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Annex 35
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Flexible Sector Coupling – Best Practice Examples

Energy Storage Academy – World Bank

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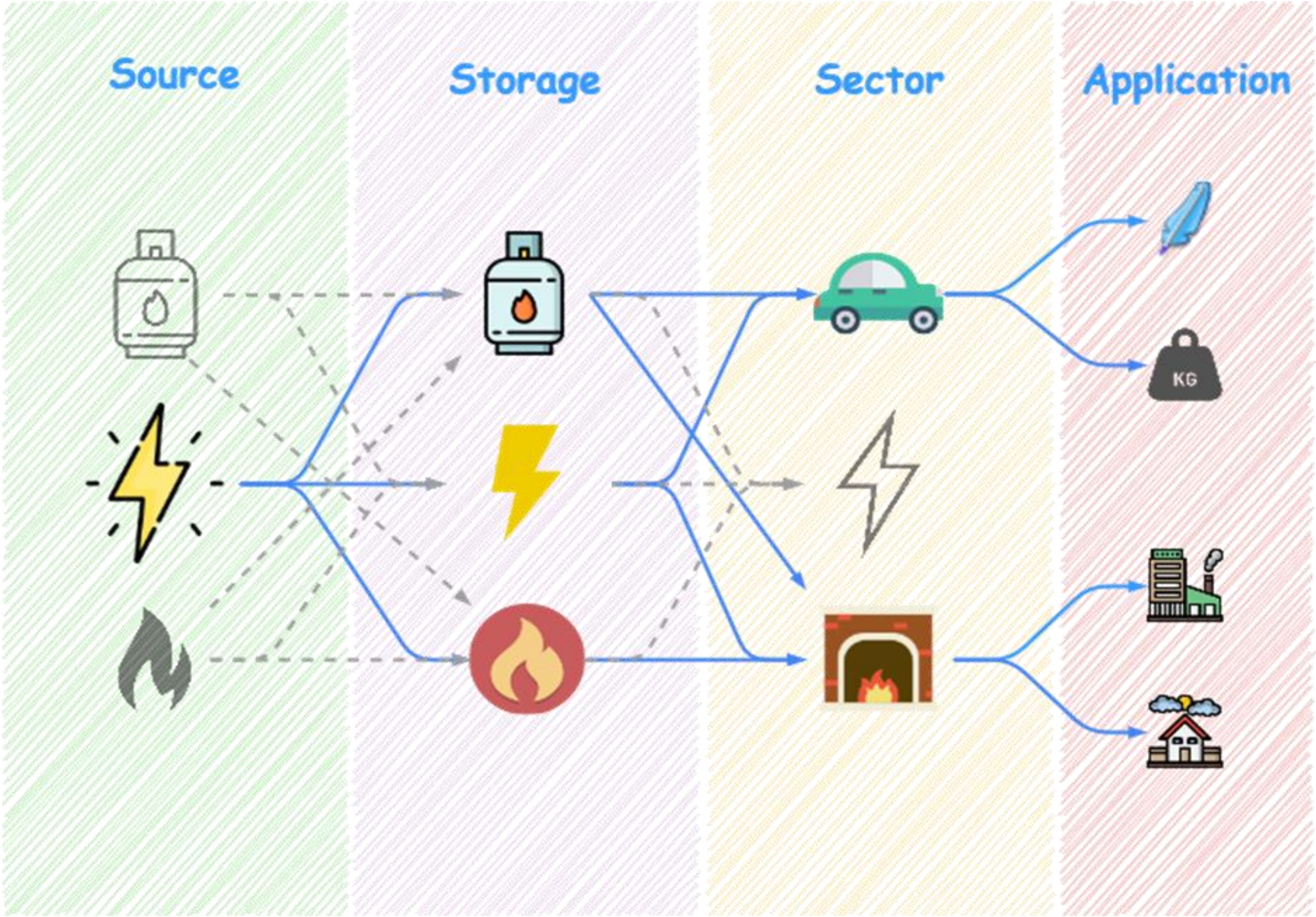
Agenda

