



What next for the GB Capacity Market?

Indications from US experience
July 2016

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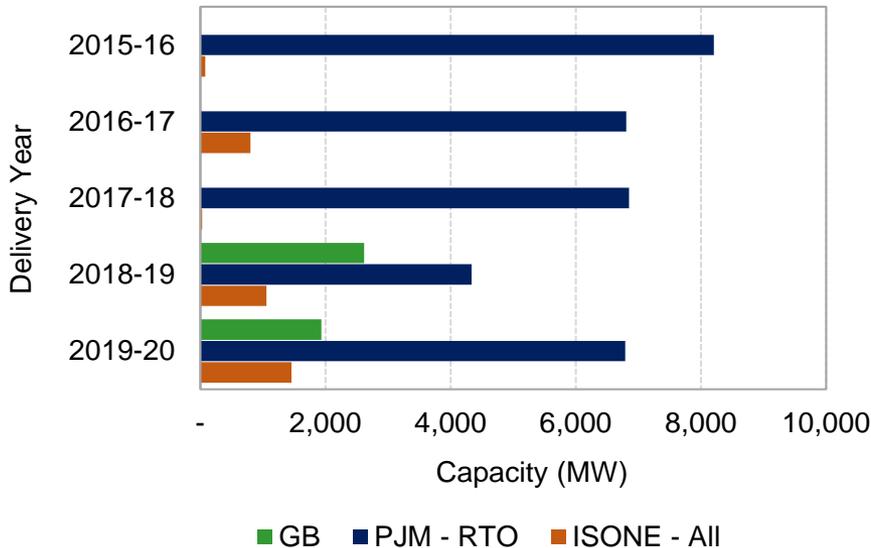
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Further capacity market reform may better support generation investment

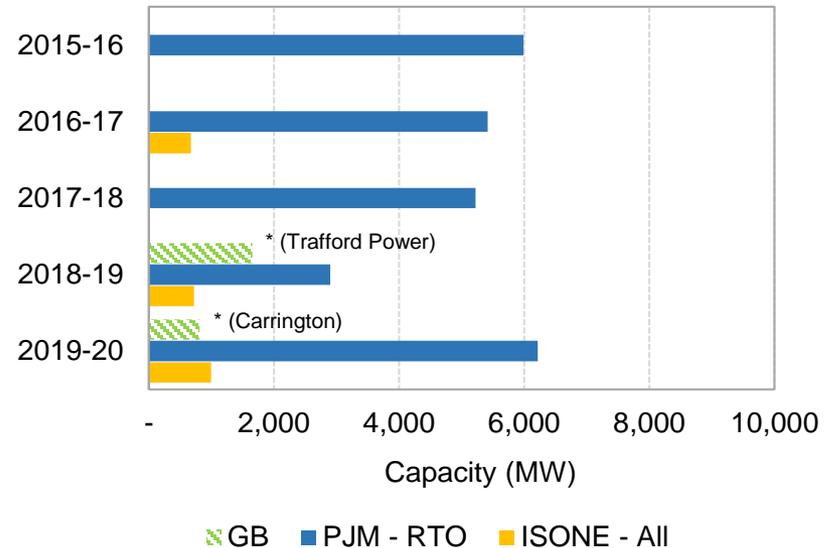
The US capacity markets have helped stimulate a large amount of new capacity development

- Over the last five auctions, close to 33 GW of new capacity have cleared the PJM auction. Of this, over 25 GW are CCGTs
- While new development has been much lower in ISO-NE (the market is ~20% the size of PJM), 3.4 GW of new capacity have cleared the auction over the last five years. Of this, around 2.4 GW are CCGTs
- By contrast, in GB, one new CCGT cleared the auction for 2018–2019, but it has not yet achieved financial close. The CCGT that cleared the 2019–2020 auction was Carrington, which has been under construction since 2013

