Cambridge Judge Business School

EPRG Spring Seminar 2015

Analysis of Strategic Bidding Behaviours and Design of the UK Capacity Market

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Presentation Scope

Key Questions

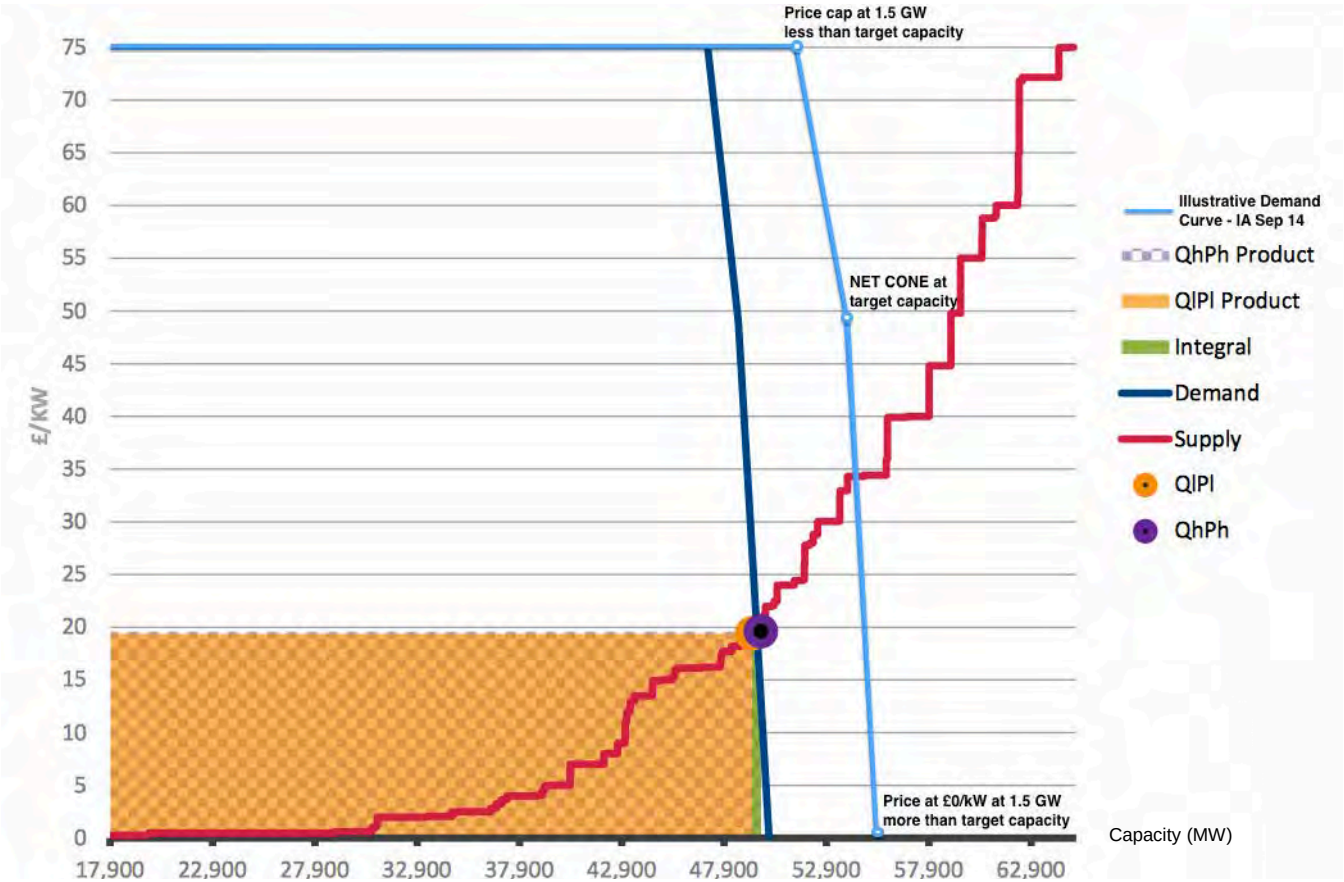
- What can UK learn from US Capacity Mechanisms?
- Was bidding in UK Capacity Market rational?

