



# How to reform an electricity market(?)

Richard Green

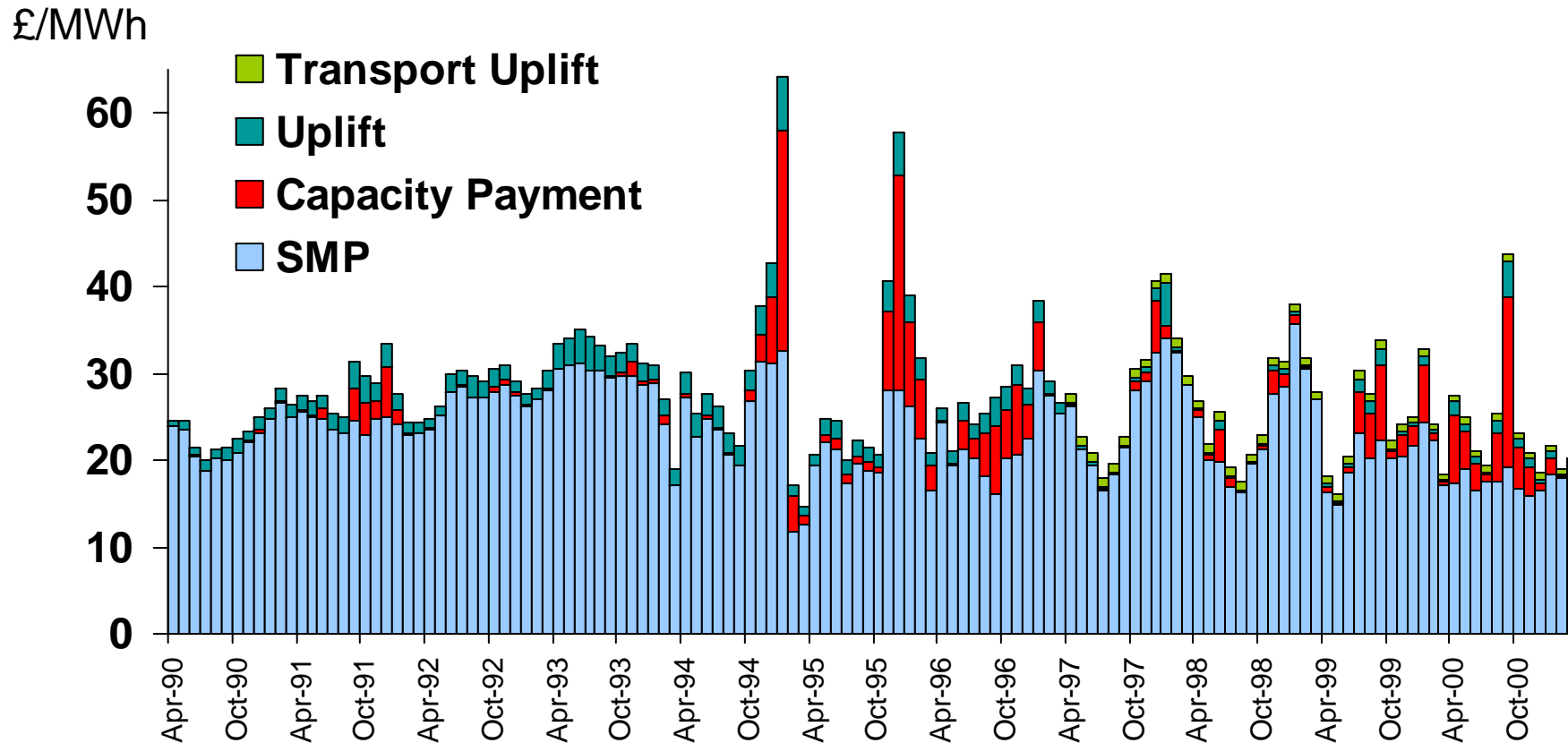
(from Sept 2011: Imperial College London)

# Where we are now (and how we got here)

## The Electricity Pool (90-01)

- Compulsory day-ahead uniform price auction, mostly covered by contracts
- System Marginal Price plus Capacity Payment plus Uplift
  - Pay-as-bid for real-time changes
  - Transmission constraint costs rose then fell after National Grid given incentives

# Pool Prices, 1990-2001





## NETA and BETTA (01-)

- Bilateral trading until Gate Closure (with day-ahead auctions more recently)
- Energy-only market
- Balancing mechanism with National Grid is pay-as-bid
- Penalties for (unhelpful) imbalances

## Renewables support

- Non-Fossil Fuel Obligation
  - Tender rounds for various kinds of capacity several times during 1990s
  - Winning price varied by type
  - No requirement to have planning permission
  - Some bidders had winners' curse (?)
  - Not all winning schemes were built



## Renewables Obligation

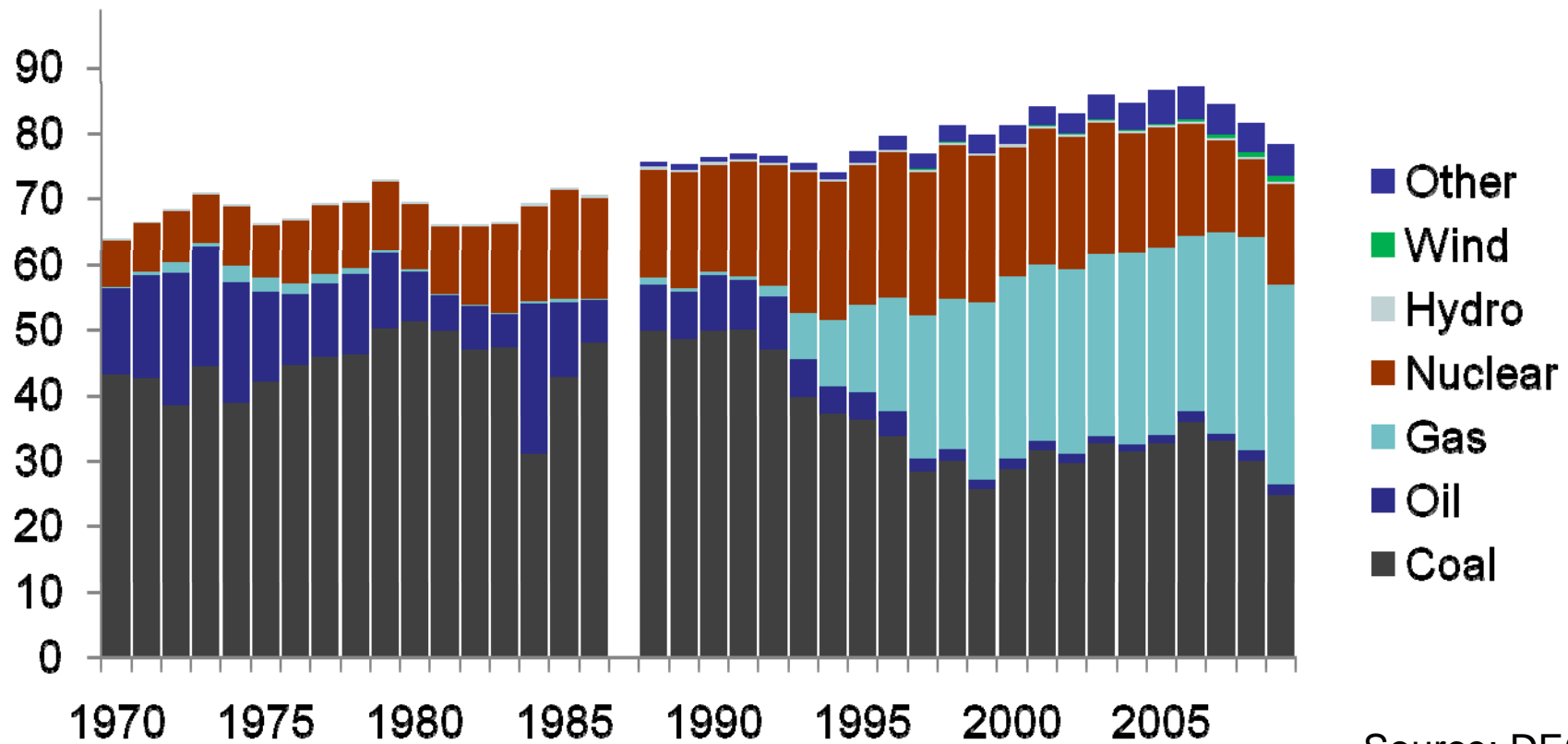
- Tradable green certificate scheme from 2002, plus market income
- Planning delays kept output below targets
- Total support “fixed” so high cost per MWh!
- Technology banding from 2009
- “Headroom” on level to maintain future price
- Starts to look like a feed-in-tariff?

