Energy Storage:
Matching Supply and Demand in the Future

Background Document for the Workshop July 14th-16th, 2010

Introduction

Energy storages are central components of many energy systems. Energy can be stored as electrical, mechanical, chemical or thermal energy (heat and cold). Energy storage systems serve many applications from the integration of renewable electricity sources to energy efficient buildings or domestic appliances.

Looking at the "Energy Technology Perspectives 2008", the reduction of CO_2 emissions until 2050 can only be achieved by a substantial introduction of renewable energies and increase of the overall energy efficiency. Both measures are tightly connected to the development of innovative storage technologies. However, it is very difficult to calculate the potential for energy storage not only in the demand sectors but also in the transport sector. The same goes for the identification of the best storage solution with respect to economy and energy. Detailed knowledge about the boundary conditions is necessary in order to calculate the costs and benefit of storage based solutions.

Since energy storages play such an important role there are a lot of R&D activities in the IEA within the different Implementing Agreements. The decision was made last year by ECES to bring the experts together with the goal of creating synergies and strengthening the R&D into storage-based solutions in all sectors.

The first workshop in Autumn 2009 underlined the need for such an exchange and collaboration. Therefore, the aim of the upcoming workshop is to identify areas for joined activities and the most suitable way(s) of collaboration for each topic.

To make the workshop as fruitful as possible, ECES prepared a background document in which three very important areas are characterized. The given numbers as well as the examples itself should be the basis for the presentations and the discussions in the working groups at the workshop. Experts from different Implementing Agreements and also from industry, representing the energy supply, distribution and demand sectors are asked to present their view on the question: Do you need energy storage? To make their views comparable their arguments should be related to the examples given in this background document.

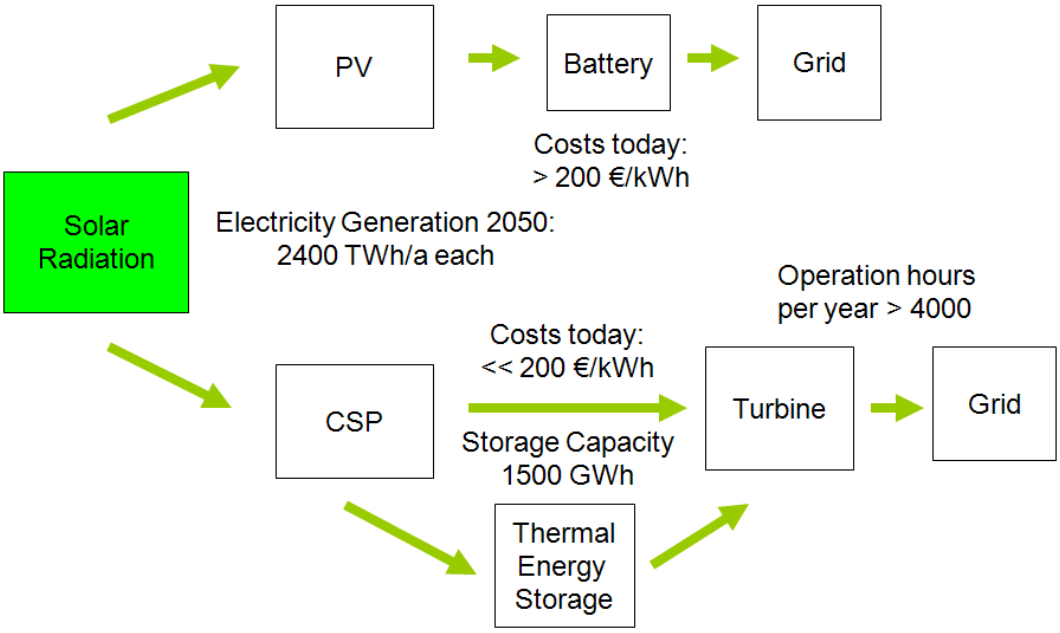
Depending on the interests of the workshop participants collaborations on specific questions could be the outcome of the workshop – this might be for example joint Annexes, expert workshops or further coordination meetings.