Project Constraint

- Publicly available data

UK 2014 T-4 Capacity Auction

Brief Background



Source:
National Grid (2014a)
Final Auction Results

"The price went so low that the only those companies operating existing storage sites unburdened by construction debt."
– **Quarry Battery Company**

"Natural Gas is the technology winner in this week's UK Capacity Market auction with 45% of awards."
- Mark Burnett
Senior Advisor Energy & Climate

Lessons for UK from US Capacity Markets

Selected Markets

- Independent System Operator New England (ISO-NE)
- New York Independent System Operator (NY-ISO)
- Pennsylvania New Jersey Maryland Interconnection (PJM)

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Lessons for UK from US Capacity Markets
Methodology

Qualitative Analysis

- Main market design features
- Analysis of historical results
- Two principal design features significant to auction results
  - Penalty Mechanisms
  - Interconnectors

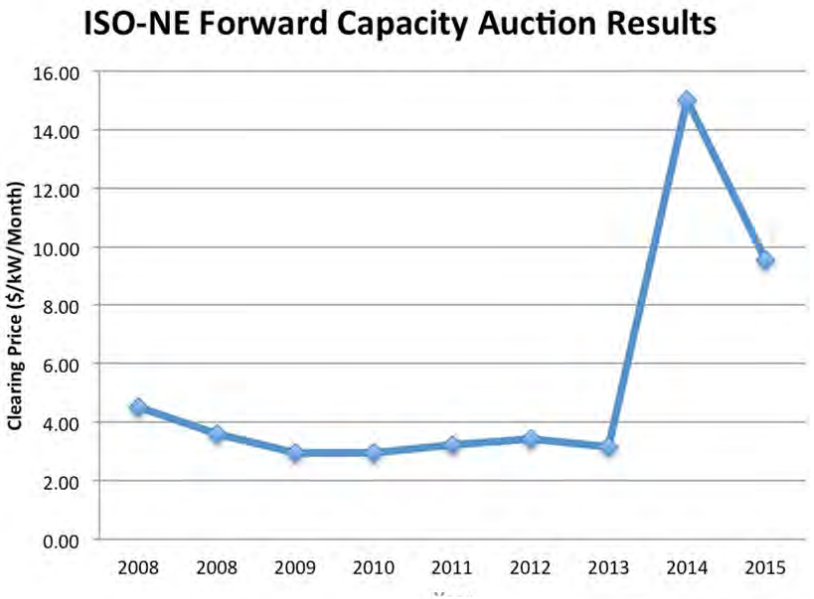
Lessons for UK from US Capacity Markets

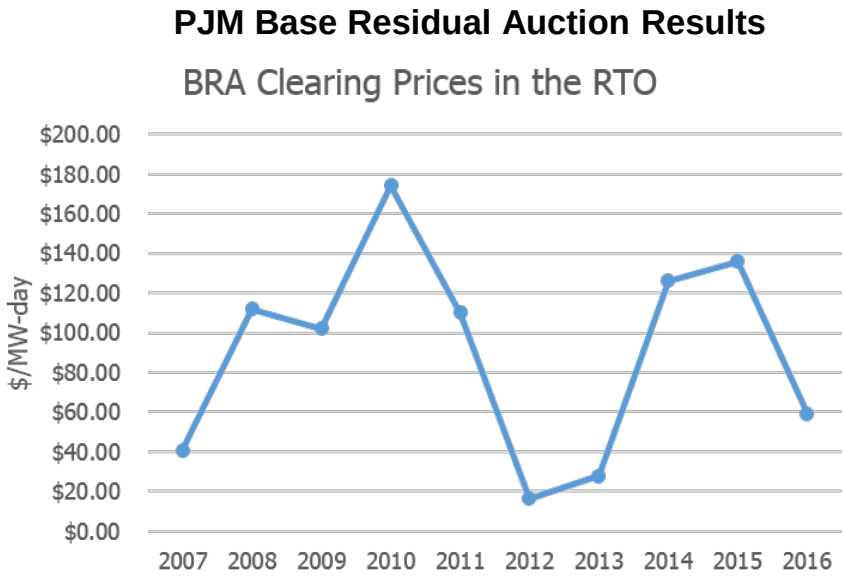
High Level Comparison

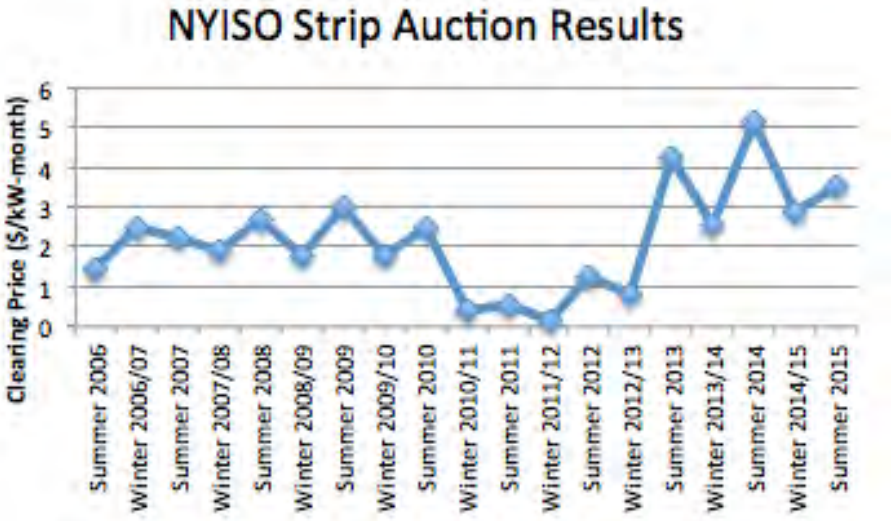
ISO-NE	PJM	NYISO	UK
Forward Capacity Auction. 3 year forward	Base Residual Auction. 3 year forward	Short-term Auctions held bi-annually and monthly	Forward Capacity Auctions 4 year forward
Volume-based, market wide Sloping demand curve	Volume-based, market wide Sloping demand curve	Volume-based, market wide Sloping demand curve (spot auction, locational)	Volume-based, market wide. Sloping demand curve
4 External Interfaces	20 External Interfaces	4 External Interfaces	No external interfaces for 2014 T-4 (will be included for 2015 T- 4 Auction)

