

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

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Spring Seminar Cambridge

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- 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

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

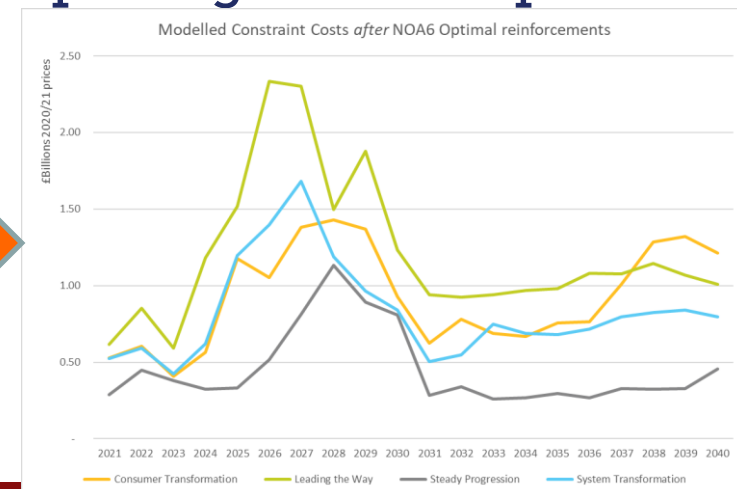


Introducing nodal pricing to the GB power market to drive innovation for consumers' benefit

Why now and how?



Locational energy pricing in the GB power



- 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

Current transmission charging methodology

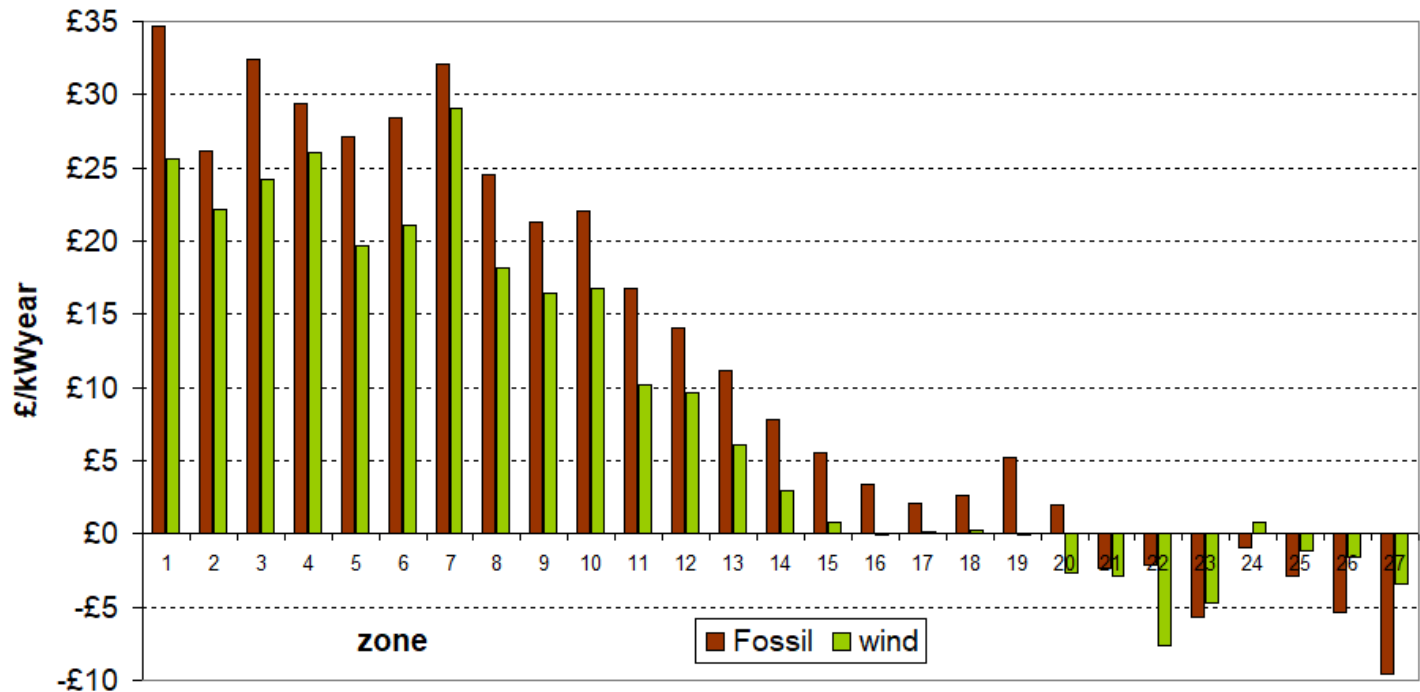
Intermittent Generators

(Wind, Wave, Tidal)



