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Market integration, regulatory framework and capacity markets

Energy Storage Seminar

21 October 2014, Trondheim

Future potential for large scale energy storages

Energy storage can supply more ***flexibility*** and ***balancing*** to the grid, providing a ***back-up*** to intermittent renewable energy.

European Commission, "DG Ener Working Paper The future role and challenges of Energy Storage", http://ec.europa.eu/energy/infrastructure/doc/energy-storage/2013/energy_storage.pdf

What is meant with ***Balancing*** the system?

In general:

Assure the *balance* between *supply* and *demand* of electricity on all *times scales*.

- Various time scales (focus on RES):
  - Yearly
    - Wet, windy, sunny year? – up to ±25% energy of normal year
  - Monthly
    - Hydro inflow, wind regimes during a year – Seasons of the year
  - Weekly
    - Days with low / high production from RES
  - Diurnal, Intra-day, Real-time:
    - RES production forecasts

=> Different markets affected and different storage technologies required

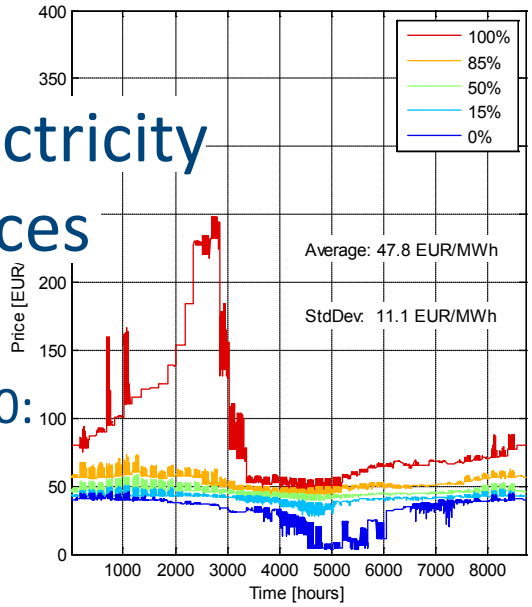
Business models for storages

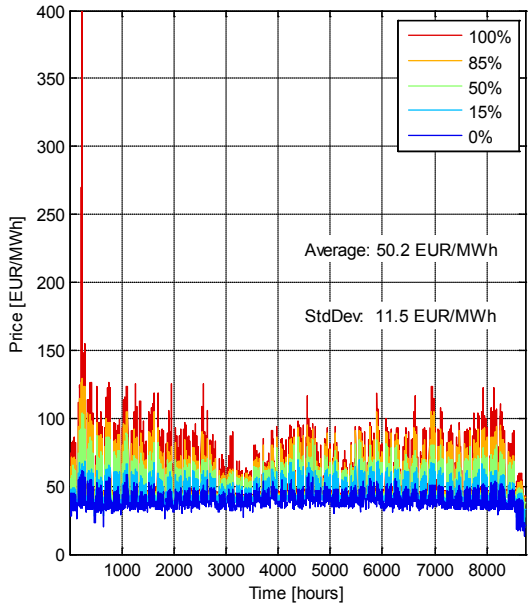
- Energy storage => arbitrage:
  - Store energy = purchase energy, when energy prices are low
  - Release energy = sell energy, when energy prices are high
  - OBS: Round cycle efficiency => $\mathbf{profit = eff_{round} * price_{high} - price_{low}}$
  - Size of storage?

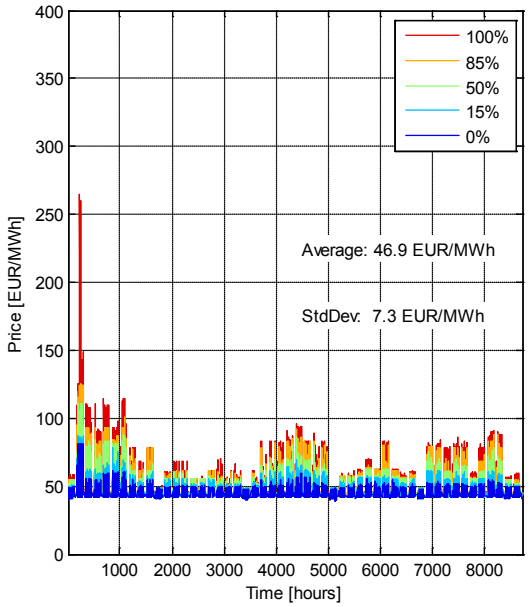
- System services:
  - Reserve capacity
  - Balancing energy
  - Black-start capability
  - …