Lessons for UK from US Capacity Markets

Key Clearing Price Movements







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Lessons for UK from US Capacity Markets

Penalty Mechanisms – Analysis

	Penalty	Cap
ISO-NE (2008 – 2014)	Annualised Payment x Penalty Factor x (1 – Shortage Event Availability Score)	Daily: 10% Annually: 100%
PJM (2007 – 2015)	Daily Deficiency Rate x Daily Commitment Shortage	No Cap but payment even for non-delivery
NYISO (1999 – 2003)	3 x Annualised Cost New Peaking Unit/MW	Fixed Charge
UK (From 2014)	**1/24th Auction Clearing Price (£/MWh)**	**Monthly: 200% Annually: 100%**
ISO-NE (From 2015)	Performance Payment Rate x [Dispatching MW – Capacity Supply Obligation] x Balancing Ratio	Monthly: [1.6 Net-CONE] x CSO Annual: 3 x Max Monthly Loss
PJM (Proposed)	Non-Shortage Hours: [Net CONE x 365] /350 Shortage Hours: $2,700 / MWh	Event: 0.5 x Net CONE Annual: 1.5 x Net CONE
NYISO (From 2003)	1.5 x Market Clearing Price x Monthly Shortfall in Capacity Obligation	Fixed Charge

Lessons for UK from US Capacity Markets

Penalty Mechanisms – Recommendations

- **Two-Settlement Mechanism:**
  Penalty Charge for Non-Delivery + Performance Payment
- **Performance Payment Financed by Penalty Charge**
- **DO NOT Cap Penalty at 100% Annual Capacity Revenues**
- **Penalty Charge should be a Function of Net CONE**

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Lessons for UK from US Capacity Markets

Interconnectors – US vs. UK Analysis

US Markets

- ISO-NE: ~5% (~1600 MW); NYISO: 2.8% (1090 MW); PJM: 4% (7483 MW)

External Generators Participation

- Both face similar rules as local actors
- Interconnectors vs. External generators participation

Conditions to Demonstrate Availability

- Stricter in US to ensure reliability

Contracts

- Exclusively bound to the specific market
- Import limits to avoid speculative bidding.

- Clear investment signal
- Gaming risk decreased
- Administrative burden decreased
- Supply security reduced
- Problem of EU market coupling algorithm

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Lessons for UK from US Capacity Markets

Interconnectors – EU & UK Analysis

EU and UK Markets

- Implicit vs. Explicit participation

EU main challenges:

- Cooperation vs. National supply security
- Potential lucrative gains

FR/DE/IT main challenges:

- Control of foreign capacities
- Equivalence MS commitment
- Uncertain de-rated factors
- Foreign TSO Involvement

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Lessons for UK from US Capacity Markets

Interconnectors – Recommendations

BREXIT

- Incentivise national investments
- Continue explicit participation (1-yr)
- CBA on generator participation
- Implement import limits

