

Costly Externalities in the Transition to Renewables: Resource Adequacy

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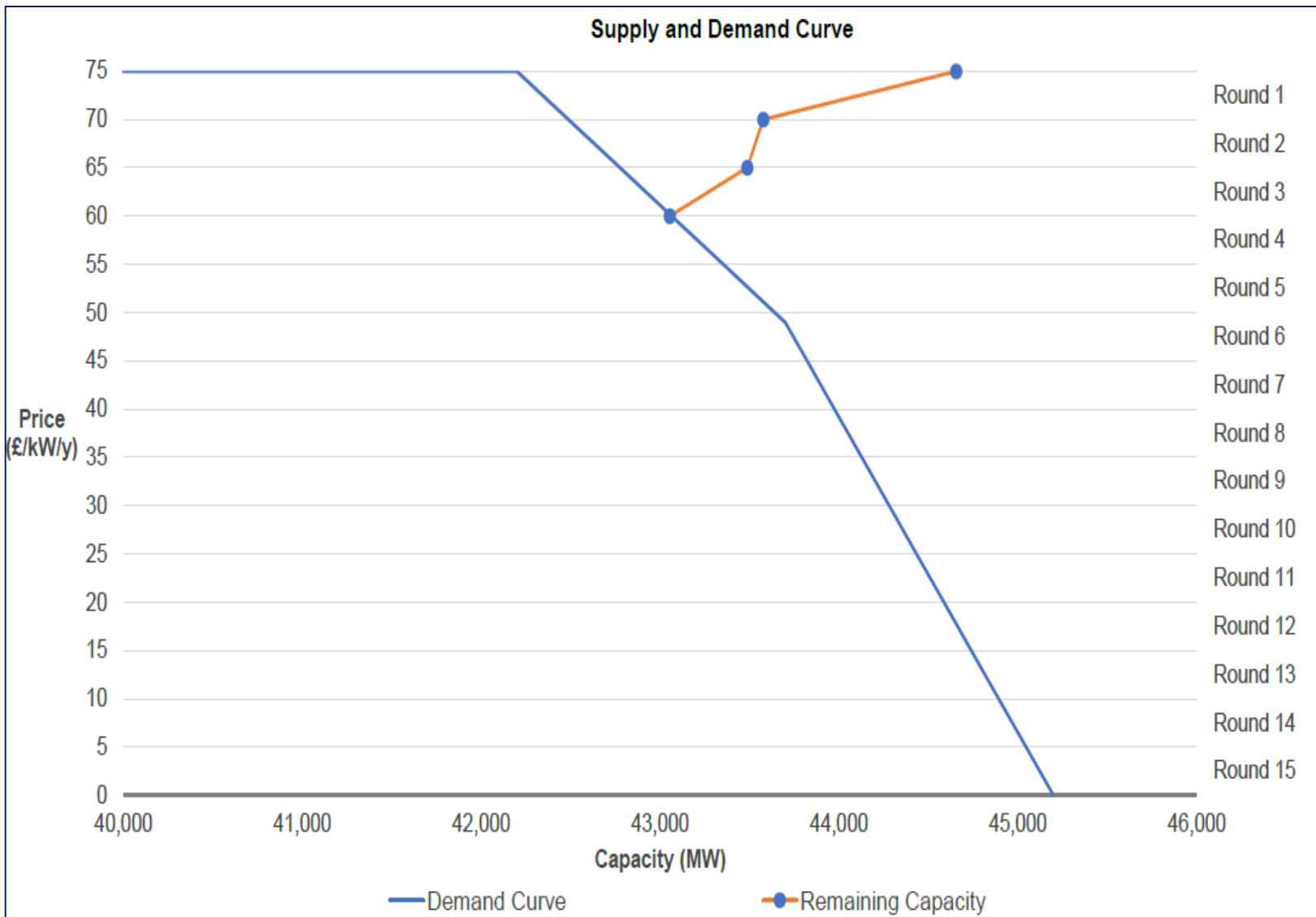
Renewables have created a greater need for Capacity Markets

- ✓ The EU has gradually accepted the inevitability of capacity payments
- ✓ Annual auctions for procurement are becoming more common
- ✓ EU policy was initially to be technology neutral...

