London Business School

8th AIEE: Current and Future Challenges to Energy Security

Some Problems with Capacity Mechanisms

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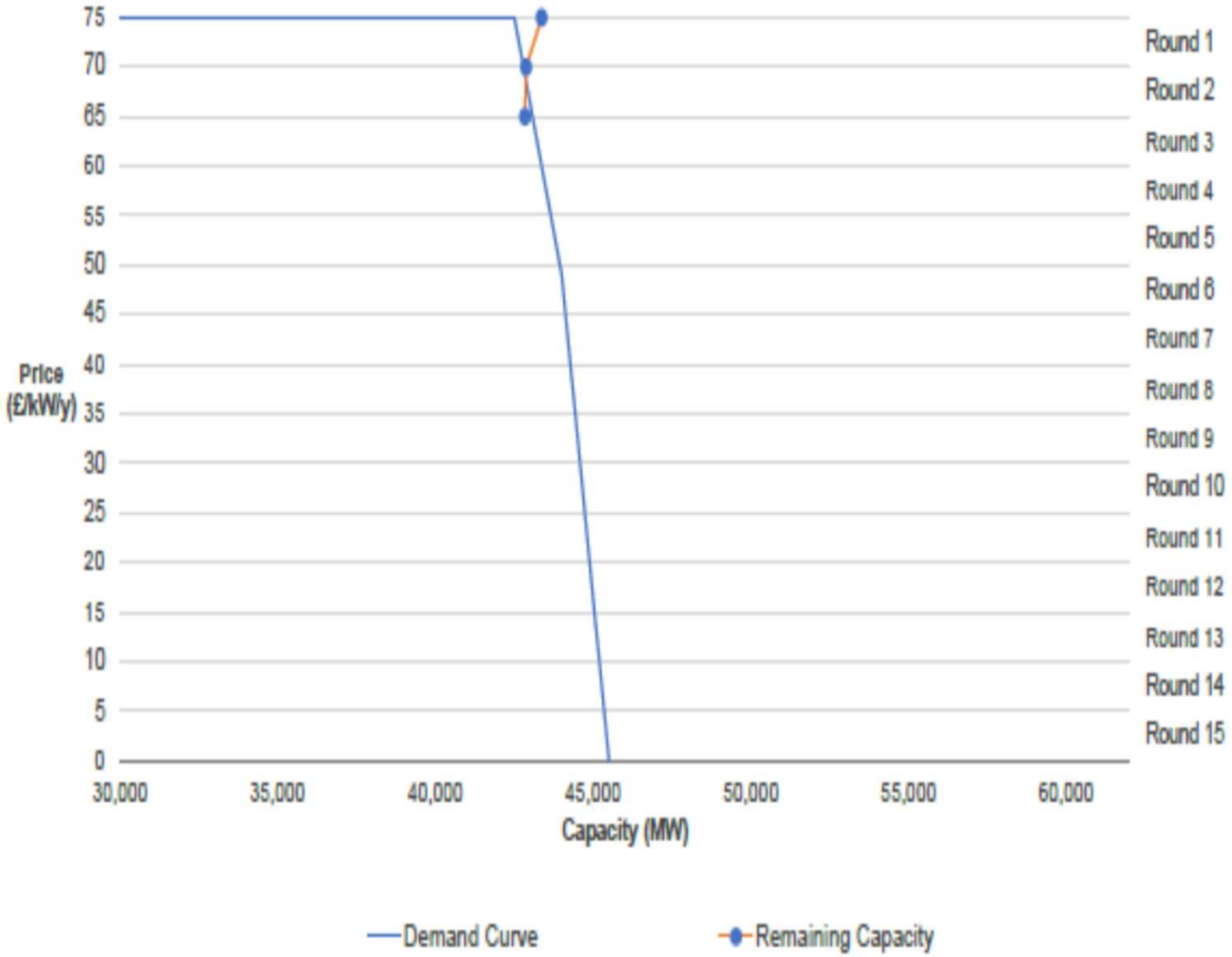
How to be paid for doing nothing….

- A consequence of increased renewable penetration is the need to support non-renewables.

- *EU was initially resistant under "state aid", then indicated they should be temporary, but now views them as structural and has directives to harmonise resource adequacy assessments.*

- Focus more upon resource adequacy than "missing money"