UK Remains EU MS

- Continue explicit participation (1-yr)
- Implement import limits

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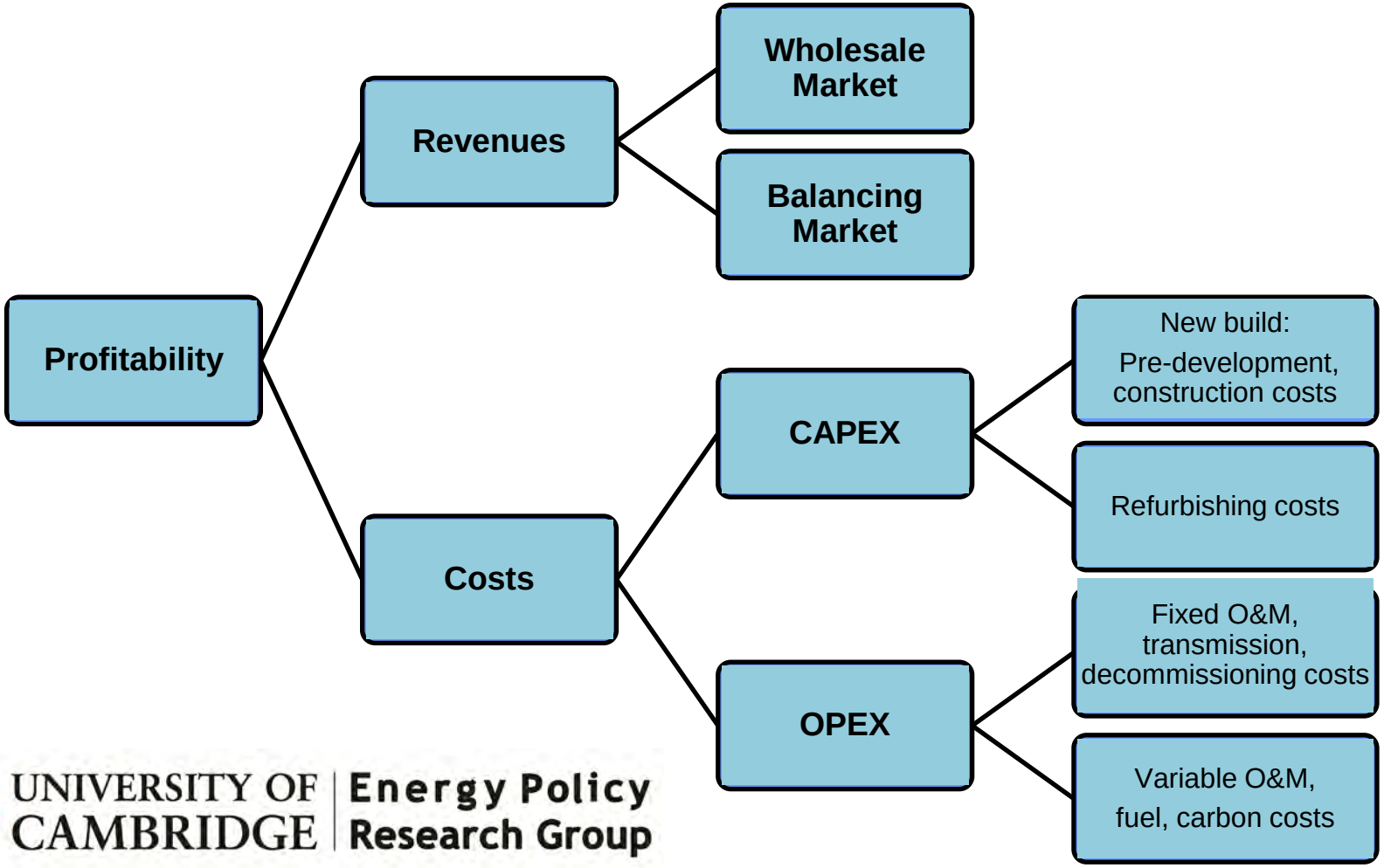
UK 2014 T-4 Strategic Bidding Behaviour

General Methodology

Micro-analysis - CMUs Profitability Model



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UK 2014 T-4 Strategic Bidding Behaviour

General Methodology

Micro-analysis

- Discounted individual CMU profits over 2015-2018 (10% discount factor) vs. Discounted 2014 auction clearing price (£14.58/kW/year)
- Classification of bidding behaviours at CMUs level as:
    - Apparently Rational
    - Apparently Irrational

Macro-analysis

- Bidders' portfolio analysis:
    - Technology mix impact on auction results

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UK 2014 T-4 Strategic Bidding Behaviour

General Methodology – Monte-Carlo Simulation

Monte-Carlo Simulation

Rationale

- Public data only: DECC, PB, ELEXON, NG, IPCC AR5, DUKES, UK ERC
- Bidders' imperfect information

Variables

- Electricity price
- Fuel costs
- Load factors

} Normal distribution with +/- 0.5 s.d.

- Balancing revenues

} Uniform distribution with +/- 25%.

