Calculation of the required amount of energy storage

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IEA Kick-Off Meeting of Annex 26
08.06.2010, Oberhausen

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AGENDA

1. Goal of the study and term definition
2. Modeling principle
3. Assumptions made in the study
4. Results
5. Conclusions and outlook

Goal of the study

Evaluation of the required amount of energy storages in Germany due to the rising share of fluctuating power sources like wind and photovoltaics at the energy supply

Aimed results:

- Required positive and negative storage power*
- Required positive and negative storage energy demand**

* Storage power = installed power

Negative storage = charge to take energy out of the grid
Positive storage = discharge to feed energy into the grid

** Storage energy demand = Cumulated amount of (dis-)charged energy over a year.
Not: storage capacity = required physical storage size
(The storage capacity will mostly be smaller because of the cyclical operation of the storage)

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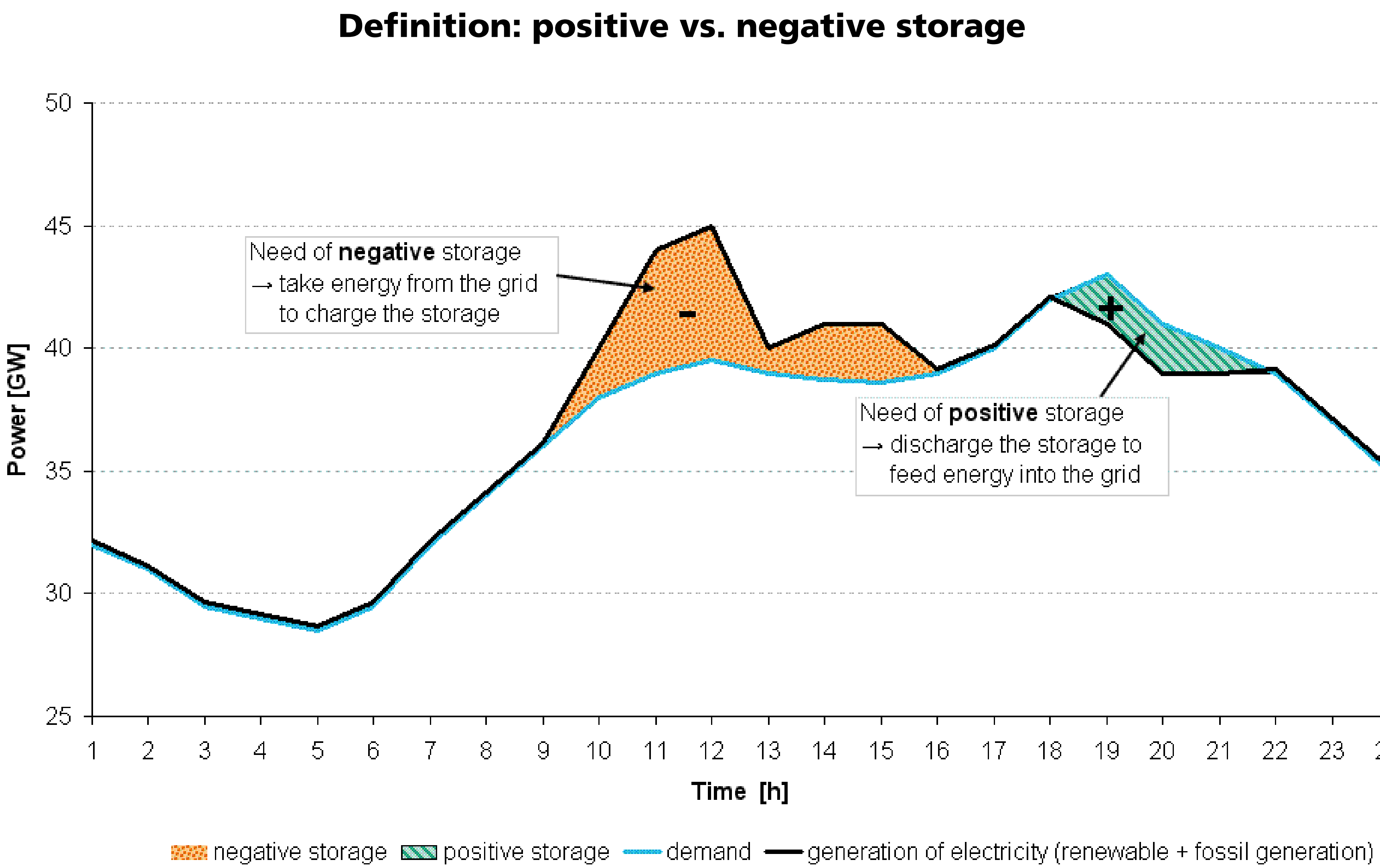
Definition of terms