## The Climate Change Levy

- Carbon tax on non-household users of fossil fuels and non-renewable electricity
- Not paid by power stations
- Electricity rate not differentiated by fuel source
- Large users can agree energy efficiency schemes and get an 80% rebate



# Fuel used for UK electricity generation

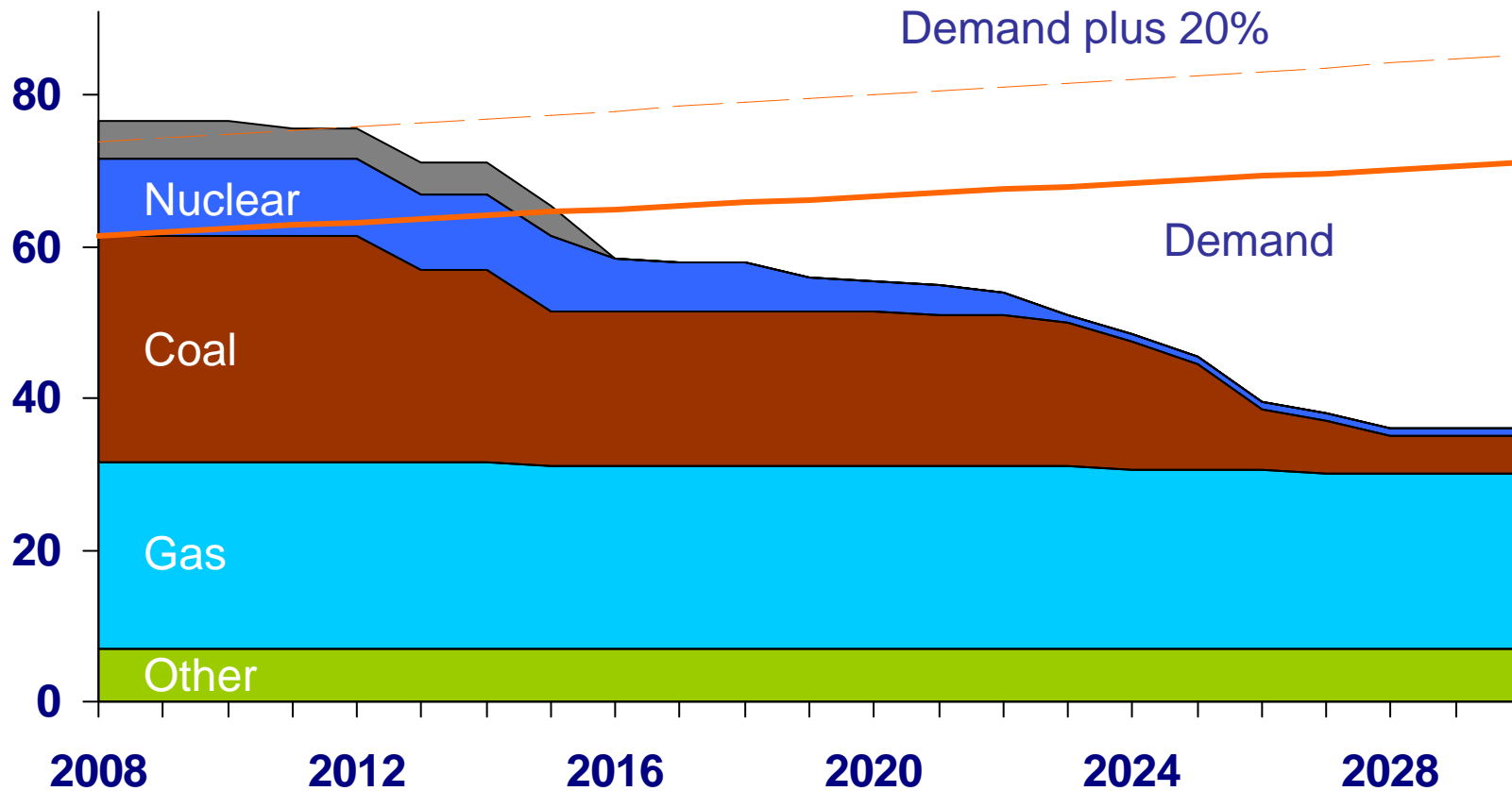


