ANALYSIS OF THE ROLE OF ENERGY STORAGE IN POWER MARKETS WITH STRATEGIC PLAYERS

15th IAEE European Conference 2017

Vienna, 06.09.2017

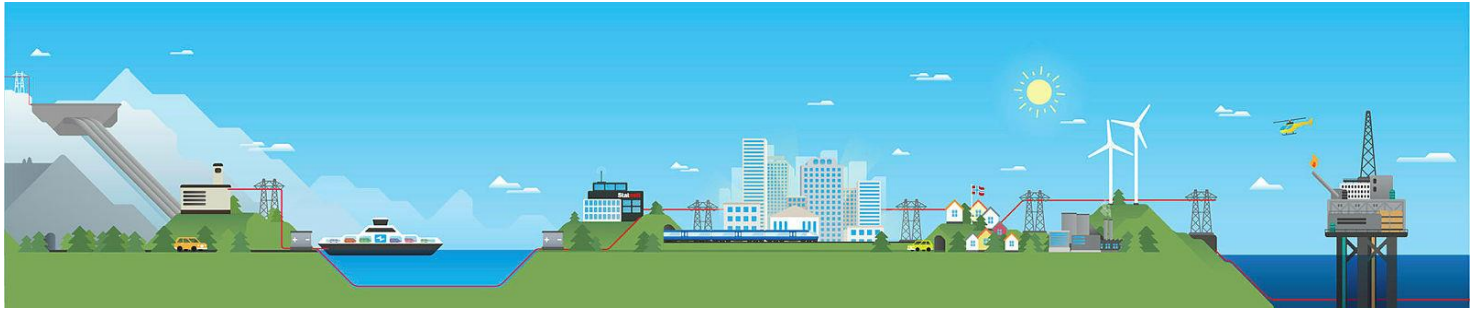
Statnett

Outline

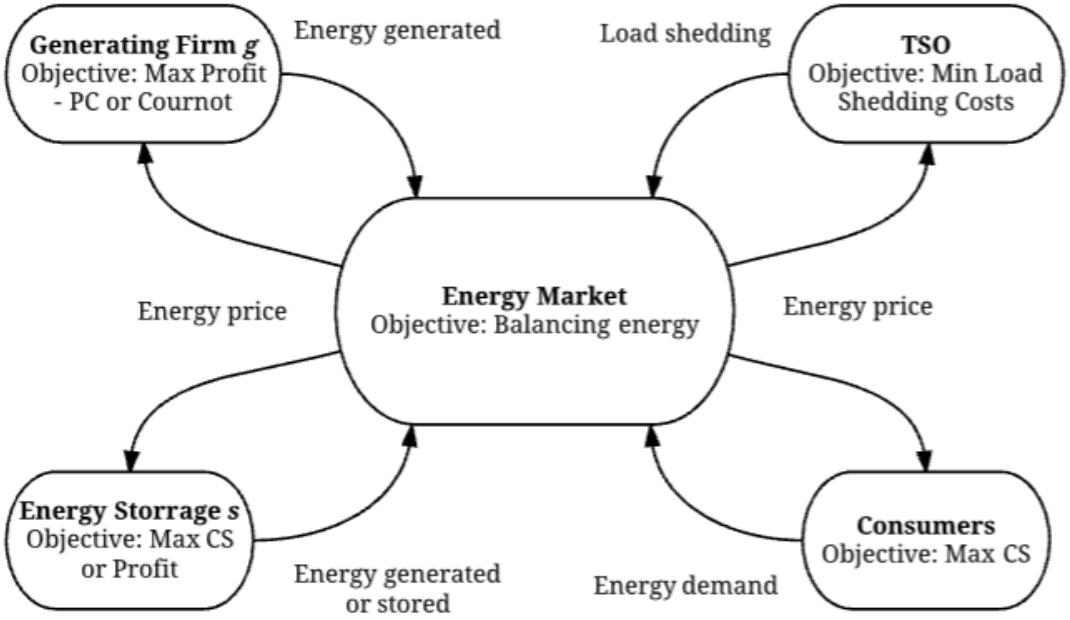
1. **Motivation: Flexibility**
   - What's the effects of ownership?
2. **Methodology: A strategic behaving energy storage**
   - Complementarity Modeling
3. **Case Study: Scarce Production Capacity**
   - What are the effects of reduced flexibility?
4. **Conclusion**
   - Clear qualitative effects, hard to quantify