UK 2014 T-4 Strategic Bidding Behaviour

Technology Specific Methodology

CCGT Methodology

- CMUs' efficiencies differentiated by age
- Load factors calculated as a linear function of efficiency

Coal Methodology

- PLATTS' dark spreads used to adjust DECC's coal prices
- Sensitivity analyses show that:

  (i) more economical to refurbish in 2017 than in 2015

  (ii) more profitable to generate at high load factors until 2018/19 than at low load factor until 2023

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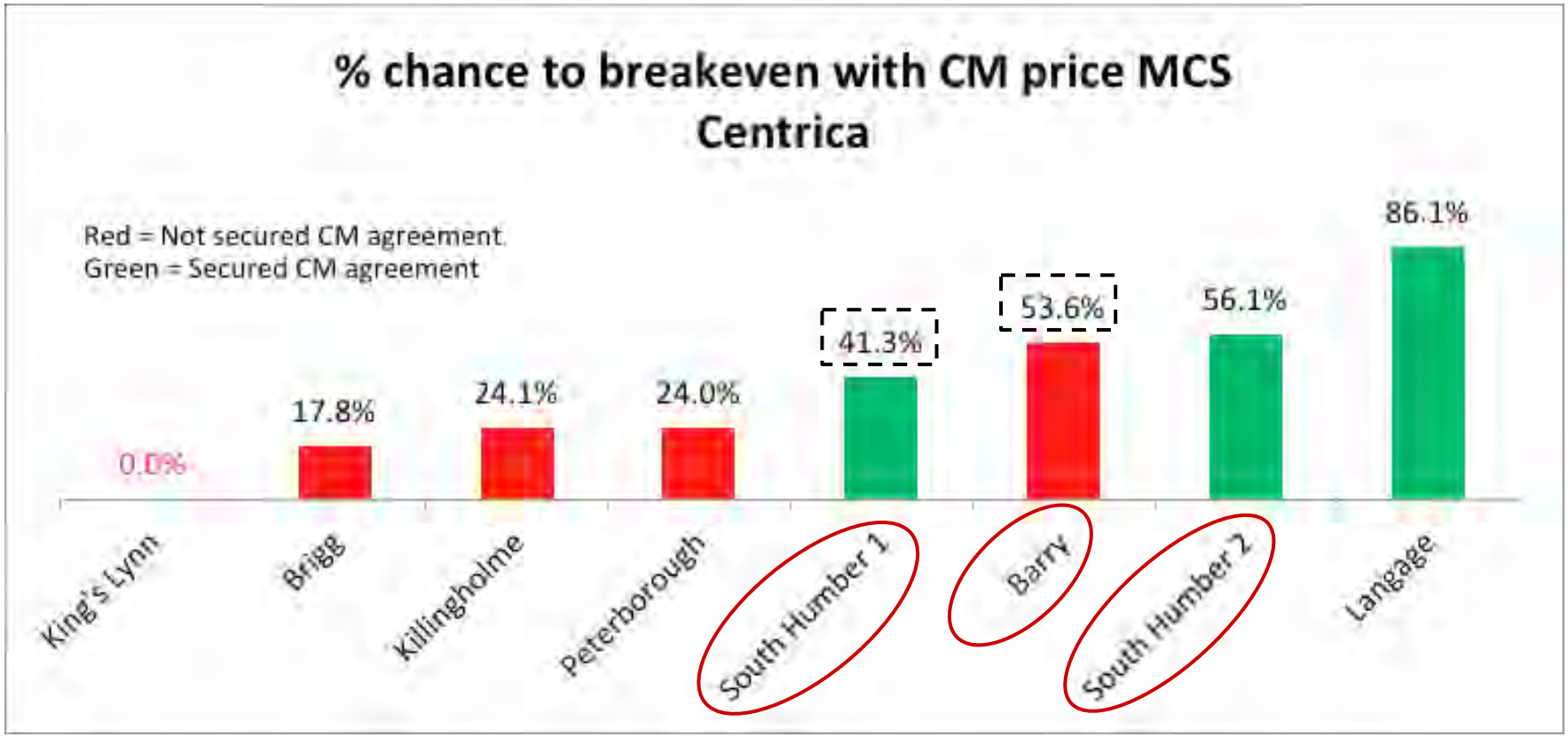
UK 2014 T-4 Strategic Bidding Behaviour

Classification of CMUs based on Model

Apparently Rational (AR) CMUs	"Profitable" CMUs Breakeven Payment Required (£/kW/yr) < Clearing Price Secured agreement	120 (55.8%)
	"Unprofitable" CMUs Breakeven Payment Required (£/kW/yr) > Clearing Price Did not secure agreement	31 (14.4%)
Apparently Irrational (AI) CMUs	"Profitable" CMUs Breakeven Payment Required (£/kW/yr) < Clearing Price Did not secure agreement	5 (2.3%)
	"Unprofitable" CMUs Breakeven Payment Required (£/kW/yr) > Clearing Price Secured agreement	59 (27.4%)