Source: DECC



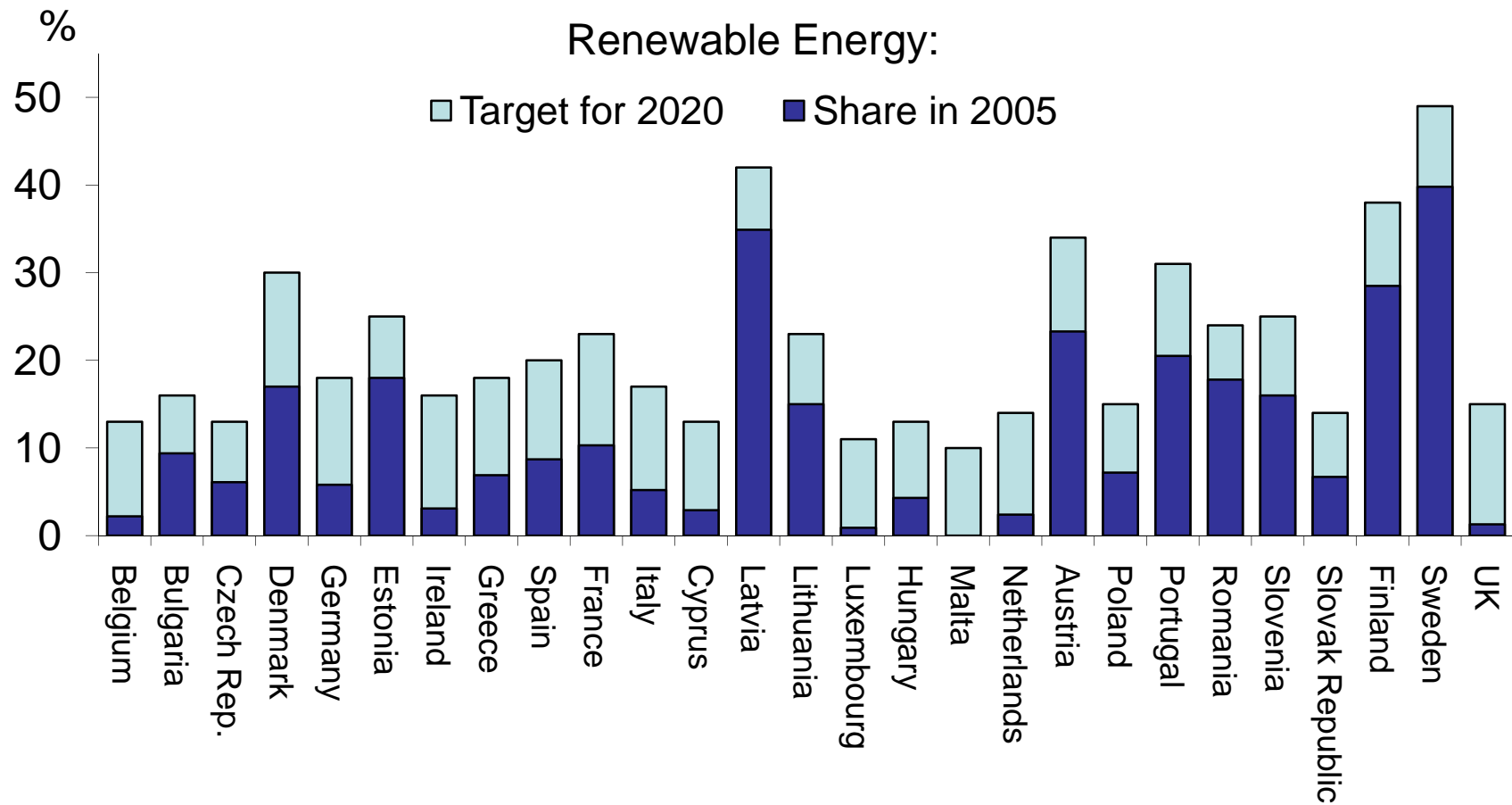
# Challenges for the future

# Plant closures

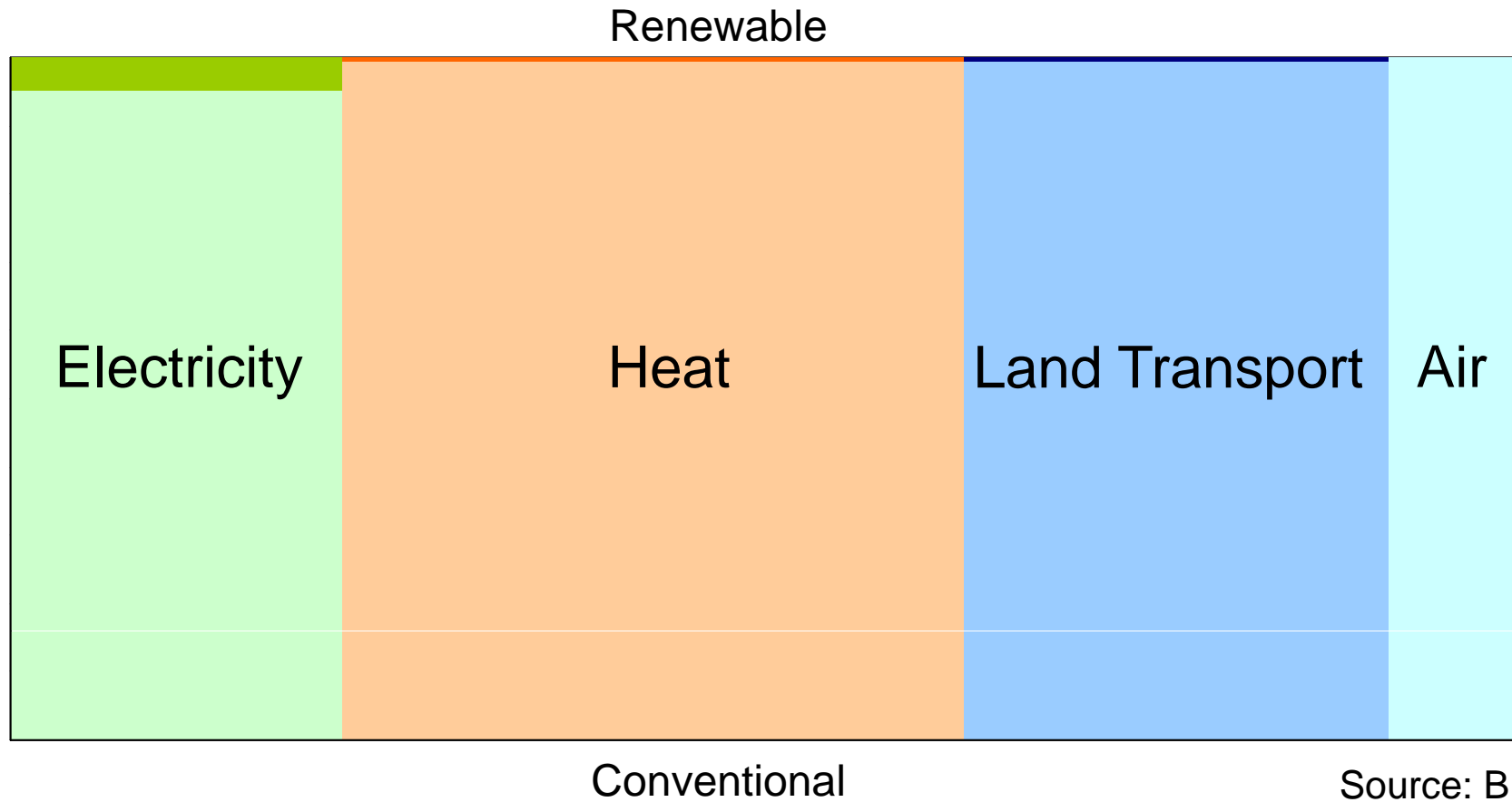


Source: E.ON UK

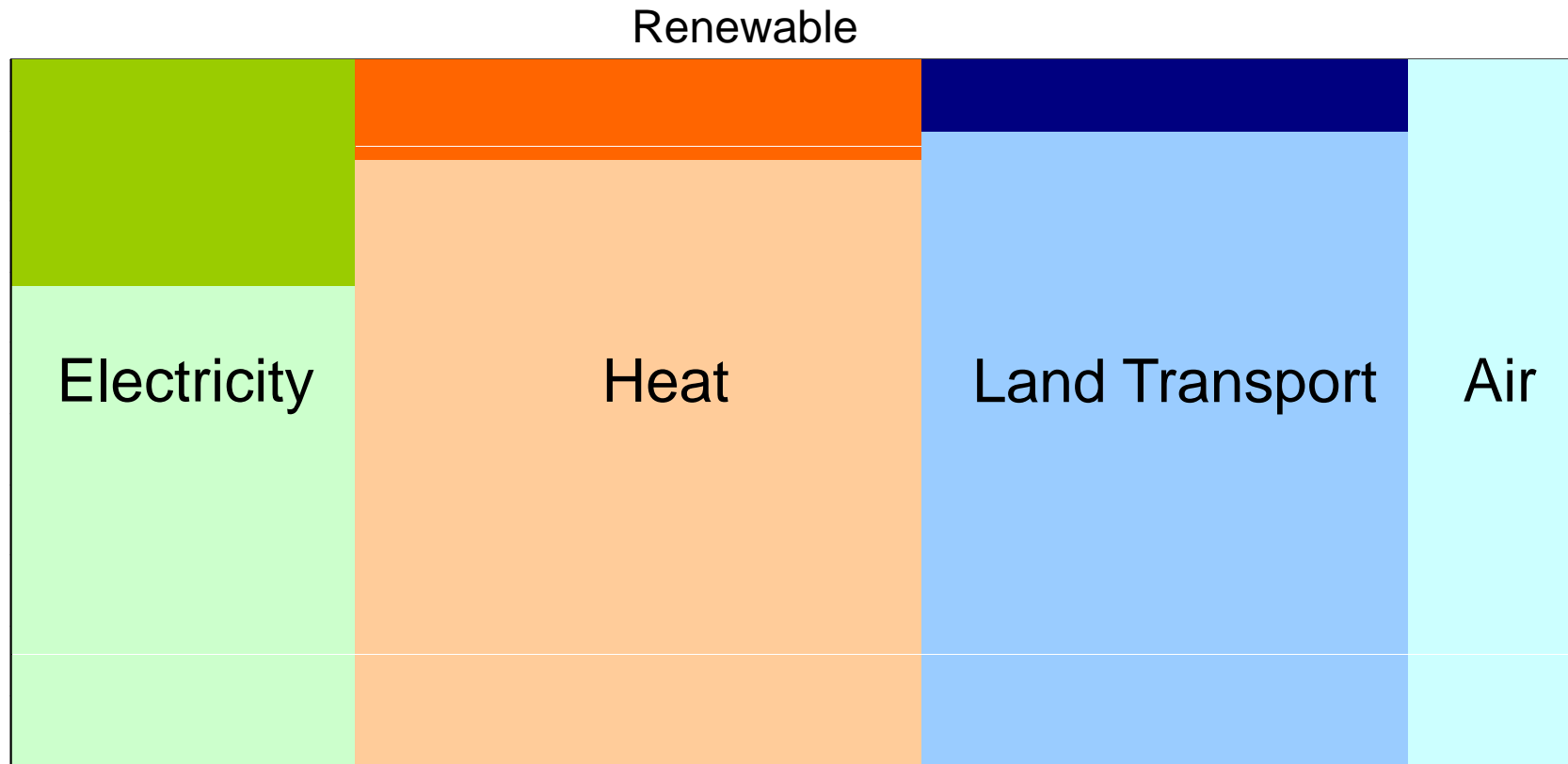
# The 20-20-20 2020 Targets



# UK Energy in 2006



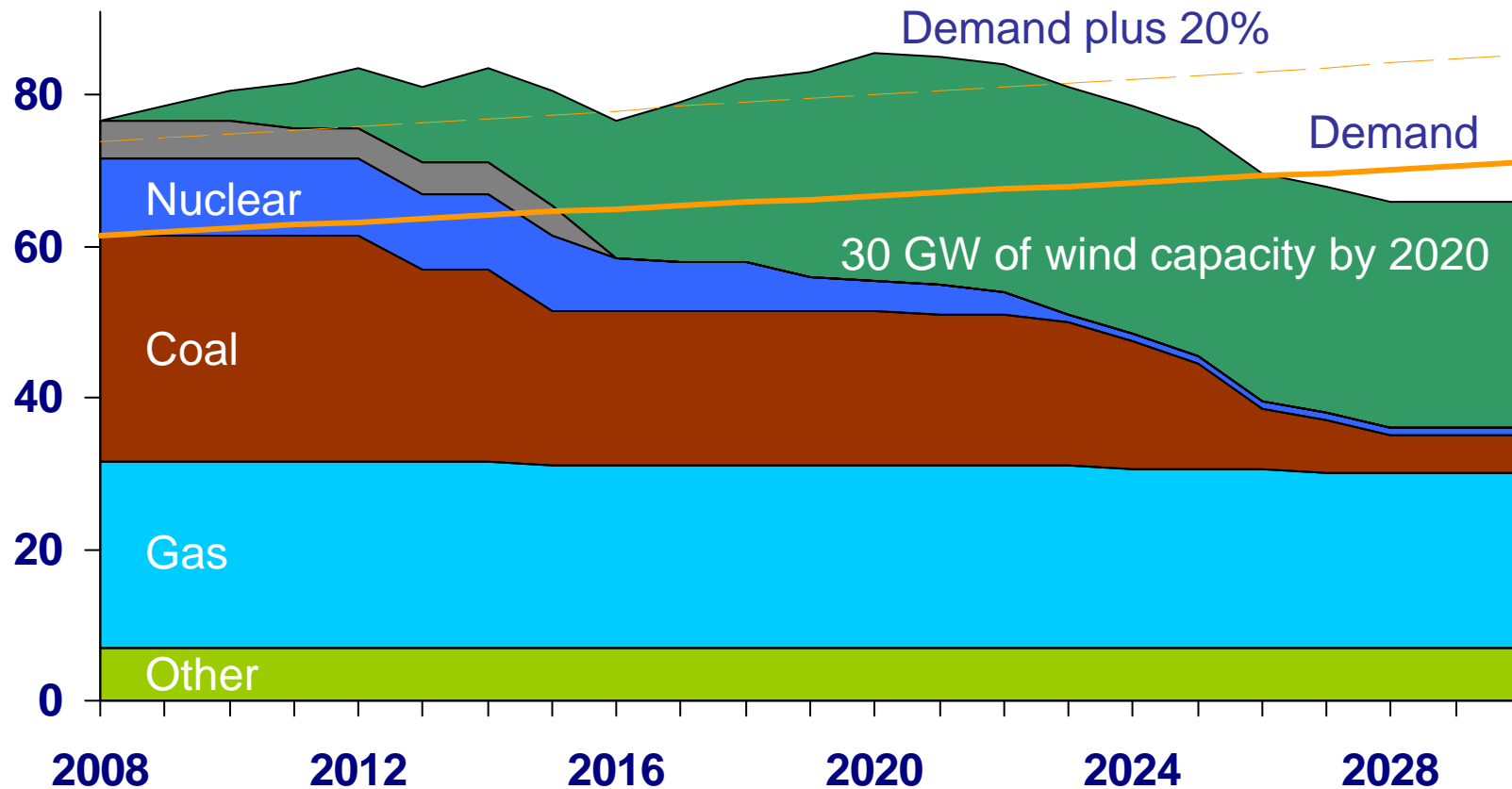
# UK Energy in 2020 (?)



