Demand response-effects on the power system

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Alternatives to transmission

FIRST CONCLUSION:

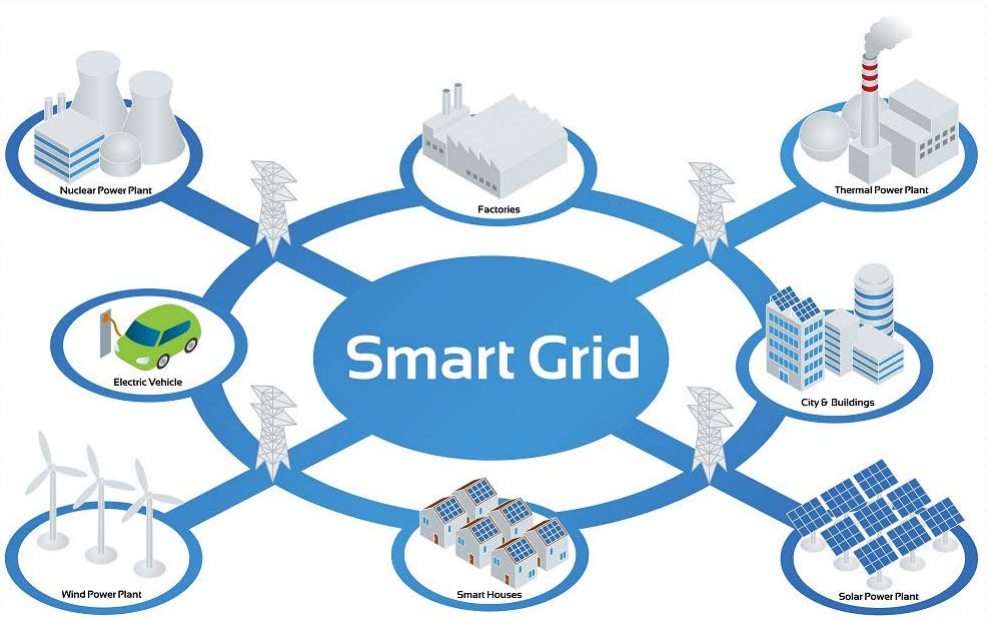
There is a high need for flexibility in the future system

In the studies I have shown, transmission investment seems to be the solution.

NEW DRIVERS:

- Demand side flexibility
- The merger of the power system and ICT

How will this affect the transition to a near zero emission power system?



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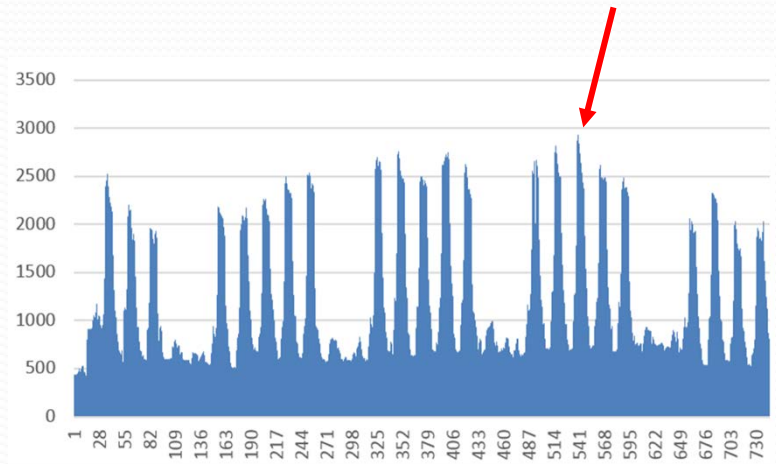
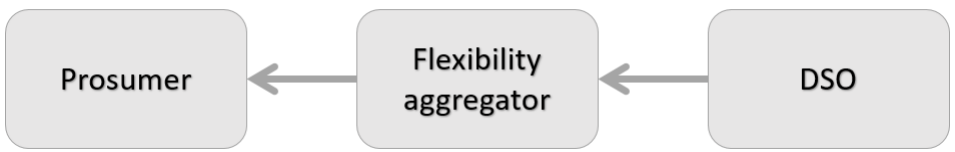
Changes in the electricity market

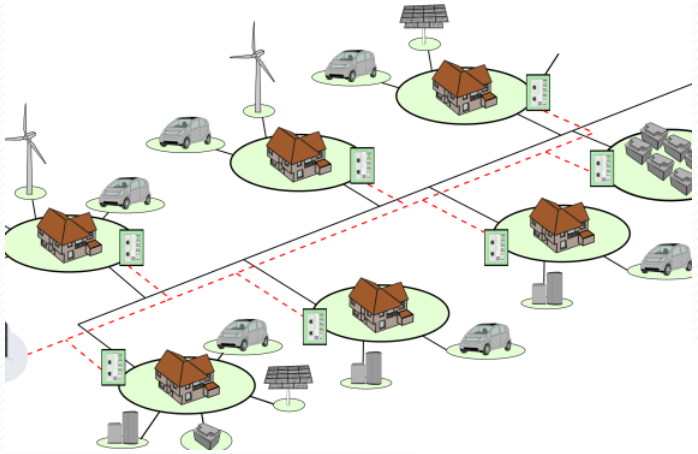
- New contract types and business models
  - Complex and dynamic price models
  - Penalization for peaks (demand charges)
  - Reward from providing flexibility



