



Presentation to the workshop
Scenarios and Storylines for EU Climate
Policy Instrumentation

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Scenario-based bottom-up: Climate Instrument Building Blocks

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Structure of presentation

- Overall approach
- Sectoral disaggregation
- Instrument identification
- Instrument interactions
- ‘Optimality’ in an n-th best world

Climate change: an unprecedented policy challenge

The Stern Review Policy Prescription

- Carbon pricing: carbon taxes; emission trading
- Technology policy: low-carbon energy sources; high-efficiency end-use appliances/buildings; incentivisation of a huge investment programme
- Remove other barriers and promote behaviour change: take-up of new technologies and high-efficiency end-use options; low-energy (carbon) behaviours (i.e. less driving/flying/meat-eating/living space/lower building temperatures in winter, higher in summer)
- Carbon pricing will both stimulate investment in low-carbon energy sources and promote behaviour change. But in the presence of market barriers and innovation failure, either prices will need to be infeasibly high, or they will need to be supported by complementary policy

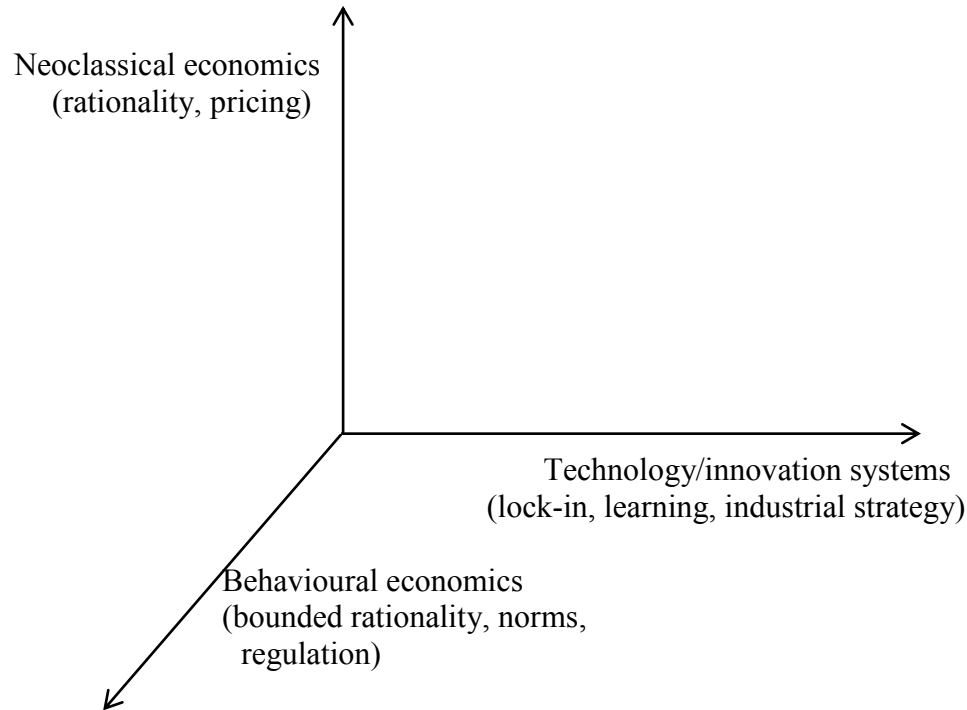
Energy policy objectives

The objectives of energy policy for the UK and many other countries are basically three:

- Transition to a low-carbon energy system (involving cuts of at least 80% in greenhouse gas (GHG) emissions by 2050, which will require the almost complete decarbonisation of the electricity system)
- Increased security and resilience of the energy system (involving reduced dependence on imported fossil fuels and system robustness against a range of possible economic, social and geo-political shocks)
- Cost efficiency (ensuring that investments, which will be large, are timely and appropriate and, above all, are not stranded by unforeseen developments)

Three domains of change

Acknowledgement: Michael Grubb, *Planetary Economics*, forthcoming



The demand side

- Buildings (residential, commercial)
- Transport (road vehicles, rail, aviation, shipping)
- Industry (energy, process)
- Agriculture

The supply side

- Vectors: electricity, heat, liquid fuels, hydrogen
- Fossil sources: coal, oil, gas (last two conventional and unconventional)
- Low-carbon sources: ambient renewables (wind, solar, wave), bioenergy, nuclear
- Low-carbon technologies: CCS, geo-engineering

UK statutory obligations

- Climate Change Act, carbon budgets, Committee on Climate Change
- EU Renewables Directive: UK 15% final energy demand from renewables by 2020; approx. 30% electricity (2007: 5%; 2011 9.4% - Renewables Obligation, shortly to become feed-in tariff); 12% heat (Renewable Heat Incentive – commercial, residential); 10% transport (Renewable Transport Fuels Obligation to implement EU Directive)

Major possible, but uncertain, developments (1)

Energy Demand: determines *how much* supply, and *what kind of* supply, is required

- **Demand reduction:** efficiency (rebound effect), lifestyles
- **Demand response:** smart meters/grids, load smoothing, peak/back-up reduction, storage, leading to implications for
- **Network design**
- **Key demand technologies:** most importantly likely be *electric vehicles* (with or without fuel cells), which could also be used for electricity storage/load smoothing, and *heat pumps*, both of which would use the decarbonised electricity. However, both technologies are in substantial need of further development and their mass deployment raises important consumer/public acceptability, as well as infrastructure, issues.

