Annex 28

Distributed Energy Storage for the Integration of Renewable Energies - DESIRE

IEA Symposium on
Demand Flexibility and RES Integration

Thinking the Smart Grid from the Consumer End

9th May 2016, Linz, Austria

Fraunhofer UMSICHT

ZAE BAYERN

Objectives

The overall goal of Annex 28 is to foster the role of **D**istributes **E**nergy **S**torages, **DES,** and to better evaluate the potential storage capacities for the integration of renewables at an economical competitive level. For this the following measures are taken:

- Identifying **actual applications for DES** to integrate fluctuating renewable energy sources into future energy systems
- Examining distributed **energy storage technologies** and their properties (including mechanical, electro-chemical, thermal and chemical and biogas approaches)
- Reviewing storage properties requirements depending on the different **renewable energy sources** (wind, PV, solar thermal, …)
- **Promoting best practice** and success stories examples
- **Quantifying potential** of DES systems for the integration of renewable energies based on the actual final energy demand
- Studying possible **control and operation strategies** for DES and technologies by smart grids

Scope

The scope of this Annex includes all energy storage technologies suitable on the consumer side. Three main fields of application – households, trade and commerce and industry – will be investigated.

The Annex will cover the following topics:

- Assessment of **all storage technologies** which show a technical and economic potential for **distributed applications** (e.g. batteries or cold and heat storages) in uni- or bidirectional operation.
- Investigation of system concepts with the temporal mismatch between **fluctuating, renewable energy sources** (wind, PV, solar-thermal, …) and the corresponding **energy demand.**
- Evaluation of **national energy scenarios** of the participating countries with focus on the development of **renewable energies**

Collaboration with Other Parties

Collaboration with other Technology Collaboration Platforms (TCPs) within the IEA Technology Network is crucial for this Annex.

- TCPs for Renewable energy sources: Wind, PVPS and Solar Heating and Cooling from the Renewable Energy Working Party (REWP)
- TCPs for Applications: buildings, appliances and electric vehicles, (EBC, Heat Pump Technologies, 4E and HEV) and Demand Side Management DSM from the End-Use-Working Party (EUWP)
- Programs for distribution and scenarios: DHC and the International Smart Grid Action Network (ISGAN) as well as ETSAP

Contents of the Workplan

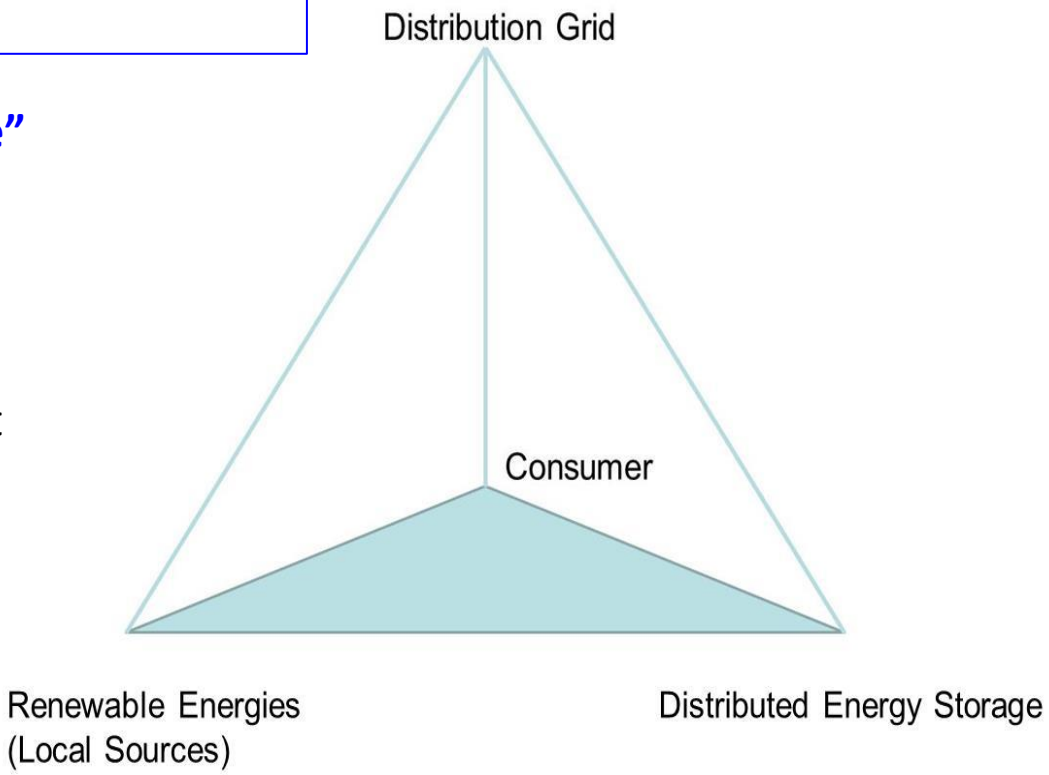
Main Question & Definition

Main Question:

What can be the contribution of distributed energy storage to the integration of renewable energies in future energy systems?

