From ROC to FIT - why and how

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http://www.eprg.group.cam.ac. uk

Outline

- EMR to de-risk low-C generation with CfDs
- does one-size fit all?
- If not, what to do with wind?
  - Comparisons of wind support mechanisms
  - compatibility with Target Electricity Model
- Missing EMR Reforms
  - reforming the balancing mechanism
  - reforming transmission access arrangements
  - creating a contracting agency
  - evolution via System Operator to voluntary pool

Electricity Market Reform

- To de-risk and incentivise low-C investment

=> Long-term contracts for credibility

=> C-price Support to underwrite wholesale price

  – ensures nuclear is not “subsidized”

=> *Capacity payments for peaking plant?*

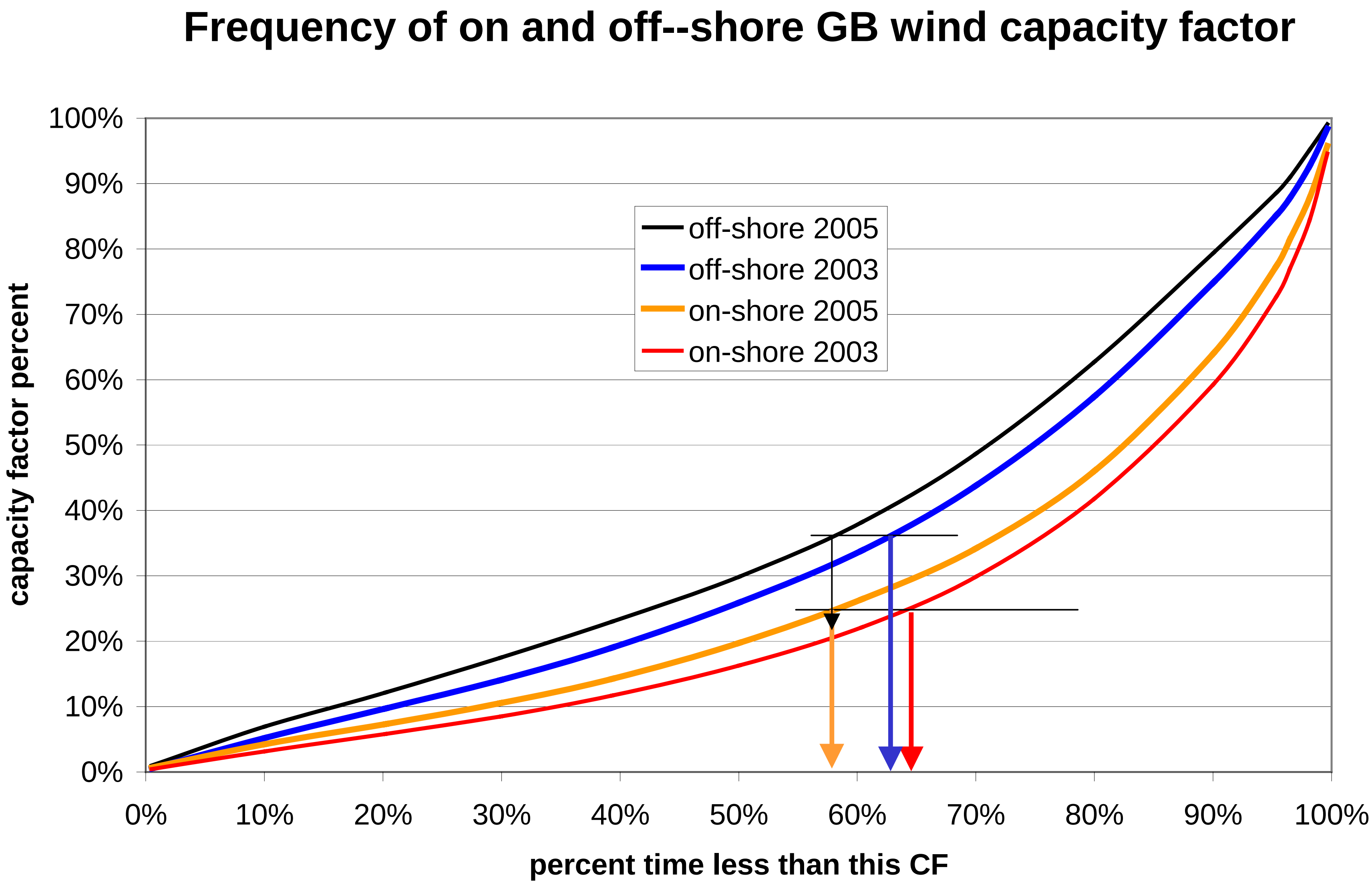
=> *EPS to deter unabated coal??*

What are the right contracts for wind?

