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The long- and short-run role for locational marginal prices for renewable electricity

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Spring Seminar Cambridge

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Outline

- LMPs to guide investment location and dispatch
- Needs sufficient central dispatch to set reliable LMPs
- Needs efficient prices and contracts
- Long-term hedges (FTRs) by TSO to guide investment
  - Convert TNUoS to FTRs with same tenor as CfD or CRM
- Spot LMPs guide dispatch => reform renewables support
  - Yardstick CfDs for wind/PV hedge on forecast local output
  - Auction determines strike price, FTRs determine location
- FTRs inadequate to fund transmission expansion

Transmission planning better informed but still needed

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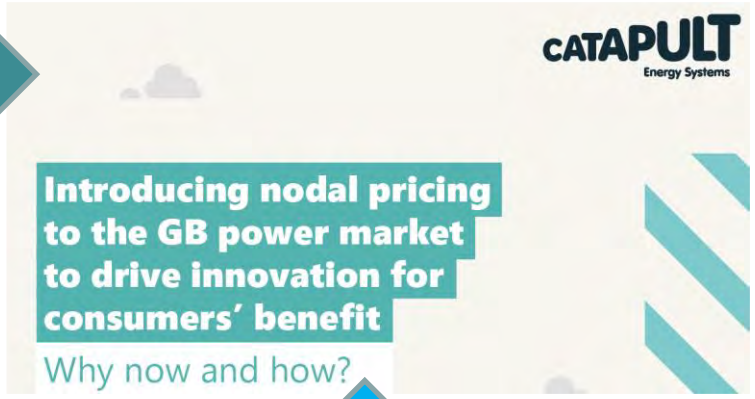
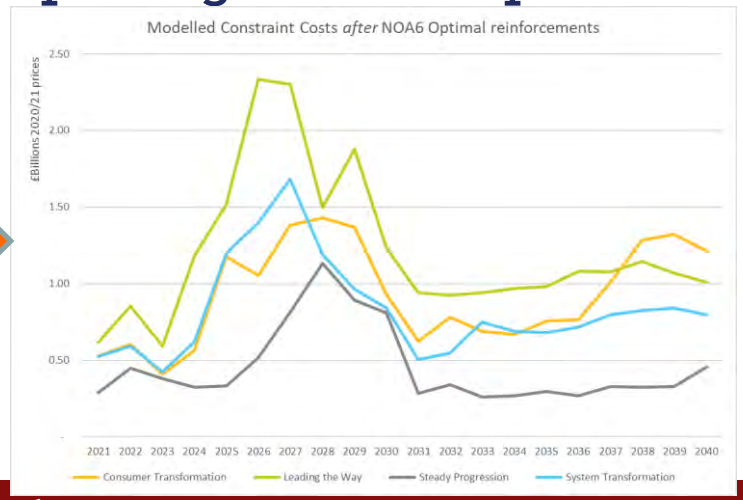
Nodal pricing: Locational Marginal Prices (LMPs)

- **Energy Systems Catapult** argues for LMP
- Ofgem: reviewing network charges since 1990
  - *Project TransmiT* 2008
  - *Targeted Charging Review* 2019
    - Response to distorting "embedded benefits"
  - *Network Access and Forward-Looking Charges*
    - To guide location decisions
- **NGESO** *Network Options Assessment*: rising constraint costs



CEPA economics matters tnei

Locational energy pricing in the GB power



Nodal pricing

- LMP = cost of delivering 1 extra MW to a node
  = Energy cost + congestion cost + marginal loss
- Proven in US, NZ for decades
- Payback in moving to LMP < 2 years
- **Central** optimal security-constrained **dispatch**
  - for a sufficient fraction to give reliable LMPs
  - Recomputed up to dispatch (at 5 min resolution)
- Removes need for ***redispatch and balancing***
- But requires suitable hedges (**FTRs**)

Long-term connection FTRs

- TNUoS were based on zonal average LMPs for conventional generation, annually reset
- Renewables based on ***annual*** load factor
- Now need ***time-weighted*** predicted LMPs for **tenor** of Yardstick FTRs and CRM certificates
  - Will differ between wind, PV, peaking and baseload
  - Tradable, can be resold to comparable technologies
  - or with adjustments to any other nodal connection
- Load pricing primarily to recover cost shortfall
  - LMP guides smart DSR

