Capacity Remuneration Mechanisms

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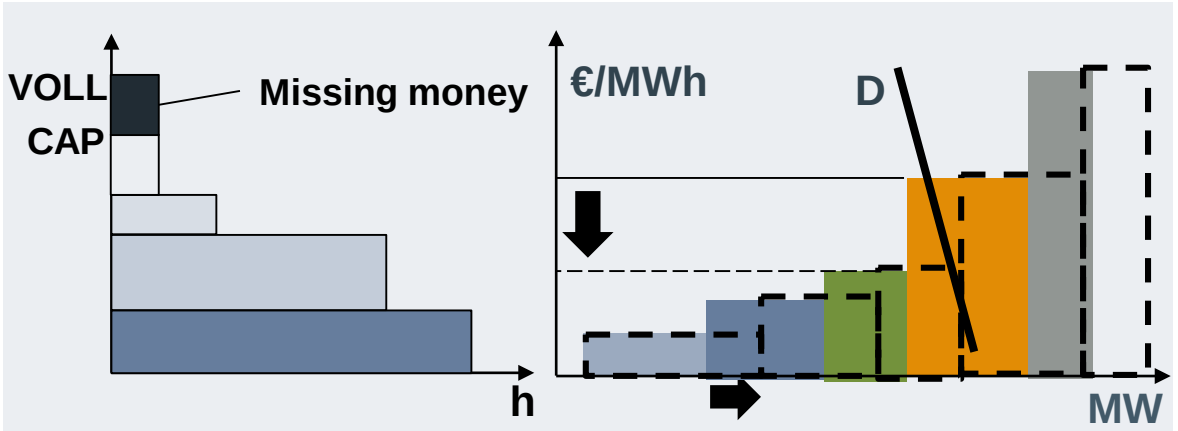
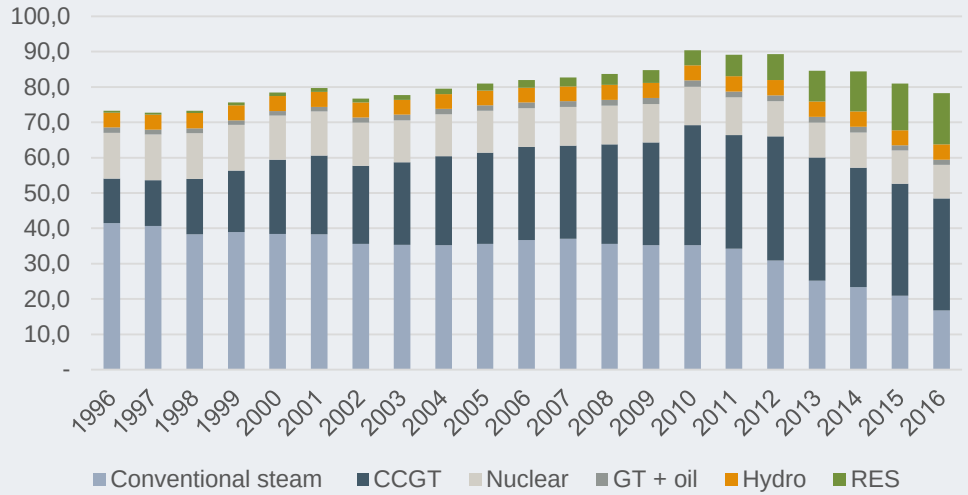
“Missing money”

- **How to “Create a stable regulatory and market framework, capable of attracting investment” + “Develop Network Energy market competition”?**
- **Fears that**
  - Reliance on market prices leads to cyclical periods of under and over-capacity and price volatility
  - Price caps below VOLL to avoid price surges disincentivise required investment as fixed costs of marginal units cannot be recovered
  - Merit order effect from promotion of RES may reduce space for new investment in conventional plants, eg in the UK market no new large CCGTs built for many years

