

Capacity Remuneration Mechanisms

Implementation issues and policies

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Reluctantly Locked-in to CRMs?

- CRMs have been a reluctant response to the missing money in wholesale energy returns for incumbent fossil generators
- And the missing money has been caused by subsidies for renewable technologies
- Scarcity pricing has not been enough because there is no scarcity
- Initially policy makers thought CRMs would be temporary to avoid incumbent asset impairments

- But as renewable subsidies finish, renewable owners now want capacity payments
- Investors like to see the fixed income element, as electricity projects become bond-like
- Debt rating agencies rate them positively

- As electricity get decommo­ditised and more like infrastructure finance, CRMs are here to stay
- Since this was caused by subsidies, will the emergence of zero subsidy renewables reverse this? *Unlikely.*

Ratings Effect

Press Releases in 2016:

**Moody's downgrades EDF's ratings to A2
outlook negative**

*“The outlook could be **returned to stable** provided... clarity develops on ...**capacity payments** that would support EDF's business model”.*

Moody's change ESB Baa1 outlook to Positive

*“The **capacity payment** mechanism also helps **stabilise** the group's generation earnings”*

Moody's affirms Viridian's stable B2 outlook

*“**downward pressure** would arise...if **adverse outcome**...affected ability to receive **capacity payments**”*

Drax 2017 Investor Relations Report

*“We announce the Group’s new strategyIt is designed to help us deliver a stronger, **more predictable, long-term financial performance**.. a project to build four new ..Open Cycle Gas Turbines (OCGT) power stations. Our intention is **only to go ahead** with building these plants **if we can secure an attractive capacity contract**”*



Capacity Payments have been Important in the US

Annual Value of Wholesale Electricity Markets



*Preliminary values
Source: ISO New England

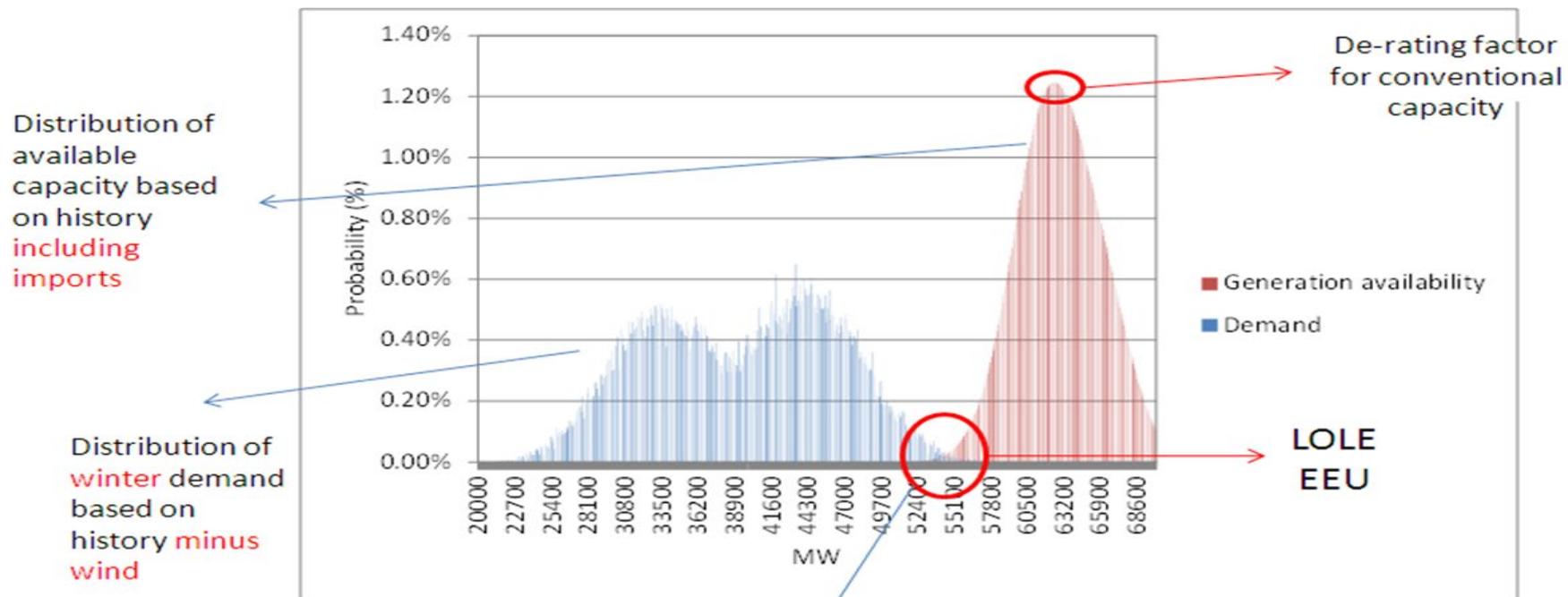
Profit Contribution ?