UK 2014 T-4 Strategic Bidding Behaviour

CCGT Discussion – Centrica



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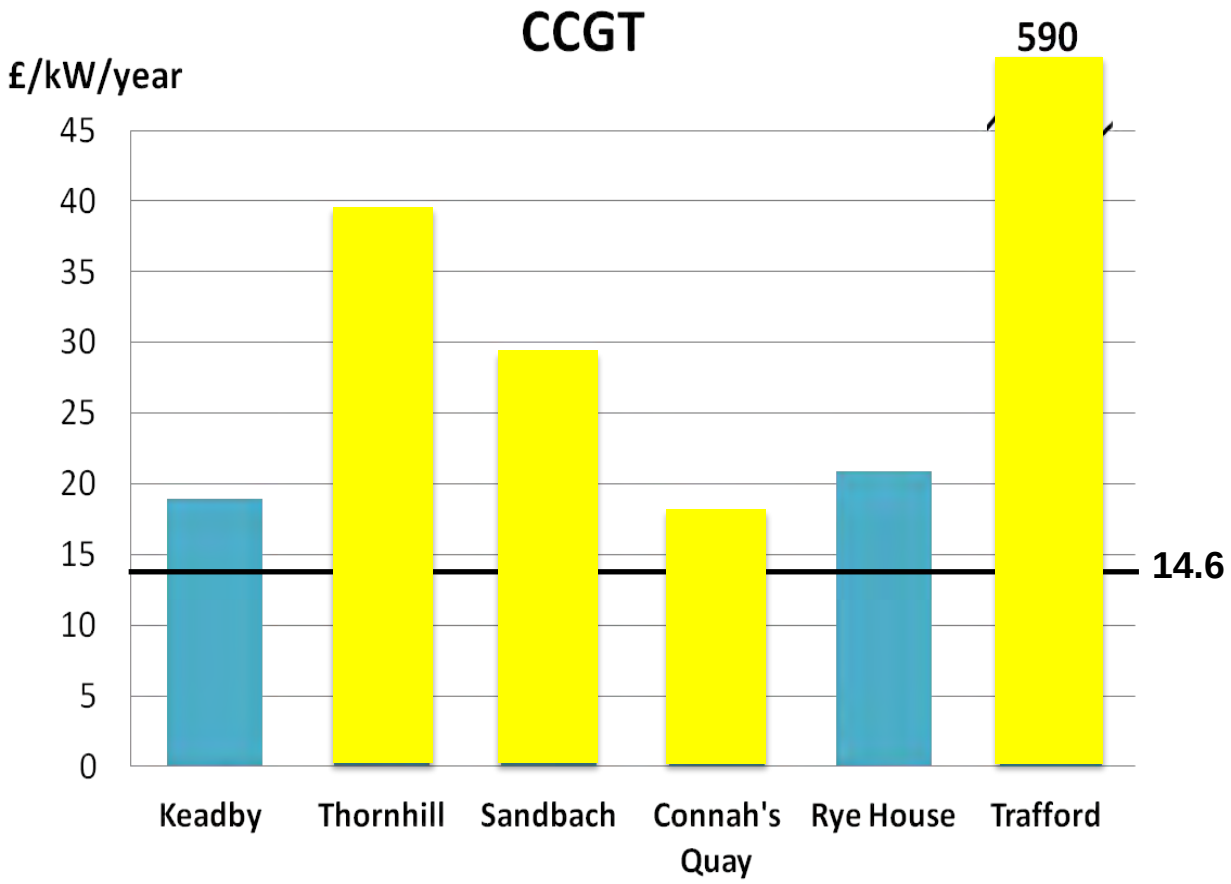
UK 2014 T-4 Strategic Bidding Behaviour

CCGT Discussion – Other Companies



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Thornhill, Sandbach, Connah's Quay (E.On)

