Modelling Decarbonisation: pitfalls and potential

Alec Waterhouse
Department for Business Energy and Industrial Strategy
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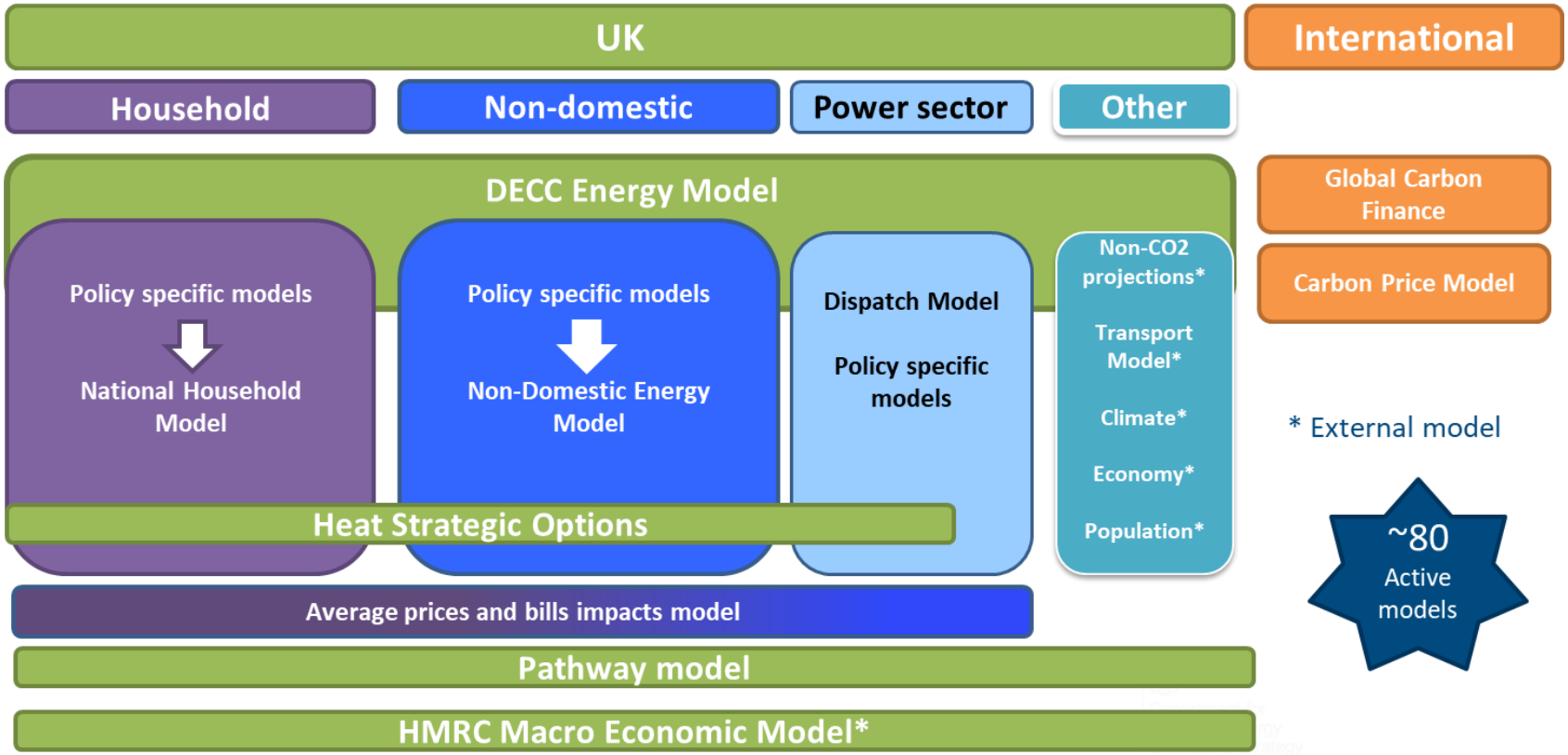
Introduction