Major possible, but uncertain, developments (2)

- **Decarbonisation of electricity** (and its use for personal transport and residential heat). This depends on the development and deployment of four potentially important low-carbon options:
 - *Large-scale renewables*: issues of incentives, deployment, supply chain, storage technologies
 - *Small-scale renewables*: issues of planning, institutions
 - *Nuclear power*: issues of demonstration, cost, risk (accident, attack, proliferation, waste, safety, decommissioning), public acceptability
 - *Carbon capture and storage (CCS)*: issues of demonstration, feasibility, cost, risk (storage, liability)

Major possible, but uncertain, developments (3)

Bioenergy - thorny issues related to:

- *Carbon reduction*: how is biomass produced?
- *Environmental sustainability*: issues of land use, biodiversity
- *Different uses of biomass*: competition between bioenergy and food
- *Social issues*: issues of power, livelihoods, ownership and control

Major possible, but uncertain, developments (4)

Internationalisation in relation to:

- *Technology*: e.g. global research, innovation, technology transfer. Balance between competition and co-operation
- *Trade*: e.g. bioenergy, electricity, carbon, border taxes
- *International integration*: grids (e.g. high-voltage DC electricity), markets (European Roadmap 2050)

Options and choices

- Different countries have different options and are likely to make different choices across all these dimensions, depending on their energy history, culture, resource endowments and international relations.
- Choices are essentially political (though industry will be inclined to argue that the country concerned 'needs' their favoured option).
- The options will play out differently in terms of energy security and cost
- The economic and political consequences of making the wrong choices are potentially enormous
- Balance between developing portfolios (diversity) and going to scale (picking winners – economic as well as energy).
- Importance of demand side (historically supply needs have been substantially over-estimated)

Possible UK timeline, 2010-2050 (1)

2010-2020:

- Supply-side options are clarified (how much renewables? Does CCS work? Which countries will go for nuclear? How much distributed generation?)
- Trajectory of demand reduction is clarified
- Trajectory of electrification of personal mobility and residential heat is clarified
- Demand response technologies are installed (e.g. smart meter roll-out) and effectiveness clarified
- Requisite institutional reforms are put in place (e.g. reform of energy markets)
- Internationalisation agreements are put in place (e.g. European integration, regulation)

Possible timeline, 2010-2050 (2)

2020-2030:

- Large-scale roll out of different supply technologies
- Establishment of new demand patterns
- Roll out of grid redesign
- Re-think/re-orientation where possible/desired to take account of new technologies and options

2030-2050:

- Large-scale deployment of chosen options
- Limited scope for trajectory change without large costs

CECILIA2050 structure of climate policies

- Carbon pricing
- Energy efficiency and energy consumption
- Promotion of renewable energy
- Non-CO2 GHGs

Landscape of UK climate policies

| Policy Instrument | Policy Landscapes | | | |
|---|-------------------|--|--|-------------------------|
| | Carbon Pricing | Energy Efficiency and Energy Consumption | Promotion of Renewable Sources of Energy | Non-Carbon Dioxide GHGs |
| Climate Change Levy (inc. Carbon Price Floor) | (✓) | ✓ | ✓ | |
| Climate Change Agreements | | ✓ | | |
| EU ETS | ✓ | ✓ | ✓ | ✓ |
| Renewables Obligation | | | ✓ | |
| Renewable Energy Feed-In Tariff | | | ✓ | |
| Renewable Heat Incentive | | | ✓ | |
| CRC Energy Efficiency Scheme | ✓ | ✓ | | |
| Carbon Trust Standard | | ✓ | | |
| LSE Carbon Reporting Requirements | | ✓ | | |
| Green Deal | | ✓ | | |
| Energy Company Obligation | | ✓ | | |
| Renewable Transport Fuel Obligation | | | ✓ | |
| Vehicle Excise Duty | | ✓ | | |
| Landfill Tax | | | | ✓ |
| Greenhouse Gas Action Plan | | | ✓ | ✓ |

