UK Electricity Market Reform and the Energy Transition: Emerging Lessons

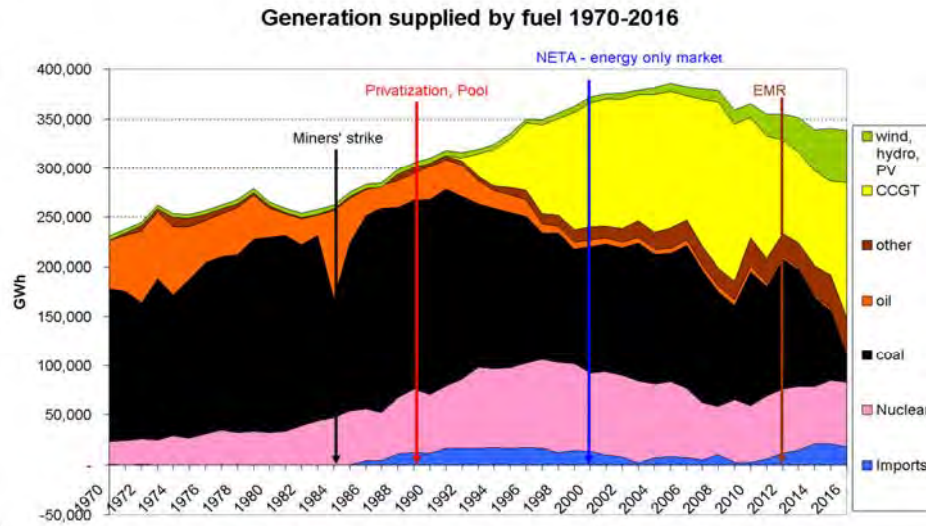
Michael Grubb, *University College London*
David Newbery, *EPRG, University of Cambridge*

41st International IAEE Conference
Groningen, The Netherlands
12th June 2018

Outline

- Evolution of UK policy & regulation
- **EMR reforms**: aims and instruments
  - Need better support for RES
  - Need better signals than ETS for decarbonization
  - Need timely flexible capacity
- **EMR results**
  - carbon price support, Emissions performance standard
  - CfDs for zero-carbon generation and auctions
  - capacity auctions
- **Lessons** for market design and regulation
  - Capacity needs reward
  - auctions better than bureaucrats
  - RES support needs improving
  - network tariffs need major rethink

Evolution of electricity market and policy



UCL Institute for Sustainable Resources

UK electricity journey – overview

	Policy environment	Regulatory remit
1990s	**First liberalisation** - Competition through electricity pool - System marginal price + capʸ payment ⇒ "Dash for gas", based on Long term contracts (PPAs) with distribⁿ companies ⇒ Some contract support for renewables ⇒ Collapse of R&D	*"Promote competition"* Concerns about oligopolistic power
2000s	**Bilateral trading** market (NETA/BETTA) - replace pool, energy-only market - Vertical integration of generators with supply companies; ⇒ Limited investment ⇒ Market certificate trading (ROCs) support for renewables	*"Protect interests of consumers"* Growing concerns about lack of investment or new entry, transmission connection & bottlenecks, and short-termism
2010s	**Electricity Market Reform (EMR)** + Climate Change Act	*"Protect interests of* present and future *consumers"*

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Why Electricity Market Reform?

UCL

- ETS offers **inadequate low-C investment signal**
- RES lagging countries with feed-in tariffs
- Ambitious RES targets increase intermittency
  - Need flexible peaking reserves
  - Normally comes from old high cost plant = coal
    - Large Combustion Plant Directive 2016 limits coal
    - Integrated Emissions Directive further **threat to coal**
    - Carbon price floor => **close old coal**
  - high EU gas prices and low load factors
    - **gas unprofitable, new coal threatened by future C price**
- Future prices now depend on uncertain policies
  - on carbon price, renewables volumes, other supports
  - on policy choices in UK and EU

Hard to justify investing in reliable power
Consensus that market not delivering objectives

ofgem Making a positive difference for energy consumers

Electricity Market Reform (EMR)

