Flexible Sector Coupling

Andreas Hauer

„(Flexible) Sector Coupling“ – Definition and Concept

Energy Demand Sectors and CO_2 Emissions

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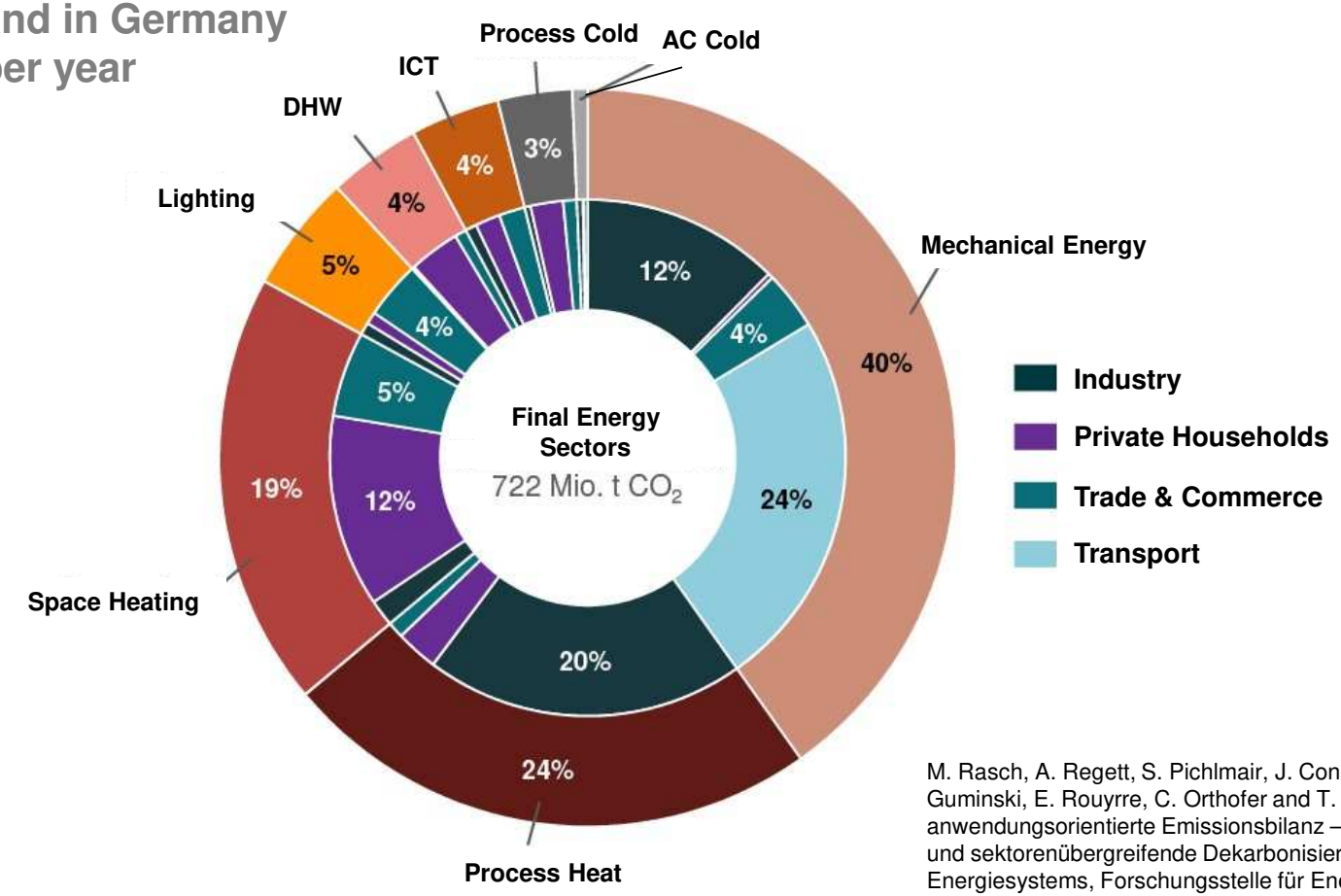
Final energy demand in Germany about 2,600 TWh per year



M. Rasch, A. Regett, S. Pichlmair, J. Conrad, S. Greif, A. Guminski, E. Rouyrre, C. Orthofer and T. Zipperle, Eine anwendungsorientierte Emissionsbilanz – Kosteneffiziente und sektorenübergreifende Dekarbonisierung des Energiesystems, Forschungsstelle für Energiewirtschaft FfE, bwk, Ausgabe 03/2017

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Energy Demand Sectors and CO_2 Emissions

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Sectors = Demand Sectors

Electricity-Sector: (= electric energy)
- Main input from renewable sources (PV/Wind)
- „Everything that consumes electricity“?
- obvious = lighting, ICT, controlling,…but also electric motors in industry, appliances in householdes etc.