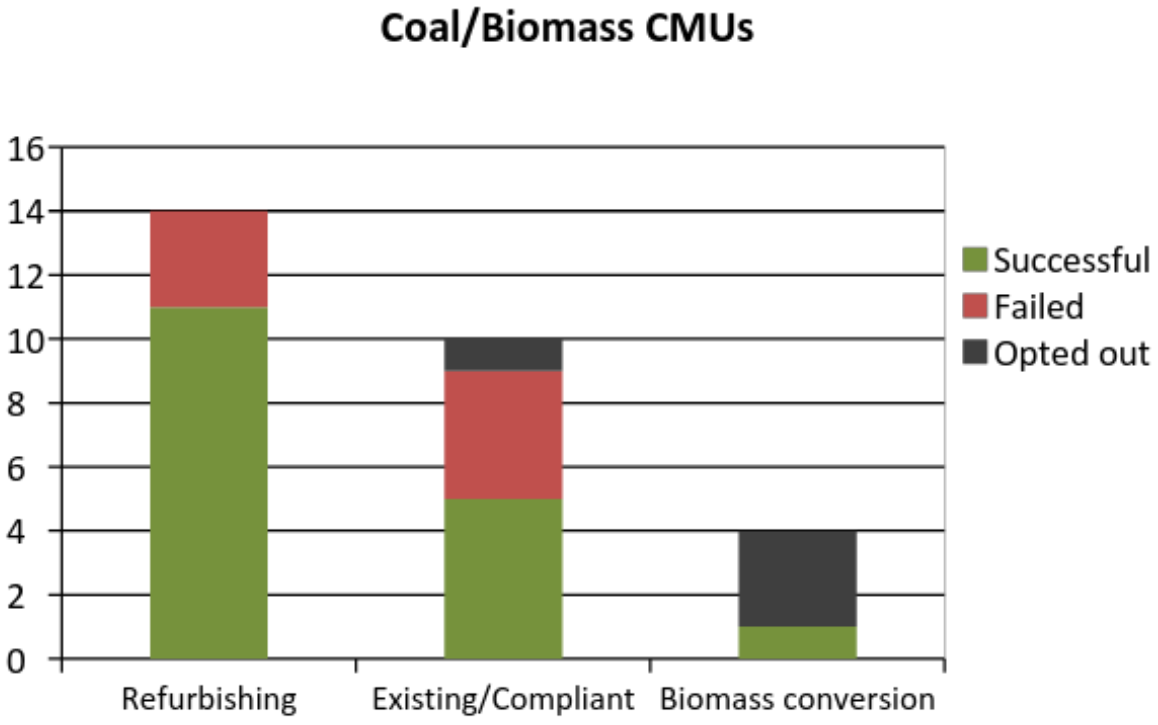
- MCS analysis
- CMUs exited at 13%
- Secured at 35.5%
- Potential optimistic view

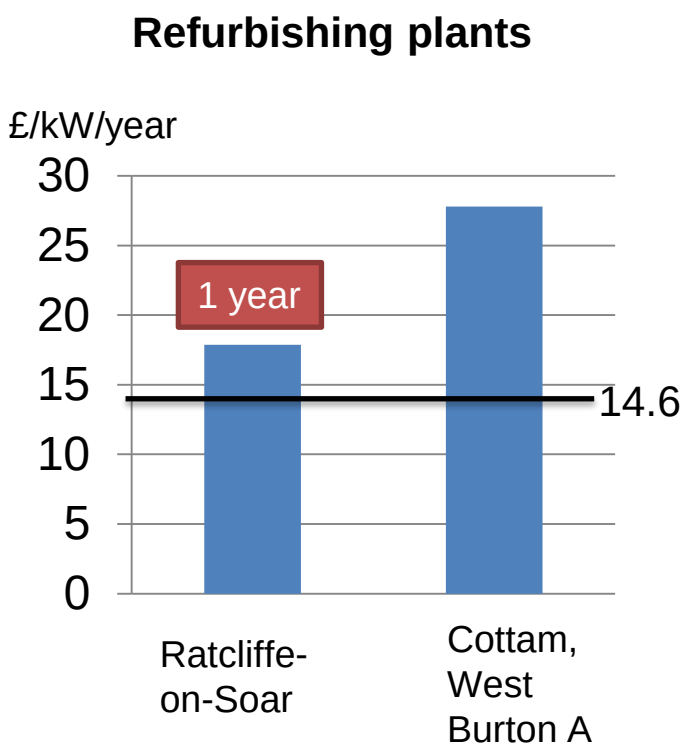
Trafford (Wainstones)

- £590/kW/year
- Attributed to our methodology
- High levels of optimism
- GE's latest 9HA tech
- Industry leading efficiency and flexibility

UK 2014 T-4 Strategic Bidding Behaviour

Coal/Biomass Discussion





- Hedging: West Burton A and SSE
- Opting out: Biomass and Longannet

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UK 2014 T-4 Strategic Bidding Behaviour

Analysis of Bidder Portfolio of CMUs

CCGT	Coal/Biomass	CHP	OCGT
• Centrica, Wainstones, Thorpe Marsh, Intergen, Seabank, ESB	• Eggborough, Drax	• VPI	• UKPR

	CCGT	Coal	CHP	OCGT	Nuclear	Hydro	Storage	Number of types
MPF	x		x					2
RWE	x	x		x				3
EDF	x	x		x	x			4
E.On	x	x	x	x				4
SSE	x	x		x		x	x	5
SP Group	x	x	x			x	x	5
GDF	x	x	x	x			x	5

Number of technology types	CMU		MW	
	Average success	Standard deviation	Average success	Standard deviation
1	52.72%	44.84%	53.98%	44.88%
2	100.00%	-	100.00%	-
3	100.00%	-	100.00%	-
4	89.66%	9.75%	91.39%	7.23%
5	88.49%	2.28%	66.40%	4.61%