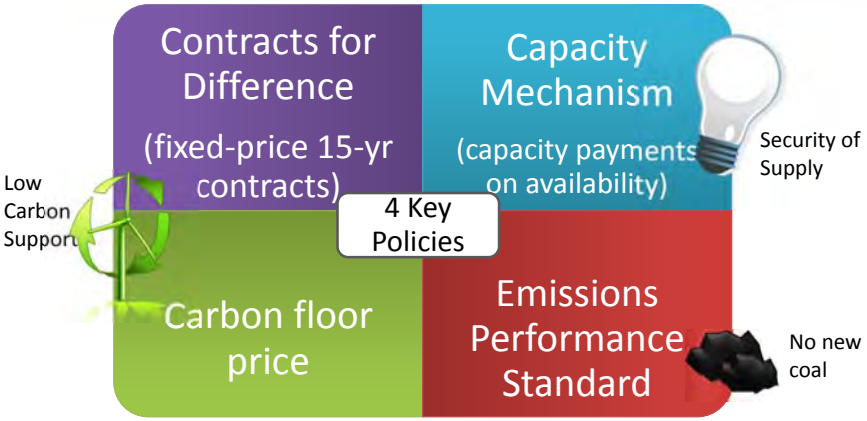
- Controversial step for a pioneer of electricity liberalisation
- Ofgem's *Project Discovery* (2009) – Regulator's detailed study of the future challenges of the electricity market
- Addressing key risks identified became the **three aims of EMR**:

1. Reduce the risks to security of supply
2. Reduce costs to consumers
3. Support progress towards climate change targets



ofgem Making a positive difference for energy consumers

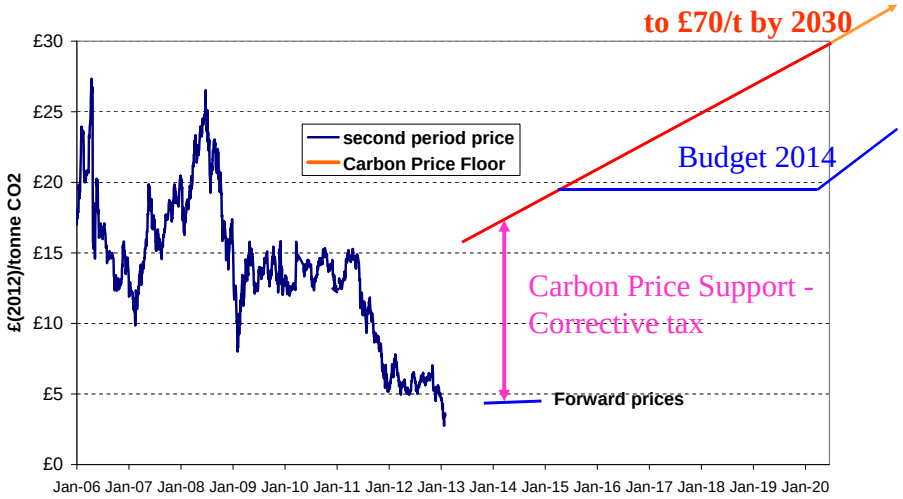
What is EMR?



EMR brought major changes to the market.
Main regulatory input on design of Capacity Mechanism and overall institutional