Characteristics of wind

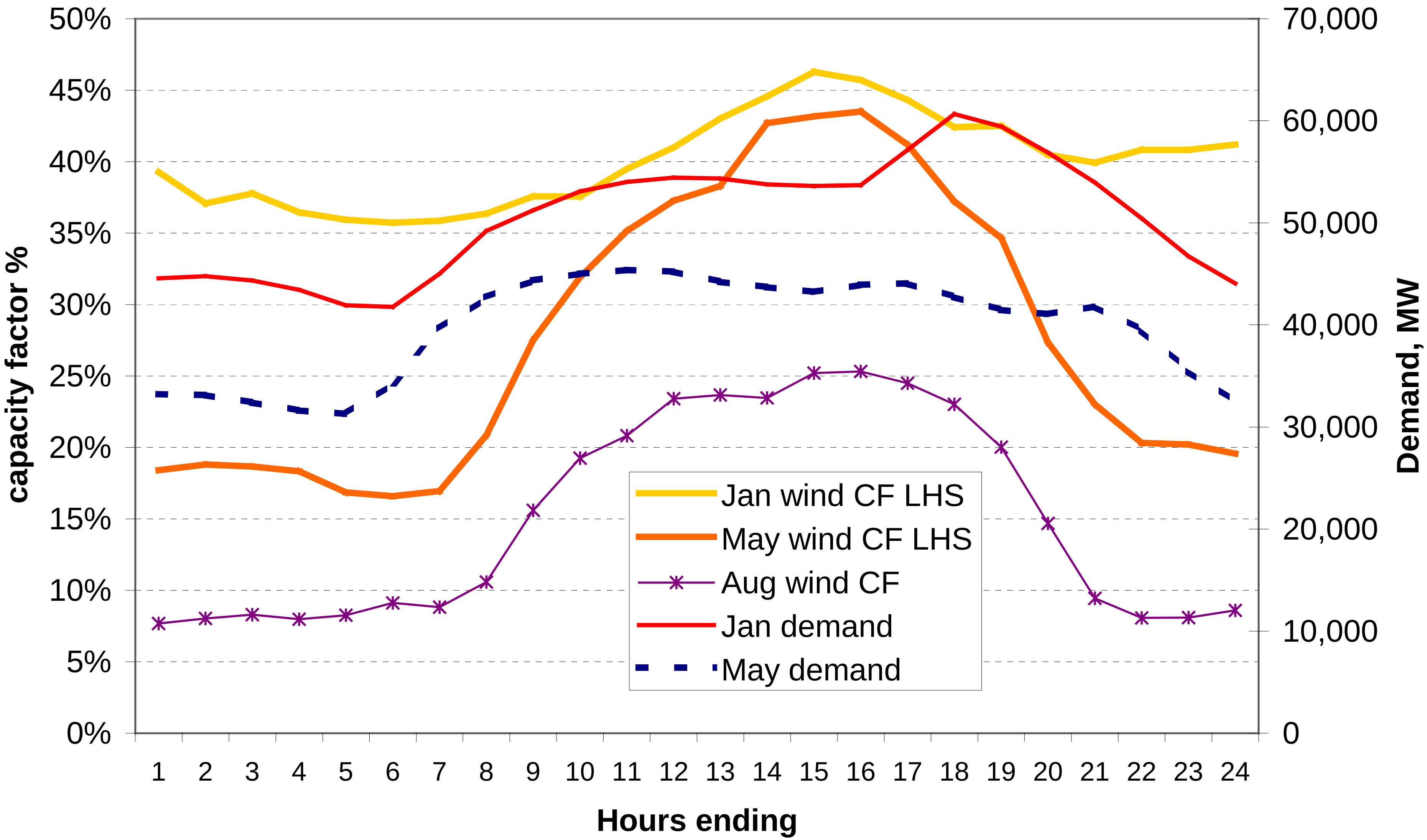
- Low capacity factor
  = 25% on-shore, 36% off-shore
  => care specifying amount of contract
- High variability
  – requires considerable flexible dispatchable reserves
- Low predictability day-ahead
  – hard to contract ahead, risk of imbalance

Capacity factors



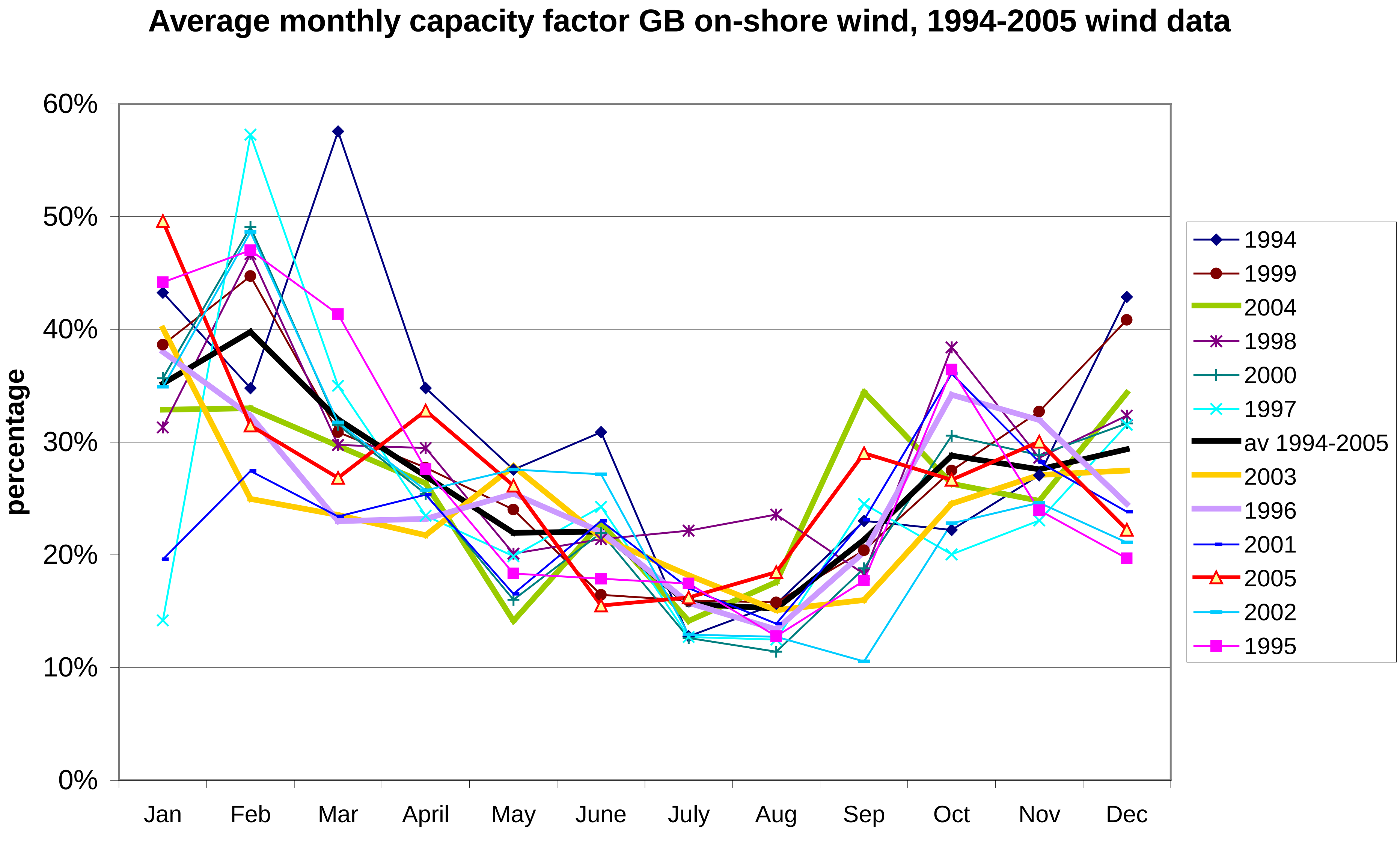
Source: Green and Vasilakos (2010)