The Standard methodology:

1. Project the installed capacity
2. Forecast Demand & Supply Uncertainties
3. Run extensive Monte Carlo simulations of risk of Loss of Load
4. Apply a Reliability Standard
5. Run an Auction

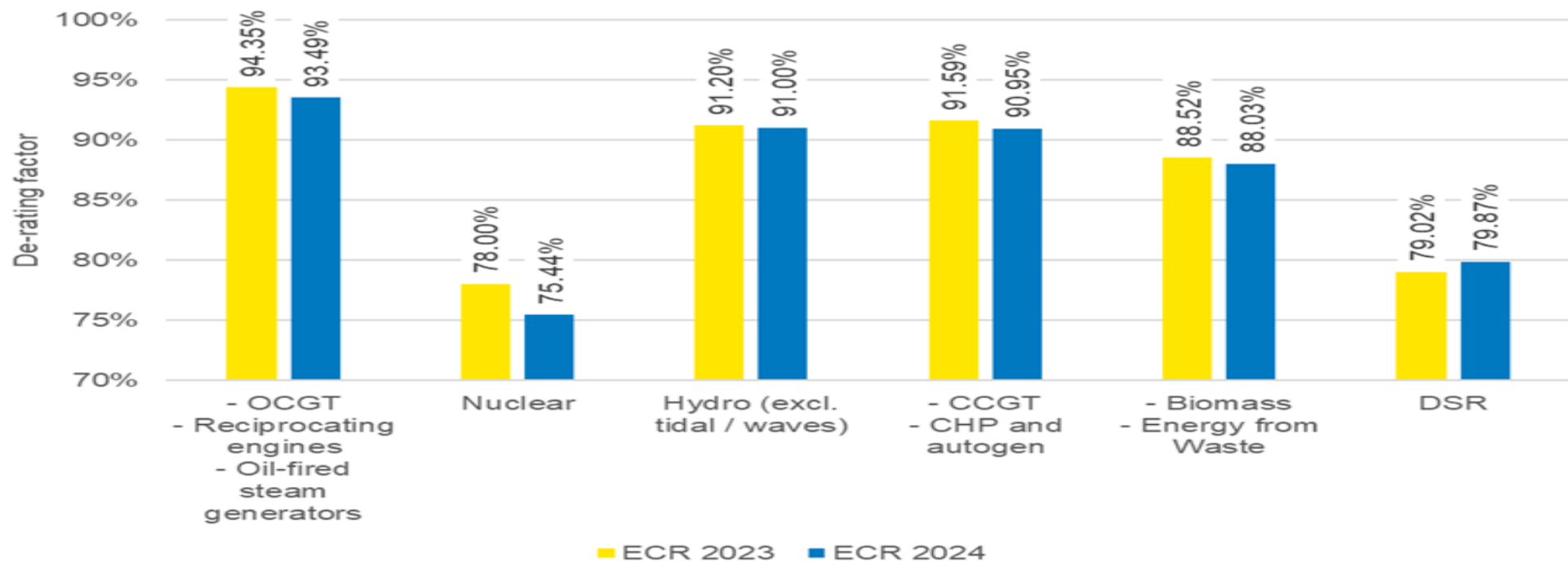
GB 2025 T-4 Auction (£3bn)



Year	Price (£/kW/yr (2012))
2014	£19
2015	£18
2016	£22
2017	£8
2018	No auction
2019	£6
2020	£16
2021	£18
2022	£30
2023	£63
2024	£65
2025	£60