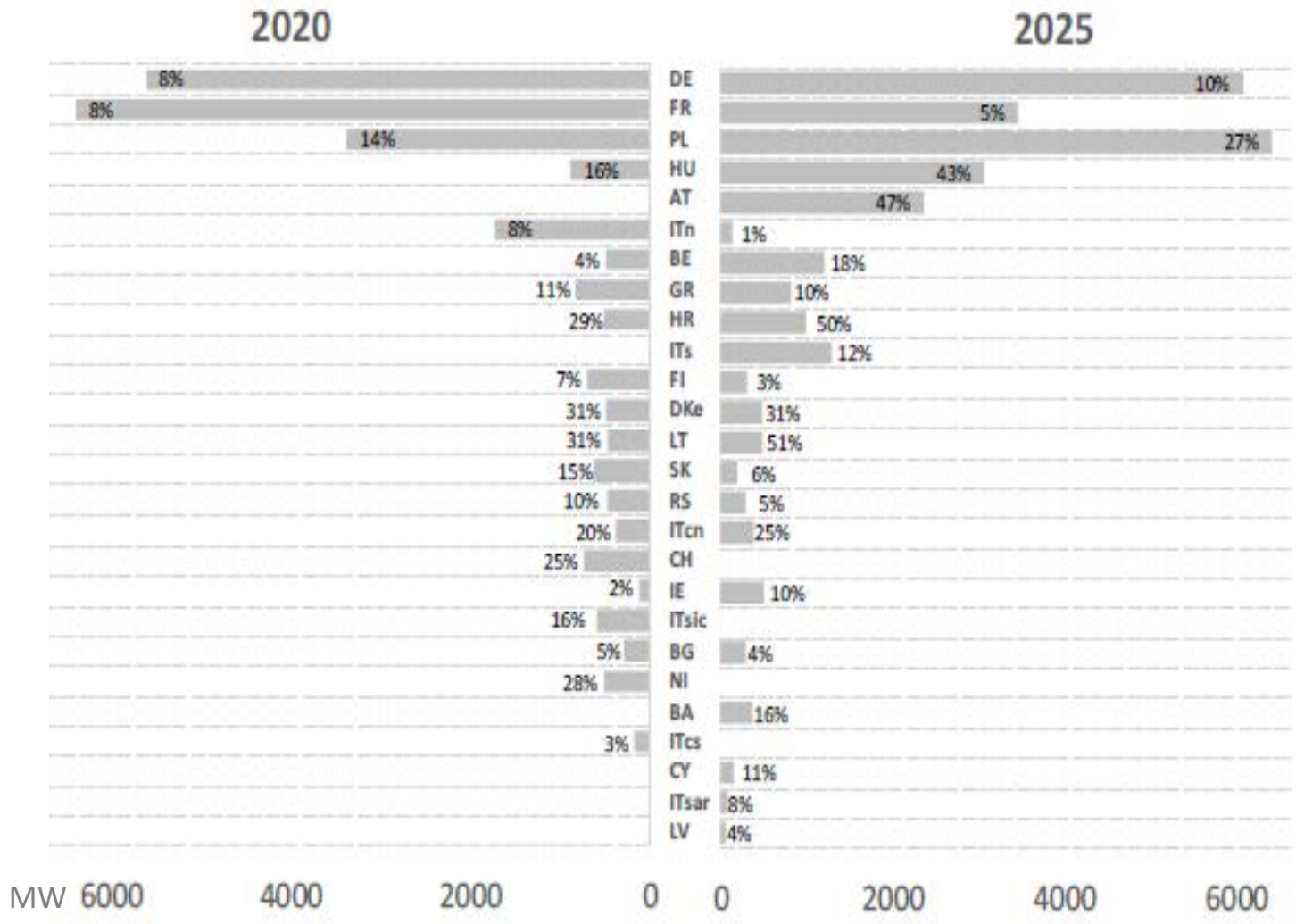


Plant capacity in the UK (GW)

