UK energy policy and market reform

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Centre for Energy Policy and Technology
Imperial College London
World-class scholarship, education and research
Number 8 in Times Higher word ranking 2015
Four faculties: science, engineering, medicine and business

15,900 students
9,100 undergraduates
3,400 taught postgraduates
3,400 research postgraduates
from 126 countries
3,800 academic & research staff
3,100 support staff
£970M annual turnover
The Energy Futures Lab is a university-wide institute that promotes cross-disciplinary research and education in energy. Approximately 200 academics and 700 researchers work in energy related topics with an annual spend of around £40M from industry and public sources. It runs an MSc in Sustainable Energy Futures.

**Sustainable Power:** includes research on marine energy; bioenergy; PV and solar thermal; fuel cells; nuclear; wind energy

**Clean Fossil Fuels:** includes research on carbon capture and storage; down-well processing; sustainable gas

**Energy Infrastructure:** includes research on smart grids; energy storage; multiple energy vectors; energy efficiency

**Cities and Transport:** includes research on electric and hybrid vehicles; transport use modelling; future fuels; more electric ships and aircraft.

**Policy and Innovation:** includes research on energy policy impacts; inventive mechanisms; energy service innovation; energy resource mix assessment
Overview of presentation

- Background on UK Energy Policy
- Recent policy changes – Electricity Market Reform
- Power system investment since liberalisation
- Changes to the UK power mix
- The capacity mechanism
- Renewables prices
- Future issues for policy and markets
Policy in the UK power sector – 2 minute history

• 1900s – private competitive – tending to monopoly
• 1950s to 90s – nationalised industry – economies of scale
• 1990s – competition, liberalisation – dash for gas
• 2000s – climate change programme and Renewables Obligation, plus EU Renewables Directive
• 2010 – Electricity market reform creates capacity market and contract for difference feed in tariff
<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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<tbody>
<tr>
<td>Pre 1989</td>
<td>State owned CEGB and regional electricity companies</td>
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<tr>
<td></td>
<td>Dispatch optimised on merit order – lowest marginal cost runs first</td>
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<tr>
<td></td>
<td>Power mix mainly coal (80%) and nuclear (20%)</td>
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<tr>
<td></td>
<td>Some hydro</td>
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<tr>
<td></td>
<td>Some oil</td>
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<tr>
<td></td>
<td>No other RE</td>
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<tr>
<td>1989/90</td>
<td>Electricity Act: Liberalisation &amp; start of Privatisation</td>
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<tr>
<td></td>
<td>The “Pool” central buyer and two main companies (running coal)</td>
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<tr>
<td></td>
<td>National Grid dispatches according to bid prices</td>
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<tr>
<td>1990-2000</td>
<td>Gradual opening of competition in supply</td>
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<td></td>
<td>Investment by new entrants and regional electricity cos</td>
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<td></td>
<td>Leads to the dash for gas</td>
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<tr>
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<td>Nuclear part privatised</td>
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<tr>
<td></td>
<td>Creation of Non-Fossil Fuel Obligation (NFFO) – designed to support nuclear</td>
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<tr>
<td></td>
<td>but open to renewables</td>
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<tr>
<td></td>
<td>First wind farms constructed (1991)</td>
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The evolution of the market, 1989-present

2001
NETA: New Electricity Trading Arrangements

bilateral trading
England and Wales

Creation of Renewables Obligation (RO) – tradable certificates plus target on suppliers

Growth in wind and landfill gas plus some small hydro

2005 - 2014
BETTA: British Electricity Transmission & Trading Arrangements

Various changes to rules for bilateral trading + Scotland

Many changes to workings and ambition of RO – eg banding

Creation of micro-gen FiT

Huge expansion of wind, then offshore wind and solar

2014
Electricity Market Reform

bilateral trading + capacity markets + CfDs

Opens support/subsidy to new nuclear

Emission performance standard
Energy Act 2013
Electricity market reform

Grubb and Newbery, 2018, UK Electricity market reform and the energy transition; emerging lessons MIT CEEPR Working paper
The changing electricity mix – from coal to gas …to renewables

https://www.gov.uk/government/collections/uk-energy-in-brief
UK operational power plants

https://www.imperial.ac.uk/energy-futures-lab/policy/briefing-papers/paper-1/
The dash for gas
CCGT capacity, 1990 onwards

CCGT installed in UK per year
(based on year of commission)

https://www.gov.uk/government/collections/uk-energy-in-brief
Renewables now supply over 25% of power
The death of coal?
2011 – 2017 CO2 emission down from 510 g to 240 g /kWh
Capacity market outcomes

Capacity price (£ per kW)

Derated capacity (GW)

Hydro
DSR
Interconnectors
Storage
Fossil peaking
CHP
Coal / biomass
Nuclear
Gas CCGT
Cost per kW

2016 (TA) 2017 (T-1 and TA) 2018 (T-4) 2019 (T-4) 2020 (T-4)

https://www.imperial.ac.uk/energy-futures-lab/policy/briefing-papers/paper-1/
Auctions drive down wind and solar prices

<table>
<thead>
<tr>
<th></th>
<th>Capacity (MW)</th>
<th>Admin Strike price 2014 (£/MWh)</th>
<th>Lowest auction clearing price Jan 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large solar PV</td>
<td>72</td>
<td>120</td>
<td>79</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>1162</td>
<td>95</td>
<td>79</td>
</tr>
<tr>
<td>Energy from Waste CHP</td>
<td>95</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>750</td>
<td>140</td>
<td>114</td>
</tr>
<tr>
<td>Advanced Conversion Technologies</td>
<td>62</td>
<td>140</td>
<td>114</td>
</tr>
</tbody>
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Grubb and Newbery, 2018, UK Electricity market reform and the energy transition; emerging lessons, MIT CEEPR Working paper
The investment challenge

Comparing historical and projected build rates CAPEX (£m)
Lessons from the UK

- ‘Dash for gas’ mainly driven by wholesale rather than capacity market
- Carbon price plus regulation drives coal to gas switching
- Capacity market creates surprises – smaller peaking plant not CCGT
- Auctions drive renewables price reductions
- ‘Subsidy free’ renewables possible but long term contracts still needed to access low cost capital
- 25% renewables integration with minimal system costs
- The future – RE contributes to balancing, flexibility from interconnection and conventional plant, storage for frequency, increased role for demand side

- Future uncertainty: What role for new nuclear? What is needed for new CCGT?
- Can we make new demands (cars, heat) flexible? Interconnection/Brexit?