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

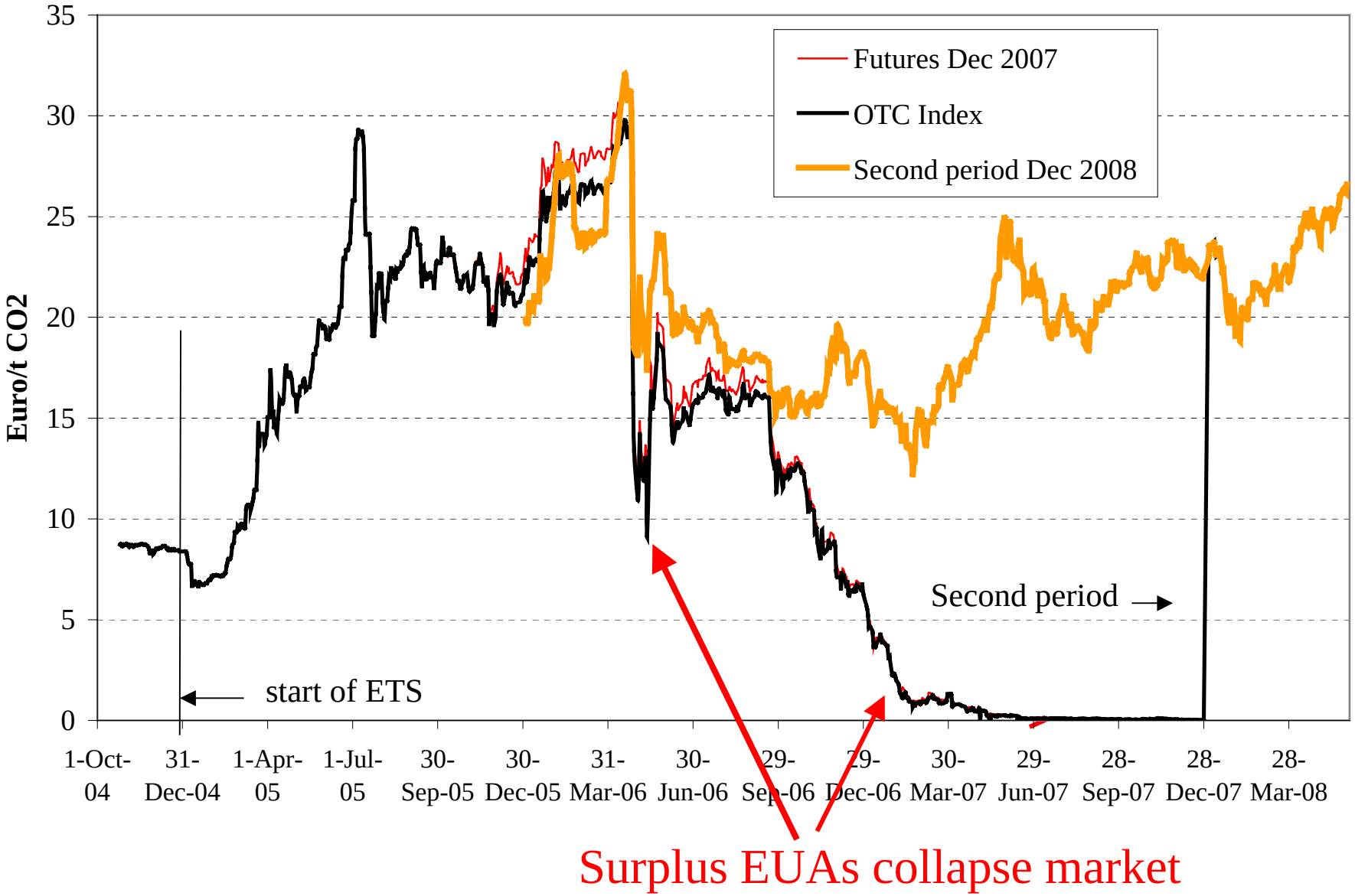
# Outline

- 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

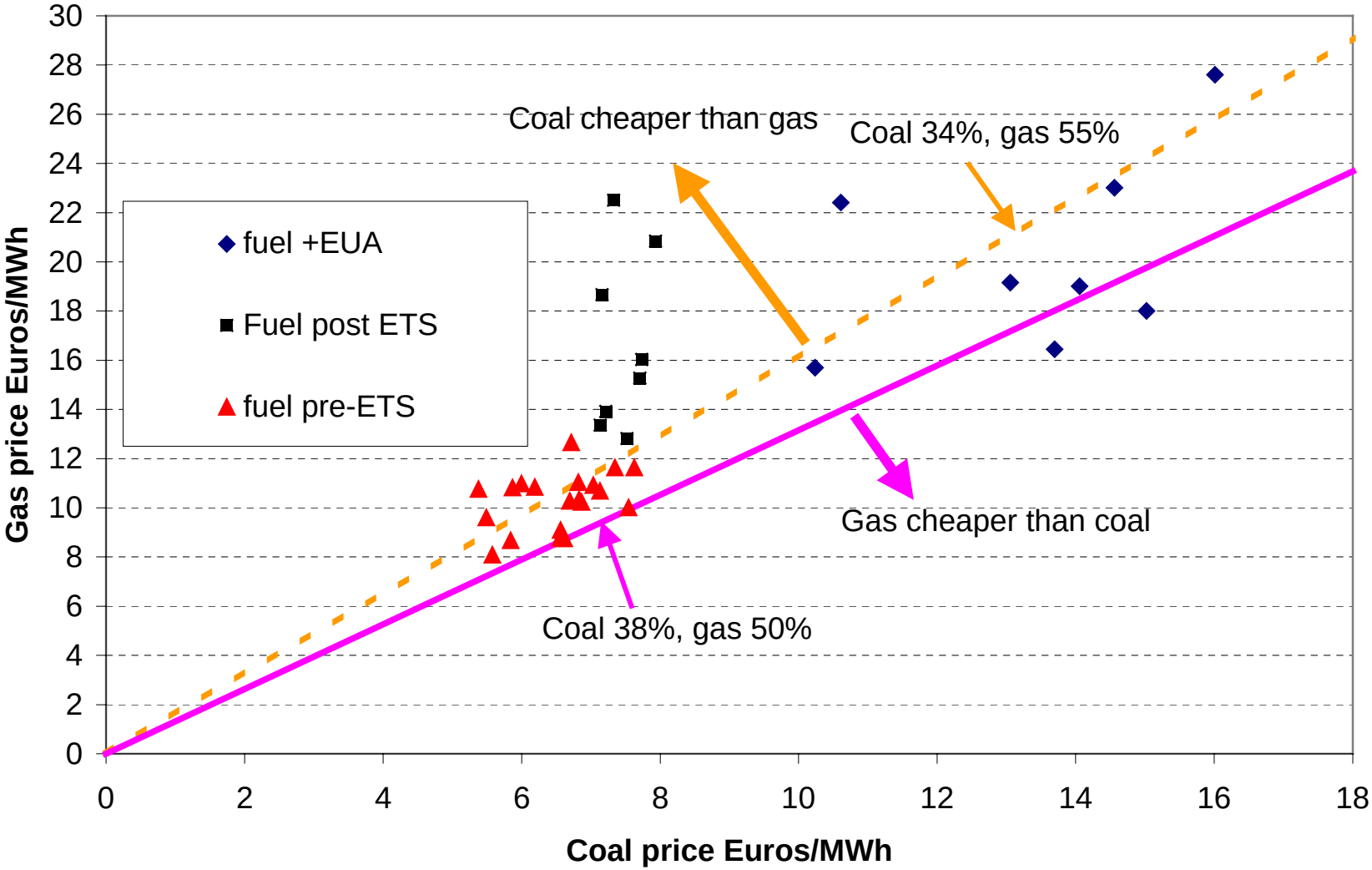