Hourly average wind and total demand



Source: Green and Vasilakos (2010)

Seasonal capacity factors



Source: Green and Vasilakos (2010)

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Long-term contracts: FiTs

- EMR offers 3 options:
  - Premium FiT, fixed price FiT, **FiT with CfD**
- wants same for all low-C: FIT with CfD
- Classic 2-sided CfD: specify vol *M* strike *s*
  - price = *p*, holder receives (pays) (*s*-*p*)*M*

  => generate when *p* > SRMC, buy if *p* < SRMC, avoid unavailability when *P* high

  => works well for nuclear, CCS, biomass

but does it work for wind?

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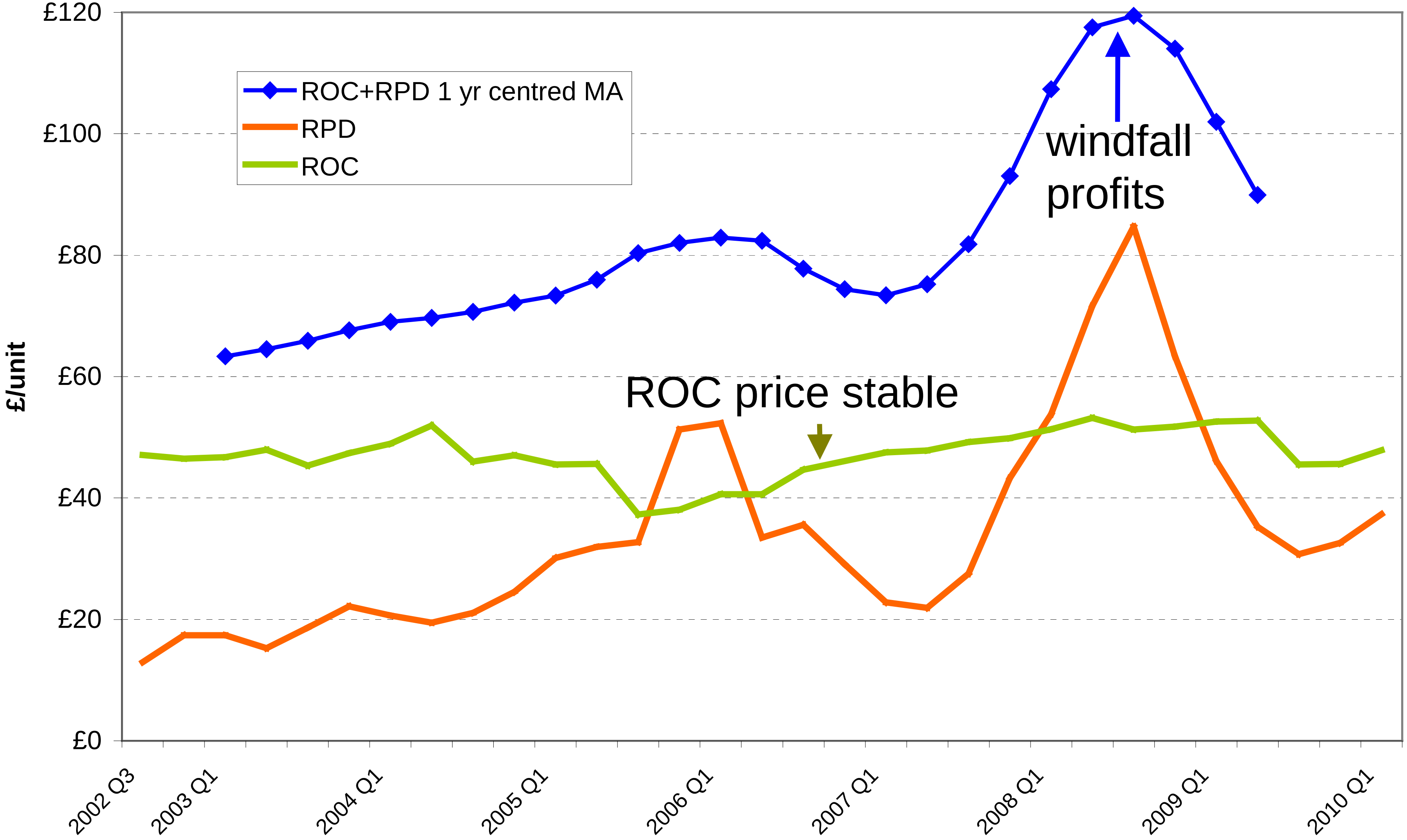
UK ROC, EUA, and electricity prices



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Designing a wind CfD

- Premium FiT is like a ROC
  - but pFiT is more credible
- faces market price risk and market selling risk
  - and derives windfalls from e.g. CPS, ETS, …
  - faces risk of market splitting under Target Model
- FiT+CfD: specify volume and reference price
- turbine 4 MW capacity => 1 MW av output
  - CfD for 4 MW? 1 MW? Or metered output?