Definition of "Distributed Energy Storage"

The picture is visualizing the relation of DES **on the consumer side** including **local renewable energy sources**, including the possibility of DES being located directly at the renewable energy source.
The **distribution grid** is placed on top of this tetrahedron to represent the connection to the higher grid levels with centralized power plants.



Classification of Storage Technologies

ECES 28 DESIRE: Integration of Renewable Energies on different levels by usage of distributed thermal and/or electrical and chemical energy storage

	EES	EES + TES	TES	P2G
Electric grid operated	1-A	1-B	1-C	1-D
Electric grid connected, but locally optimized	2-A	2-B	2-C	2-D
„Island“ solution	3-A	3-B	3-C	3-D

Sub-Task Structure

Sub-Task 1
Distributed Energy Storage Solutions
Leader: The Netherlands

Sub-Task 2
Economic Analysis & Business Cases
Leader: Sweden

Sub-Task 3
Potential of Distributed Storage Solutions for the Integration of Renewable Energies
Leader: Denmark

Sub-Task 4
Control Requirements for Distributed Energy Storages

- Subtask 1: Distributed storage solution in ongoing R&D projects
- Subtask 2: Economic analysis and existing business cases
- Subtask 3 has to identify the general potential of DES solutions in different countries
- Subtask 4: Necessary control requirements for the operation of DES solutions (smart grid activities)

The Subtasks and Examples

Subtask 1: Distributed Energy Storage Solutions

Subtask 1: "Storage Solutions for the Integration of Renewable Energies"

All storage technologies – **electrical, thermal, chemical** - suited for distributed applications should be **characterized** within **relevant applications** (including the renewable energy source and the final consumer!).

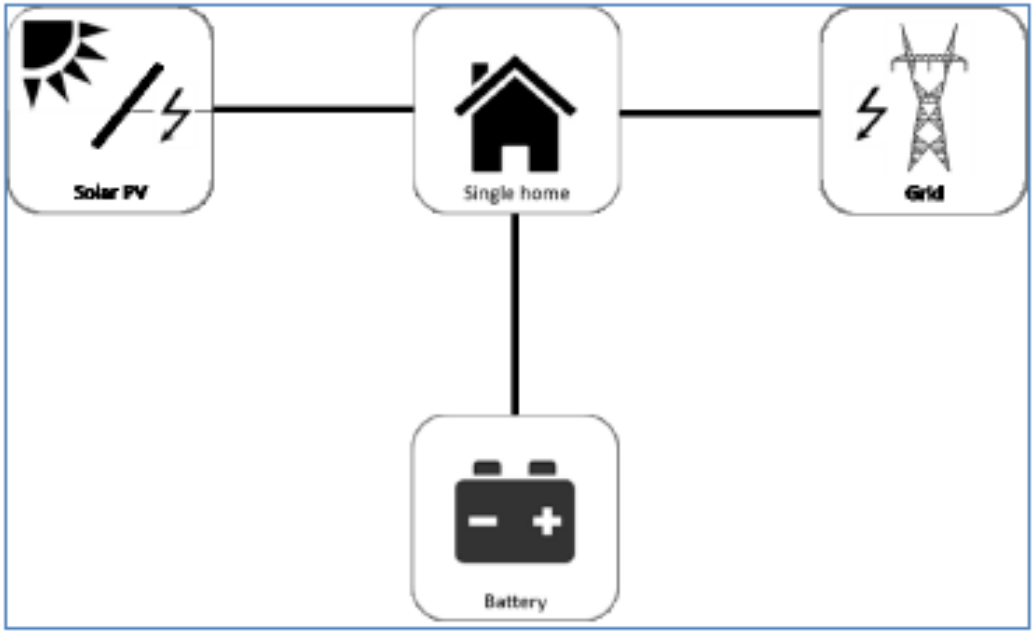
The work plan of Subtask 1 comprises the following activities:

- **Defining and describing all relevant energy storage systems** (electrical, thermal and chemical) including the **energy input** and **final consumer**. Technologies with TRL 3 – 9 are taken into account.
- Characterization of the storage systems by their **power input** (e.g. electric input in kW), by typical **storage capacity** (e.g. hot water tank in kWh), by **power output** (e.g. cooling output in kW) and by round-trip **efficiency**.
- Description of the DES technologies with **respect to an actual application**

