



# Market design for flexible network operation

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# Market design to support operation and investment



Uncertainties

- Nuclear policy
- CO<sub>2</sub> policy
- Finance
- Renewable support
- Planning
- Supply chain

Generation investment

- finance
- enable
- pricing
- flexibility

Network investment

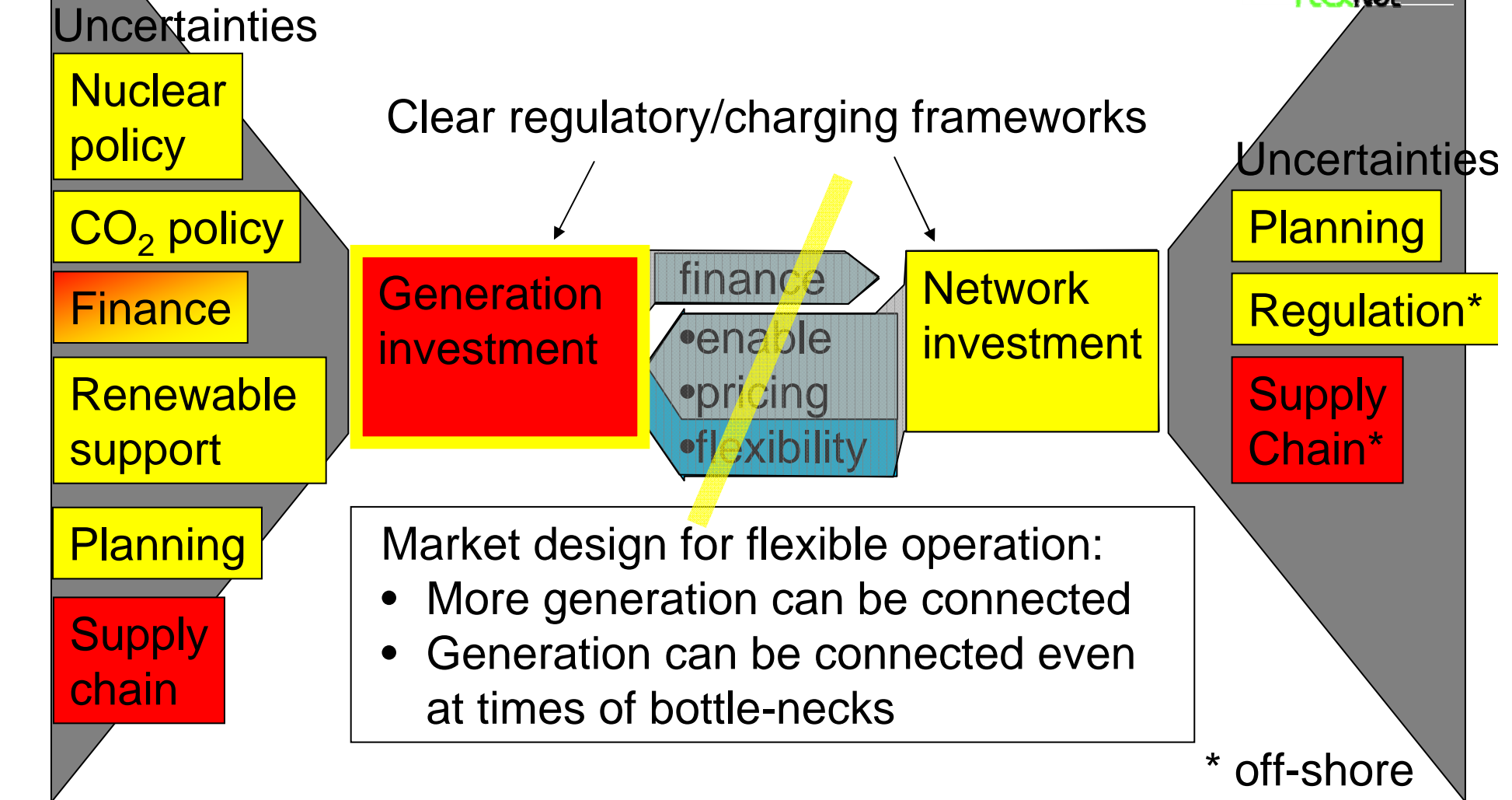
Uncertainties

- Planning
- Regulation\*
- Supply Chain\*

\* off-shore

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# Market design to support operation and investment