Mobility-Sector: (= kinetic energy)
- Transportation of goods and poeple
- cars, trucks, trains, ships, planes,…

Thermal-Sector: (= thermal energy)
- Heating & cooling in buildings and industry
- process heat &cold, space heating, DHW,…

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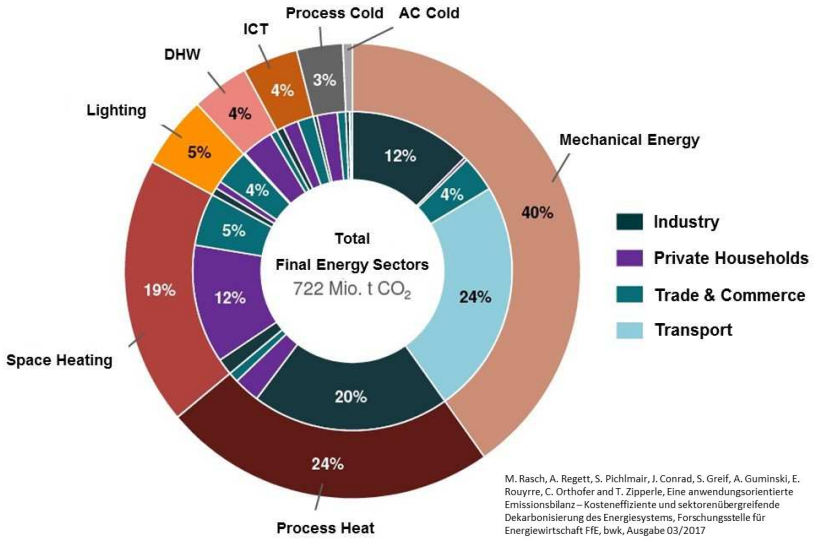
„Energy Sectors“ and CO_2 Emissions

Distribution of CO_2 emissions among the „Sectors“:

- **Electricity** **24%**
  - Lighting 5 %
  - ICT 4 %
  - Mech. Energy in Ind./T&C 16 %
- **Thermal** **> 50 %**
  - DHW 4 %
  - Process Cold 3 %
  - Process Heat 24 %
  - Space Heating 19 %
  - AC <1 %
- **Mobility** **24 %**



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The thermal and the mobility sector cause about 75 % CO_2 emissions in developed countries!

