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Intermittency and Generation Investment

Renewables and the Electricity Market

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EPRG/NERA Winter Seminar, Cambridge

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At first EMR favoured ‘targeted’ capacity payments, to address intermittency



UK *Electricity Market Reform* (December, 2010):

- intended to ensure *security of supply* and *CO2 reduction*;
- discussed a capacity payment mechanism to ensure *flexible*, back-up capacity, because:
 - “In the current system [investment signals] are unlikely to be strong enough to provide the absolute level of capacity required or the **flexible capacity needed to support increasing level of intermittent generation.**” *
- The Government:
 - appeared initially to favour a **targeted** capacity mechanism
 - but also considered a **market-wide** capacity mechanism

* *EMR Consultation, 2010, p.24; emphasis added*

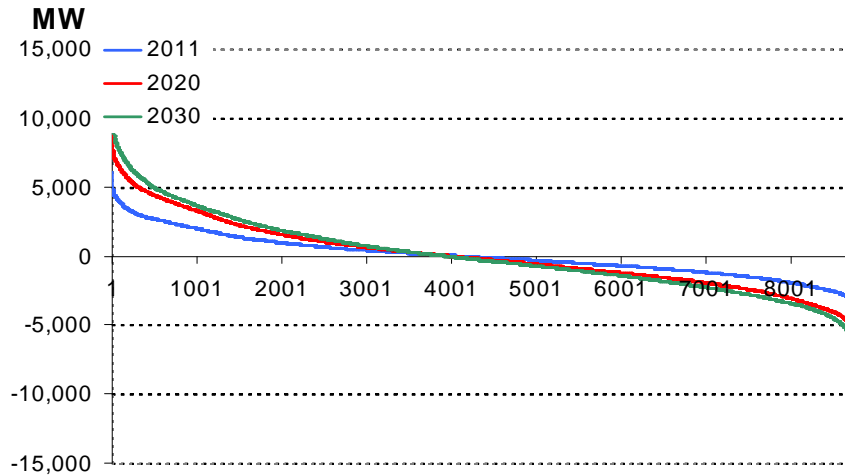


The Nature of Intermittency

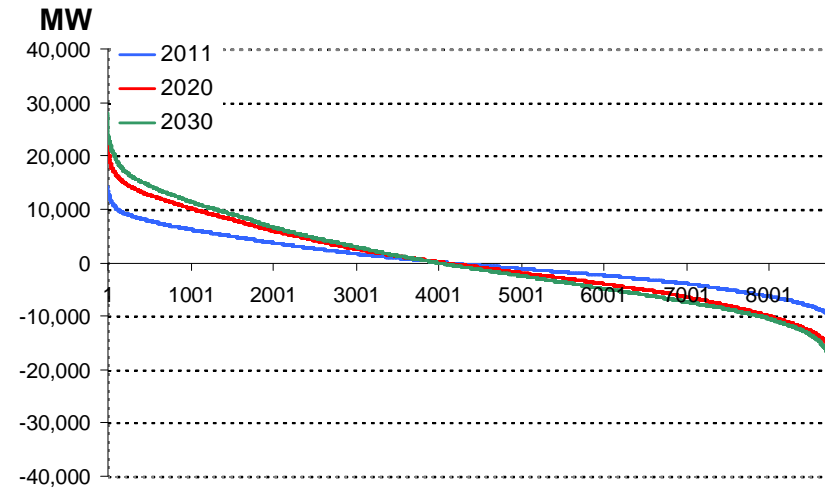
Spain: wind output is variable, but diversified, so it changes only slowly



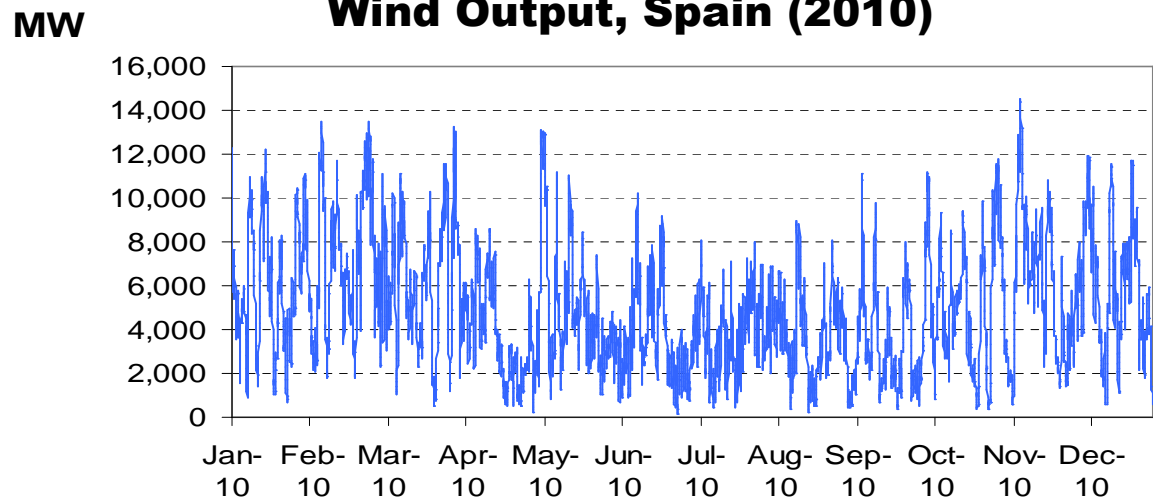
1-Hour Variation in Net Demand



4-Hour Variation in Net Demand



Wind Output, Spain (2010)

