Flexible Sector Coupling

Andreas Hauer

„Flexible Sector Coupling“ – Definition and Concept

Task 35

Energy Demand Sectors and CO_2 Emissions

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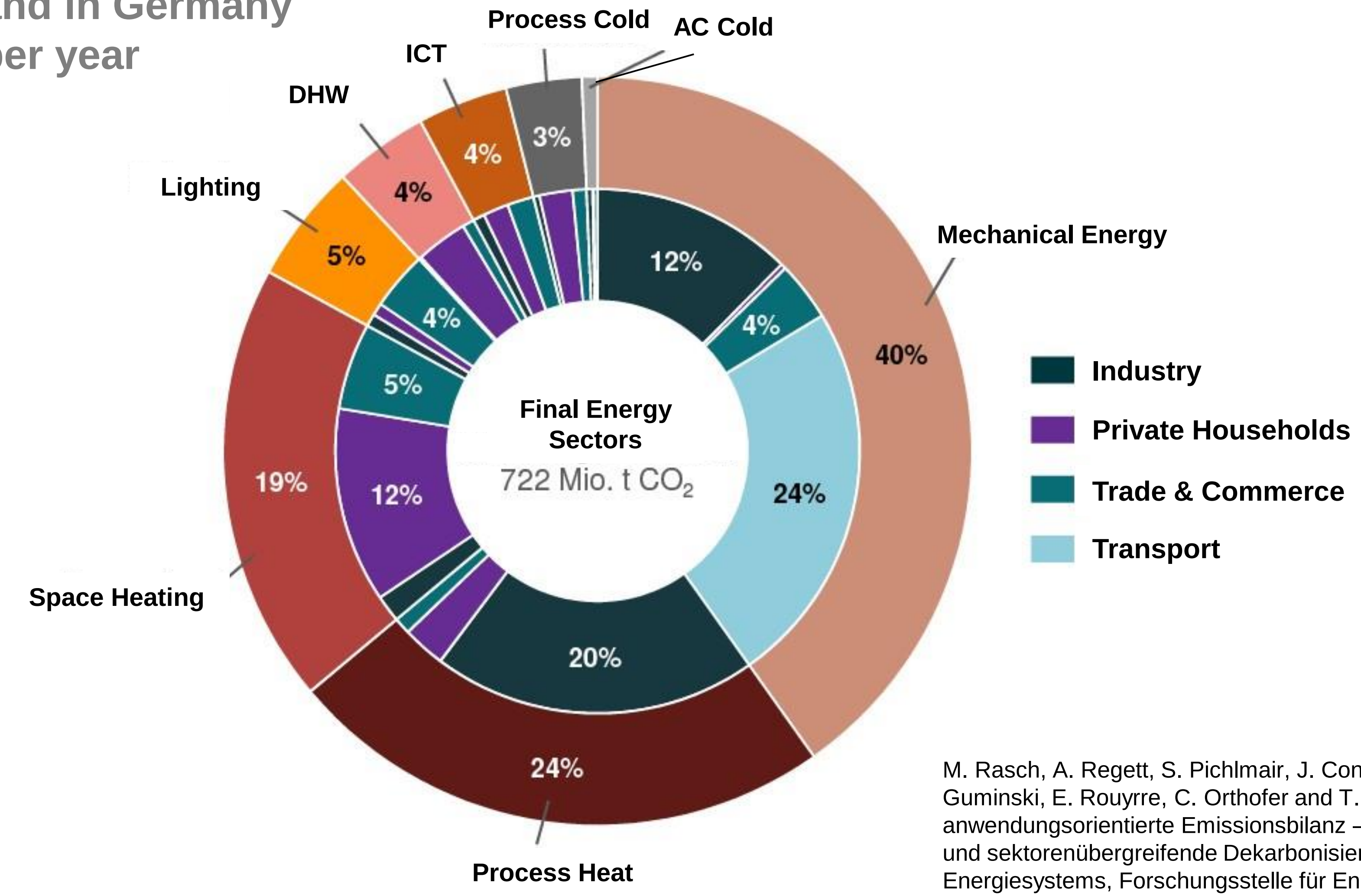
Final energy demand in Germany about 2,600 TWh per year