Or offer CfD on metered output?

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Basis risk

- Basis risk = sales price *less* reference price
- Reference price: average day-ahead price
  - assuming we can find a reliable liquid market
    - or a reliable reference price: LEBA index & N2EX?
- If all output could be reliably sold spot, wind only faces *basis risk*

How large is basis risk now and in future?

Basis about £1/MWh +/- £1.50

Table 2 Average prices received selling spot vs. selling at daily base-load average

	1999/2006	2001/2007	2002	2003	2005	2005/2009
wted av on-shore	£38.45	£29.64	£15.78	£18.14	£34.54	£39.30
wted av off-shore	£37.81	£29.28	£15.75	£18.69	£35.89	£38.92
time av	£37.75	£28.53	£15.23	£18.36	£36.49	£36.92
ratio on-shore	101.9%	103.9%	103.6%	98.8%	94.6%	106.4%
ratio off-shore	100.2%	102.7%	103.4%	101.8%	98.3%	105.4%

Source: wind data from Green and Vasilakos (2010); prices from UKPX RPD

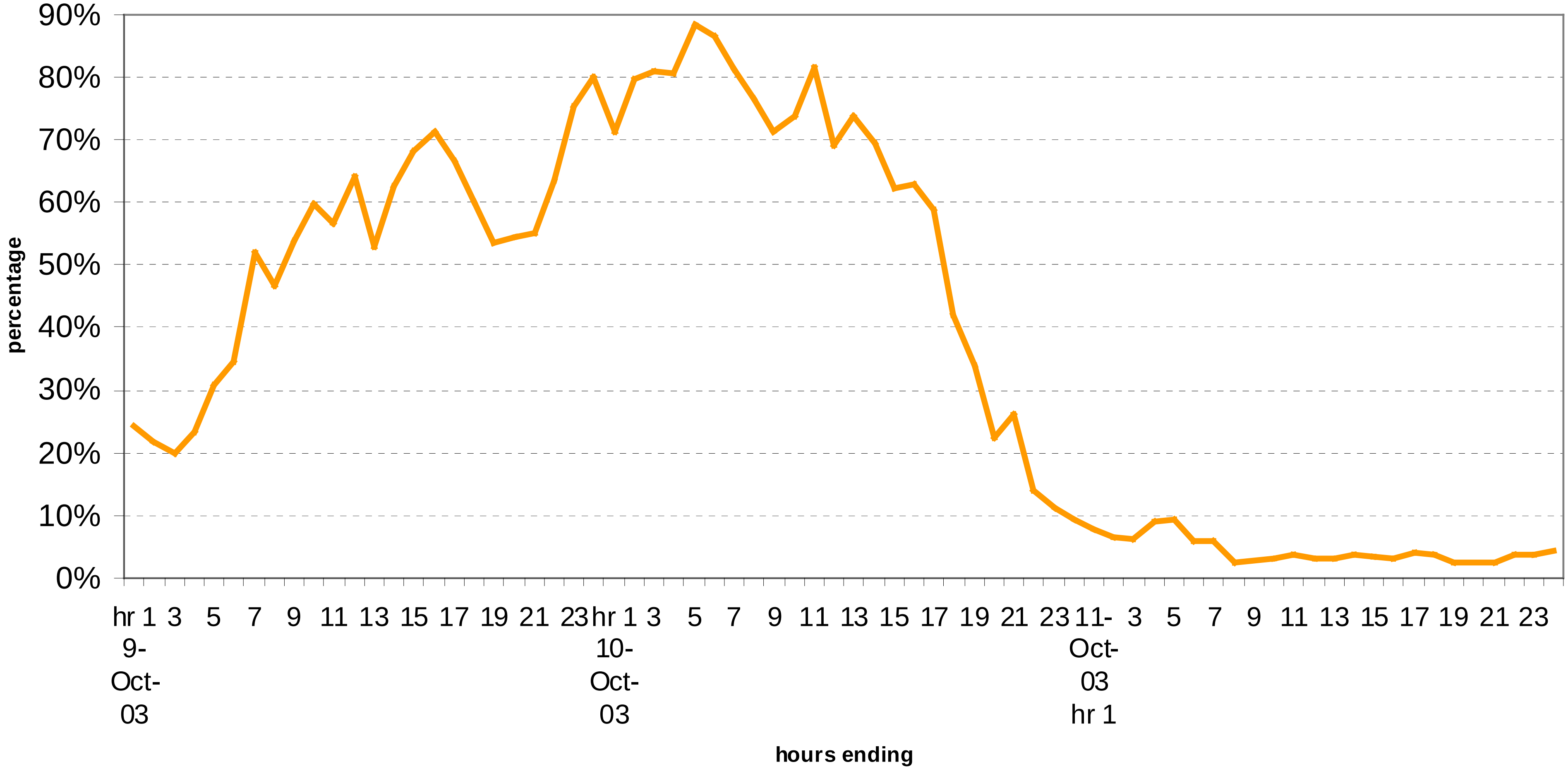
Table 4 Average prices received selling spot vs. at 2020 predicted daily averages

	1999	2001	2002	2003	2005
wted av on-shore	£24.18	£37.04	£25.13	£24.59	£24.20
wted av off-shore	£24.50	£35.87	£25.14	£24.77	£24.67
time av	£25.88	£35.22	£26.49	£26.56	£26.12
ratio on-shore	93.5%	105.1%	94.9%	92.6%	92.7%
ratio off-shore	94.7%	101.8%	94.9%	93.3%	94.4%

Source: wind and price data from Green and Vasilakos (2010)