Subtask 1: Distributed Energy Storage Solutions

Storage Configurations:

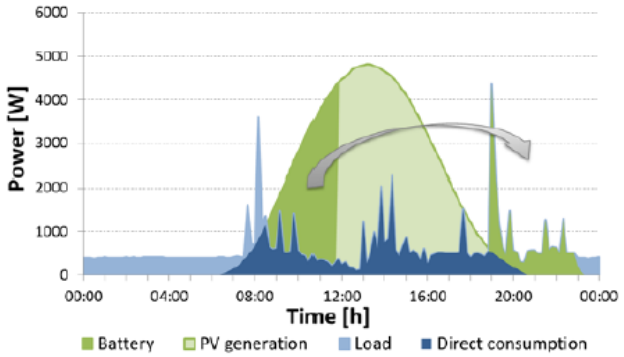
- Energy Source
- Energy Consumer
- Energy Storage
- Grid Connection



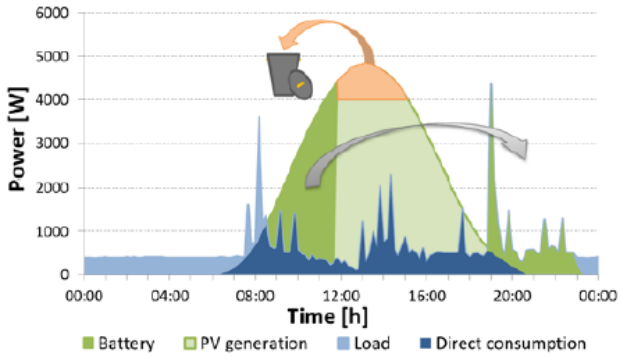
PV + Home Battery, for Single-Familiy House, Grid Connected

Subtask 1: Distributed Energy Storage Solutions

- Battery storage systems are able to raise self-consumption AND relieve the grid when they are managed properly
  - Owner of the PV-storage-system
    - High self-consumption
    - No energy loss



    - Use generated energy whenever possible
    - Store energy as soon as possible
  - Distribution grid operator
    - Low feed-in power, constant voltage



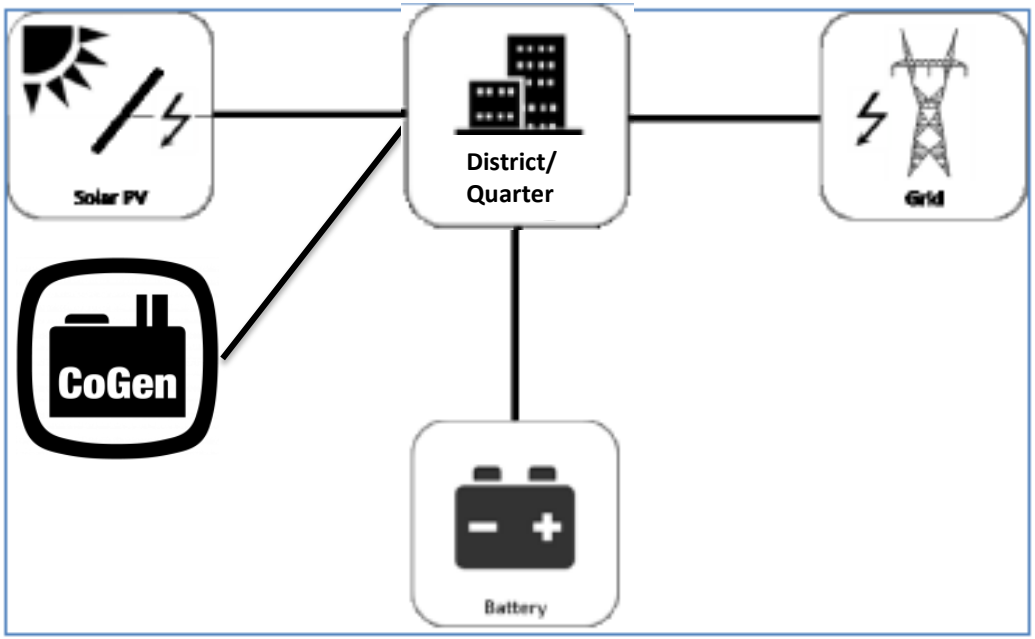
    - Limit feed-in power

- Battery storage managed with forecasts has higher potential to relieve grid without significant energy losses due to feed-in limitation