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

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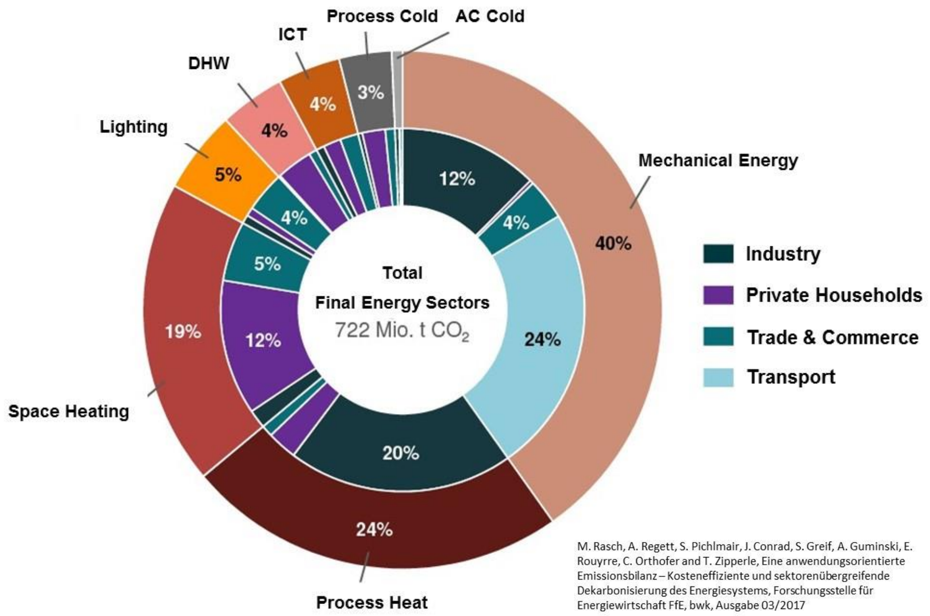
Distribution of CO_2 emissions among the „Sectors“:

- **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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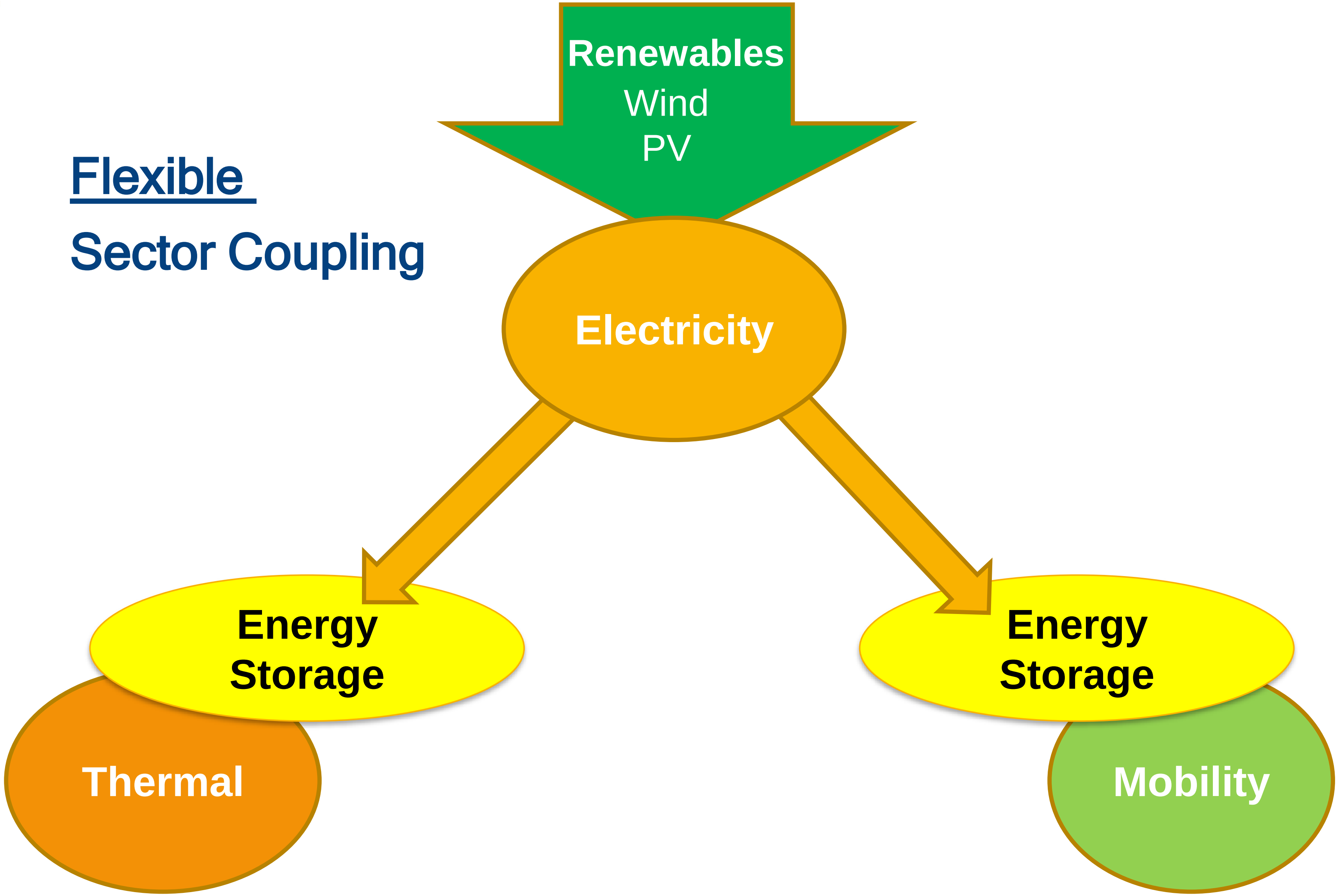
Flexible Sector Coupling (FSC) Concept Development - Introduction