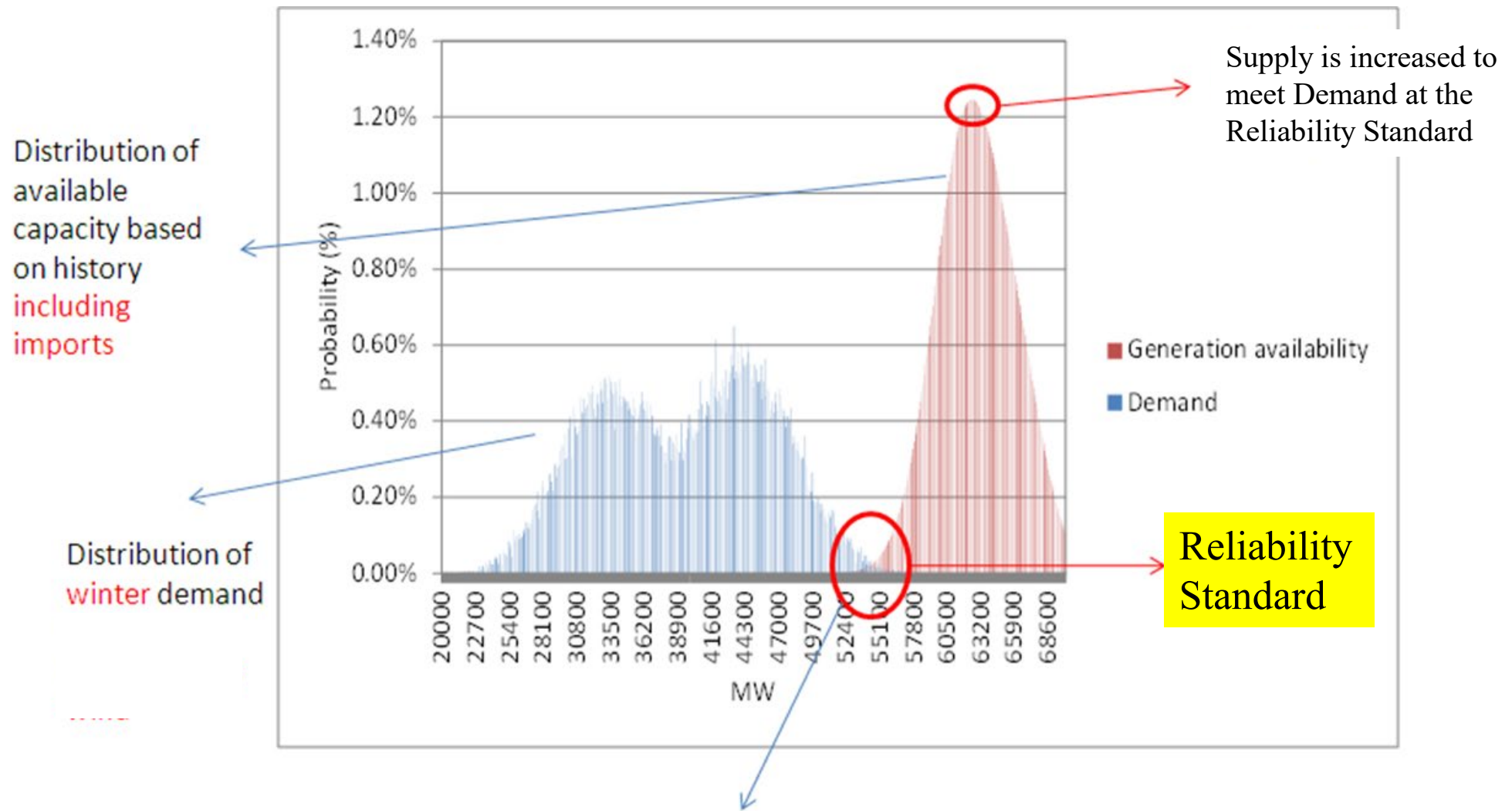
Reliability Equivalence from Different Resources?

- A fair auction requires all facilities to have their capacities adjusted to Equivalent Firm Capacities (EFCs)
 - Historical availability probabilities used for conventional units eg CCGTs. (EFC = $p \cdot C$)



- *But are these accurate for assets approaching de-commission, those in financial distress, and some new builds?*

But EFC is specific to a Reliability Standard



The EFC replaces a non-firm technology with a firm one to maintain the same risk of Loss of load

EFCs are different to Capacity Factors

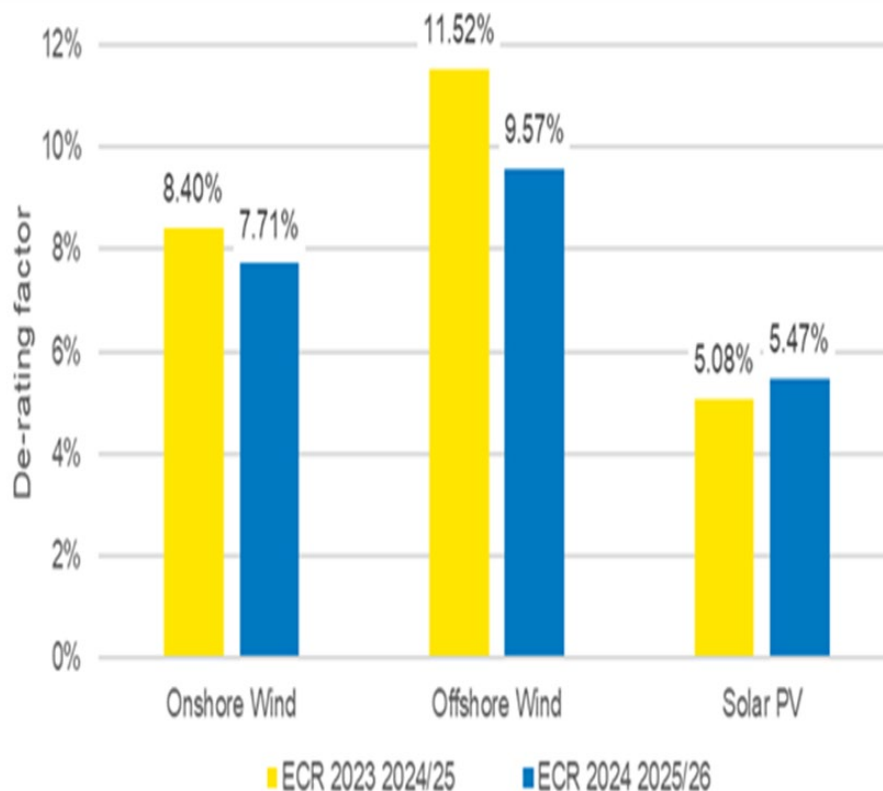
❖ So, for renewables, storage, & interconnectors, the availabilities at stress events are very different from normal periods.