Agenda for today

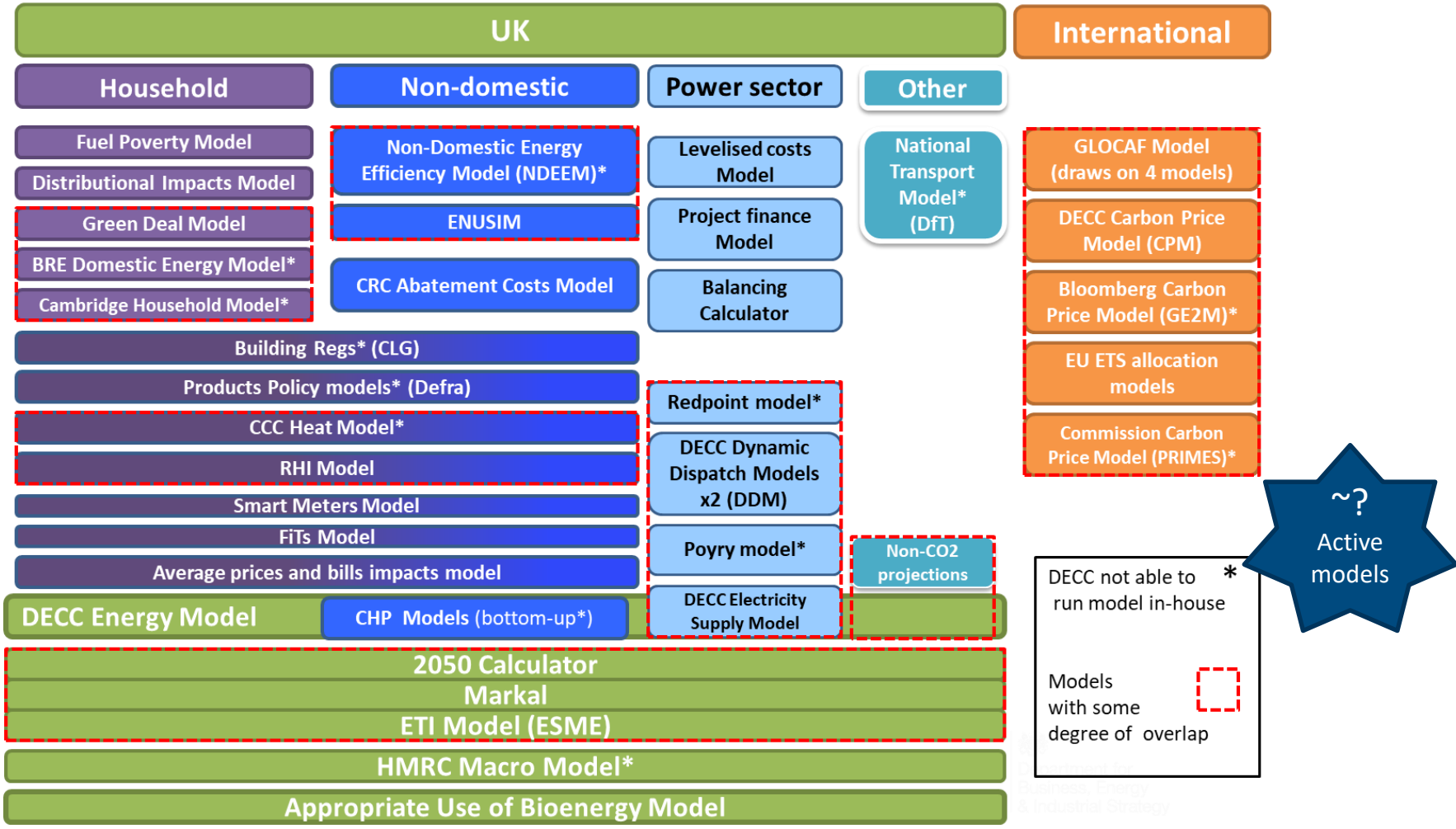
- Who I am and what I do
- Areas of interest
- Least cost optimisation – a quick overview
- A case study – the fifth Carbon Budget
  - The process – analytical and social
  - Hidden assumptions and their consequences
- Assurance
- What next – the future of energy systems