- Market participant changes
  - Passive consumer => flexible prosumer
  - New-comers: Energy Service Companies (ESCo), Aggregators ++



- New markets and changes in market rules
  - More focus on (close to) real time
  - Local markets



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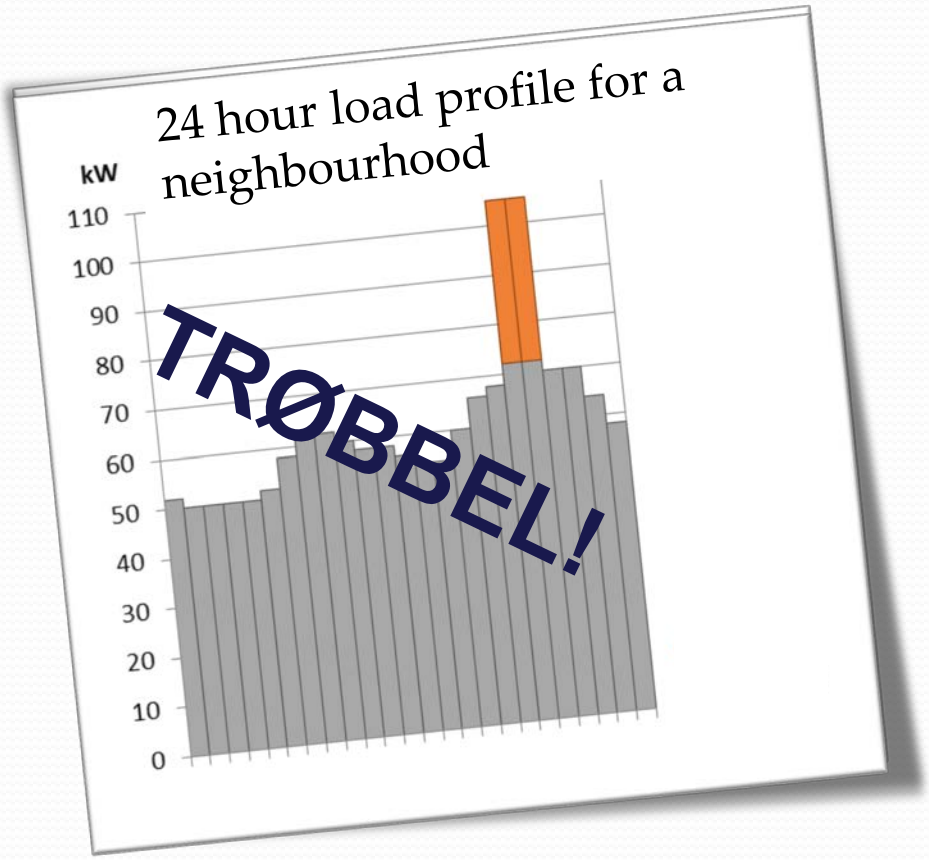
Challenge: ”Trouble in the neighbourhood”



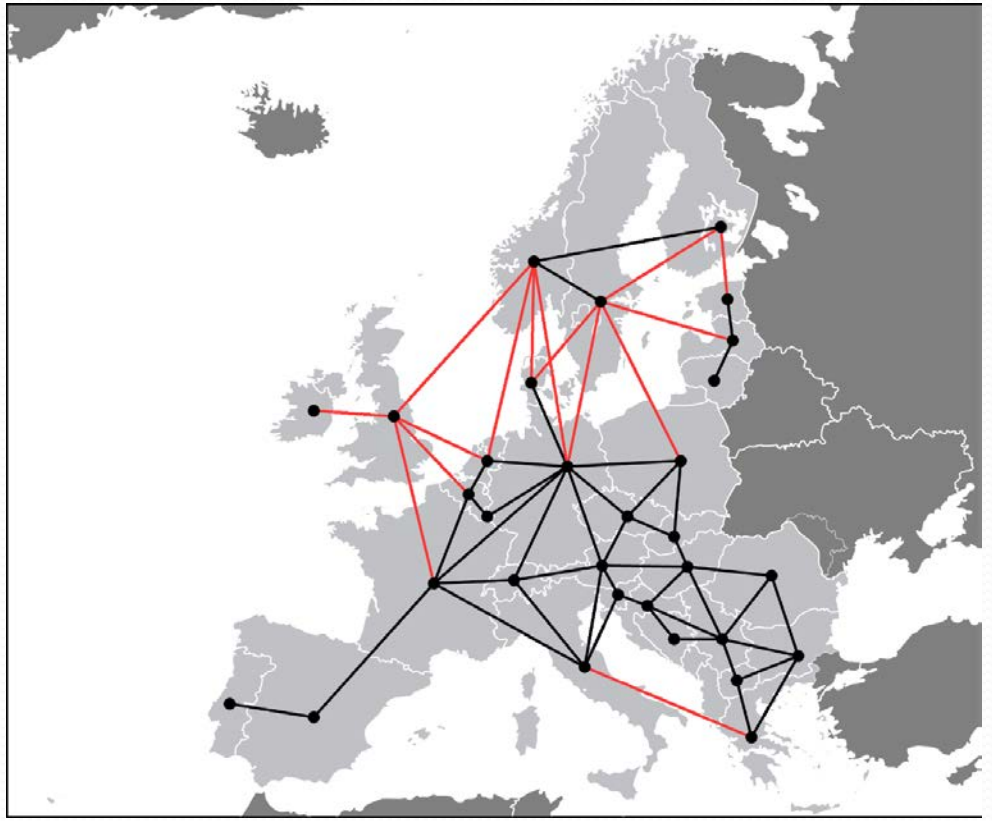
SmartGrid

- Active interaction between smart end users and the energy system/market to create benefits in the value chain
- Demand side flexibility
- Why this flexibility has an increasing value
  - New distributed renewable energy generation
  - Electric vehicles creating peak problems
- Local challenges must be met by local solutions
- Need proper decision models