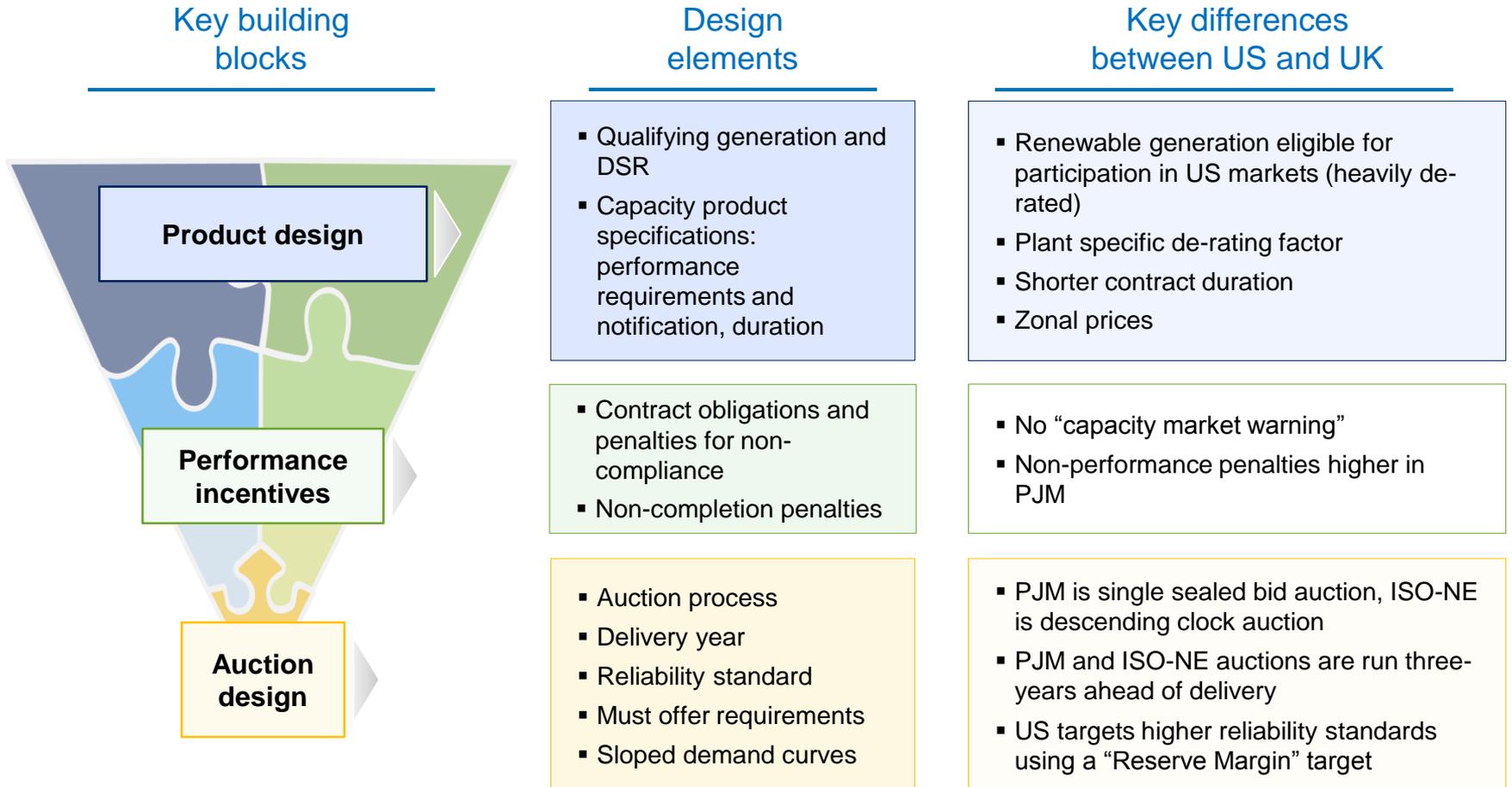
Cleared New Capacity



Cleared New CCGT Capacity



The GB capacity market drew on the US capacity markets, but there are significant differences in each of the key building blocks of market design