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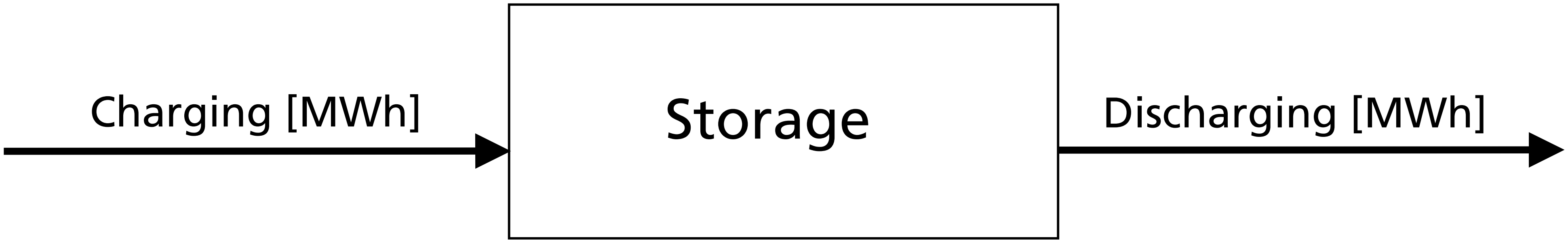
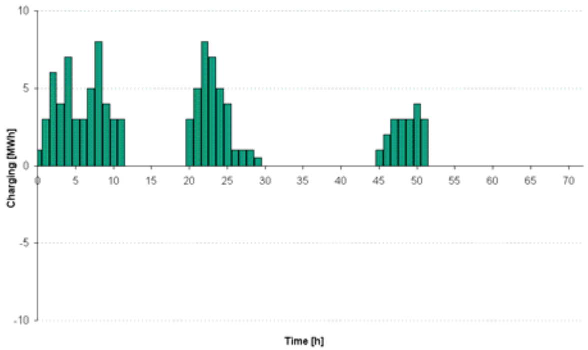
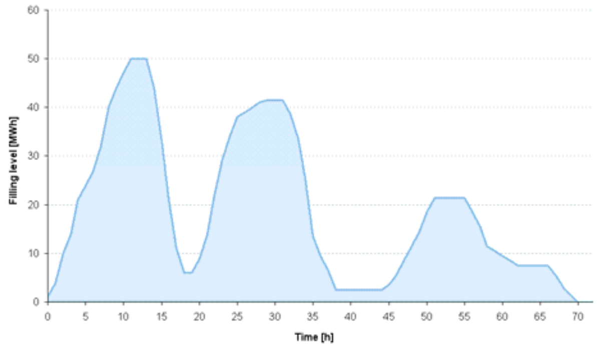
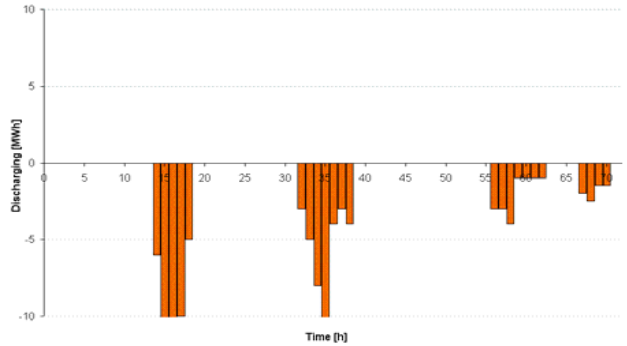
Definition of terms