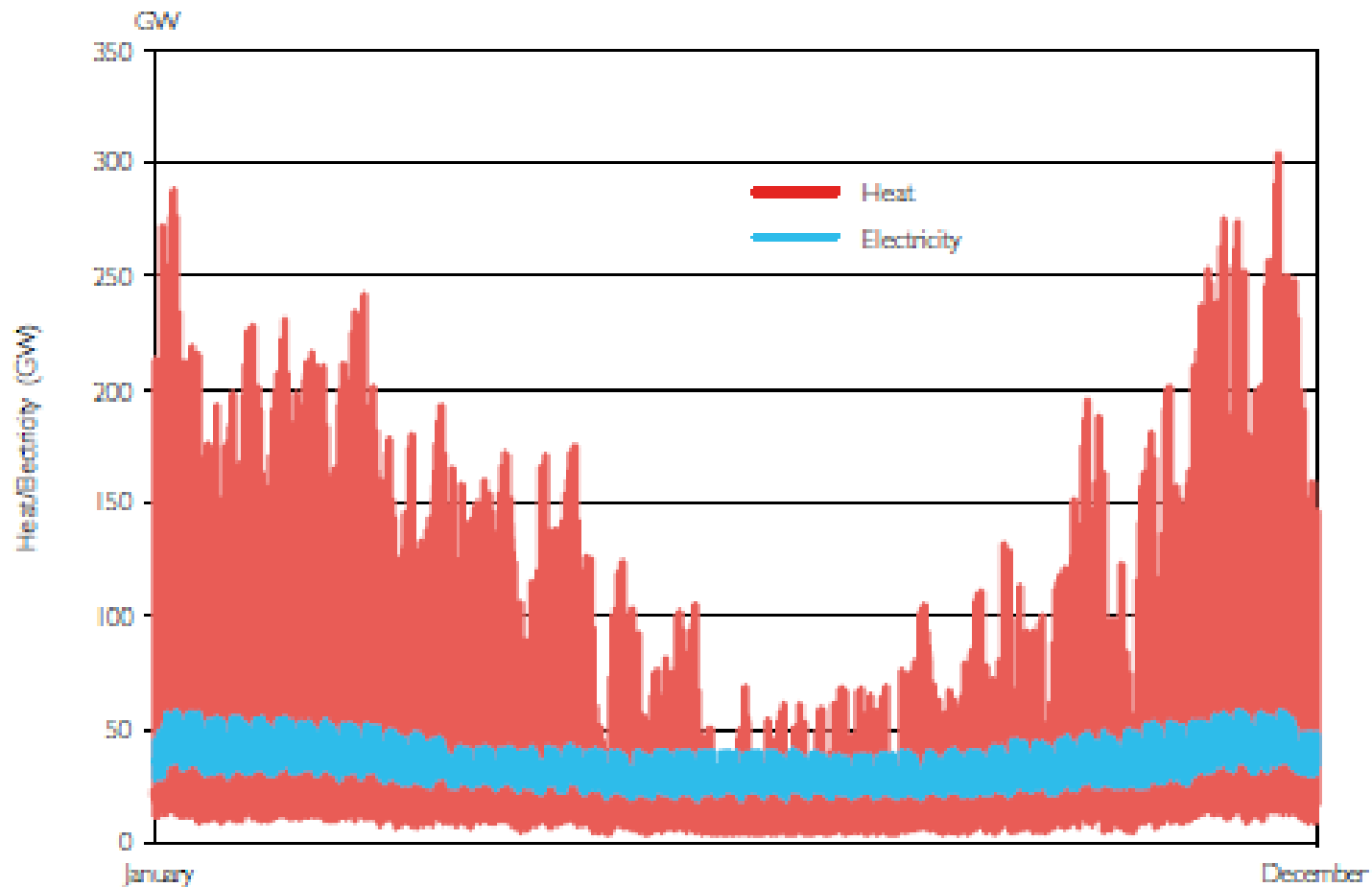
Bottom-up scenario construction

- *Ex ante* estimation of effect of instrument (inc. rebound effect if appropriate)
- Consideration of interaction between instruments, inc. order of implementation (e.g. home insulation, can only save energy once)
- Reality check on energy system implications (e.g. substitution of low-carbon electricity for gas-based heat, see next slide)
- Bottom-up modelling (e.g. MARKAL/TIMES)

Variability in energy consumption

Source: DECC Heat Strategy, 2012, p.12 (daily consumption also relevant)

Chart 2: Comparison of heat and electricity demand variability across a year (domestic and commercial) – 2010⁷



‘Optimality’ in an n-th best world

- Effectiveness (e.g. extent of emissions reduction)
- Cost efficiency (equalisation of marginal cost; stimulation of innovation/technology; stimulation of behaviour change)
- Feasibility (political economy [international and domestic], complexity)
- Two views:
 - Existential: the existing mix is the best that could have been achieved
 - Optimal: anything less than the neo-classical optimum is unacceptable
 - Shots-in-the-locker: develop alternative policies to be ready for window of opportunity



Thank you

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