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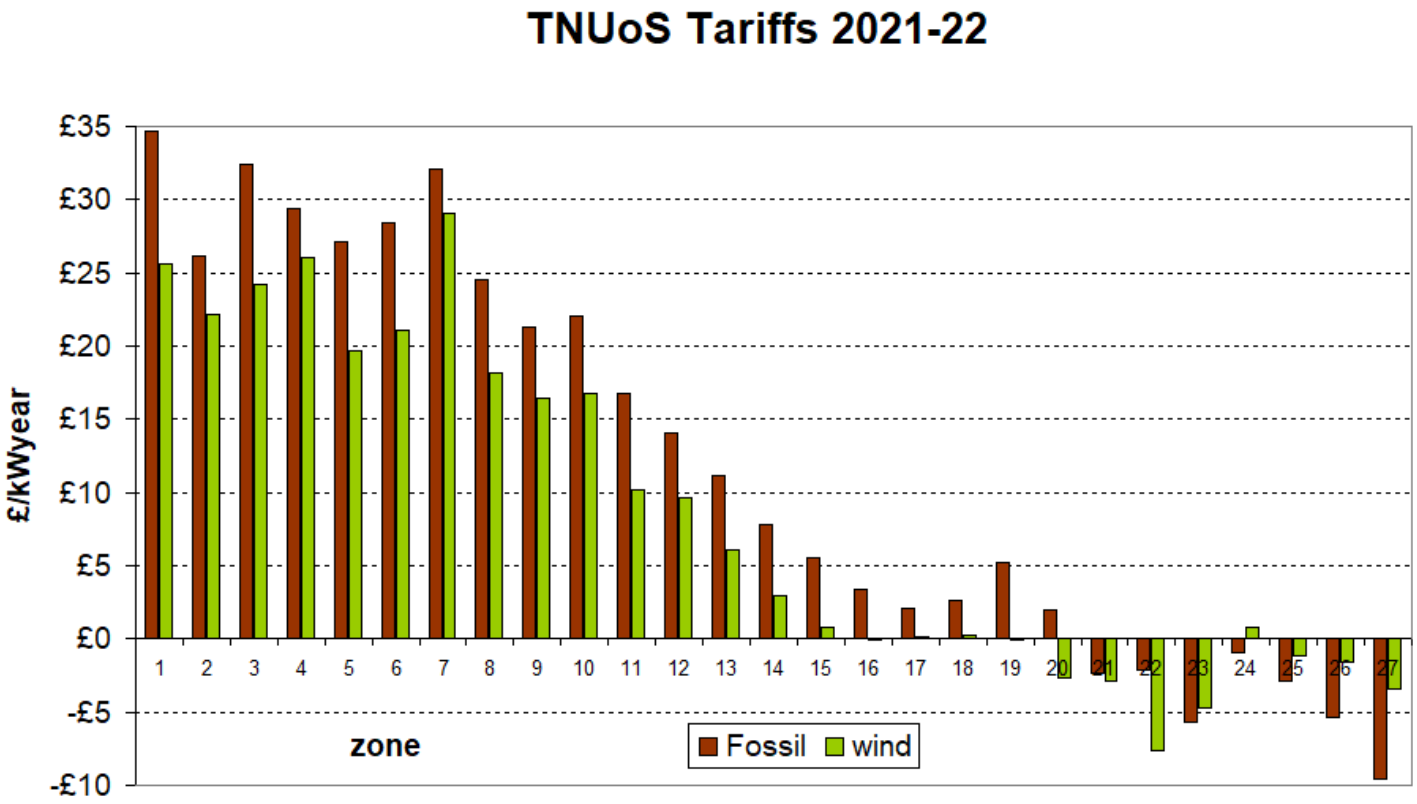
Current transmission charging methodology