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

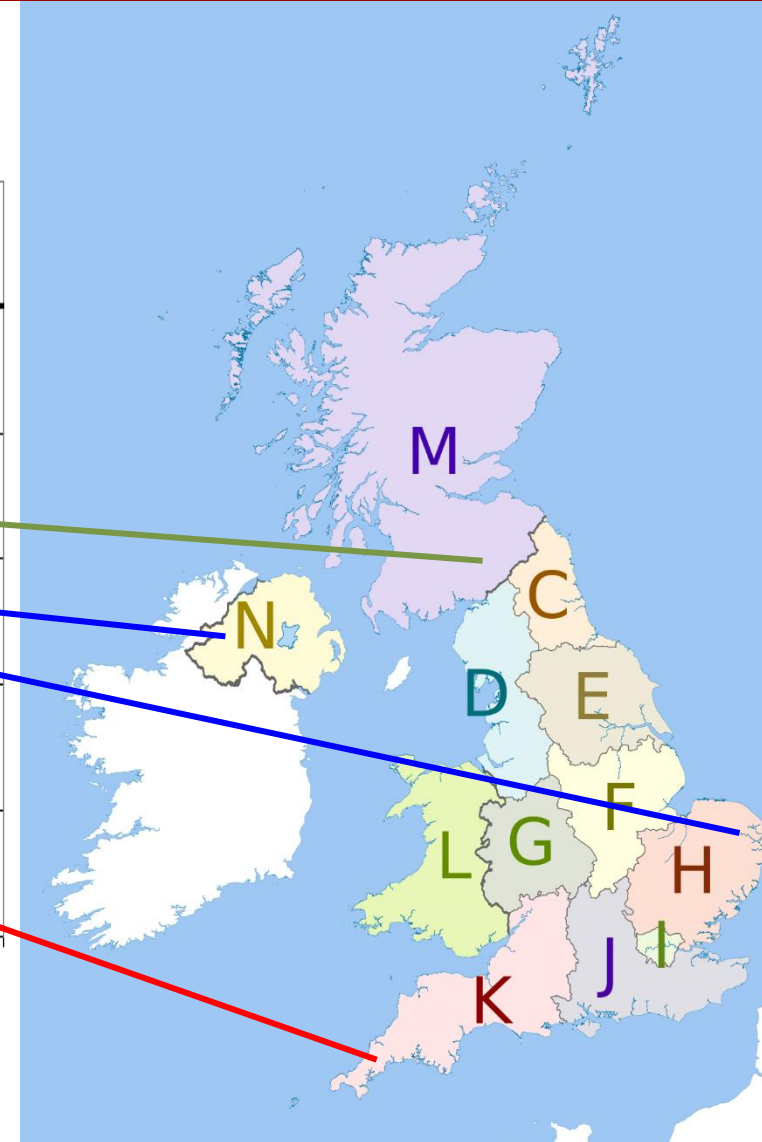
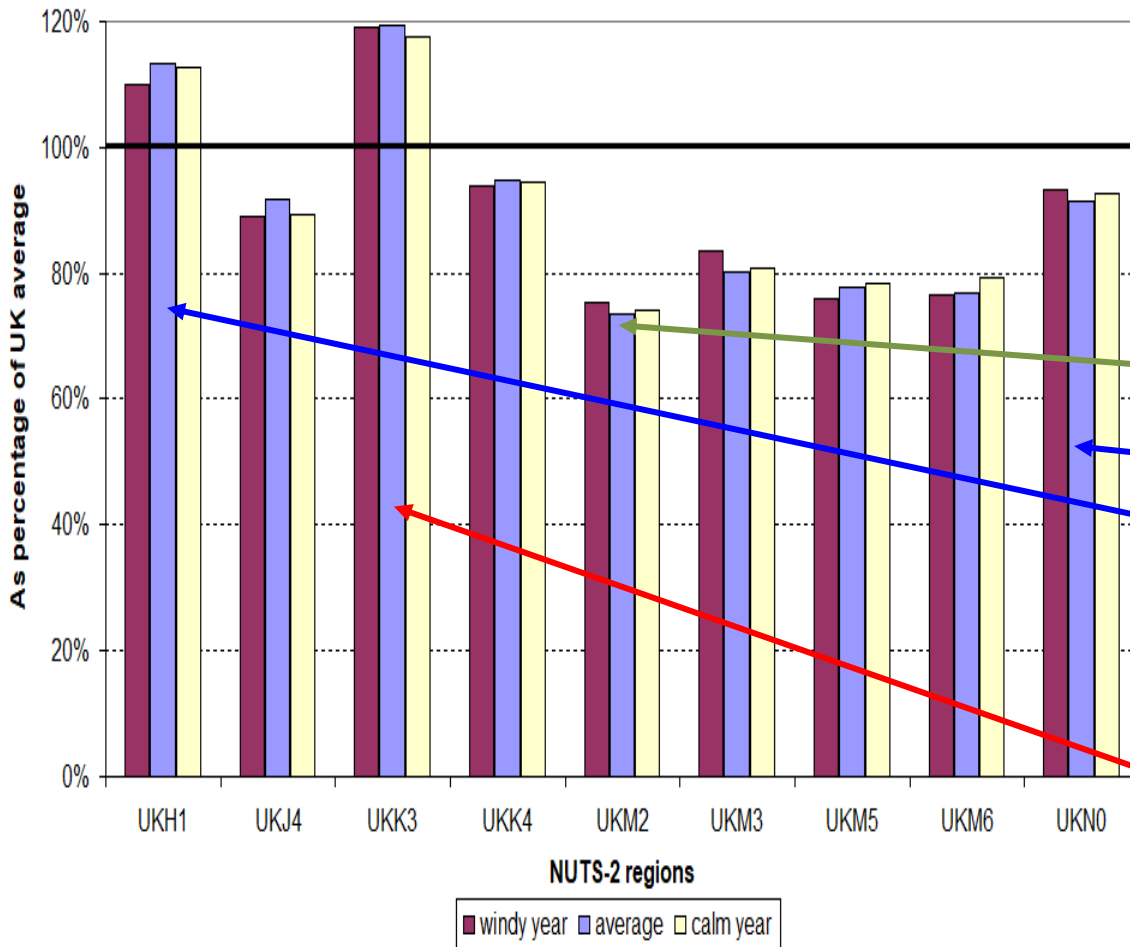
TNUoS Tariffs 2021-22