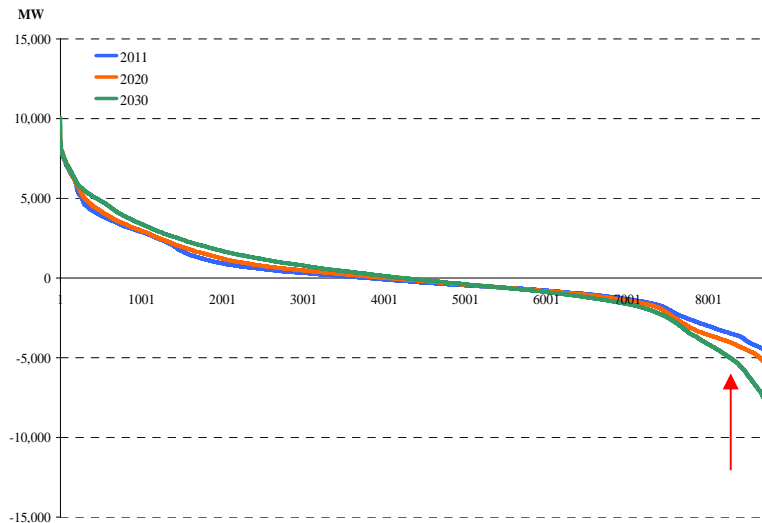


Britain: Short-term variation in wind output indicates no new need for “flexibility”...

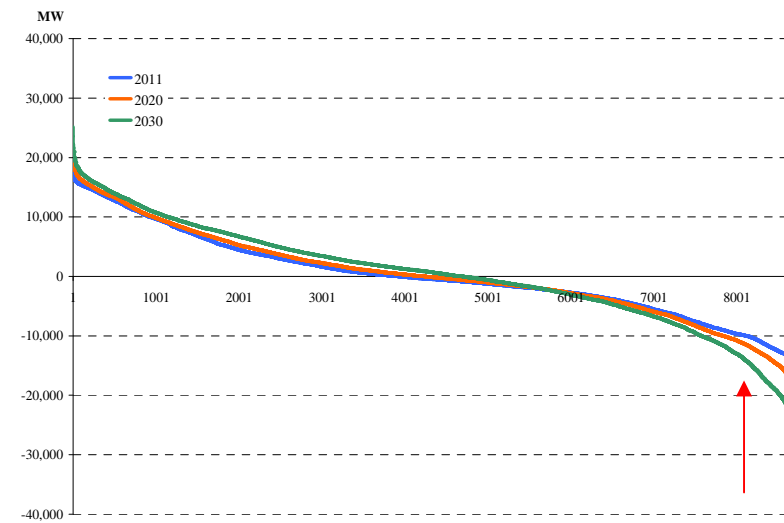


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1-Hour Variation in Net Demand



4-Hour Variation in Net Demand



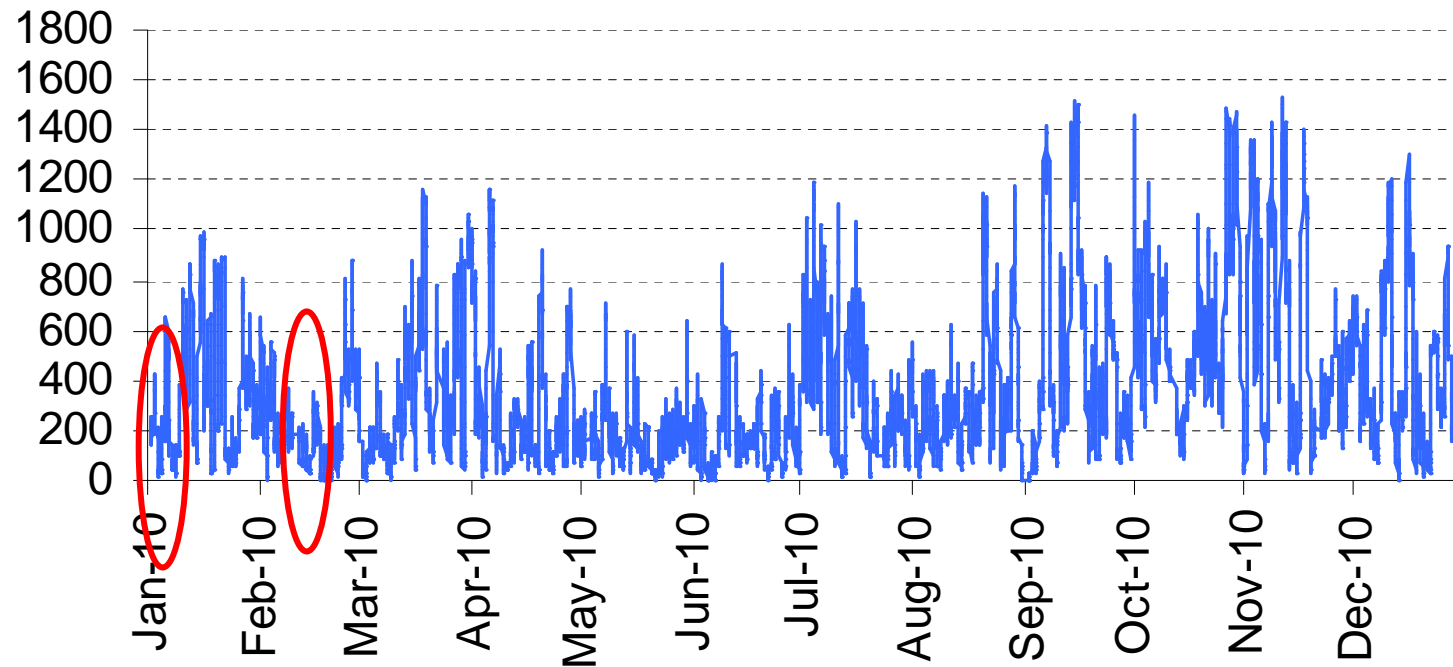
- Even by 2030, few extreme cases
- Forecast generation portfolio has enough ramping capacity to cope