Electricity prices

2010:





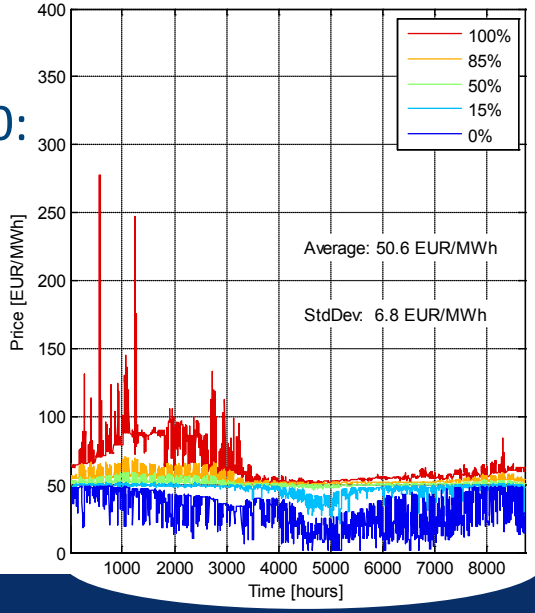


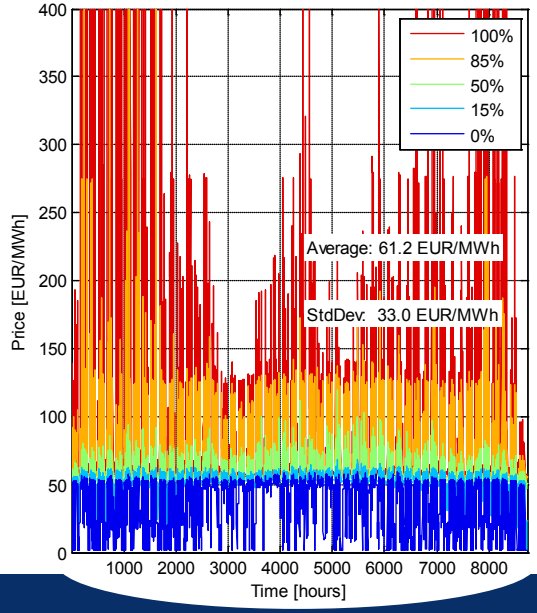
Norway

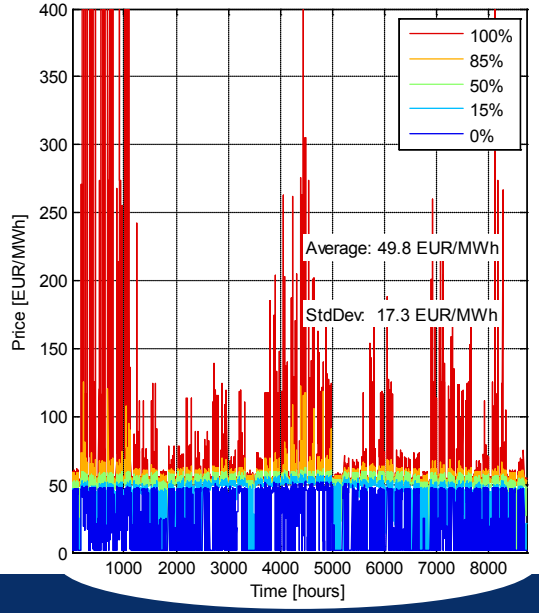
Germany

Great Britain

2030:



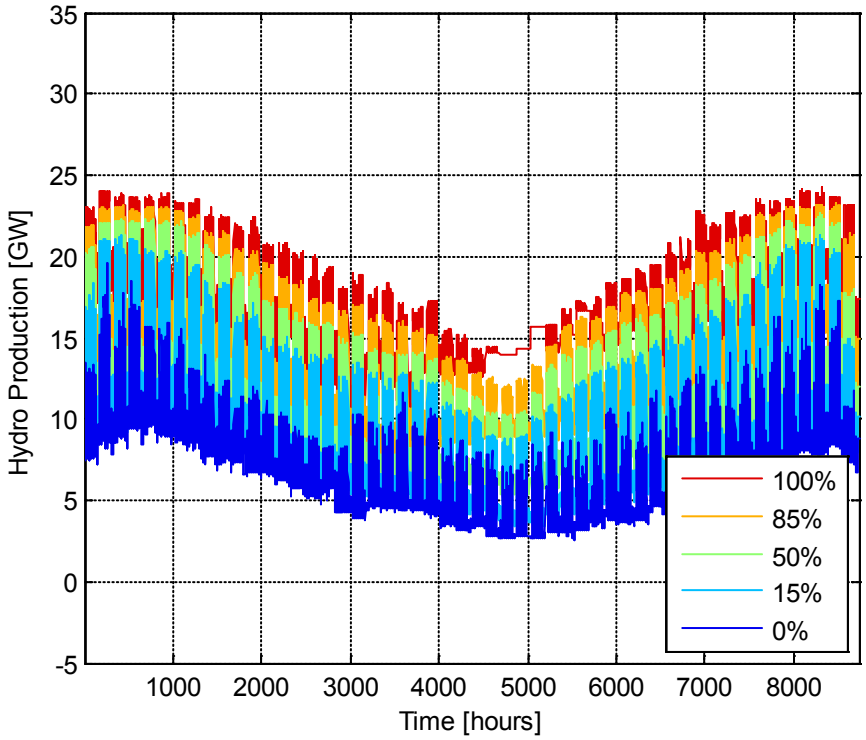




TWENTIES - Task 16.3, " Possibilities of Nordic hydro power generation flexibility and transmission capacity expansion to support the integration of Northern European wind power production: 2020 and 2030 case studies", http://www.twenties-project.eu