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

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

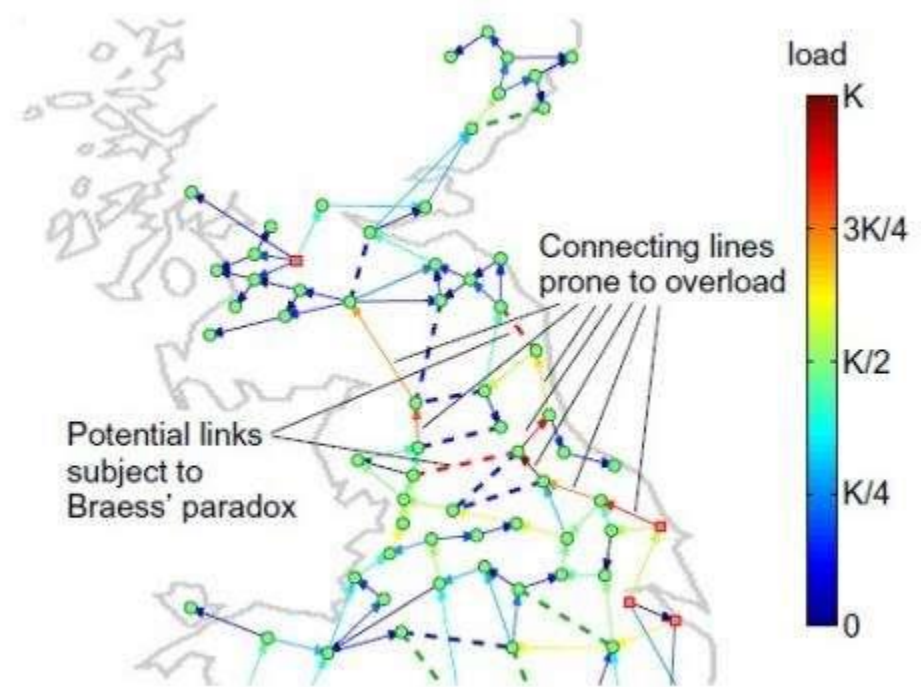
Relative revenue/MW across UK regions



- 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
⇒ *need system designer*



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

- 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., 2021. Designing efficient Renewable Electricity Support Schemes, at <https://www.eprg.group.cam.ac.uk/eprg-working-paper-2107/>
- Strbac, G., R, Green, C.V. Konstantinidis, I. Konstantelos, R. Moreno, D.M. Newbery, M. Pollitt, 2013. Integrated Transmission Planning and Regulation Project: Review of System Planning and Delivery, Ofgem, June at https://www.ofgem.gov.uk/sites/default/files/docs/2013/06/imperial_cambridge_itpr_report_0.pdf
- 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>