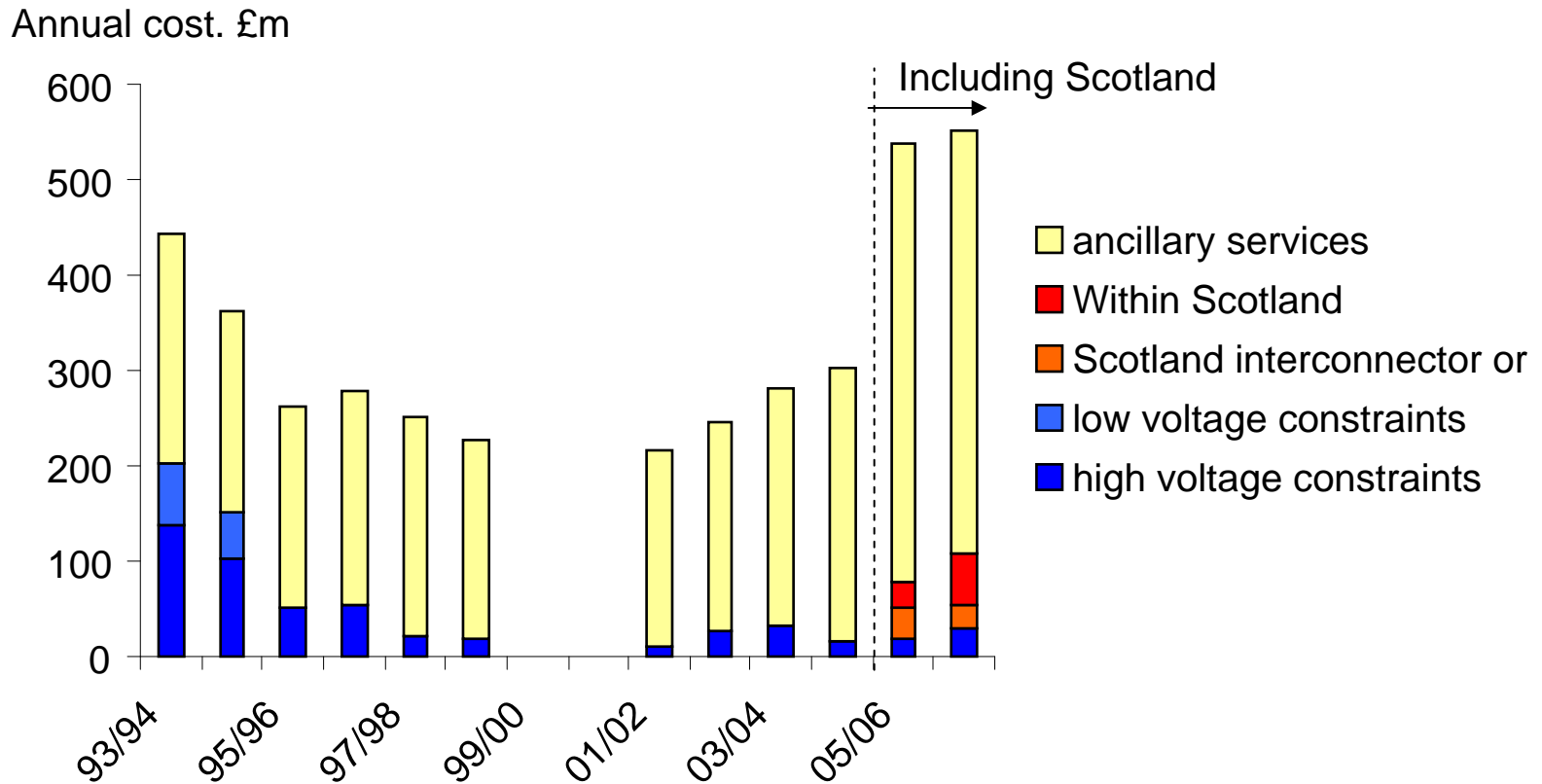
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# Current transmission access