BUT: *Prolonged* falls in wind output will increase demand for “peaking plant”...



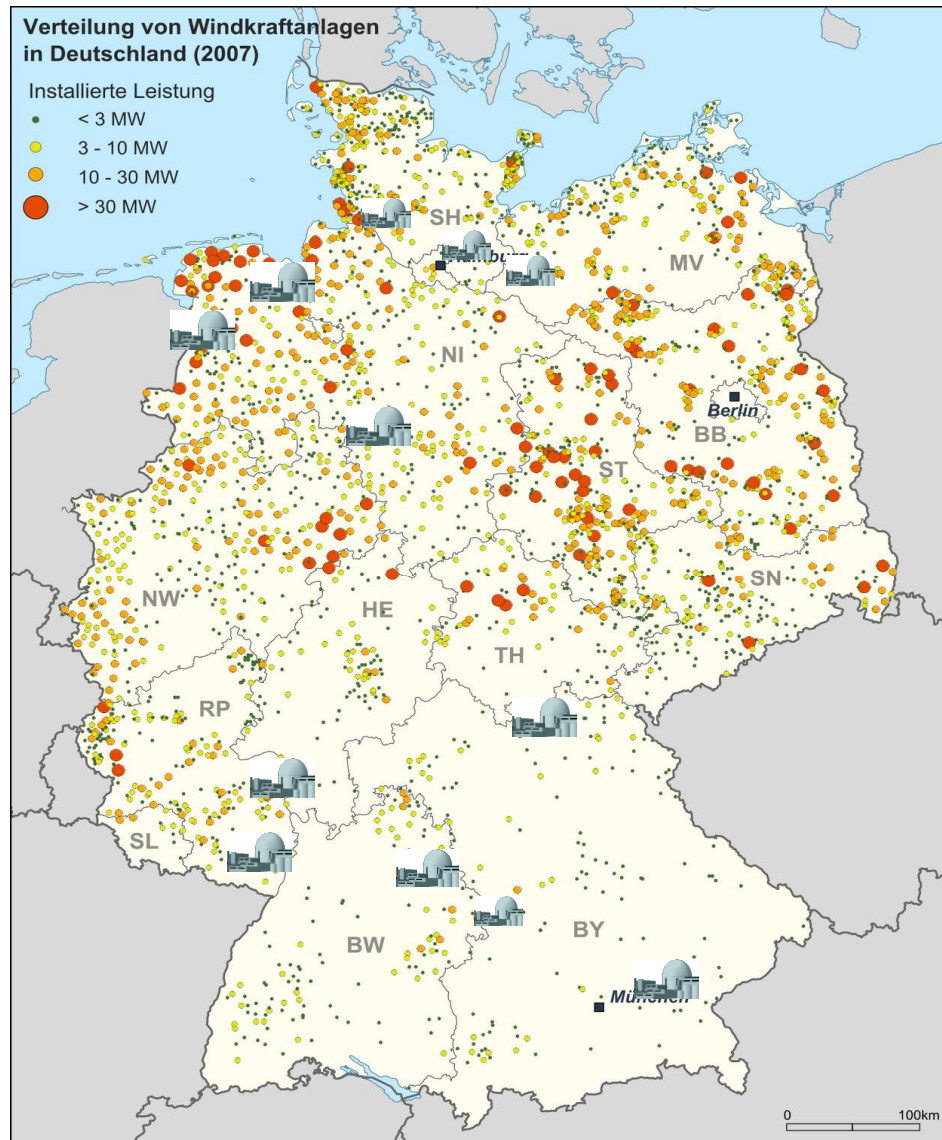
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Britain: Wind Output (2010)