Intermittent Generators

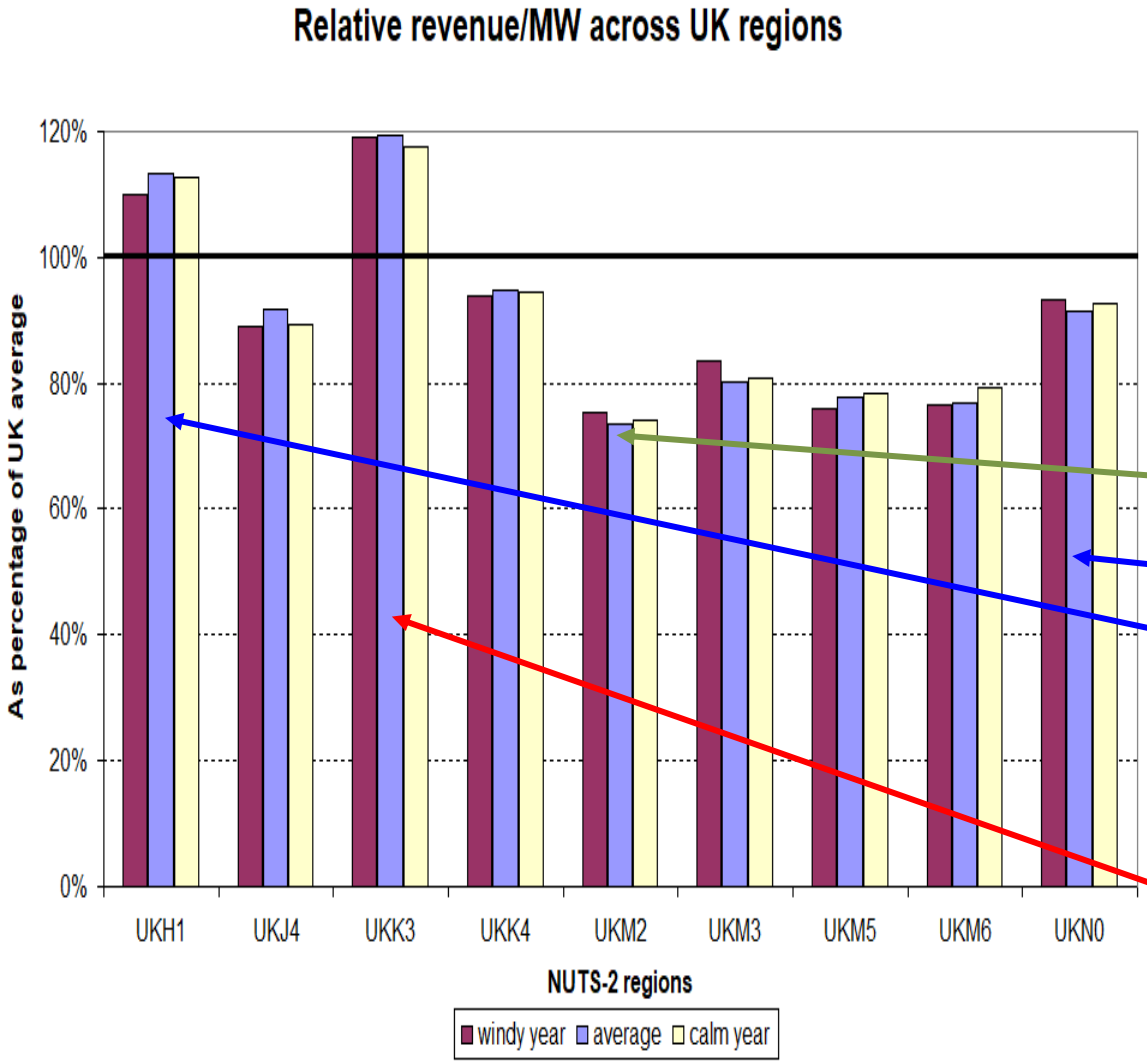
(Wind, Wave, Tidal)

