UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Carbon Emissions: Opportunity or Cost

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Leaders in Energy and Commodities 2008

Lehman Brothers 4 June

http://www.electricitypolicy.org.uk

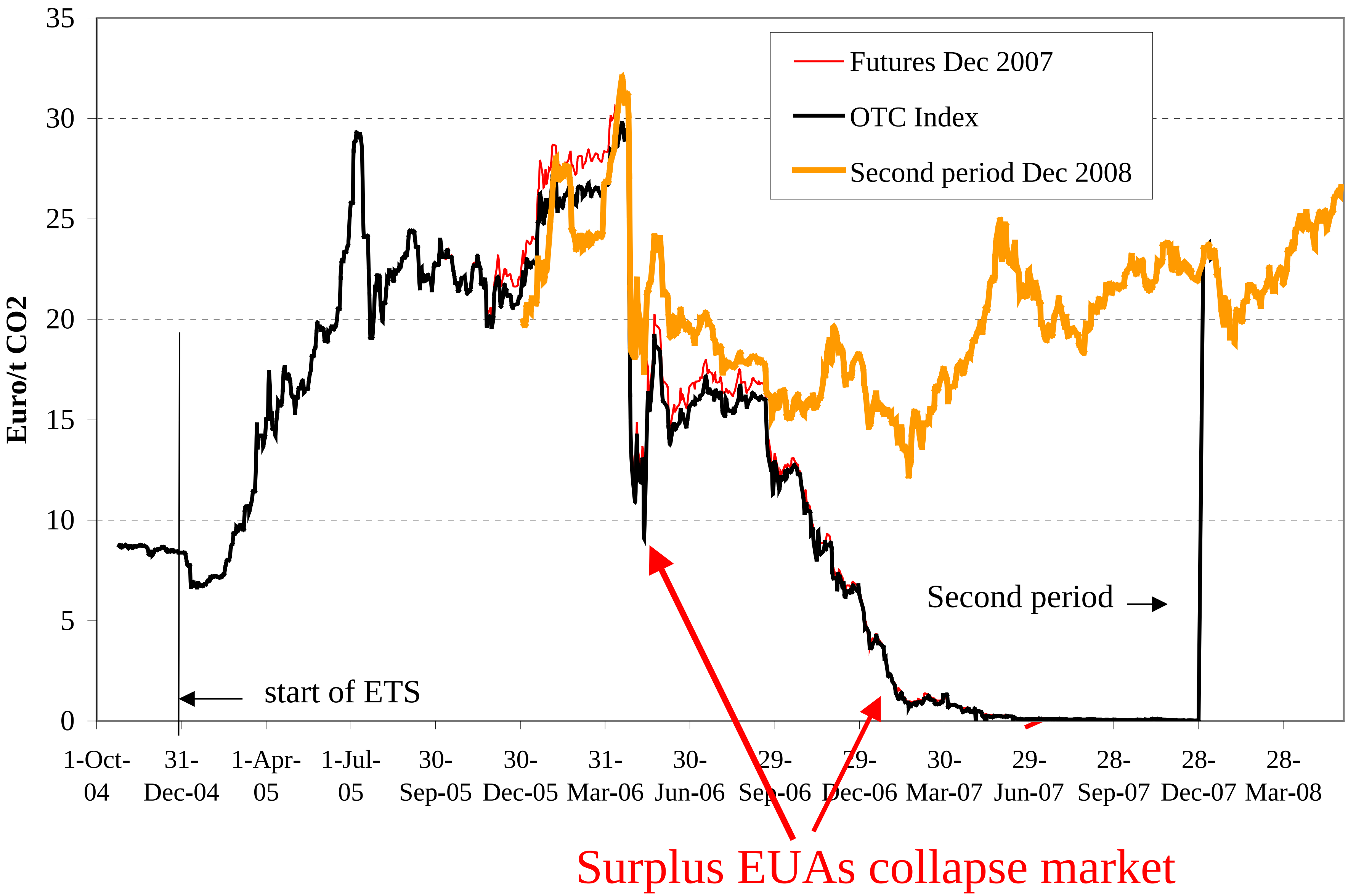
Outline

- object is to properly price carbon
  - to guide efficient abatement
- intended to make carbon a ***cost*** and to provide ***opportunities*** for low-carbon options
  - as part of an EU burden sharing arrangement
  - that ideally will be extended to others (rest of OECD esp US & Canada, + BRIC)
- if done badly the costs will be excessive, the policy may be unsustainable, could create political uncertainty, and hence undermine global alliances for addressing the problem of climate change.

