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Energy system modelling of the UK energy policy reset – a multi-sector analysis

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Multi-sector analysis motivated by UK Energy Policy ‘reset’

- The November 2015 the UK Government spending review and Amber Rudd’s policy reset speech made several changes related to policy for low carbon technologies:
  - Unabated coal power to be phased out by 2025
  - The demonstration funding for carbon capture and storage (CCS) was cancelled
  - New support for R&D in nuclear small modular reactors (SMRs)
  - Changes to the renewable heat incentive
  - Encouragement for shale gas development

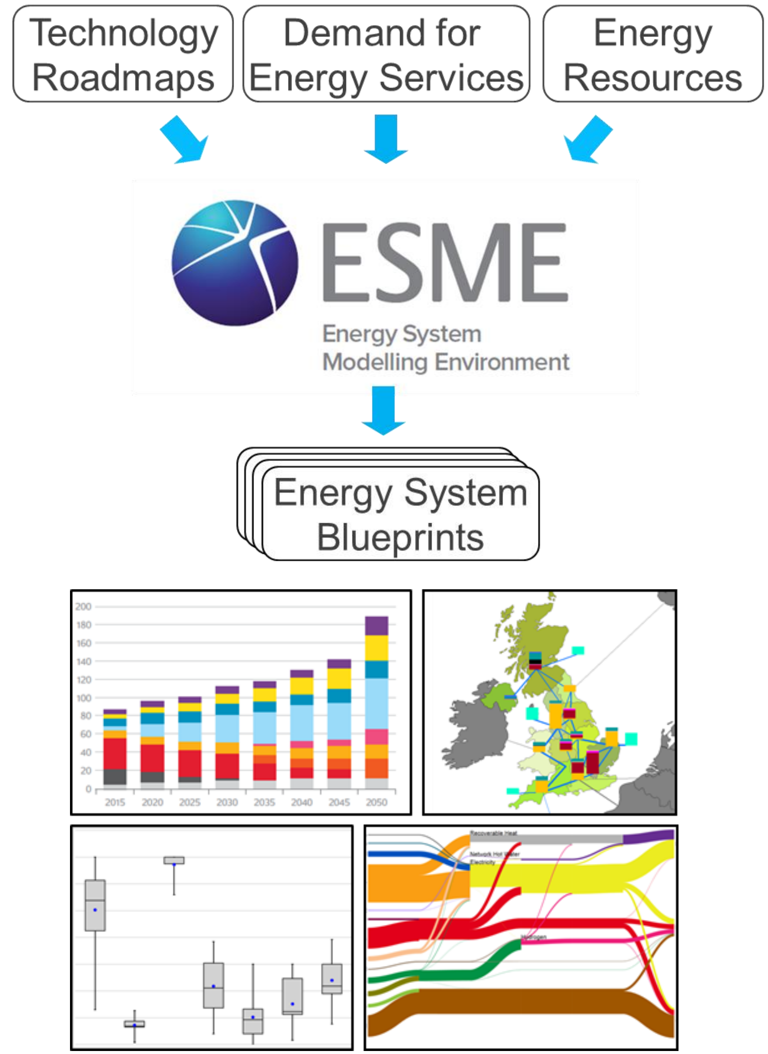
- ETI has investigated the implications, both long term and short term, of these announcements using its ESME model.

- A multi-sector approach is key. The power sector does not exist in isolation, it is important to consider synergies and trade-offs between technology choices and emissions reductions in different sectors.
  - e.g. Power sector vs Heat sector
  - or Power sector vs Transport sector

