Achieving long-term UK emissions reduction target in the light of short-term political and societal challenges

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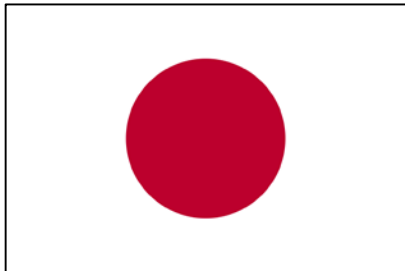


Overview of talk

1. The UK energy **policy journey**
   - **Setting** groundbreaking decarbonisation targets
   - The challenges in then **implementing** this low-carbon agenda
2. How energy modelling has underpinned evidence-based policy making
   - FROM
     - Conventional optimisation energy models that focus on **technological and economic** uncertainties
   - TO
     - Insights from new socio-technical energy transition (STET) models that focus on **policy and society**

Opening question 1:

Is energy decarbonisation a *special* policy area?

- Both YES and NO
- Yes
  - A **government-led** innovation, pricing and market enabling process
  - Impacts **all** sectors of the economy, and **all** segments of society
  - **Incumbent** stakeholders, technologies, institutions
- No
  - Competing policy priorities within the fast-moving high-stakes political process

Part 1:
The UK energy decarbonisation journey (so far…)

Historical UK energy policy

- Department of Energy (1974 – 1992)
  - Established after first oil price crisis
  - Rising importance of North Sea oil and gas

- Disbanded in April 1992
  - Self sufficiency of North Sea oil and gas
  - Dismantling of national coal monopoly and union power
  - Privatisation of energy-related industries

- The energy issue had been solved…!

Setting decarbonisation targets (2000-2008)

RCEP 2000

EWP 2003

EWP 2007

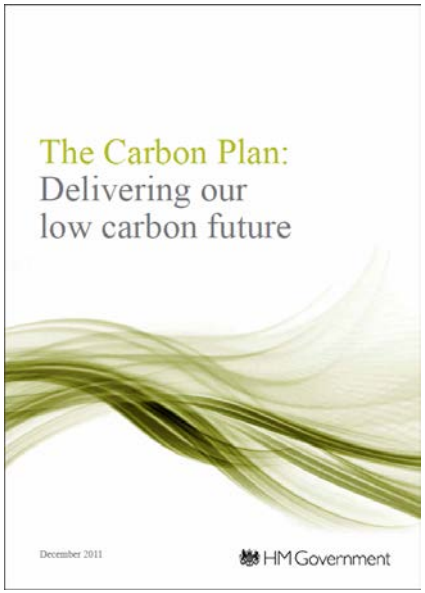
CCC 2008

Proposed targets → **Building evidence base and political consensus** → **Legislative framework and targets**

Institutional framework is vital

- UK was the first G20 economy to legislate long-term decarbonisation targets (Climate Change Act, 2008)
- CCC: Committee on Climate Change (2008 -
  - Independent advisory body that sets and monitors 5-yearly carbon budget process to reach an 80% reduction by 2050
- DECC: Department of Energy and Climate Change (2008 - 2016), with 4 main tasks
  - **Legally binding long-term (2050) GHG emission reduction targets**
  - Energy security (net importer of energy from 2006)
  - Equitable access to energy (fuel poverty)
  - Open and competitive energy markets (EU interaction)

Implementation of decarbonisation policy (2008 -



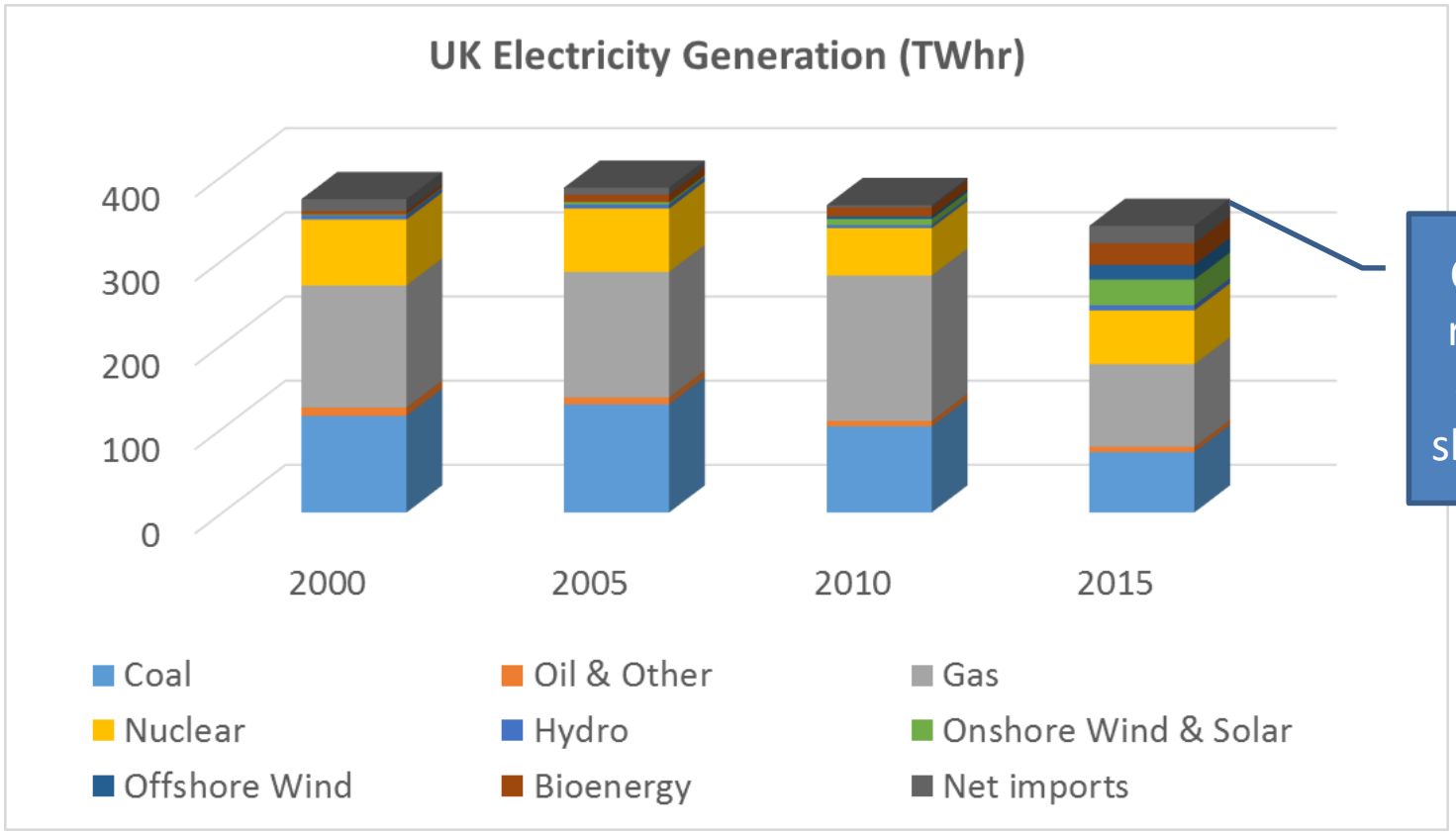
- Focused on electricity
  - UK Renewable Obligation
  - UK Electricity Market Reform (2013)
    - » Carbon price floor
    - » Feed in tariffs for low-carbon electricity (CfD)
    - » Capacity markets for flexible generation
    - » Emissions performance standard (450g/kWh)
- Plus a set of enabling measures
  - Smart meter roll out (all residential homes by 2020)
  - Green Investment Bank – £3.4 billion (¥500 billion) invested
  - Large increases in research and innovation funding

UK carbon budgets (all GHGs)

BUT: 2008 financial crisis, UK territorial only

Budget	Carbon budget level	% reduction below 1990	Notes
1st (2008-12)	3,018 MtCO2e	**23%**	Achieved
2nd (2013-17)	2,782 MtCO2e	**29%**	Achieved
3rd (2018-22)	2,544 MtCO2e	**35%**	On track
4th (2023-27)	1,950 MtCO2e	**50%**	???
5th (2028-32)	1,765 MtCO2e	**57%**	??? Electricity generation target (50 gCO_2/kWh) **not** adopted International aviation and shipping **not** included