Pricing carbon

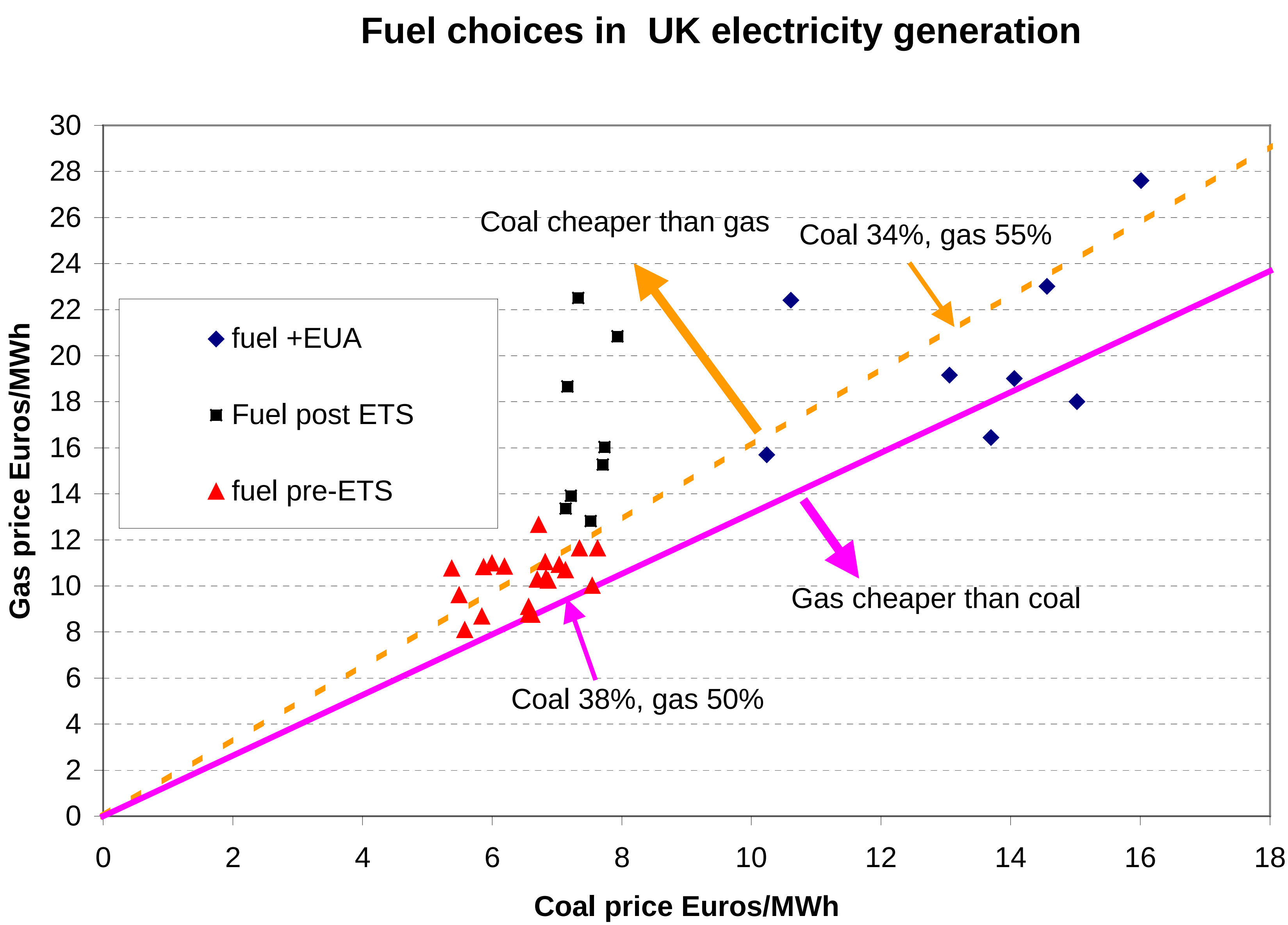
- Currently priced by EU ETS
  - determine EU allocation for covered sectors => NAPs => sectoral allocations
  - trading determines price across EU
  - banking between years
- But to date EUA price has been very volatile