Negative **storage energy demand**

Storage capacity = 50 MWh

Positive **storage energy demand**

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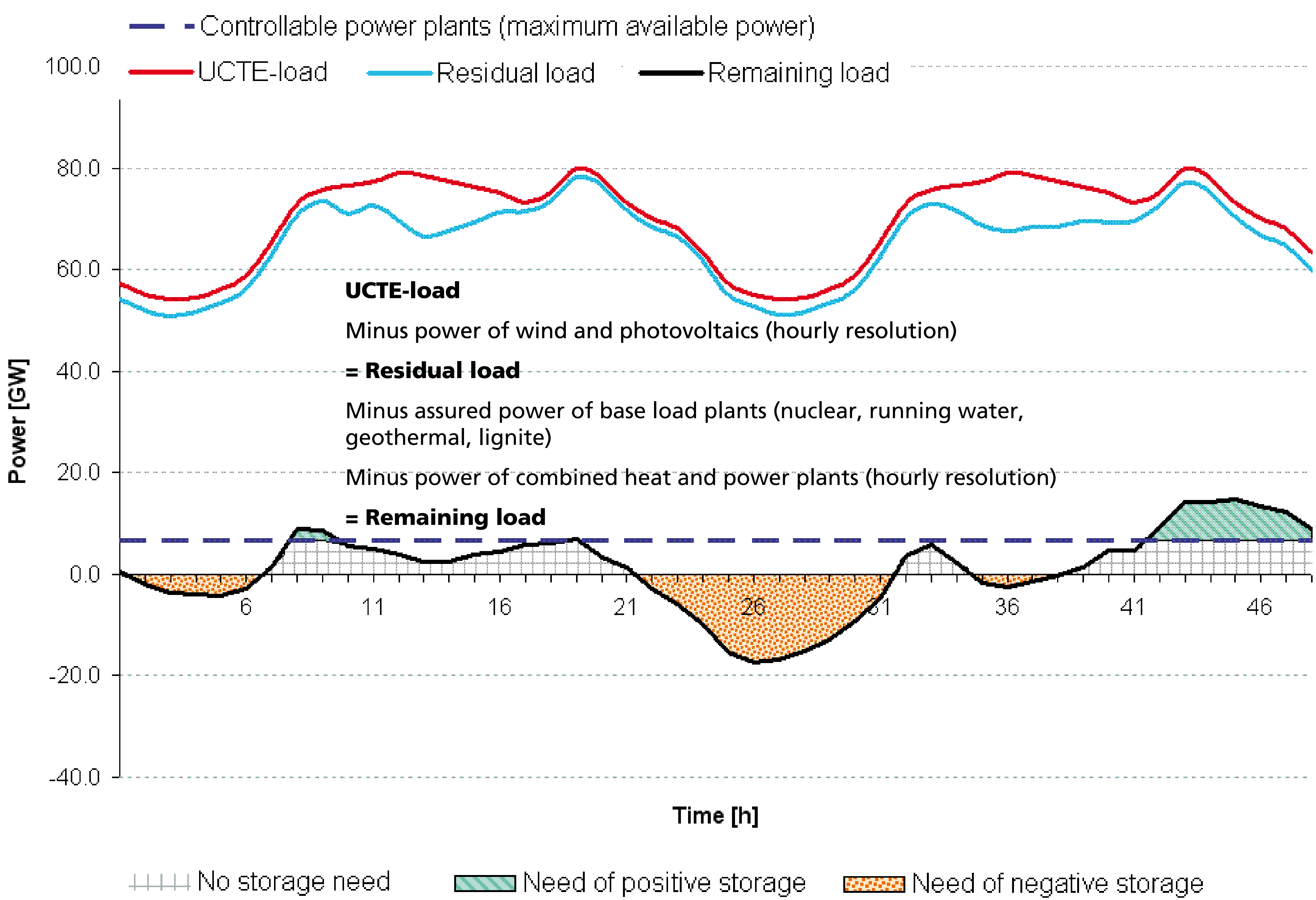
Modeling principle



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Modeling principle

- Need of storage can be satisfied by existing storages (in Germany mostly PHES)
  - Power: ~ 6.5 GW
  - Capacity: ~ 40 GWh

- Additional need of positive storage appears if …
  - … the power needed is bigger than the aggregated discharging power of existing PHES
  - … the current stored energy in existing PHES is not sufficient

- Additional need of negative storage appears if …
  - … the power surplus is bigger than the aggregated charging power of existing PHES
  - … the current free capacity of existing PHES is not sufficient