Renewable energy winners and losers

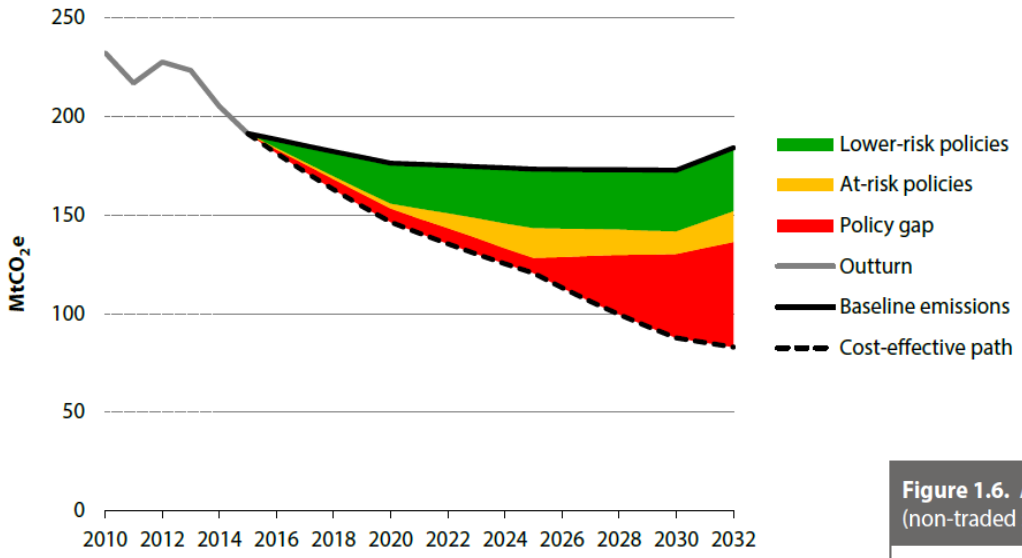


Combined renewable electricity share 23.4%

BUT, limited policies on buildings and transport

- 22 million residential gas boilers (97% market share)
- 28 million privately owned petrol/diesel cars (99% market share)

Figure 1.7. Assessment of current and planned policies against the cost-effective path for emissions (traded sector)

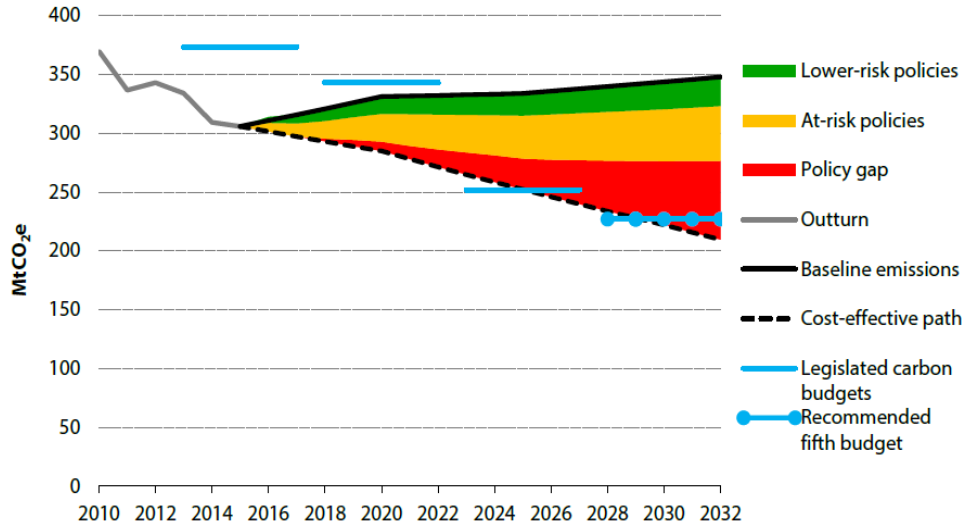


Source: DECC (2015). *Updated energy and emissions projections 2015*; CCC analysis.
Notes: Shows the cost-effective path for actual emissions in the traded sectors. This is not directly carbon budgets, which are based on net emissions for the traded sectors (see section 1).

Committee on Climate Change projects wide shortfall of policies to meet 2025 and 2030 emissions targets

When will the new Emission Plan be published…?

Figure 1.6. Assessment of current and planned policies against the cost-effective path for emissions (non-traded sector)



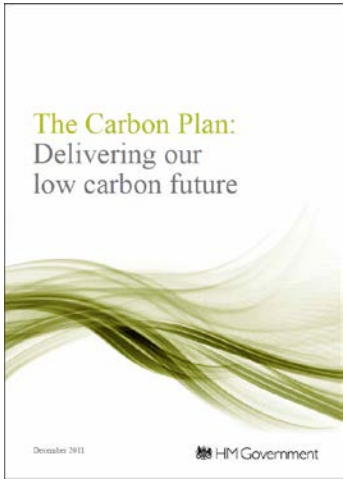
Source: DECC (2015) *Updated energy and emissions projections 2015*; CCC analysis.
Notes: Allowed non-traded emissions are estimated.

New government (2015), new controversies

- New nuclear plant (Hinkley) at a guaranteed strike price of £92.5 (14,000¥) per MWhr for 35 years
  - Illustrates investment uncertainty in the UK electricity market
- Axing of CCS demonstration programme
  - Chancellor needed to plug a £1 billion hole in government budget
- Renewable obligation closed early to onshore renewables and solar
- Carbon price floor reduced from £75/tCO_2 (in 2030) to £18/tCO_2
- Cancelling of the Green Deal, the flagship programme for residential building retrofitting
- Approval of London Heathrow airport's 3rd runway
- A £500 million overspend on the Northern Ireland Assembly's renewable heat incentive
  - Cost £300 (45,000¥) per person, and a flashpoint for new elections

Impact of Brexit (2016)

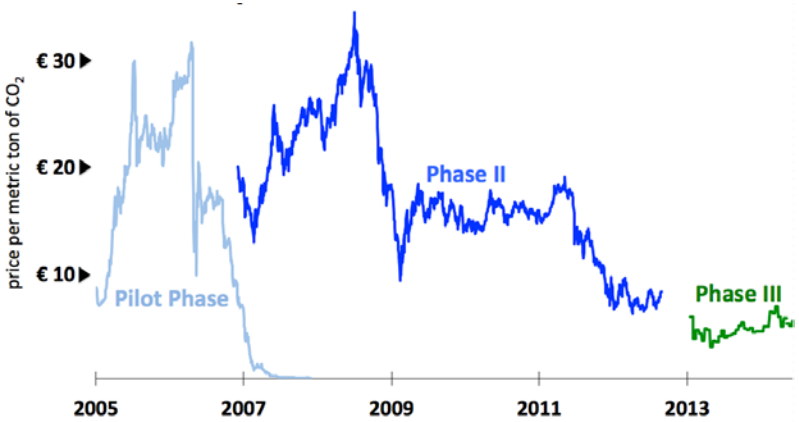
- UK Government in paralysis
  - All available policy band-width targeting the uncertainties surrounding the process of Brexit
  - STILL using the 2011 Carbon Plan
    - Long awaited Emissions Plan
    - Expected by end 2015, 2016, now 2017...



- Demise of DECC as an independent department
  - Final action was to approve the 5th carbon budget period (2030)
  - Energy rolled into the Industry department (BEIS)
    - New industrial strategy focused on job creation, supporting key (export) industries

Will UK recreate EU climate policy framework?