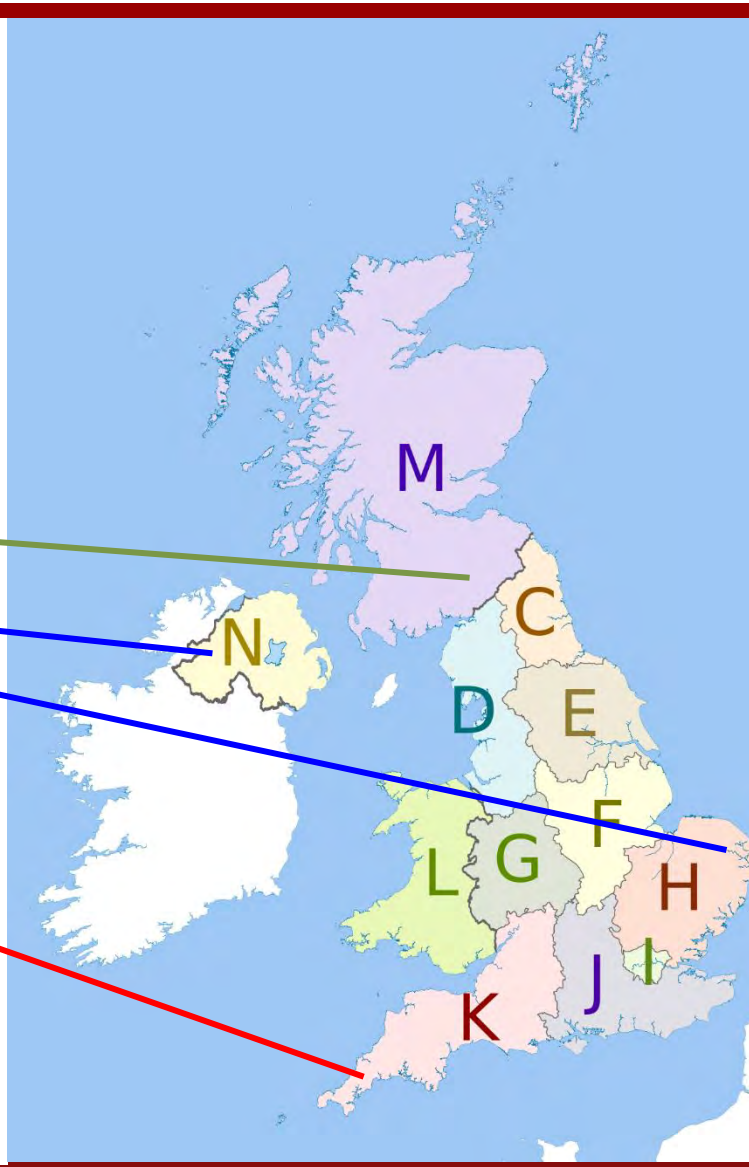
Problem: **local** hourly pattern of generation not reflected in Annual Load Factor (**ALF**)

Problem: charges **annually reset**, discourages substantial necessary changes



Output and value/MW vary across regions (from SW to NW and NI)





Efficient spot pricing

- LMPs require Variable Renewable Electricity (VRE) to face **local spot prices**

⇒ move from CfD/FiT payment on metered output to yardstick – on local ***forecast*** output for fixed number of MWh/MW

⇒ plus long-term yardstick FTR on nodal price

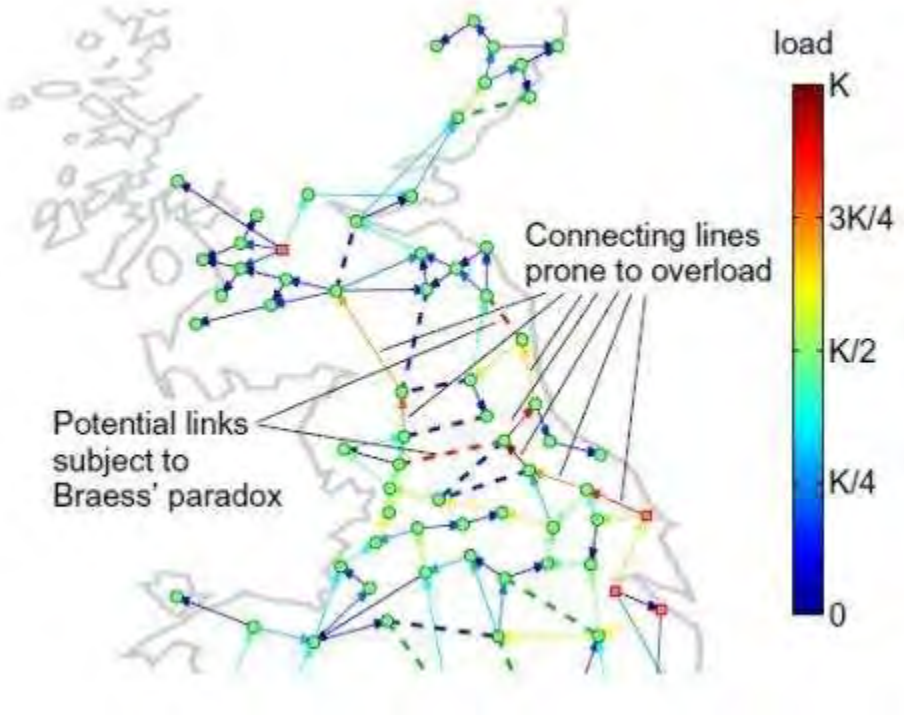
⇒ offer mutually advantageous contract switch for existing CfDs and RO holders