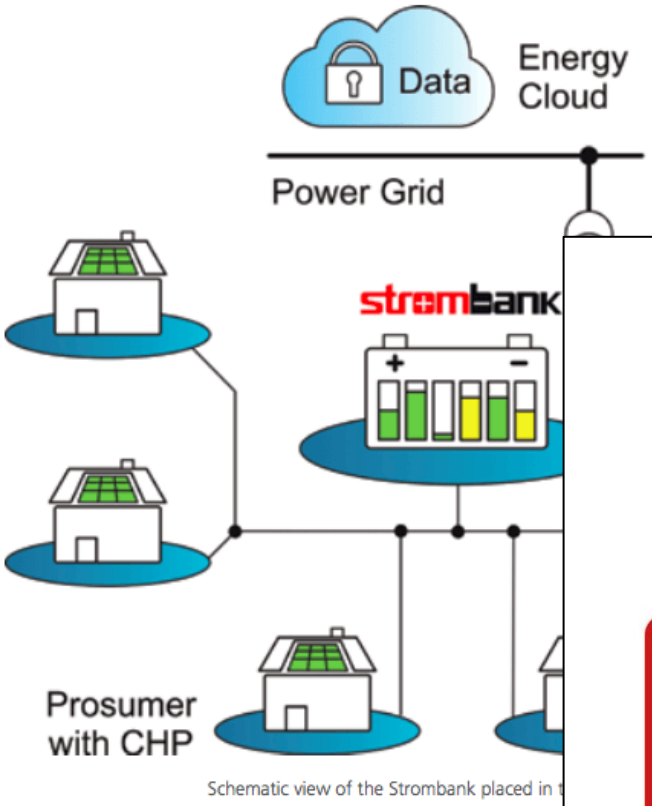
Subtask 1: Distributed Energy Storage Solutions

Storage Configurations:

- Energy Source: PV + CHP
- Energy Consumer: District/Quarter
- Energy Storage: Battery (> 1MW)
- Grid Connection: Yes



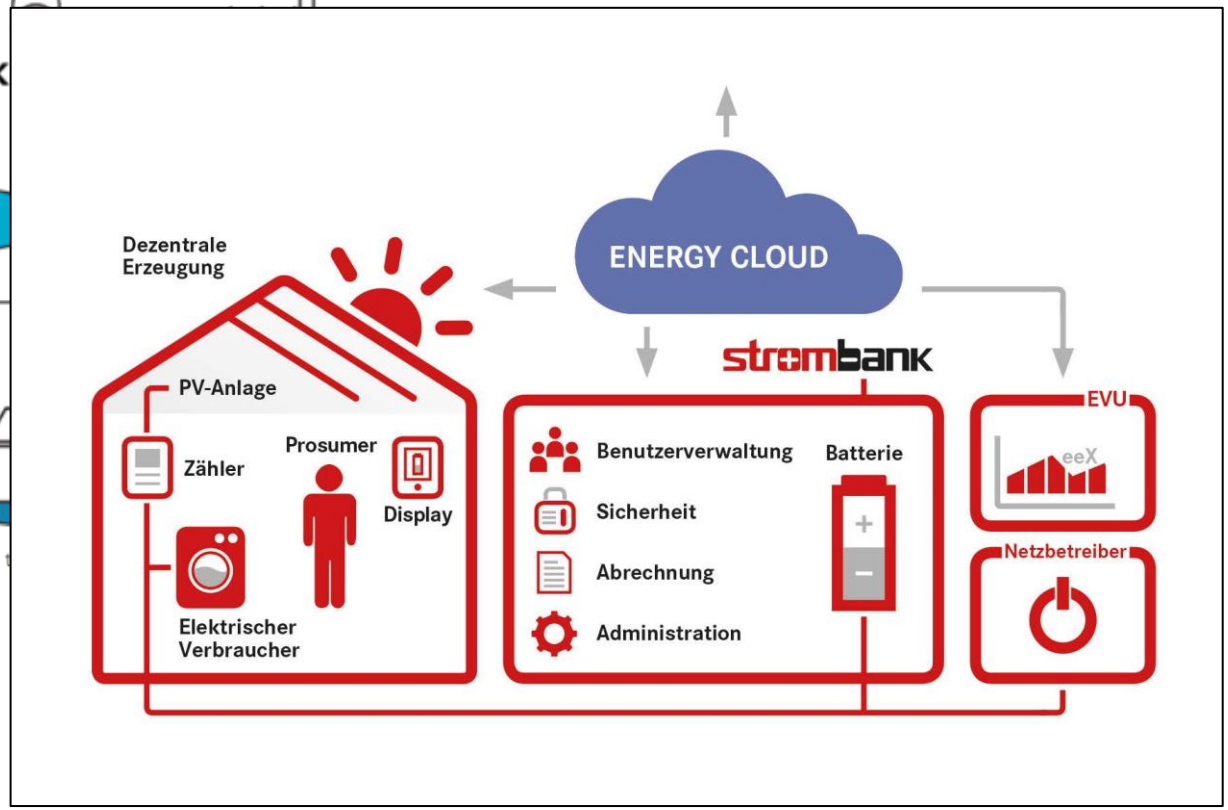
Subtask 1: Distributed Energy Storage Solutions



Schematic view of the Strombank placed in t

„Strom Bank“

Local Electricity Storage for Districts



Subtask 2: Economic Analysis & Business cases

Subtask 2: "Economic Analysis & Business Cases"

This Subtask will focus on actual **examples of distributed energy storage systems**. It will cover **real applications** which are operated due to economic reasons as well as **demonstration plants**, which will be able to be operated in the future in an economical way.