UK's Carbon Price Floor - Budget March 2011

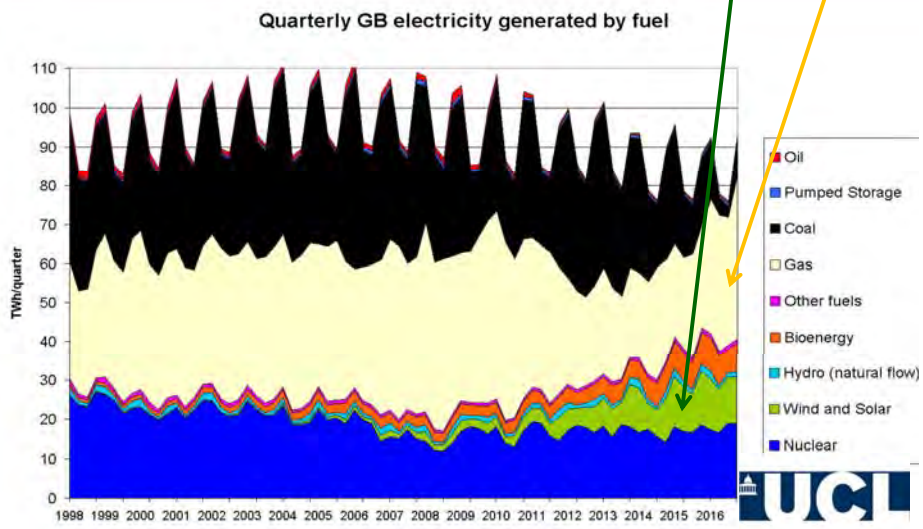
EUA price second period and CPF £(2012)/tonne



Source: EEX and DECC Consultation

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Coal displaced by RES & gas: carbon price floor working

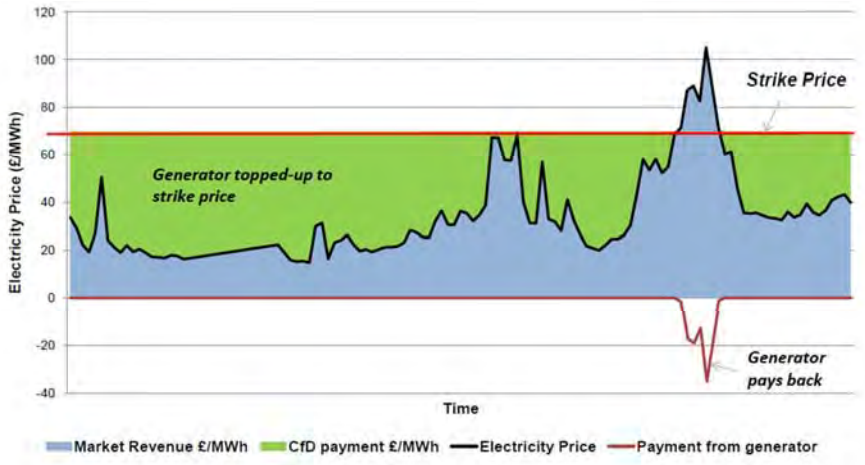


UCL

ofgem Making a positive difference for energy consumers

Contracts for Difference (CfDs)

(structure for renewable energy & nuclear)



UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

RES CfD 2015 auction results

UCL

Auctions better than bureaucrats!

Technology		admin price	lowest clearing price	2015/16	2016/17	2017/18	2018/19	Total Capacity (MW)
Advanced Conversion	£/MWh	£140	£114.39			£119.89	£114.39	
Technologies	MW					36	26	62
Energy from Waste with	£/MWh	£80	£80				£80.00	
Combined Heat and Power	MW						94.75	94.75
Offshore wind	£/MWh	£140	£114.39			£119.89	£114.39	
	MW					714	448	1162
Onshore wind	£/MWh	£95	£79.23		£79.23	£79.99	£82.50	
	MW				45	77.5	626.05	748.55
Solar PV	£/MWh	£120	£50.00	£50.00	£79.23			
	MW			2.88	36.67			69.55