EUA price 25 October 2004-28 May 2008



The future price of carbon

- Low-C energy options are (mostly) not commercial at current fuel prices excluding C-price
- nuclear and on-shore wind become attractive at current oil, gas, coal and carbon prices
  - but fuel prices are historically high in real terms
  - and the C-price is driven by the gas/coal price



Fuel choices in UK electricity generation
Gas price Euros/MWh
Coal price Euros/MWh
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
fuel +EUA
Fuel post ETS
fuel pre-ETS
Coal cheaper than gas
Coal 34%, gas 55%
Gas cheaper than coal
Coal 38%, gas 50%

What determines future carbon price?

- Supply and demand!
- Based on forecast BAU carbon emissions and need to reduce C by 20% from 1990 by 2020 (with an option of 30% if other countries sign up) + 2020 Renewables and efficiency targets
- But BAU is hard to forecast
  - Accession members were very energy inefficient and so can reduce energy intensity at low cost
  - higher than expected fuel prices will reduce demand
  - coal/gas prices hard to predict, LCPD complicates further
- Renewables + efficiency reduce CO_2 anyway

The fragility of price forecasts

- 20% efficiency gain and 20% renewables ***energy*** share => considerable fall in CO_2 without any C price
- C price depends on the difference between this uncertain future demand for CO_2 emissions, the allowed supply of CDMs, and the 2020 CO_2 target
  - failure on efficiency and renewables => excess demand for EUAs and high C price
  - success, plus CDMs, plus high coal/gas price crash market?

What is the cost of uncertain future C price?

Costs without opportunities?

- Uncertain future C price => delay investments, especially in electricity
  - delays are costly in terms of prices, blackouts
  - may cause panic abandoning of LCPD and higher C emissions, with even higher C prices
  - encourages dash for gas and market power in gas market

=> puts pressure on political consensus for climate change policy

Factors exacerbating uncertainty

- Electricity is simplest low-C option
- EU Directive =15% renewable **ENERGY** for UK

=30-40% renewable **ELECTRICITY**

- likely to be large shares of wind
  - Much in Scotland: queue of 11 GW, 9GW Wales
  - offshore wind becoming very costly, competes with off-shore oil equipment, skills, steel, ...
  - currently supported by volatile ROCs
  - hindered by planning delays
  - and current grid access arrangements

Challenge of the renewable target

- At 25% capacity factor, 25% wind (rest biomass,..)
  - = 100% peak demand

=> volatile supplies, prices, congestion, ….