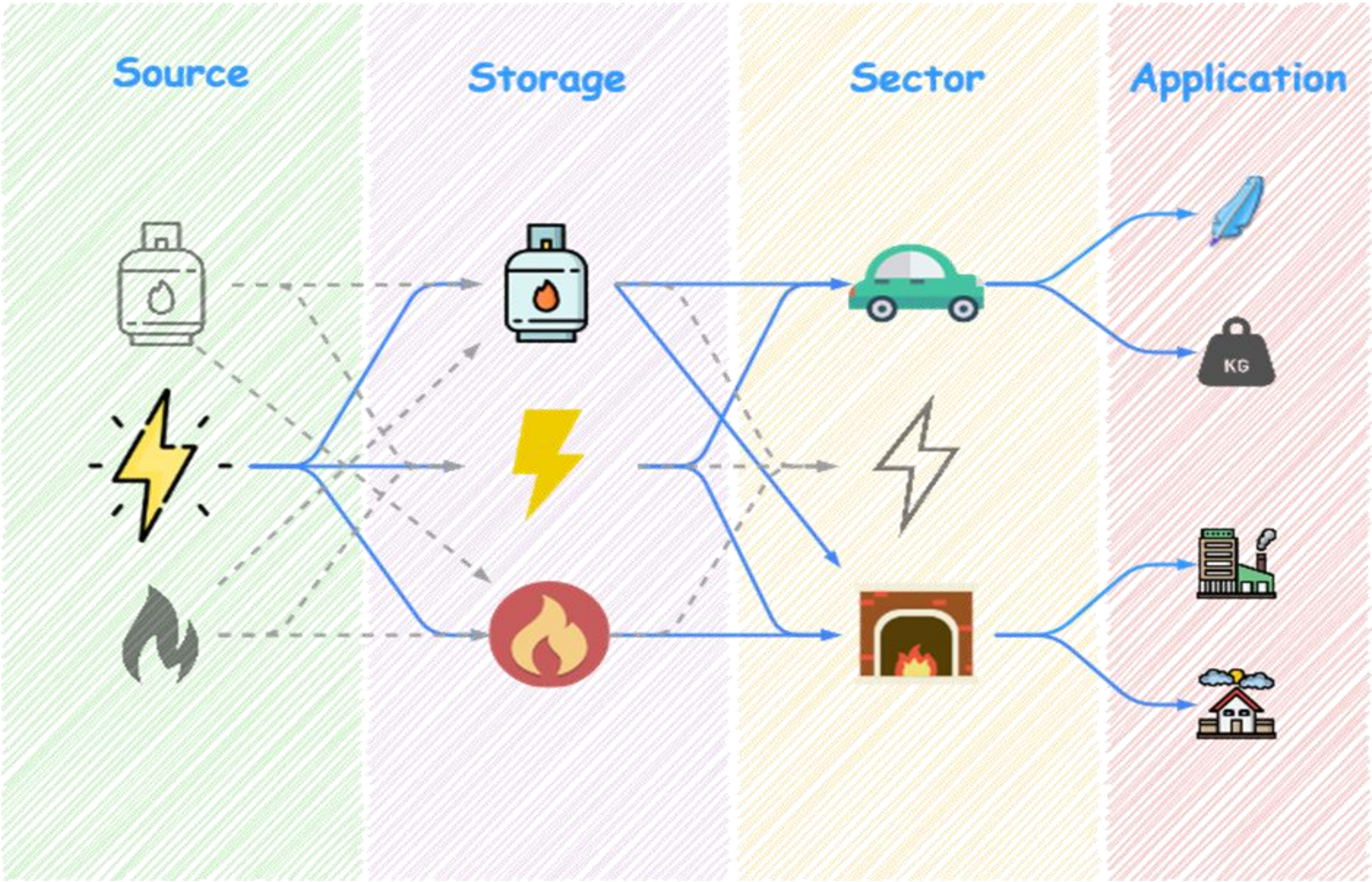
- Overview of Sector Coupling
- Overview Storage Technologies for Flexible Sector Coupling
- Best Practise Examples
- Conclusion

Overview of Sector coupling



Categories

- Gas Storage for Power-2-Mobility
- Gas Storage for Power-2-Heat
- Battery storage for Power-2-Mobility
- Battery storage for Power-2-Heat
- Heat storage for Power-2-Heat