Flexible Sector Coupling (FSC) Concept Development

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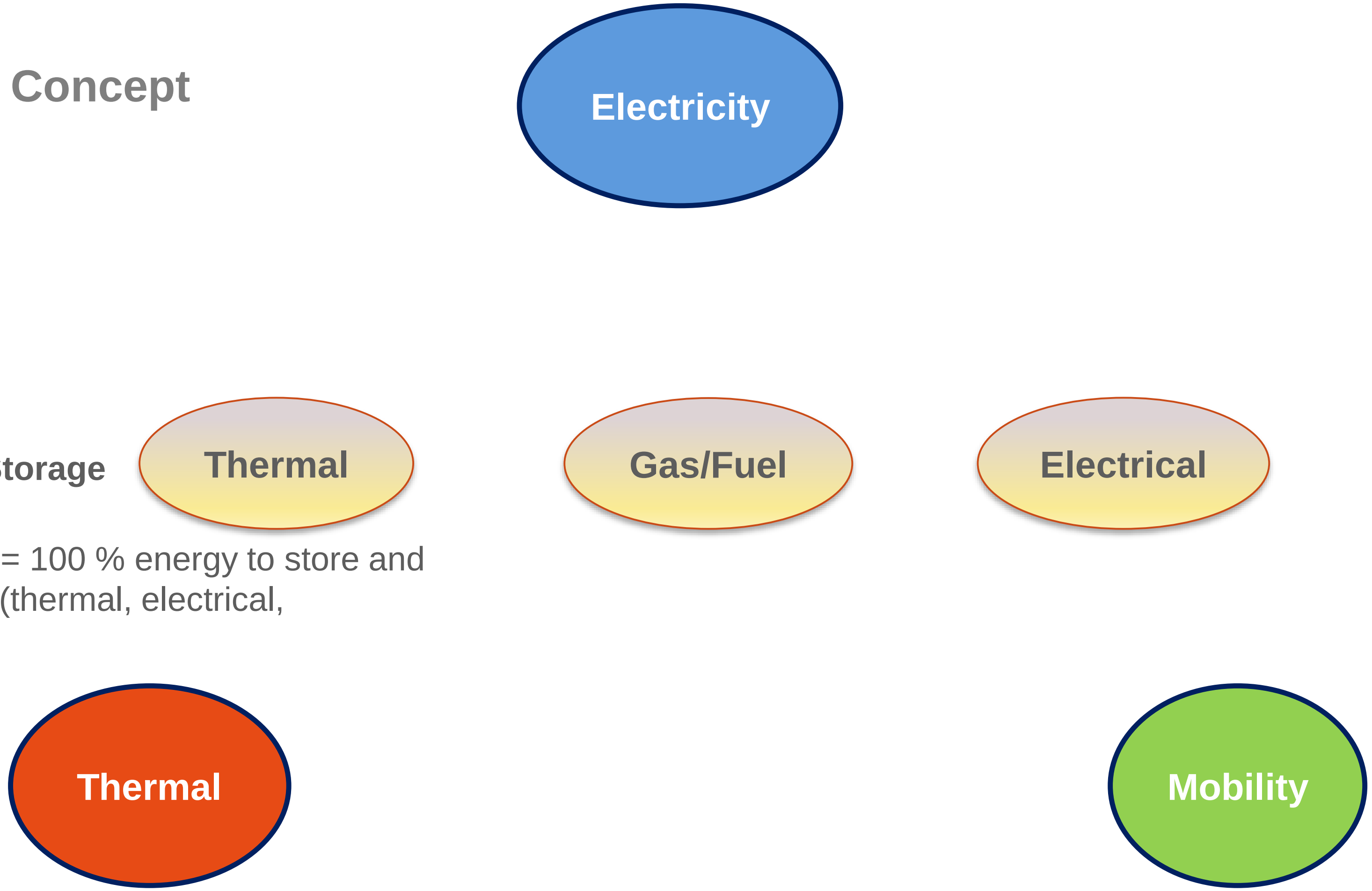
Latest Way of Visualizing the Concept