Locked-in Capacity Revenues Important aspect of Investor Disclosures

Capacity to Procure is Model and Policy Based

It should be simple.....

1. Project the installed capacity
2. Assess their reliabilities
3. Forecast Demand Uncertainty
4. Do the Simulations
5. Establish a Reliability Target

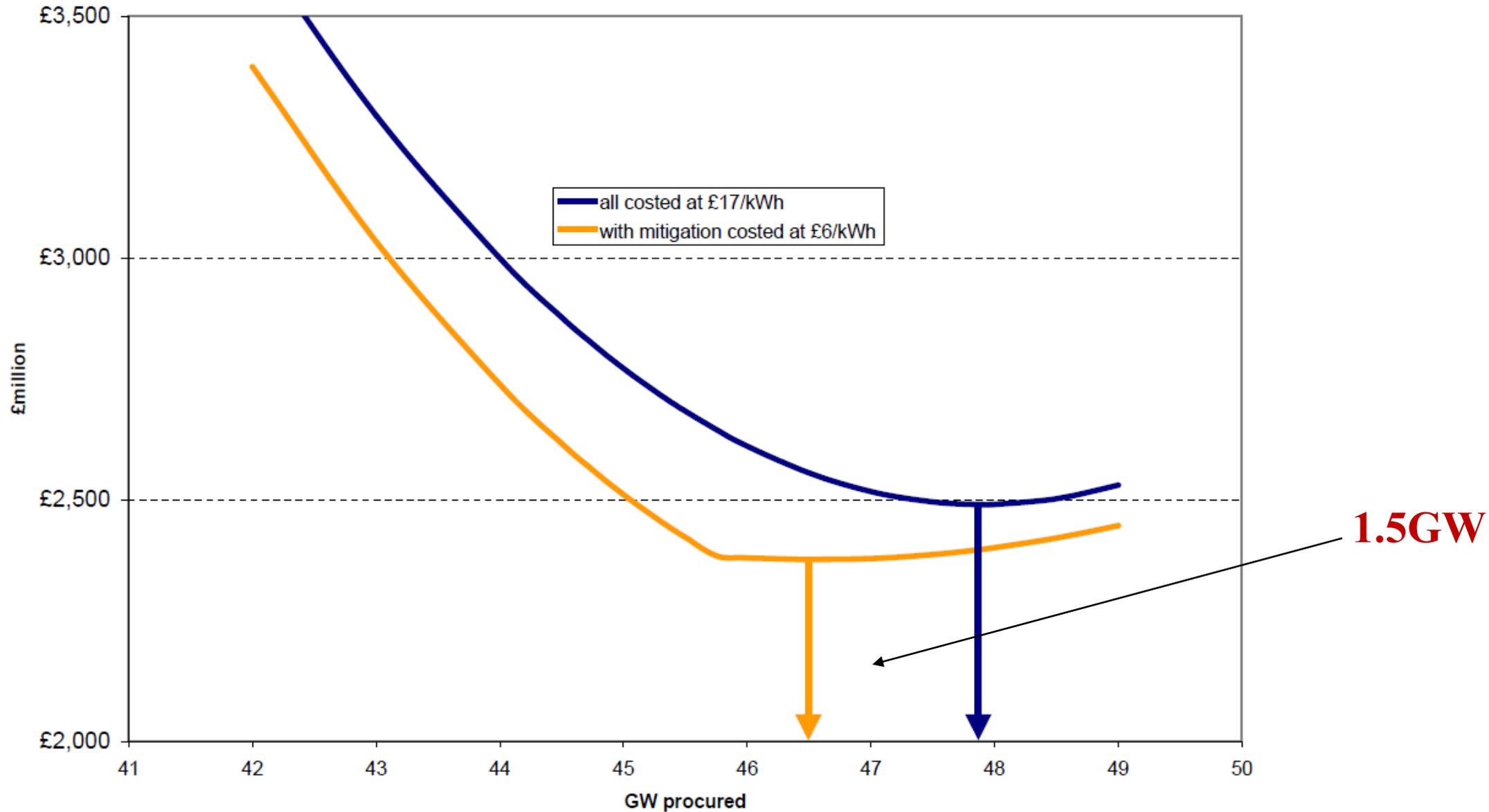


When this is realised, NG will take mitigation actions and controlled disconnections only occur when the mitigation actions are exhausted