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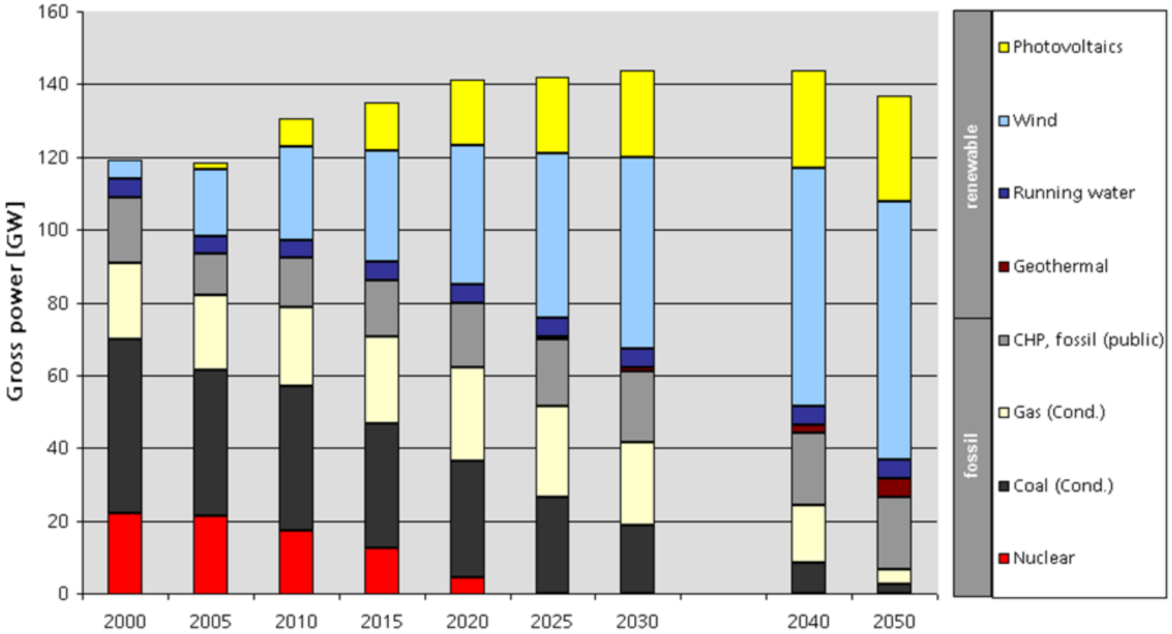
Assumptions

- The development of the German power plant fleet until 2050 bases on the "BMU-Leitstudie 2008"
  - Load will slowly decrease
  - Change from conventional to renewable power plants and nuclear phase-out