- Connect for firm access
  - delay until reinforcements in place
  - > excessive T capacity for wind
  - > excessive delays in connecting wind
- TSO uses contracts and balancing mechanism to manage congestion
  - weak incentives on G to manage output
  - costly to deal with Scottish congestion

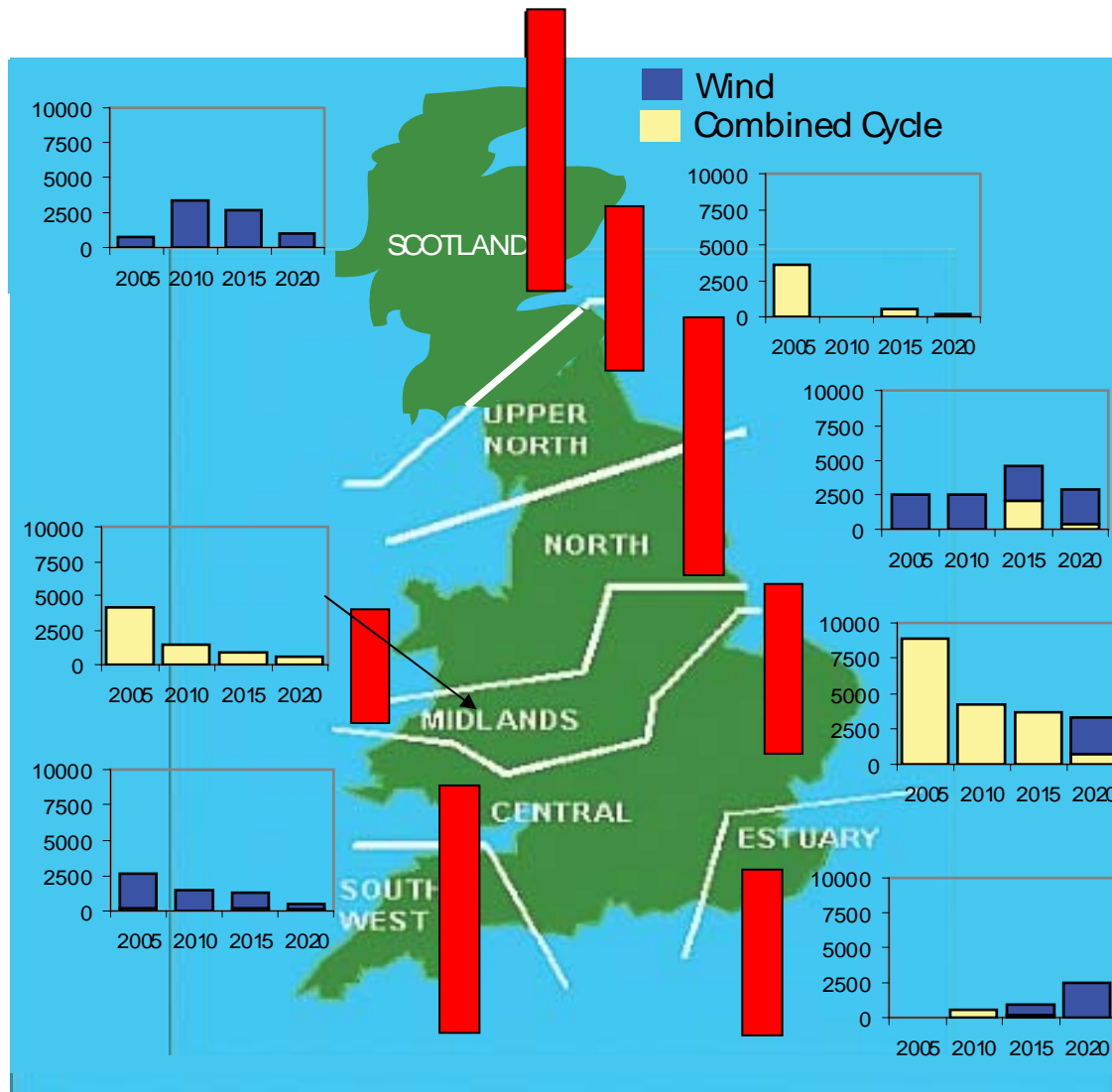
# Re-dispatch to resolve constraints in England and Wales