Reliability Targets are Arbitrary

- ✓ How is the Target Policy expressed?
 - Loss of Load Expectation (**LOLE**) in hrs/yr eg 3 for GB, Fr, Bel, IT, PL, GR; 4 for NL, 5 for DE, PT; 8 for IE
 - Loss of Load Probability (**LOLP**): 1 event per 10 yrs in PJM, ISO-NE, NY ISO, MISO
 - Expected Energy Unserved (**EEU**): 0.002% annual demand in Australia
- ✓ How is it conceptualised?
 - As a standard
 - Using a Value of Loss of Load (**VOLL**)
 - In equilibrium: **LOLP*VOLL = Net Marginal New Entrant Cost**
 - But how to estimate VOLL and can it really be **one value**?
 - There is often a disconnect between **VOLL in wholesale trading** and **VOLL in capacity markets** (eg £6k and £17k in GB) Why?

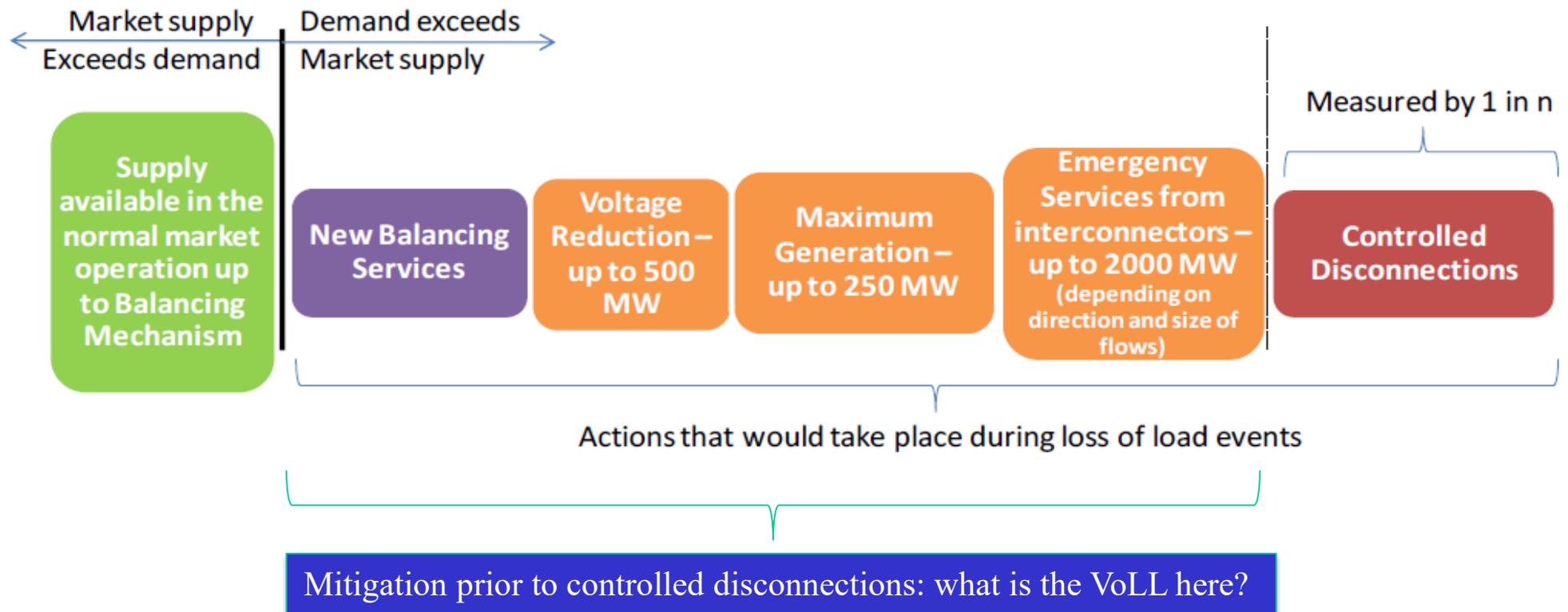
Sensitivity to a Lower VoLL: Expected Cost of Under and Over Procurement as a function of GW Procured



Sources: Blue line: Electricity Capacity Report, National Grid (Figure 14), 2015; Orange line: EMR Panel of Technical Experts' Final Report (Figure 2), PTE, 2015, with thanks to Andris Bankovskis