✓ Thus, EFC is unlike the usual “capacity factor” or “load factor” of the asset, since it measures the marginal contribution to resource adequacy, not average production.

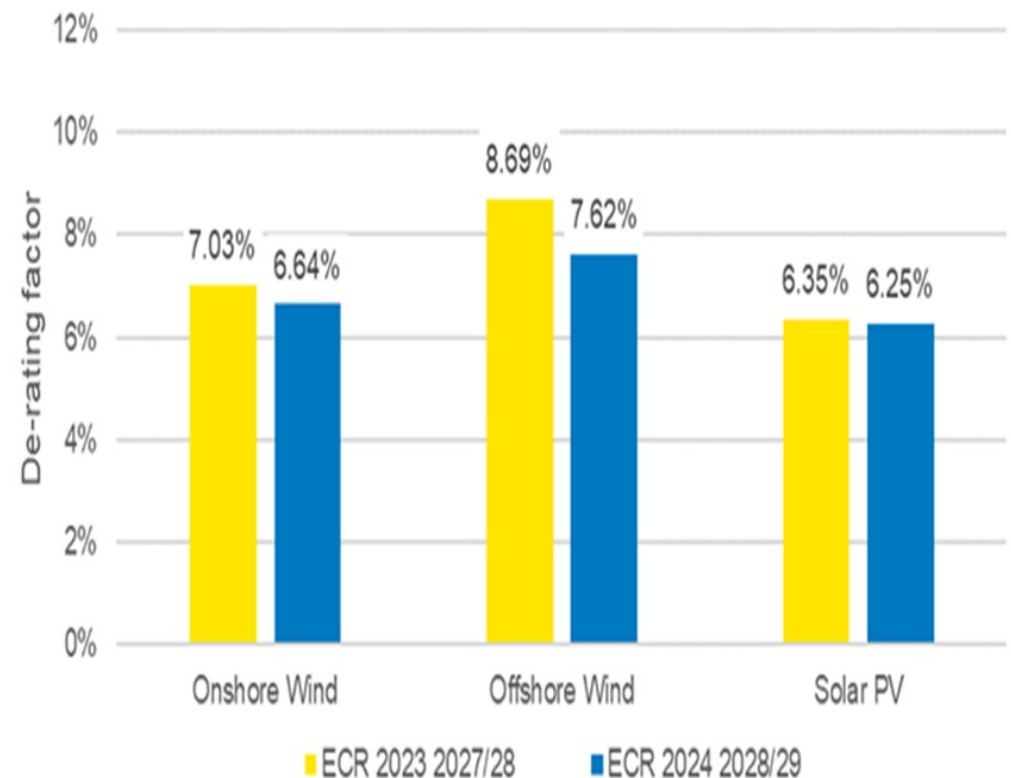
(This is a common mistake).

Some Problems with EFCs for non-firm Technologies

1. They decline over time as more technology gets introduced.
 - >>>> correlated contributions at times of stress.
 - Applies to renewables, storage and interconnectors