- Yes
  - 40% reduction in GHG emissions (from 1990 levels)
    - EU the UNFCCC signatory
    - EU submitted an overall INDC to the Paris COP in 2015
  - EU-ETS
    - But very low prices



- ???
  - 27% renewable energy share (not nationally binding)
  - Energy efficiency: Indicative target of 27%
  - Vehicle emissions standards
  - EU Ecodesign of energy related products

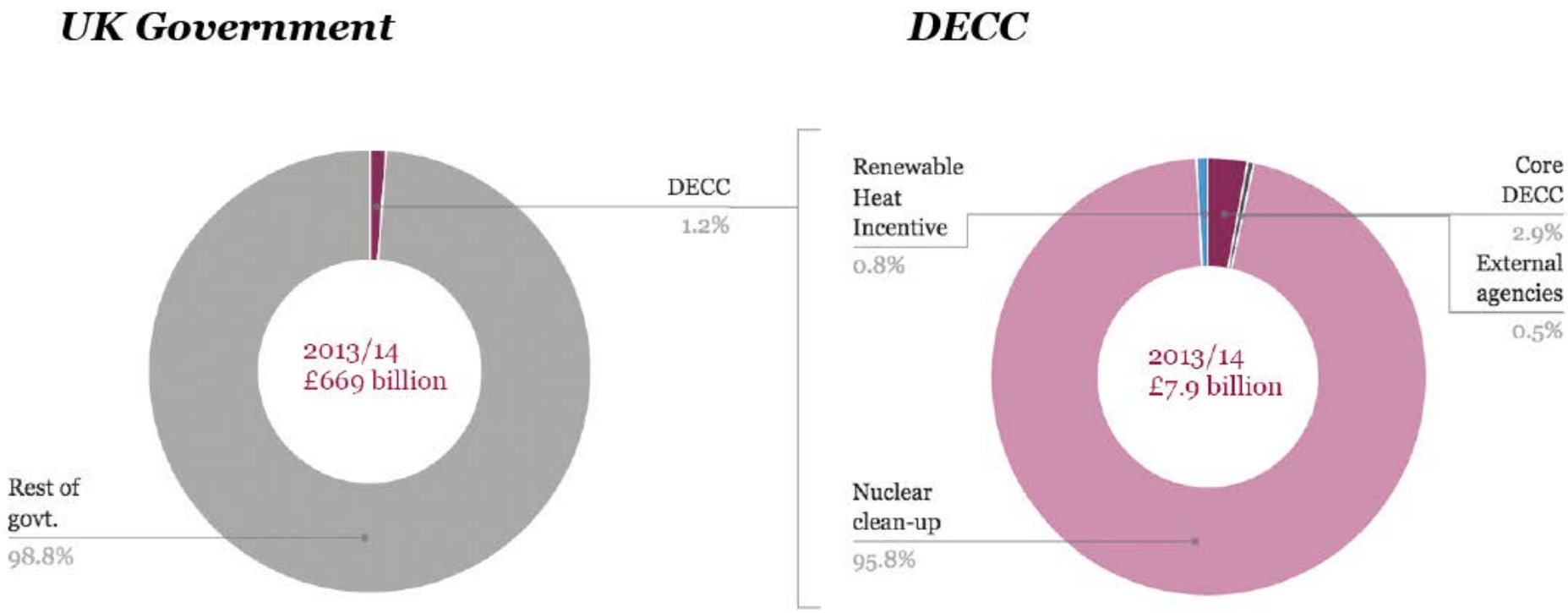
Implementation challenge:

Instability in the UK energy ministry

Department	Date	Minister
BEIS	14 July 2016	Gregg Clark
DECC	11 May 2015	Amber Rudd
	3 Feb 2012	Ed Davey
	12 May 2010	Chris Huhne
	3 October 2008	Ed Milliband
BERR	28 June 2007	John Hutton
DTI	5 May 2006	Alastair Darling
	6 May 2005	Alan Johnson

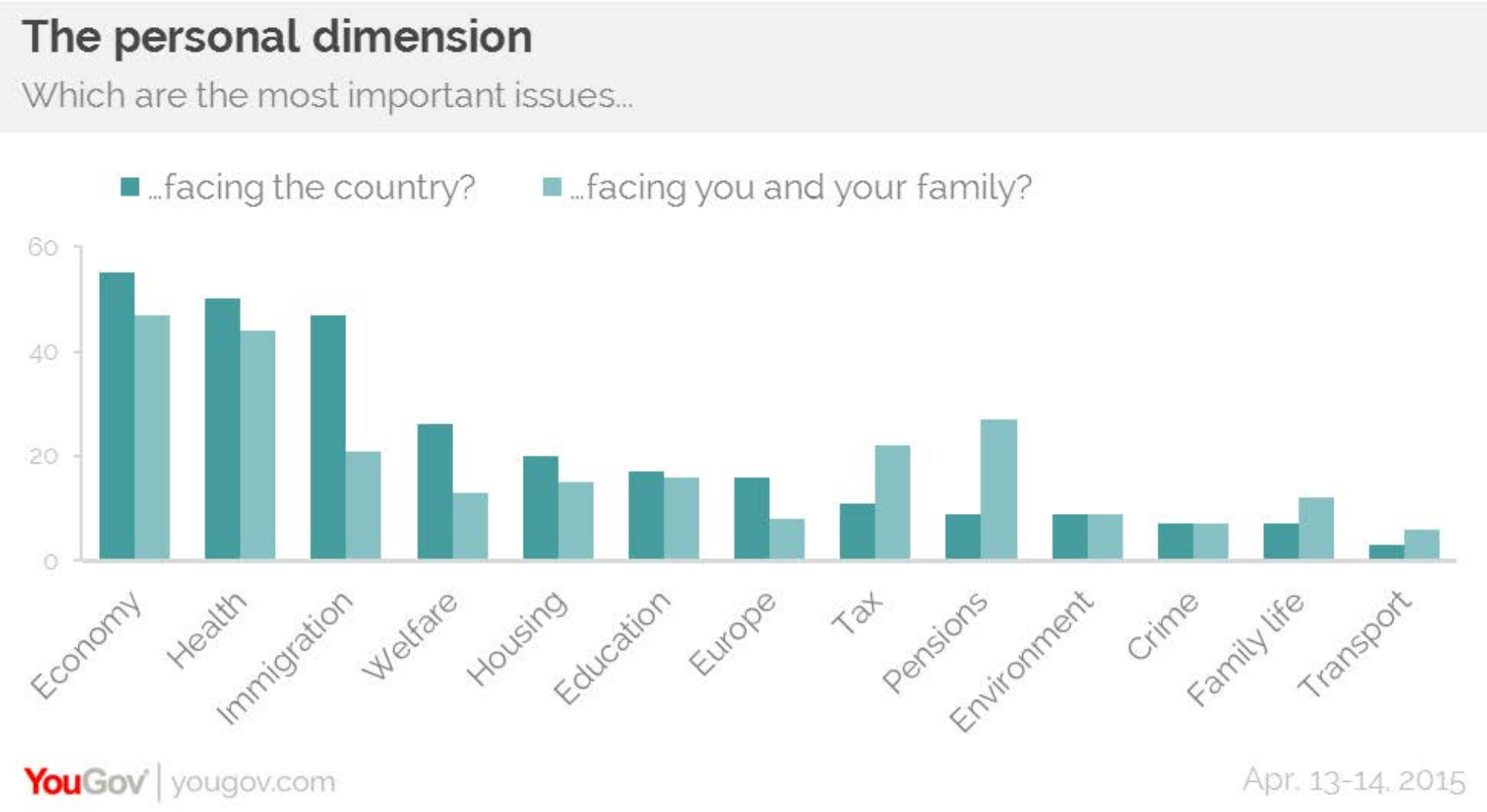
Implementation challenge:

Energy not a powerful player within government



Implementation challenge:

Energy/climate is NOT a core voting issue



Part 2:
Energy modelling for evidence-based policy making

Energy Systems Modelling for UK Energy Policy

A strategic modelling partnership between academic researchers (UCL) and government modellers

Proposed targets → **Building evidence base and political consensus** → **Developing the legislative framework and confirming targets** → **Developing the Implementation framework**