And LoLE is not Actually Expected Loss of Load

Entso-e look at adequacy in the traded wholesale energy market and do not include operational reserves (but curiously include “Replacement Reserves”)



Some Capacity Markets include some of these actions before LOLP, eg NY, NE, Denmark

Risk and Uncertainty

Historical Probabilities for Generation and Demand go into the simulations to produce LOLE: *But*

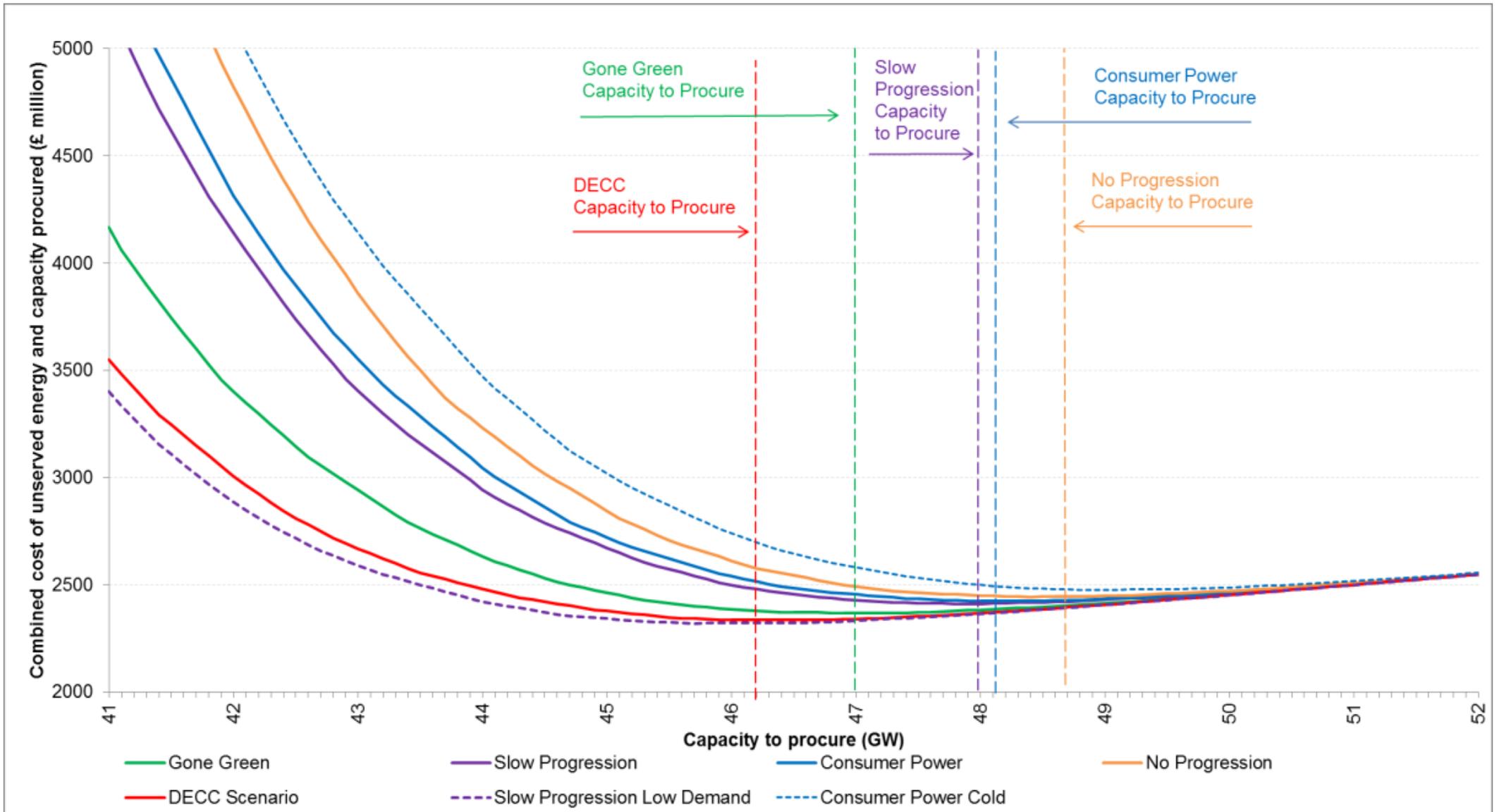
- **New** units and **Old** units are different
 - ❖ Units close to retirement do not get well-maintained
- **Interconnector Flows** are hard to model
 - ❖ Inter-regional models do not consider intra regional constraints
- **Weather data needs to be extensive**
 - ❖ Entso-e MAF 2019 gives LOLE for France of 4.1, based upon 35 climate year simulations, whereas RTE use 200 simulations and have $LOLE < 3$

Major Uncertainties in the Future have no probabilities:

- New build, retirements, EVs, batteries lead to multiple scenarios.