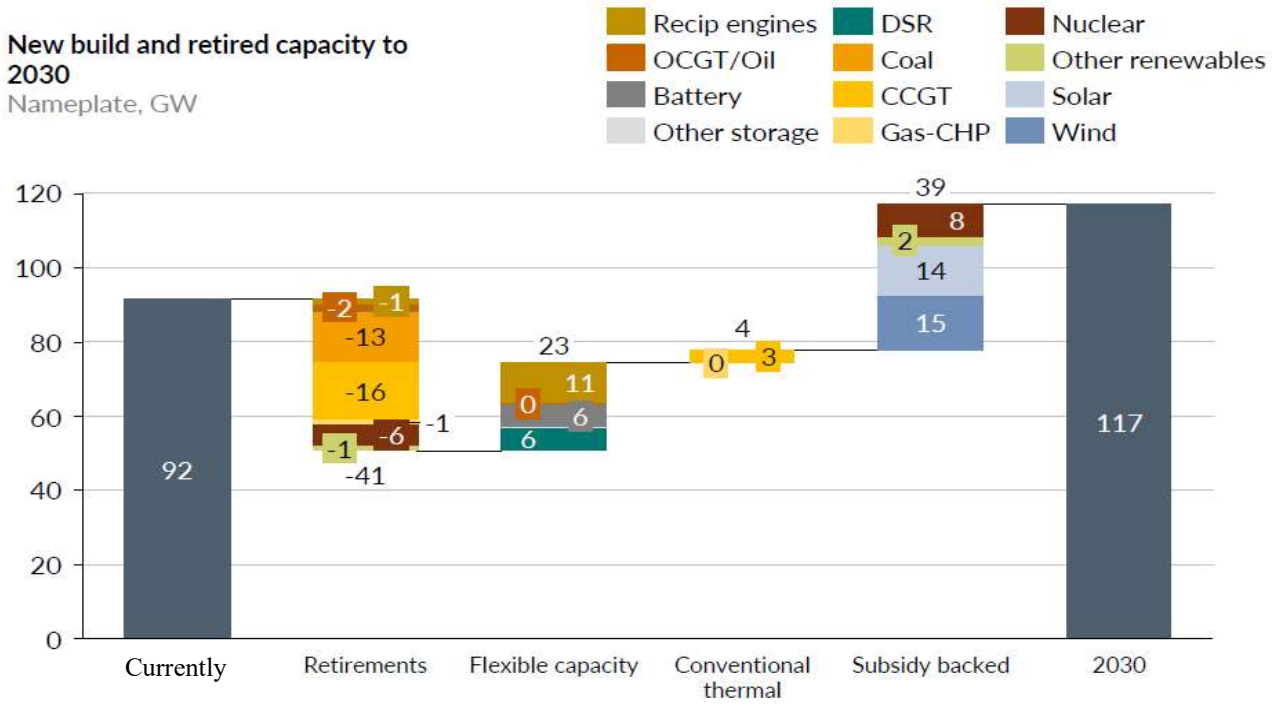
GB 2024 T-4 (£3.9bn) and Historic CM Prices

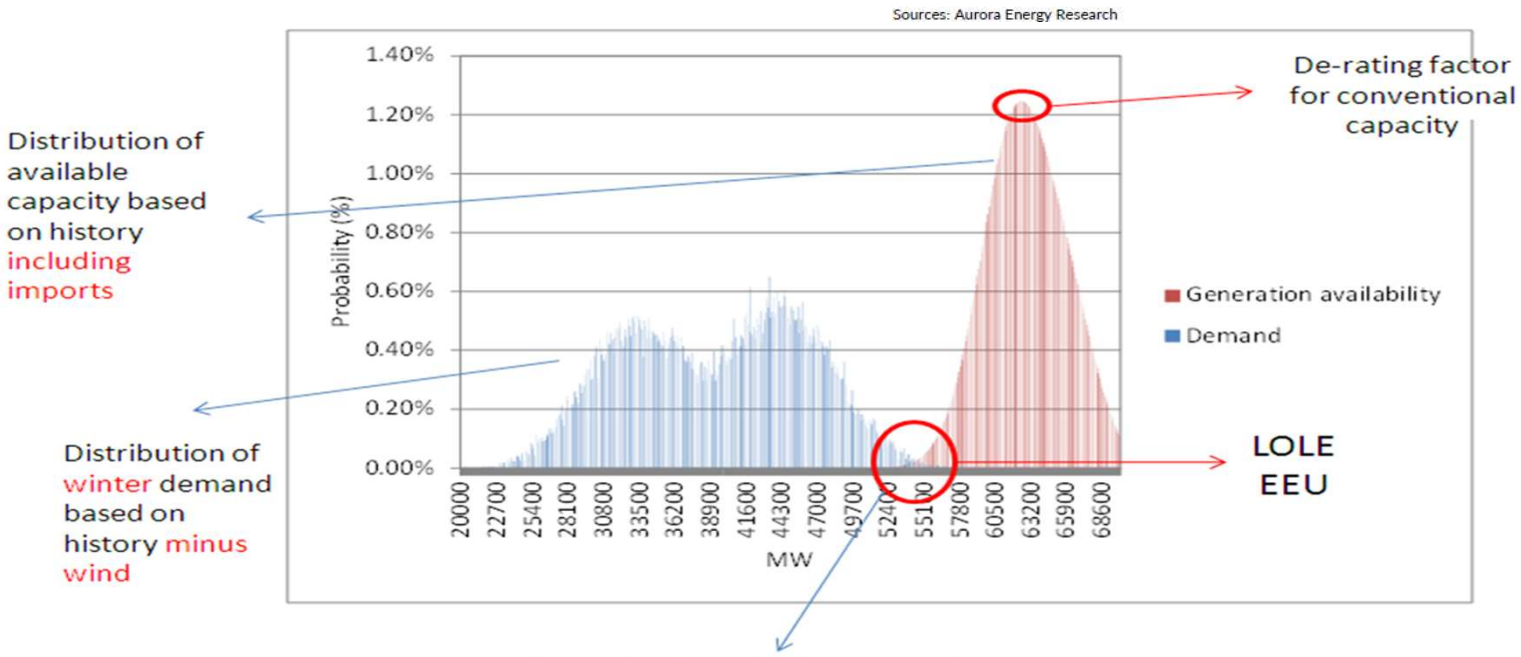


£/kW/yr (2012)	
2014	£19
2015	£18
2016	£22
2017	£8
2018	n/a
2019	£6
2020	£16
2021	£18
2022	£30
2023	£63
2024	£65