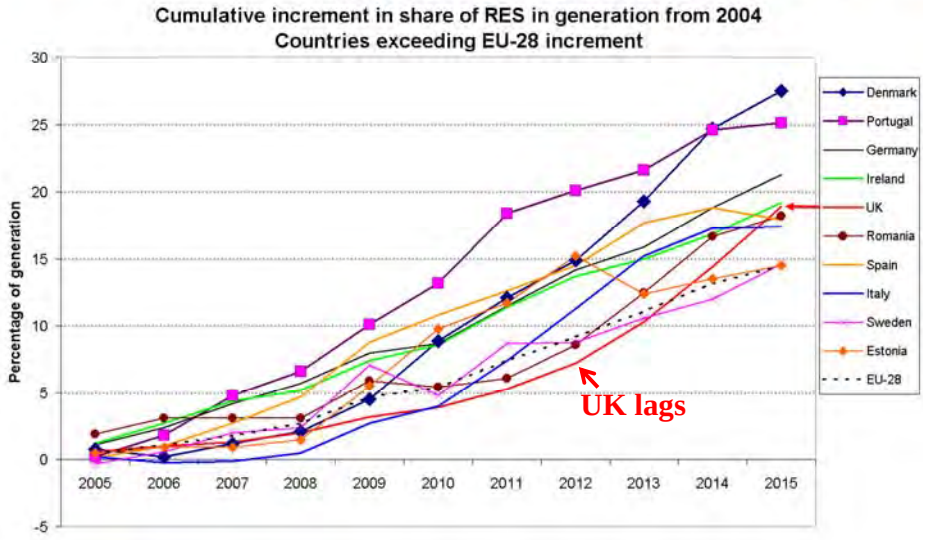
withdrawn

Source: DECC (2015)

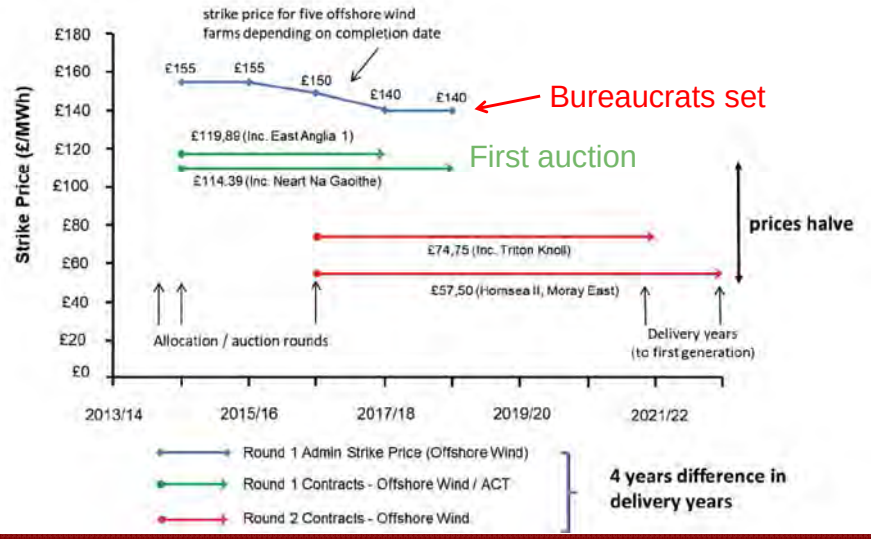
UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

UK RES catching up

UCL



UK Off-shore wind auction prices



Reforming RES-E support

- Learning spill-overs need remuneration
  - Almost entirely from making and installing equipment

⇒ Contract €*X*/MWh for (e.g.) 30,000 MWh/MW, auction determines premium €*X*

Reasons:

- Subsidy targeted on source of learning = ***investment aid***
  - Reduces cost of capital and risk via debt finance
  - Ideally associated with CO_2 credit per MWh
- Could expose RES to current locational spot price
  => **incentivizes efficient location, connection**
- Does not amplify benefits of high wind/sun
  - **Not over-reward favoured locations with same learning**
- **Auction** better than bureaucrats at minimizing cost

Capacity Mechanism / Market

(to reward 'firm' generating capacity)

Why

- Ensure market can deliver **security of supply**
- Payment for availability to **encourage investment**