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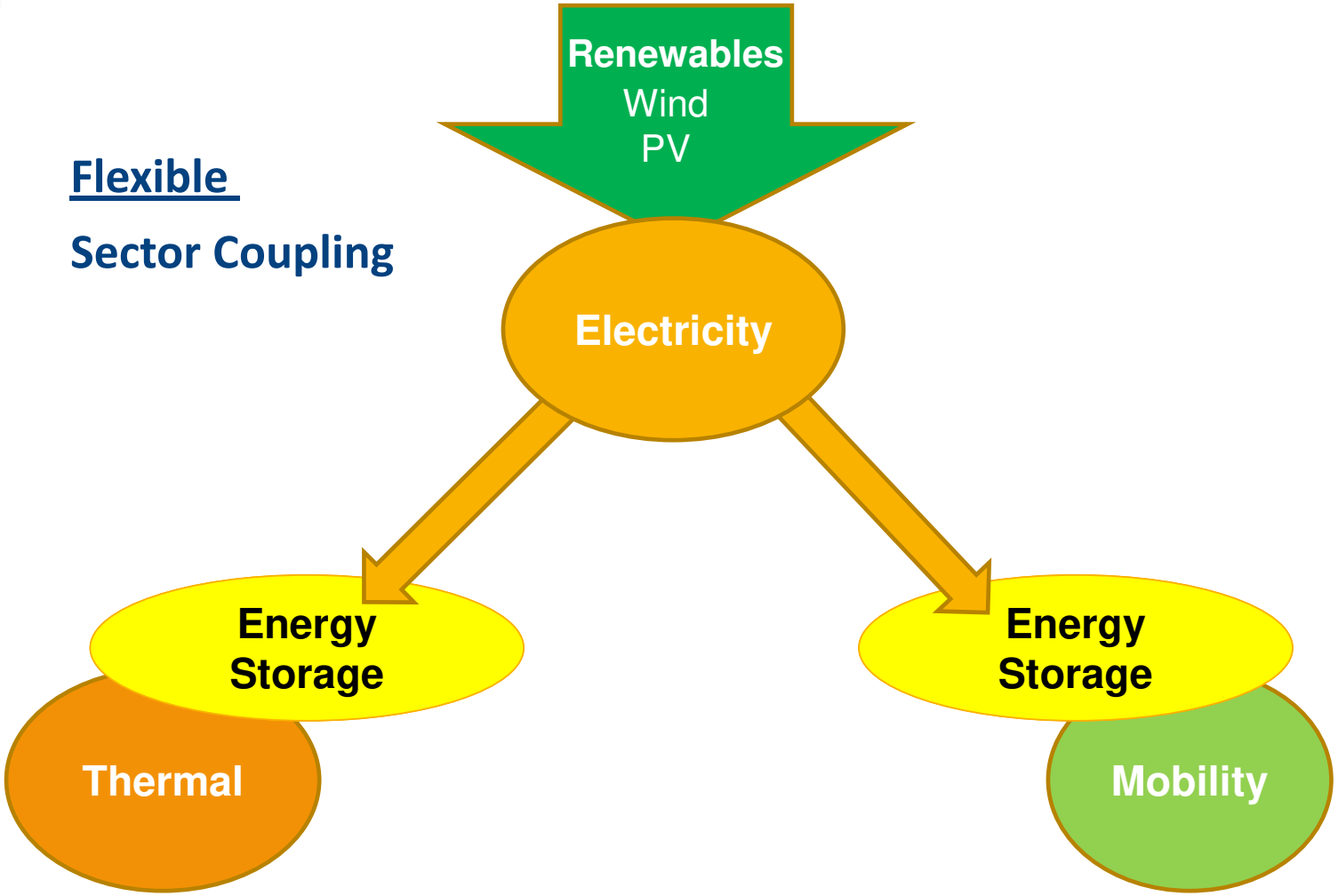
Flexible Sector Coupling (FSC) Concept Development - Introduction

Flexible

Sector Coupling



Flexible Sector Coupling (FSC) Concept Development

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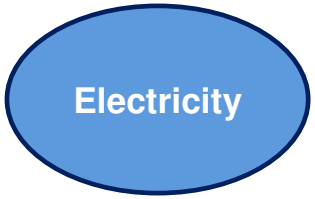
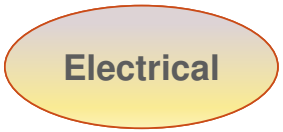
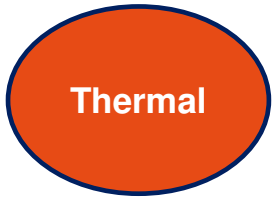
Latest Way of Visualizing the Concept



Carrier / Storage



All Carrier = 100 % energy to store and to provide (thermal, electrical, chemical)



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Flexible Sector Coupling (FSC) Concept Development

