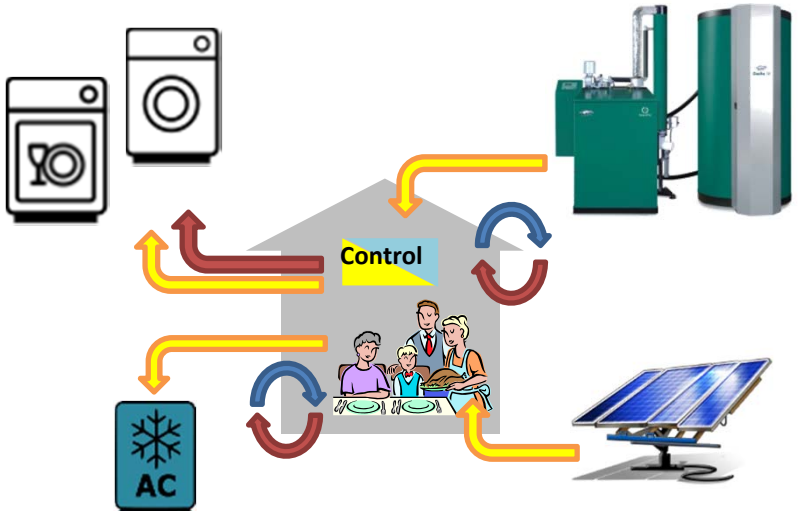
Lessons Learned

- The energy transition is a large project for future generations
- Data flows and data life cycles in multi-commodity scenarios are complex
- Systematic approaches are needed, in order to reduce this complexity
- Data life cycle analyses can be employed to gain a better understanding
- Scenarios should be divided into several use cases



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Karlsruhe Institute of Technology (KIT), Germany
rigoll@kit.edu / gitte@kit.edu / schmeck@kit.edu

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Thank you for your kind attention!
Feedback? Questions?

Picture: "Turbines" by Steven Feather via flickr, 8 Sept 2014

Backup Slides

Picture: "Turbines" by Steven Feather via flickr, 8 Sept 2014

KIT: 30 Fields of Competence Bundled in 6 Areas of Competence

Matter and Materials

- Elementary Particle and Astroparticle Physics
- Condensed Matter
- Nanoscience
- Microtechnology
- Optics and Photonics
- Applied and New Materials

Earth and Environment

- Atmosphere and Climate
- Geosphere and Risk Management
- Hydrosphere and Environmental Engineering
- Buildings and Urban Infrastructure

Applied Life Sciences

- Biotechnology
- Toxicology and Food Science
- Health and Medical Engineering
- Cellular and Structural Biology

Systems und Processes

- Flow and Particle Dynamics
- Chemical and Thermal Process Technology
- Fuels and Combustion
- Systems and Embedded Systems
- Power Plant Technology
- Product Life Cycles
- Mobile Systems and Mobility

Information, Communication, and Organization

- Algorithms, Software, and Information Science Systems
- Cognitive Systems and Information Processing
- Communication Technology
- High-performance Computing and Distributed Systems
- Mathematical Models
- Organization and Service Design

Technology, Culture, and Society

- Cultural Heritage and Social Change
- Economic Organization and Innovation
- Interaction of Science, Technology, and Society

KIT Centers: Focus on Topics, Strategic Research Planning

- Climate and Environment
- Energy
- Materials, Structures, Functions
  (former KIT Center NanoMicro and KIT Focus Optics and Photonics)
- Elementary Particle and Astroparticle Physics
- Climate and Environment
- Mobility Systems
- Information, Systems, Technologies
  (former KIT Focuses COMMputation and Anthro-pomatics and Robotics)
- Humans and Technology

Add-On Heating Element

Source. Cf. Technical Manual Senertec Dachs

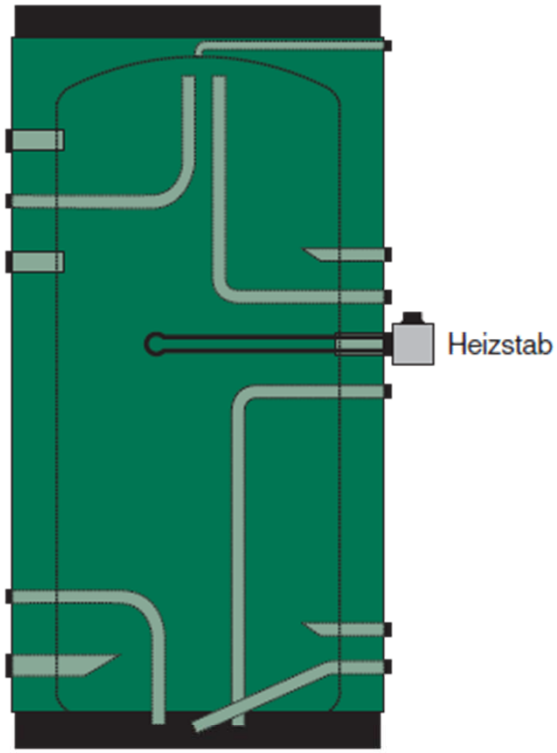

Abb. 16: Anschluss für Heizstab am Pufferspeicher

Abb. 17: Montage - Heizstab am Pufferspeicher

Abb. 15: Abbildung und Leistungsdaten - Heizstab

Betriebsarten Heizstab		
Betrieb	Leistung	Sicherung im Heizstabschaltkasten
3-phasig	5,5 kW	F1, F2, F3 ein
2-phasig	ca. 3,6 kW	F2 **oder** F3 aus
1-phasig	ca. 1,8 kW	F2 **und** F3 aus