Motivation

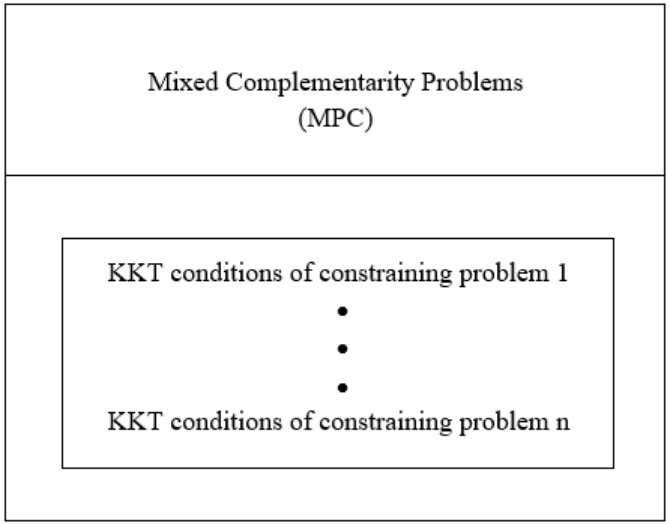
- Increasing penetration of renewables, electrical cars
- Buzzwords as SmartGrid, MicroGrids and Aggregators
- Who controls the flexibility?

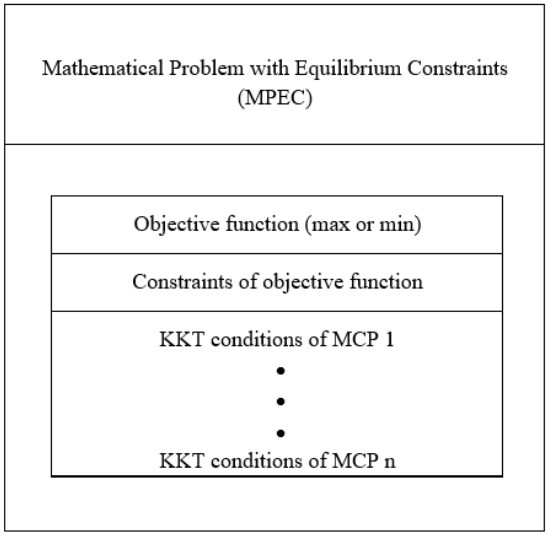


Model


Generating Firm g
Objective: Max Profit
- PC or Cournot
Energy generated
Load shedding
TSO
Objective: Min Load
Shedding Costs
Energy price
Energy Market
Objective: Balancing energy
Energy price
Energy Storrage s
Objective: Max CS
or Profit
Energy generated
or stored
Energy demand
Consumers
Objective: Max CS