Carrier / Storage

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

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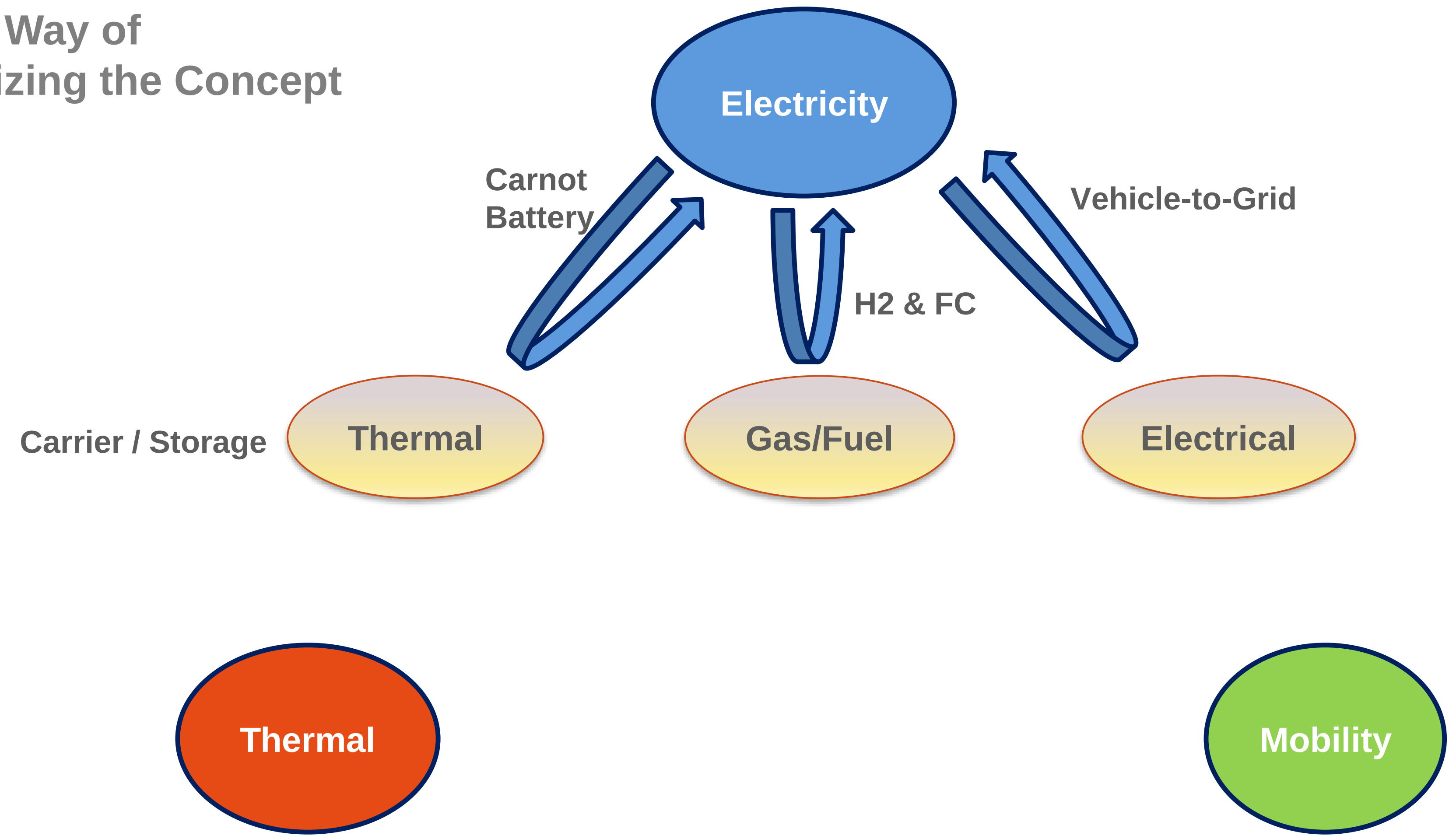
Flexible Sector Coupling (FSC) Concept Development