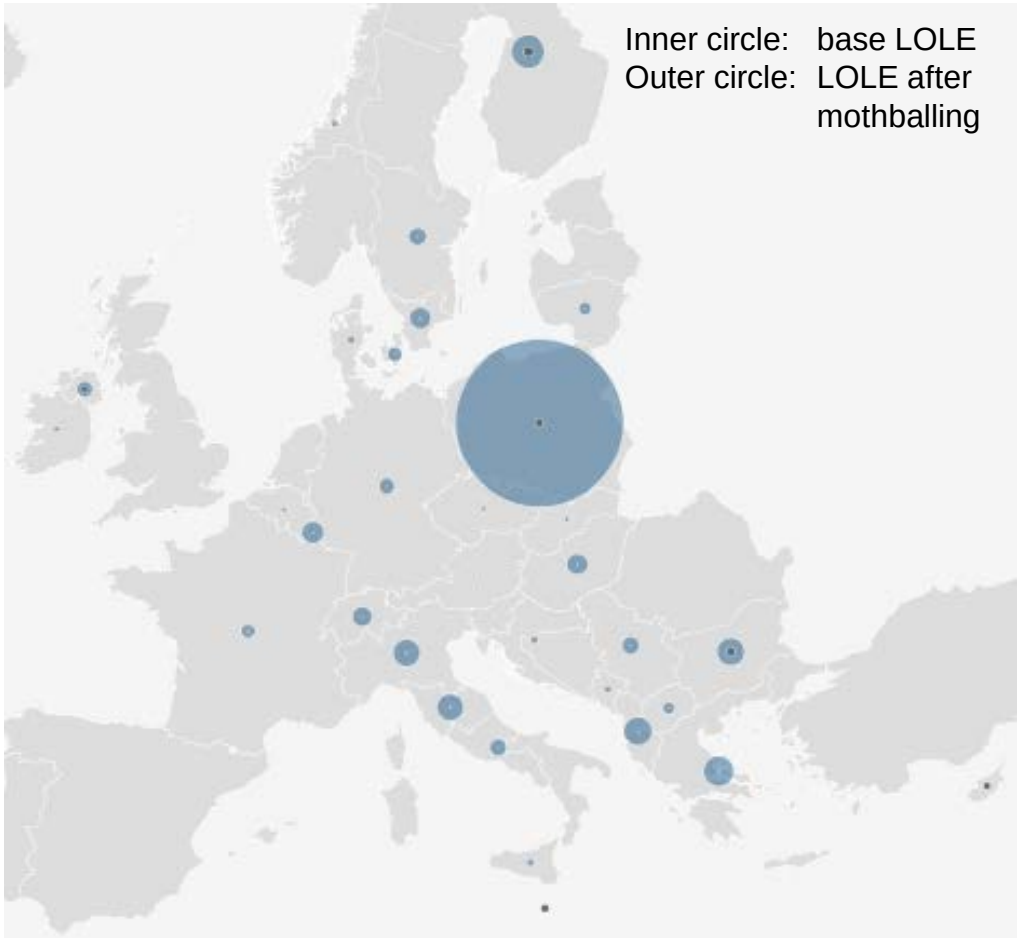


Source: Digest of UK Energy Statistics (DUKES), 2017

The risk of generator “mathballing”



The impact of average mothballing on LOLE in 2020



Source: ENTSO-E, Mid-term adequacy forecast, 2017 Edition

Any type of “Capacity”?

- **Power generation not equally fast, neither equally sustainable among different technologies**
  - Hydro: fast / restricted by dam size
  - Coal plant: slow / sustainable
  - Diesel, open cycle gas turbine: fast / sustainable (expensive)
  - Batteries: very fast / not sustainable
- **Different type of capacity needed or appropriate to follow load, or provide reliability margin**
- **Part loading, load following and plant cycling have an impact on efficiency, emissions, and power plant life**