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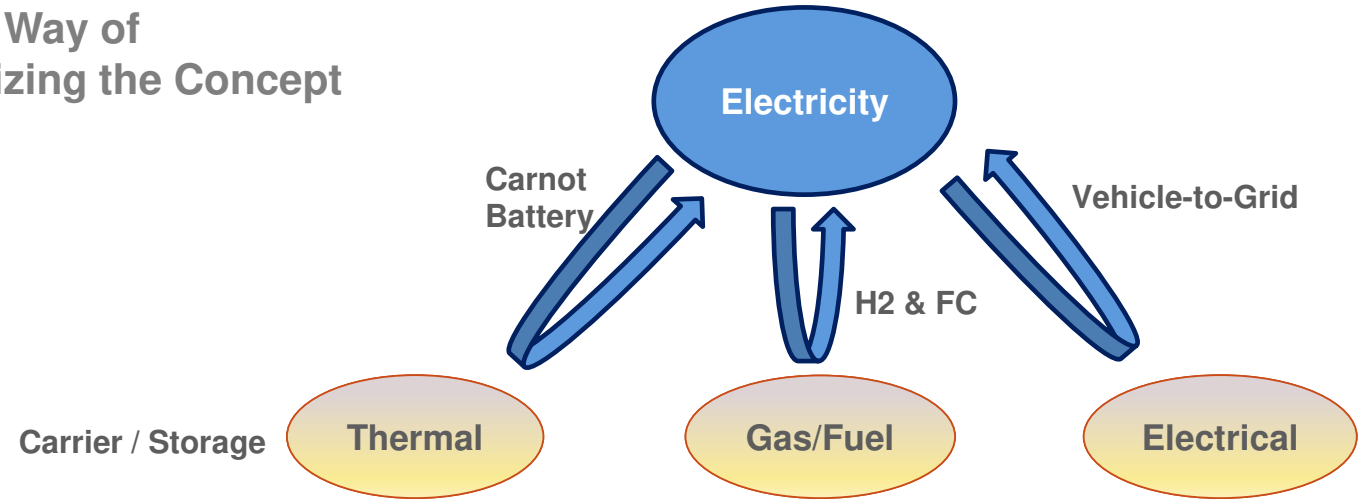
Latest Way of Visualizing the Concept



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Flexible Sector Coupling (FSC) Concept Development - Introduction

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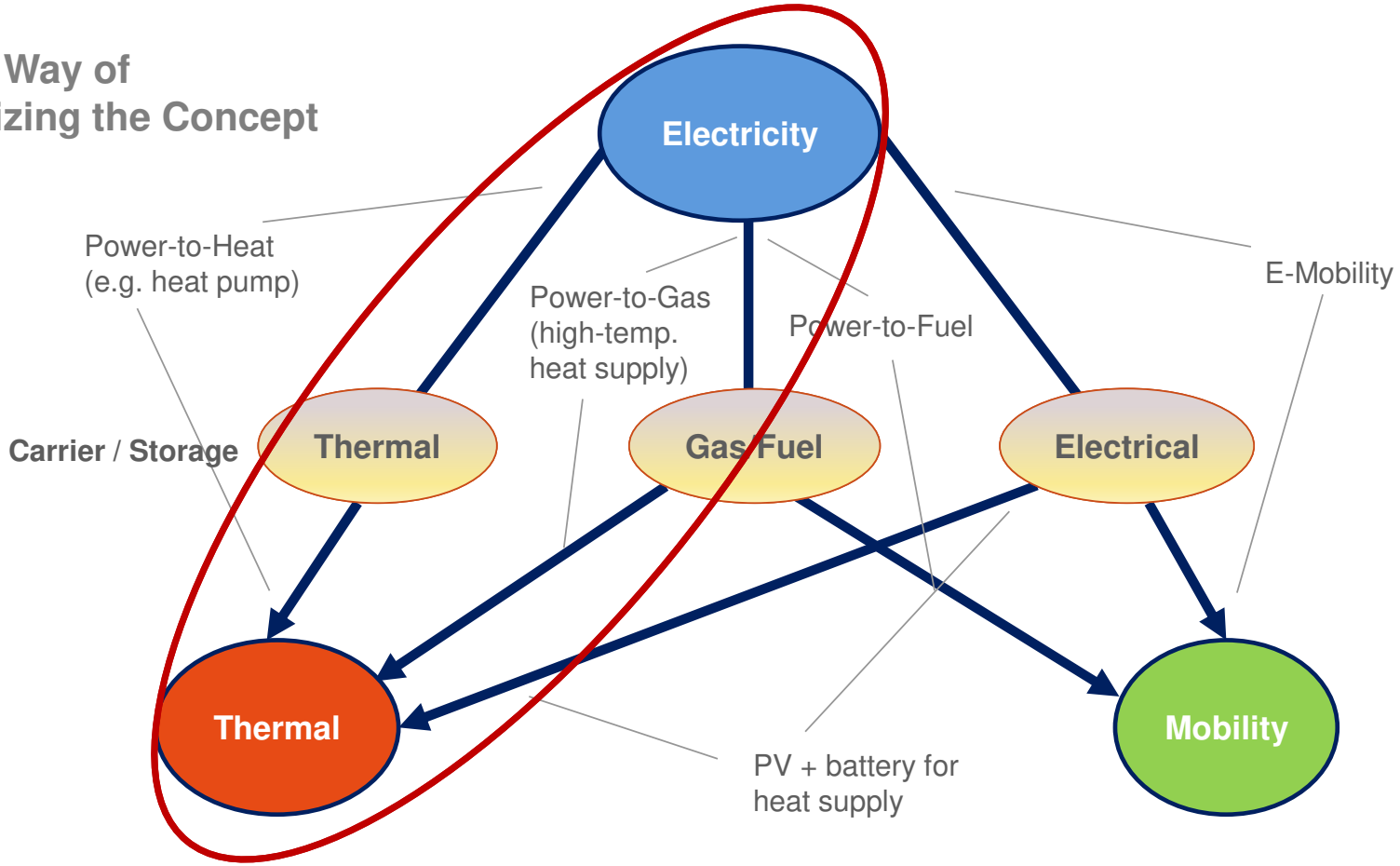
Latest Way of Visualizing the Concept