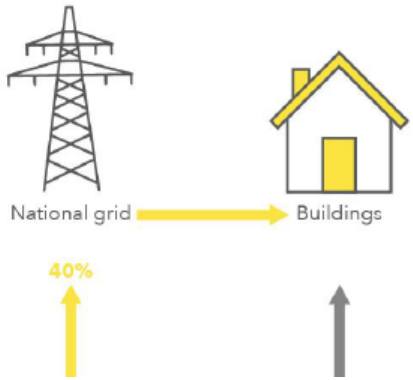
The work plan of Subtask 2 comprises the following activities:

- A **techno-economic analysis** of demonstration projects and commercial installation of DES systems
- Listing of **existing business cases** for DES applications
- A **country specific** description of the **economic** and **regulatory framework** (short) including their impact on the economic performance of DES solutions.
- Identification of **non-technical barriers** for the operation of DES solutions of different bottlenecks given by the economic/regulatory framework and recommendations to overcome these bottlenecks.

Subtask 2: Economic Analysis & Business cases

Functional scheme power gap filler.

Consumption of hydrogen.



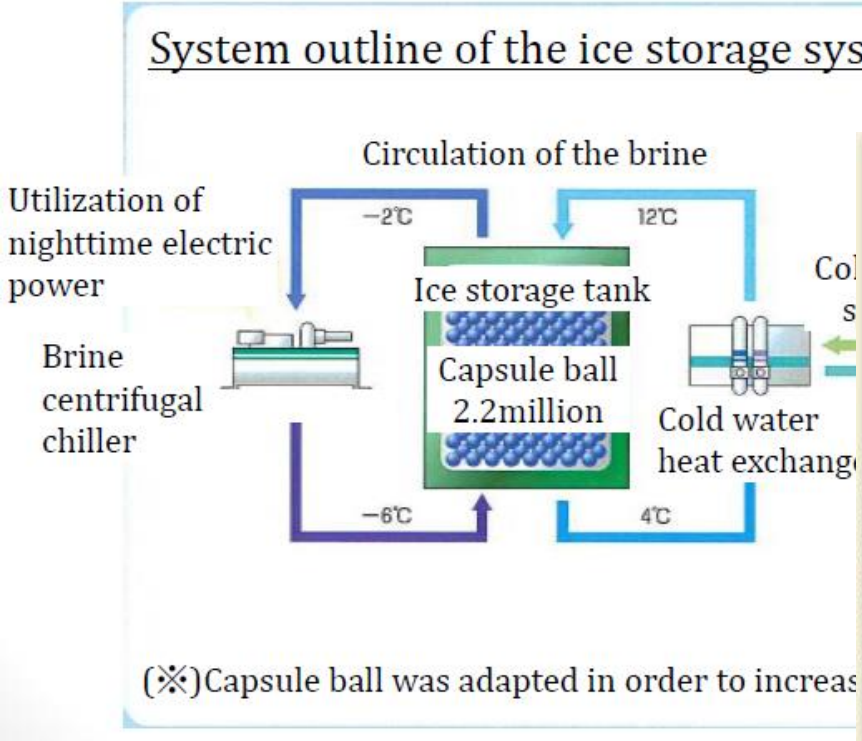
Fact sheet.