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

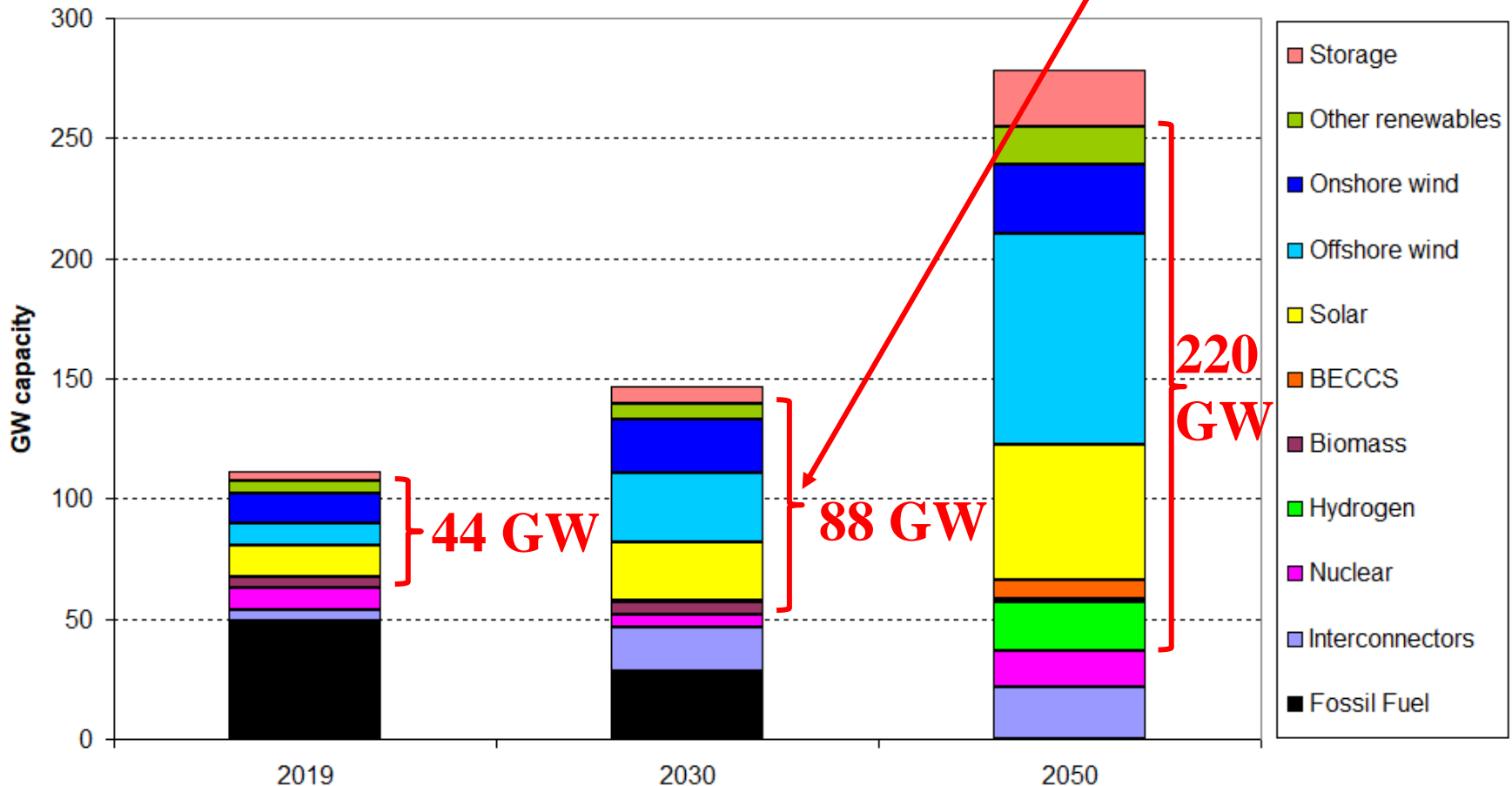
VRE: variable renewable electricity

YCfD: Yardstick CfD



UK renewable electricity capacity to double by 2030