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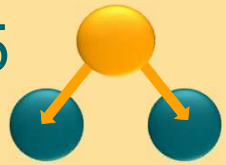
„Flexible Sector Coupling“ – Task 35 Structure

Objectives of Task 35

ES TCP Task 35
FLEXSecCoup



Main Goal:
Clarify possibilities and impact of energy storage implementation in Flexible Sector Coupling

Develop FSC concept & Whitepaper	Identify ES technologies for FSC	Identify non-technical barriers for ES in FSC
Quantification of storage potentials in FSC	Technical and economic comparison to “no-storage”	Identify most promising storage configurations

FSC = Flexible Sector Coupling

ES = Energy Storage

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Scope of Task 35

The scope of this Task includes all energy storage technologies suitable for sector coupling applications. It is important to strictly focus on **energy storage only!**

The Task will cover the following topics:

- Assessment of **all storage technologies**
- Investigation of **all applications in the heating and cooling sector** (buildings, DHW, process heat/cold in industry)
- Investigation of **all applications in the mobility sector** (private transport, public transport, freight traffic) and **all propulsion technologies** (EV, fuel cell, hydrogen,…)

Subtask Structure

Subtask 1: FSC Concept Development

- Basic Concept of Flexible Sector Coupling (FSC)
- Put FSC in context of overall energy system transformation
- Distinction from other flexibility measures to emphasize focus on energy storage
- Identify bottlenecks in the legal framework hindering the deployment of energy storage in FSC
- Deliver white paper as living document reporting the progress of FSC concept development

Subtask 2: Configuration related storage technology specifications

- Collect existing and future storage applications in the context of sector coupling
- Characterize FSC storage configurations
- Identify promising applications for scenario analysis

Subtask 3: Local Energy System Design and Operation

- Energy system analysis on a local level (cities, districts/quartiers, buildings).
- Design and operational optimization of storages.
- Evaluation of the potential of flexible sector coupling on a local system level.

Subtask 4: National scale energy system analyses of FSC potential

- National energy system analysis of different scenarios
- Elaborating on the findings for the local level studies (ST 3) to scale up the use and consider a mix of such solutions
- Quantify potential of large scale FSC

Policy and R&D recommendations

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„Flexible Sector Coupling“ – Storage Configurations