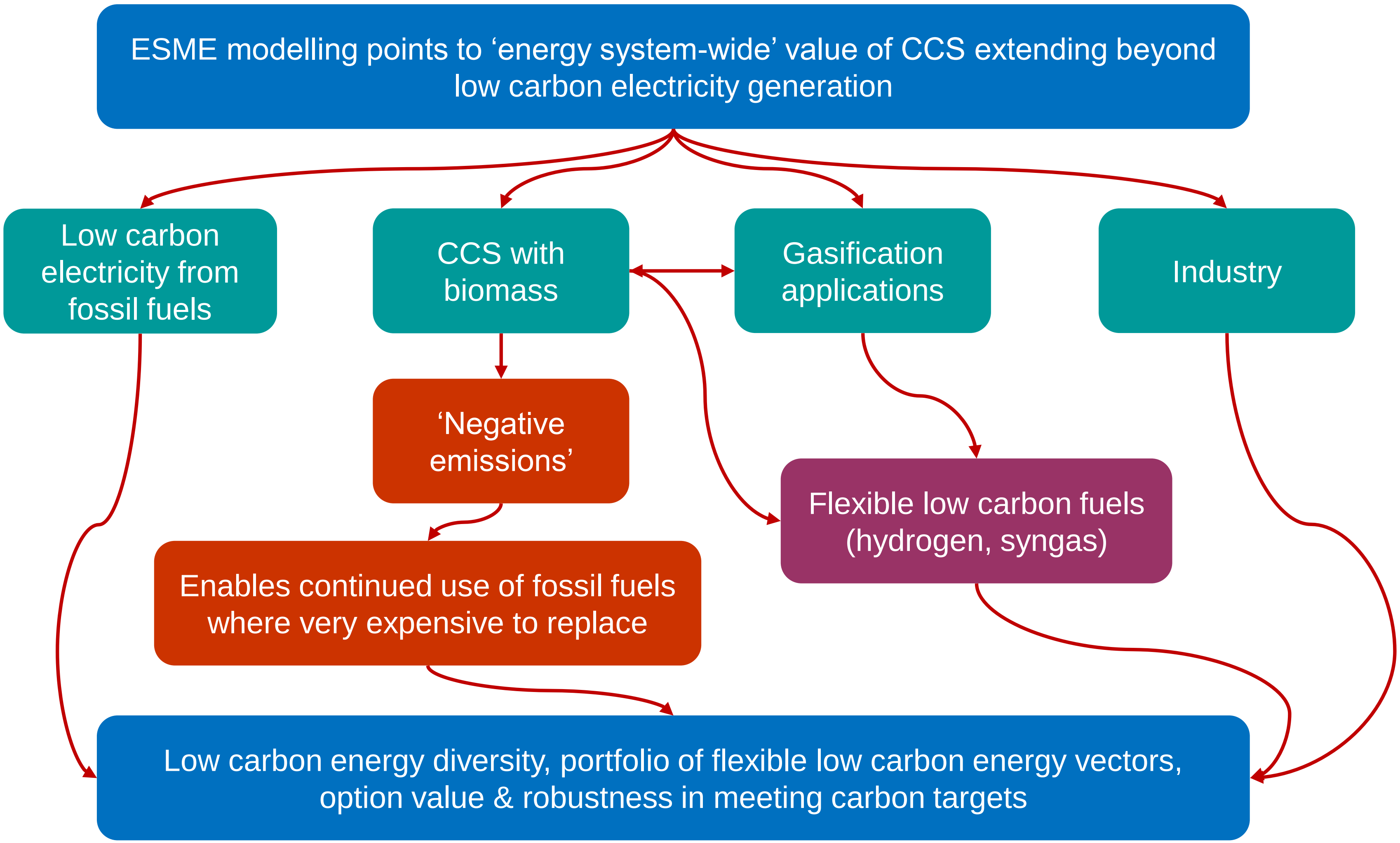
- This presentation will focus in particular on a multi-sector analysis of CCS

The ESME model

- Whole-system approach: power, heat, transport, industry and energy infrastructure
- Least cost optimisation, policy neutral
- Deployment & utilisation of 300+ technologies
- Probabilistic treatment of key uncertainties
- Pathway and supply chain constraints to 2050
- Spatial and temporal resolution sufficient for system engineering



Value of CCS from a whole-system view



Sector breakdown of the value of CCS

- Measure the value of CCS by its opportunity cost, the additional cost of a “no CCS” model run relative to a baseline model run