Capacity to Procure is **Deceptively Precise**

1. Project the installed capacity
2. Assess their reliabilities
3. Forecast Demand Uncertainty
4. Apply a Reliability Standard





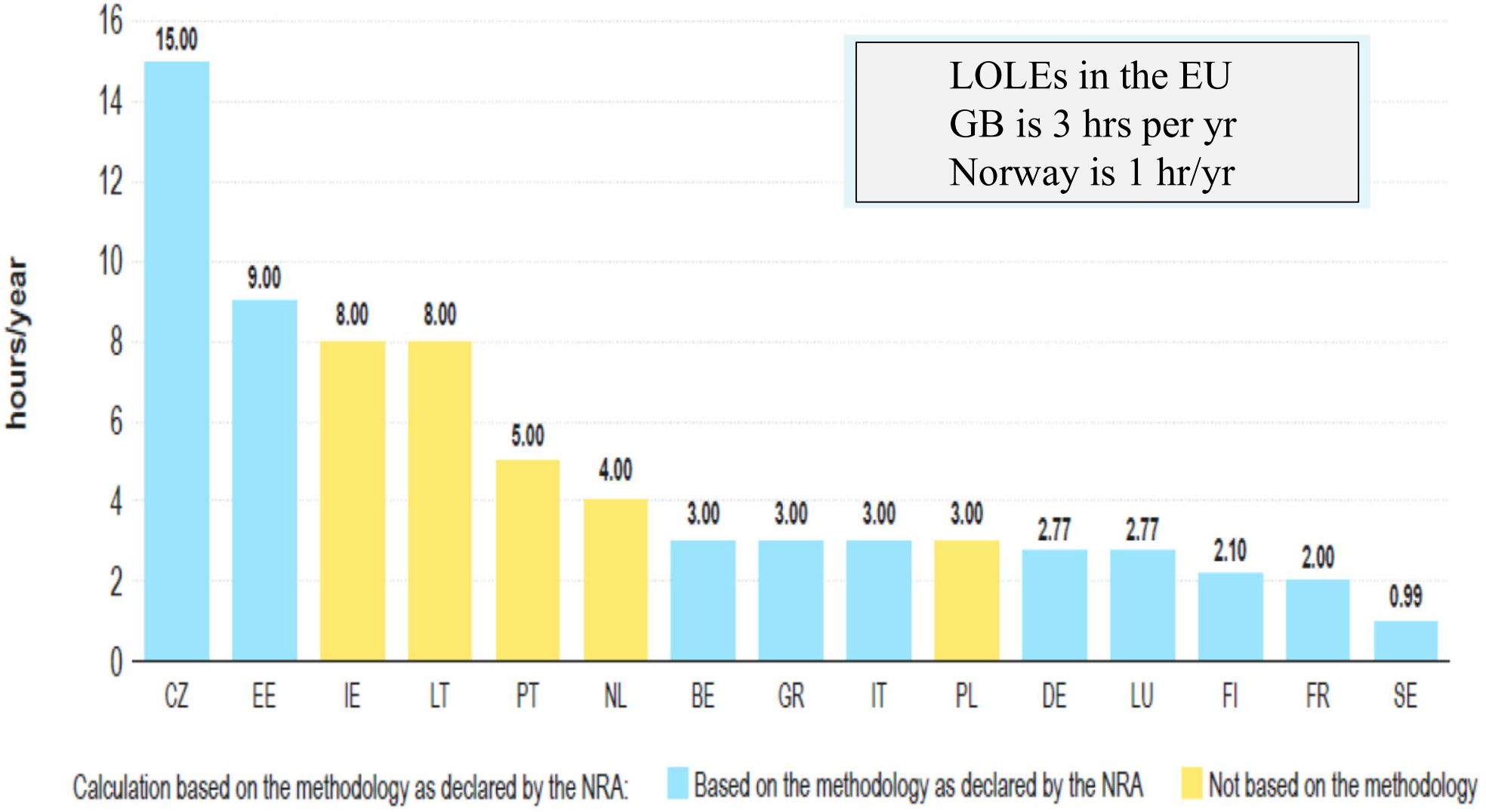
The Reliability Standard

Procurement via auctions, eg T-1, T-4

Fair auctions need:

- Each asset with a de-rating factor for expected % output at stress events

Reliability Standards using Loss of Load Expectations



Source: ACER, SOS monitoring report - 2021, based on NRA data.

The reliability standard is not a sound parameter

✓How is it determined?