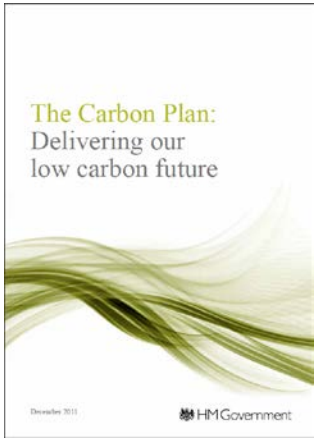
RCEP 2000

EWP 2003

EWP 2007

CCC 2008

DECC 2011

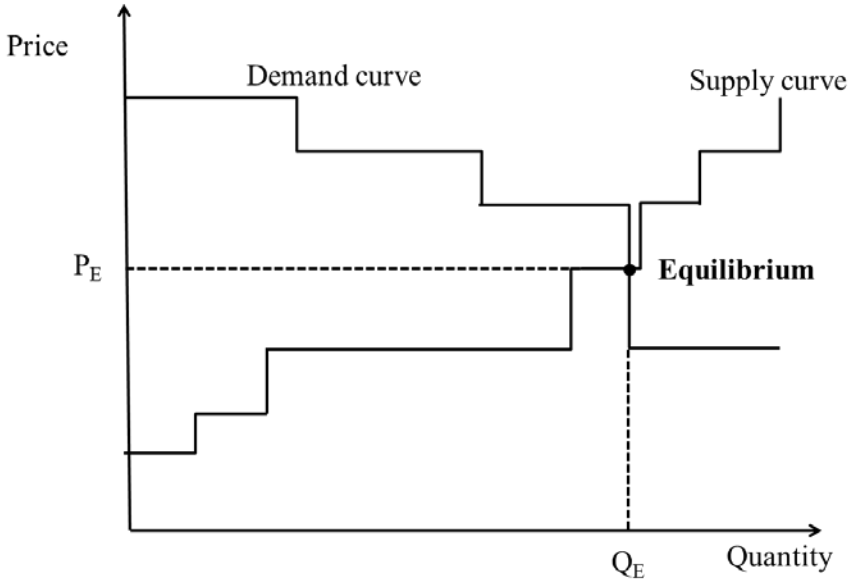


CCC 2013

Typical energy-economic model

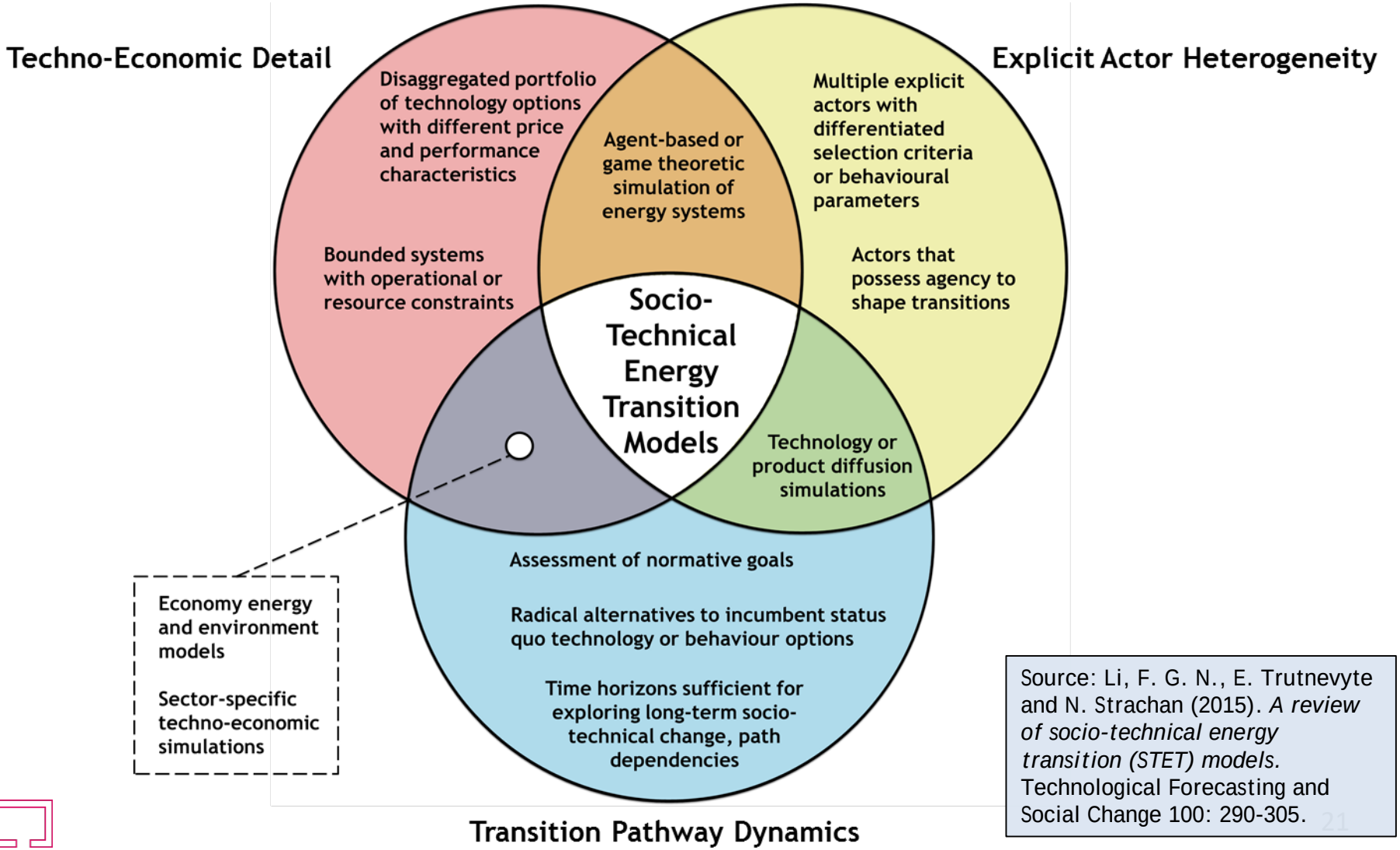
- Optimal technology pathways are achieved with the implicit assumptions of:

- Rational decision-making
- Perfect information
- Competitive markets
- Perfect foresight
- "Social planner" perspective
- Only price-based demand response



- This does *not* account for the (non-marginal) societal change needed for the energy transition
- *Nor* for how policy works in practice

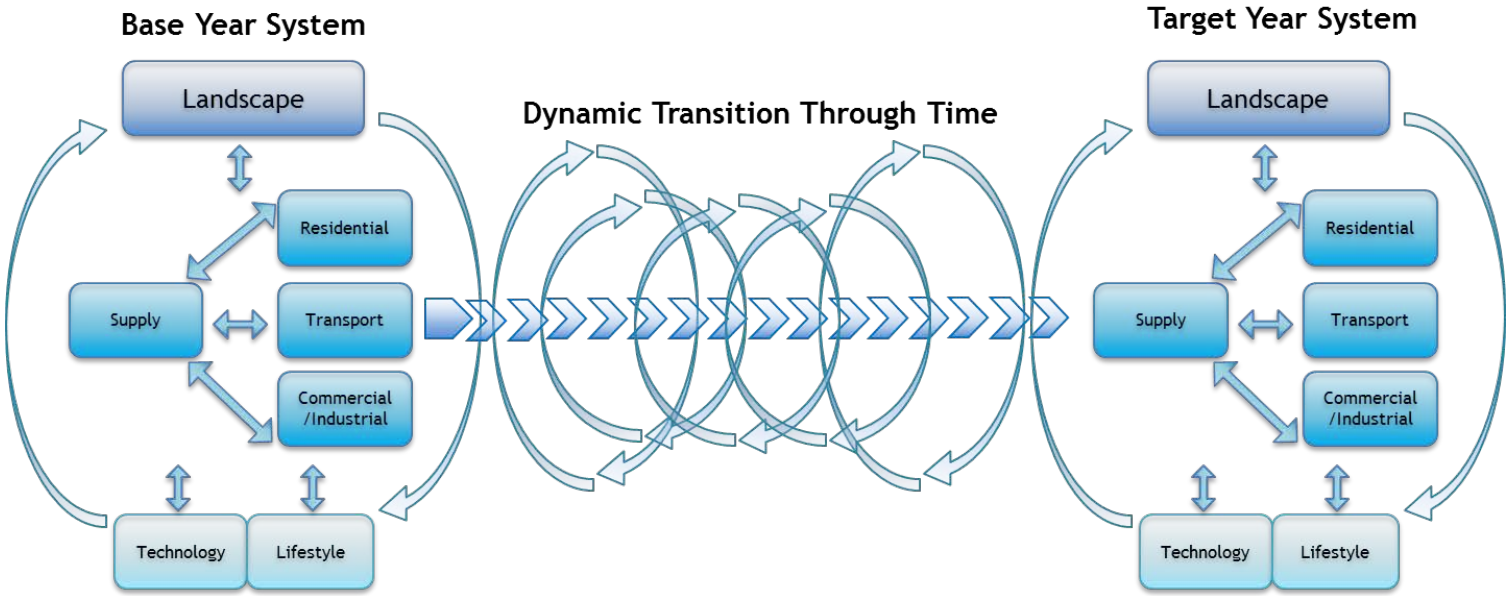
Socio-Technical Energy Transition (STET) Modelling



Source: Li, F. G. N., E. Trutnevyte and N. Strachan (2015). *A review of socio-technical energy transition (STET) models.* Technological Forecasting and Social Change 100: 290-305.