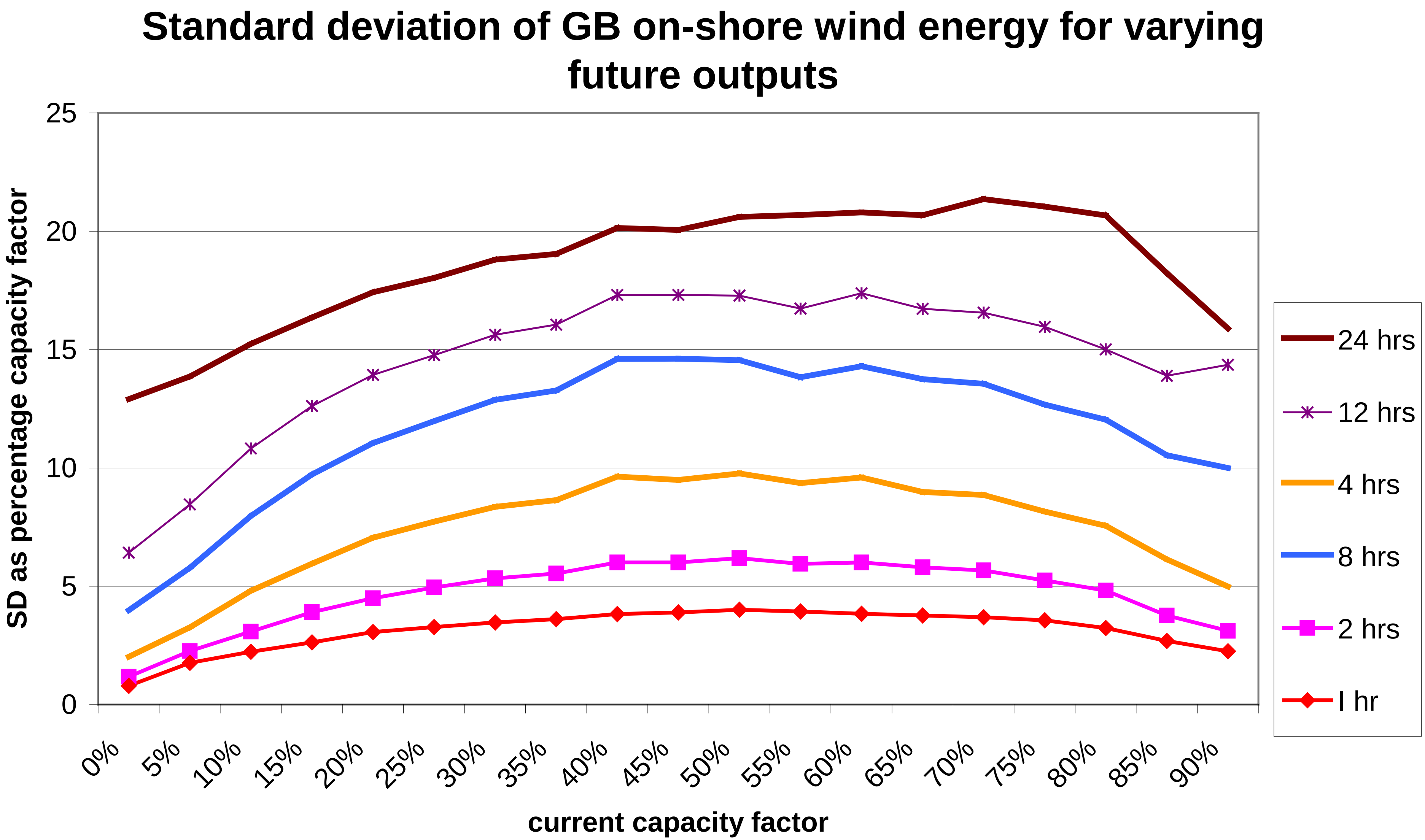
Variability and need for back-up

On-shore wind capacity factors 9-11 Oct 2003



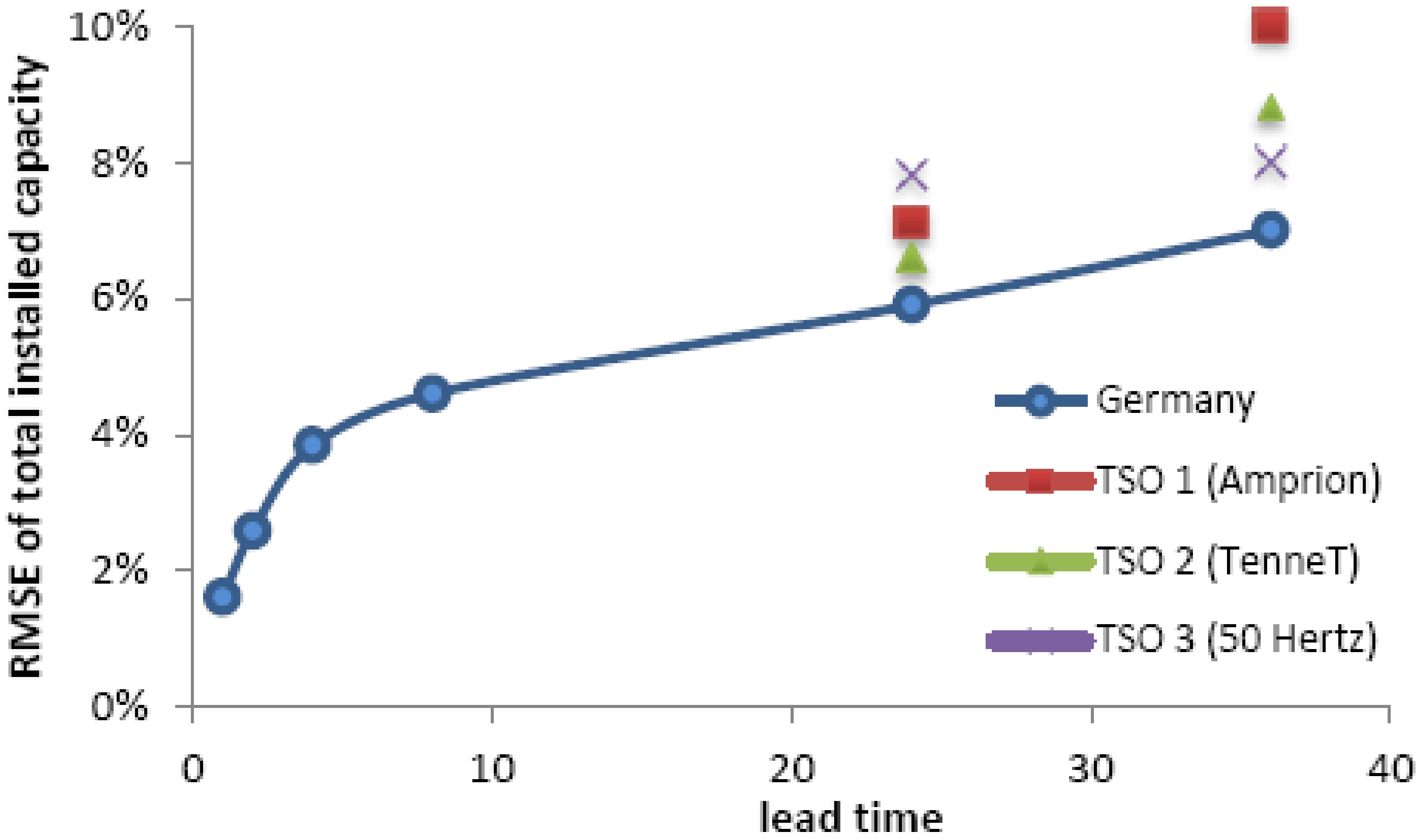
Source: Green and Vasilakos (2010)