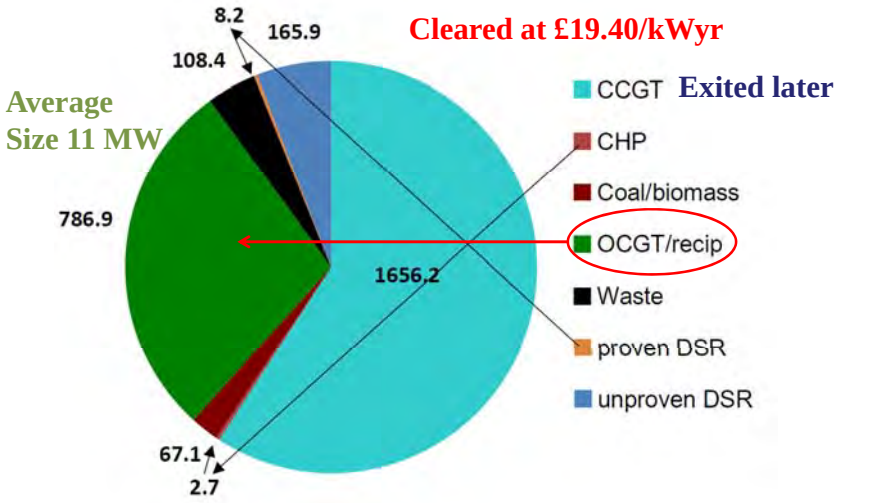
How

- **Market wide** auction of capacity obligations, run by National Grid
- Successful bidders get fixed **revenue** additional to wholesale market
- **Obligated to deliver capacity** when needed or face penalties
- Technology neutral – but those receiving CfDs are not eligible
- Pilot scheme to help Demand Side Response (DSR)

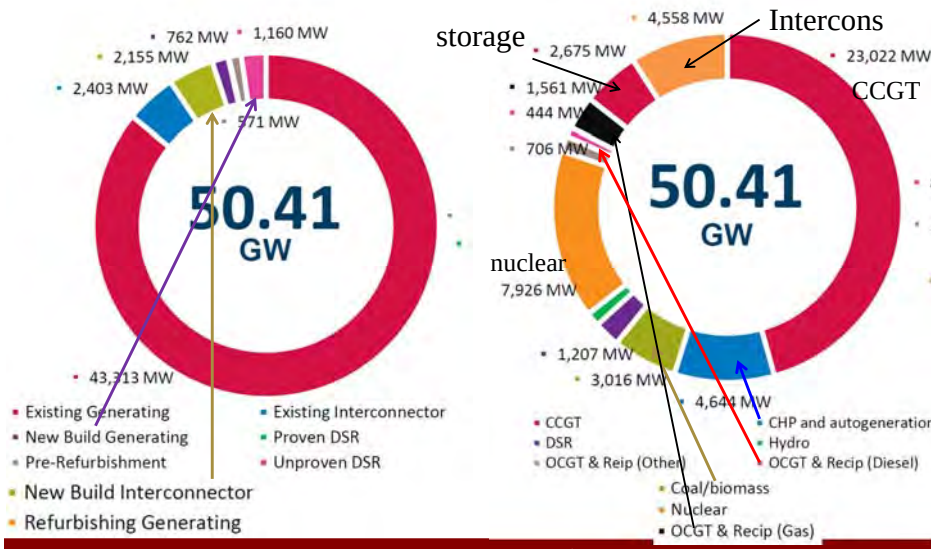
Effect

✓Reduces price volatility
✓Insurance against blackouts
✓Encourages demand side - somewhat
? Expected cost – estimate required for new CCGTs, around **£50/kw/yr**
⇒ **Would appear to cost consumers £2.5bn/yr for 50 GW capacity**
⇒ Lower prices – impact on interconnector / other investment
× Design makes it very difficult for DSR to participate equally

New build 2014 T-4 auction



T-4 for 2021/22 cleared at £8.40/kWyr



Flaws in GB Capacity Procurement

- Transmission-connected generation TG ***pays*** full G TNUoS
- Distribution-connected generation DG ***receives*** L TNUoS
  - But avoided cost at most the transmission demand residual
  = extra money to pay full cost *less* efficient charge of transmission