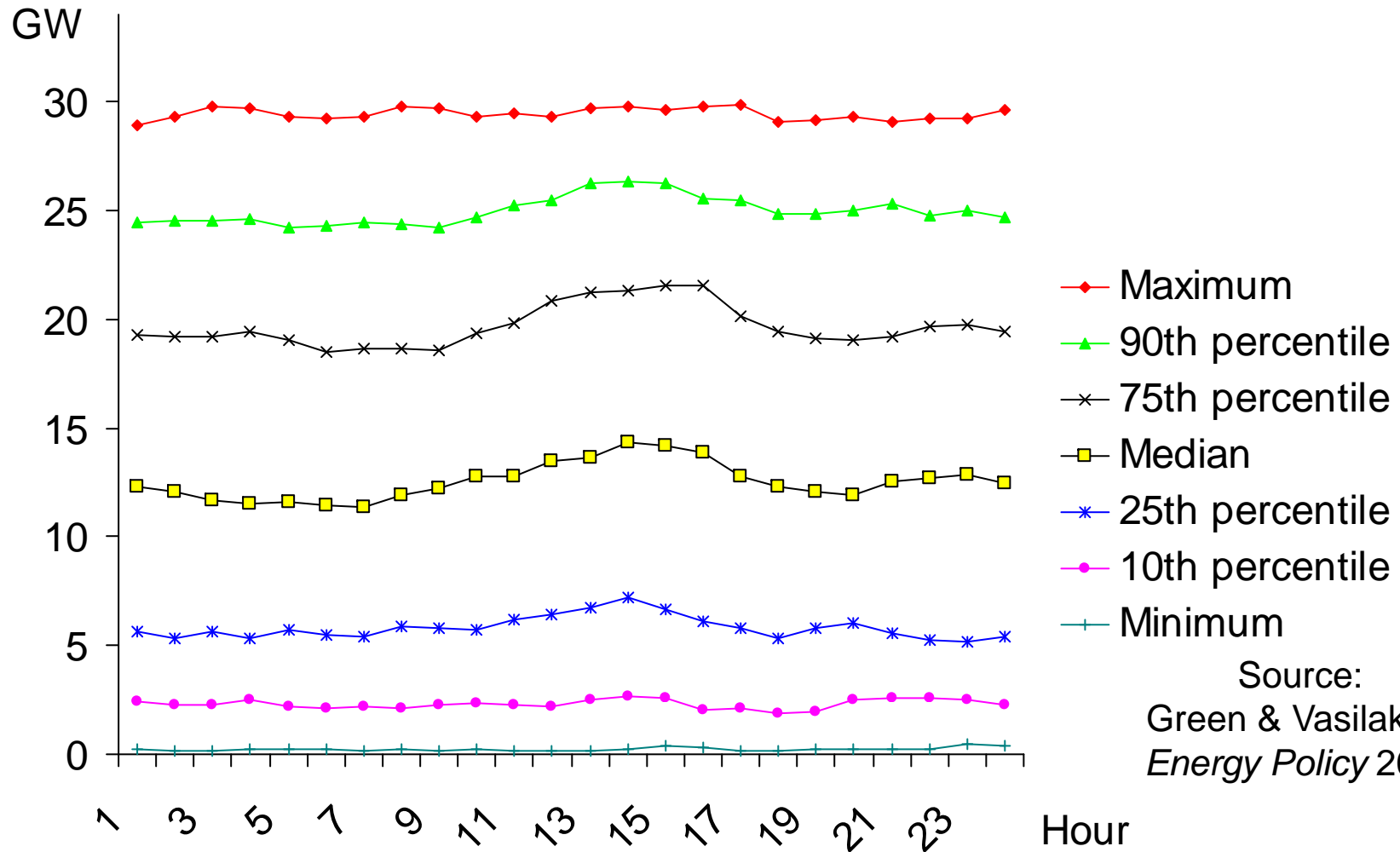
Conventional

Source: BERR

# The growth of wind capacity



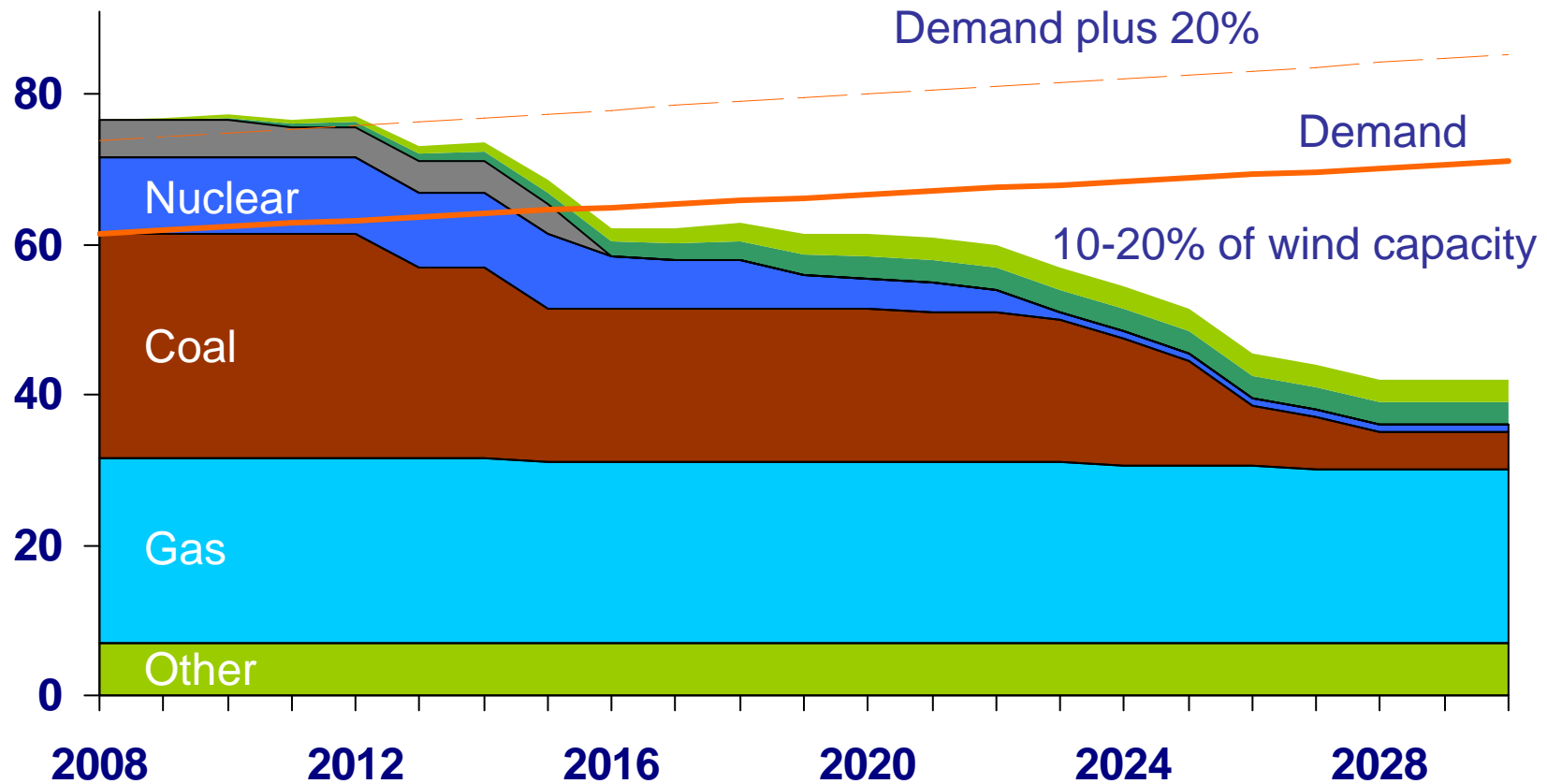
# Wind output variation - January



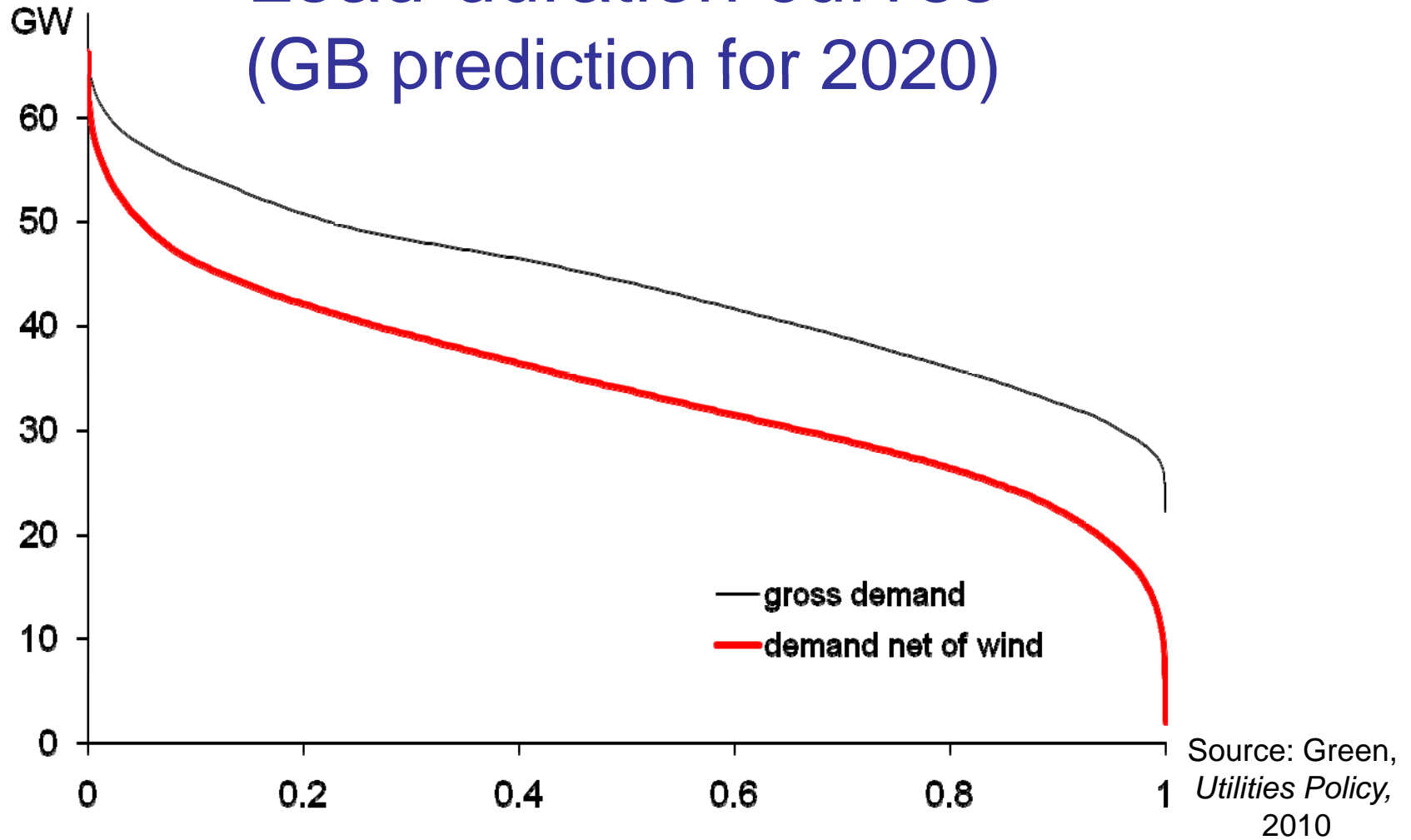
Source:  
Green & Vasilakos,  
*Energy Policy* 2010



# The wind capacity credit

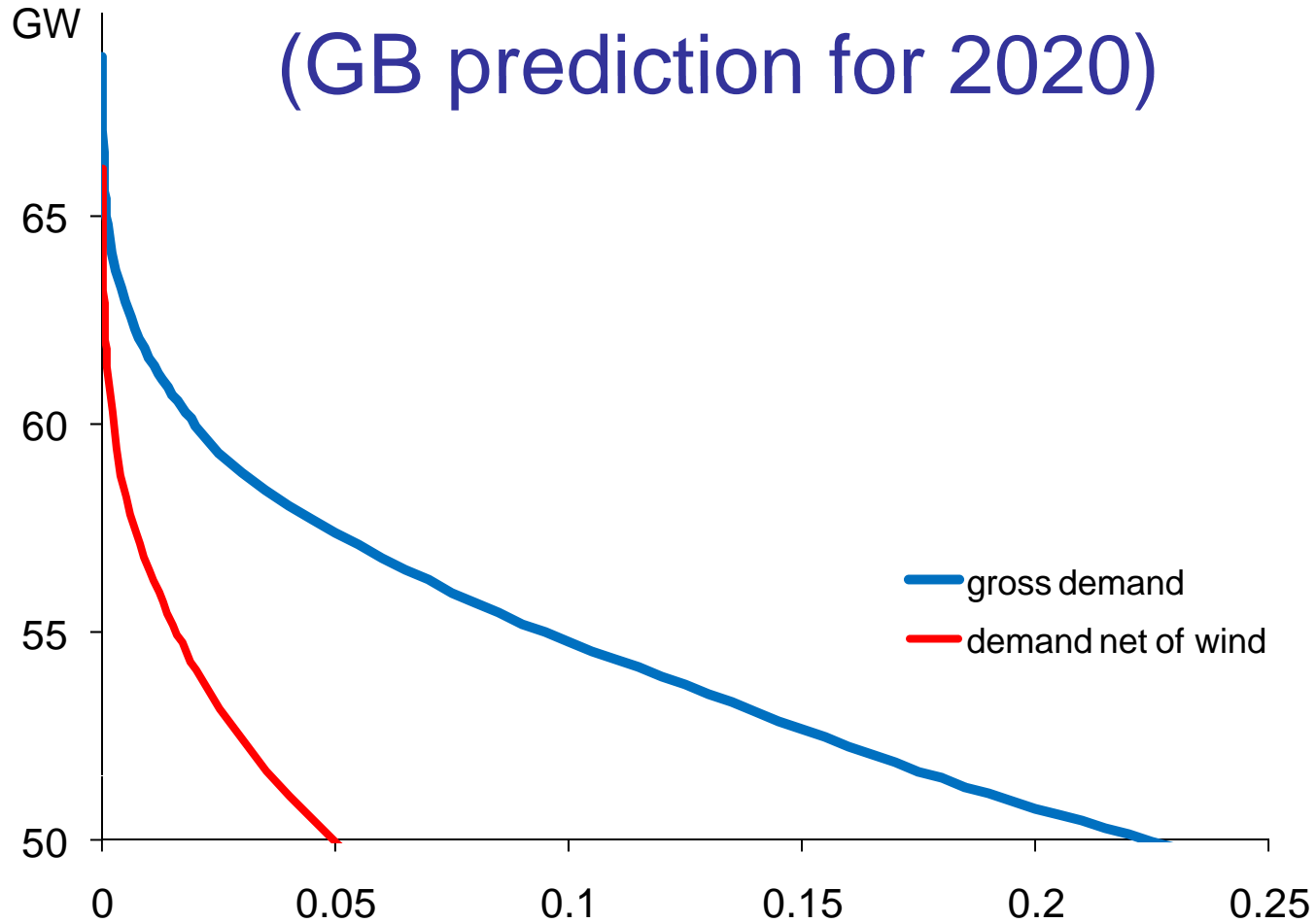


# Load-duration curves (GB prediction for 2020)





# Load-duration curves (GB prediction for 2020)



Source: Green,  
*Utilities Policy*,  
2010

# The regulator worries...

# Project Discovery Stress Tests

Stress test	Today	Green Transition	Green Stimulus	Dash for Energy	Slow Growth
Re-direction of LNG supplies	●	●	●	●	●
Russia-Ukraine dispute	●	●	●	●	●
Bacton outage	●	●	●	●	●
No wind output	●	●	●	●	●
Electricity interconnectors fully exporting	●	●	●	●	●

Ofgem (2010) *Project Discovery: options for delivering secure and sustainable energy supplies*

## Project Discovery Remedies

- Minimum carbon price
- Sharper short-term price signals
- Market rules to promote demand response
- Enhanced Obligations
  - Suppliers to show contracted capacity
  - System operator to show contracted reserve
- Central dispatch of renewables (as in Spain)

## Project Discovery Remedies

- Tender for renewable capacity
  - Supplement to market price
- Tender for all capacity
  - Type (and perhaps location) specified
  - Capacity continues to compete day-to-day
- Central energy buyer
  - Capacity and energy in long-term contracts
  - Central dispatch, selling on to retailers



...the government responds



## Electricity Market Reform

- Capacity market (design not yet decided)
  - Government favoured a “last resort” model
- Contracts for low-carbon generators (ditto)
- Carbon price support
  - Supplementary tax + ETS price = pre-set path
- Emissions Performance Standard
  - Long-term right to run part-abated coal plant

## Paying for capacity: options

- Use peak energy prices (GB at present)
- Capacity payment for all plants (Spain)
  - Linked to supply-demand gap (Ireland, Pool)
- Capacity market for all plants (PJM, NE)
- Capacity tender for reserve plants (Sweden)



What do you get in return if you...

use peak energy prices?

- A system that works in theory
- Low prices in years with low demand

## What do you get in return if you...

give all plants a capacity payment?

- Lots of capacity (and no market power) sends price down to Marginal Cost
- Day-ahead capacity payment matches energy prices based on forecasts



# What do you get in return if you...

run a capacity market for all plant?

- Incentives to build the right amount
- Refunds on high spot prices
  - New England's Installed Capacity market contracts use these to penalise non-delivery
  - Link between payment and energy price caps the cost (and incentive to raise the price)



What do you get in return if you...

run a tender for reserve plant?