From Flexible Sector Coupling Concept to Storage Configurations

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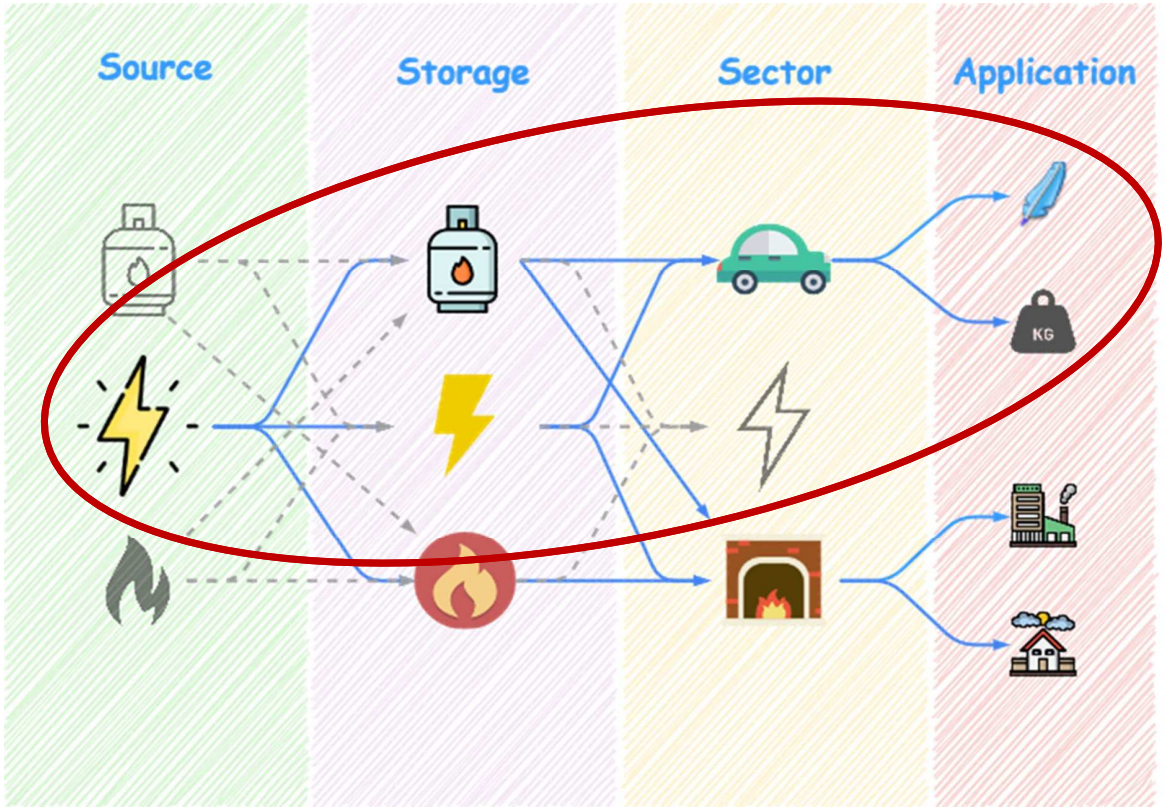
Pathways for the Integration of Renewable Energies



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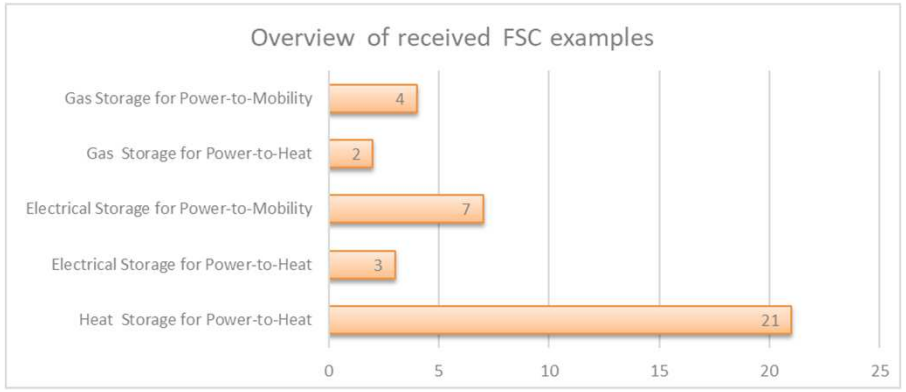
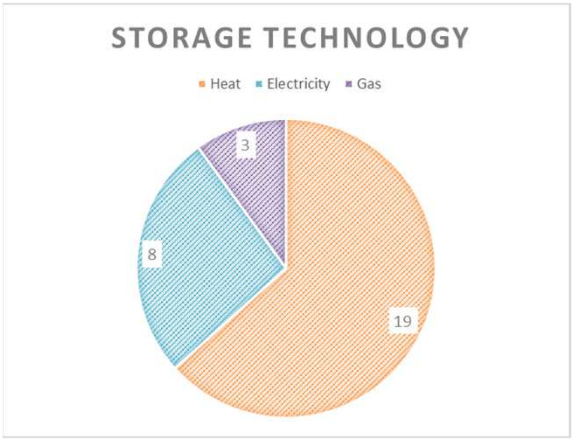
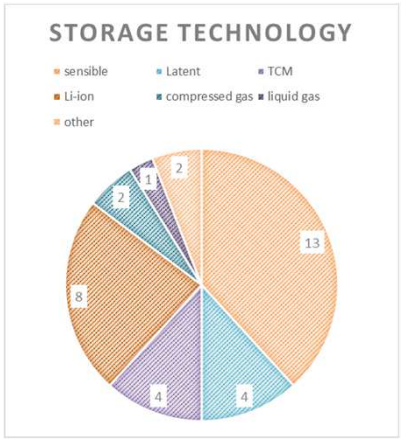
Collection & Evaluation of Project Examples