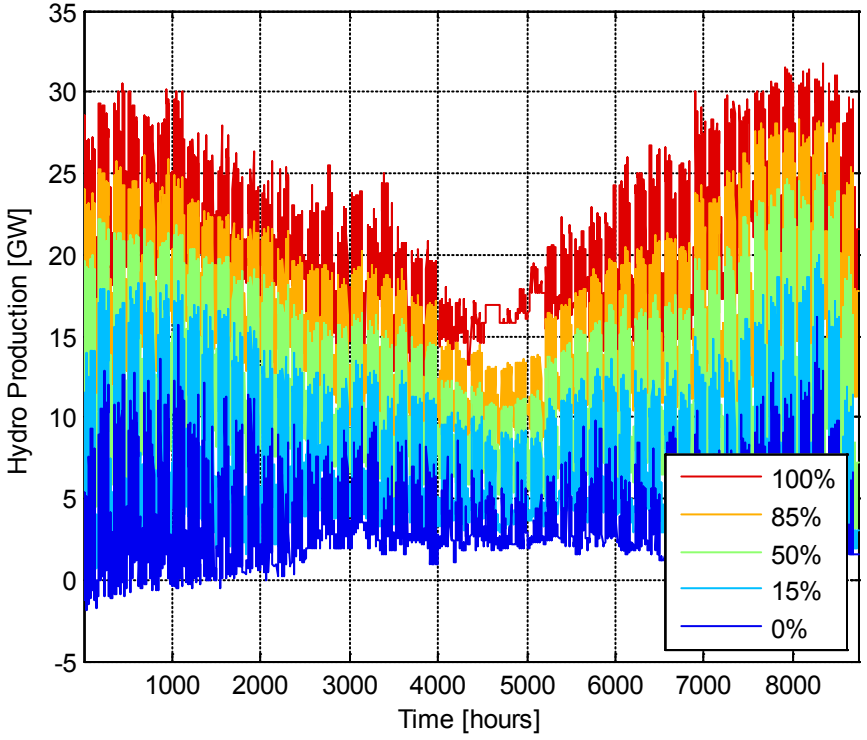
Hydro power production in Norway

2010



Total annual production: 113 TWh

2030



109 TWh

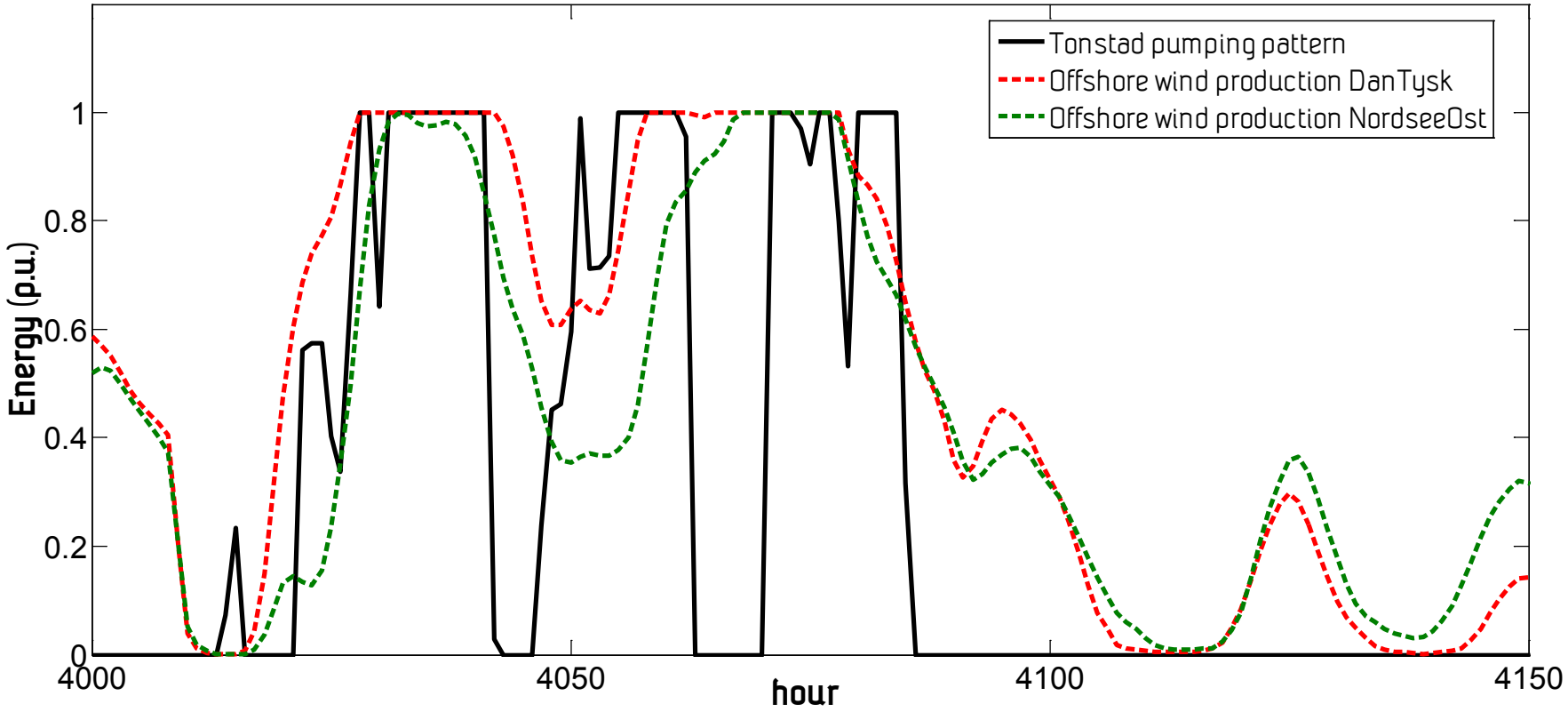
Transmission system

- Geographic location of "big" storages mostly given by landscape:
  - Mountains for pump storages
  - Caverns for compressed air storages

  => connection of storage and production / consumption facilities required
  => transmission system necessary

- Resulting challenges:
  - Additional investment cost for the transmission expansion
  - Potential congestions in the transmission system
  - Losses in the transmission system add up to the round cycle efficiency

Tonstad – pumping pattern



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European Regulatory Framework

Electricity Directive 2009/72/EC:

- Concept of storage not mentioned

ACER's Framework Guidelines / ENTSOE's Network Codes:

- Electricity Balancing
- Grid Connection
- Electricity System Operation

Guidelines for trans-European energy infrastructure:

- Prominent position together with "transmission assets"
- Potential of financial support for storage facilities
- But: Pump storage explicitly left out from financial support / incentives, as it is a mature technology

stoRE Project, "European Regulatory and Market Framework for Electricity Storage Infrastructure", 2013, http://www.store-project.eu/documents/results/en_GB/european-regulatory-and-market-framework-for-electricity-storage-infrastructure

Grid tariffs

Important issue to energy storage operators – potential double payment

- How are storage facilities treated?
  - Production, consumption, as both, different?

- Why should it be treated different than generators or consumers?
  - Most often more price elastic
  - Principle of price causality => is the storage triggering grid investments?
  - Levelling line loading?