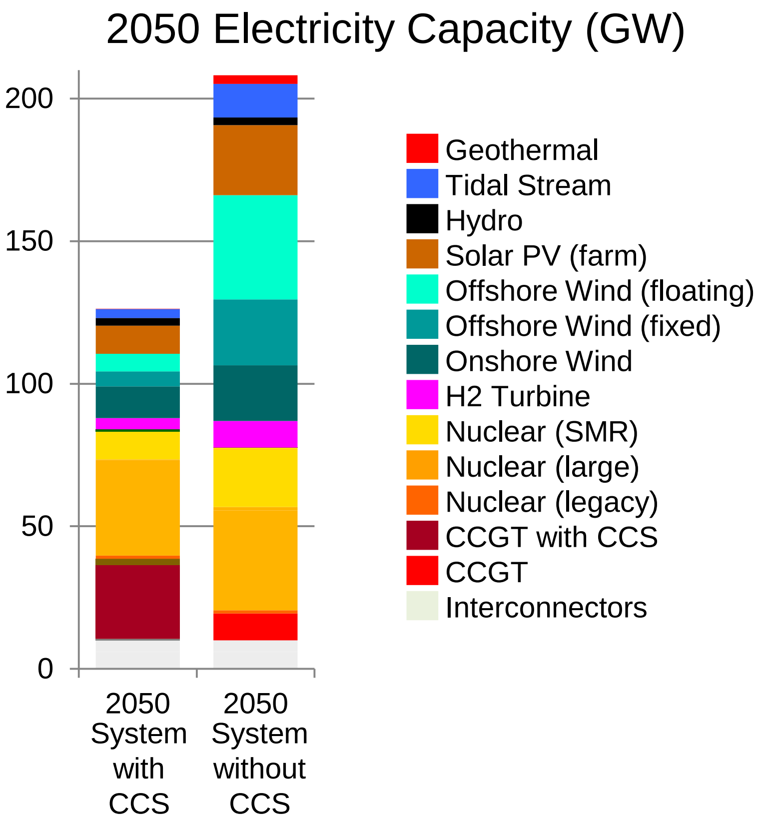
- The figure using ESME v4.1 is 270£bn for the cumulative discounted cost 2015-2050. More important than the precise numerical value is the consistent finding that it is much higher for CCS than other low-carbon technologies

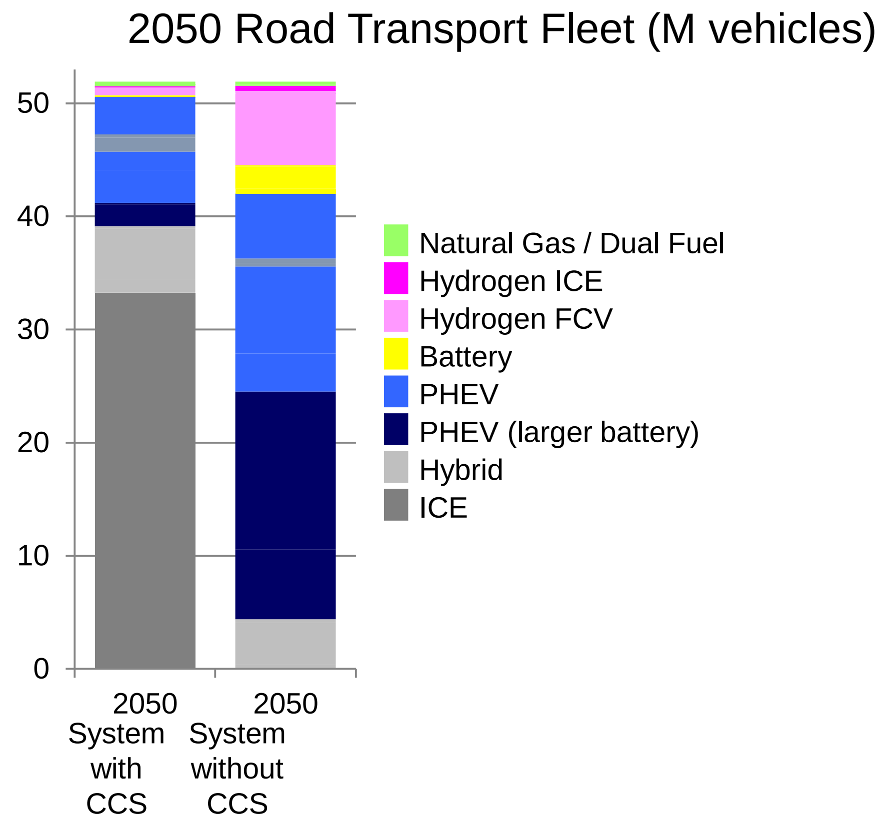
- For context, it is approximately equal to the abatement cost of the baseline, so:
  - Taking CCS from the portfolio could approximately double the cost of meeting CO_2 targets
  - *or equivalently* deploying CCS could halve the cost of meeting CO_2 targets

A breakdown of the opportunity cost by sector shows that transport is a particularly important sector

Transport vehicles	161
Power & conversion technologies	156
Resource costs	-141
Buildings & heat	67
Energy transmission costs	19
Energy storage costs	11
Industry	-3
Total	**270**

Transport and power sectors in detail





The impact of delaying CCS

- Our current baseline assumption for the **earliest possible** deployment of CCS is:
  - 2 Demonstration plants (total 1GW) possible during 2020-25
  - Commercial deployment (GW per year) possible after 2025

- We will use this baseline to compare to a “delayed” scenario in which the above dates are pushed back by 5 years