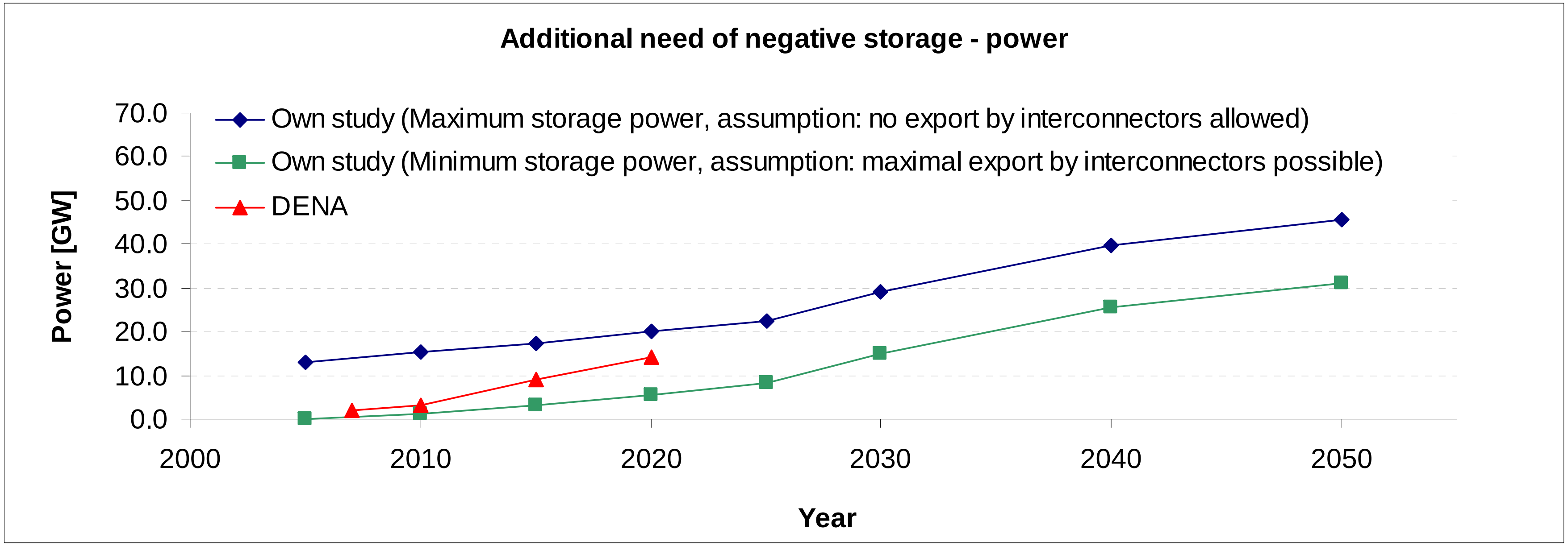


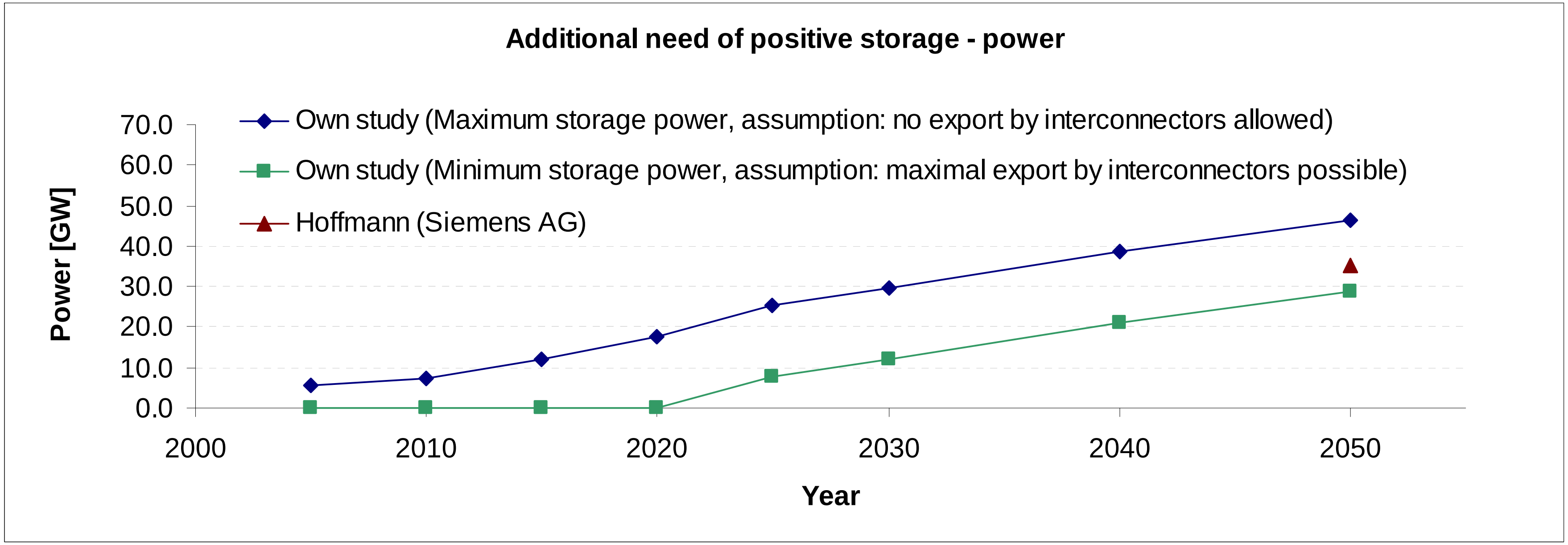
Source: BMU (Leitstudie 2008)
Picture: Fraunhofer UMSICHT

Assumptions

- The electricity grid is ideal ("copper plate")
- Capacity of interconnectors does not change over the years
  - Import capacity: 17.6 GW
  - Export capacity: 14.2 GW
- 7 GW have to be maintained for ancillary services
  - In the model 3.5 GW are maintained by controllable power plants
  - In the model 3.5 GW are maintained by existing PHES
  → Only 3 GW from existing PHES are left for cyclical storage operation
- Charging of existing PHES by surplus power from controllable power plants (Reason: positive storage is needed more often than negative storage)