Storage Technologies

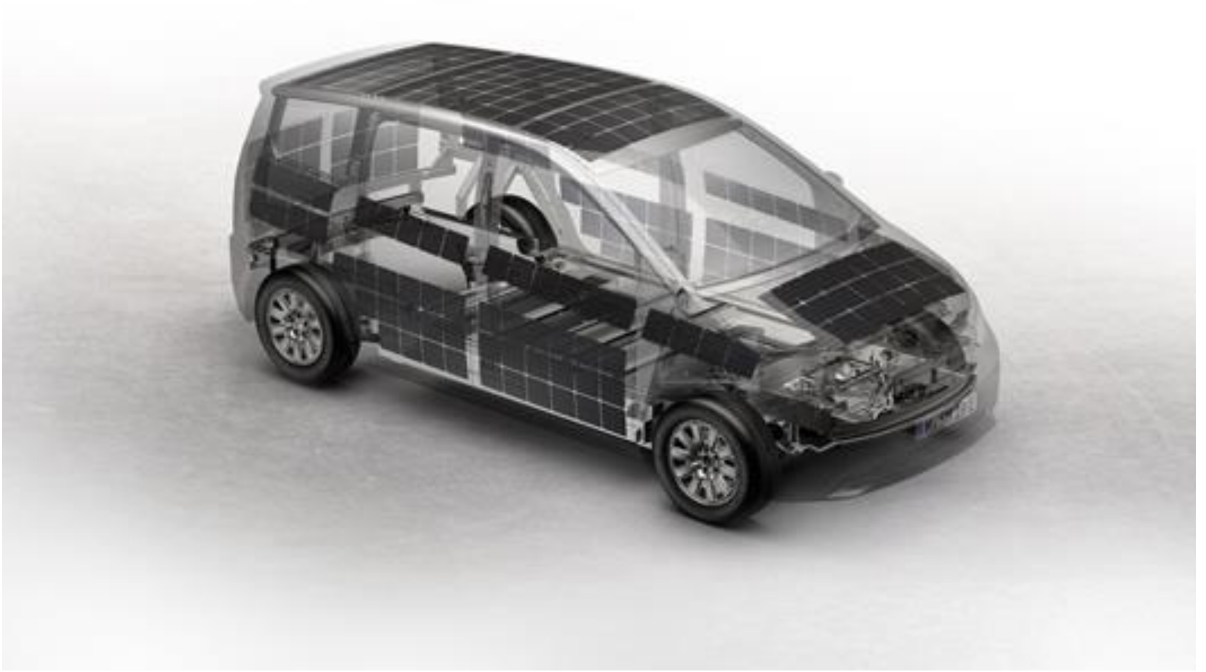
- **Gas storage**
  - Hydrogen
    - Compressed
    - Liquid
    - Hydride
    - Liquid Organics
    - Adsorbent
  - Methane/Methanol
    - Compressed
    - …
  - …
- **Battery Storage**
  - Li-Ion
  - Lead- Acid
  - Nickel
  - Redox-Flow
- **Heat Storage**
  - Sensible
    - Water
      - Tank storage
      - Pit storage
      - Borehole
      - …
    - Solid
    - Other liquids
  - Latent
    - Solid-liquid
    - Solid - solid
  - Thermo-chemical
    - Adsorption
    - Absorption
    - Chemical reaction

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.

1. Electric Bus On-Route Charging

NRCan, Canada

TRL	*7*
Storage tech.	*Li-Ion Battery*
Capacity	*2,5 MWh*
Power	*0,0025 MW*
Storage Period	*Seconds*
Sector	*Mobility*
Application	*Heavy Traffic*

Description:
eCAMION is partnering with the City of Edmonton and the Universities of Alberta and Calgary to demonstrate core technology solutions that are required to electrify Alberta's transit, thus transitioning buses from highly emissive diesel to Alberta's grid electricity. A 1.5 MWh battery storage will be installed at the City of Edmonton's KATG facility for bus-charging.

Heat and Cold Storage for Power 2 Heat

1. Ministor

HSLU, Greece/Hungary/France

TRL	*5*
Storage tech.	*Latent/TCM*
Capacity	*30 MWh*
Power	*20 MW*
Storage Period	*Hours/Days*
Sector	*Heat*
Application	*Building*

Description:
MiniStor´ system optimizes the use and management of thermal energy and electricity from PV by allowing it to be stored in a TCM or latet heat storage, levelling demand peaks and increasing the use of renewables affected by intermittency such as solar-based heating. The systems have been validated by 5 demonstration sites.