# EUA price 25 October 2004-28 May 2008



# 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



# 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, ….

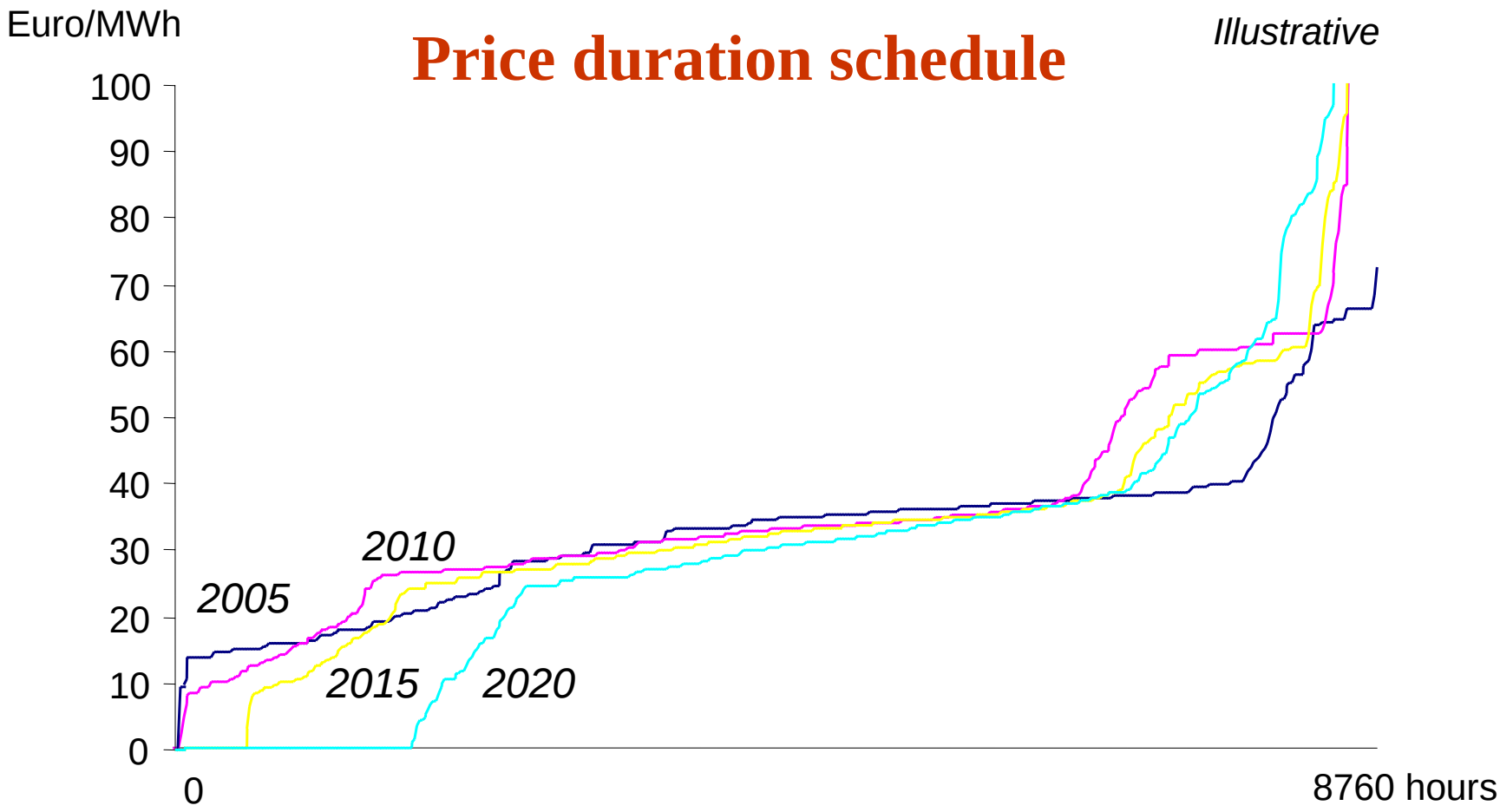
=> needs complete redesign of grid access and system operation to non-firm access, nodal pricing, FTRs and pool for balancing+energy => single price at each node and half-hour