So the result is a set of **uncertain scenarios for LOLE** - *now what?*

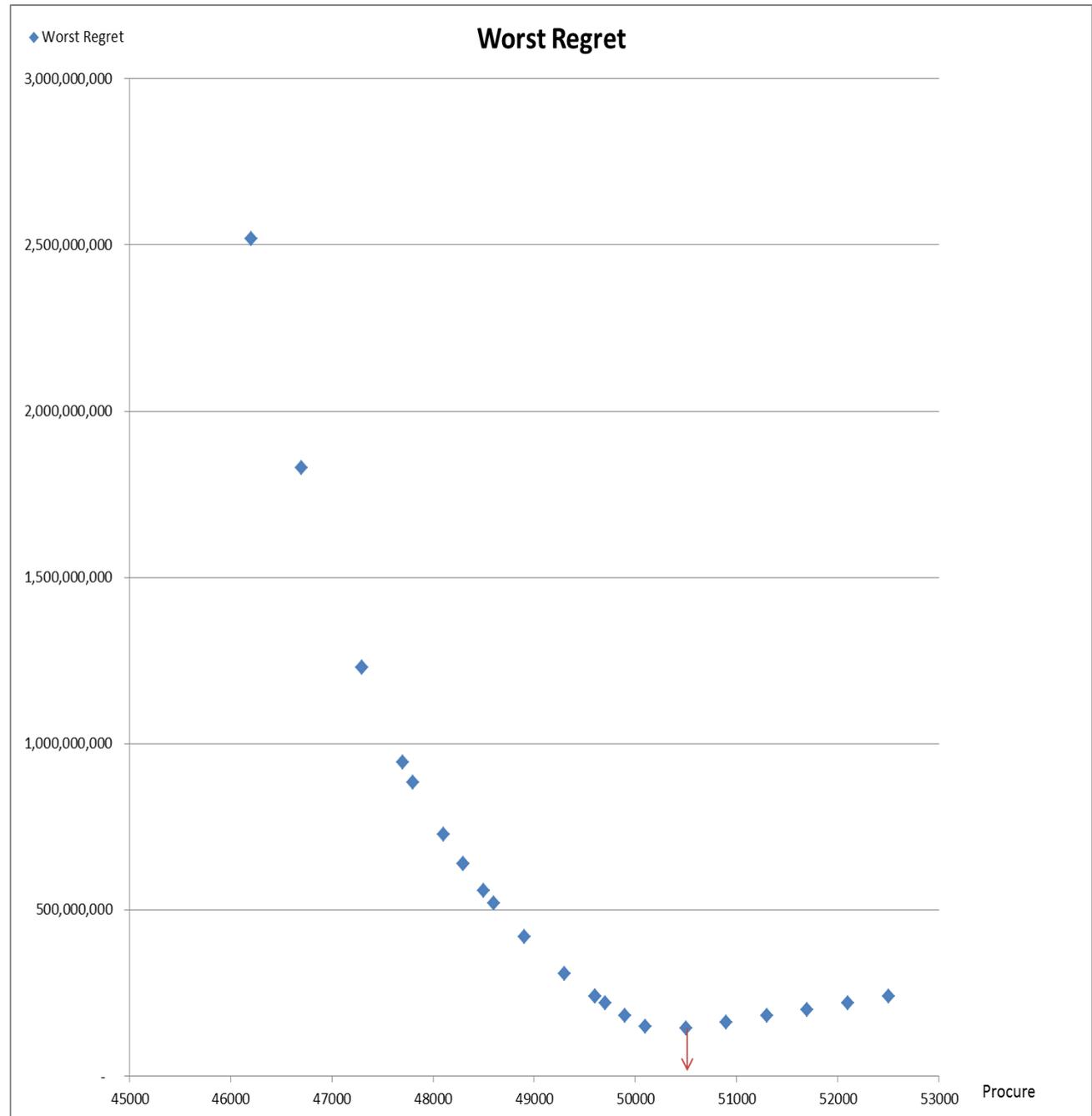
The Various Scenarios have Optimal Procurements



GB uses Least Worst Regret (LWR)

- For each scenario determine the cost of meeting the LOLE < 3hrs target
- For all scenarios compute the maximum regret if any of the other scenarios occurred
- Plot these worst regrets against capacity to procure
- Select the minimum

Evidently its rationale depends upon selecting a representative spread of scenarios.