T-1

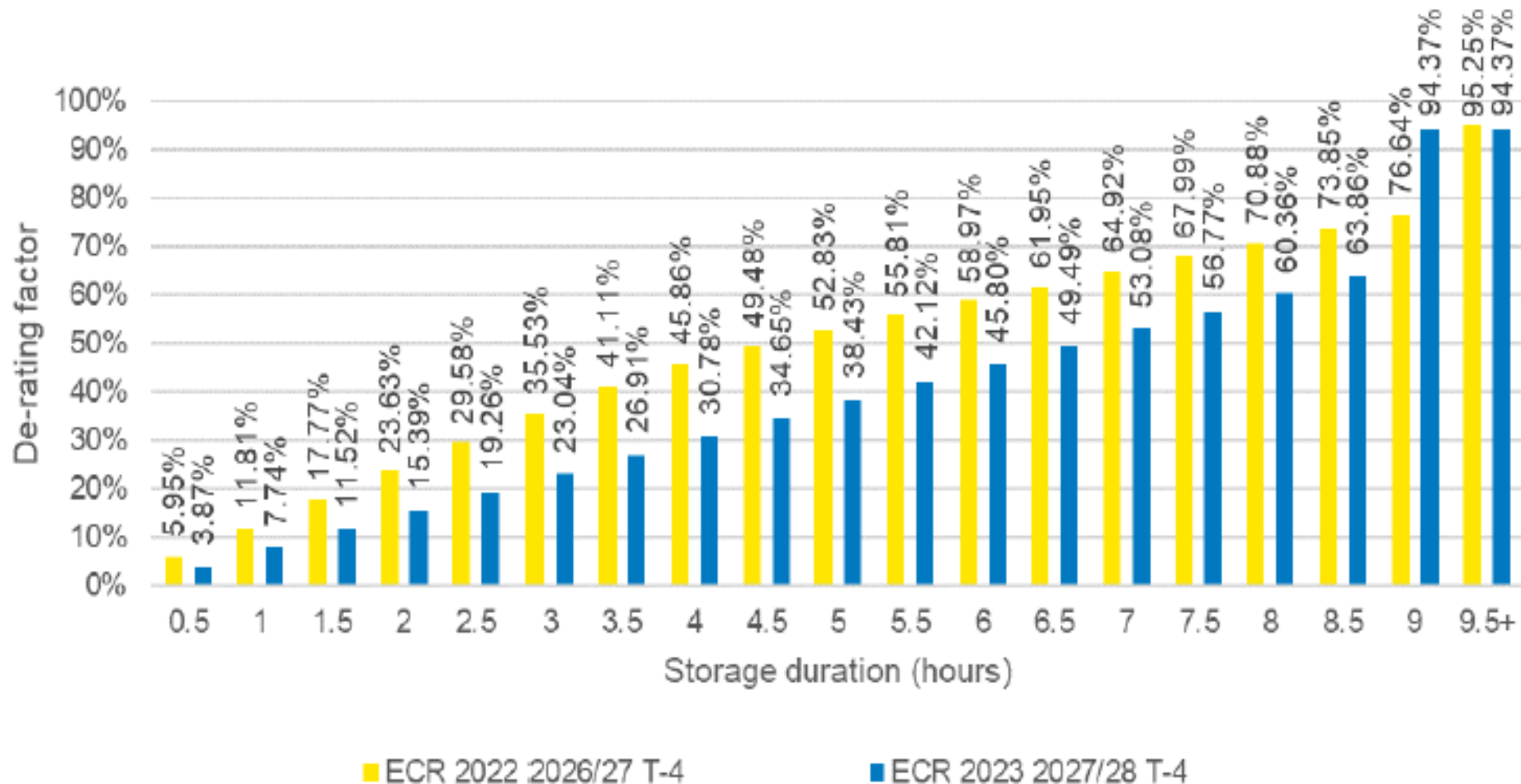


T-4

Duration Limited Resources are Very Awkward

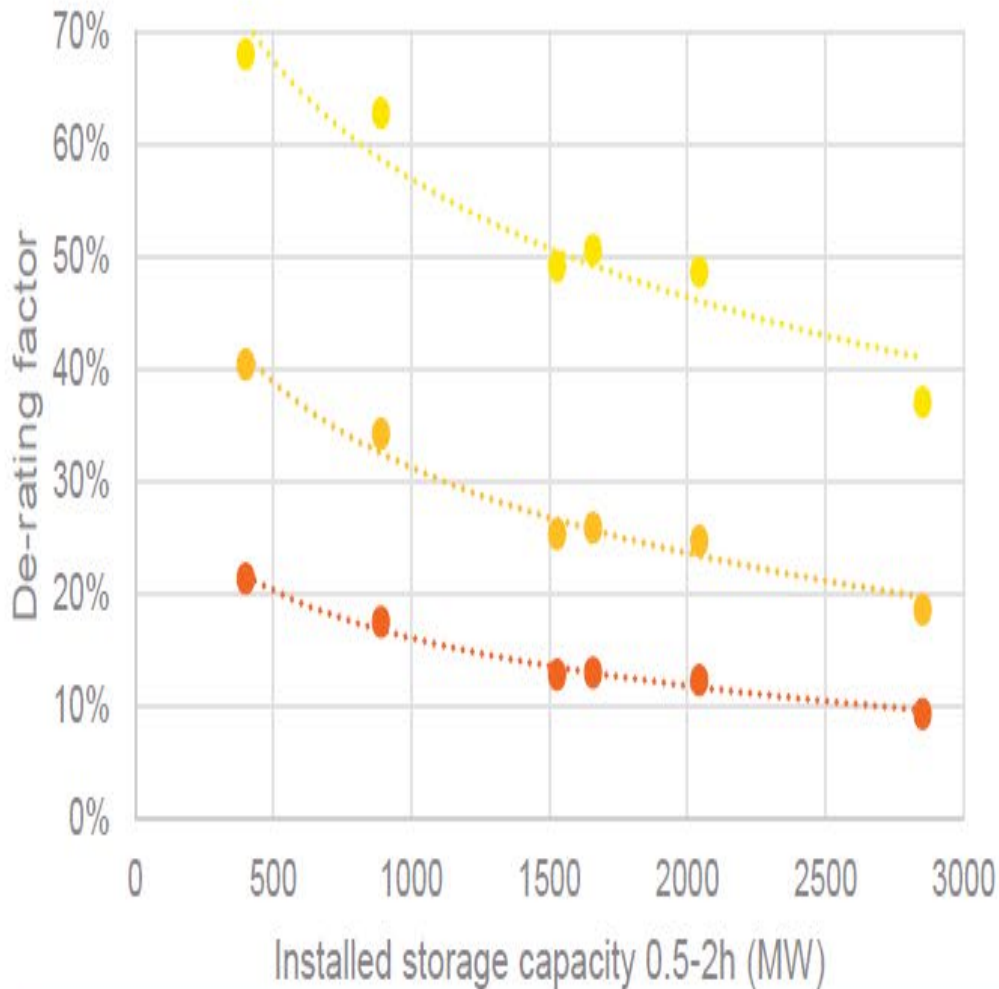
➤ EFCs for batteries depend upon durations