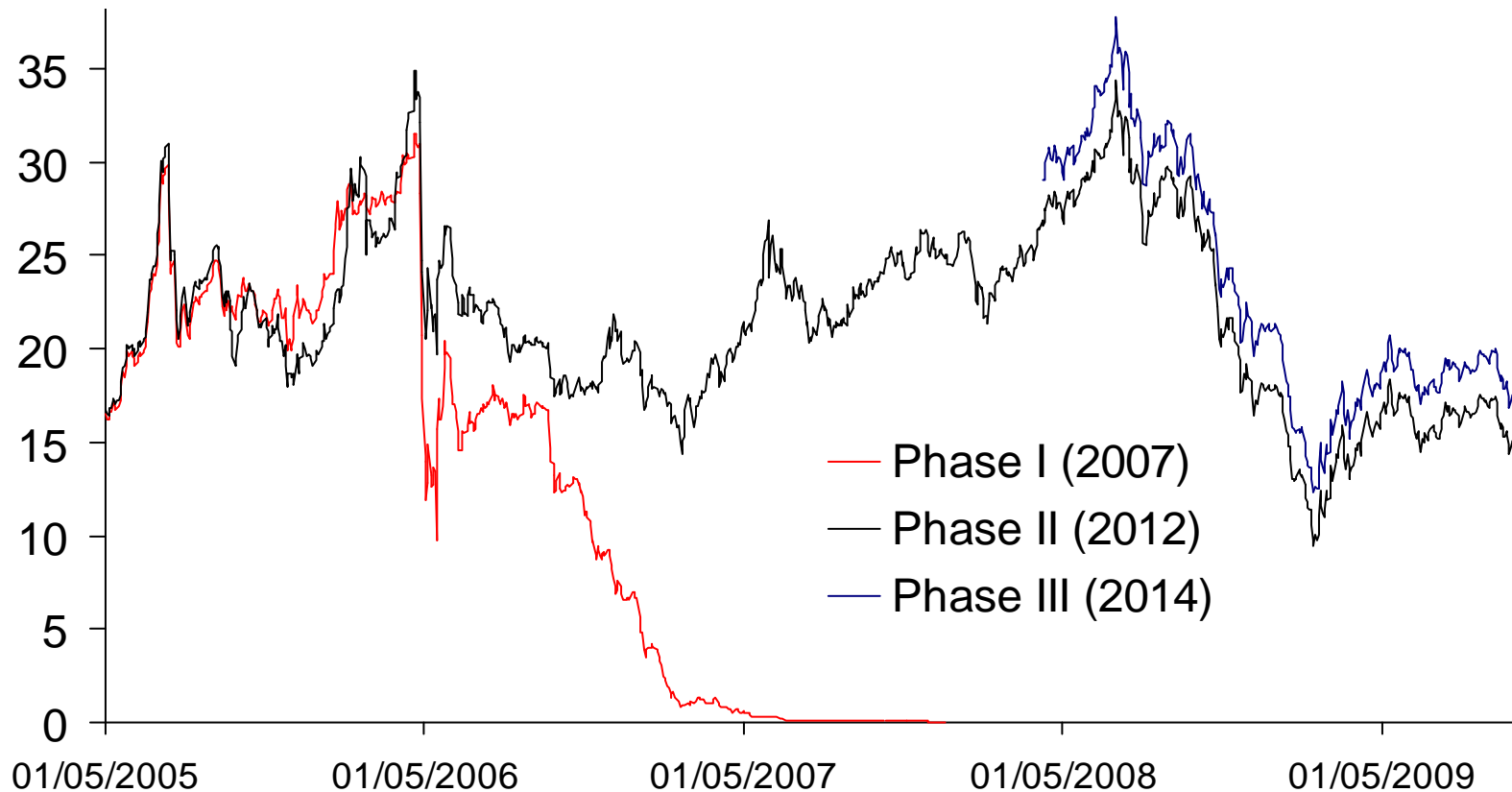
- Reserve capacity which is required to sell at cost (maybe only as a last resort)
  - What happens to generators with no contract?
  - “Missing money”? (Joskow, *Utilities Pol.* 2008)
- UK government favours this option



# The price of carbon

# European carbon prices

€/tonne of CO<sub>2</sub>

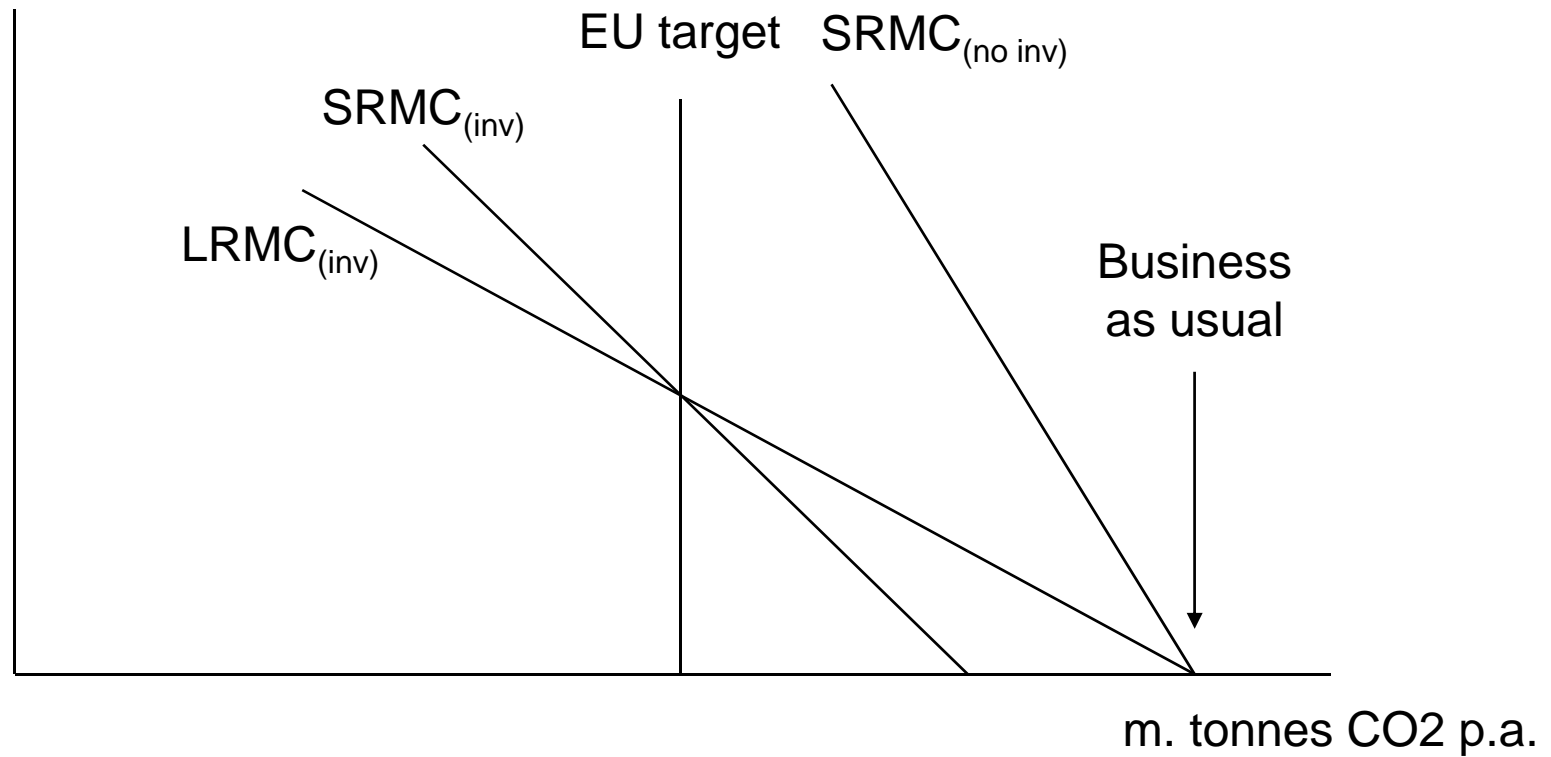


Source: European Climate Exchange



# Carbon market equilibrium (?)

€/tonne CO<sub>2</sub>



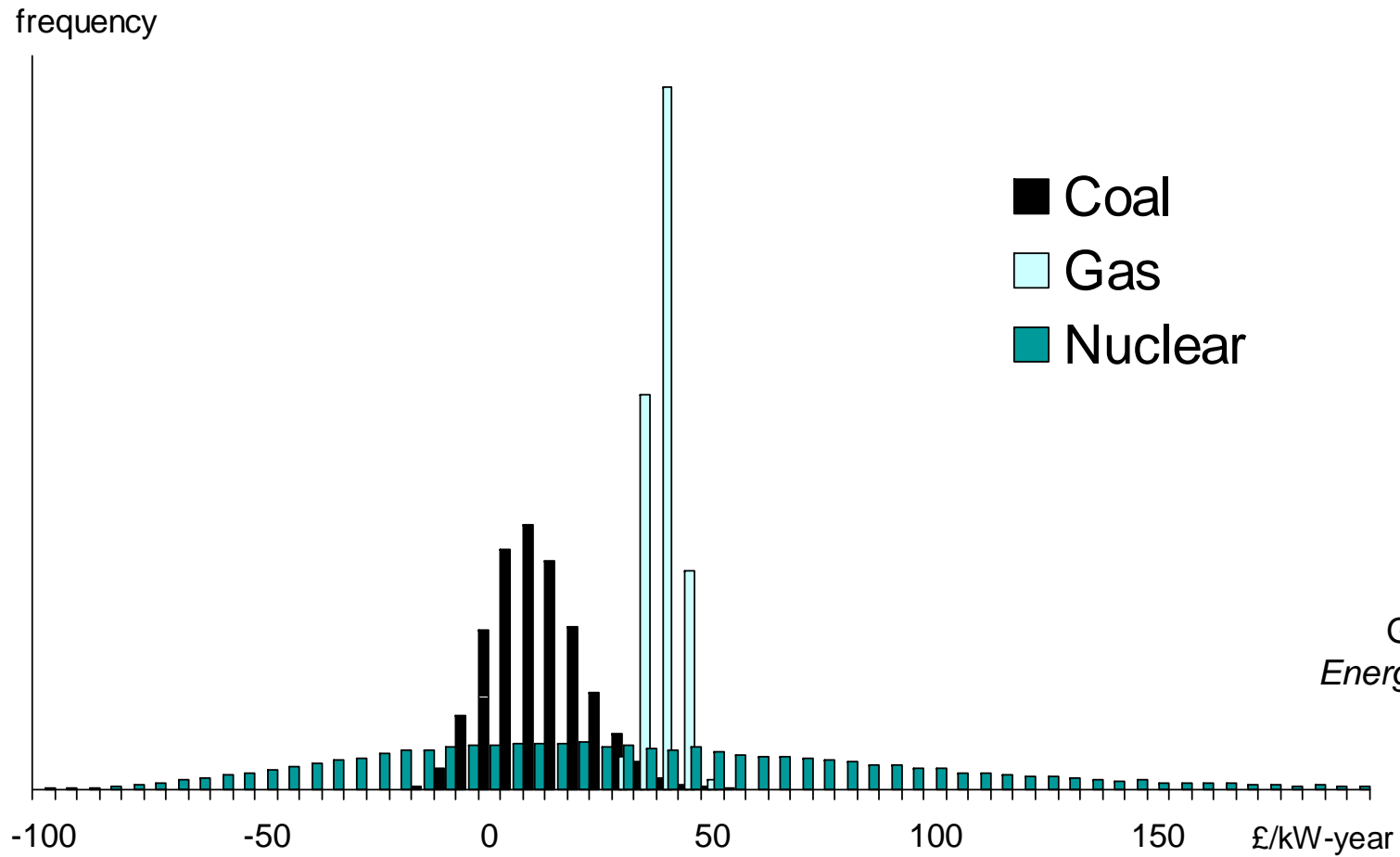
## So what's the problem?