Forecasting ahead



Source: James Cox, Poyry

Forecasting errors



Borggrefe and Neuhoff (2011)

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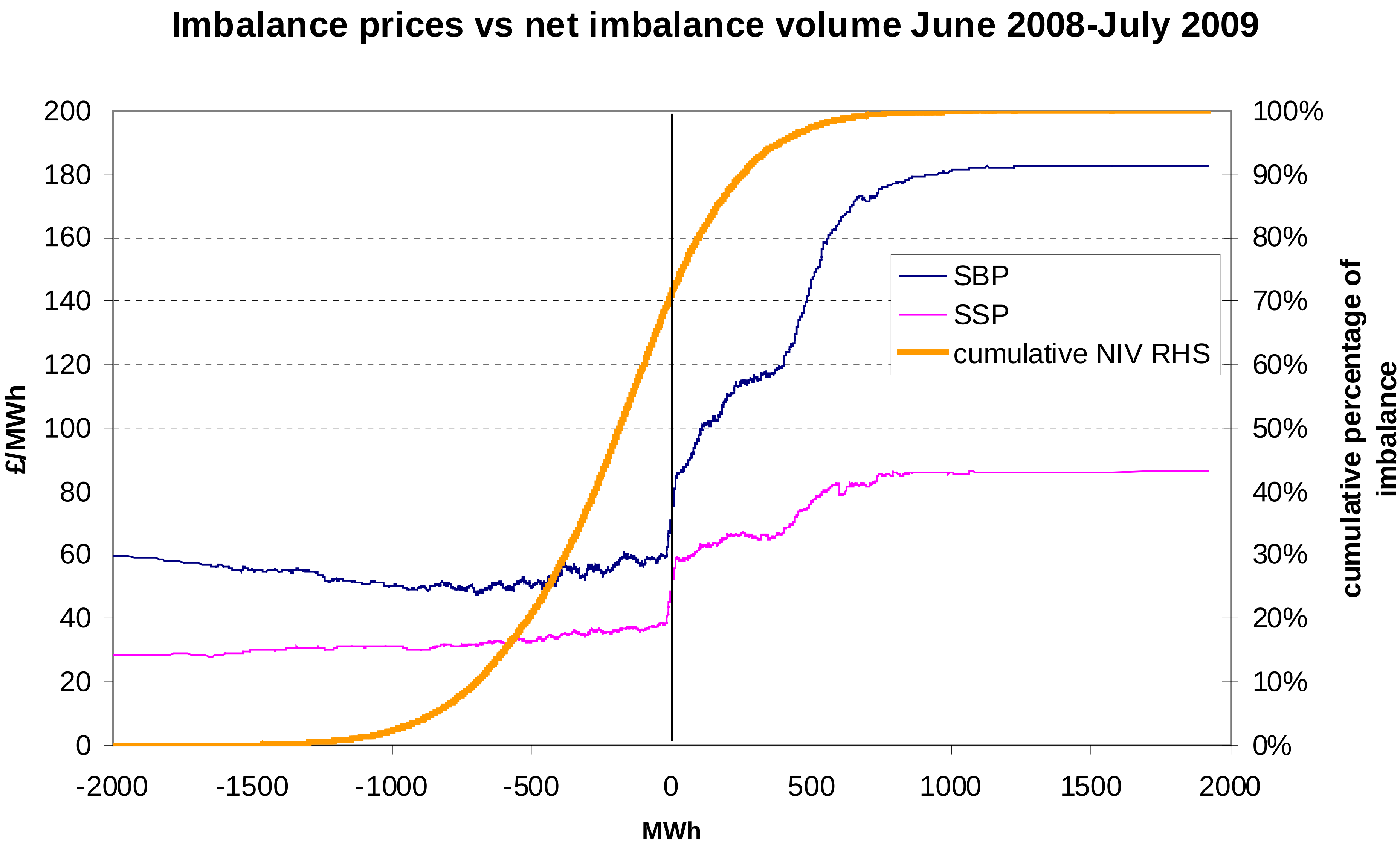
Sales risk

- FiT/CfD requires wind farm to sell output
- under BETTA contract ahead
  - possibly 24+ hours for predicted output
- but actual output differs from predicted output
- RMSE of 24hr forecast = 12%? Average deviation = 9%
- 4GW turbine: Average imbalance = 0.36 MW

What is imbalance penalty?