- Q&A

The modelling landscape - after



The modelling landscape - before



UK TIMES – our main pathway model

Model for the whole UK energy system

Developed by the IEA's Energy Technology Systems Analysis Program

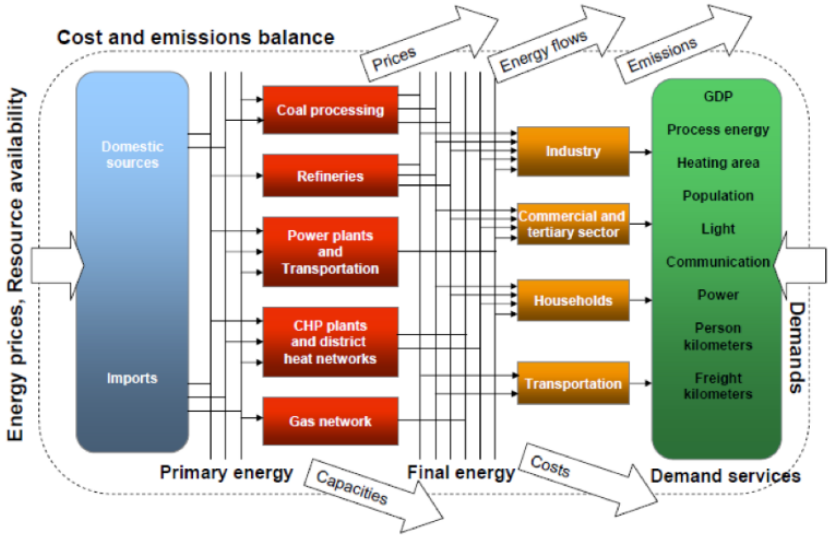
Extended by UCL and modified by BEIS

It tries to answer these questions:

- What should the UK build
- When

Given that:

- Demand must be met
- Lowest possible cost
- Technology constraints



https://iea-etsap.org/index.php/documentation

Modelling paradigm

- Least cost optimisation with discounted costs
- Assumes:
  - economically rational behaviour
  - perfect information
  - perfect foresight
- Technology rich
- Constraints bound the system and behaviour
- Doesn’t forecast

A digression – linear programmes

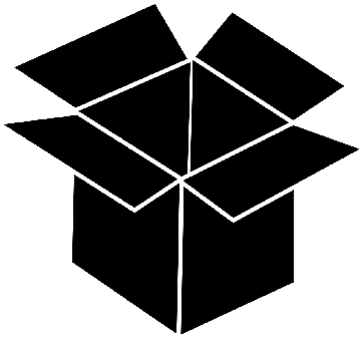
Linear programme combines:

- Decision variables
- Constraints
- Objective function

Minimises / maximises objective function subject to:

Constraints

Modelling process



Build evidence base
Update
Model construction
Validate and verify

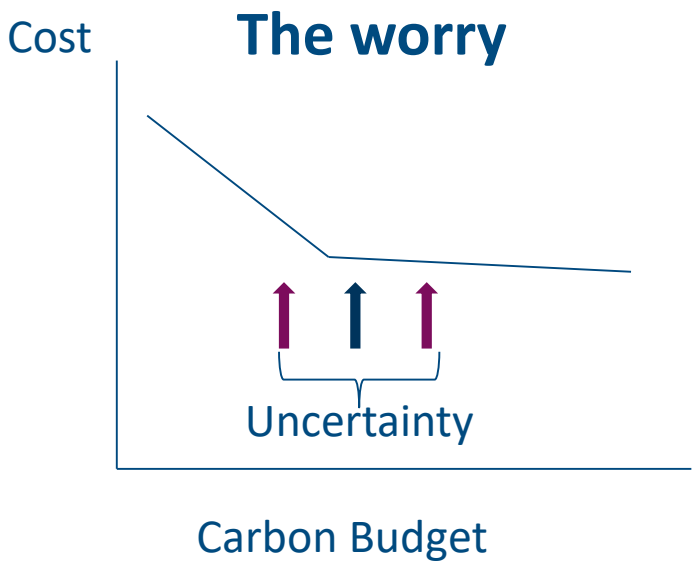
Batch runs to:

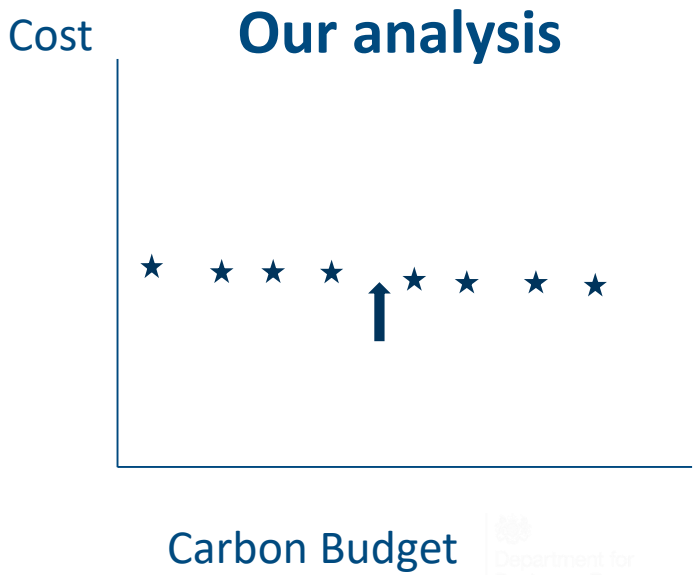
- Relax or introduce constraints to gain insights
- "Knock out" technologies
- What ifs?

An example – 5th Carbon budget

Recommended budget from the CCC

The question: given the uncertainty are there any discontinuities in cost - the “Hockey Stick” problem

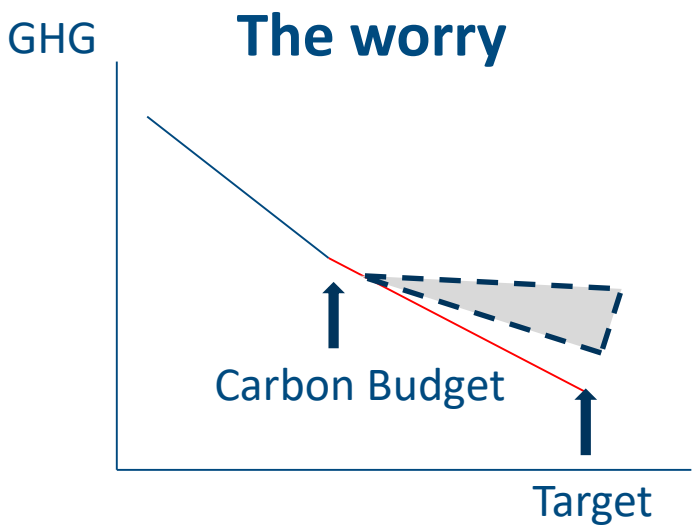


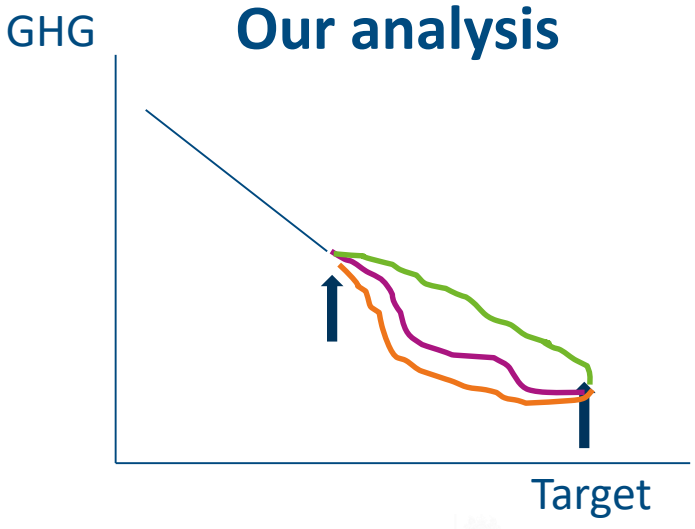


Another example – Clean growth strategy

Strategy for the 5th carbon budget 2032

The question: is the strategy for reaching CB5 consistent with our 2050 goal.





What can UKTM do well?