blue Behaviour Lifestyles and Uncertainty Model

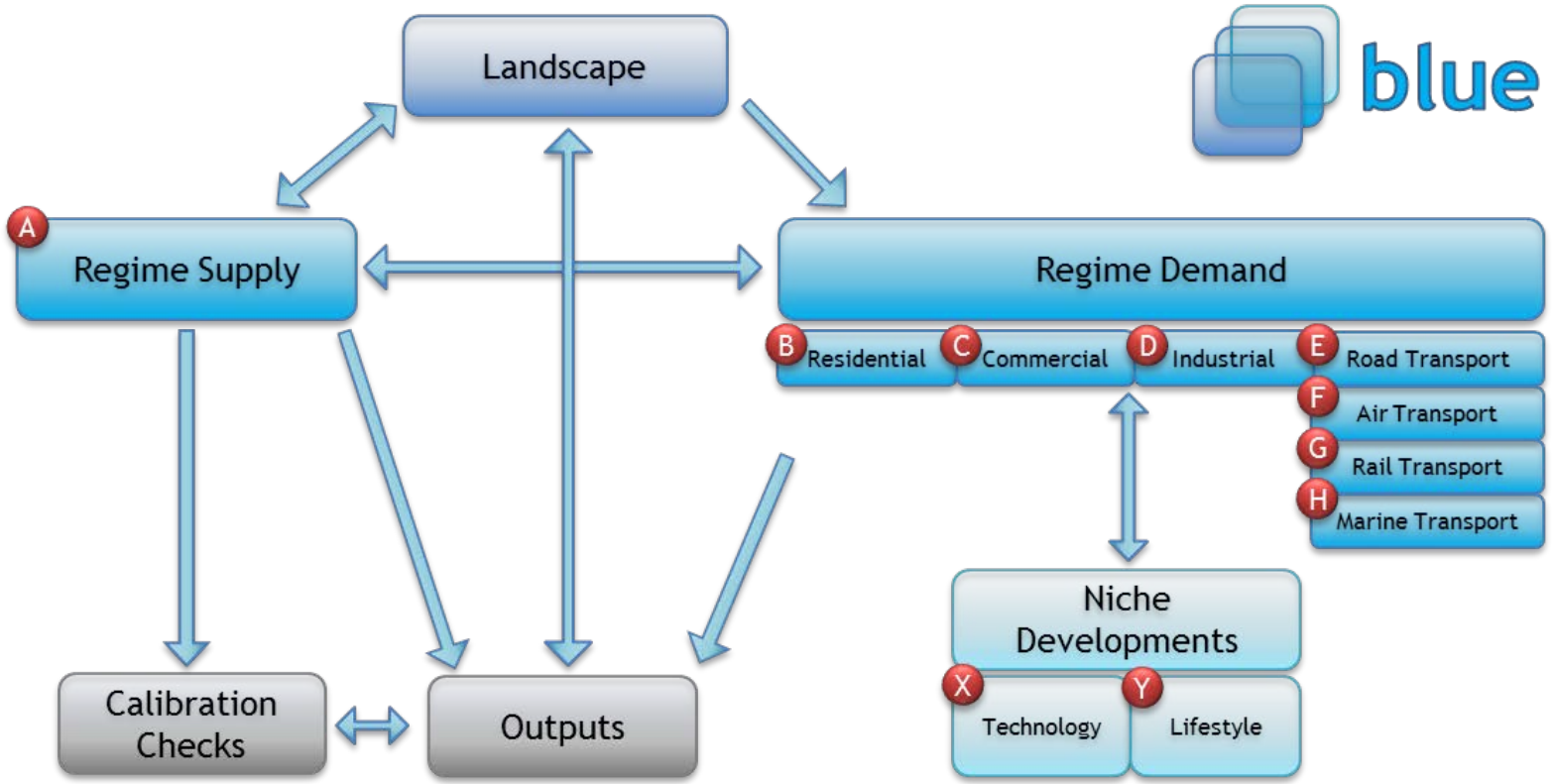
- Stylized probabilistic energy simulation model
- Lowest cost solution
- But with changing landscape drivers, and new niche social practices
- Actors make independent reactive investment decisions with highly limited knowledge of the future



Detailed model information: Li F. and Strachan N. (2016), *Modelling energy transitions for climate targets under landscape and actor inertia*, Environmental Innovation and Societal Transitions, http://dx.doi.org/10.1016/j.eist.2016.08.002

BLUE: Structure and Actors

- Currently eight actors (A-H), each representing decisions taken in individual sectors
- Stylized model with a limited number of transition technologies (X) and changes to lifestyles (Y)



BLUE: Actor's behaviour

- Actors are differentiated in their micro-economic behaviour by a set of elicited/exploratory parameters

Micro-economic Behaviour	BLUE Parameters
Demand elasticities (e)	Actors are sensitive to energy price changes
Replacement/retrofit rates (b)	Actors experience different limits to deployment rates
Intangible/hidden costs (i)	Different actors can view identical technologies as having "hassle" or barrier costs to them
Hurdle rates (r)	Actors have different sensitivities to up front investments
Heterogeneity of response (v)	Actors have different responses to competing levelised technology costs (V = ∞ is cost dependent, v = 0 is cost independent)

For a fully cost-optimal framework: $v \to \infty$; $r \to r_{social(3.5\%)}$; $i \to 0$; $b \to 1$; $e \to 1$

Illustrative scenarios

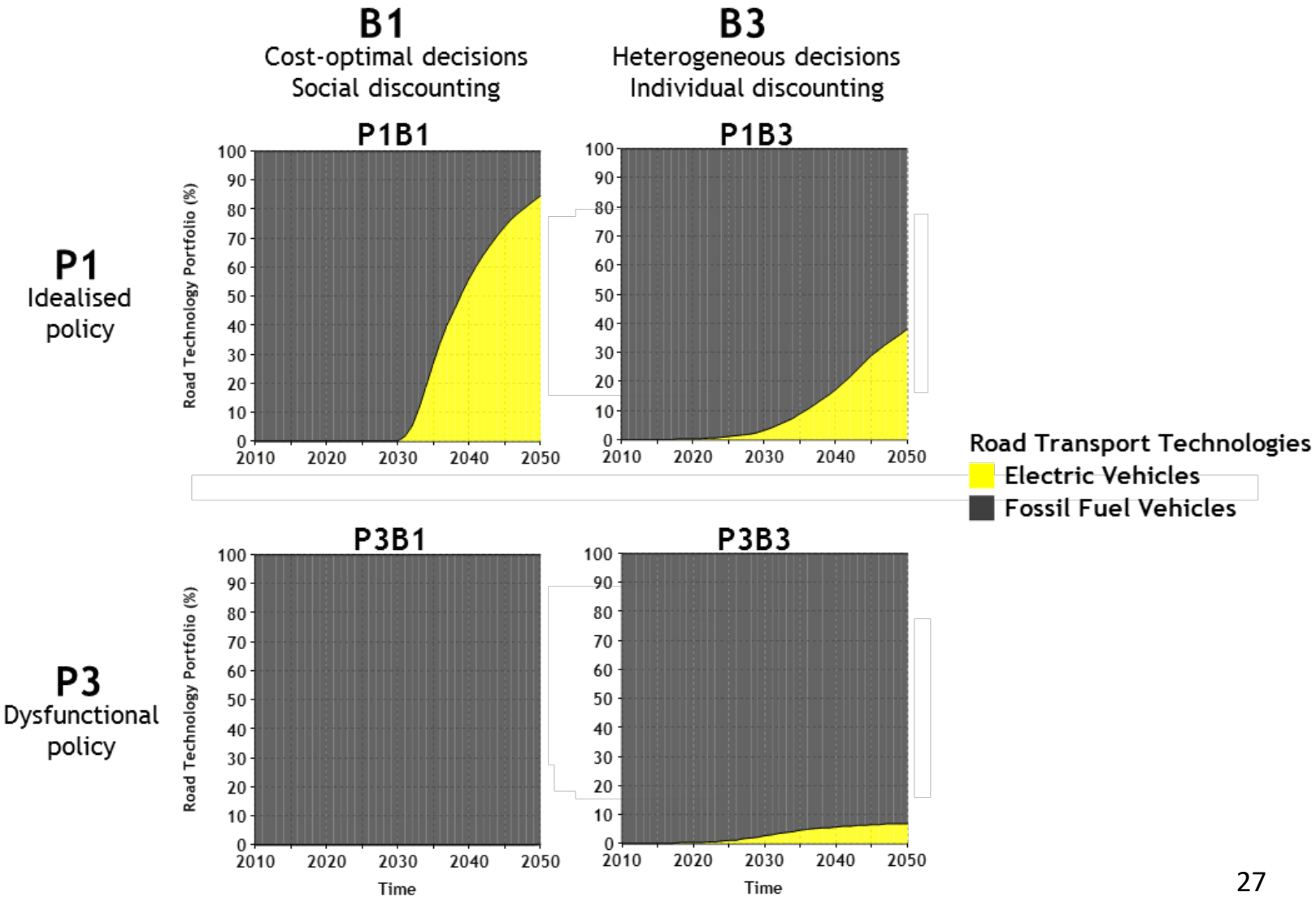
POLICY	Name	Description
P1	Idealised policy	Smooth path to high carbon price, no volatility in implementation
P3	Dysfunctional policy	Only low carbon pricing allowed, substantial volatility in implementation