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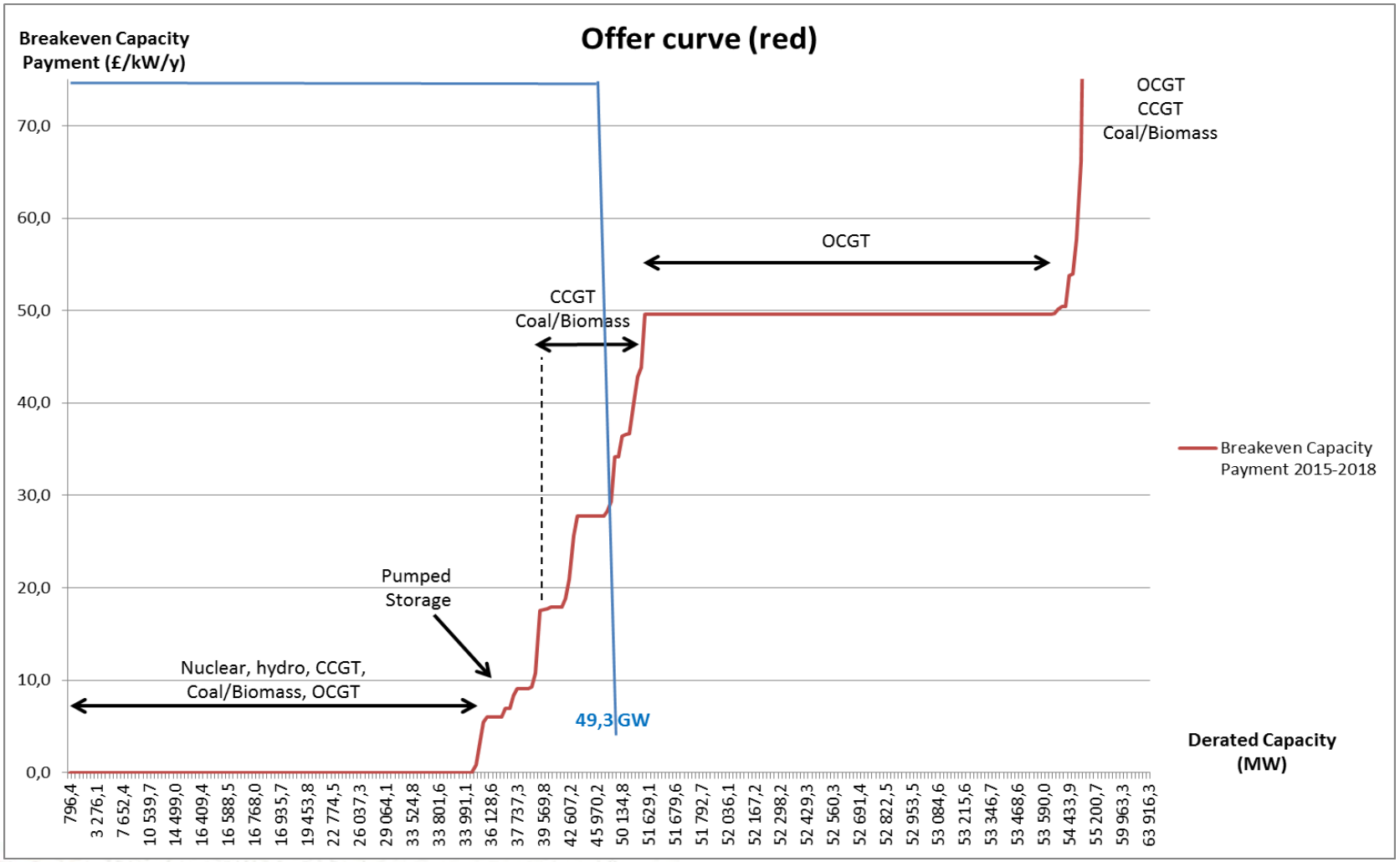
UK 2014 T-4 Strategic Bidding Behaviour

Modelled Offer Curve



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Conclusion

Lessons for UK from US Capacity Market

- **Penalty Mechanisms**
  - Current UK mechanism only provides minimum incentive
  - Recommend two settlement mechanism and increased penalty cap
- **Interconnectors**
  - Recommendations depend on upcoming referendum
  - Explicit Interconnector participation to provide investment incentives while maintaining control with one-year agreements
  - Establishing import capacity limits to prevent speculative bidding

Conclusion

UK 2014 T-4 Strategic Bidding Behaviour

- Classified as Apparently Irrational and Apparently Rational
- Apparently Irrational behaviour due to future optimism and other revenues
- Portfolio analysis of bidding companies demonstrate advantages of having large range of technologies