Examples for grid tariffs

- Norway [1]:
  - Classified as producer and consumer
  - Hourly marginal losses determined, based on expected load flow
    => potential income from grid tariffs
  - Reduction of tariffs in case of high flexibility
- Germany [2]:
  - Classified as consumer
  - Since 2011 - new storage facilities and pump storage expansions exempted from grid tariffs
- Switzerland [2]:
  - Legally exempted from grid tariffs

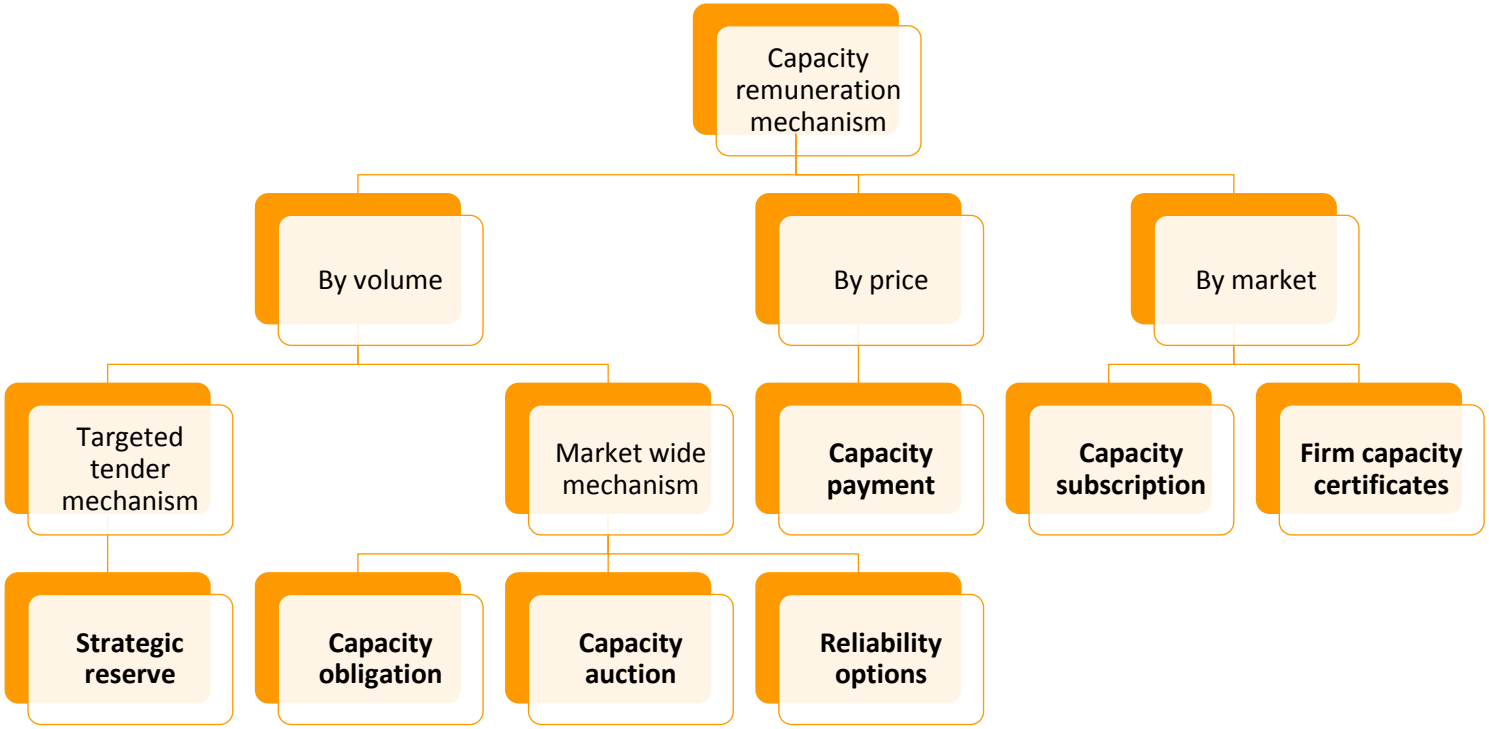
[1] Statnett, "Sentral nettariffen 2015", 2014,
http://www.statnett.no/Global/Dokumenter/Kraftsystemet/Tarfiff%20og%20tilknytning/Tariffhefte%202015.pdf
[2] BMWi, "Zusammenfassung der Studie: Pumpspeicher im trilateralen Umfeld Deutschland, Österreich und Schweiz", 2014
http://www.bmwi.de/DE/Mediathek/publikationen,did=649640.html