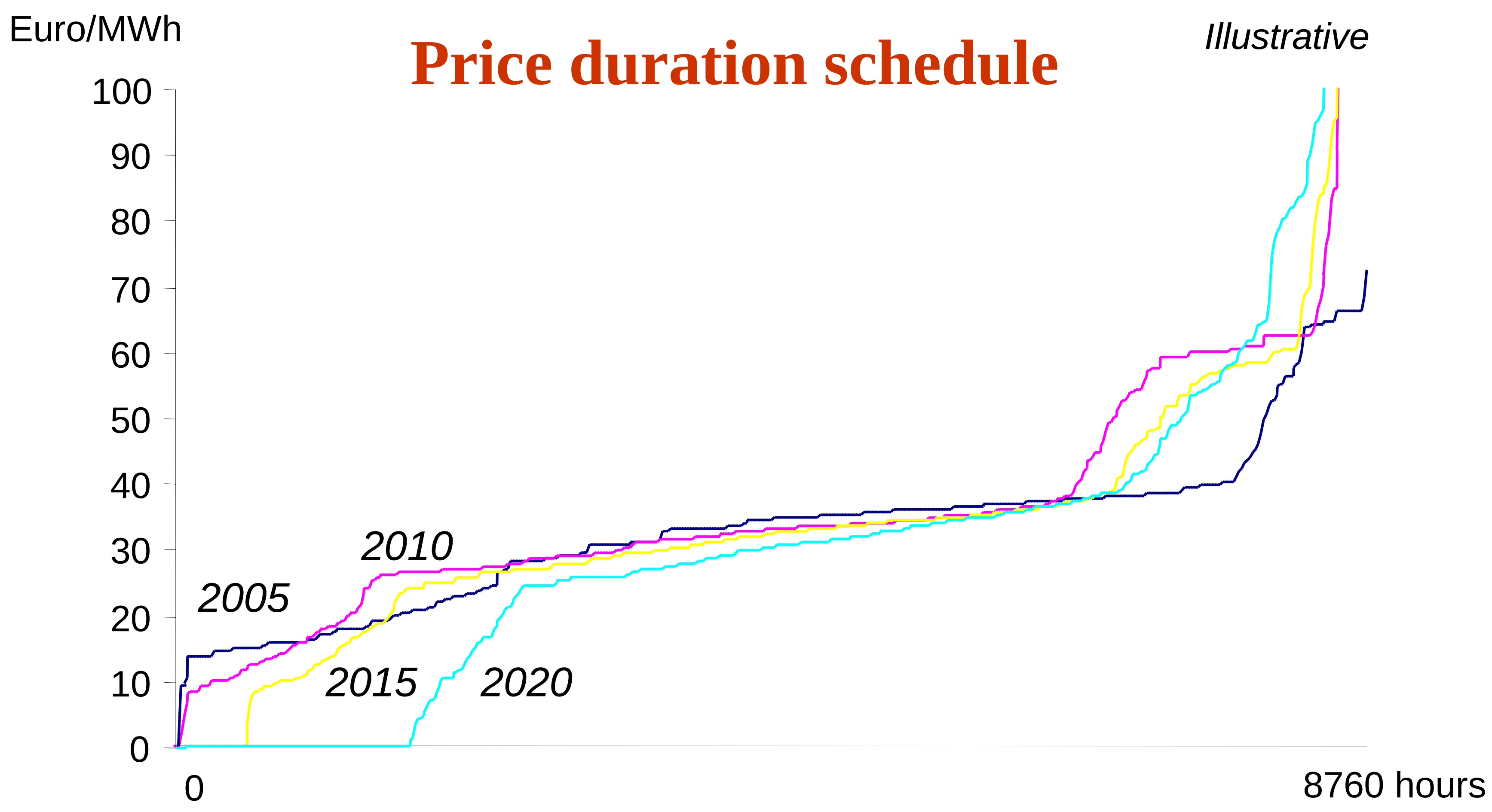
=> needs complete redesign of grid access and system operation to non-firm access, nodal pricing, FTRs and pool for balancing+energy => single price at each node and half-hour

for details see annex and Spring 2008 seminar presentation (Newbery and Neuhoff) at http://www.electricitypolicy.org.uk/events/

Implications of substantial wind

- Much greater price volatility
  - over time and space
- Reserves (much larger) require remuneration
  - will require contracts or capacity payment
  - will raise average cost of electricity
  - as will extra transmission investments
- ROCs inadequate to task
  - without giving high rents to favoured locations
  - and raising cost of electricity to poor

Simulation – more volatility, adequate reward for CCGT



Implications of carbon and electricity price volatility

- Raises cost of capital
  - important for capital-intensive plant (nuclear, wind)
  - transfers rents from consumers to share-holders
  - favours vertically integrated electricity companies
  - discourages innovative merchant renewables entry
- encourages a further dash for gas (as gas and electricity prices likely to be correlated)
- amplifies uncertainty in ROC price

Solutions

- replace ROCs by feed-in tariff
  - tailored to place and technology to minimise rents, maximise predictability, lower WACC
- target and finance support for renewable RD&D by different mechanism (so not a tax on poor)
  - leave C price to deal with climate change
- place a floor on the EU carbon price (and possibly a ceiling (allocate a share of member states allocations to Carbon Bank to buy and sell to stabilise C price, profits to MSs)