- UK wants to take on a tougher target than the EU targets would imply?
  - We need a higher carbon price, and our actions reduce the ETS price
- Investors don't trust the carbon price will be high enough to recover fixed costs?

## Supporting the carbon price

- Generators to pay the Climate Change Levy
- Rate (inversely) linked to ETS price
- ETS plus CCL at carbon price support rate will equal a pre-set price path
  - £16/tonne CO<sub>2</sub> in 2013; £30/tonne in 2020
- Removes political risk from carbon market
- Removes gas-carbon price correlation

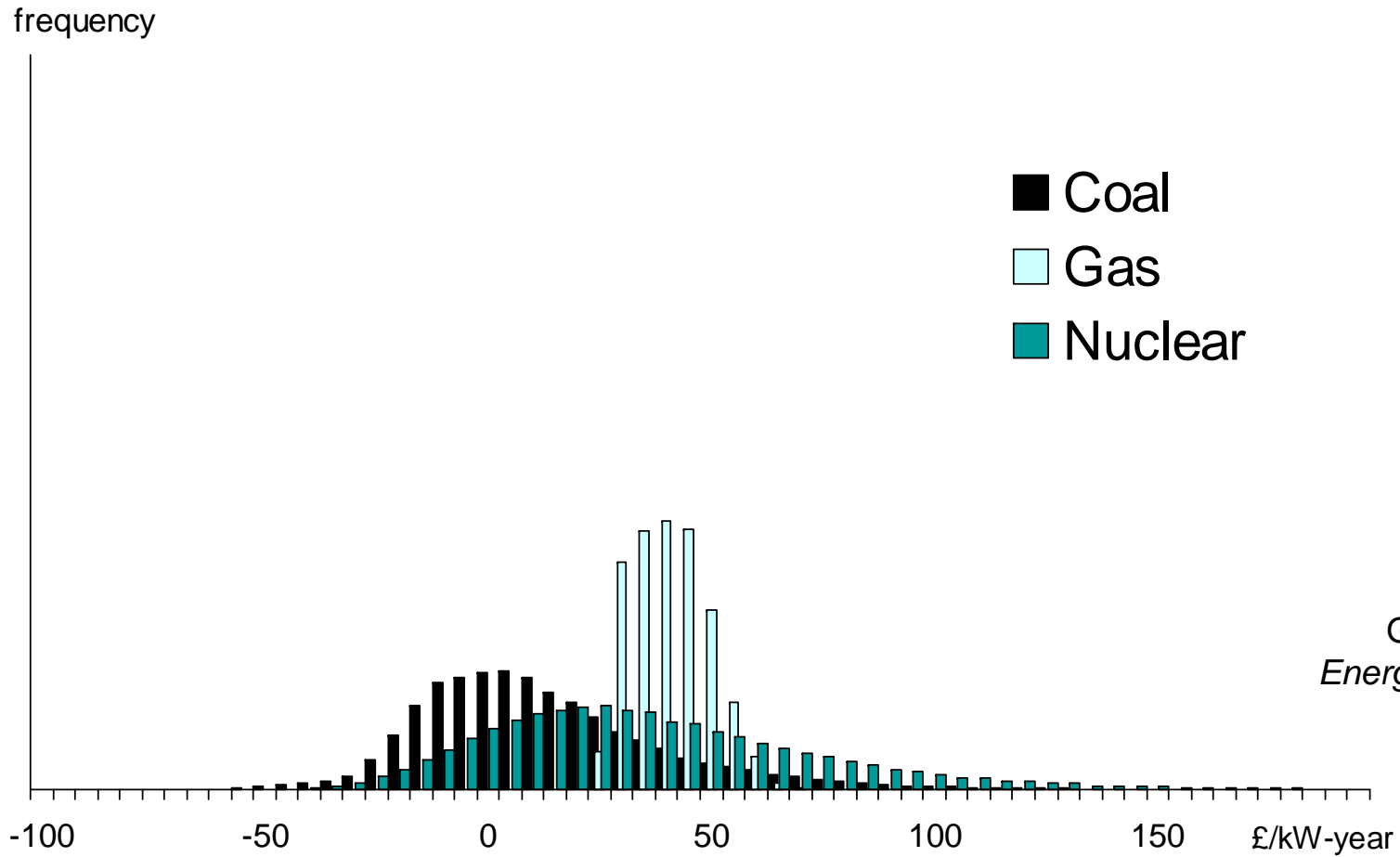
## Profits with carbon emissions permits