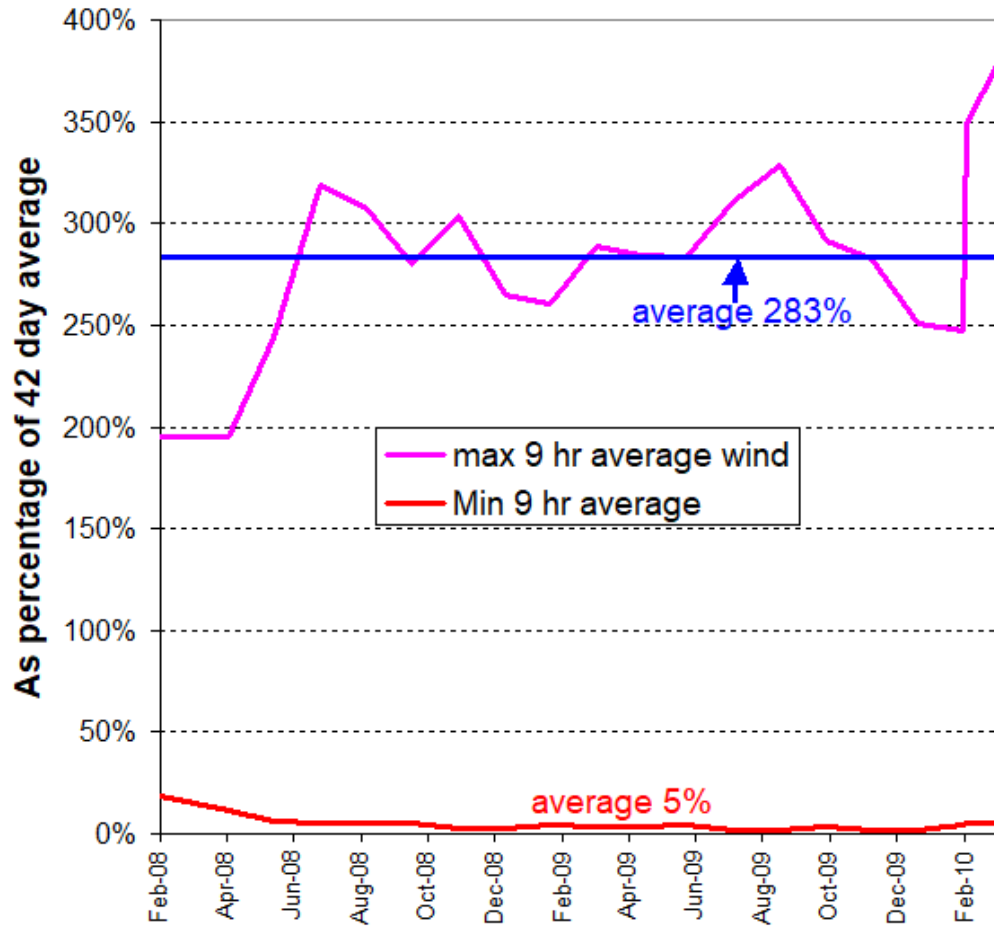
UK System Transformation Future Energy Scenarios for generation capacity





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