Flexibility of Conventional Power Generation Technologies

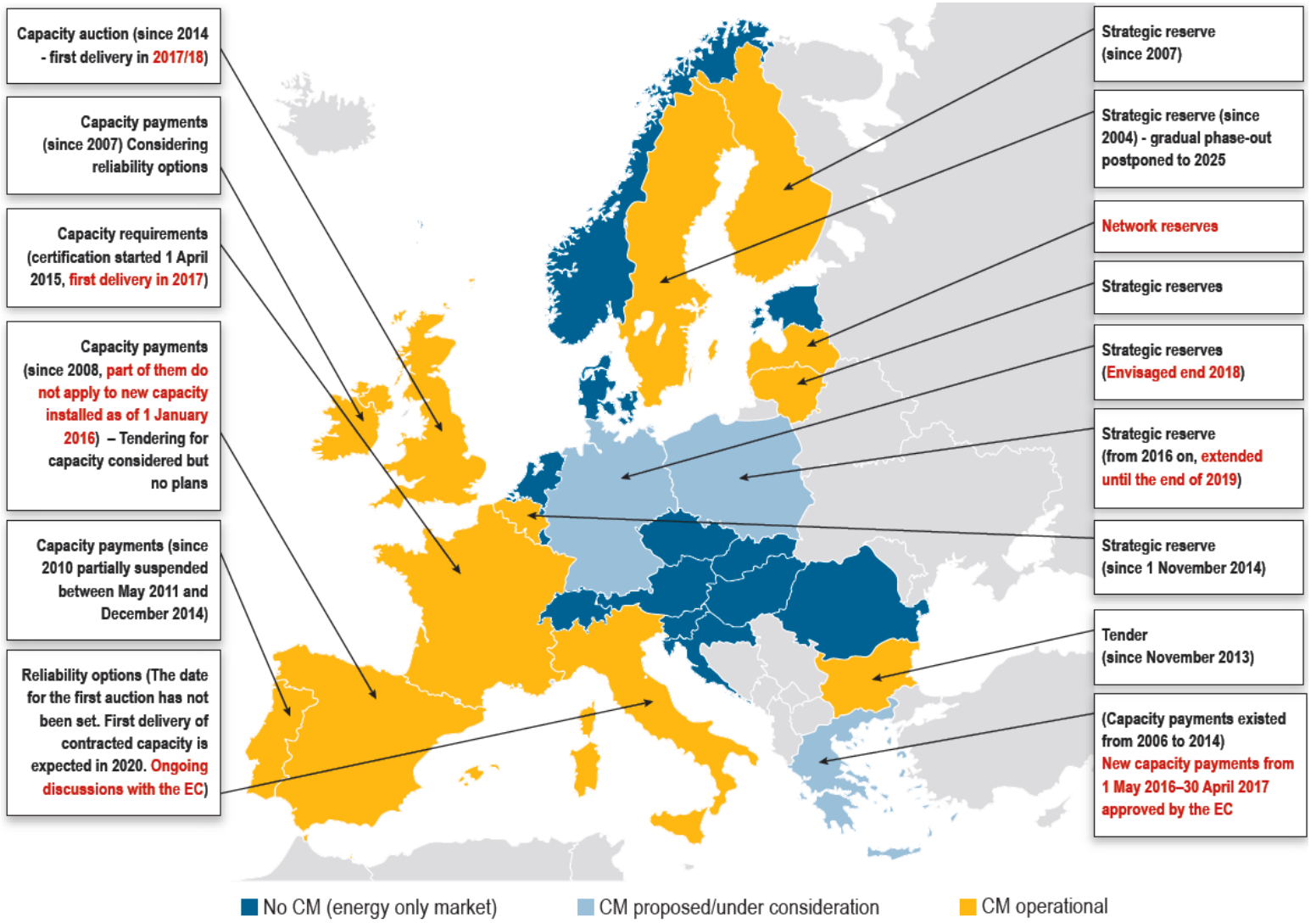
	Nuclear	Hard coal	Lignite	CCGT	Pumped storage
Start up time “cold”	~40h	~6h	~10h	<2h	<0.1h
Start up time “warm”	~40h	~3h	~6h	<1.5h	~0.1h
Load Gradient (±% of Nominal Output)	~5%/min	~2%/min	~2%/min	~4%/min	>40%/min
Minimal Shutdown Time	NO				~10h
Minimal Possible Load	50%	40%	40%	<50%	~15%

Source: Flexible Generation: Backing up Renewables, 2011, EURELECTRIC

Capacity Remuneration Mechanisms in the EU

"Member States proposing capacity mechanisms should make appropriate efforts to address their resource adequacy concerns through market reforms. In other words, no capacity mechanism should be a substitute for market reforms" (EC, Final Report of the Sector Inquiry on Capacity Mechanisms, 2016)