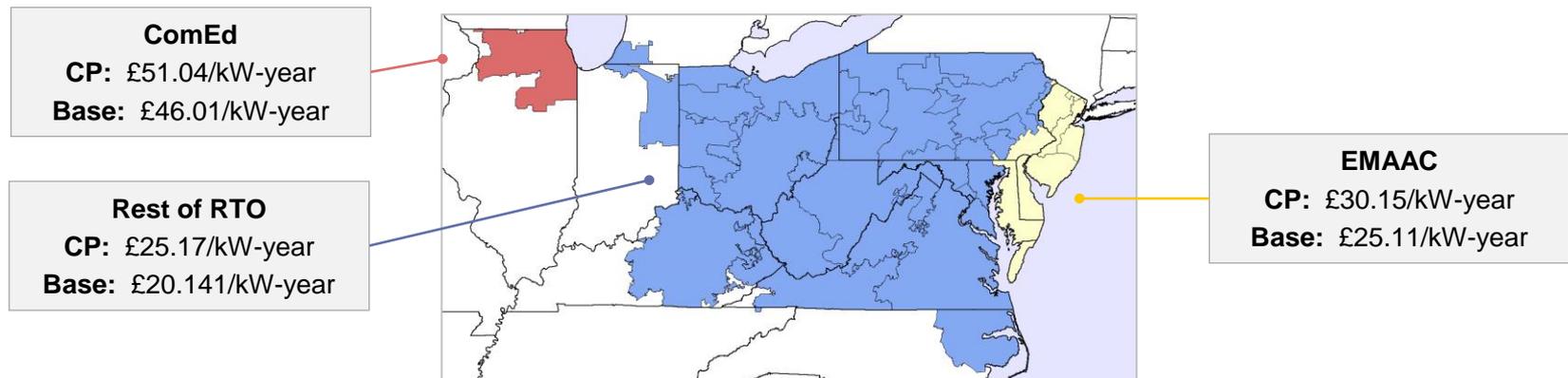


Some US-GB differences have a significant pricing impact

Locational requirements in GB would drive up prices in southern zones

CM Component	Design Considerations	US Experience
Locational requirement	<ul style="list-style-type: none"> Need to balance the increased competition possible through system-wide mechanisms with the locational requirements of reliability Parameters used to define constrained zones may be complex Methodology used to determine locational prices (e.g. separate auctions by zone or clearing algorithms) 	<ul style="list-style-type: none"> PJM and ISO-NE clear congested zones separately (Locational Deliverability Areas or LDAs) In PJM, when the system-wide clearing price does not attract sufficient resources to meet the requirements for a zone (inclusive of transmission imports), a locational price adder will reflect the price of the local resources that are needed

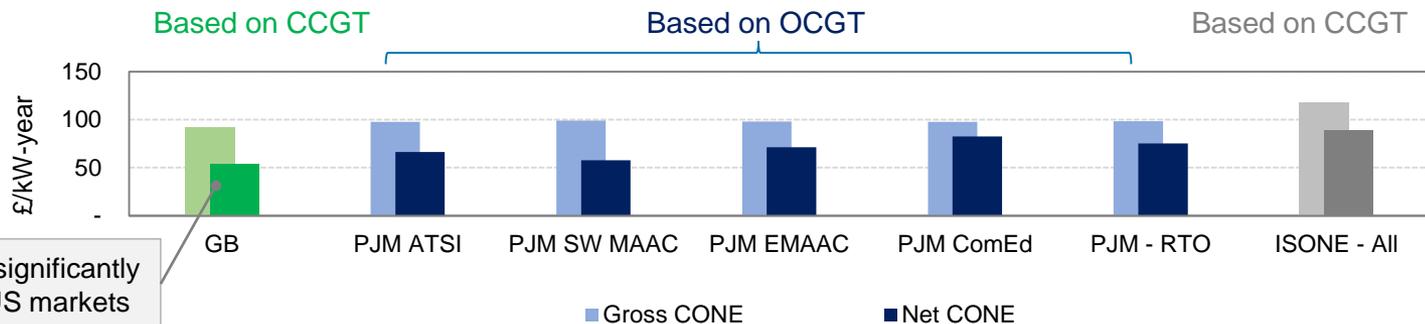
PJM Capacity Clearing Prices (2019–20)



Some US-GB differences have a significant pricing impact

DECC estimation of net CONE impacts slope of demand curve

CM Component	Design Considerations	US Experience
CONE	<ul style="list-style-type: none"> Cost of New Entry (CONE) represents the first-year total net revenue (net of variable operating costs) a new generation resource would need in order to recover its capital investment and fixed costs The difference between gross CONE and net CONE should reflect expected energy and ancillary services revenues The technology that is used as a benchmark for “new generation resource” dictates important parameters on the demand curve and CRM design 	<ul style="list-style-type: none"> The US ISOs typically used simple-cycle combustion turbines as the reference technology for CONE. However, recent proposals have suggested basing CONE on both the cost of an OCGT and CCGT <ul style="list-style-type: none"> ISO-NE now bases CONE on a dual-fuel combined cycle technology PJM still bases CONE on a simple cycle technology (dual fuel) Following consultations in 2014, GB moved from a proposed CONE based on OCGT to one based on CCGT a few months before the auction but it is unclear how Net CONE was then calculated



GB Net CONE significantly lower than in US markets

* Gross CONE for GB calculated by CRA using DECC's capital cost assumptions, 7.5% WACC and 20-years recovery.