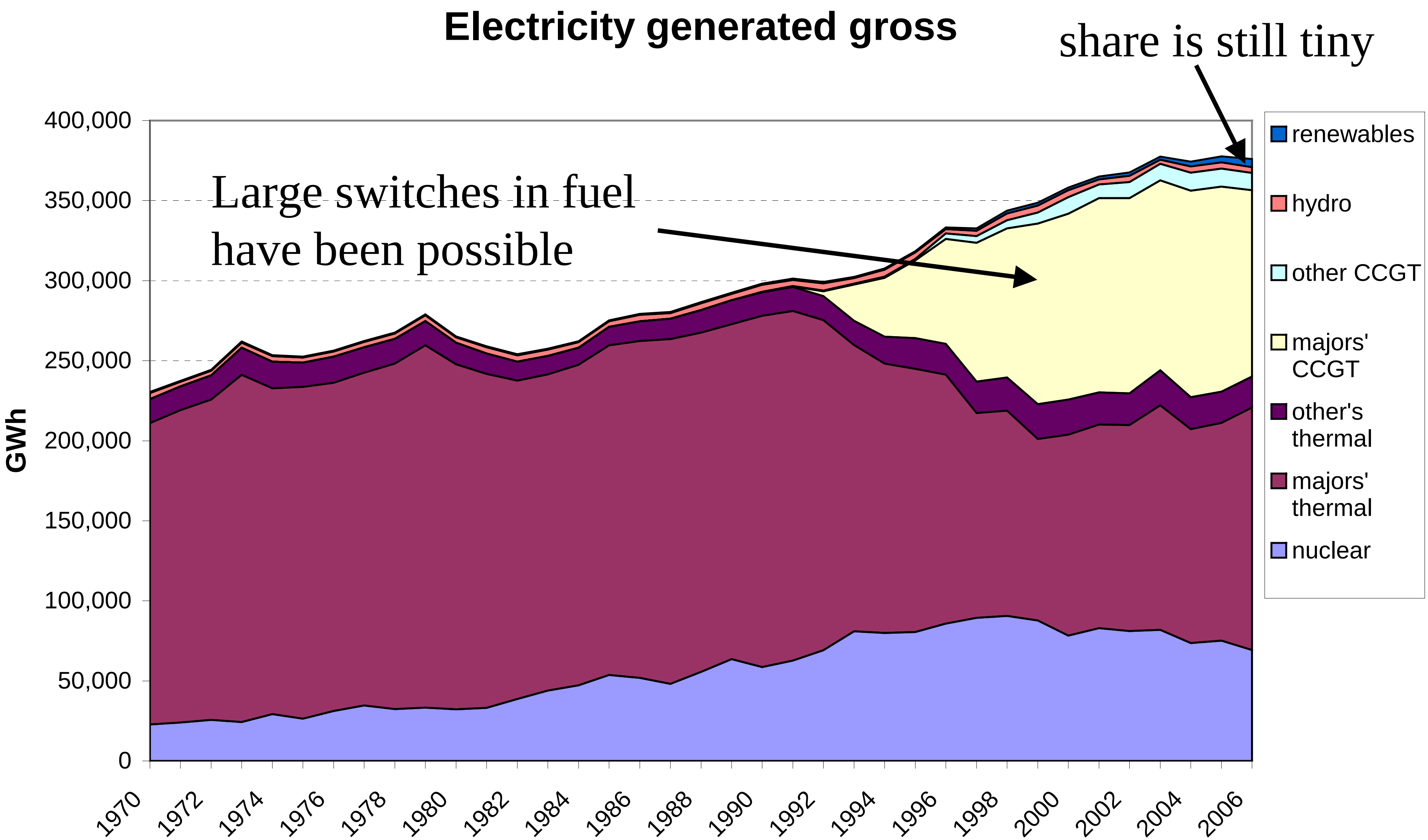
Conclusions

- EU climate change policy - politically astute but lacks economic rationality
- Renewables policy is a poorly designed RD&D policy picking wind as a winner
- C policy fails to deliver stable C price signals
- bio-fuels is a disaster
- successful at stimulating collective action
- can now aim to improve rationality