**Costs rise rapidly with constrained links to Scotland**

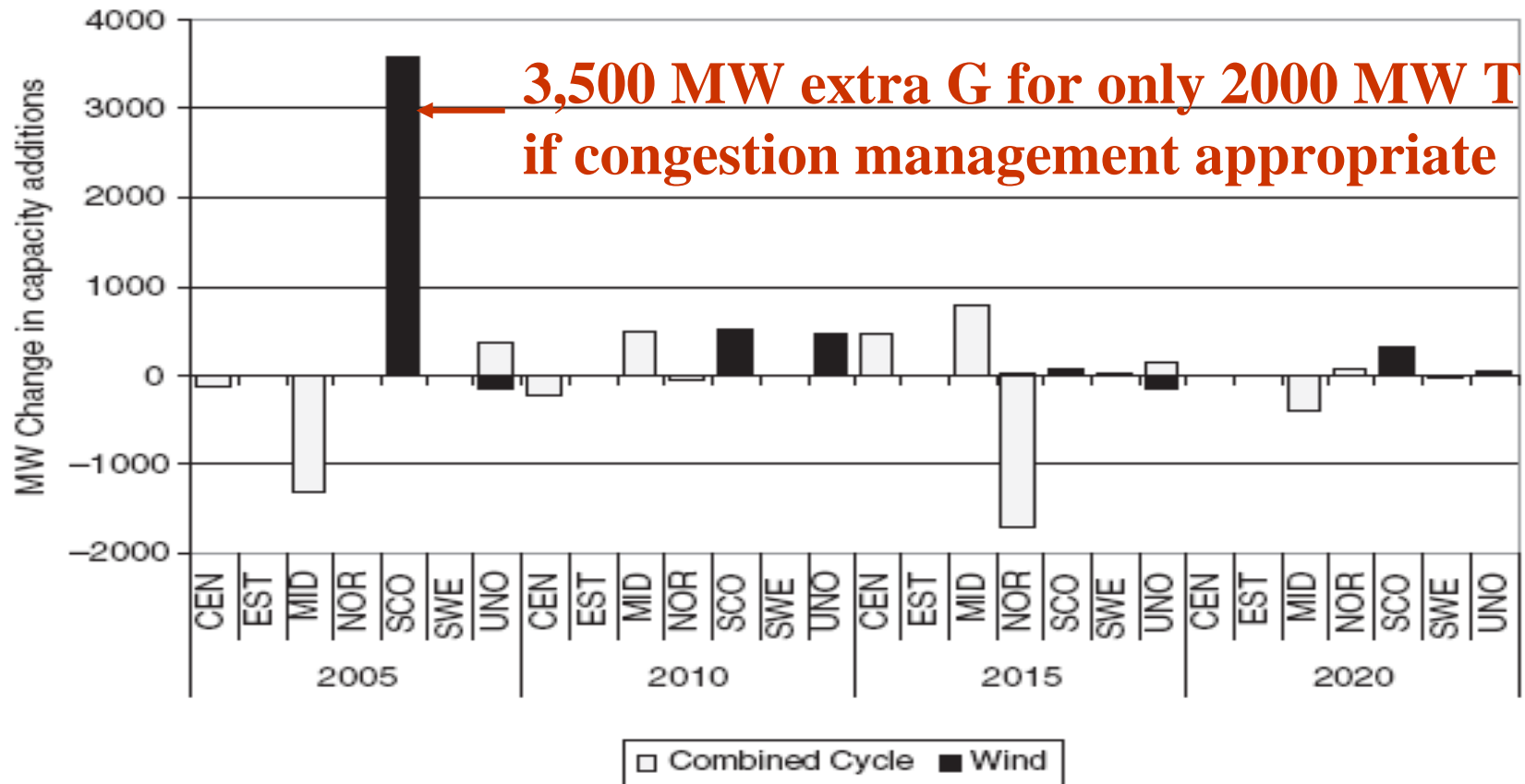
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# Modelling of UK power investment



