Flexibility of power plants with CCS in a future low-carbon power system

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Introduction

• PhD project on implementation of CCS in The Netherlands
• CCS is likely to be implemented in a low-carbon future
• Interaction between renewable sources and CCS unclear

• Main question:
  – “What flexibility is needed for large shares of IRES, and how can this be delivered by power plants with CCS in an economic and technically feasible way in a future electricity system?”
Contents

• REPOWERS model
• Effects of wind power
• Flexibility of CCS
• Results
• Discussion
• Conclusion
REPOWERS model (1/2)

• Simulates unit commitment and dispatch

• Accounts for flexibility constraints

• Timestep of 1 hour
REPOWERS model (2/2)

- Dutch power system in 2030

- Input data largely adopted from other models

- 2 weeks have been simulated for each scenario

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<th>High flexibility</th>
<th>Reference flexibility</th>
<th>Low flexibility</th>
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<tr>
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Impact of wind power

• Four power system impacts of wind power
  1. Increase in reserve size
  2. Thermal generation capacity is displaced
  3. Efficiency of thermal generators is lowered
  4. Curtailment of power production
Flexibility of plants with CCS (1/2)

• Effects of capture unit on flexibility of power plant

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<td>Ramp rate [% of max load /minute]</td>
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<td>Start-up time [hours]</td>
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*Same as power plant without CCS
Flexibility of plants with CCS (2/2)

- Based on IGCC flexibility without CCS

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Preliminary results (1/3)

• NGCC-CCS plants displaced
• Flexibility only beneficial at 60% wind
Preliminary results (2/3)

Electricity generation during high-wind week

- CHP-Natural Gas
- CCS-Natural Gas
- Natural Gas
- Coal
- CCS-Coal
- Nuclear
- Wind
- Load
Preliminary results (3/3)

- Flexibility only affects short-run profits at 60% wind
- Difference between high wind & low wind weeks
Discussion

• Sensitivity analysis
  – Change of coal:natural gas price ratio
    • 1:3 to 1:2
  – Absence of interconnection capacity

• Improvements of the model
  – More detailed interconnection capacity
  – Modeling of reserve markets
Conclusions

- Higher load factor and short term revenue for coal fired power plants with CCS

- Flexibility only affects performance at 60% wind penetration

- Further research needed
Thank you for your attention

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