The modelling requires dubious behavioural assumptions

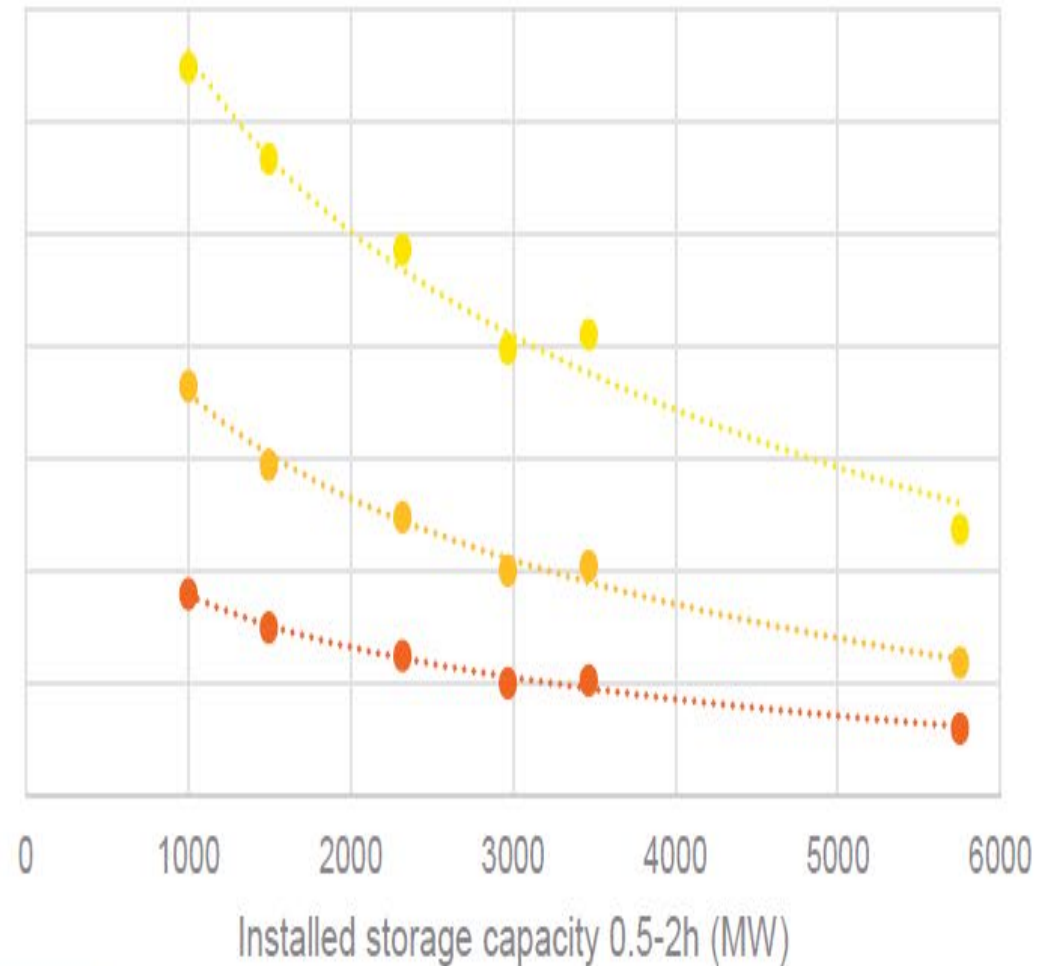


Storage de-rating also declines with Scale

T-1 auctions

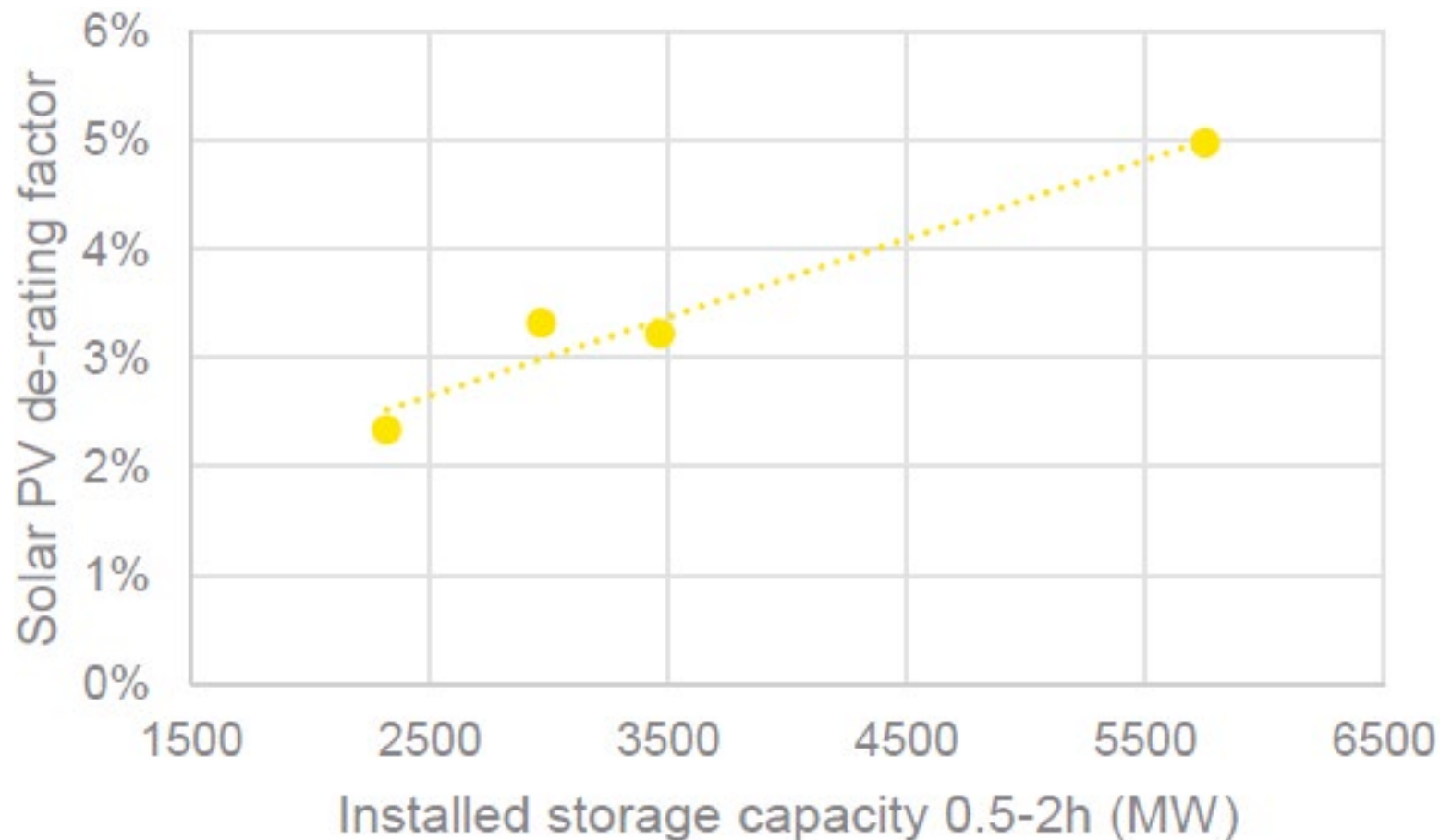


T-4 auctions



Interactions can be surprising

An increase in short term storage capacity can shift distribution of stress event to longer events starting in the afternoon