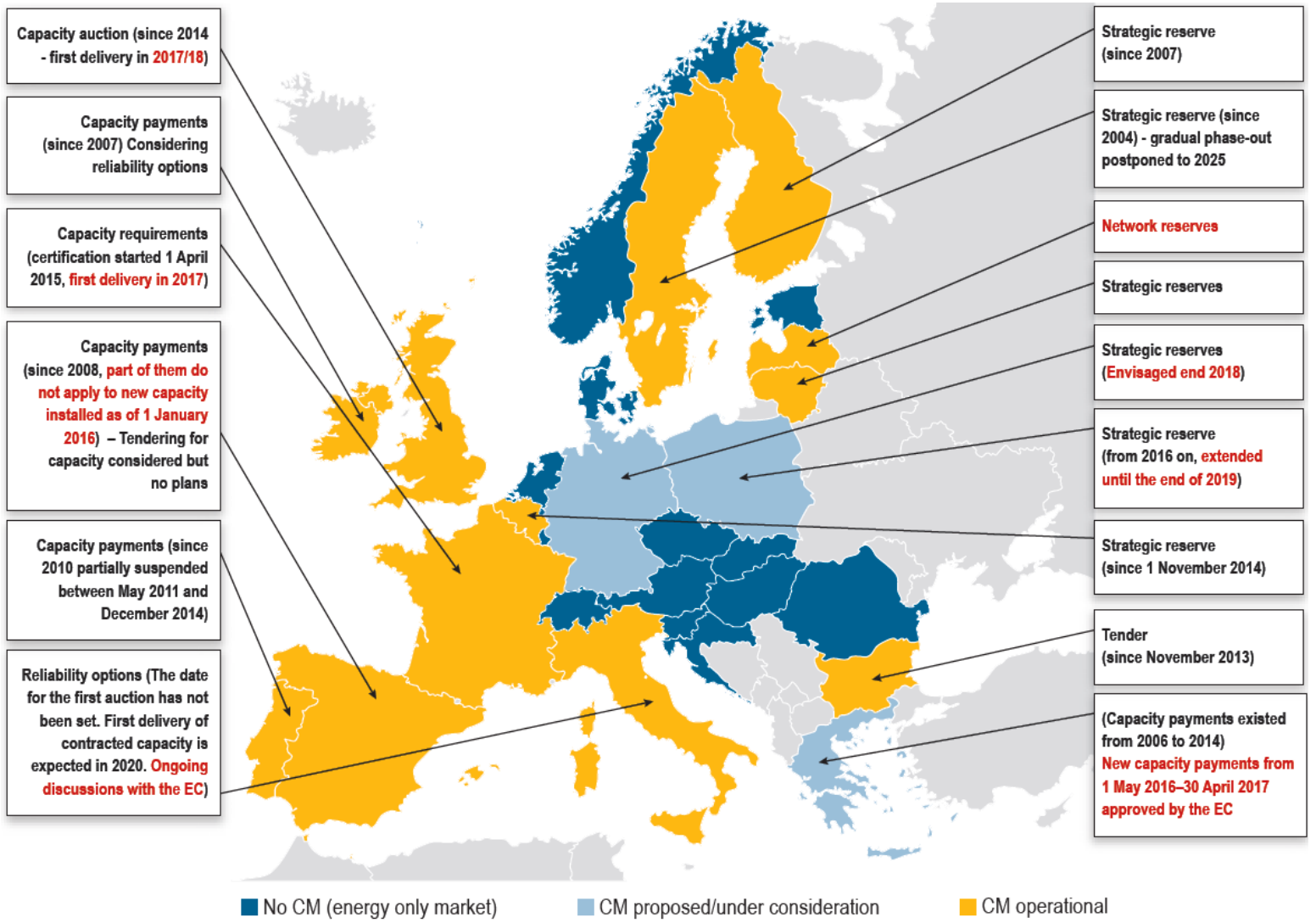
- **35 CRM in 11 MS**
  - Volume based: Targeted – Market-wide
  - Price based
- **Use of interconnectors?**



Source: ACER, Annual report on the results of monitoring the internal electricity markets in 2016

Capacity Remuneration Mechanisms in the EU

- **Capacity Payments**
  - TSO pays fixed amount for firm capacity to all
- **Capacity Market**
  - **Capacity obligations** imposed on suppliers relative to their contracted or expected supply, or
  - **Capacity auctions.** Costs allocated to suppliers pro rata, or through tenders. Firm or option contracts, eg **reliability options**
- **Strategic Reserves**
  - Tenders for required capacity. Long term. Withdrawn from wholesale market. Only activated if DAM is unable to cover demand