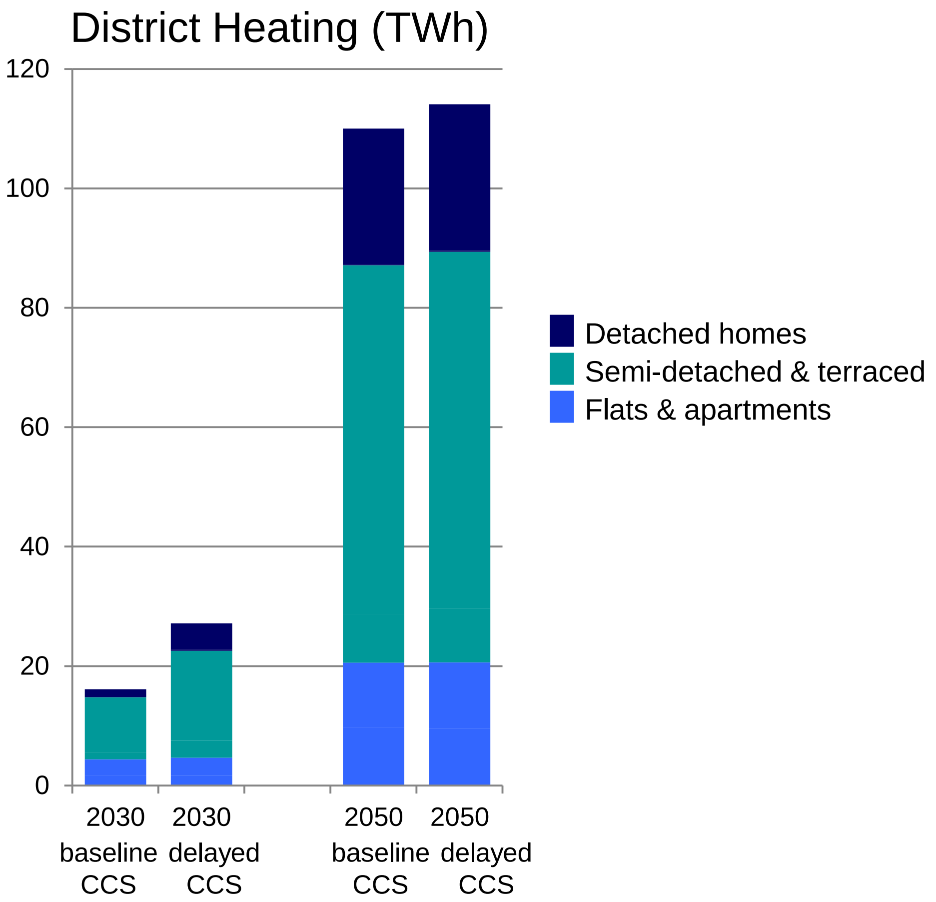
- We find that delaying CCS in the UK by 5 years has a high chance of increasing the cost of carbon abatement to the UK economy:
  - an increase in cumulative discounted abatement cost of £10bn by 2030
  - by 2050 the delayed CCS infrastructure matures & the gap begins to narrow, but legacy effects cause an additional £40bn cumulative discounted cost by 2050

- These are significant additional costs, e.g. in comparison to the spending review announcements

- … but they are small in comparison to the total value which CCS could provide to the abatement pathway as presented in the previous slides.

Mid & long term sector views of CCS delay

- Accelerated decarbonisation of space heating, in particular district heat networks by 2030 (see right)
- The power sector has 50% greater capacity of renewables by 2030, largest increase in solar PV
- But each sector is able to “catch up” the baseline by 2050, so the biggest costs of the “no CCS” case are in fact avoided