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*

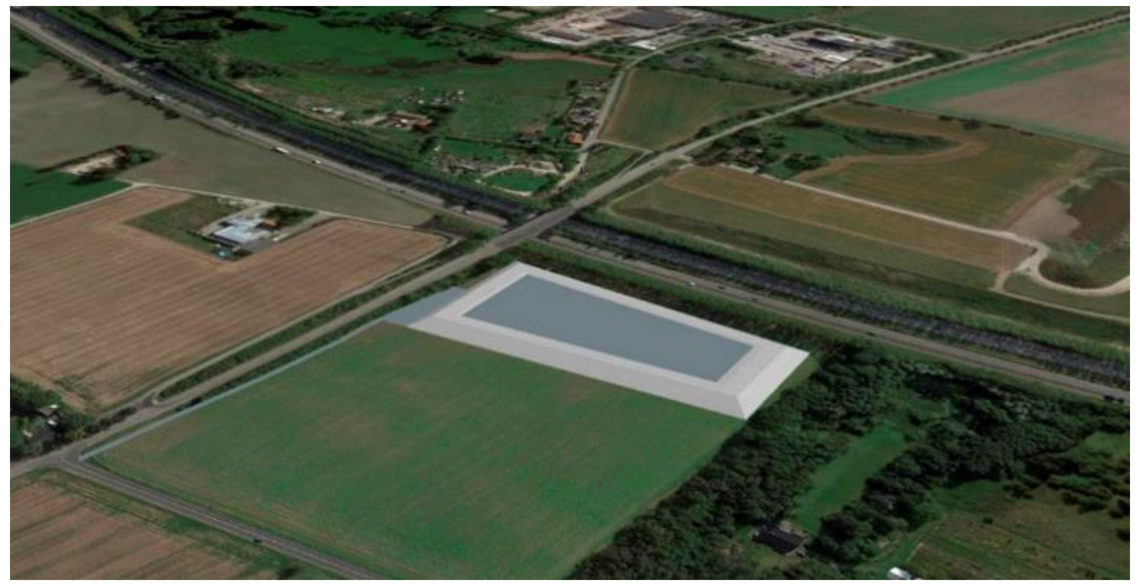
Description:
Distributed and centralized cold storages are used for peak cold shaving for the district cooling grid. The aim is to increase the renewable electricity utilization, lowering CO2 emissions, cost reductions, and increase efficiency. The cold storage is charged during off-peak hours, using 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.

Heat Storage for Power 2 Heat

1. Large-scale load balancing

PlanEnergi, Denmark

TRL	*7*
Storage tech.	*Pit storage*
Capacity	*4000 MWh*
Power	*40 MW*
Storage Period	*Days*
Sector	*Heat*
Application	*Building*



Description:
The project in Høje Taastrup is currently under construction. The purpose is to increase the flexibility in the widespread district heating system in the Copenhagen area. It will serve to balance supply and demand to increase the heat production from CHP plants, waste incineration, industrial excess heat production and possible large scale heat pumps in the future.

1. Giga_Tes

AEE, Austria

TRL	*4-5*
Storage tech.	*Pit storage*
Capacity	*70.000 MWh*
Power	*70 MW*
Storage Period	*Seasonal*
Sector	*Heat*
Application	*Building*

Description:
In this project, a pit store for seasonal energy storage is used for sector-coupling. Excess heat and electricity in combination with heat pumps is used to heat up the pit storage and deliver heat to the district heating system. Due to high land prices, the surface should be kept as low as possible, to ensure cost efficiency and therefore new construction methods and materials are investigated.

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).

1. Drakes Landing Solar Community

NRCan, Canada

TRL	*7*
Storage tech.	*Buffer, Borehole*
Capacity	*700 MWh*
Power	*1200 MW*
Storage Period	*Seasonal*
Sector	*Heat*
Application	*Buildings*