Complementarity Modeling

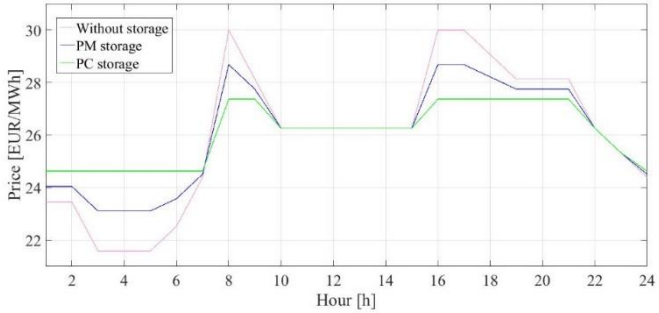


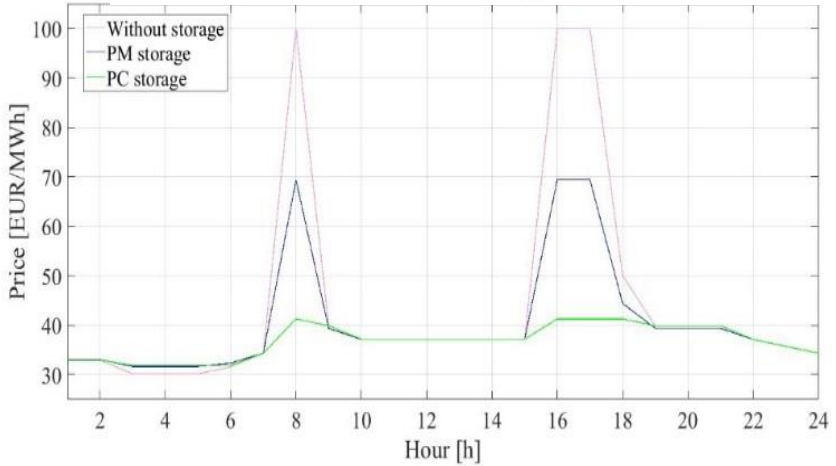


Case Study

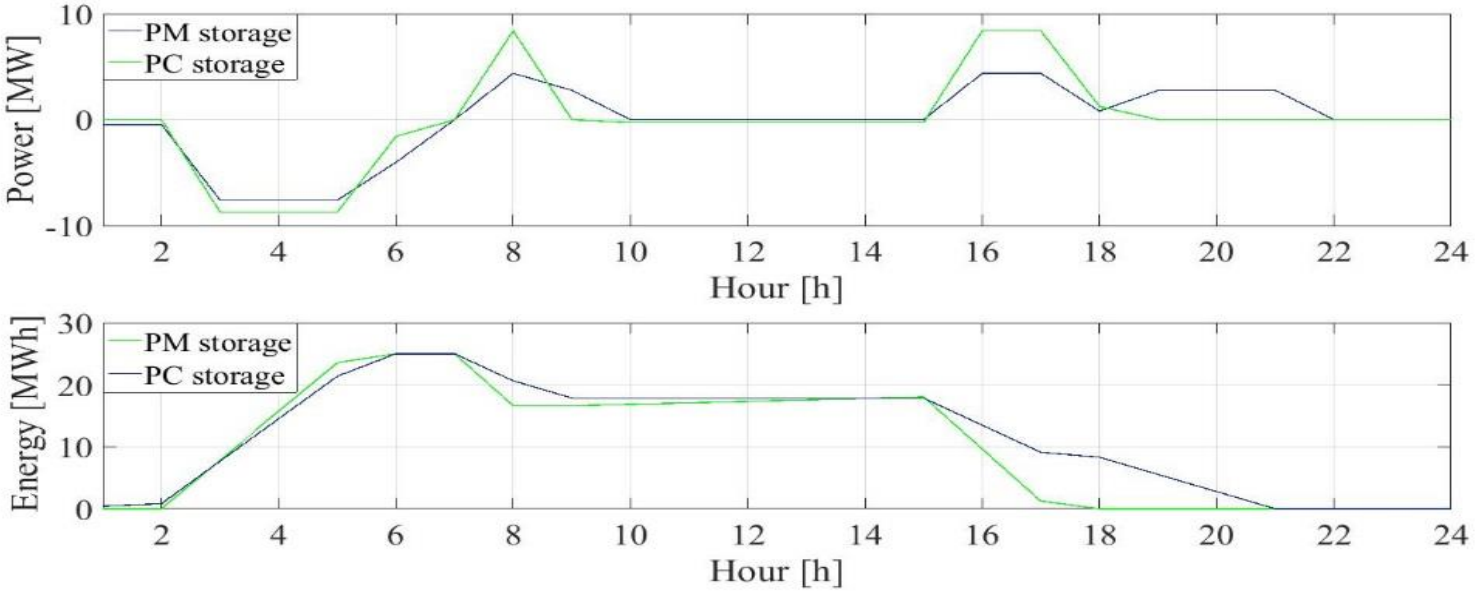
- Scares production capacity
- Storage capacity 10 % of demand
- Peak-hour price elasticity, 3 %