⇒ at end of contract revert to annual YCfDs/FTRs

Transmission investment

- Persistent nodal price differences ***indicate*** the value of grid reinforcement
- Congestion revenue does not cover optimal expansion – ***economies of scale/network effects***
- **Braess paradox** – adding an apparently profitable link may increase total congestion congestion

⇒ ***need system designer***



https://phys.org/news/2012-10-power-grid-blackouts-braess-paradox.html

Conclusions

- In large systems move to LMPs a no-brainer
- Most VRE support schemes distort location and dispatch
  - Location distortions critical: **durable**, require **costly grid investment**
- Hedging risk is key to lowering VRE cost

  ⇒ CfDs with FiTs for wind, PV are on metered output => distortive

  ⇒ Yardstick CfD for VRE for fixed MWh/MW => efficient dispatch

  ⇒ Long-term FTRs on time-weighted LMPs => efficient location
- LMPs signal grid upgrades, but dangerous to decentralise

System planning and designing long-term FTRs key

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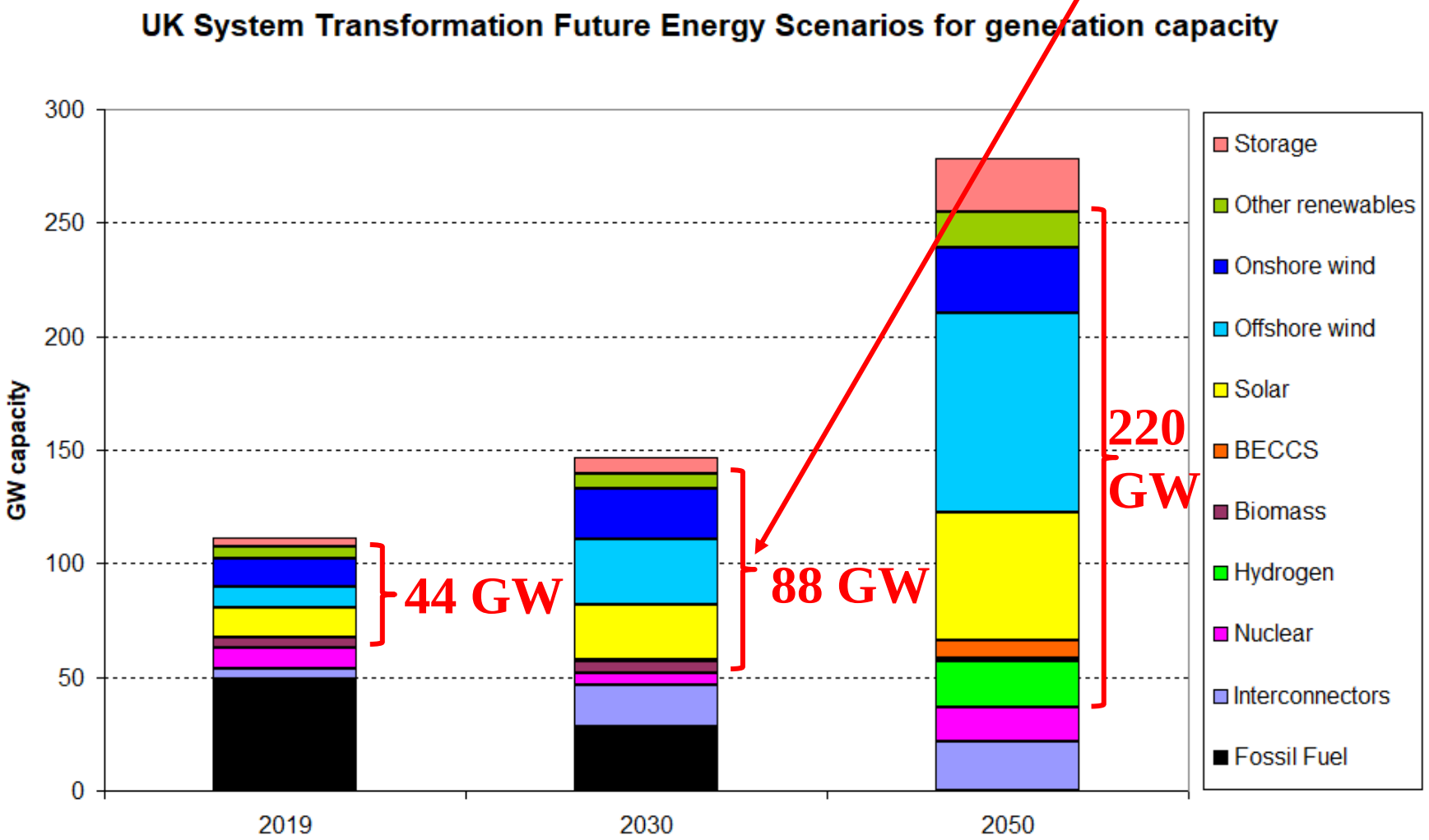
- Newbery, D.M., 2011. *High level principles for guiding GB transmission charging and some of the practical problems of transition to an enduring regime*, report for Ofgem, at http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=93&refer=Networks/Trans/PT