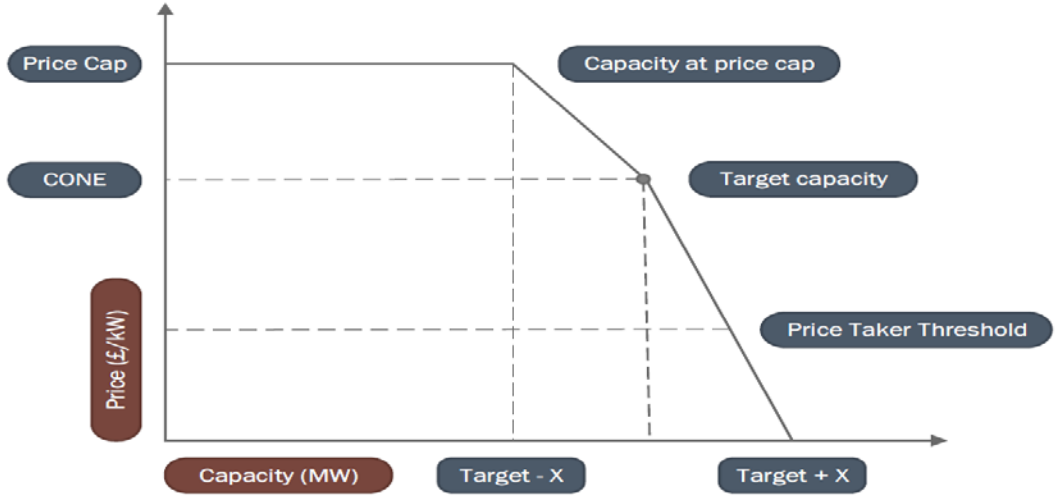
Source: ACER, Annual report on the results of monitoring the internal electricity markets in 2016

The UK capacity market – auction design

- **Central auction**
  - Primary auction (T-4) 4 years ahead of delivery year
  - T-1 for fine tuning
- **Market wide - participants**
  - Generation
  - Demand Side Response (DSR)
  - Storage
- **Capacity not withdrawn from wholesale market**
- **Contract duration:**
  - New plant up to 15 years
  - Refurbished above a threshold 3 year
  - Existing plant, DSR, etc 1 year
- **Penalties for non availability of capacity providers in the delivery year**
- **Costs of capacity shared between suppliers**
- **Eligibility – excluded facilities:**
  - Under short term operating reserve contracts
  - Receiving support (FiT, RHI, ROO, NER300, CCS) and low carbon
- **Reverse auction, pay as clear (clearing algorithm maximizing consumer welfare)**

The UK capacity market – auction parameters

- **Capacity to target annually**
  - Electricity Capacity Report (NG),
  - Independent Panel of Technical Experts
  - Reliability standard = 3 h of LOLE/y
- **Net Cost of New Entrant**
  - after accounting for wholesale and ancillary market revenues
  - Reference technology (from OCGT in 2013 to CCGT in 2015)
  - Capital, O&M, expected operating performance
  - NetCONE = 49 £/kW-year
- **Price cap** (netCONE estimate uncertainty)
  - 1.5 x netCONE = £75/kW-year



Source: OFGEM

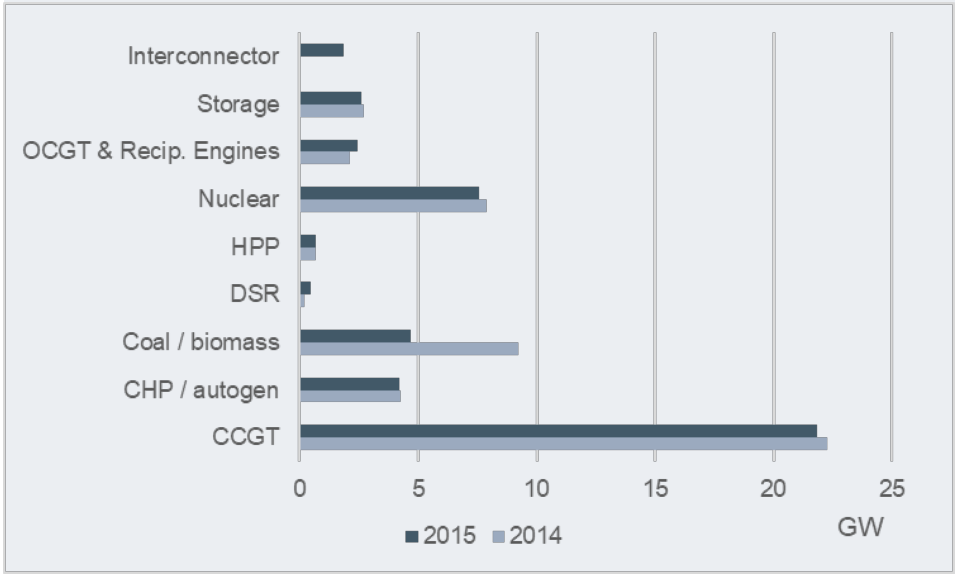
- **Price-taker threshold**
  - Cover majority of existing plant, so that total revenues (from wholesale market, AS and CM combined) do not significantly exceed that of a competitive outcome
  - £25/kW (50% of netCONE)
- **Capacity tolerance** (anti-gaming)
  - Target capacity ± 1.5 GW