- Peak-hour price varies
  - 40, 69 and 100 EUR/MWh

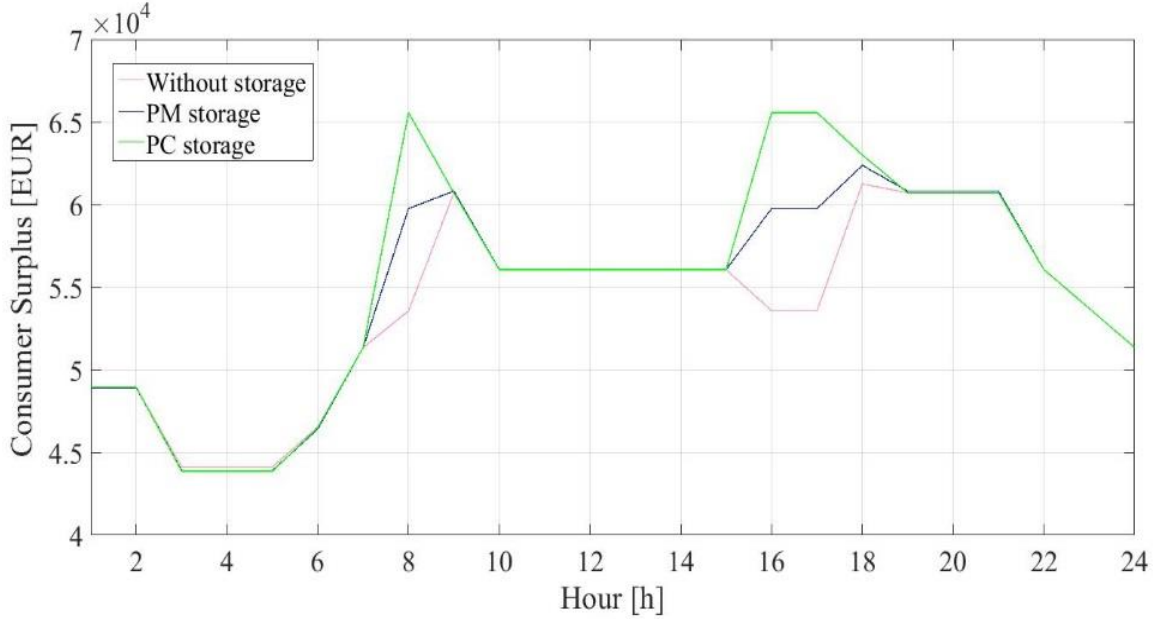




Results


PM storage
PC storage
Power [MW]
10
0
-10
2
4
6
8
10
12
14
16
18
20
22
24
Hour [h]
PM storage
PC storage
Energy [MWh]
30
20
10
0
2
4
6
8
10
12
14
16
18
20
22
24
Hour [h]

Results


×10^4
7
6.5
6
5.5
5
4.5
4
Consumer Surplus [EUR]
Without storage
PM storage
PC storage
2
4
6
8
10
12
14
16
18
20
22
24
Hour [h]

Discussion and Conclusion

1	**Clear evidence of market distortions due to the strategic behavior of the storage** - Both with and without restriction on production capacity
2	**The magnitude of the distortion is unclear** - Need a more realistic model and input to quantify the effects
3	**Highly relevant in MicroGrids** - Few market participants and potential low flexibility
4	**Conclusion** - Clear qualitative effects, hard to quantify


Thank you for your attention!