- Technologies featuring in many scenarios
- Rough order of actions
- Budget levels consistent with developing key technologies
- Gives a great start for sector level validation
  - Balances it's books
  - "Trades off" between sectors
  - Exposes robbing "Peter to pay Paul"

… and not so well?

- Precise carbon budgets
- Which pathway is most likely to be cheapest
- Human effects and barriers to deployment
- Effect technology costs change with uptake of measures
- Regional and temporal impacts

Modelling assurance

Why should you care?

- For your own peace of mind
- Your licence to operate
- Because BEIS takes it seriously
  - Procurement
  - Use

The most serious was that, in their Excel spreadsheet, **Reinhart and Rogoff** had not selected the entire row when averaging growth figures: they omitted data from Australia, Austria, Belgium, Canada and Denmark. ... When that **error** was corrected, the "0.1% decline" data became a 2.2% average increase in economic growth.
22 Apr 2013

The Reinhart-Rogoff error – or how not to Excel at economics
theconversation.com/the-reinhart-rogoff-error-or-how-not-to-excel-at-economics-13646

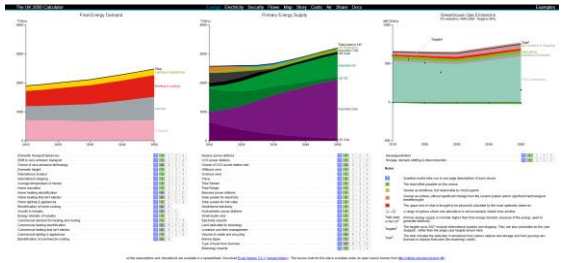
The future…

Some principles for models

- Effective
- Accessible
- Coherent
- Transparent
- Efficient
- Robust

The future for whole system models

- Is least cost useful?
  - Replace or complement
  - Growing role for pathway analysis
- Temporal effects
- Management flight simulators



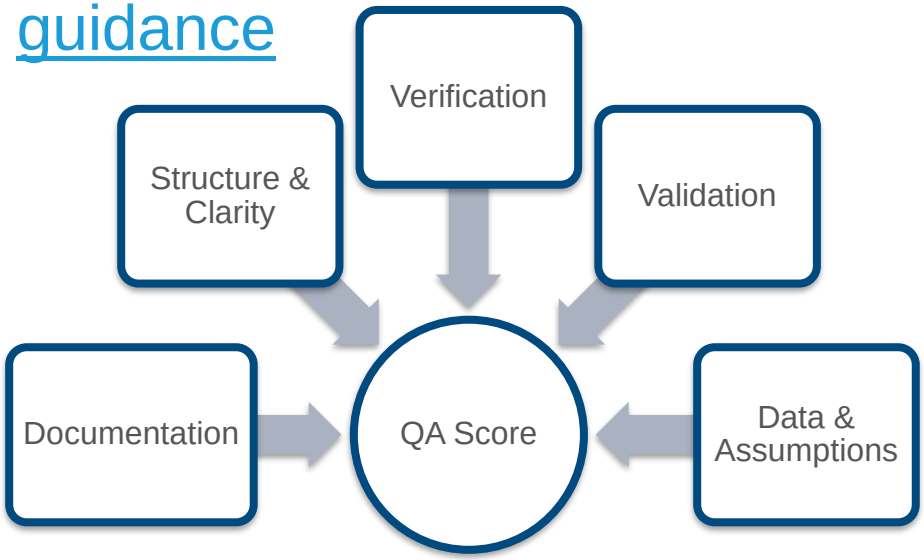
The Five Pillars of Quality Assurance

Documentation	Structure & Clarity	Verification	Validation	Data & Assumptions
Good documentation minimises the risk of knowledge loss or misuse of the model	Models with a good structure and minimised complexity have shorter familiarisation times and errors are less likely to occur.	Verifying a model gives confidence that there are no errors in its execution.	Models are designed to answer questions. Validation measures how well they do that.	Understanding the quality of input data decreases the risk of relying on outputs where the quality is uncertain.

An “off the shelf” approach

[The Aqua Book: guidance on producing quality analysis for government]

[BEIS Modelling Quality Assurance tools and guidance]



- **Model Report** for documentation
- **Assumptions** log for data and assumption
- **Excel Model** Template for structure

Thank you