Demand response in EMPIRE

Demand Response module in EMPIRE : in testing now
Multiscale geographical representation

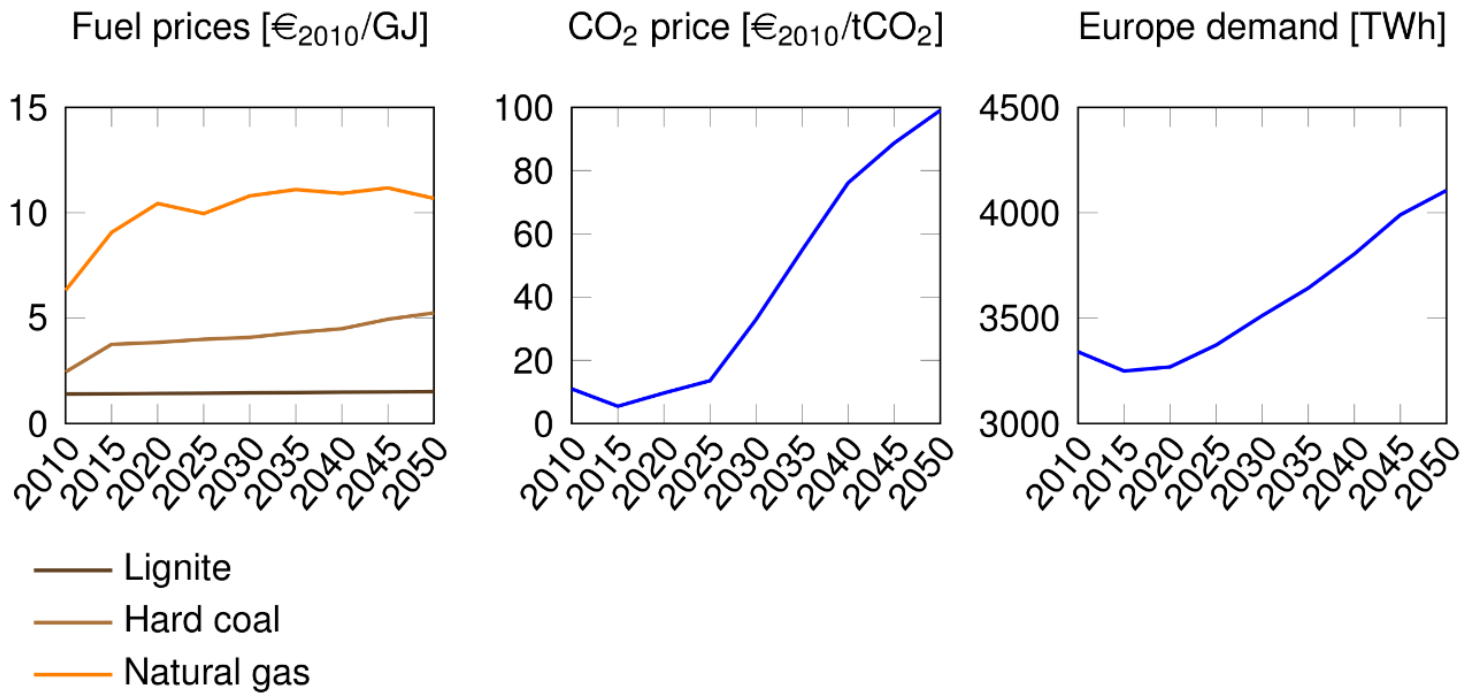
- Countries
- Regions
- Neigbourhoods



How does it change the technology mix?

Kilde 3M SmartGrid: http://solutions.3m.com/wps/portal/3M/en_EU/SmartGrid/EU-Smart-Grid/