Overview of received sector coupling examples

- Wide variety of storage technologies available
- Many of them already on the market
- A lot more to get on the market the next years (under research at different readiness level)

Compilation of collected project examples

1. Bidirectional Solar Electric Vehicle

Sonomotors, Germany

TRL	*5*
Storage tech.	*Li-Ion Battery*
Capacity	*305 kWh*
Power	*110 kW*
Storage Period	*Days*
Sector	*Mobility*
Application	*Light Traffic*

Description:
The Solar Electric Vehicle (SEV) is equipped with mono-cristaline pv-cells. The cells are fully integrated in the exteriour. On a sunny day the electricity generated is sufficient for a range of 34km. Moreover, the SEV can be charged with 11kW AC or up to 50kW DC via charging infrastructure. The installed On-Board-Charger is bidirectional and capable of suppling up to 11kW AC back to the Grid.

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Heat and Cold Storage for Power 2 Cold

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1. Distributed Cold Storage District Cooling

KTH, Schweden

TRL	
Storage tech.	
Capacity	
Power	
Storage Period	
Sector	
Application	

Description:
Distributed and centrali
aim is to increase the r
increase efficiency. Th
electricity to run the ch
need during the day.

1. Scores

AEE, Austria

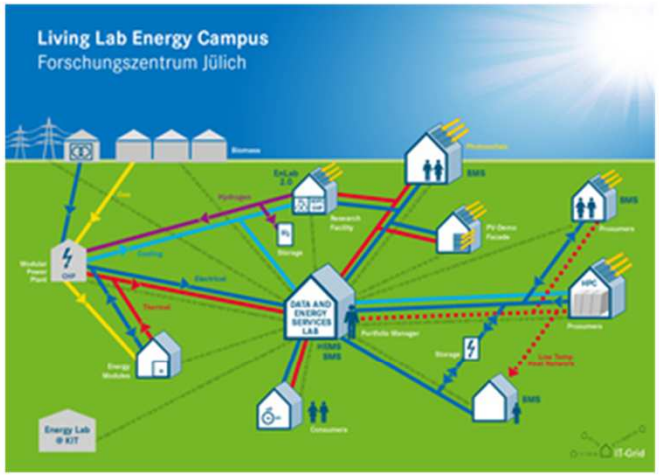
TRL	
Storage tech.	Ch
Capacity	
Power	
Storage Period	Dc
Sector	
Application	

Description:
The SCORES concept is
increase the self-consum
building. The storage tec
(short term), second-life

1. Living Lab Energy Campus

Jülich, Germany

TRL	*7*
Storage tech.	*Li-Ion/H2*
Capacity	*330 MWh*
Power	*1,8 MW*
Storage Period	*Seconds-Seasonal*
Sector	*Heat/Mobility*
Application	*Building/Light traffic*



The basic idea of all projects in the LLEC is to link electrical, thermal and chemical energy flows in the plant network via a new intelligent IT system. For this purpose, part of the campus is transformed into real-life laboratory, where interactions between technology, energy sources and consumers, are investigated. Storage technologies used are Li-Ion batteries, compressed Hydrogen an LOHC storage for battery electric vehicle or hydrogen vehicle and heat distribution over grid.