Imbalance risks



Source: Nigel Cornwall

Estimating imbalance exposure

Table 5 Average GB BM spreads when short and long

	shares	2006/7	shares	2008/9
overall	100%	£13.32/MWh	100%	£26.83/MWh
average long	71%	£7.22/MWh	71%	£19.80/MWh
average short	29%	£28.26/MWh	29%	£44.02/MWh

When helping reduce imbalance receive spot price: 50%

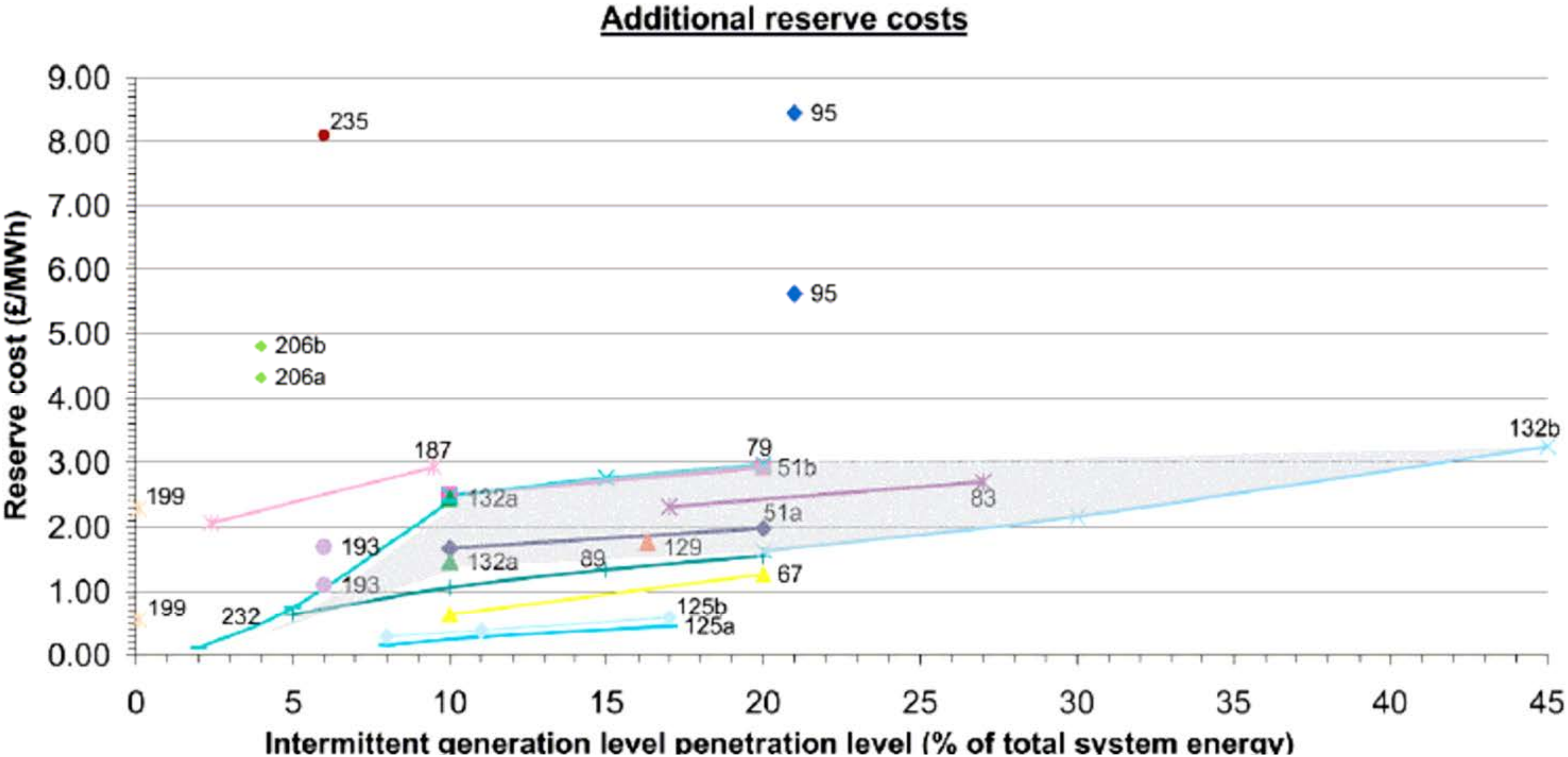
Expected cost:

When long = 71% x 50% x £7.22/MWh x 0.36MW = £0.92, (in 2008/9 = £2.53)

When short = 29% x 50% x £28.26 /MWh x 0.36 /MW = £1.47 in 2006/7 and £2.30 in 2008/9,

Total cost = £2.60/MWh (06/7), £4.83/MWh (2008/9)

Range of estimates of costs of additional reserves



Key: 51 (Mott MacDonald 2003), 67(Holttinen 2004), 79(Dale et al 2003), 83(Ilex and Strbac 2002), 89(Milborrow 2004), 95(Bach 2004), 125(Ilex et al 2004), 129(Pedersen et al 2002), 132(Milborrow 2001), 187(Seck 2003), 193(Hirst 2002), 199(Hirst 2001), 206(Fabbri et al 2005), 232(Dale 2002), 235(Milborrow 2005)

Source: UKERC 2006

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PPAs with Big Six

- Offer discount of 10% (?) on reference price
  - average ROC+market price = £80/MWh
  - discount = £8/MWh
- extra imbalance risk + basis risk = £4-6/MWh?
- But extra system cost might be £2-3/MWh
- so contracting this way costs £2-4/MWh

=> 20% wind = 70TWh/yr = **£140-£280 mill/yr**

The answer is a fixed FIT!

