Consequences of the UK Energy Market Reform on the Development of CCTS –
A two sector Modeling approach

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Agenda

1. UK Electricity Market Reform
2. Motivation and Research Question
3. Model Framework
4. Assumptions and Tentative Scenario Results
5. Future Work
Our research idea is to examine the future electricity market of the UK

UK’s climate targets for GHG reduction:
34% by 2020 & 80% by 2050 (base year: 1990).

Electricity production per fuel type in 2013 for UK
Source: DECC (2014) – UK Energy Brief

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Coal</td>
<td>35%</td>
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<tr>
<td>Oil &amp; other fuels</td>
<td>18%</td>
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<tr>
<td>Gas</td>
<td>9%</td>
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<tr>
<td>Nuclear</td>
<td>5%</td>
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<tr>
<td>Hydro (natural flow)</td>
<td>4%</td>
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<tr>
<td>Wind &amp; Solar</td>
<td>27%</td>
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<tr>
<td>Other renewables</td>
<td>1%</td>
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<tr>
<td>Net imports</td>
<td>1%</td>
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</table>

Source: DECC (2014) – UK Energy Brief
...the upcoming decade becomes vital to prevent sunk investments in carbon intensive power plants.

Source: Own illustration based on Platts (2011)
The Electricity Markets Reform (EMR) in UK comprises of several instruments:

- **Contract for Differences**
- **Emissions Performance Standard (EPS)**
- **Capacity Markets**
- **Carbon Floor Price**

### Timeline

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<tbody>
<tr>
<td>Legislation</td>
<td>White Paper</td>
<td>Bill introduced</td>
<td>Royal Assent</td>
<td>Statutory Instruments in force</td>
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<td>Renewal energy target</td>
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<tr>
<td>Institutional Framework</td>
<td></td>
<td>Initial work to establish organisation</td>
<td>Organisation receives legal powers</td>
<td>Organisation up and running, delivers first contracts</td>
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<tr>
<td>Feed-in Tariff with Contract for Difference (FIT CfD)</td>
<td></td>
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<td></td>
<td>First FIT CfD contracts signed</td>
<td>Possible first payments made</td>
<td></td>
<td></td>
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<tr>
<td>Capacity Mechanism (CM)</td>
<td></td>
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<td>Capacity in place</td>
<td>Lead in time for capacity (could be compressed if necessary)</td>
<td>Capacity in place (could be earlier)</td>
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<tr>
<td>Carbon Price Floor (CPF)</td>
<td></td>
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<td></td>
<td>CPF rising incrementally along published trajectory</td>
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<tr>
<td>Emissions Performance Standard (EPS)</td>
<td></td>
<td></td>
<td></td>
<td>Report on Decarbonisation and CCS Progress</td>
<td>EPS applied to all new build</td>
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<tr>
<td>Transition to EMR</td>
<td></td>
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<td>Renewables Obligation (RO) open to new generation</td>
<td>Choice between RO and FIT CfD</td>
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Source: DECC (2012)
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Motivation and research question

EMR is controversially discussed, e.g. by (Pollitt and Haney 2013)

- as a whole, it is not a consistent strategy to achieve the three main energy policy priorities of competitiveness, energy security and decarbonization
- will increase the wholesale electricity price and the consumers energy bill substantially
- removes ability to react quickly to new information, and competition in planning for the future; generation mix will no longer be decided based on price signals but be determined by the government.

Wrong incentives through the EMR might lead to sunk investments in carbon intensive power plants. These lead to a risk of induced welfare losses as well as breeched climate targets (see e.g. Johnson et al. 2014).

→ We want to analyze the measures of the UK-EMR, specifically the Carbon Price Floor (CPF), Emissions Performance Standard (EPS) and Contracts for Differences (CfD), and how they will influence the construction of new generation capacities, with a special focus on CCTS.
Motivation for designing a new model: The ELCO model

Current Representation of CCTS

- Electricity market models (e.g. Egerer et. al 2013, Kunz et al. 2013, Leuthold et al. 2012)
- CCTS infrastructure models (e.g. Oei, Herold, and Mendelevitch 2014; Mendelevitch 2014)

They neglect:

- CO₂ transport and storage aspects incl. competition for storage usage with the industry
- The electricity system

Our model should simulate:

- regionally disaggregated electricity generation and flows
- CO₂ capture from power generation and CO₂-intensive industry, CO₂ transport and storage (incl. CO₂-EOR)

Included Features:

diffusion and curtailment constraints, environmental regulation and targets, time-specific CO₂ stream, location-specific technology costs and constraints, endogenous or exogenous feed in tariffs
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Assumptions for a Tentative Scenario

• **Electricity sector**
  – RE-Diffusion: Exponential growth depending on starting capacity
  – CfD: Exogenous strike price projections for 2015 and 2020
  – Nuclear: Max 5 GW new capacity
  – CO₂ target: 90% reduction until 2050 (base 1990)
  – CO₂ certificate price: from 20€/t in 2015 to 80€/t in 2050
  – No specific RE-Target
  – EPS: 450 gCO₂/kWh for new capacity
  – Demand Reduction: 20% until 2050

• **Steel and Cement sector**
  – CO₂ Emissions Reduction: 40% until 2050

• **Storage**
  – Oil: price 65€/bbl, CO₂ efficiency: 3bbl/tCO₂
  – Available storage types: offshore CO₂-EOR, DOGF, Saline Aquifer

• **General**  2015-2050 in 5 year steps; 5 weighted time slices; 3 nodes; no line congestion
Results of a Tentative Scenario: The Electricity Sector…

- Diversified electricity portfolio in 2050: RES-E (47%), gas (25%), nuclear (14%), and CCTS (14%)
- Constant growth of renewables
- CfD covers more than 70% of the market in 2050; its expenses rise to 23 bn. € in 2050 (equivalent to a tax of 100 €/MWh)
- Investments only in EOR storage, regardless of additional incentives from the energy market
- CO2 flow from industry is more constant than from electricity sector
Results of a Tentative Scenario: …including the CCTS chain

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Next steps

• Compare the costs of different incentive schemes and analyze their effects on the deployment of different low carbon technologies, with a special focus on CCTS with and without the option for EOR.

• Further consider the role of industry CCTS

• Study the feedback effects between the CfD scheme and the electricity price, and investigate the incentives of the government which acts along the three pillars of energy policy: cost-efficiency, sustainability and security; in a two-level setting

• Use our results to draw conclusions and possible policy recommendations for low carbon support schemes in other counties
Thank you for your attention!!!