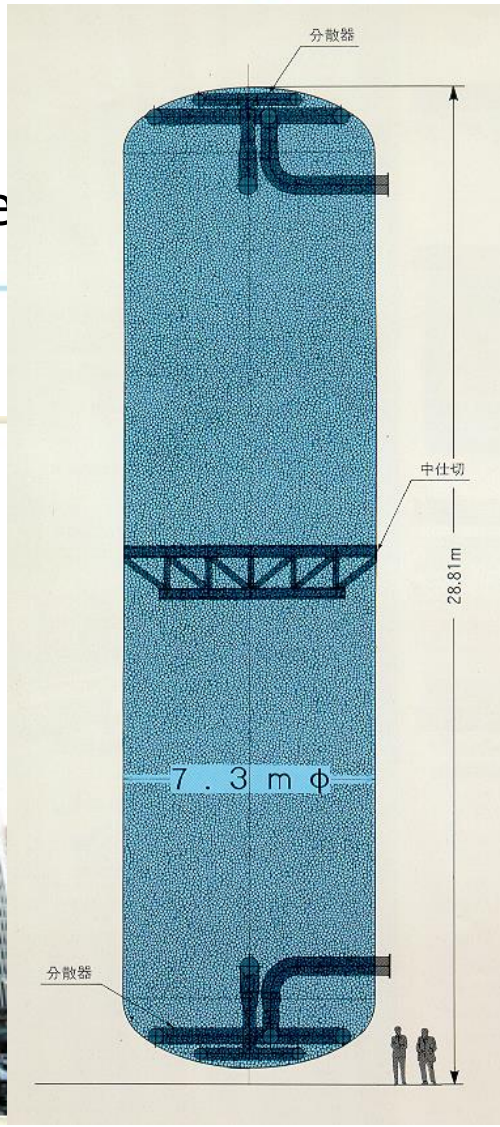
- Percentage of hydrogen in gas mixture — *up to 20%*
- Power to gas efficiency — *≈ 75%*
  Power to gas to power efficiency — *≈ 40%*
- Power to gas incl. use of waste heat — *up to 95%*
  Power to gas to power efficiency incl. CHP — *up to 85%*

Subtask 2: Economic Analysis & Business cases

Ice Storage for Air Conditioning

- Charged by cheap night time elctricity
- Encapsulated Ice Balls, 1226 m³, 49 MWh storage





Subtask 3: Potential of Distributed Energy Storage Solutions

Subtask 3: "Potential of Distributed Storage Solutions for the Integration of Renewable Energies"

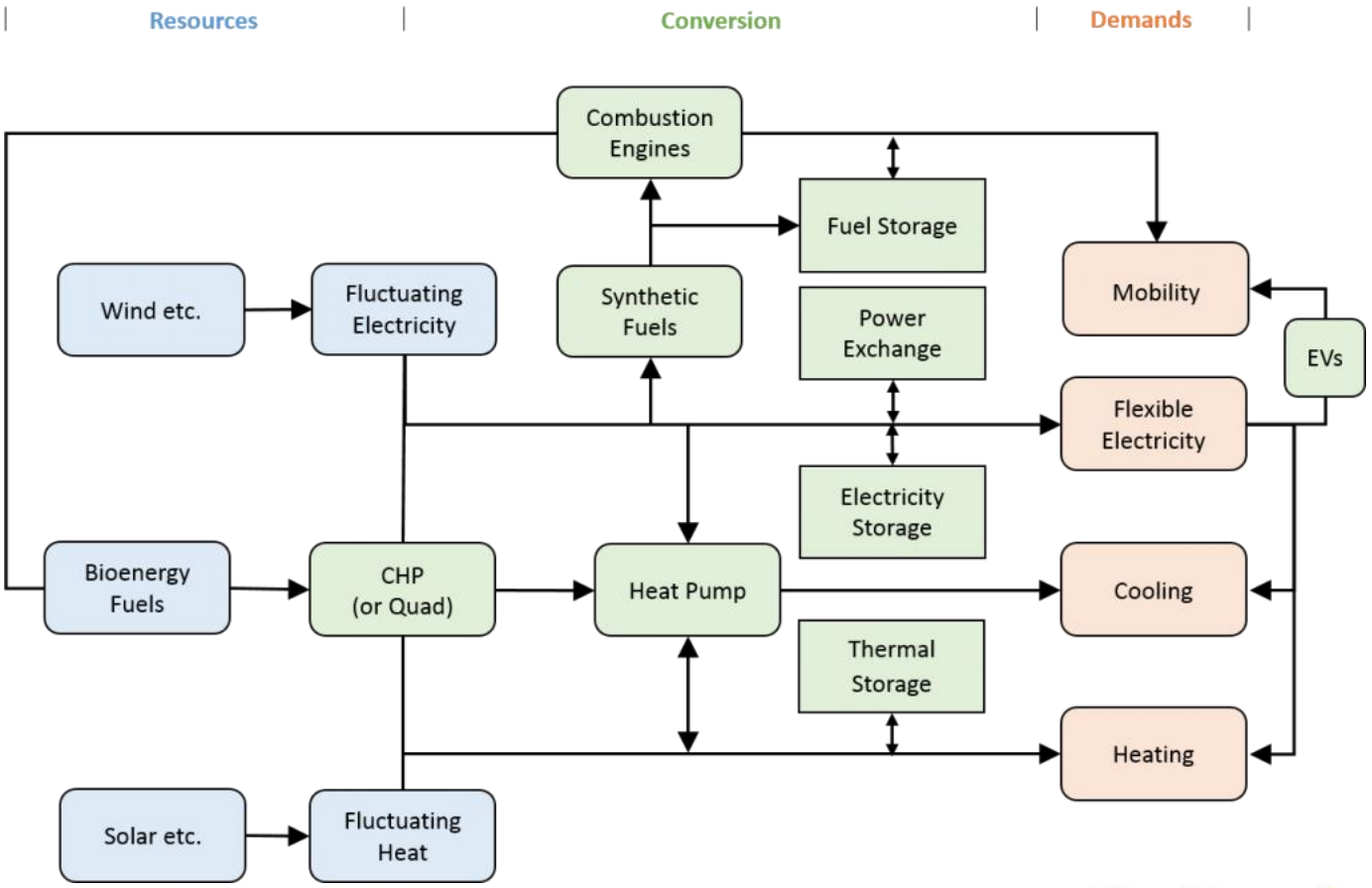
This subtask is based on the outcome of subtask 1 and 2. Here the **potentials of DES** solutions within the different fields of application in different countries or regions shall be quantified. The potentials have to be qualified regarding a **"technical potential" and an "economic potential"**. From this potential a rough estimation could be derived about the future use of these solutions. Promising **future business cases** for DES solutions within the scope of this Annex shall be identified and listed.