Some US-GB differences have a significant pricing impact

System stress notification in GB makes participation lower risk for small-scale participants

CM Component	Design Considerations	US Experience
Capacity obligation	<ul style="list-style-type: none"> US obligation for base capacity is year-round There is no pre-notified system stress event 	<ul style="list-style-type: none"> PJM and ISO-NE have moved from a one settlement system based on yearly capacity payments with little or no penalties for non-performance, to a two settlement system with an initial capacity payment, adjusted with over or under-delivery payments Performance penalties are high in PJM but participants can use incremental auctions to adjust their exposure

Potential penalties for non-performance in PJM are higher

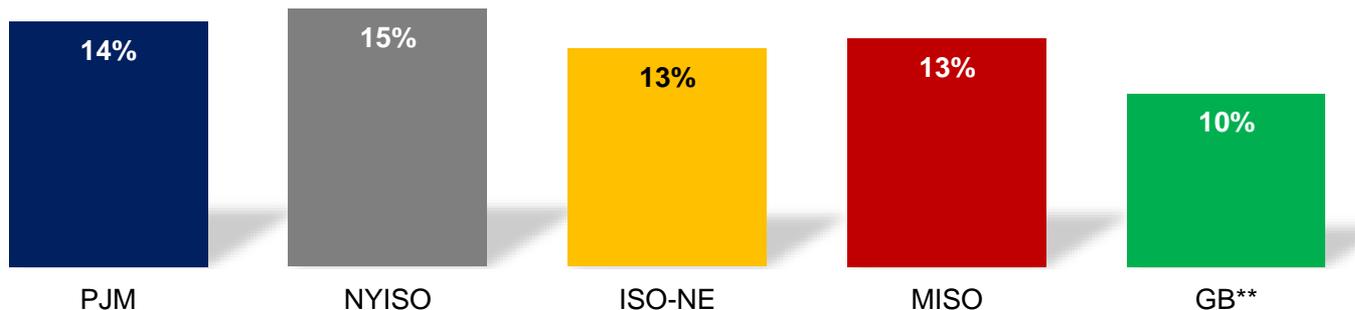
PJM	ISO-NE	GB
<ul style="list-style-type: none"> Penalty charge is Net CONE / 30 (~\$3,000/MW with significant regional variance); the PJM non-performance charge is capped at 1.5 x Net CONE annually 	<ul style="list-style-type: none"> Penalty charge transitions from \$2,000/MWh to \$5,455/MWh. In ISO-NE, the monthly limit is 2.5 x monthly capacity revenues and the annual limit is 12 months of capacity revenues 	<ul style="list-style-type: none"> Penalty charge is capacity clearing price / 24. The GB market caps potential losses at 200% of monthly revenues and 100% of overall annual revenues

Some US-GB differences have a significant pricing impact

Capacity requirements in GB anticipate tighter margins than in the US

CM Component	Design Considerations	US Experience
Capacity requirements	<ul style="list-style-type: none"> Choice of security standard <ul style="list-style-type: none"> Reserve margin/ capacity margin LOLE Estimation of plant performance (outage rates) Near-term vs. multi-year capacity requirements 	<ul style="list-style-type: none"> US capacity markets justify different security standards based on level of interconnection and largest contingencies US markets calculate plant-specific outage rates, while GB has gone with a generic outage rate approach Consistent over-estimation of forward capacity requirements was a persistent problem in the PJM market