- Wind output can drop at any time (including peaks)

Germany's wind output is not diversified and creates different problems

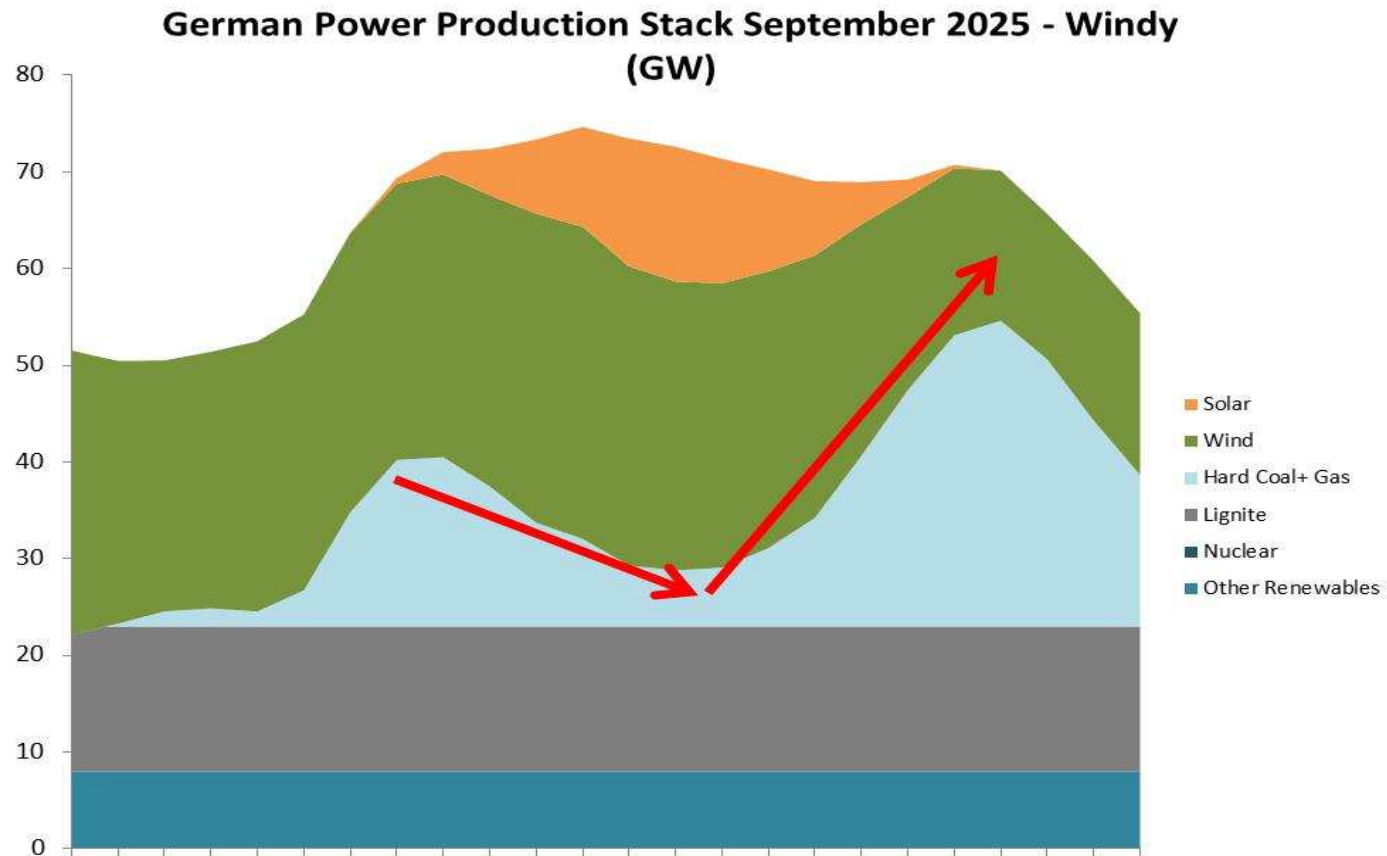


- Wind farms are concentrated in Northern Germany
 - no diversification of output
 - net demand may vary more
- Nuclear decommissioning will hit energy production in Southern Germany
- More North-South transmission capacity will be needed to carry fluctuating flows
- Electricity market already shows wide fluctuations in price