Latest Way of
Visualizing the Concept



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Flexible Sector Coupling (FSC) Concept Development - Introduction

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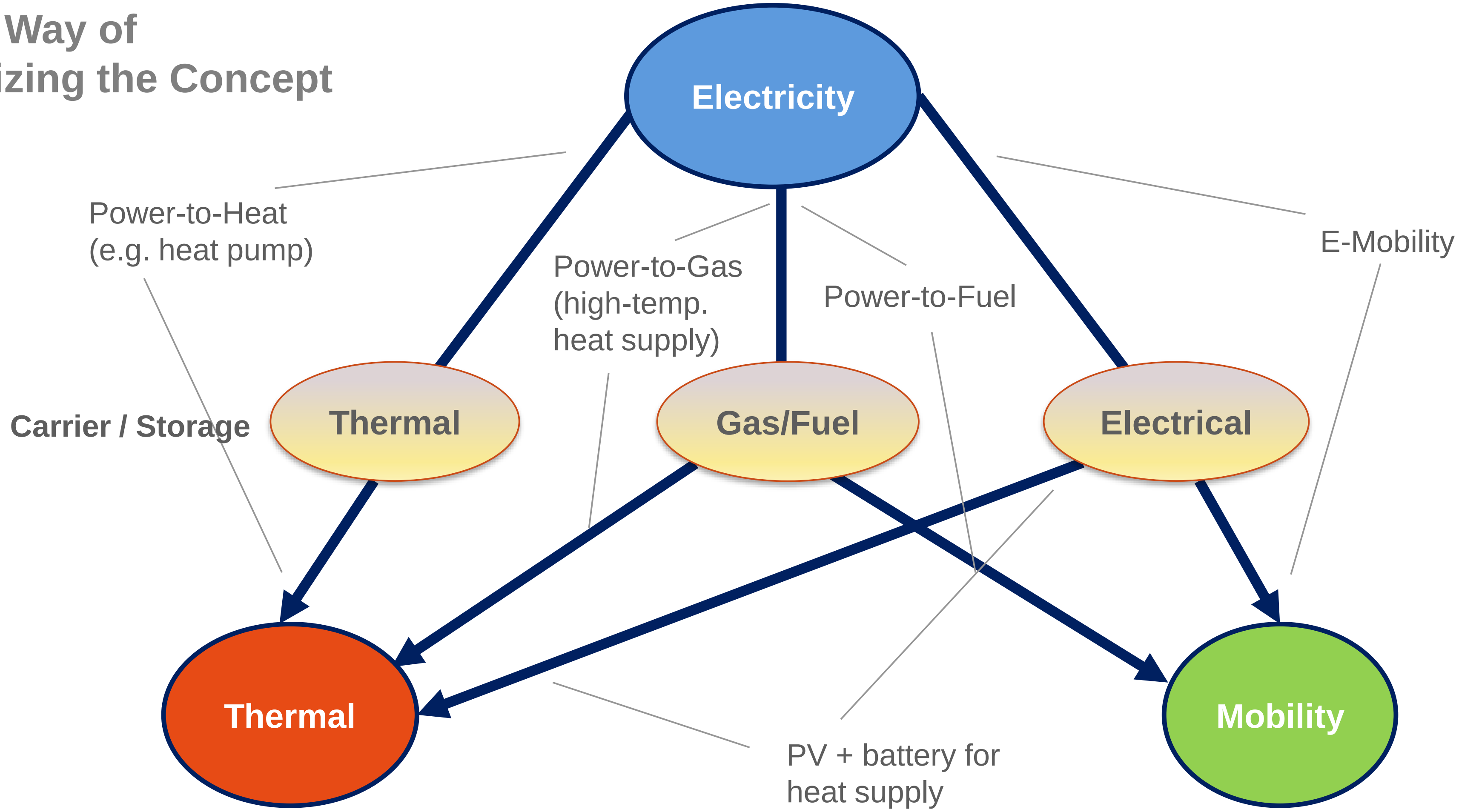
Latest Way of Visualizing the Concept