Annex

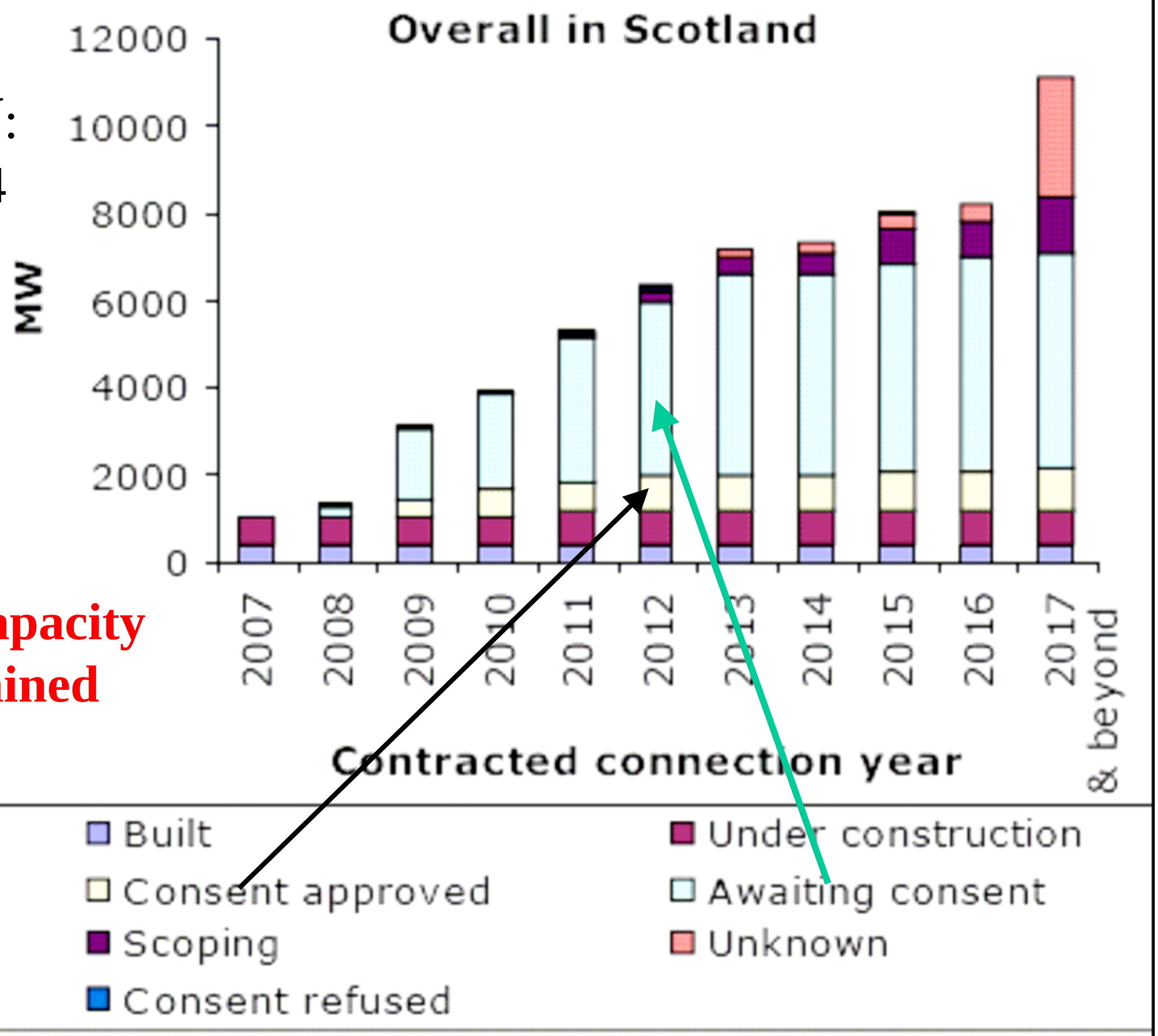
- full presentation available from EPRG's Spring Seminar web site http://www.electricitypolicy.org.uk/events/spring08/programme.html paper by Newbery and Neuhoff
- following slides taken from that presentation

But renewables share is still tiny



Existing MW:
Thermal = 1,524
Hydro = 1,100
Wind = 650
pump
storage = 300
demand = 1650

2 GW export capacity already constrained



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

The argument for change

- A flawed system can be improved

=> potentially everyone can be made better off

- The challenge:
  - identify the efficient long-run solution
  - that can co-exist with an evolving regime for incumbents
  - apply new regime to all new generation
  - which compensates incumbents for any change
  - while encouraging them to migrate

Efficient congestion management

- Nodal pricing or LMP 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
- Financial transmission contracts hedge T price risk

Efficient balancing market

- Use right combination of plants to
  - provide spinning reserve
  - provide flexibility to vary output over periods of mins - 4 hours (i.e. are warm, and given ramping constraints)
  - 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

=> POOL type approach

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)

Transition for existing plant

- Existing G receives long-term transmission contracts but pays grid TEC charges
- for output above TEC, sell at LMP

$\Rightarrow$ G significantly better off than at present

$\Rightarrow$ No T rights left for intermittent generation

Challenge: devise contracts without excess rents and facilitate wind entry