Acronyms

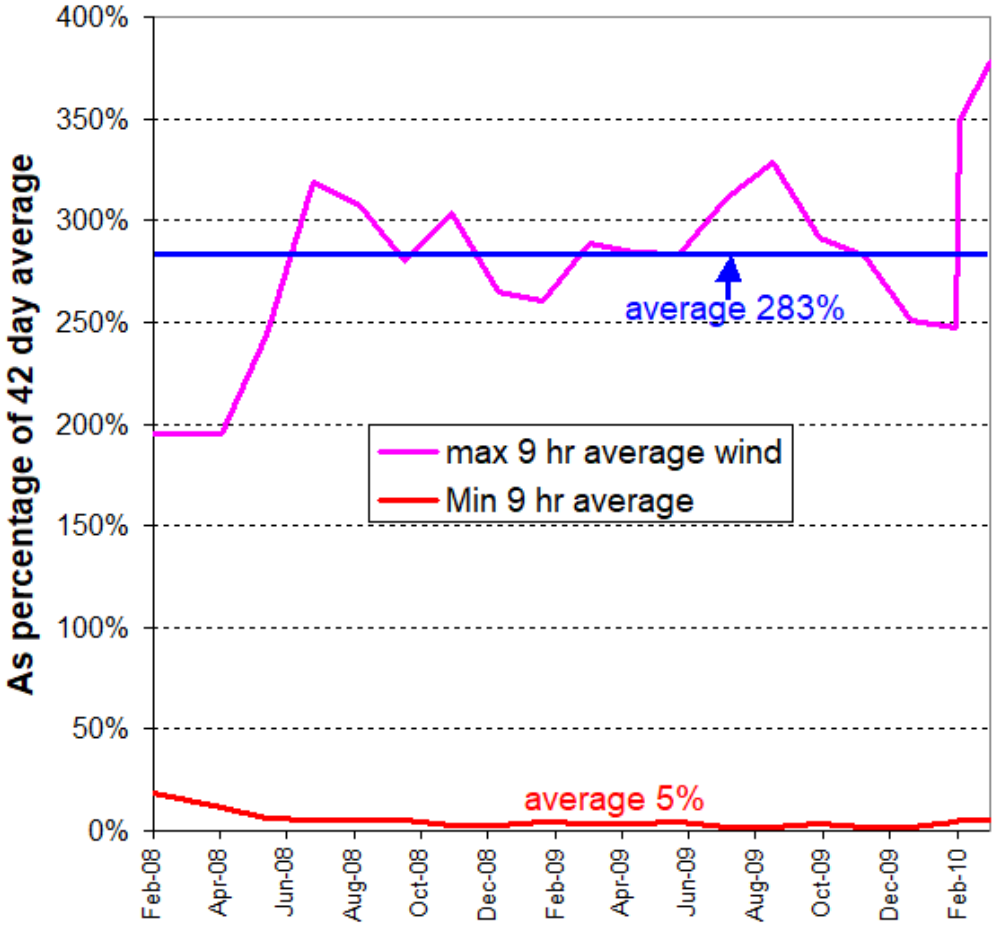
CfD: Contract for Difference
FiT: Feed-in Tariff
CfD with FiT: pays on metered not pre-specified output
CRM: Capacity Remuneration Mechanism
FTR: Financial Transmission Right
LMP: Locational Marginal Price
RE: Renewable electricity
RESS: Renewable electricity support schemes
RO(C): Renewable obligation (certificate)
TNUoS: Transmission Network Use of System
VRE: variable renewable electricity
YCfD: Yardstick CfD

UK renewable electricity capacity to *double* by 2030



Wind and sun are variable, 9 hr periods high or low output: important to get dispatch right (replacement power, spilling wind)

Wind variability SEM 2008-2010



Ratio of capacity to average demand