Germany: Variation in solar output adds to the need for ramping



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■ Source: VGB

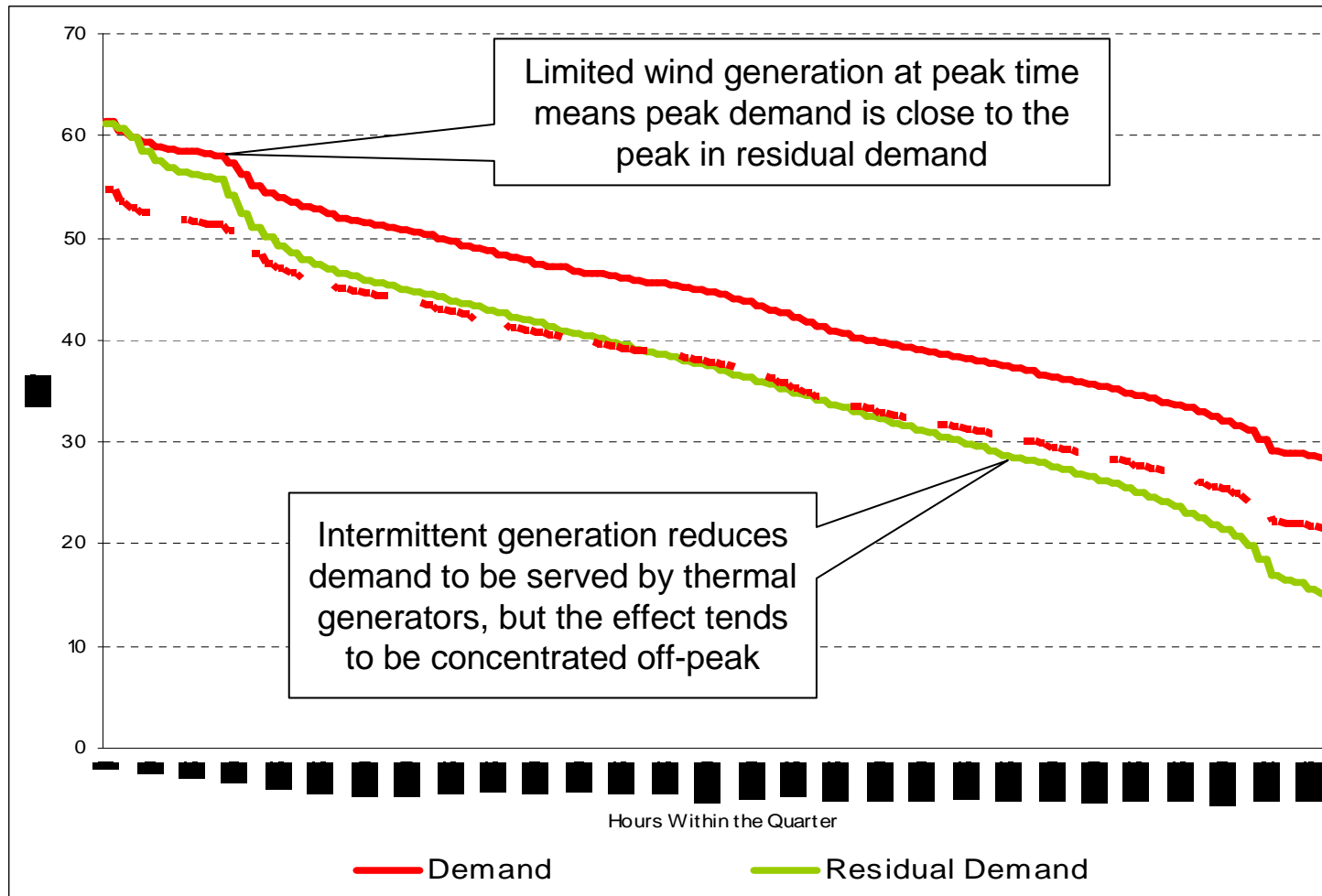


The Economics of Electricity Markets

Optimal Generation Mix with Intermittency

A “peakier” load curve requires more peaking and less baseload generation