Results





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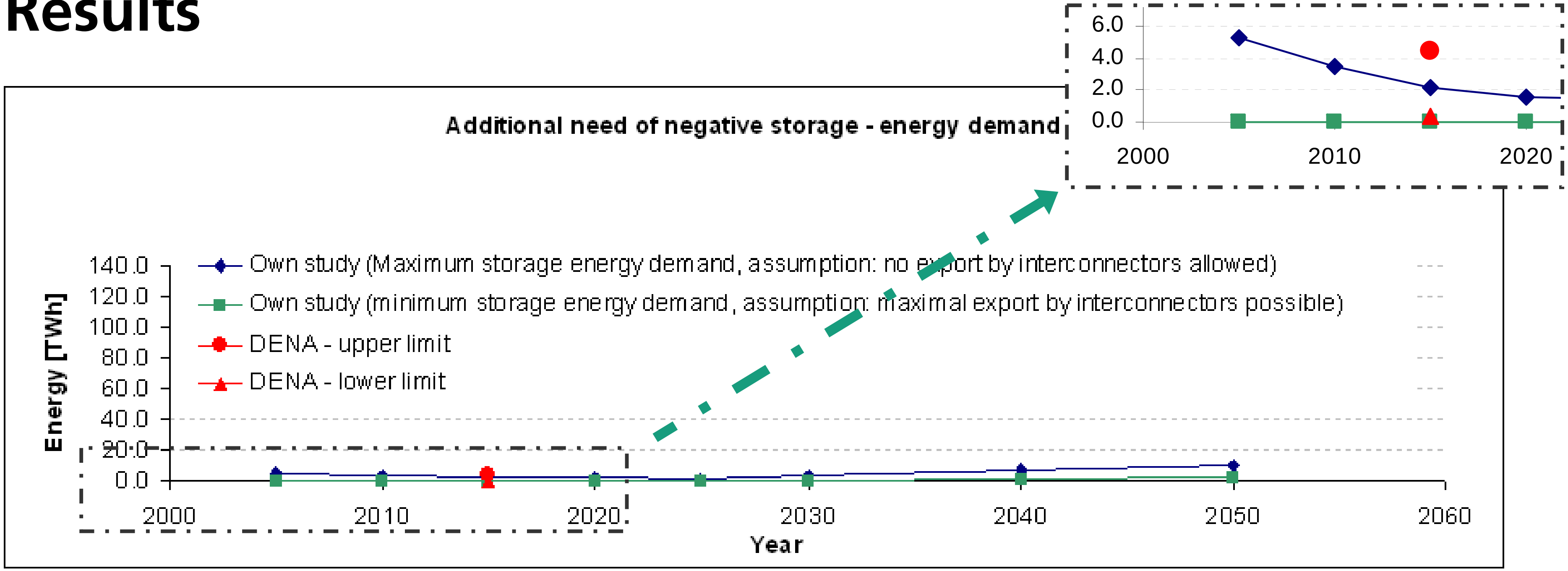
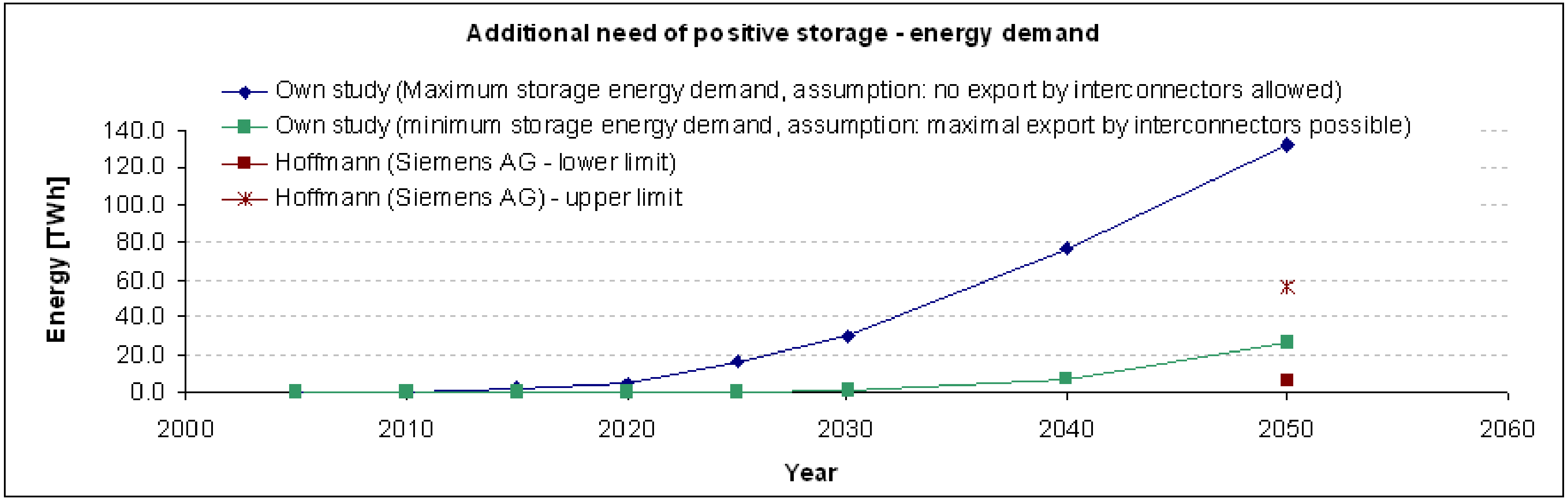
Results