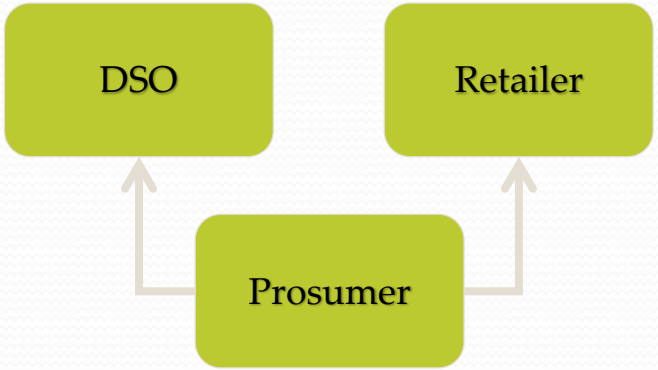
Major assumptions

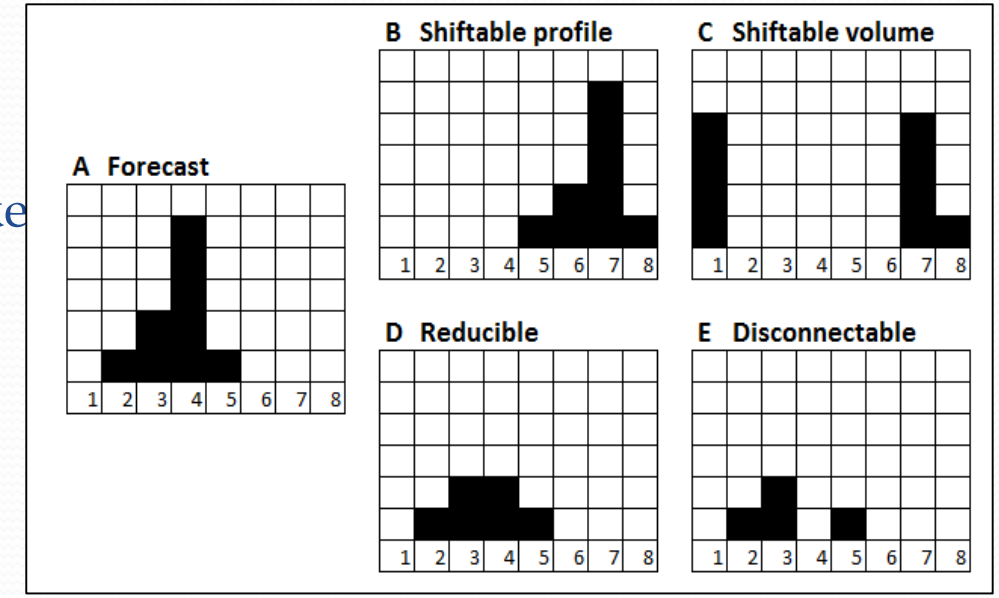


All technology cost assumptions from: ZEP. (2013). *CO2 capture and storage (CCS): Recommendations for transitional measures to drive deployment in Europe*. Available from http://www.zeroemissionsplatform.eu/library/publication/240-me2.html

A stochastic model for scheduling energy flexibility in buildings

- Context: A prosumer in the end-user market
- Problem: *How to schedule flexible units to minimize total energy-related costs*?
- Develop a basic model for demand side flexibility used throughout the thesis
  - Load units classified according to their flexibility properties:
    - Shiftable (in time)
      - Profile: Start time can be changed, but profile must be ke
      - Volume: Profile can be altered
    - Curtailable
      - Reducible: Load can be reduced without disconnection
      - Disconnectable: On or off
    - Inflexible