BEHAVIOUR	Name	Description
B1	Cost-optimal	Individual choice as found in a typical cost-optimisation model
B3	Heterogeneous decisions & individual	Actor decision making behaviour is varied by cost response and by discount rates (note, firms more cost driven than individuals)

Detail on model runs: Li F. (2017), *Actors behaving badly: Exploring the modelling of non-optimal behaviour in energy transitions*, Energy Strategy Reviews, http://dx.doi.org/10.1016/j.esr.2017.01.002

Residential sector transitions

Transport sector transitions



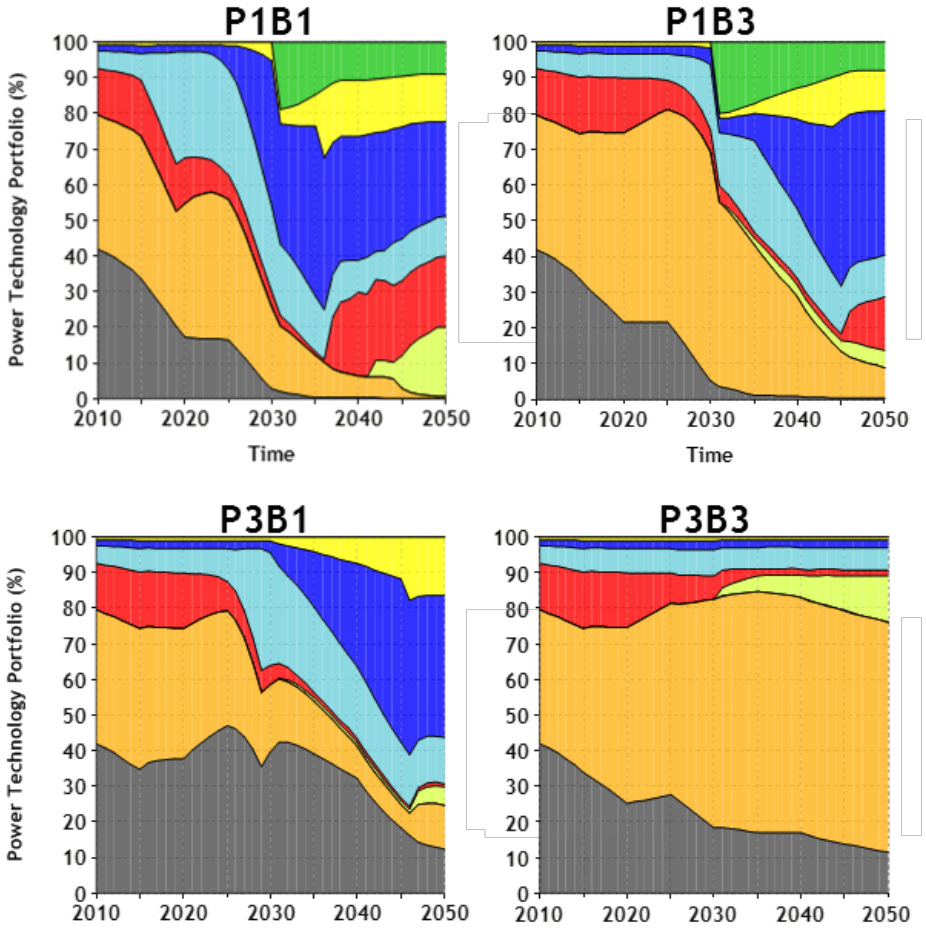
Power sector technology transitions

B1
Cost-optimal decisions
Social discounting

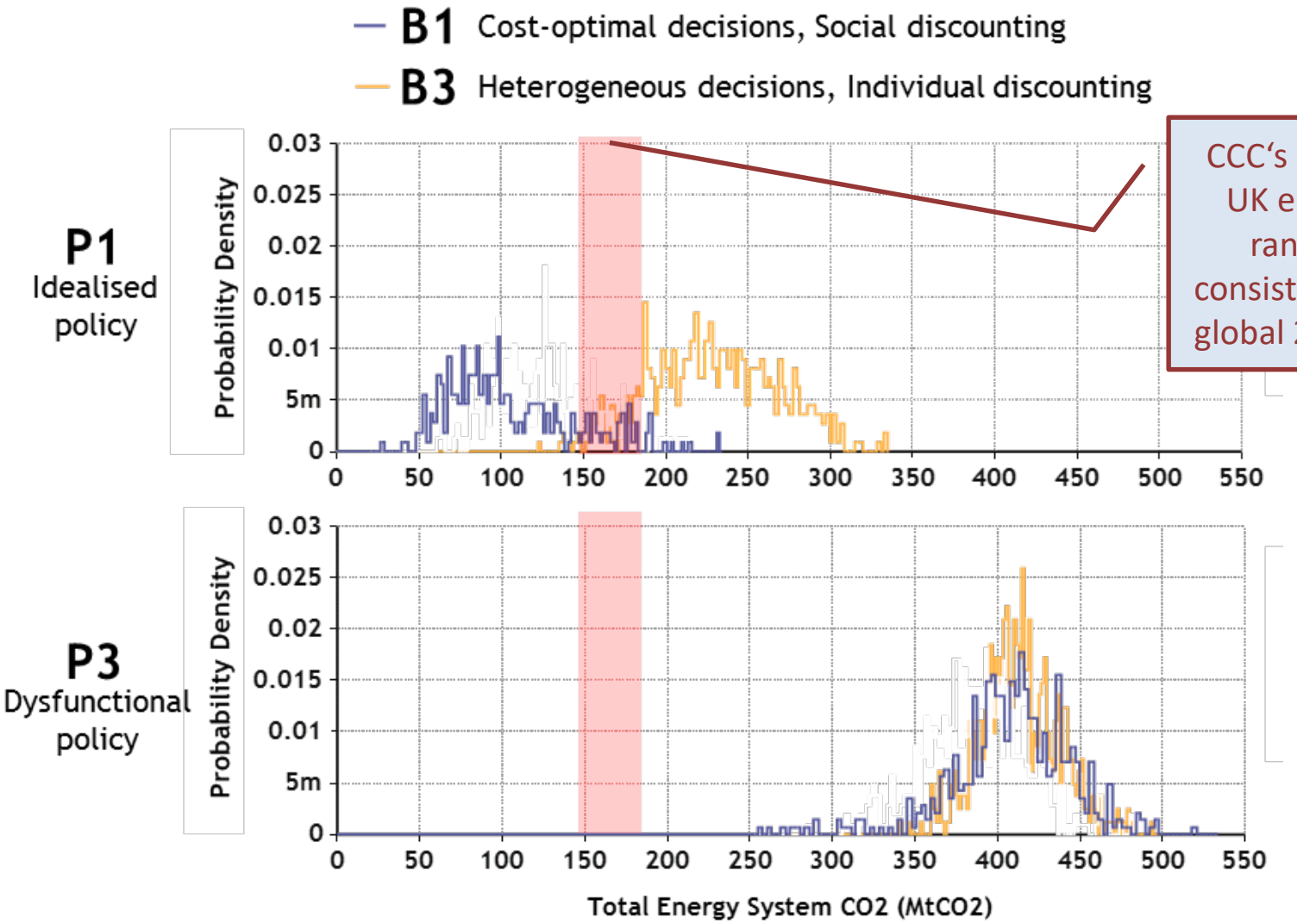
B3
Heterogeneous decisions
Individual discounting