- An arbitrary "me-too" standard
- Using a Value of Loss of Load (VOLL) for consumers
- In equilibrium: LOLE*VOLL = Cost of New Entrant
- The EU requires a sampling approach to VOLL estimation

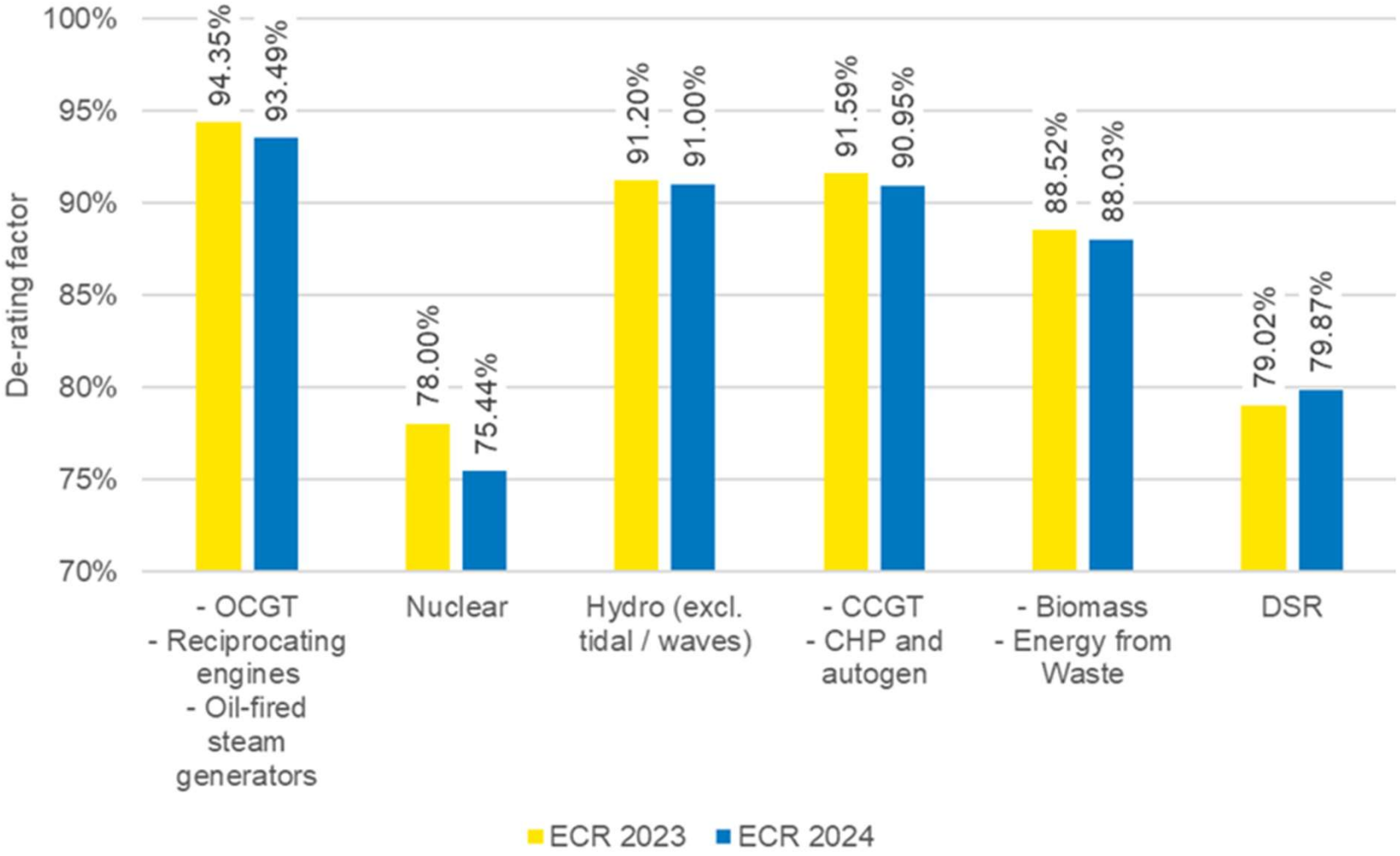
✓ But Expediency seems to prevail:

- GB has a 3 hour LOLE but regularly procures at 0.3 hr LOLE !
- Belgium recently revised VOLL and CONE substantially, but coincidentally the ratio still gave 3 hrs LOLE !

✓ And simulated loss of load may not actually be loss of load

Reliability from Unreliable Resources

Derating conventional facilities with historical availability probabilities implies that historic unplanned outage rates will also apply in stress events.