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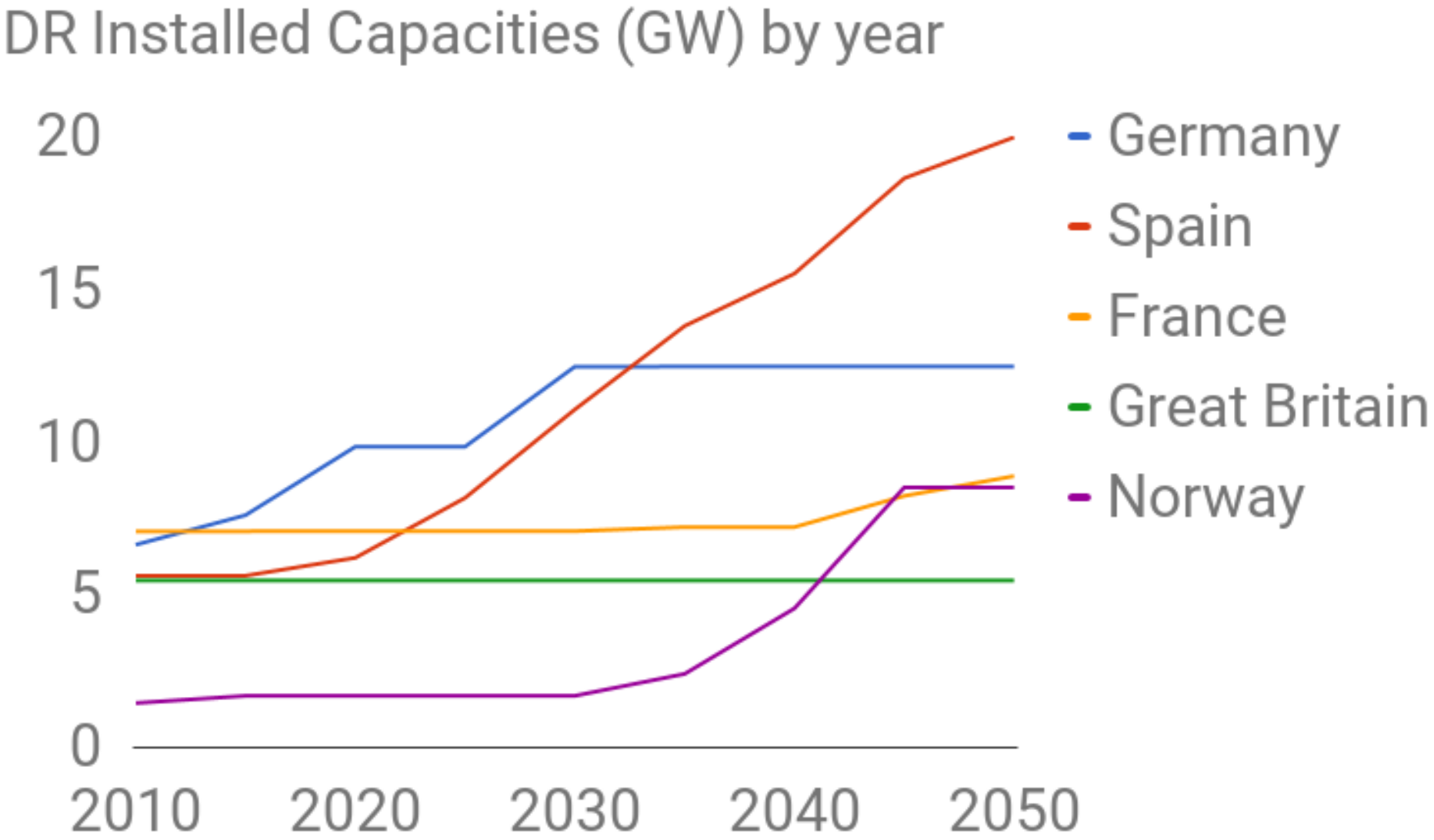