⇒ represents ***extra*** £50/kWyr embedded benefit in 2018/19

⇒ Auction cleared at £20/kWyr

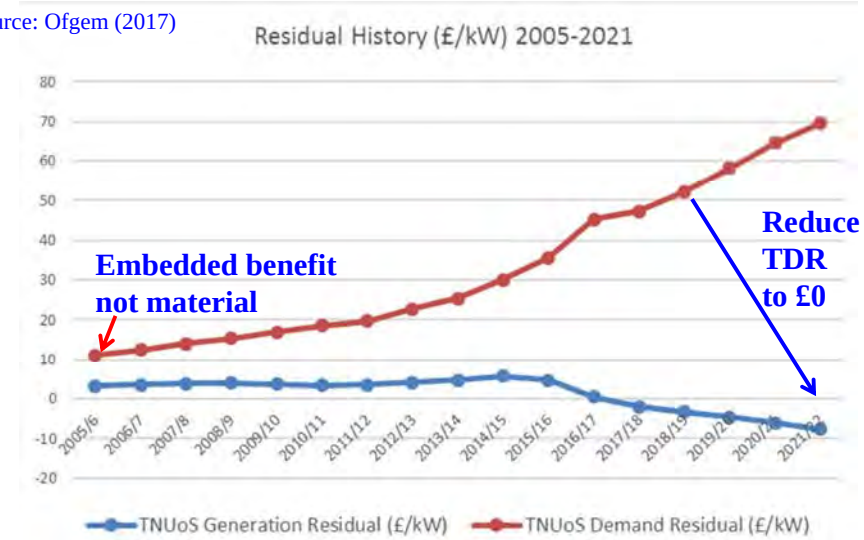
⇒ DG gets £70/kWyr and TG gets £20/kWyr

⇒ Large number of small (10 MW) diesel and reciprocating engines win capacity contracts on distribution network

Over-encourages entry of costly subscale plant

GB Transmission demand *residual – extra to DN connex*

Source: Ofgem (2017)



Reliability Options (RO) preferable to Capacity agreements

- RO sets strike price, ***s*** (e.g. at €500/MWh)
- Market price ***p*** reflects scarcity (Voll x LoLP)
  - SO sets floor price to reflect spot conditions
  - Wholesale price signals efficient international trade
- RO auctioned for annual payment ***P***
  - 7-10 yrs for new, 1 yr for existing capacity
- Gen pays back wholesale price ***p***
  - less strike price if available (***p – s***)
  - G chooses whether to be paid ***p*** or ***s + P***
- Suppliers hedged at strike price ***s*** for premium ***P***

Trade over interconnectors efficient

No need to pay foreign generators

Criticisms of EMR

- "Contracts mark return to Single Buyer Model"
  - but all IPPs in 1990s had long-term PPAs
- "Bureaucrats, not markets choose investment"
  - but current RES support Govt designed after intense lobbying by incumbents

  => tenders, auctions to create competition

  => contracts should incentivise efficient operation
- "Wholesale price will be distorted by contracts"
  - fossil mostly at margin until 2020+, problem is excess PV on sunny summer weekends
  - Problem from RES, not contracts

UK Electricity Market Reform - Key lessons

- For Strategic investments – e.g. security and sustainability, especially emerging renewables - a role for government is inescapable
- Can shifting some risk to government (e.g. long term contract) be good? *Yes* if
  - *the risks arise from private perception of policy risk;*
  - *markets (particularly capital markets) are myopic; or*
  - *the benefits are partly public (e.g. due to inadequate environmental pricing, or innovation / learning, etc.)*
- Do we need a Capacity Mechanism in addition to low carbon supports?
  - *Yes in UK conditions – but scope is crucial, so too is design*
- Auctions are very valuable – competitive pressures remain important
  - Better than government decision at cutting costs / finding options
- Institutional complexities
  - *contracting bodies and their governance*
- Transmission and distribution – *new frontiers?*

Reference

This presentation is based on the working paper

Grubb, M. and D. Newbery (2018). UK Electricity Market Reform and the Energy Transition: Emerging Lessons, CEEPR WP 2018-4 at http://ceepr.mit.edu/files/papers/2018-004.pdf