The workplan of Subtask 3 comprises the following activities:

- Estimation of the **grid balancing potential for RE** of DES solutions described in Subtask 1 and 2. Technologies with TRL 3 – 9 are taken into account.
- Estimation of **grid-connected and locally optimized or non-grid-connected** DES system for the Integration of RE.
- Estimation of the total (technical and economic) **potential of DES** solutions for different countries or areas

Subtask 3: Potential of Distributed Energy Storage Solutions

Model of the Energy System in Denmark:



Subtask 3: Potential of Distributed Energy Storage Solutions

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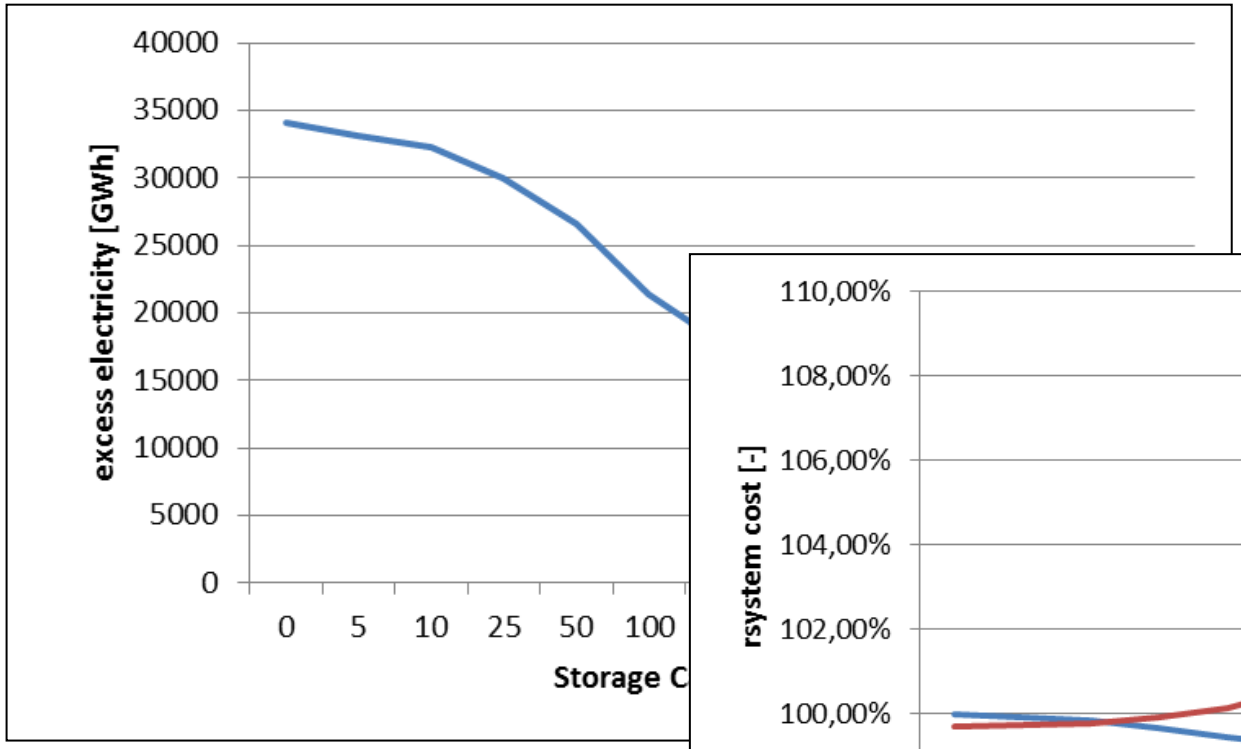
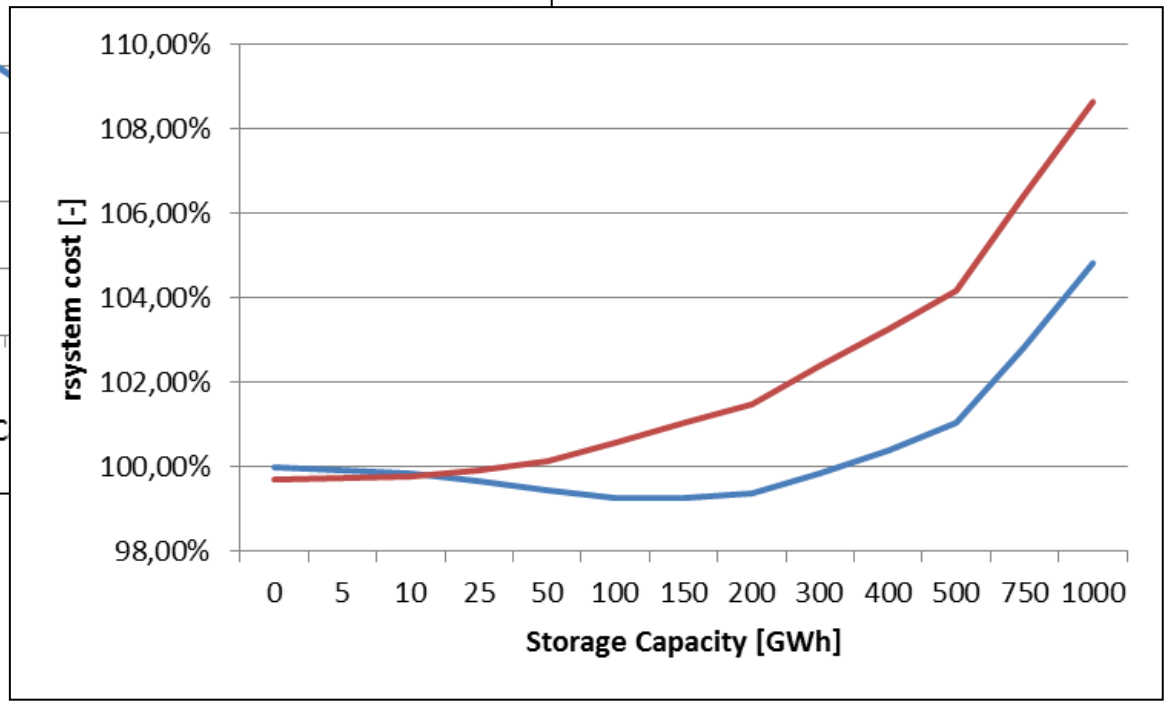
Model of the Energy System in Germany:



…can show how excess electricity can be utilized by



Subtask 4: Control Requirements for Distributed Storages

Subtask 4: "Control Requirements for Distributed Energy Storages"
Important for the successful operation of distributed energy storage solutions are **intelligent operation and control mechanisms**. This could be realized by "Smart Grids". In this point a strong **collaboration** with other parties e.g. the ISGAN IA, would be very important. Existing Smart Grid technologies should be identified.

- Collecting the **state-of-the-art** in Smart Grid solutions

Subtask 4: Control Requirements for Distributed Storages

„Storage of surplus electricity in fridges“

Cold storage can generate dispatchable load within the electricity grid by transforming power to cold

- 20 Million Fridges in Germany (<50% of households)
- PCM cold storage for 12 hours
- Charging time 3 hours
- Price about 5 €

→ **Electric Power** **1,15 GW**

→ **Storage Capacity** **3,5 GWh**

To use this as a felxibility option, a „Smart Grid“ is necessary!

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Distributed Energy Storage for the Integration of Renewable Energies

A rapidly growing contribution by renewable energies to the overall energy production can be expected worldwide. Most renewables, like wind, PV or solar-thermal, are fluctuating resources. With increasing integration of renewable energies energy storage and energy balancing capacities are needed. So far the focus is on large, central and most cost effective energy storage technologies like pumped hydro or the conversion of surplus electricity into hydrogen. The potential and contribution of small and medium sized, distributed energy storage (DES) technologies to balance fluctuation caused by renewable energies is mostly unexplored. Annex 28 DESIRE addresses this topic.

Legal Disclosure

Next Meeting

October 20/21 2016
in Paris at the IEA

Thank you very much for your attention!

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