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„Flexible Sector Coupling“ – Storage Configurations

From Flexible Sector Coupling Concept to Storage Configurations

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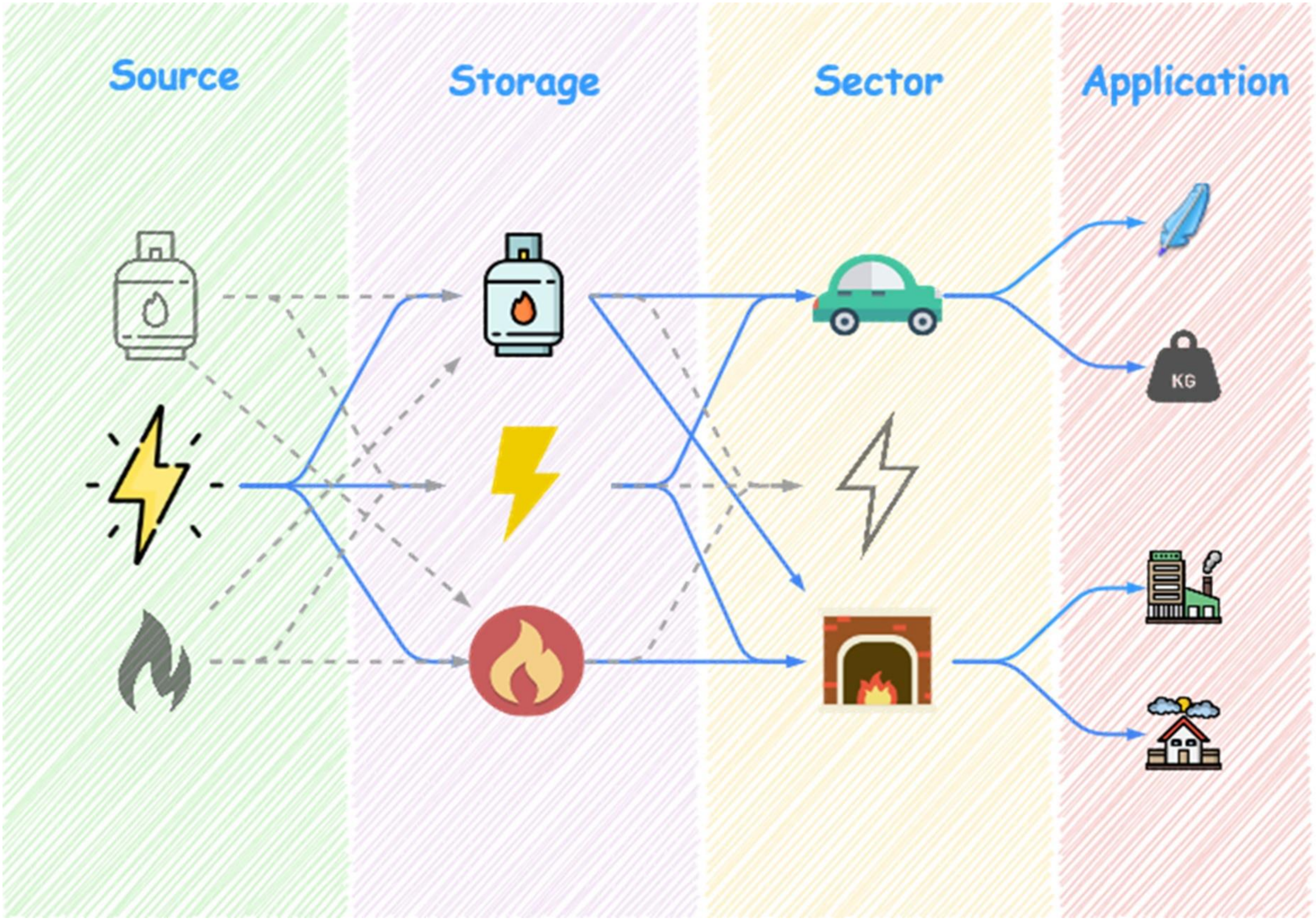
**Pathways
for the Integration
of Renewable
Energies**