Auctions and Contracts

- Annual Auction for new and existing plant.
- **Derating factors** applied to indicate expected availabilities: but how to derate:
 - Interconnectors
 - Embedded distributed resources
 - Storage
 - Wind
- Auctions are often **4 years ahead** to allow new build
- But also **1 yr ahead** is useful to maintain existing facilities.
- In GB, new plant get 15yrs, existing 1yr
- But then what does VOLL and LWR at t-4 auction mean if it can be corrected at t-1 auction?
 - *After 5 years in GB, the risk averse nature of LWR at t-4 is leading to negative requirements at t-1, and that is a policy headache.*

Auction Results

> 1st Auction cleared at £19.40/kW

> 2nd Auction cleared at £18/kW

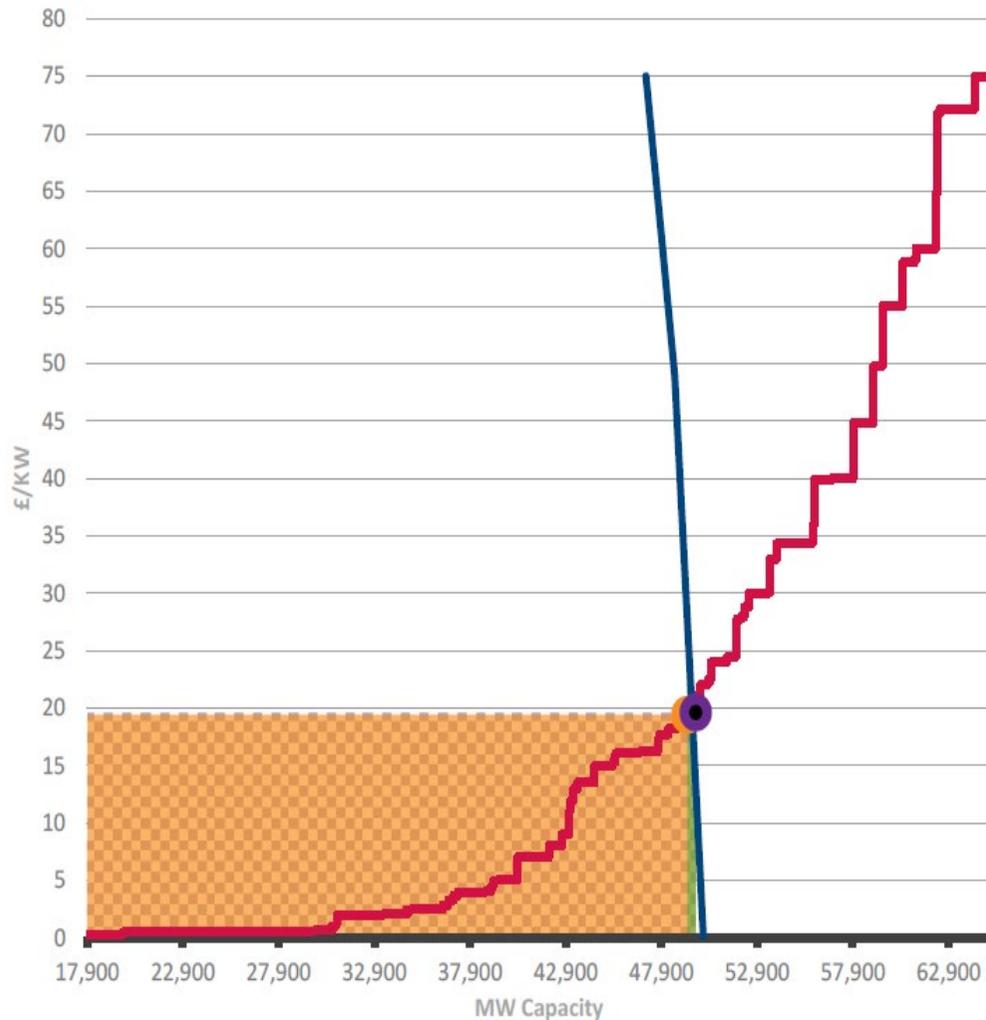
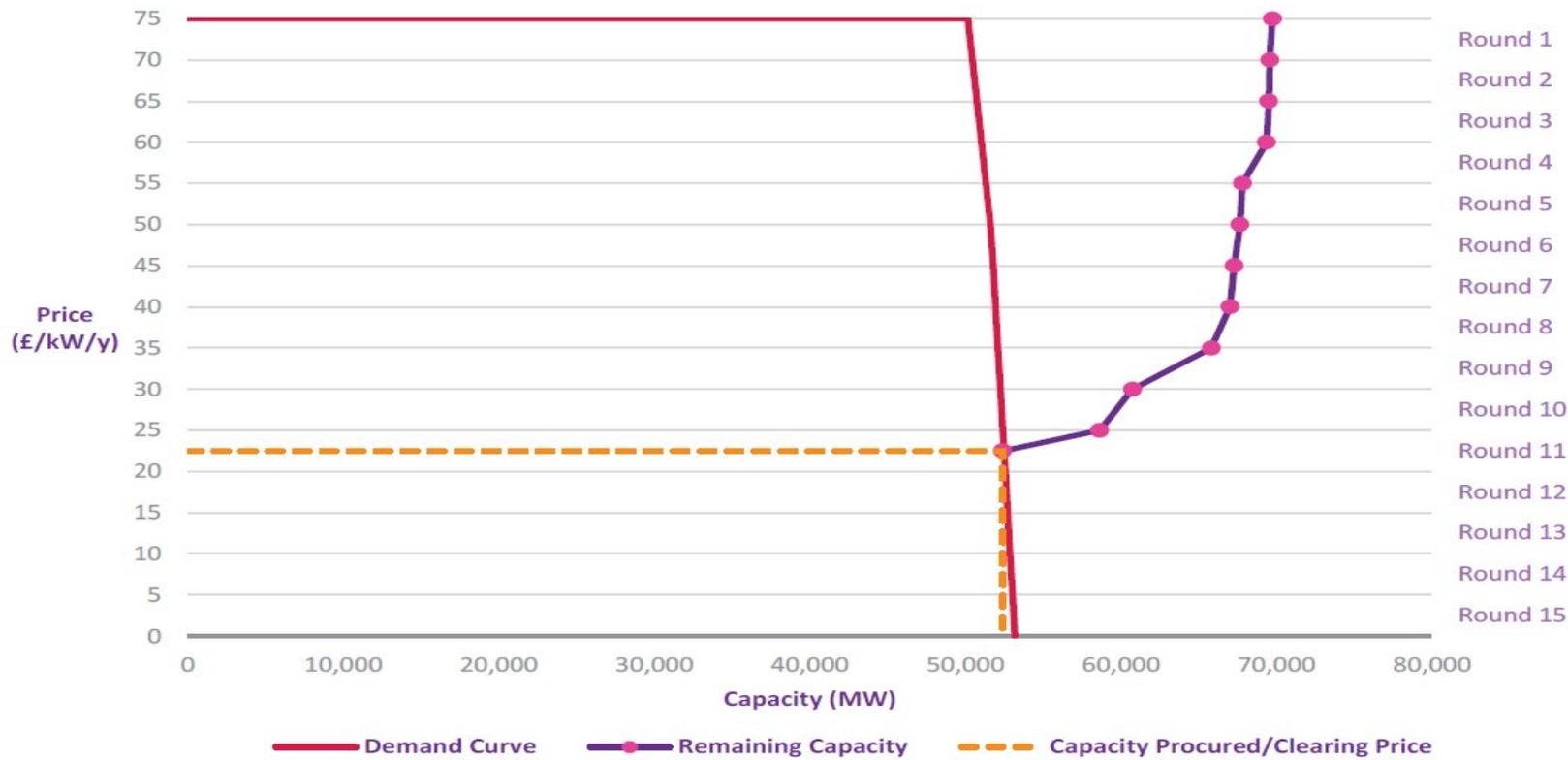