Capacity markets

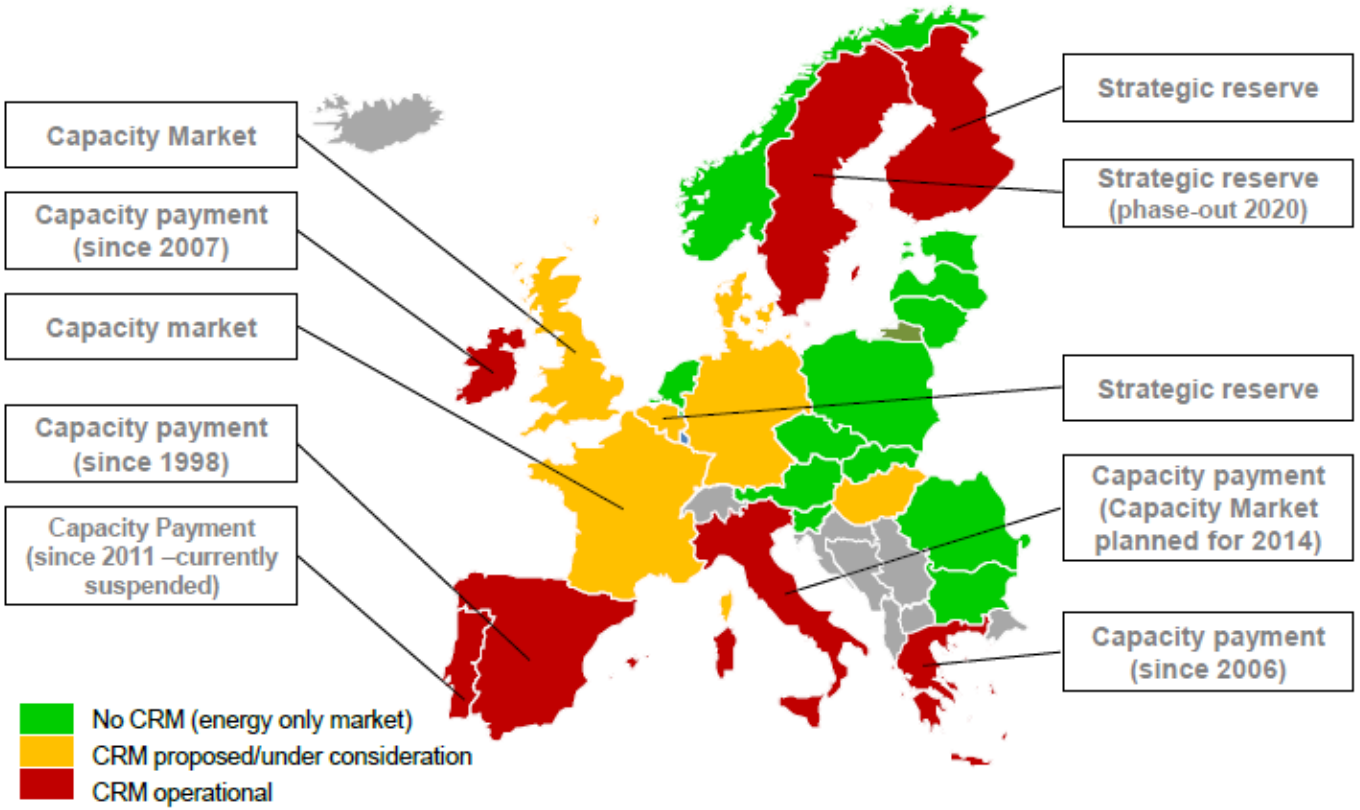
Capacity (remuneration) mechanisms - **CRM**

- **Requirements** for or **Remuneration** of **installed** / **available** generation capacity
- Implementation to ensure system adequacy (sufficient generation capacity to cover the peak demand)
- Payments in EUR/MW installed / available generation capacity

CRM classification



Status in Europe



ACER, "Report: CAPACITY REMUNERATION MECHANISMS AND THE INTERNAL MARKET FOR ELECTRICITY", 2013, http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/CRMs%20and%20the%20IEM%20Report%20130730.pdf

Energy storages in the context of CRMs

Opportunities

- Participation in CRM
- Provision of back-up capacity

Challenges

- Reduced price volatility
  => less arbitrage potential
- General reduced price level
- Availability / Firmness of storage capacity?

=> CRM and energy storages are more complementary.

Technology for a better society