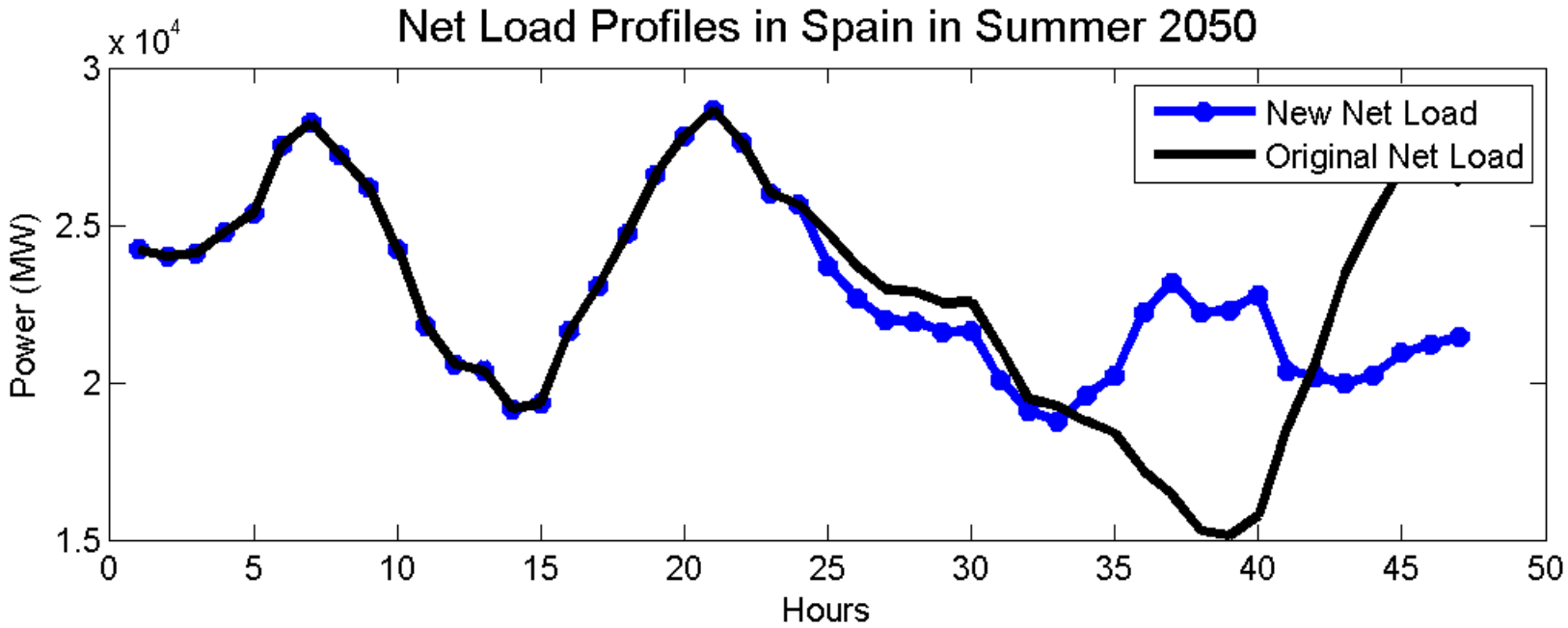
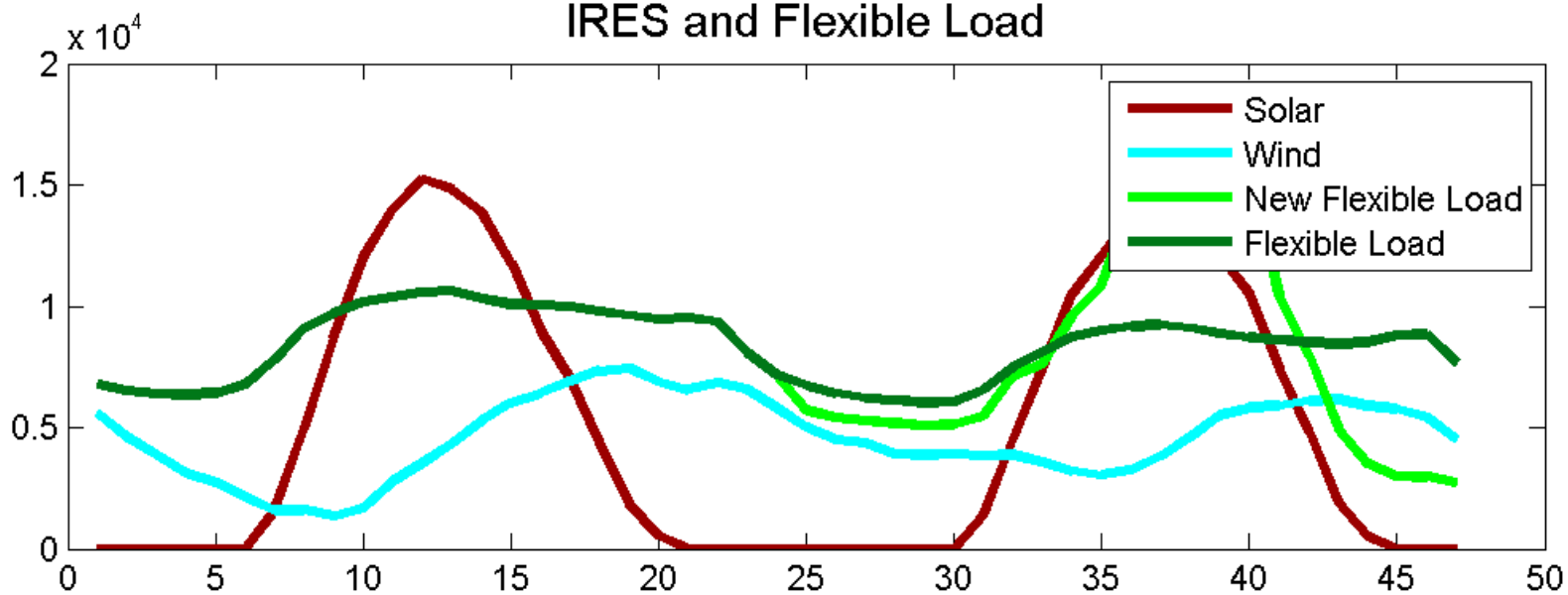
DR costs characteristics