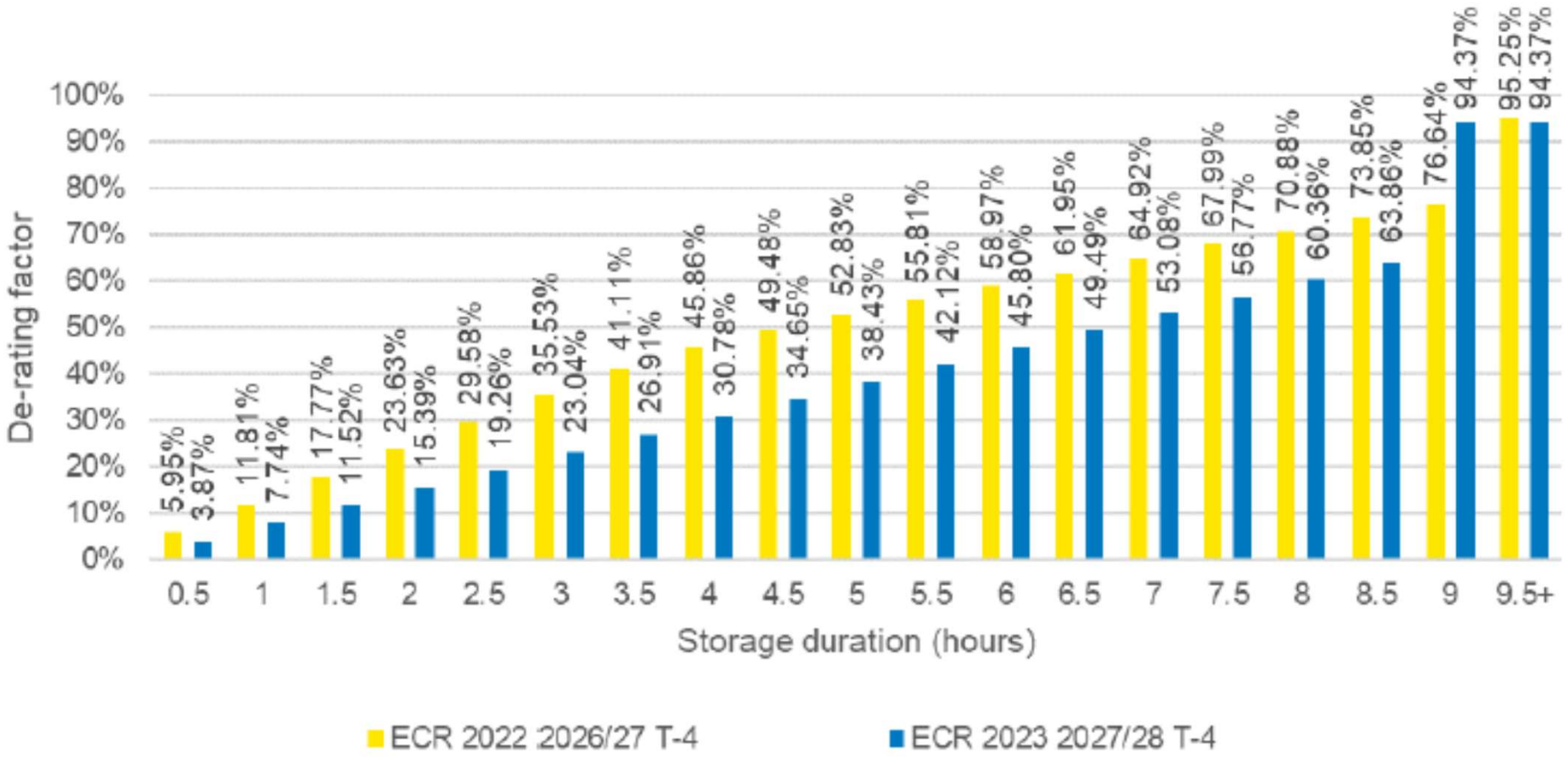
De-rating intermittent and energy-limited facilities….?

Equivalent Firm Capacities (EFCs) are often used for renewables, storage and interconnectors

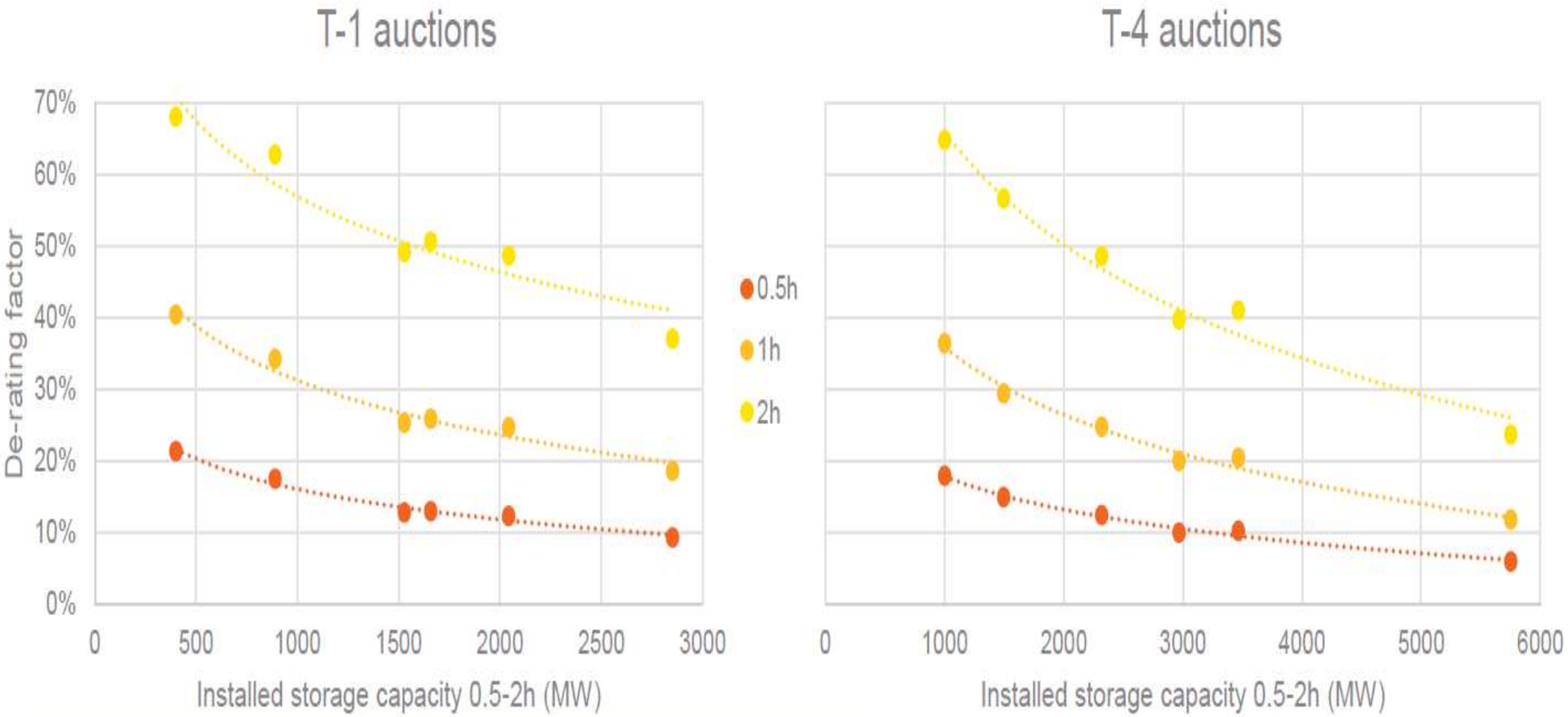
- ✓Simulate the reliability of the system under artificial stress to give the target EEU and seek a solution with the same EEU by replacing the stochastic technology (eg wind) with a firm quantity. Use the ratio as the derating factor. (ELCC, UCAP)
- ✓This is different to the "capacity factor" or "load factor" of the unit, since it measures the marginal contribution to aggregate LOLE
- ✓This sharpens the distinction between capacity payments for missing money or for resource adequacy