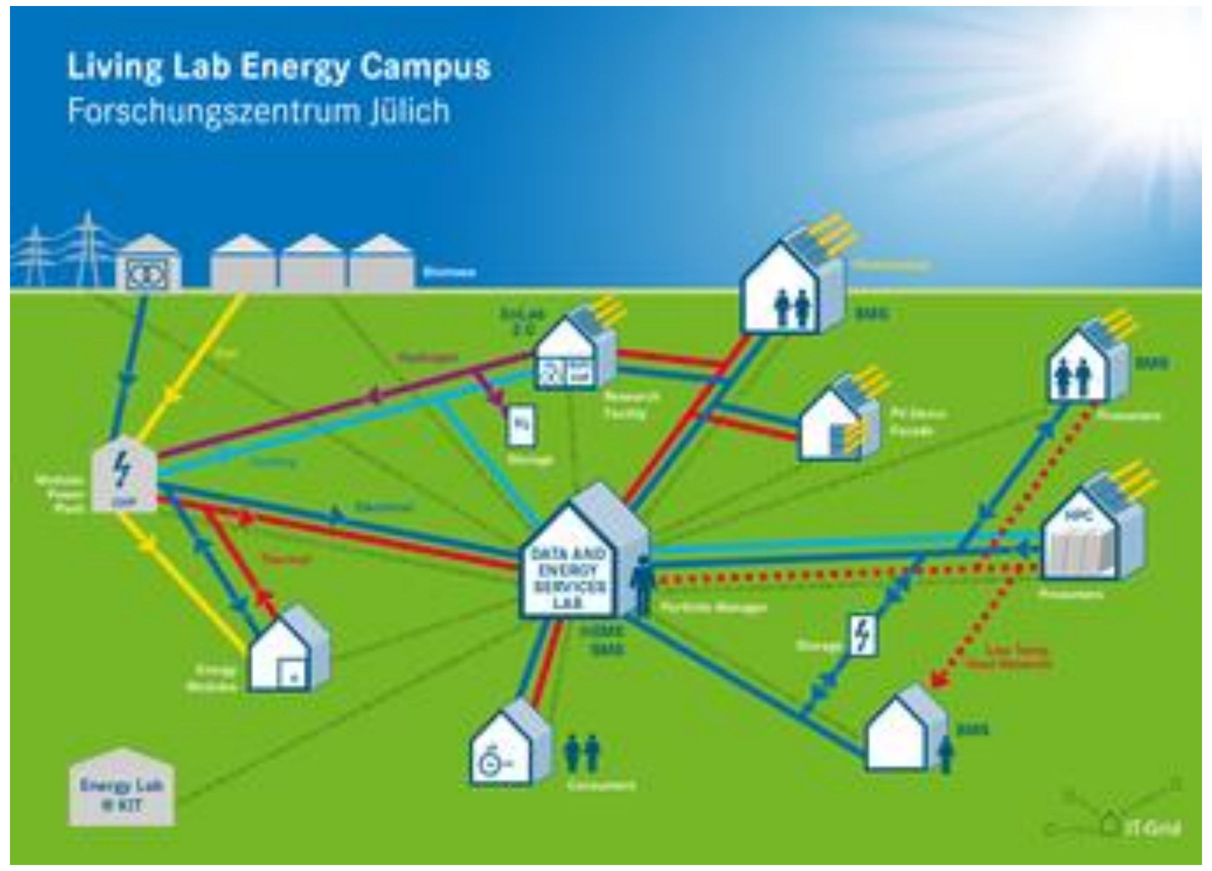
Drakes Landing Solar Community is a master planned neighbourhood that covers 90% of its energy consumption for space heating by solar energy. Seasonal energy storage is enabled by Borehole thermal energy storages. Short-term storage tanks provide a central hub for heat movement.

Heat, Battery & Gas Storage for P2H, P2M

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.

1. EnFF Stadt FlexQuartier

HAW Mittelessen, Germany

TRL	*8*
Storage tech.	*Li-Ion/Sensible heat*
Capacity	*8,72 MWh*
Power	*1,38 MW*
Storage Period	*Minutes/Days*
Sector	*Heat/Mobility*
Application	*Building/Light traffic*

Sector coupling in the district's energy center will be realized by developing a new type of high-temperature storage technology, in combination with a multifunctional battery storage system for electricity and a central hot-water stratified storage system for waste heat. Electromobility will be realized as an additional building block so that all consumption sectors are taken into account.

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Conclusion

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- Wide variaty 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 readyness level)
- High potential for sector coupling – huge storage capacities required in future
- No standard solution - Best technology / configuration depend on boundary conditions and specific requirments of the application
- Regulatory boundaries necessary to introduce sector coupling on the market

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