The impact of delaying CCS

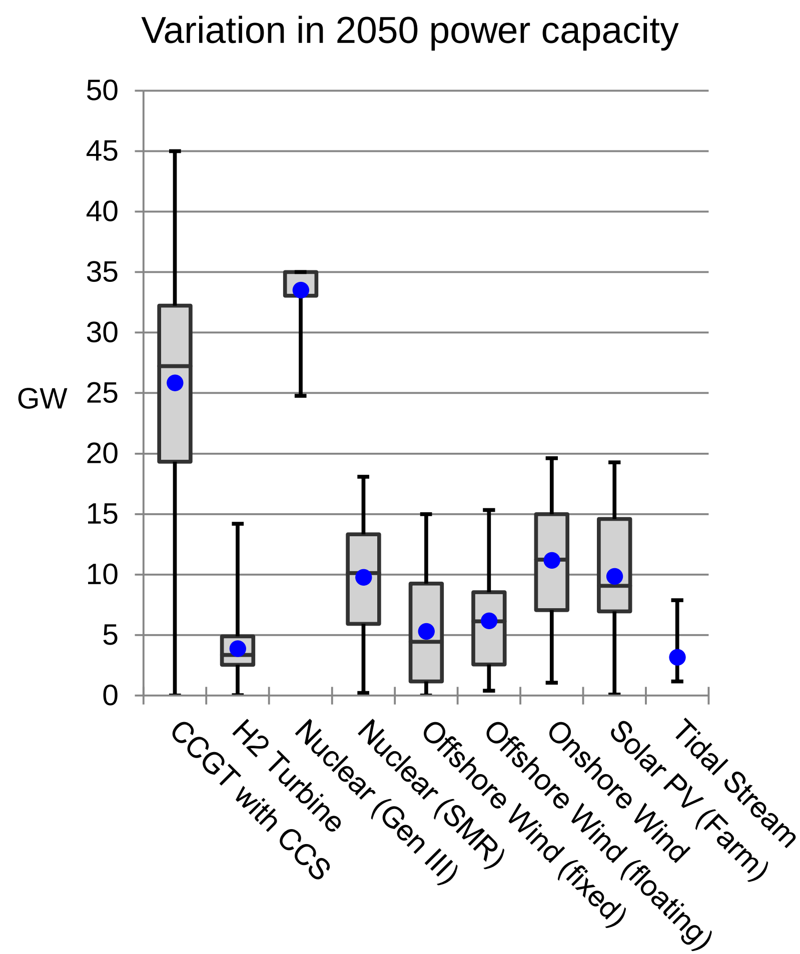
- The 5 year time step of the ESME model limits the level of detail which it is possible to explore with an analysis of this type, but nevertheless some high level conclusions can be drawn

- Although the abatement cost has increased relative to the baseline case, the increase is substantially smaller than in the “no CCS” scenario.
  - But near-term action on nuclear, renewables and heat is made increasingly important; each has policy challenges
  - Avoiding even higher costs in the longer term depends on capability to rapidly rollout CCS for power, gasification **and** industry in the 2030s and 2040s
  - More rapid deployment, simultaneously in several sectors, means increased risk

- We have also looked at scenarios with CCS permitted 5 years earlier than our baseline, which showed corresponding improvements in cost and risk
  - Overall our modelling evidence suggests that both costs and risks to the UK’s decarbonisation pathway could be reduced by bringing forward, rather than delaying, the deployment of CCS.

Uncertainty in cost assumptions

- Cost assumptions are critical to the technology choices made by the ESME model, so how does this affect the conclusions for CCS?
- ESME has an in-built Monte Carlo treatment of uncertainties. Our standard assumptions for CCS plants is a range of +/- 40% on the nth of a kind (NOAK) cost in 2050
- Our Monte Carlo results show some significant variations – see right
- So, what if we have been consistently over optimistic?



A “high CCS cost” scenario

- We tested a scenario with high CCS costs:
  - Supposing CCS costs were to stay at first of a kind (FOAK) demonstration costs and never substantially reduce e.g. 170£/MWh for CCGT with CCS and corresponding costs for other plants
  - This is more extreme than the cost ranges in our standard Monte Carlo analysis, and is something like a worst case scenario

- The model results are a sort of hybrid between the previous cases of “no CCS” and “delayed CCS”:
  - The opportunity cost of CCS is reduced by about half. A substantial reduction, but the remaining value is still greater than other individual technologies
  - No longer any fossil CCS in the power sector; renewables and nuclear are preferred
  - CCS continues to be used at the higher cost with biomass gasification processes to produce hydrogen, methane and power, and also in industry
  - Negative emissions are still delivered, so can be offset against the expensive to decarbonise transport sectors

- CCS would still be capable of significantly reducing national abatement costs, but the value is now almost entirely outside the power sector
  - Demonstration and deployment still very important, but probably more difficult outside the power sector?

Conclusions

- CCS is a high value option in the portfolio of low-carbon technologies, its value is derived from a variety of applications: power, bio-CCS, hydrogen, industry abatement, bio methane, …
  - CCS should be viewed as an enabler of decarbonisation options in multiple sectors rather than as a single technology

- A whole-system analysis is key to reflecting the full value of CCS
  - A simpler approach, e.g. power sector LCOE, risks overlooking the significant value of CCS which is outside the power sector

- Overall our modelling evidence suggests that both costs and risks to the UK's decarbonisation pathway could be reduced by bringing forward, rather than delaying, the deployment of CCS

- The above statements are robust to a very wide range of cost assumptions.

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