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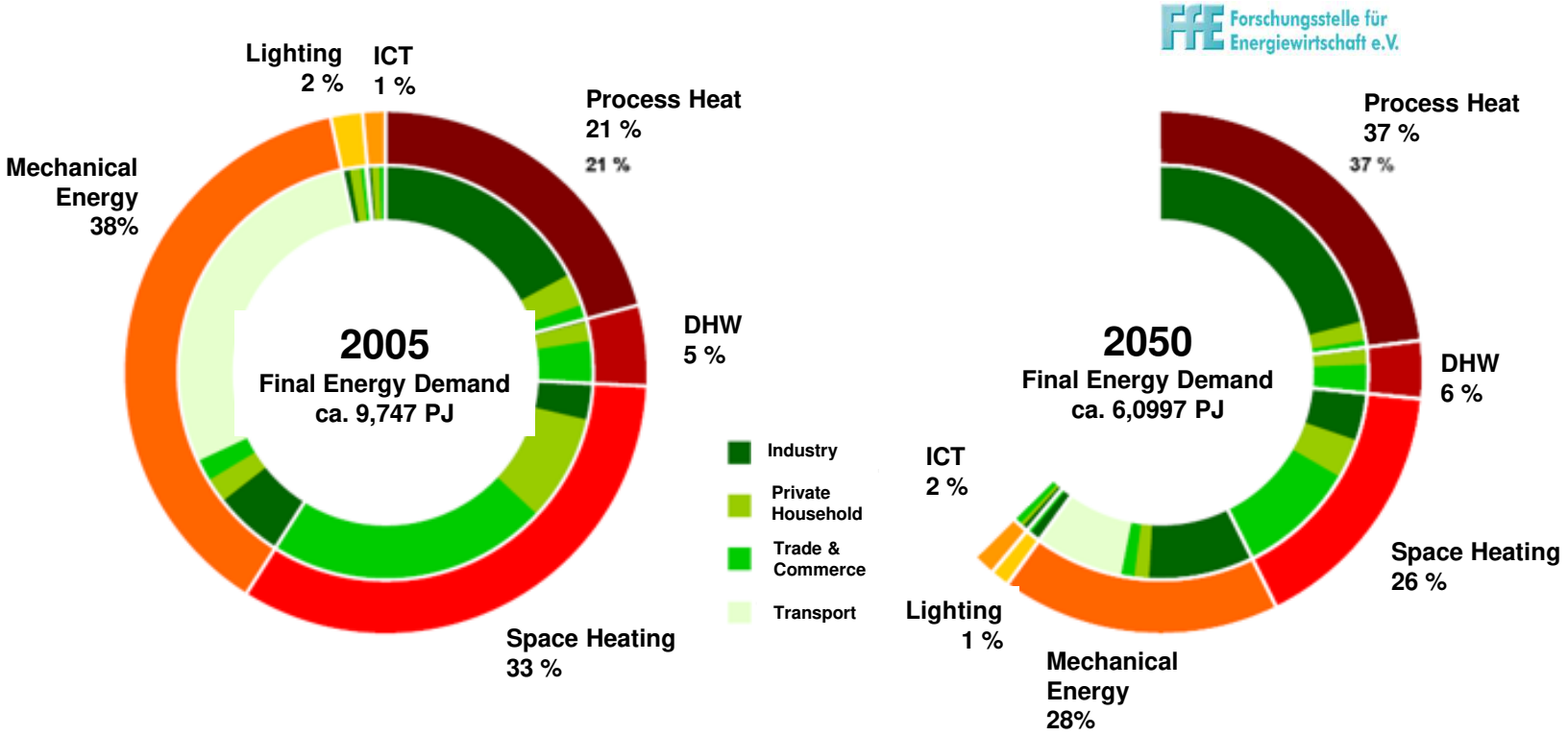
…the Future?

Final Energy Demand - Future



- Electricity about 10 %
- Thermal 59 %
- Mobility about 30 %

- Electricity about 15 %
- Thermal 69 %
- Mobility about 15 %

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New Paradigm?

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- Today most important = independence, energy supply security
- New Key Question: How fast can it be implemented?

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Conclusions

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- The electricity sector will have the highest share of renewable energy input
- Thermal sector is responsible for more than 50 % of CO_2 emissions
- Sector coupling is crucial for decarbonizing the thermal sector
- Only „Flexible Sector Coupling“ allows to match supply and demand = (Thermal) Energy Storage
- A number of energy storage technologies is available to address this approach

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Thank you very much for your attention!