Figure 1: Demand and Possible Supply Range



Then 2016 revealed and emerging concern: too many small diesel units



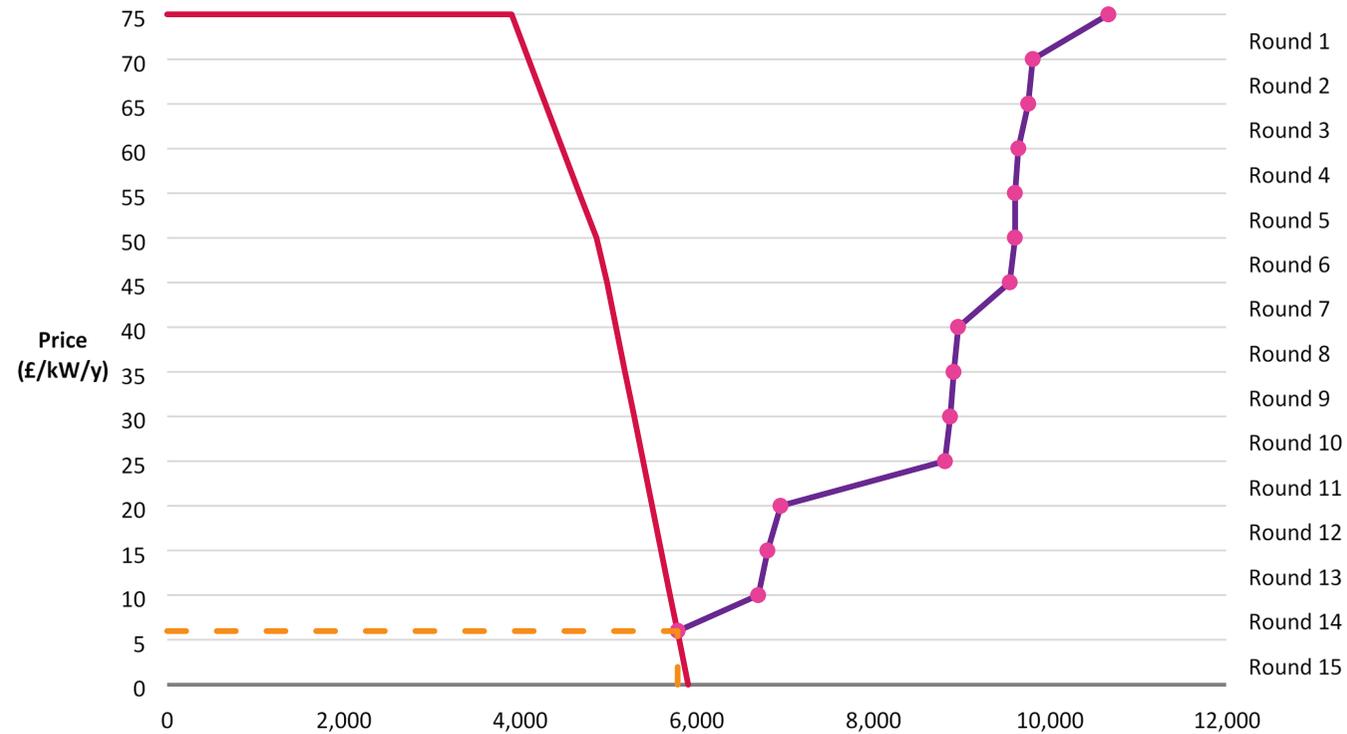
Too Many
small carbon
intensive units
and unproven
DSR

CMU Type	Capacity (MW)	%	No. of CMUs	%
Existing Generating	44,464.301	84.81	243	50.31
Existing Interconnector	2,342.100	4.47	4	0.83
New Build Interconnector	0.000	0.00	0	0.00
New Build Generating	3,412.520	6.51	129	26.71
Proven DSR	44.068	0.08	8	1.66
Refurbishing Generating	173.322	0.33	2	0.41
Pre-Refurbishment	622.106	1.19	8	1.66
Unproven DSR	1,366.885	2.61	89	18.43

In Conclusion

- ✓ CRMs are **here to stay**
- ✓ Electricity Investment is now part of **Infrastructure Finance**
- ✓ **Auctions work well** with policy to achieve required quantities at competitive price
- ✓ Establishing the Capacities to Procure
 - Needs to become more **computationally intensive** to deal with **weather interactions**
 - Understand **EVs, Batteries, Interconnectors and Distributed Resources**
 - Resolve its **LOLE, VOLL, EEU and Decision Criteria**

2017 T-1 Auction clears at £6/MWh



Again, a lot of small facilities

Thus for 2018, procurement was:

CMU Type	Capacity (MW)		%		No. of CMUs	
	T-4	T-1	T-4	T-1	T-4	T-1
Existing Generating	31,398.07	4,692.291	66	80.93	168	111
New Build Generating	942.64	657.819	2	11.35	73	66
Proven DSR	8.23	85.009	0	1.47	2	9
Refurbishing Generating	15,016.85	0.000	32	0.00	44	0
Pre-Refurbishment	0.00	4.741	0	0.08	0	1
Unproven DSR	162.36	358.354	0	6.18	12	32

Footnote: trials on Including Energy Efficiency proved Expensive

- Whilst DSM has been efficiently included
- And US auctions include energy efficient investments (PJM has 1GW)
- GB and others have been slow to include EE
- Separate Auctions in 2015, 2016 cleared at £229/kW, £203/kW
- Mostly for lighting.
- Only a 1yr award and perceived as a “sweetener”