Smart Grids Plus
ERA-Net

Scoping Workshop, Malmö 2015

Storage at the Service of the Energy System: Gaps and RTD needs

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BACKGROUND

- PhD in Physics
- 23 years EU RTD projects in the field of renewable energies
- Involved in EU projects from FP2 to FP7, H2020, IEE; German RTD
- Author of study on state-of-the-art of storage technology and use (2013)

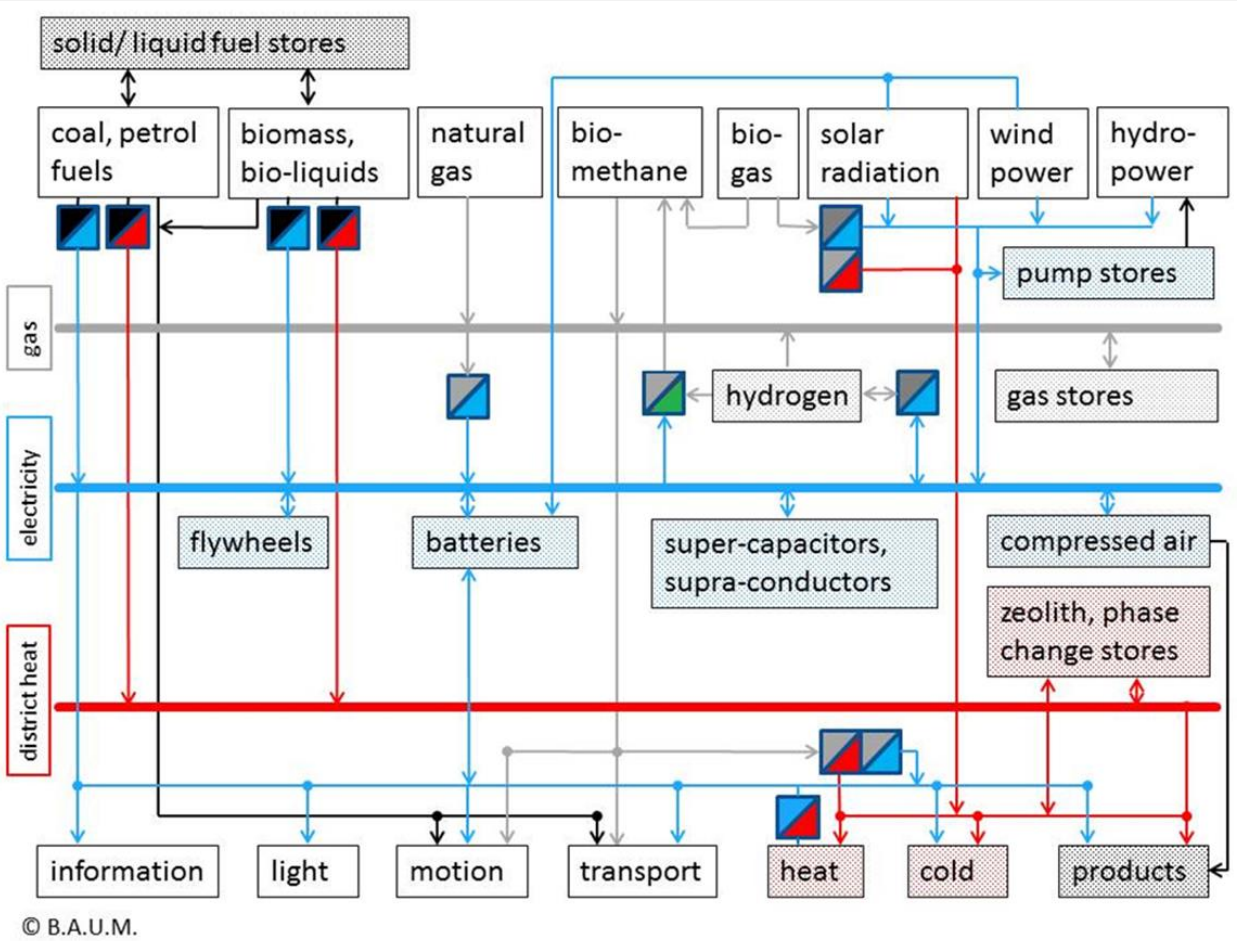
STORAGE IS NOT AN END IN ITSELF …

… people need products and services.