Duration Limited Resources are Very Awkward

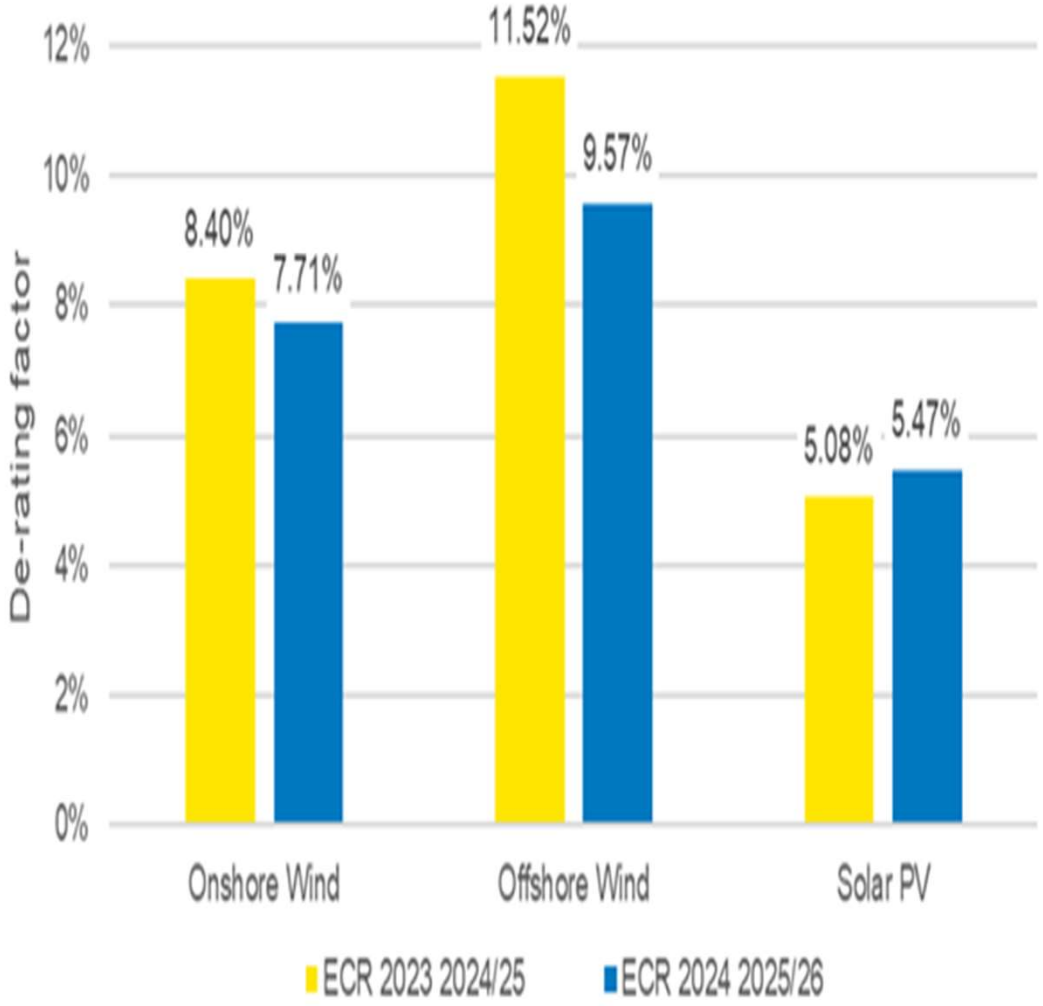
- EFCs for batteries and DSR, depend upon durations
- The modelling requires behavioural assumptions