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Institutional change

- Leave detailed contract design to new contracting institution
  - with rights to charge consumers for extra cost
- Designate System Operator as buyer of fixed FITs and flexible balancing services
  - optimise system dispatch, collect best wind forecast

=> SO sets up voluntary pool + central dispatch

eliminates balancing inefficiency with minimal change

Capital cost

- Remove market/imbalance risk => increase gearing from 75% to 85% (on-shore)?
- Index FiT price to RPI?
  - Borrow at indexed rates 3% real not 4% real?
  - Equity = 16% nominal, 13.5% real
  - post-tax WACC falls from 6.4% real to 4.6% real
- on £30 billion wind invest **save £0.54 bill/yr**

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Conclusions

- Fixed FiT + SO to buy/dispatch for wind
- Need institutional reform
  - contracting agency (Ofgem?)
  - central dispatch of wind, voluntary pool
- FiTs then site-specific => efficient location
- Perhaps an agency to procure and auction sites?

Good contract & market design save £800 mill/yr over 15 years = £12 billion - not bad!

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Appendix: extra slides

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Target Electricity Model

- ACER to design instruments for 3rd package
  - network codes, capacity allocation, congestion management

=> market coupling/splitting with zones defined by congestion not countries

  - Cheviot border => Scotland has lower prices

- impacts ROCs and pFiTs for Scottish wind
- but fixed FiTs can fix local price

Fixed FiTs more resilient to market changes

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Transmission access review

- At present wind pays higher TNUoS in distant locations to reflect transmission costs
  - but Scotland is lobbying for a uniform charge
- but receives same ROCs for higher output
- learning benefits come from capacity not output

=> extra output excessively rewarded

=> encourages costly and distant wind farms

FITs could handle this if sensibly designed- need to be location-specific

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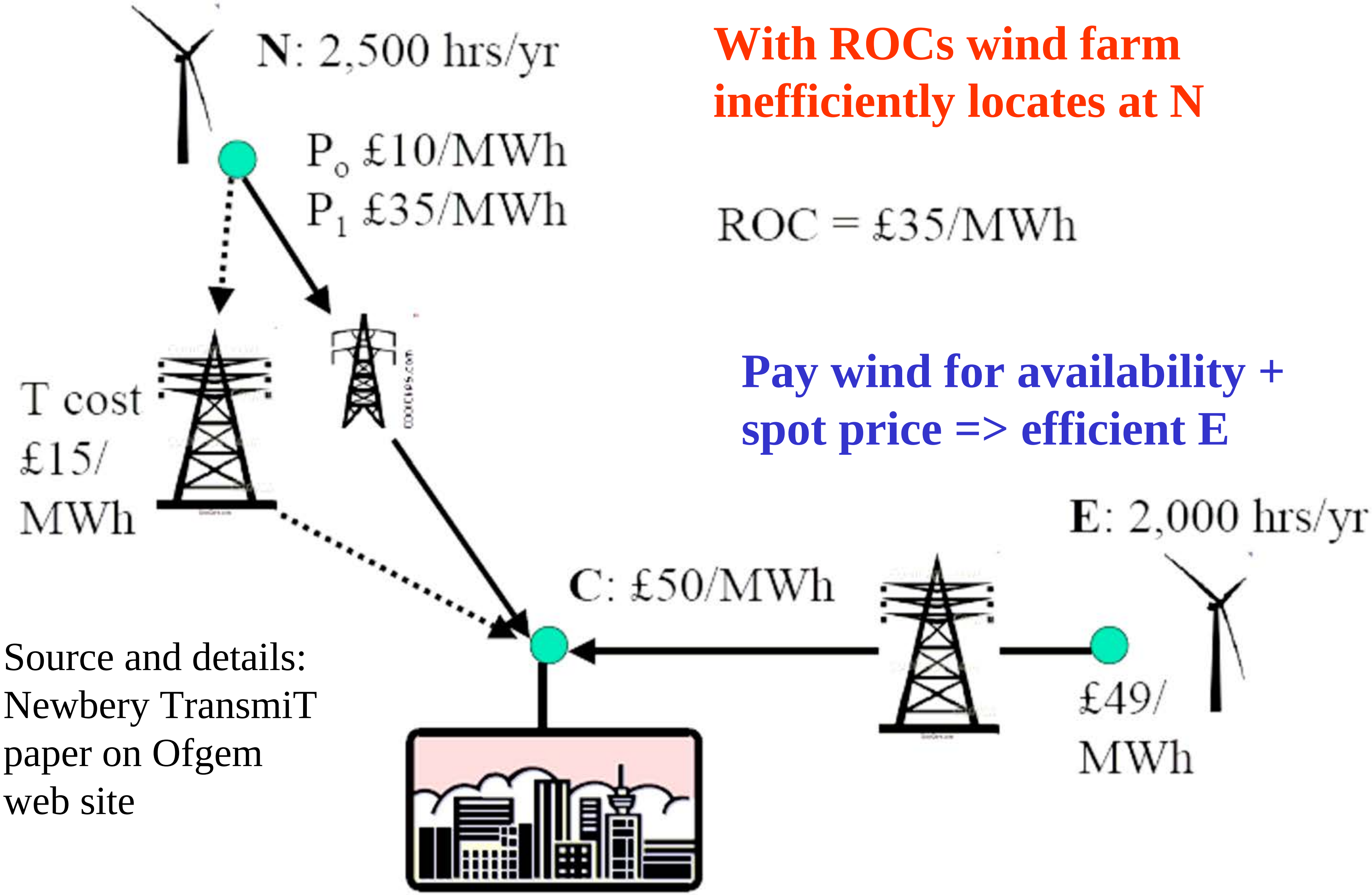
Location choices under LMP and spot pricing for wind



With ROCs wind farm inefficiently locates at N

Pay wind for availability + spot price => efficient E

Source and details: Newbery TransmiT paper on Ofgem web site