Acronyms

CfD	Contract for Difference
CP	Capacity payment
CPF	Carbon Price Floor
DG	Distribution-connected Generation
DN	Distribution Network
EMR	Electricity Market Reform
G, L	Generation, Load
LoLP	Loss of Load probability
PPA	Power Purchase Agreement (long term contract)
RES	Renewable energy/electricity supply
RO	Reliability option
ROC	Renewable Obligation (i.e. green) Certificate
SMC/P	System Marginal Cost/Price
T-4	Auction 4 yrds before delivery at date T
T&D	Transmission and Distribution
TDR	Transmission demand residual
TG	Transmission-connected generation
TNUoS	Transmission Network Use of System, G =Generation, L=Load
VOLL	Value of Lost Load

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Acronyms

CfD	Contract for Difference
CP	Capacity payment
CPF	Carbon Price Floor
DG	Distribution-connected Generation
DN	Distribution Network
EMR	Electricity Market Reform
G, L	Generation, Load
LoLP	Loss of Load probability
PPA	Power Purchase Agreement (long term contract)
RES	Renewable energy/electricity supply
RO	Reliability option
ROC	Renewable Obligation (i.e. green) Certificate
SMC/P	System Marginal Cost/Price
T-4	Auction 4 yrds before delivery at date T
T&D	Transmission and Distribution
TDR	Transmission demand residual
TG	Transmission-connected generation
TNUoS	Transmission Network Use of System, G =Generation, L=Load
VOLL	Value of Lost Load

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Spare slides

Michael Grubb, *University College London*
David Newbery, *EPRG, University of Cambridge*

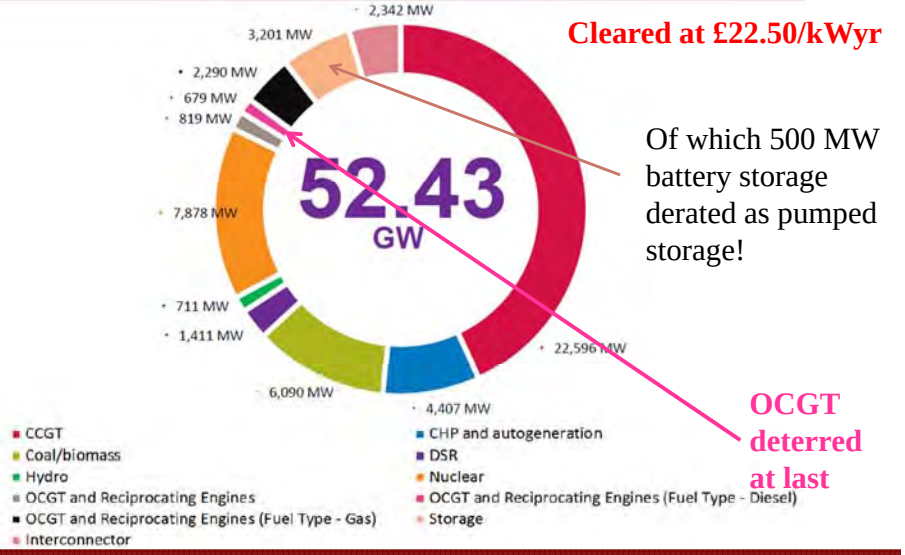
41st International IAEE Conference
Groningen, The Netherlands
12th June 2018

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

T-4 auction Dec 2016 for 2020/21

UCL

Cleared at £22.50/kWyr



Of which 500 MW battery storage derated as pumped storage!

OCGT deterred at last

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Efficient tariffs

- Distinguish efficient price and short-fall in required revenue
  - Efficient peak T price is marginal expansion cost
  - At best 30% average cost, less if demand falling
- Ramsey-Boiteux pricing => "tax" inelastic demand
  - ⇒ equi-proportional reductions in all types of demand
    - incl. option to take up to *N* Kw
- Diamond-Mirrlees: tax only ***final*** consumers

⇒ T&D revenue shortfall on final consumption ***not*** net demand (at network connection)

⇒ reduces embedded G benefit from £60 to < £10/kWyr

⇒ **Regulator**s need to compute efficient T&D tariffs

⇒ and move faster. Auction in 1 day grants 15-yr contract

UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

GB TNUoS (Network) charges