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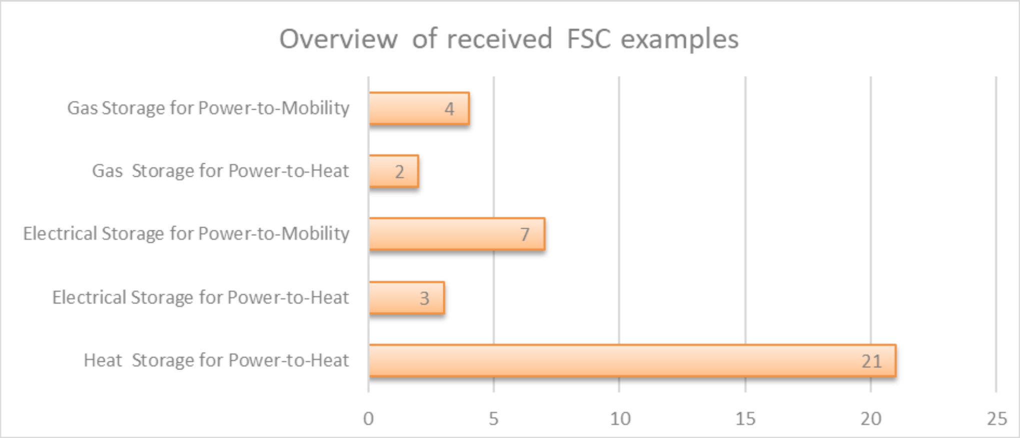
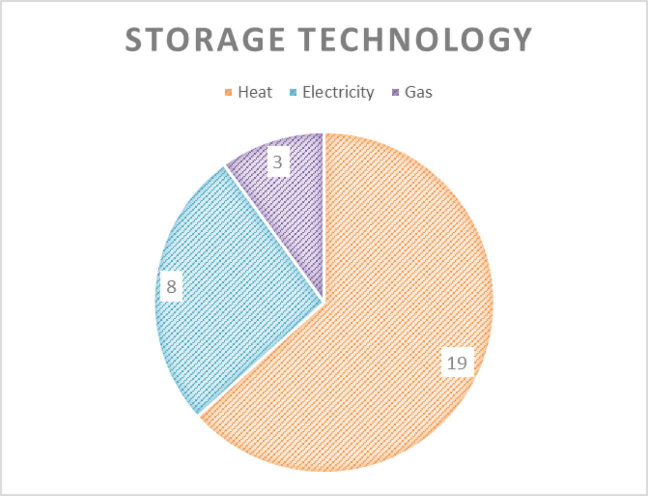
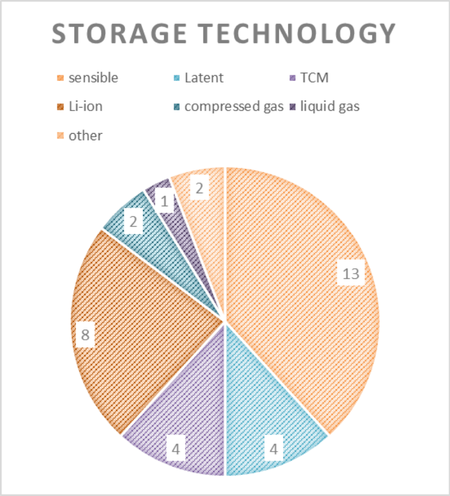
Collection & Evaluation of Project Examples



Overview of received sector coupling examples





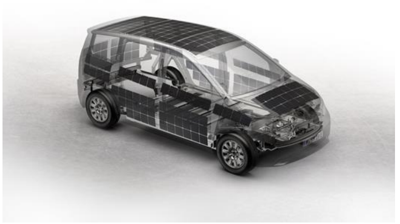
- Wide variety of storage technologies available
- Many of them already on the market
- A lot more to get on the market the next years (under research at different readiness level)