Source: Neuhoff, K., Ehrenmann, A., Butler, L., Cust, J., Hoexter, H., Keats, K., Kreczko, A. and Sinden, G., Space and Time: Wind in an Investment Planning Model, Energy Economics.

# Nodal pricing for effective network utilisation



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# Can present system be made to work?



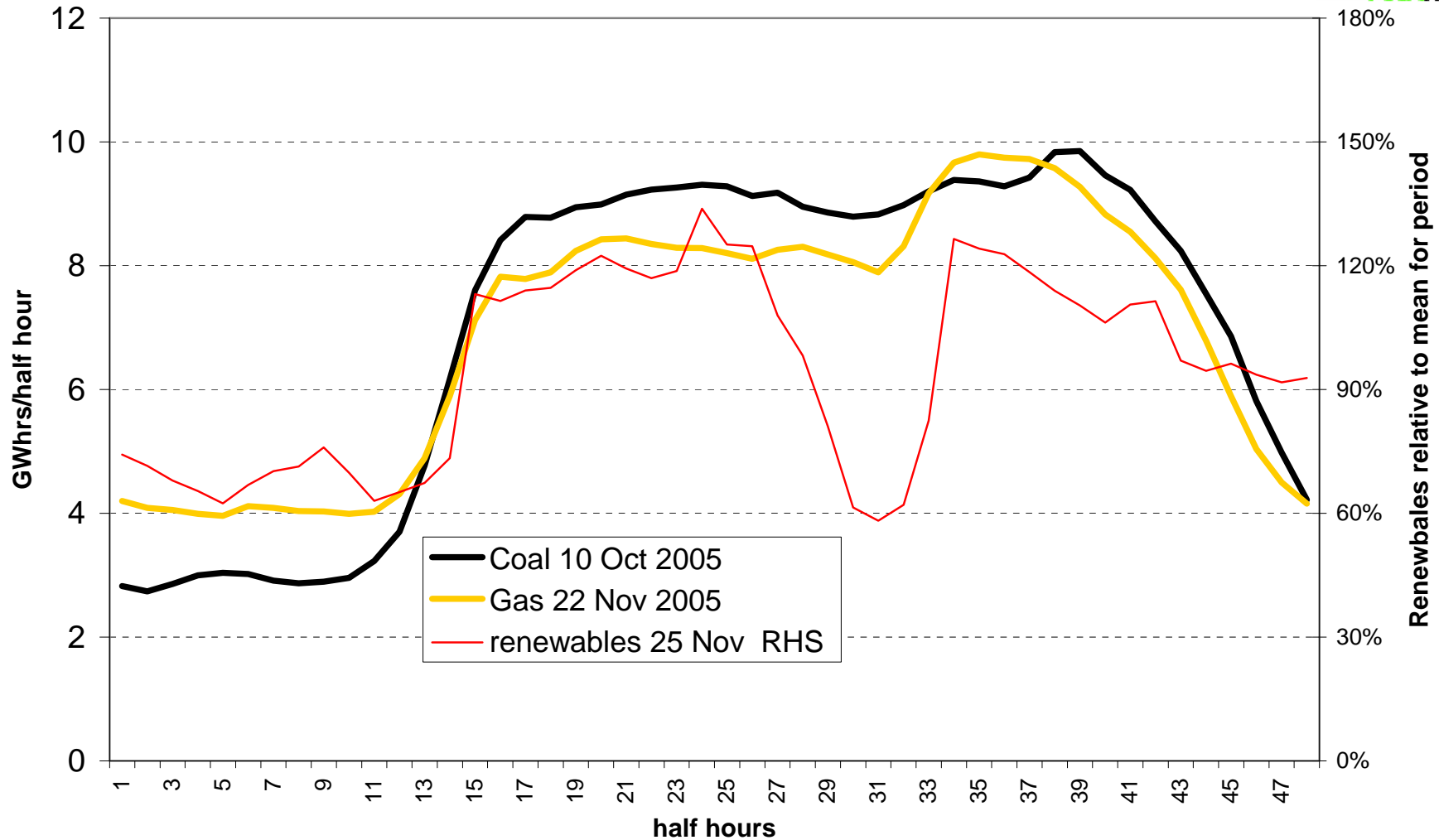
- Allow G entry - connect and manage?
  - what about efficient spatial and temporal dispatch?
  - what about gaming (inc-dec game)?
  - what about NGT incentives?
- Trading of firm access rights?
  - Liquidity – does not even exist at UK level balancing
  - Loop flows – require complex reconfiguration
  - cannot address efficient inter-temporal dispatch/balancing