P1
Idealised policy

P3
Dysfunctional policy



Probability of UK CO_2 emissions in 2050



CCC's assumed UK emission range for consistency with global 2°C target

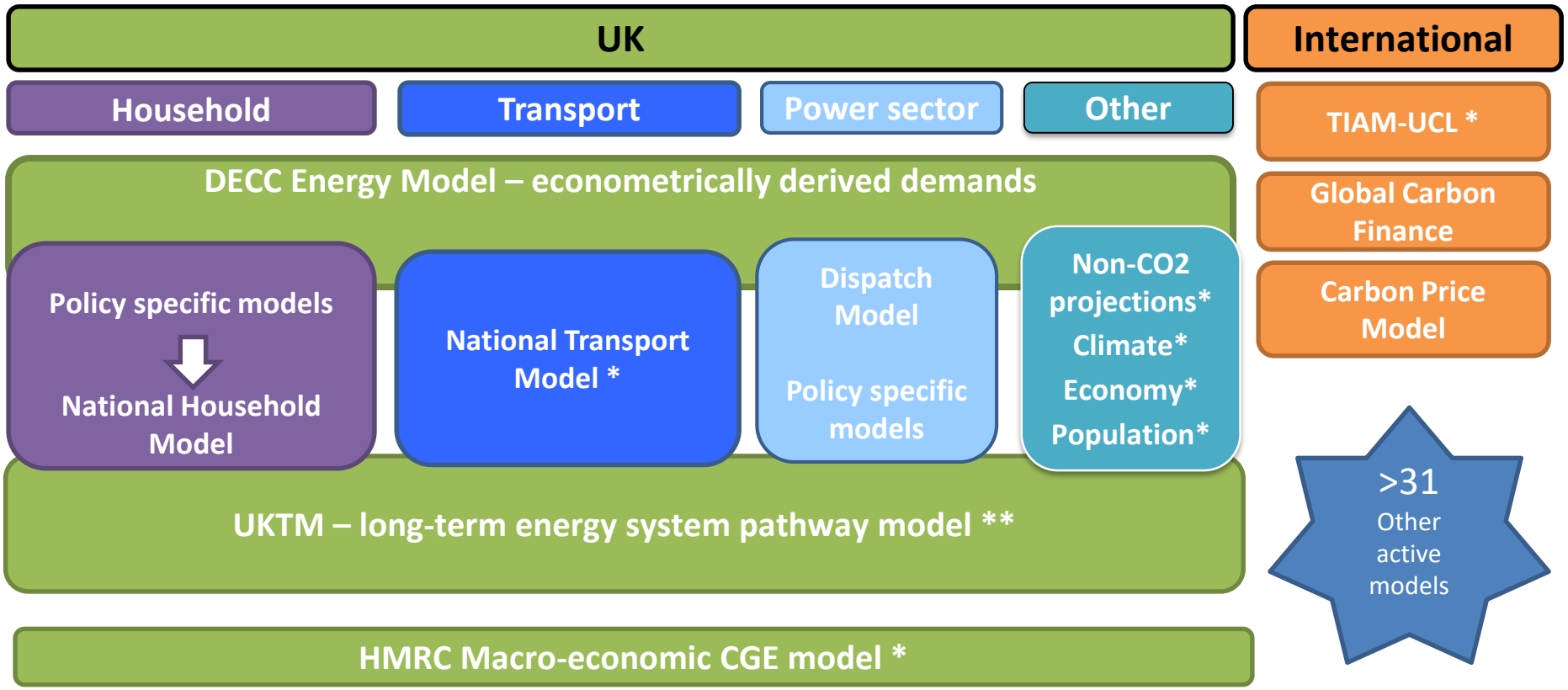
Closing thoughts

- Setting decarbonisation targets is easier than the long process to implement them
- Should we be optimistic or pessimistic on the chances of achieving energy decarbonisation?
  - Optimistic only if ....
    - Drive new technologies to widespread diffusion
    - Engage with society and appreciate the pace of change
    - Maintain consistent and well designed policies

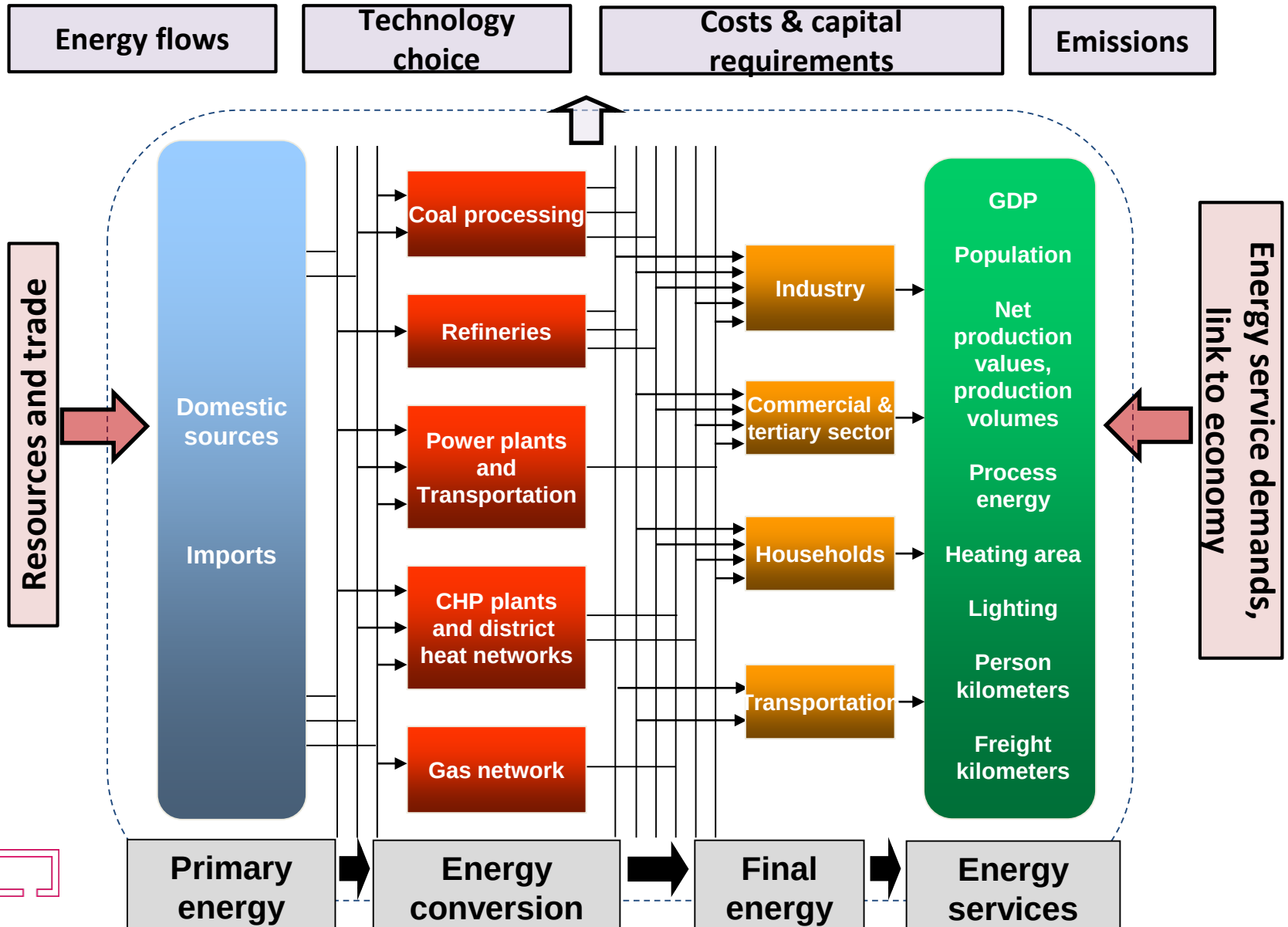
Back-up slides

DECC's In-House Modelling Capacity

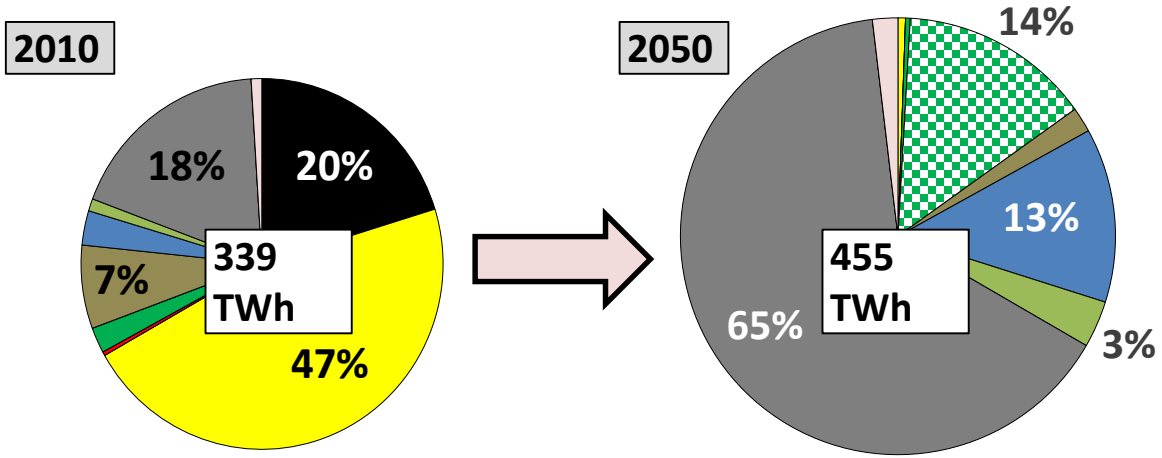
- Energy system optimisation models (UKTM, TIAM-UCL) are a key part of the UK government modelling portfolio