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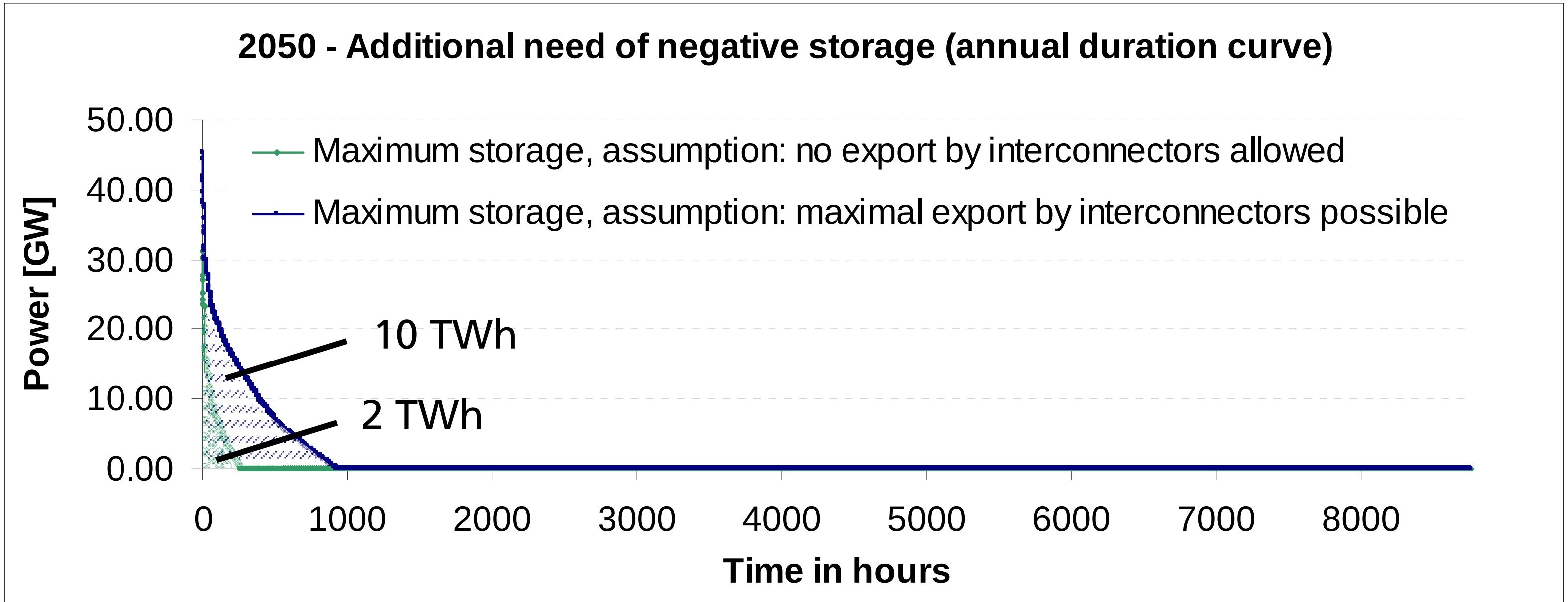
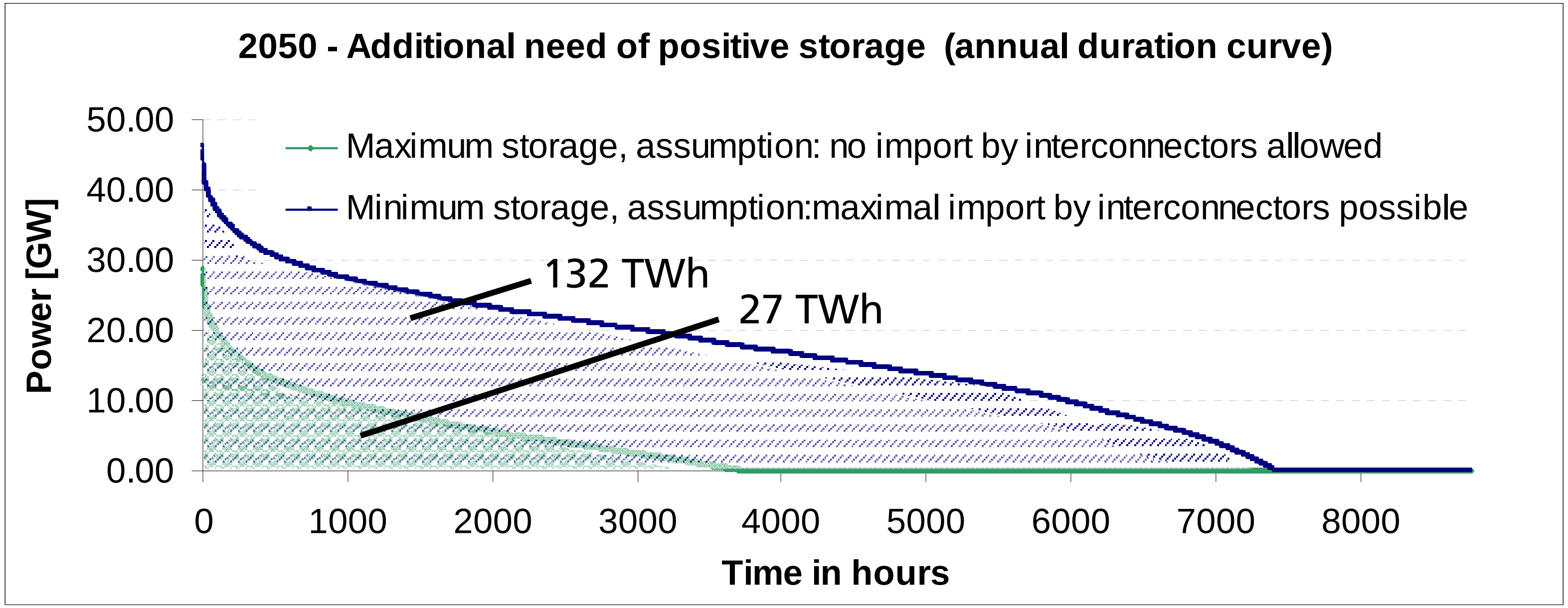
Results





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Conclusions

- Important assumptions:
  - Ideal grid (“copper plate”)
  - Development of power plant fleet for example nuclear phase-out and change from conventional to renewable power plants
- Storage is needed more and more
- Distinctions between need of positive and negative storage as well as storage power and storage energy are important
  - Required positive and negative storage power is nearly similar (~ 30-45 GW until 2050)
  - After 2020 the required positive storage energy grows highly (30-130 TWh), the required negative storage energy remains on a small level (2-10 TWh)

  → Additional need of fast-starting power plants or upgrading of interconnectors to increase the maximal import capacity

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Conclusions

- The annual load duration curve show that the maximum power is only required in a few hours
  - → Dimensioning of the storage on a medium power to achieve higher full load hours

Outlook

- Study was carried out for Germany
- Results can be totally different for other countries, especially depending on the share of base load power plants and fluctuating power sources at the energy supply
  - Example France: share of nuclear power plants is about 80%

  → Supposed that the installed power of renewable energy sources will be increased, the relative need of negative storage energy will probably be higher than in Germany
- Sensitivity study (choose different power plant fleet) has to be accomplished to come to general predictions for Germany as well as for other countries