Green,  
*Energy Journal*,  
2008



# Profits with a carbon tax





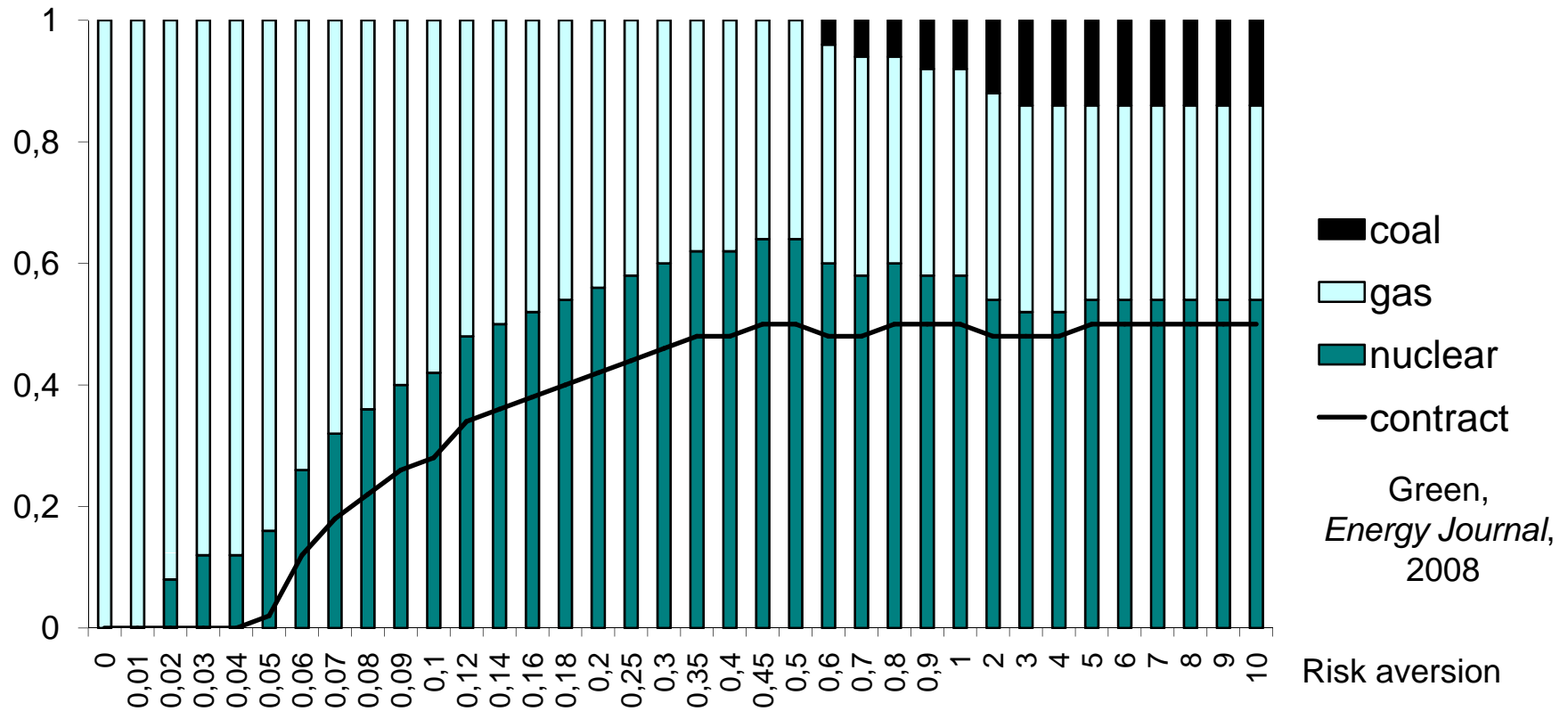
# The need for long-term contracts



## Fossil fuel price risk

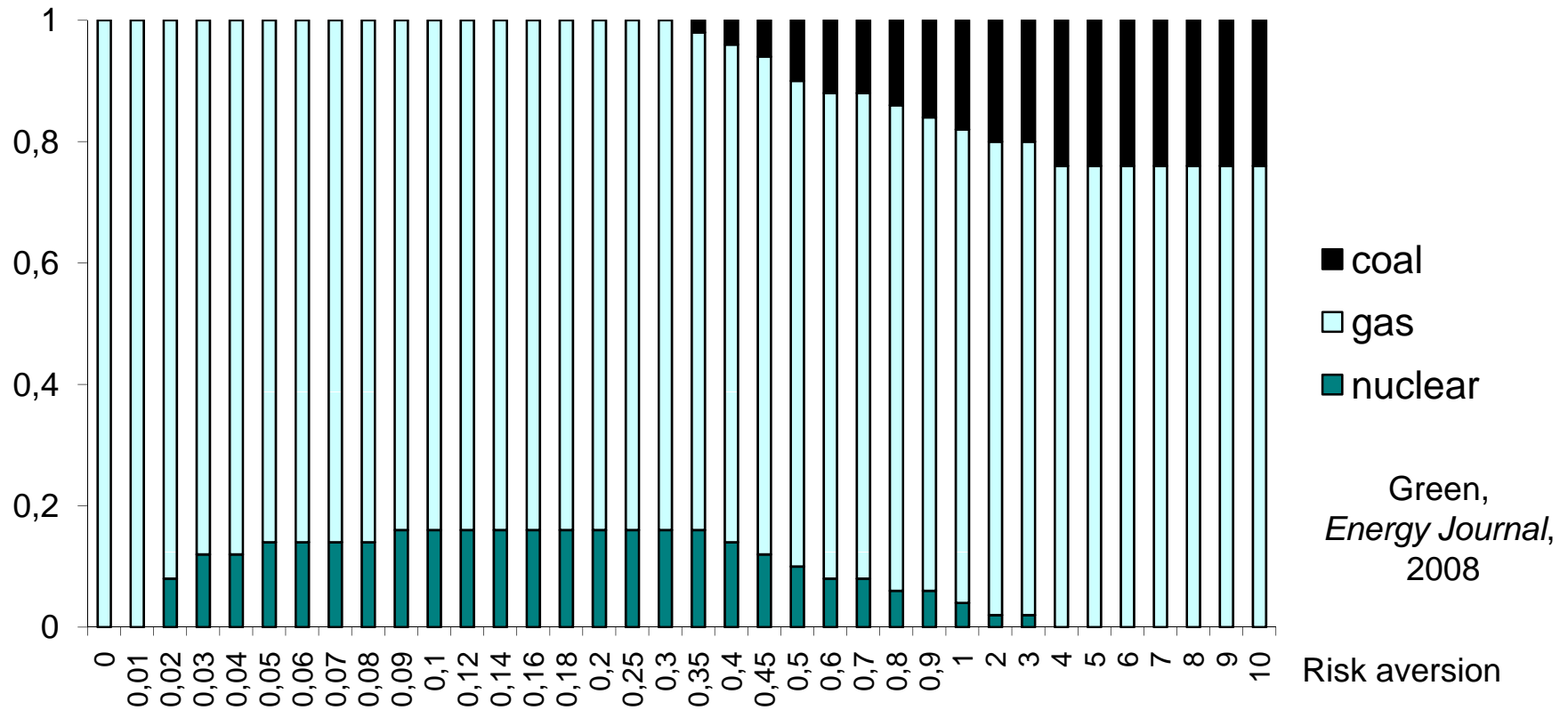
- Liberalised power prices follow fossil fuels
- Low-carbon generation costs do not
- Can generators accept revenue risk?

# Optimal portfolios with a carbon tax

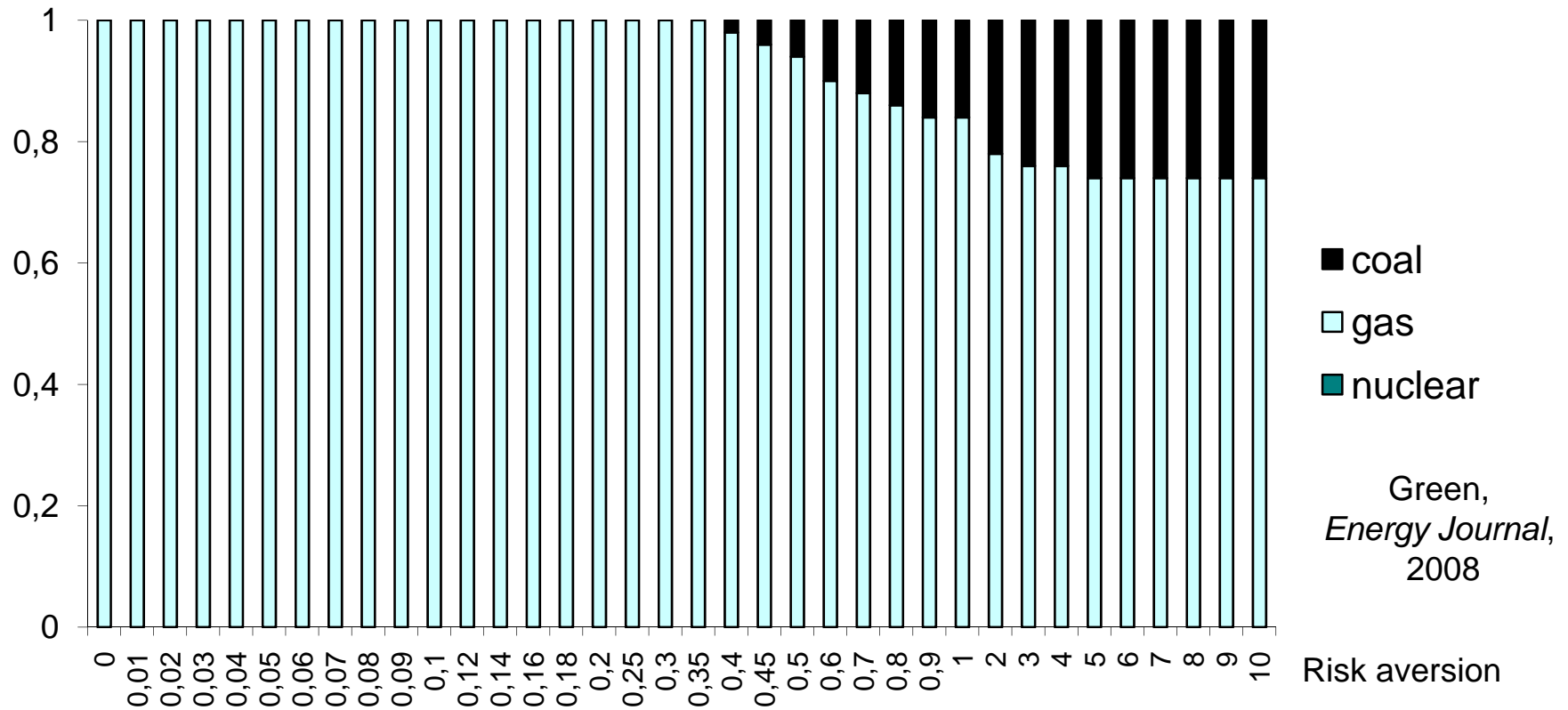




## Optimal portfolios with a carbon tax and no long-term contracts



## Optimal portfolios with carbon trading and no long-term contracts



## Proposed remedy

- Long-term contracts for differences
  - Raise generator's income when average power prices are low (& vice versa)
  - Generator still receives market price for its output, so should have the right incentives, IF it can control its output
  - Reduces risk for generator and for retailer & customers (average power price less volatile)



## Who chooses the contracts?

- Does the government set the price(s)?
- Does the government set the quantities?
- Is it better to set up an appropriate agency and let it design sensible contracts?

## Will it work for wind?

- David Newbery has pointed out that a contract for pre-set hourly volumes leaves wind very exposed to price risks
  - Market prices inversely related to wind output
- Contract on actual output = Feed-in Tariff
  - Need to also pay for constrained-off output to avoid absurd Balancing Mechanism bids
    - Need to monitor to avoid the DEC game

## “The Squeezed Middle”

- Baseload nuclear get a contract
- Renewables get a contract
- Reserve plant get a contract
- We still need some plant to run mid-merit
- Will this plant be missing money?

# Electricity *Market* Reform

## The challenge for trading

- Loads on thermal plant fluctuate more and at short notice
  - Need a liquid, efficient, market
- Many good renewable resources are far from (most) demand
  - Cost of transmission infrastructure investment
  - Constraints sometimes mean power cannot be delivered



## Who should pay for congestion?

- New generators in an area?
  - Reduces profitability of entrants *for a given market price and level of renewable support*
- All the generators in a constrained area?
  - Better for entrants (see above); reduces incentive to avoid poor areas
- All ~~generators~~ customers

## Possible improvements

- Establish and promote day-ahead and real-time auctions
- Ensure transmission charges reflect true costs for future generators
  - Financial contracts may compensate existing generators to make change politically acceptable
- Make renewable contracts area-specific
  - Extra help if really needed to offset costs

# The real problem with nuclear power?

## Olkiluoto 3 (Finland)

- Contract signed in 2003
  - €3.2 billion, construction from 2005-2009
- Commercial operation now expected 2013
- TVO (buyer) and Areva (builder) are suing each other
- Areva has made accounting provisions of €2.6 billion (as of June 2010)

## First-of-a-kind support

- Who should bear these risks?
  - Is there a public good in the supply chain?
- Who should manage these risks?
  - How much incentive do the builders need?
- What kind of insurance could the state offer?



# Summing up

## Conclusions

- Contracts for differences and feed-in tariffs could help low-carbon investment
- A capacity market could help mid-merit generators
- A more efficient electricity *market* is needed

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Thinking Networks