***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

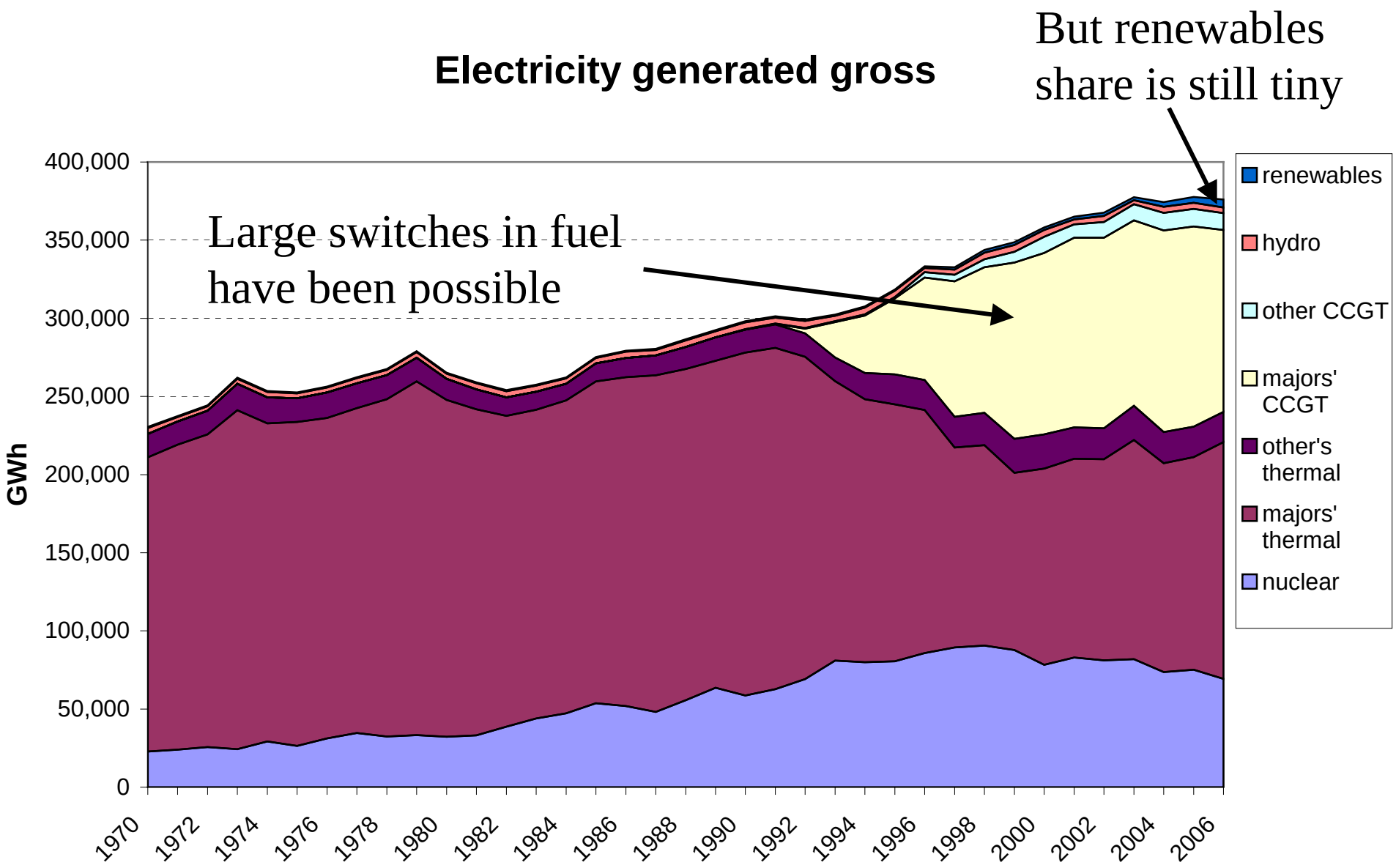
- replace ROCs by feed-in tariff
  - tailored to place and technology to minimise rents, maximise predictability, lower WACC
- target and finance support for renewable RD&D by different mechanism (so not a tax on poor)
  - leave C price to deal with climate change
- place a floor on the EU carbon price (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