Therefore energy is required. Storage is one means for providing it when it just in time.

FLEXIBILITY 1.0

- Generation management (non-use or storage of primary energy before conversion to electricity)
- Demand response (time-shift or storage of energy service provided with electricity: heat, cold, chemicals, products, etc.)
- **Storage (conversion of energy into another form of energy and back to the 1st form or further to a 3rd)**
- Grid extension to cope with whatever might happen on the generation or demand side
  → often high initial/ transition costs, time and potentially social tensions



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STORAGE LINKING ELECTRICITY, HEAT AND GAS

STORAGE FOR SECONDS TO DAYS

- Required capacity not exactly known (estimations strongly depend on granularity of model)
- Broad range of storage technologies available: batteries, pumped hydro, compressed air, etc.
- Strong competition with other flexibility options
- Li-ion batteries undergo strongest technological development, cost decrease and market expansion
- PV + Li-ion batteries can already compete with end user electricity tariffs in Germany

Gap: Exploring the full potential for low-cost, secure, etc. Li-ion batteries and other storage and demand response technologies

STORAGE FOR WEEKS AND MONTHS

- Required capacity ≥ 10% of annual electricity demand
- Only Power-to-gas (PtG; means H_2 and CH_4) and very large heat reservoirs technically suitable
- Only PtG has sufficient potential, but $\eta_{el \rightarrow el} \approx$ 30-45%
- Gas storage reservoirs, distribution and use infrastructure (gas pipelines, power stations, CHP, heaters) are readily available
- 20 plants operate in DE; industrial deployment started

Gap: Efficient, flexible and low-cost PtG-converters

FLEXIBILITY 2.0

1. **Cross energy carrier synergies**
   - Electricity to heat/cold: making use of cheap/ inherent options for heat/cold storage, e.g. cooling houses
   - Electricity to gas: making use of existing natural gas transport, storage (120TWhel in DE) and use infrastructure
   - Energy to chemicals/products: making use of existing storage options of chemicals/products, e.g. hydrogen
2. **Rendering the infrastructure itself flexible**
   - Relocatable storage units and other components
   - 2nd life of existing infrastructure: natural gas power stations, pipes, and stores, etc.

RELEVANT SCENARIO FOR PROPOSED RESEARCH

- Developing a Holistic View of the Energy System in Transition

USE CASE FOR EXPECTED RESULTS

- Holistic Physical View of the Energy System for Achieving Societal Consensus
- Adapting Market Frameworks for Optimum Course Setting of Energy Transition

RESEARCH TOPICS AND QUESTIONS (1)

Appropriate models for cross-carrier energy systems

- Which is the best mix of flexibilities at different scales and in different geographical areas?
- Which is the optimum mix of central/ decentralised generation and storage, and grid extension?
- Which transition paths are robust with regard to uncertainties and which measures are not regrettable?

RESEARCH TOPICS AND QUESTIONS (2)

Appropriate storage and demand response technologies

- standardised, cheap and secure storage technologies
- connecting different energy sectors
- relocatable units to respond flexibly to development of generation and demand
- maximum use of existing infrastructure and 2nd life

RESEARCH TOPICS AND QUESTIONS (3)

Identifying optimum energy transition corridors taking market aspects into account

- How do different market frameworks impact on the energy transition?
- Which are optimum corridors for cost-effective energy transition paths?
- Which market rules do best suit optimum energy transition paths?

ERA-Net Smart Grids Plus will be supported by funding from the European Union's Horizon 2020 research and innovation programme.