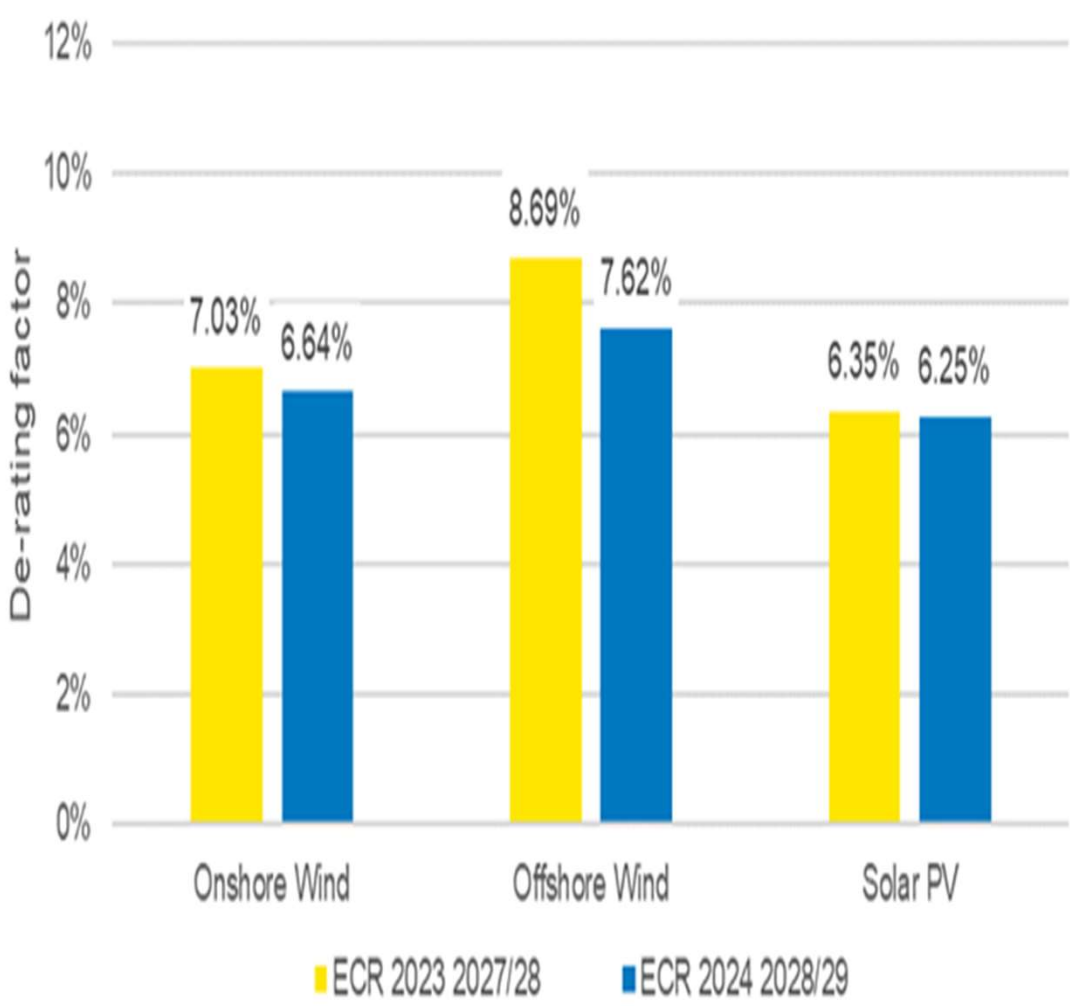


Storage de-rating declines with Scale



Same is True for Wind and Solar

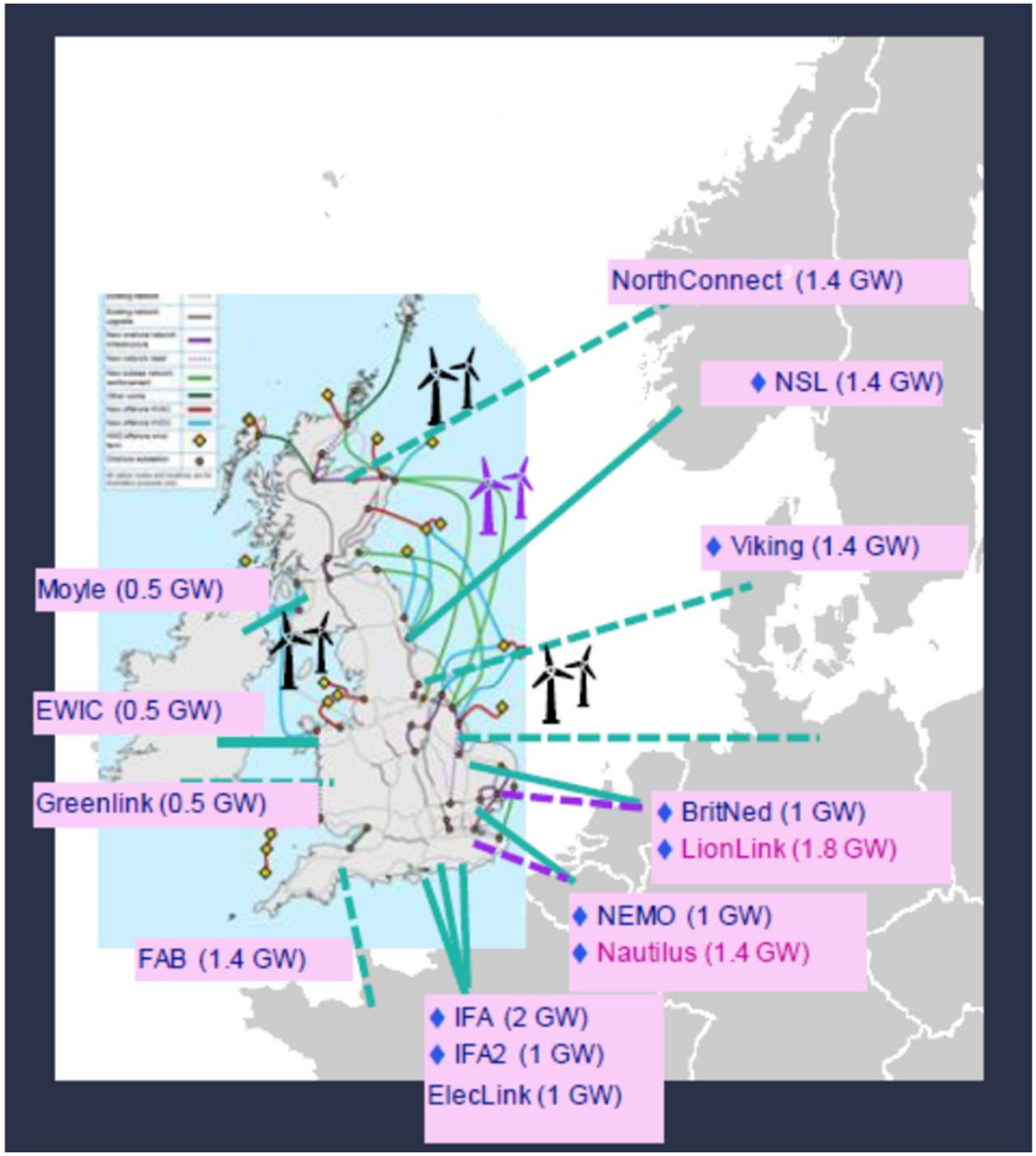




Interconnectors Benefit without Penalties

- Wider connections improve reliability from weather intermittencies
- Pan-European power-flow modelling during stress periods give EFCs
- Correlated weather patterns under estimated

	2028/29 (T-4)
Ireland	55%
France	68%
Belgium	68%
The Netherlands	68%
Denmark	66%
Norway	82%
Germany	66%



Probabilistic simulations are conditional on various non-probabilistic scenarios >>>>> *now what do we do?*

Name	Graph Code	Capacity to Secure (GW)	Outside CM (GW)	Previously Contracted Capacity (GW)	Total derated capacity (GW)	ACS Peak (GW)
DECC Scenario	DECC	45,9	18,1	6,4	64,0	61,2
Base Case Warm Winter	BC_WARM	46,1	15,4	3,5	61,5	60,2
Base Case Low Demand	BC_LOW_DEMAND	46,7	15,5	3,5	62,2	59,0
Slow Progression	SP	47,0	15,3	3,5	62,2	59,9
No Progression	NP	47,1	16,1	4,8	63,2	60,8
Base Case High Wind	BC_HIGH_WND	47,5	15,7	3,5	63,3	60,2
Base Case	BC	47,7	15,6	3,5	63,2	60,2
Base Case Low Availability	BC_LOW_AVAIL	47,7	15,6	3,5	63,3	60,2
Base Case High Availability	BC_HIGH_AVAIL	47,7	15,5	3,5	63,2	60,2
Base Case Low Wind	BC_LOW_WND	47,8	15,3	3,5	63,1	60,2
Base Case Non Delivery Scenario: -400	BC_NON_DEL_400	48,1	15,2	*	63,2	60,2
Gone Green	GG	48,1	14,2	1,8	62,3	59,7
Base Case Non Delivery Scenario: -800	BC_NON_DEL_800	48,5	14,8	*	63,2	60,2