# Efficient congestion management

- Nodal pricing for optimal spatial dispatch
  - all energy bids go to central operator
  - determines nodal clearing prices
  - reflect marginal losses with no transmission constraints
  - otherwise nodal price = MC of export (or MB of import)
- Bilateral energy contracts
  - Can submit firm bids => pay congestion rents
  - Can submit price responsive bids => profit over firm bids
- Financial transmission contracts hedge T price risk

# Ability to vary thermal output



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# Balancing - problems and requirements



- efficient dispatch: schedule ahead of time
  - to allow for warm-up, ramping, etc
- wind forecasts increasingly accurate at - 4hrs
  - day-ahead market inappropriate for wind contracting

# Efficient balancing market



- Use right combination of plants to
  - provide spinning reserve
  - provide flexibility to vary output over periods of mins-hours
  - meet next demand peak and demand low
  - handle varying transmission constraints
  - > inter-temporal optimisation, updated with new wind/demand forecasts
- Market participants submit multi-part bids
  - Start up cost/time, Ramping rates, etc
  - Marginal generation cost
  - Part load constraint, etc

# Spatial and temporal optimisation



=> nodal pricing + central dispatch

- Nodal price reflects congestion & marginal losses
  - lower prices in export-constrained region
  - efficient investment location, guides grid expansion
- Central dispatch for efficient scheduling, balancing
- Market power monitoring – benchmark possible
- PJM demonstrates that it can work
  - Repeated in NY, New England, California (planned)

# What objections have to be addressed?



- Disadvantages Scottish generators
  - Large revenue shifts
  - but would benefit voting Scots consumers!
- Earlier attempts thwarted by courts
  - complaints about process, not substance
- Complexity of new system?
  - No need to re-invent the wheel
- > Compensate losers?
- > Make change before large investments

# Ensuring today's investment can provide required system services



Market based

Administrative requirements



*Reactive power*

*Fast response*

*Black start capability*

*Fault ride through*

Incentives from future profitability?

Do we need forward looking standards?

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# Market design for flexible network operation

- Increase network utilisation & reduce operation cost
- Decouples investment uncertainties associated with networks & generation
- Find the right balance
  - as close to physical reality as necessary
  - as simple as possible
- > Nodal pricing and integrated dispatch
- > Financial contracts to hedge transmission risk

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