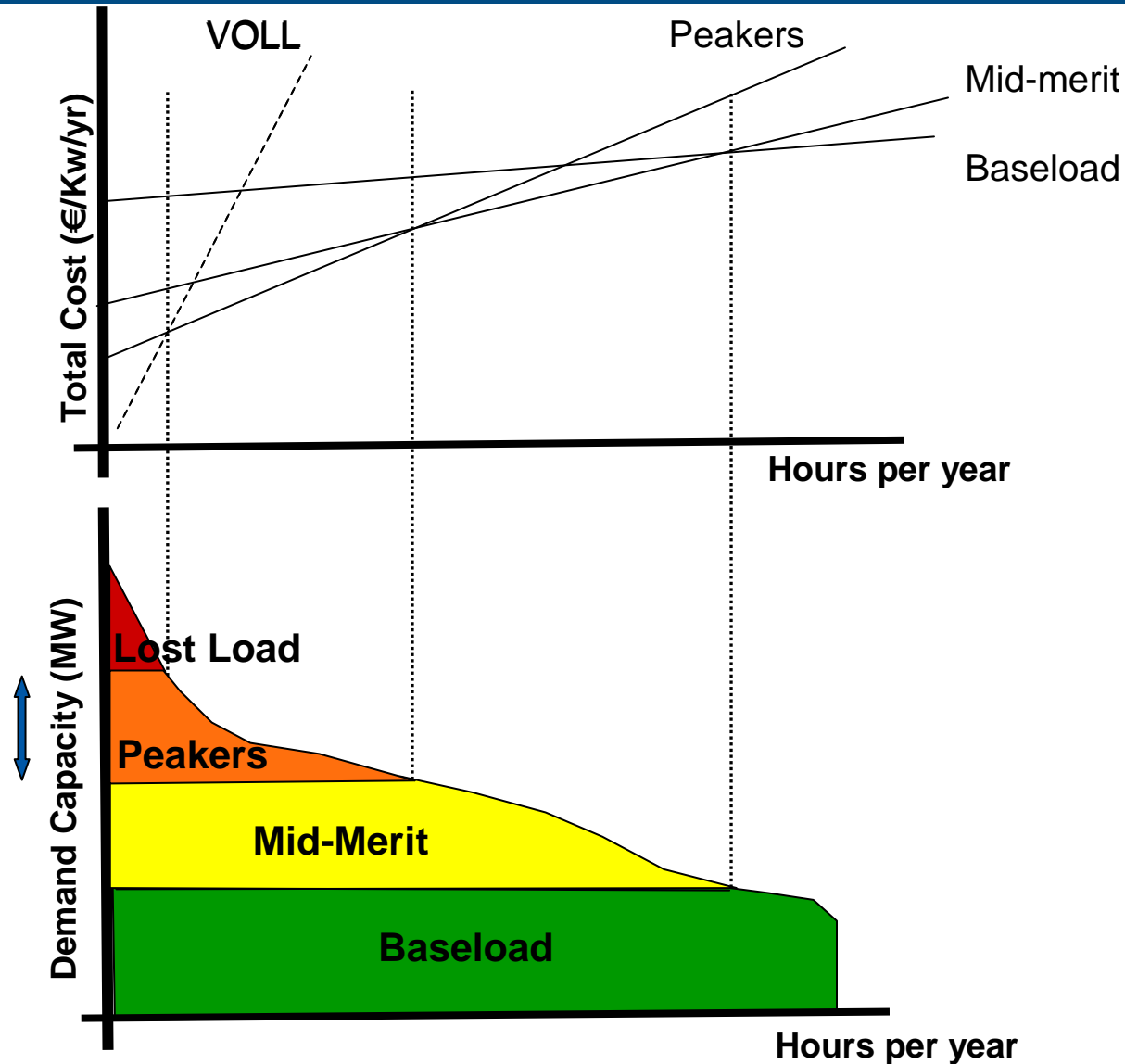
Example: Demand in Great Britain, Q1 2025



Efficient investment depends on costs and the shape of the load duration curve



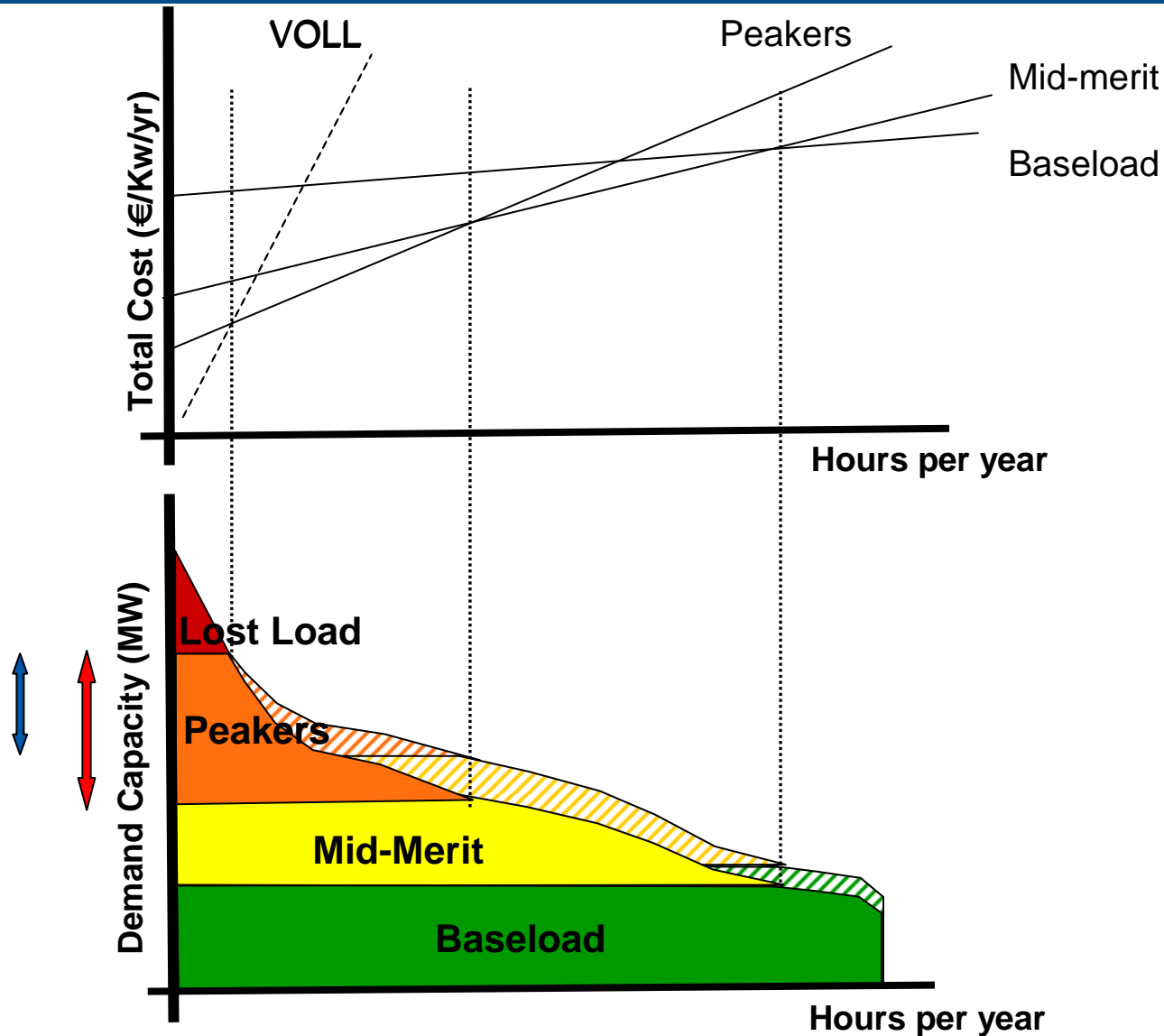
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A peakier load duration curve requires more peaking capacity