Base Case Cold Winter	BC_COLD	48,6	15,6	3,5	64,2	60,2
Base Case High Demand	BC_HIGH_DEMAND	48,8	15,6	3,5	64,4	61,4
Base Case Non Delivery Scenario: -1200	BC_NON_DEL_1200	48,9	14,4	*	63,2	60,2
Base Case Non Delivery Scenario: -1600	BC_NON_DEL_1600	49,3	14,0	*	63,2	60,2
Consumer Power	CP	49,5	14,1	1,8	63,5	60,7
Base Case Non Delivery Scenario: -2000	BC_NON_DEL_2000	49,7	13,6	*	63,2	60,2
Base Case Non Delivery Scenario: -2400	BC_NON_DEL_2400	50,1	13,2	*	63,2	60,2
Base Case Non Delivery Scenario: -2800	BC_NON_DEL_2800	50,5	12,8	*	63,2	60,2
Base Case Non Delivery Scenario: -3200	BC_NON_DEL_3200	50,9	12,4	*	63,2	60,2
Base Case Non Delivery Scenario: -3600	BC_NON_DEL_3600	51,3	12,0	*	63,2	60,2

MinMax Regret is sometimes used…..

Summary: the Devils in the Details

1. Performance at stress events is imaginary
2. The reliability standard is arbitrary
3. Loss of load may not actually be loss of load.
4. Demand elasticity is considered as a resource
5. Non-firm resources are treated with firm equivalents
6. Interconnectors are highly uncertain and correlated
7. Batteries are very behavioural
8. Probabilistic analysis confounded with scenarios.

Insecurity

- Complicated modelling with fragile parameters
- Nevertheless, Capacity Remuneration Mechanisms are becoming long-term policy for security and key revenue streams for assets.
- Optimised Capacity CRMs for technologies and locations are emerging

"*Though this be madness, yet there is method in it…*" Shakespeare, Hamlet