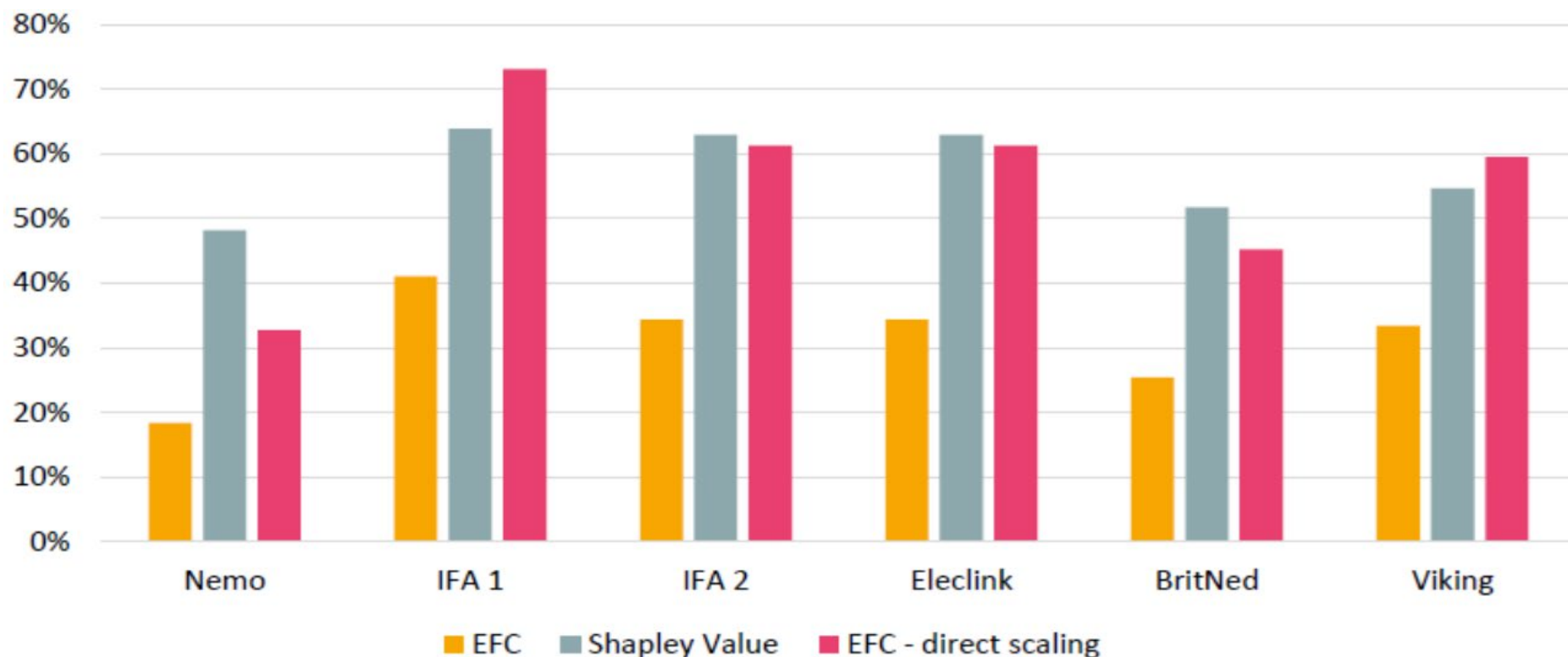


Some Problems with EFCs for non-firm Technologies

2. The marginal EFCs do not sum up properly for the auctions..
- In practice they are rescaled, but this is not ideal

For example, interconnector EFCs should sum to the total EFC for the fleet of interconnectors.

- In theory Shapley values would be better but rescaling is close and easier.



Move to discriminated products?

- So, EFCs for groups of correlated assets needed for additivity
- Battery-specific capacity market products are emerging, eg Italy and Australia
- Very large projects are not included in the normal auctions, eg cap and floor support
- GB is discussing separate auctions for firm and non-firm assets
- Demand-side management is elusive to de-rate.
- Technology and spatial discriminations may interact
- *Is there a better way than de-rating for technology neutrality?*

“Though this be madness, yet there is method in it...” Shakespeare, Hamlet