Target Capacity Margin*



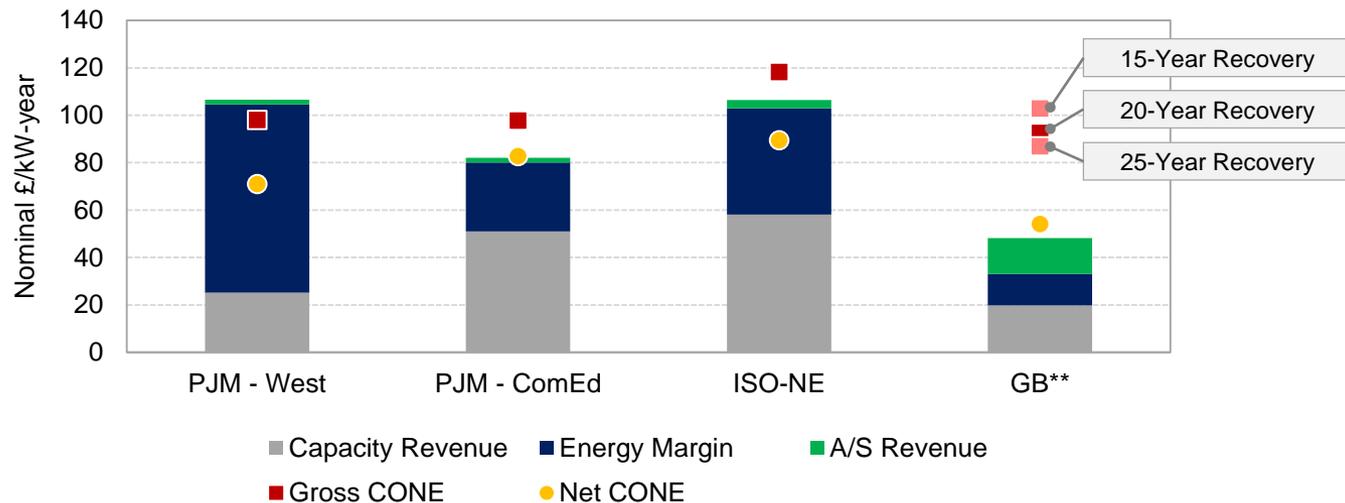
* All US capacity markets have Reserve Margin ((Capacity-Demand)/Demand) targets based on installed capacity. These have been converted to Capacity Margins ((Capacity-Demand)/Capacity).

** Based on our analysis of Ofgem and National Grid reports, GB's 3 hours LOLE reliability target roughly equates to a 10% Capacity Margin based on un-derated capacity.

New CCGT development is driven by *both* energy market fundamentals and capacity market revenues

- Energy margins for some CCGTs in PJM (particularly those with access to cheap gas from the Marcellus and Utica production regions) can expect energy gross margins in excess of Net CONE
- In other regions (like PJM-ComEd or ISO-NE), higher locational capacity prices help compensate for lower energy margins
- In contrast in GB, while capacity scarcity is expected to lead to increasing price volatility over the next couple of years, energy margins around 2019-2020 are expected to remain low due to growing renewable generation, increased interconnection, and gas-on-gas competition at the margin
- Low Net CONE values, low requirements from LOLE, lack of locational capacity prices and competition from distributed generation (subject to any reform of transmission charges) may further limit new CCGT development in GB

Expected Gross Margins for a CCGT in 2019/2020



* Indicative numbers for new representative CCGTs in each region

** Gross CONE numbers for GB calculated based on DECC latest cost of generation estimates

Incentives for GB investment can be enhanced by further capacity market reform

- Incentives for new CCGT development are a function of the combination of expected energy market revenues and capacity payments
- But differences in the design of capacity markets can by themselves materially impact the level of capacity payments

CM Component	Impact on Investment	US Experience
Reliability targets	<ul style="list-style-type: none"> ▪ Drives capacity demand 	<ul style="list-style-type: none"> ▪ Reliability targets are typically set higher in US markets
Net CONE	<ul style="list-style-type: none"> ▪ Used to determine the slope of the demand curve 	<ul style="list-style-type: none"> ▪ Net CONE higher in US markets driven by higher capital costs used to calculate gross CONE and lower energy and A/S revenue adjustments used to set net CONE
Resource participation	<ul style="list-style-type: none"> ▪ Number, type and size of competitors 	<ul style="list-style-type: none"> ▪ Distributed generation, load reduction and intermittent renewables eligible in US markets
Penalties and incentives	<ul style="list-style-type: none"> ▪ Risk of penalties to be factored into capacity market bid ▪ Competition limited to those confident in meeting contract obligation 	<ul style="list-style-type: none"> ▪ More stringent performance requirements in the US (performance assessed in retrospect without a 4-hour warning) ▪ Non-performance penalties in PJM can exceed capacity payments
Zonal prices	<ul style="list-style-type: none"> ▪ Higher value assigned to generation placed in constrained regions 	<ul style="list-style-type: none"> ▪ Unlike GB, the PJM and ISO-NE capacity markets have zonal capacity prices
Contract length	<ul style="list-style-type: none"> ▪ Length of fixed revenue stream can lower cost of capital 	<ul style="list-style-type: none"> ▪ New plant can opt for 3-year contracts in PJM, 7-year contracts in ISO-NE and 15-year contracts in GB

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