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Market Design and Investment Incentives

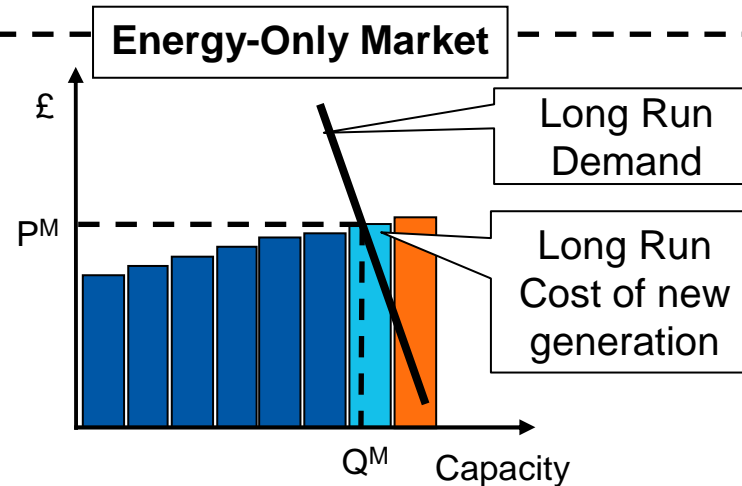
Capacity Payment Mechanisms in the EMR

A “Targeted CPM” will cause high cost plant to displace cheaper investment



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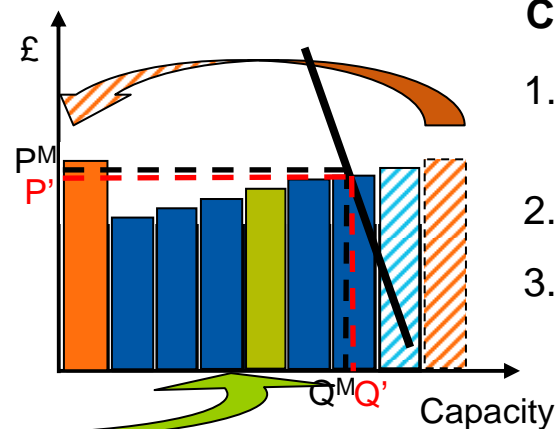
The market level of capacity (Q^M) depends on long run costs of generation and demand



Targeted Capacity Payment Mechanism

Contracts with “in-merit” plant:

1. offer some investors additional revenue, but...
2. ...do not change average market prices, and
3. do not raise the supply of capacity



Contracts with “out-of-merit” plant:

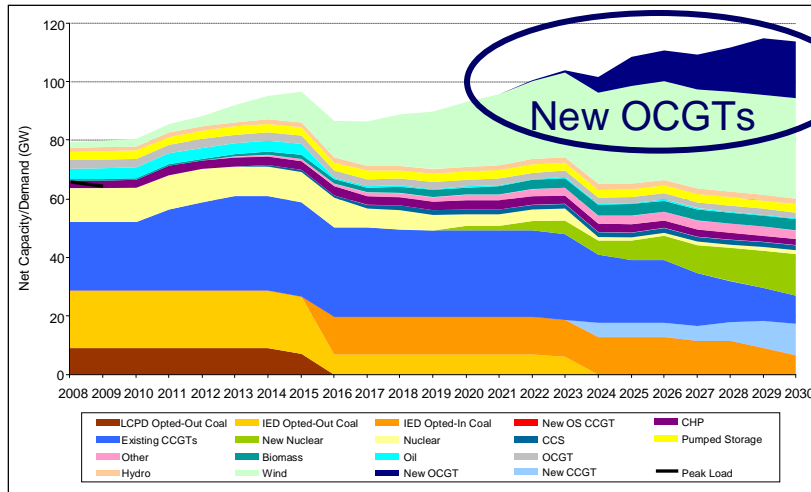
1. increase capacity and reduce prices (by a negligible amount);
2. displace other, cheaper capacity;
3. Raise total costs of generation but depress prices.