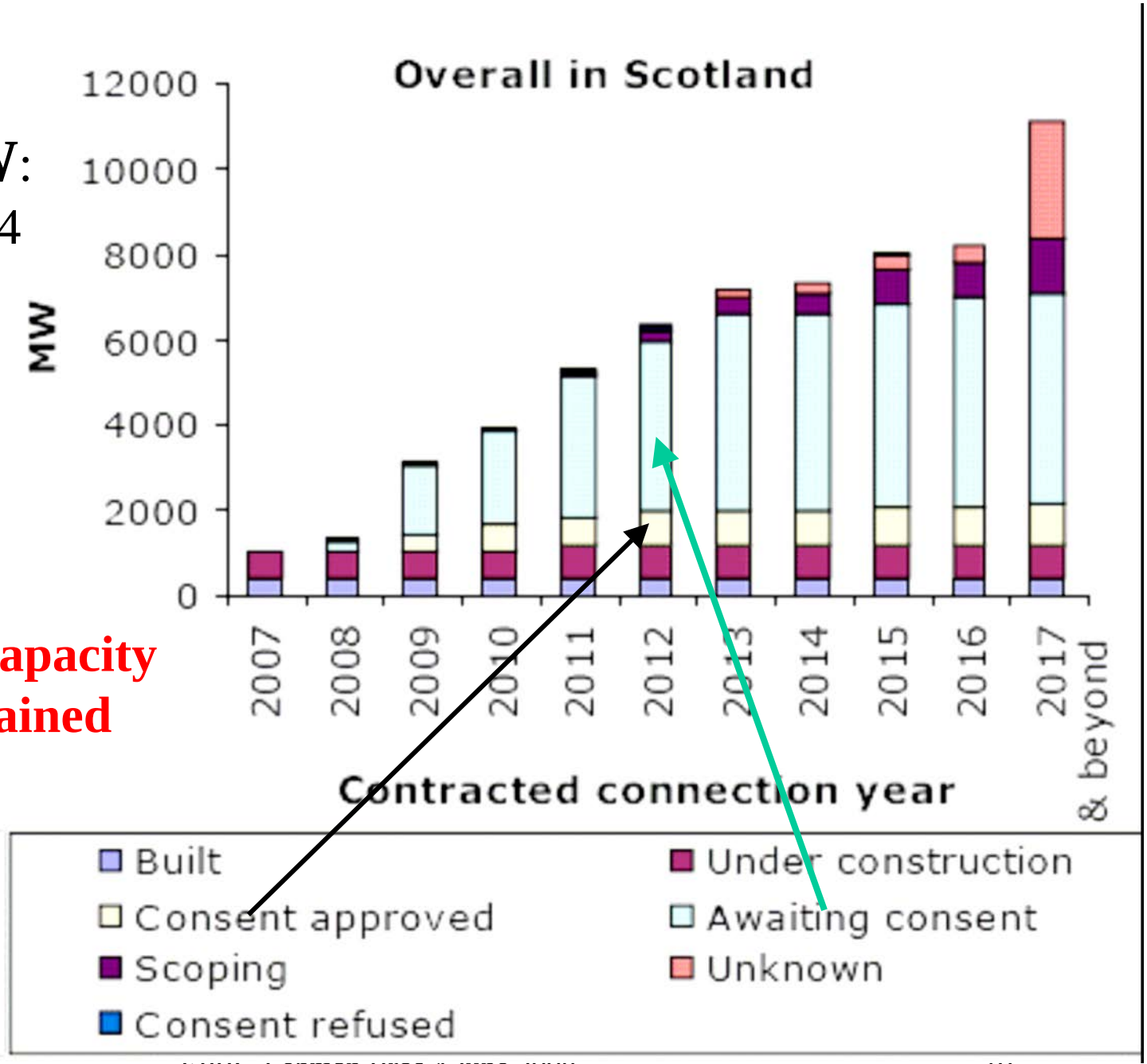
# Annex

- 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


Electricity generated gross
But renewables share is still tiny
Large switches in fuel have been possible
GWh
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
renewables
hydro
other CCGT
majors' CCGT
other's thermal
majors' thermal
nuclear

**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***