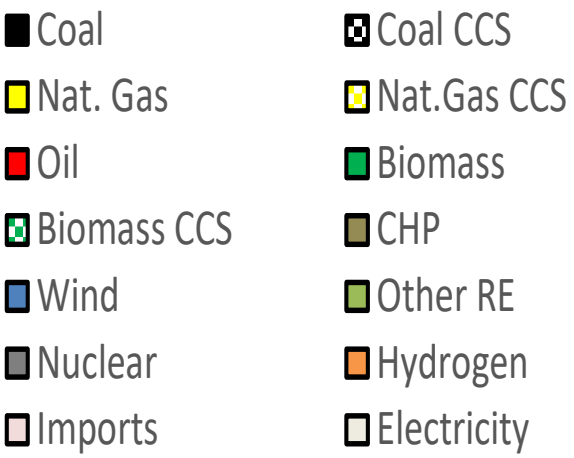


UKTM – The UK TIMES energy system model

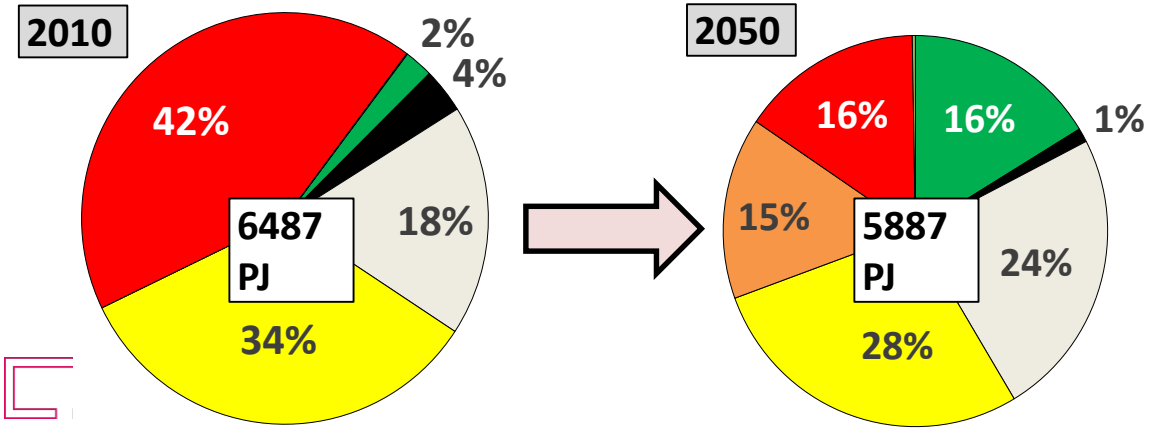


Reference low-carbon transition: electricity generation





...and final energy consumption



The impact of technology uncertainty

The reference case shows a consistent, least-cost pathway to achieve the UK's low-carbon energy transition, but …

Feasibility of large-scale energy investment projects?

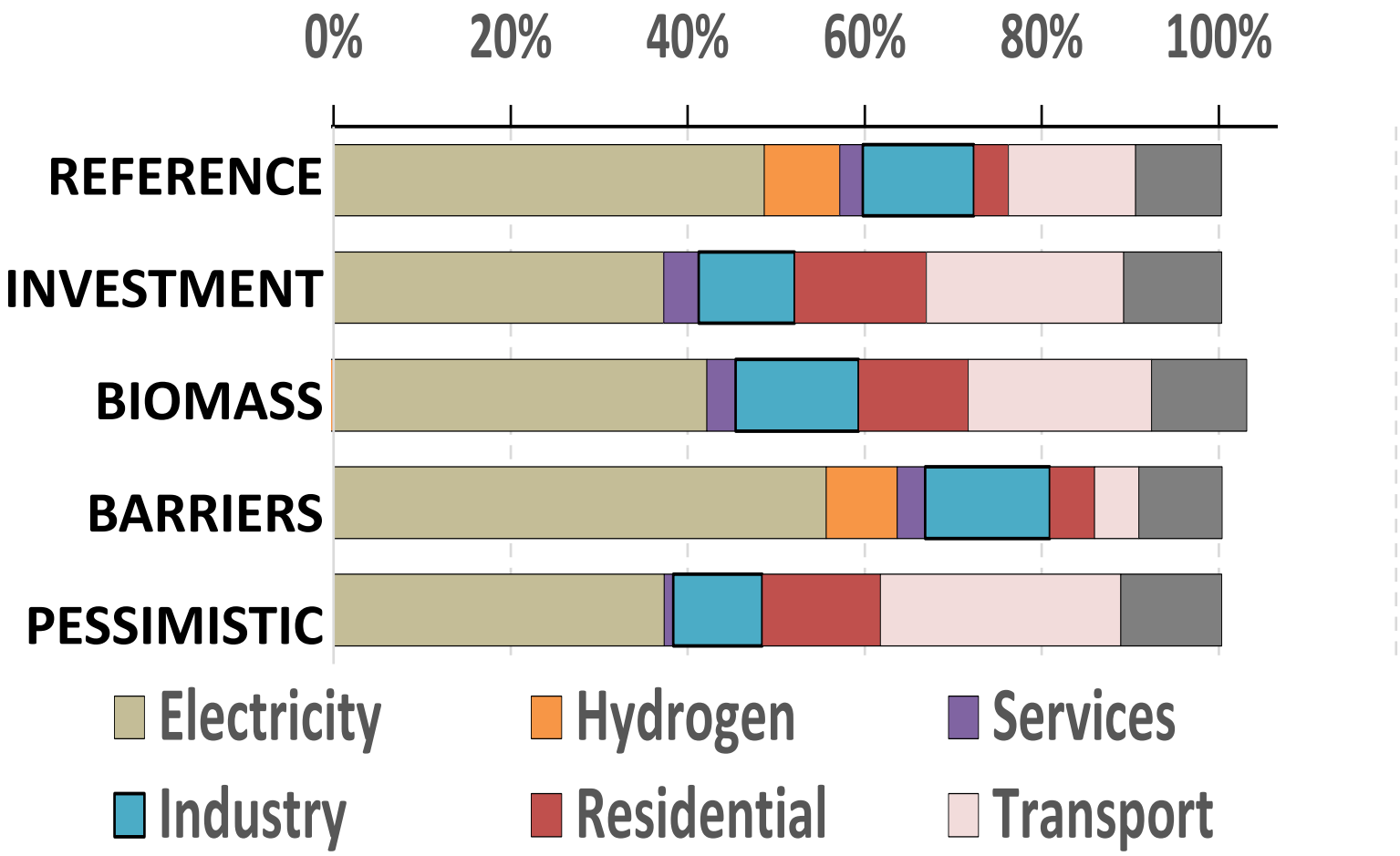
Biomass availability?

Barriers to investments in the end-use sectors?

Comparative scenario analysis on the reference case

Name	Alternative assumptions on technology availability
INVESTMENT	No new investments in nuclear and CCS technologies
BIOMASS	Low biomass availability; based on CCC Bioenergy Review - Constrained Land Use Scenario
BARRIERS	Higher hurdle rate (20%) on highly efficient and innovative technologies
PESSIMISTIC	Pessimistic scenario, combination of the three cases above

Scenario Comparison: Emission reduction: 2050 vs. 2010



Scenario comparison: Carbon price