Table 1 shows a number of energy storage technologies described by parameters like storage capacity, power, efficiency, storage time and cost. However, the values in table 1 are in most cases strongly depending on the boundary conditions of the actual application and can not be compared without taking this into account.

Table 1 : Mechanical, electrical and thermal energy storage technologies

Storage Technologies	Capacity kWh/t	Power MW	Efficiency	Storage Time	Cost €/kWh
Pumped Hydro	1	1-500	80%	day - month	50
Flywheel	5-100	1-100	90%	hour	3000-5000
CAES	2 kWh/m³	300	40-70%	day	400-800
Lead-Acid	40		85%	day - month	200
Li-ion bat.	130	0.02 - ??	90%	day - month	1000
NaS bat.	110	0.05 - 50	85%	day	300
Redox-Flow bat.	25	0.01-10	75%	day - month	500
SMES	3	10	95%	hour - day	100000
Supercaps	5	0.001 - 1	95%	hour - day	100000
Hot Water	10-50	0.001 - 10	50-90%	day - year	0.1
PCM	50-150	0.001 - 1	75-90%	hour - week	10-50
Chemical Reactions	120-250	0.01 - 1	100%	hour - day	8-40
Hydrogen	30000	0.001 - 1	25-50%	day - year	1000 €/kW

Example 1: Potential of Photovoltaic (PV) and Concentrated Solar Power (CSP)



Conclusion:

- PV has two bottlenecks: Costs for PV itself and for the storage system

  Central Question: Increase of efficiency for PV and decrease costs for balancing the net

  Who is addressed: PV sector, Storage Technologies, Energy Distribution

- Thermal energy storage is able to provide a longer operation time for the turbine

  Central Question: Identification of a suitable high temperature (> 400 °C) storage material

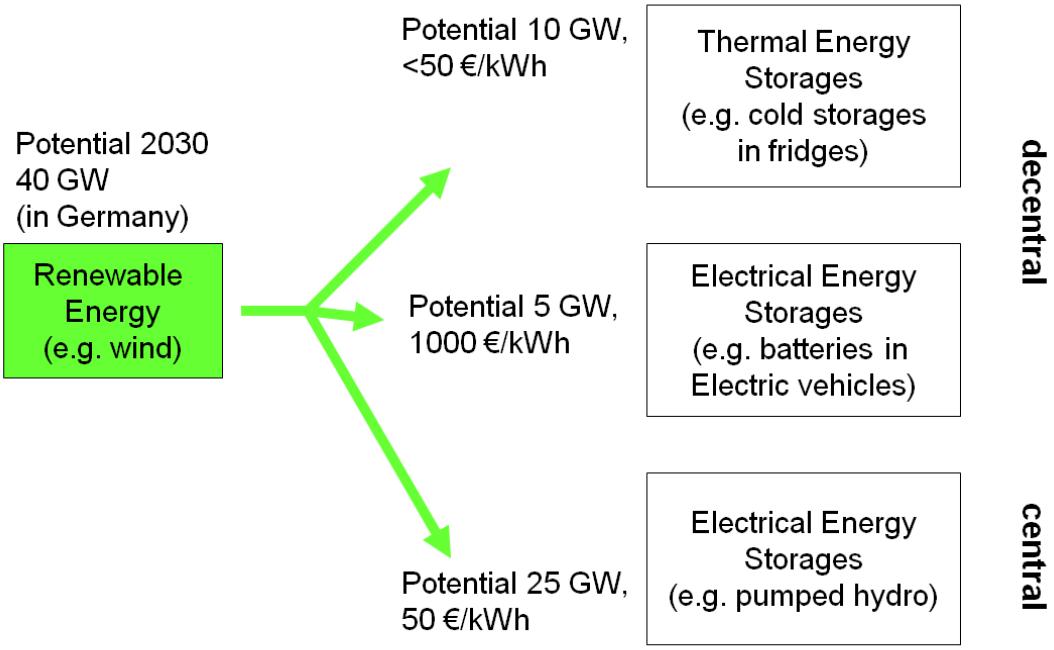
  Who is addressed: Solar power sector, storage technologies

- Storage enables CSP to cover the electricity production base load

  Central Question: Influence on the cost calculation for the solar electricity integration

  Who is addressed: Energy distribution, power sector, storage technologies, renewable energies

Example 2: Balancing the grid to increase the use of the Renewables



Conclusion:

- Decentral solutions based on storages may offer both: The potential of balancing the grid and decreasing energy consumption.