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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Battery Storage for Power 2 Mobility

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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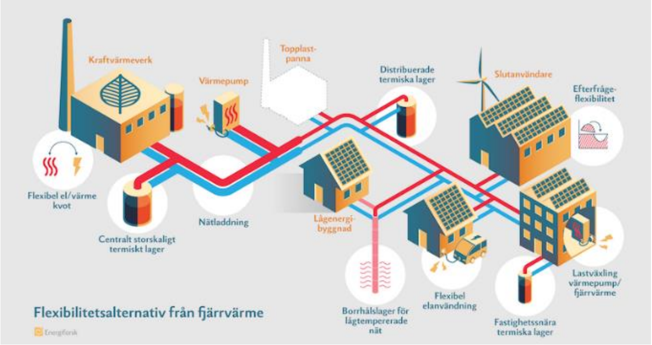
1. Distributed Cold Storage District Cooling

KTH, Schweden

TRL	*8-9*
Storage tech.	*Cold storage*
Capacity	*70 MWh*
Power	*10 MW*
Storage Period	*Hours/Days*
Sector	*Cold*
Application	*Building*



Description:
Distributed and centralized cold storages are used for peak cold shaving for the district cooling grid. The aim is to increase the renewable electricity utilization, lowering CO_2 emissions, cost reductions, and increase efficiency. The cold storage is charged during off-peak hours, using cheaper nigh-time electricity to run the chillers to feed the storages. The cold storage is discharged to cover the peak cold need during the day.

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Heat & Electricity Storage for Power 2 Heat

1. Scores

AEE, Austria

TRL	*4-9*
Storage tech.	*Chemical/LiIon*
Capacity	*240/62 kWh*
Power	*30 kW*
Storage Period	*Daily/Seasonal*
Sector	*Heat*
Application	*Building*

Description:
The SCORES concept is based on a hybrid system combining heat and electrical storage solutions to increase the self-consumption of locally produced PV electricity by providing electricity and heat to the building. The storage technologies used are: a sensible buffer storage in combination with a heat pump (short term), second-life Li-Ion Batteries (short term), and a chemical heat storage (long term).

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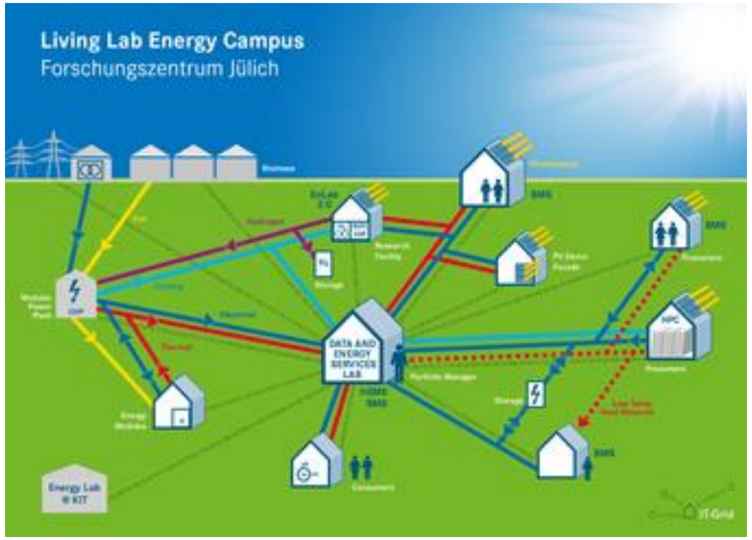
1. Living Lab Energy Campus

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.

Task 35

„Flexible Sector Coupling“ –
Task 35 Structure

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Objectives of Task 35

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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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Subtask Structure

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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/quarters, 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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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,…)

Conclusions

- The electricity sector will have the highest share of renewable energy input
- Thermal and the mobility sector are responsible for 75 % of CO_2 emissions
- Sector coupling is crucial for decarbonizing all sectors
- Only „Flexible Sector Coupling“ allows to match supply and demand!
- A number of energy storage technologies is available to address this approach

Thank you very much for your attention!