The UK capacity market – problems, calibration

- **Plenty of diesel units, increasingly batteries, but only 2.6 GW of new CCGT in 2014, very low DSR**
  - Of which, the only one 15-year contract (Trafford) withdrawn in 2016 due to lack of financing.
  - Low capital costs, fast response, benefitting from other revenue streams (eg, avoided transmission costs)
- **Review in 2016**
  - Removal of double payment for Capacity Market Supplier Charge providing unfair advantage to small scale embedded generators
  - New emission limit rules penalizing mainly diesel generators
  - Derating for limited sustainable delivery period (eg 60-minute batteries)
  - Eligibility threshold reduced to 500kW to enable a wider range of DSR resources enter the 2017 TA

Date	Type	Delivery from	Contracted	Clearing price (£/kW)
Dec 2014	T-4	2018/19	49.3 GW	19.4
Dec 2015	T-4	2019/20	46.35 GW	18
Jan 2016	TA	2016/17	803 MW	27.5
Dec 2016	T-4	2020/21	52.42 GW	22.5
Feb 2017	T-1	2017/18	53.6 GW	6.95
March 2017	TA	2017/18	312 MW	45

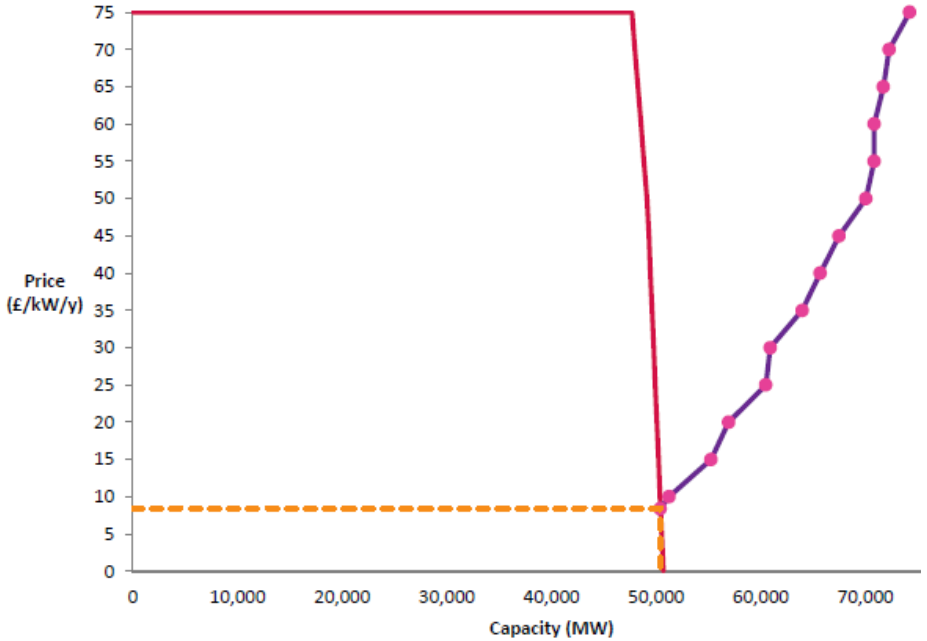
Source: EMR Delivery Body



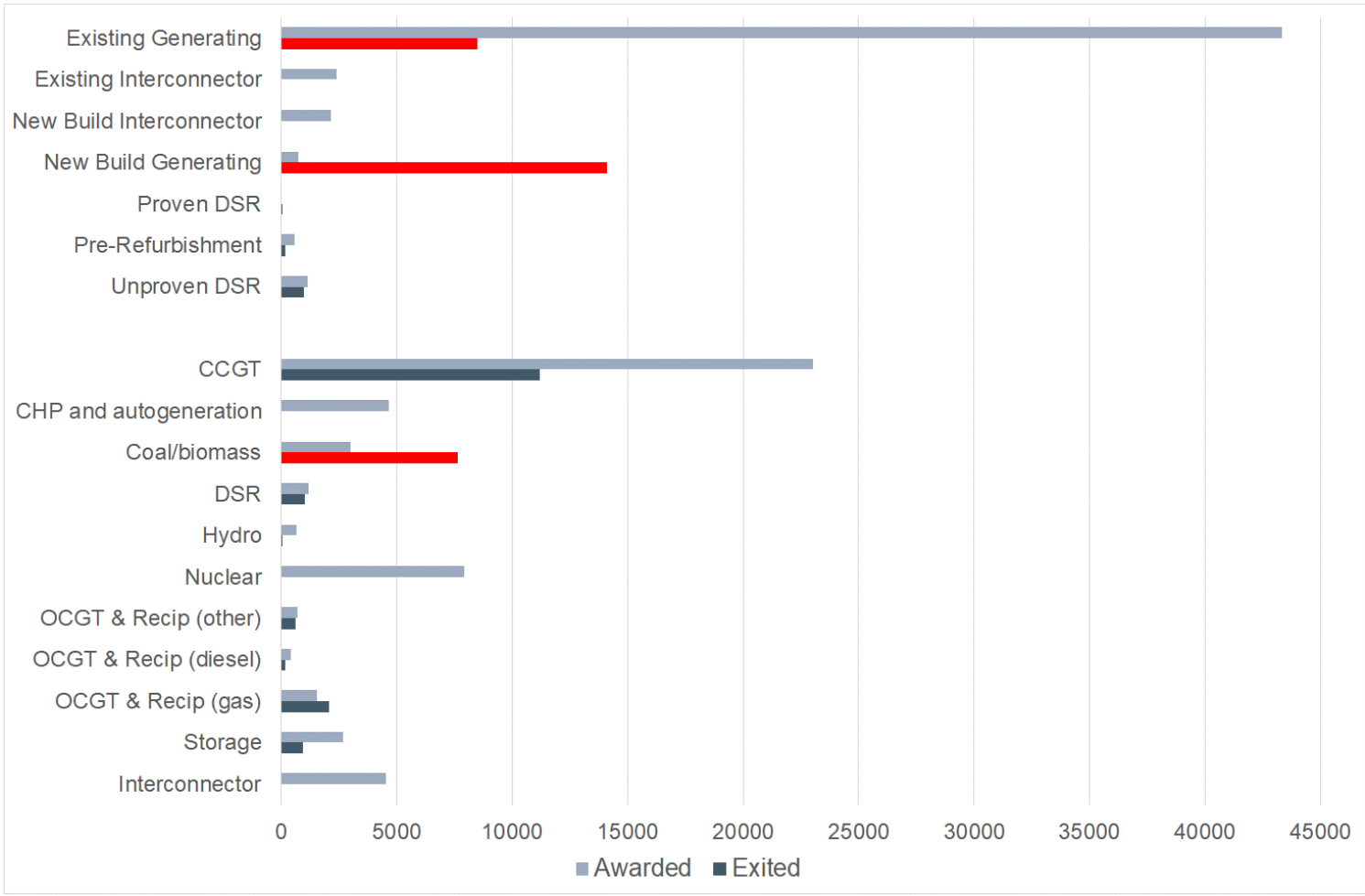
T-4 capacity auction, 2018 (delivery 2021-22): record low price

- Clearing price 8.40 £/kW
- 50.4 GW awarded
- 8 GW of coal not awarded
- 14.1 GW of new generation not awarded

Demand and possible Supply range



Awarded and exited capacity by type and technology



Source: National Grid, Provisional auction results T-4 Capacity market auction for 2021/22

The UK capacity market – concerns, criticism

- **Prices too low to incentivise major investments, especially in CCGT**
- **Market pays existing plant, which may be already amortised and would have remained in operation even without the capacity payment (eg coal plants)**
  - Open to existing capacity
  - Payments at marginal price
  - **Alternative:** only contract for existing capacity needed for security and would otherwise close (eg the short term operating reserve [STOR] payment to coal plants); and procure new capacity
- **Procurement of peaktime capacity, rather than firm energy**
- **Alternative:**
  - Procure a given amount of energy delivery over time, through distributed load obligation, capacity payments, or a reliability option.
  - Underlying requirement: firm generation (based on a probabilistic calculation across the full supply curve) according to its ability to offer firm energy across the year, not just at peak
- **(Or leave it to the market…)**

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