  Central question: Identifying further applications and evaluating economic potential

  Who is addressed: Building sector, storage technologies, home appliances

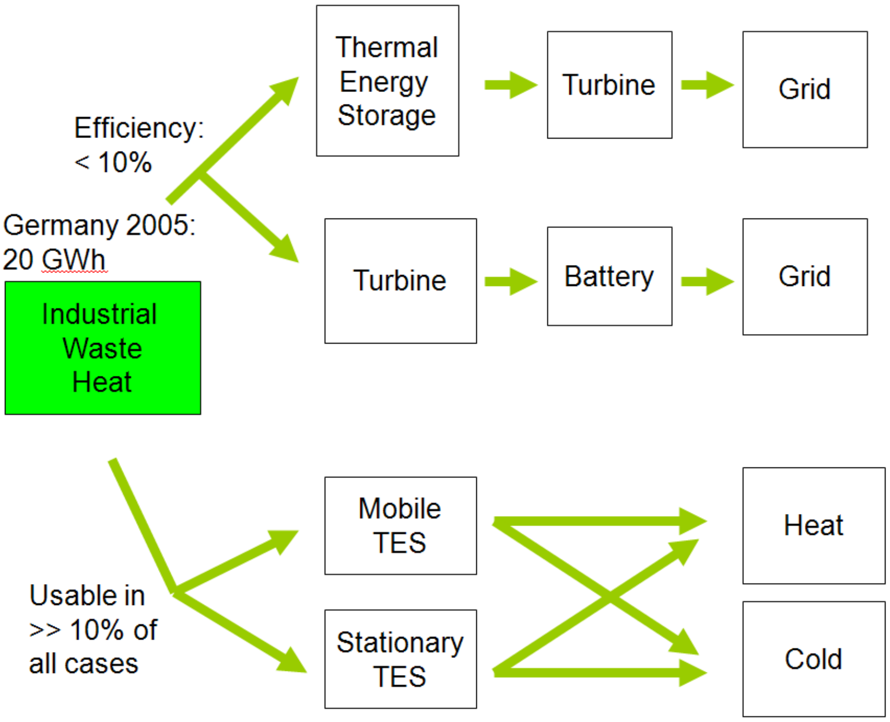
- Costs for decentral and central solutions with and without storages have to be compared concerning costs and energy efficiency / energy consumption

  Central questions: Calculating the costs for further control demand, distribution, increasing electrification of demand side, etc.

  Calculating the costs for surplus Renewable installation (as the electricity demand has to be fulfilled even in times with less supply)

  Who is addressed: Energy distribution, power sector, storage technologies, Renewable energies

Example 2: Potential of Industrial Waste Heat Utilization



Conclusion:

- Thermal Energy Storage may be the most cost-efficient way to optimize the energy efficiency of industrial processes

  Central question: Characterisation of industrial processes with regard to the potential of the increase of energy efficiency and costs using thermal energy storages
  Who is addressed: Industrial sector, storage technologies

- Using even low-temperature waste heat for generating electricity may decrease need for conventional power plants

  Central questions: Compare costs and primary energy consumption with other measures to increase energy efficiency in the industrial processes
  Compare cost and primary energy consumption with other measures to reduce need for conventional power plants
  Who is addressed: Industrial sector, energy distribution, power sector, storage technologies

Suitable forms of collaboration in all areas:

	Phase 1	Phase 2	Output (phase 1+2)
Coord. level	- Potential studies - Evaluating results according to joint workplan	- Demonstration projects	- Messages for policy makers, stakeholders
IA level	- Different Annexes in each IA	- Joint Annexes	- Reliable results on different technologies and systems