Technology	Investment Cost (€/kW)	Fixed OM (€/kW) pr. yr.	Variable OM (€/MWh)	Efficiency	Fuel Cost
HeatingAC	250	7,50	10	0,97	
HVAC-ComInd	10	0,30	5	0,97	
CoolingWater-ComInd	5	0,15	20	0,98	
ProcessShift-Ind	0	0,00	150	0,99	
WashingEq-Res	30	0,90	50	1,00	
StorHeat-ResCom	20	0,60	10	0,98	
ProcessShed-Ind	0	0,00	1000	1,00	
Battery Storage (Li-ion)	1195			0,88	
Battery Storage (Zn)	588			0,75	
Pumped Storage Hydro	1000			0,80	
Gas CCGT	650	30,38	0,45		42


DR Installed Capacities (GW) by year
20
15
10
5
0
2010
2020
2030
2040
2050
Germany
Spain
France
Great Britain
Norway

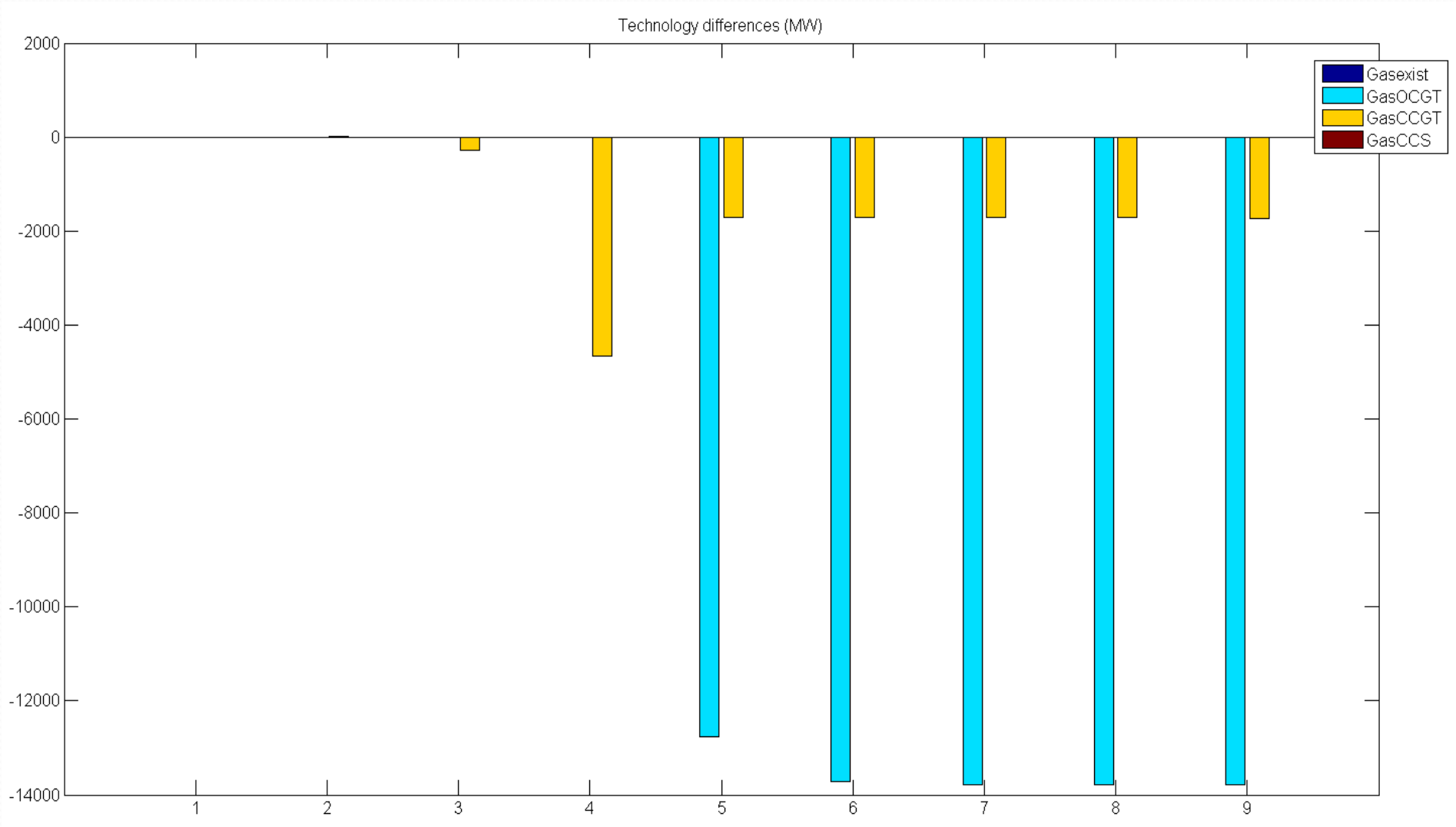

Net Load Profiles in Spain in Summer 2050
x 10^4
Power (MW)
Hours
New Net Load
Original Net Load


IRES and Flexible Load
x 10^4
Solar
Wind
New Flexible Load
Flexible Load

Capacities comparison between DR2 and DR0

- The following bar graphs show the main differences in technology capacities in the case with DR (case DR2) and without (case DR0) between year 1 (2010) and year 9 (2050).
- The positive y-axis indicate larger capacity in DR2 than in DR0 and viceversa

Gas plants



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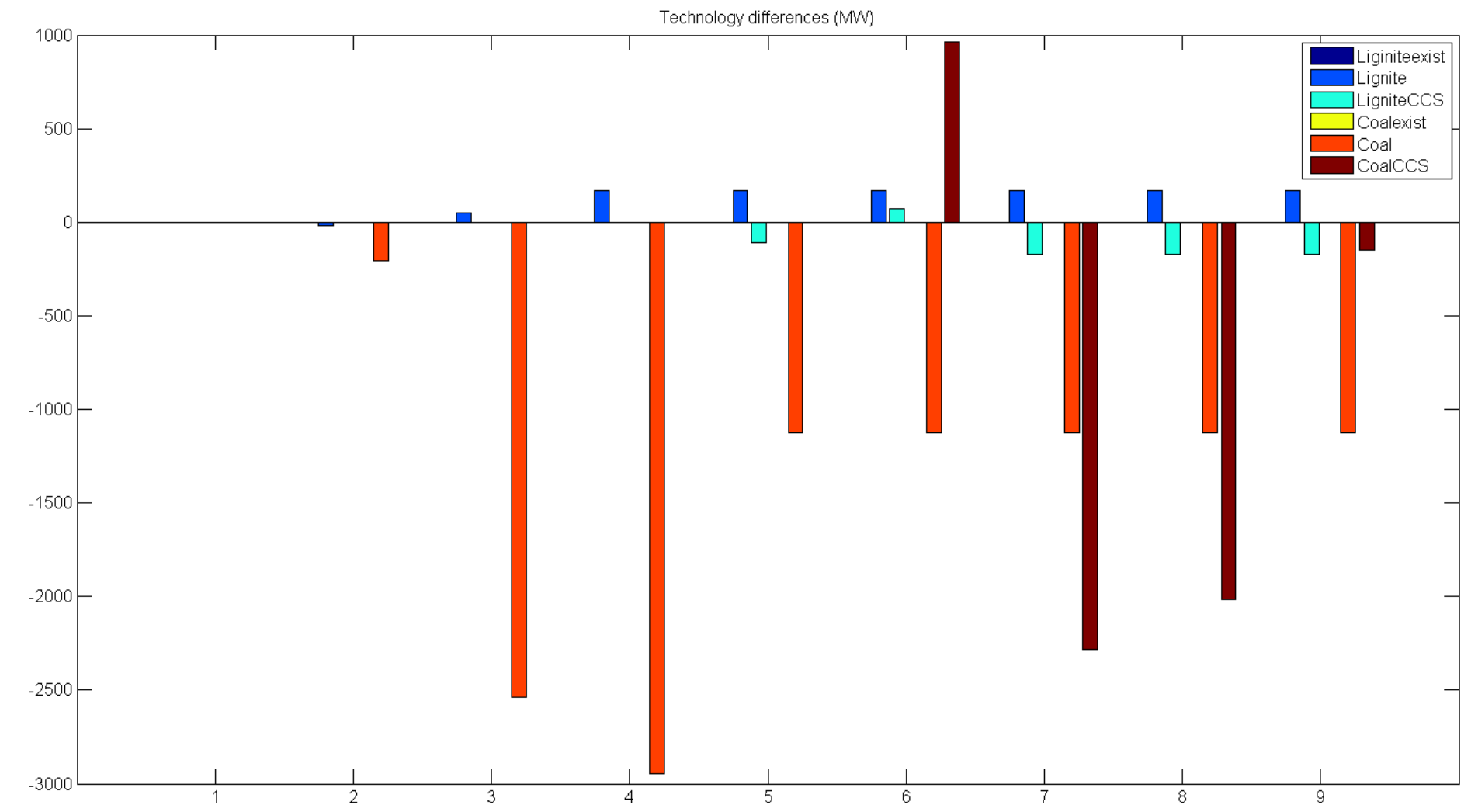
Coal plants