A "Market-Wide CPM" improves Security of Supply; a "Targeted CPM" does not

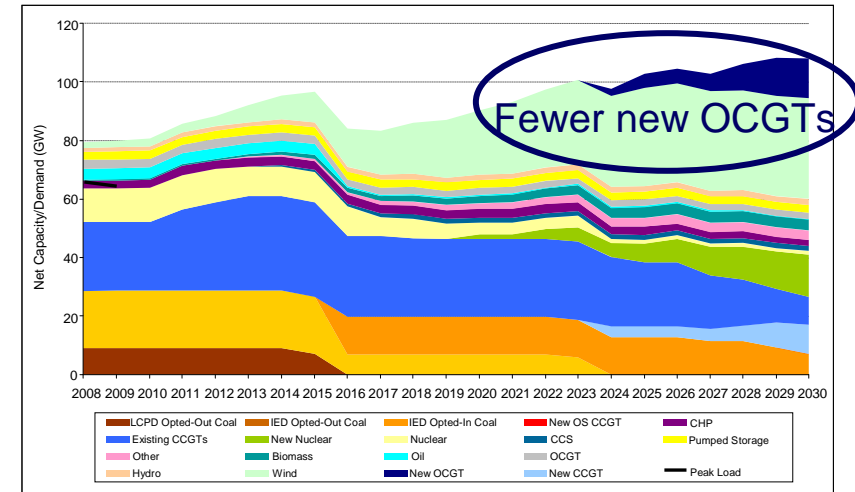


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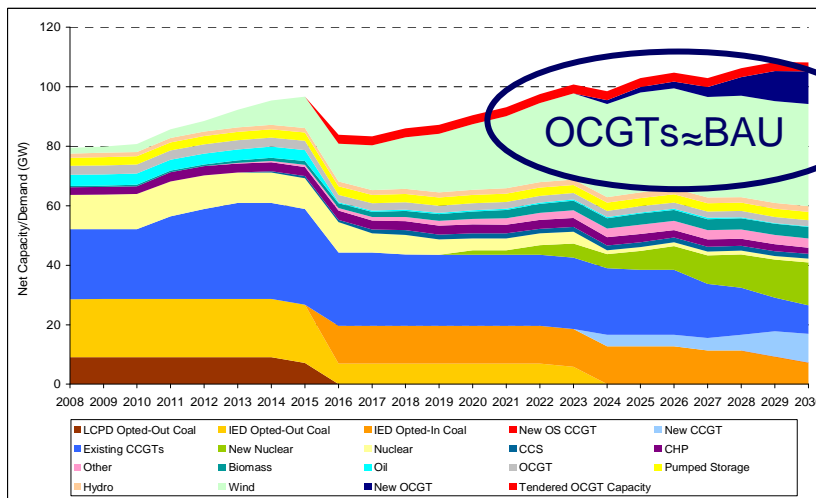
(1) Baseline (=Efficient Outcome)



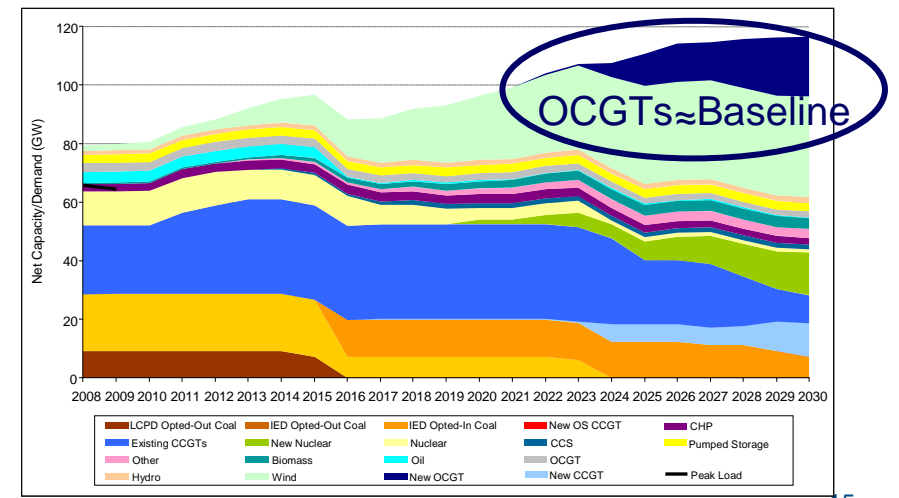
(2) BAU: Price Cap at €1,000/MWh



(3) Targeted CPM



(4) Market Wide CPM =/= Baseline



CO2 price = £30/tCO2 from 2020

In Britain, growing reliance on wind will increase the need for *peaking* plant



- Wind Power: Not intermittent, just unreliable
 - Unreliable wind plant requires back-up by peakers
 - “Flexibility” is a free by-product of investing in peakers
- Capacity mechanisms offer a more stable substitute for investment incentives in peak prices:
 - “Missing money” may reflect price caps or regulatory risk
- You cannot “intervene in part of a market”:
 - Targeted mechanisms offer no benefit, due to crowding out
 - Market-wide mechanisms strengthen (2nd best) incentives

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