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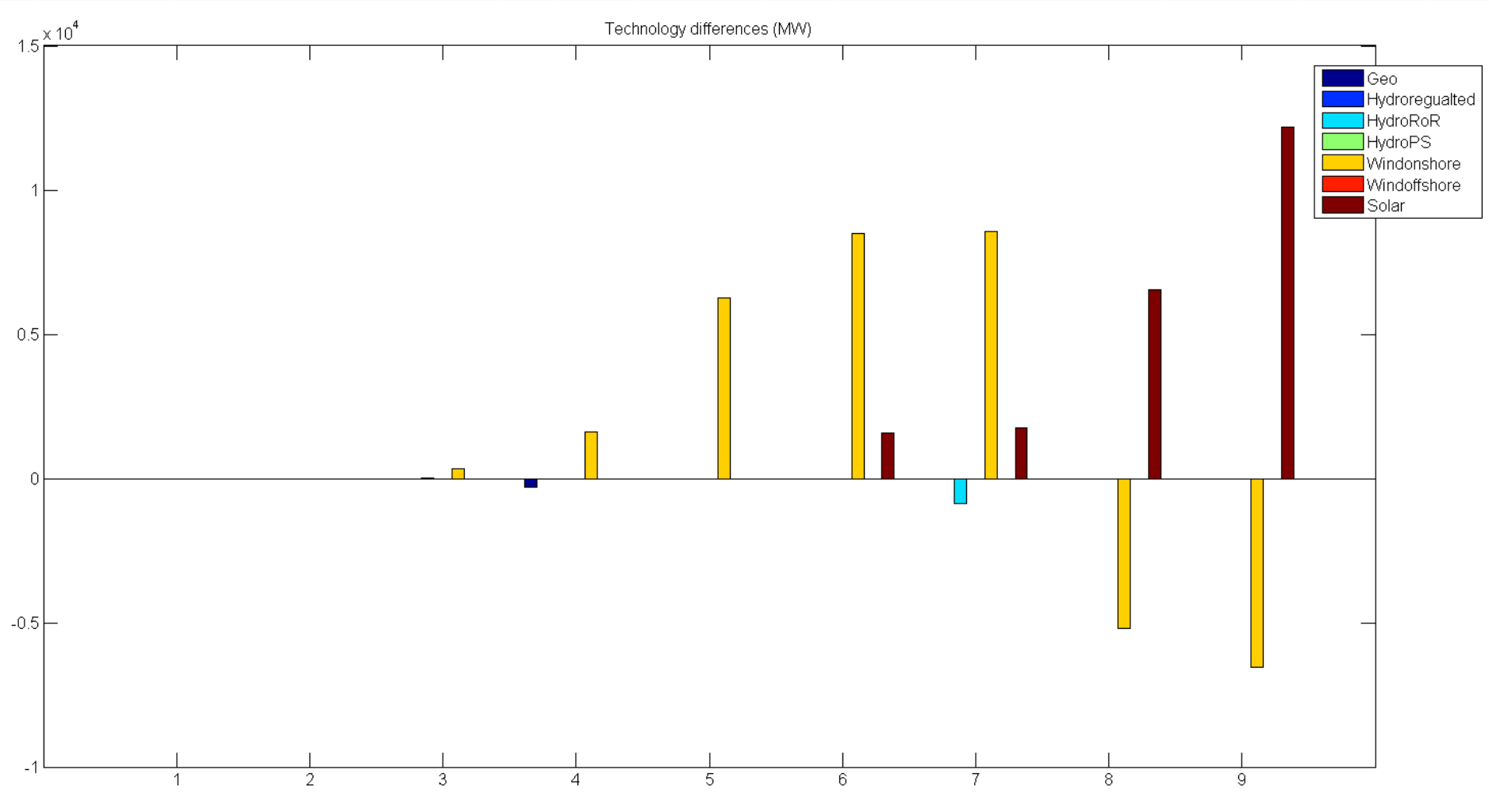
RES plants



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Summary

- New technologies increase the need for flexibility at different levels
- New technologies increase the potential for flexibility provision from demand side
- Flexibility can create values at different levels (prosumer, DSO, TSO…)
- Aggregation needed
- The aggregator's decision problem is a complex task
- Demand response will put pressure on other technologies, both transmission and other flexibility sources.

Research questions

- What is the value of demand side flexibility in the transition to a low-carbon power system?
- How does demand side flexibility interact(/compete) with other types of flexibility options?
- What is the actual potential (at a system-level) of demand response? What will the costs be?
- How do the future demand profiles look?
- How important are local details (constraints) when we model large regional systems?

References

Demand response and the aggregator role

- Hector Maranon-Ledesmaa , Asgeir Tomasgard, Christian Skar, Long-Term Electricity Investments Accounting for Demand and Supply Side Flexibility, in progress.
- Ottesen, Stig Ødegaard; Tomasgard, Asgeir; Fleten, Stein-Erik *Multi market bidding strategies for demand side flexibility aggregators in electricity markets, in review process. Working paper can be downloaded.*
- Ottesen, Stig Ødegaard; Tomasgard, Asgeir; Fleten, Stein-Erik. (2016) Prosumer bidding and scheduling in electricity markets. *Energy.* vol. 94.
- Stig Ø. Ottesen & Asgeir Tomasgard, A stochastic model for scheduling energy flexibility in buildings, Energy, vol 88, 2015