UKERC
Assess-BECCS

Exploring the Uncertainty of BECCS in the Future UK Low-Carbon Energy System

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Outline

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- BECCS in UKTM
- Scenarios
- Results
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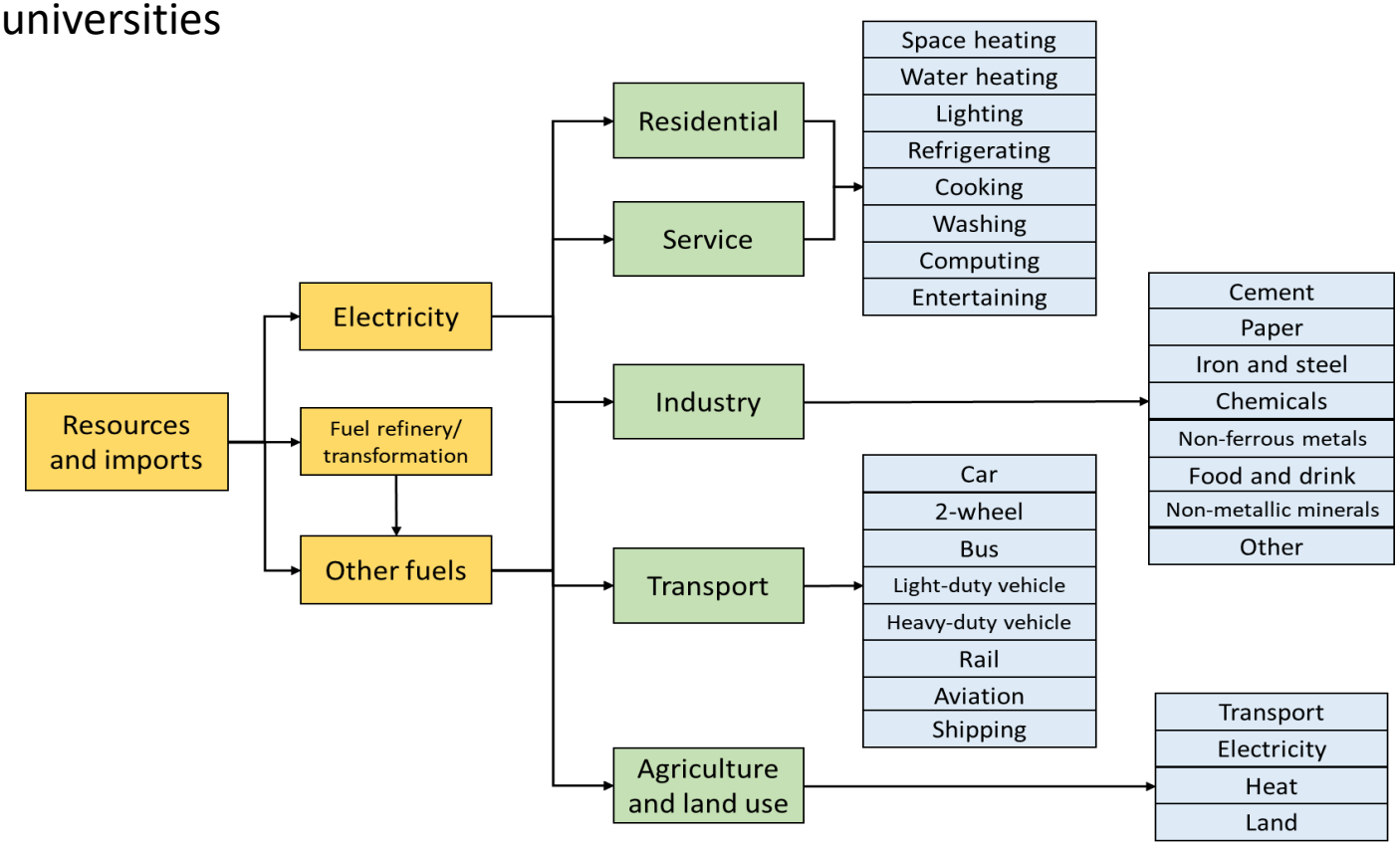
Introduction

- 2008 UK Climate Change Act: 80% reduction by 2050
  - Five carbon budgets (up to 2032) so far
- Paris Agreement (12th Dec, 2015)
  - "The Paris Agreement, in seeking to strengthen the global response to climate change, reaffirms the goal of limiting global temperature increase to well below ***2 degrees Celsius***, while pursuing efforts to limit the increase to ***1.5 degrees***."
- IPCC 1.5 degree special report (8th Oct, 2018):
  - only 12 years left to limit climate change catastrophe
- UK government (15th Oct, 2018) requested the CCC:
  - Evaluate when and how to achieve net zero GHG emissions

- Negative emission technologies (including BECCS) are crucial
- But BECCS is highly uncertain!!

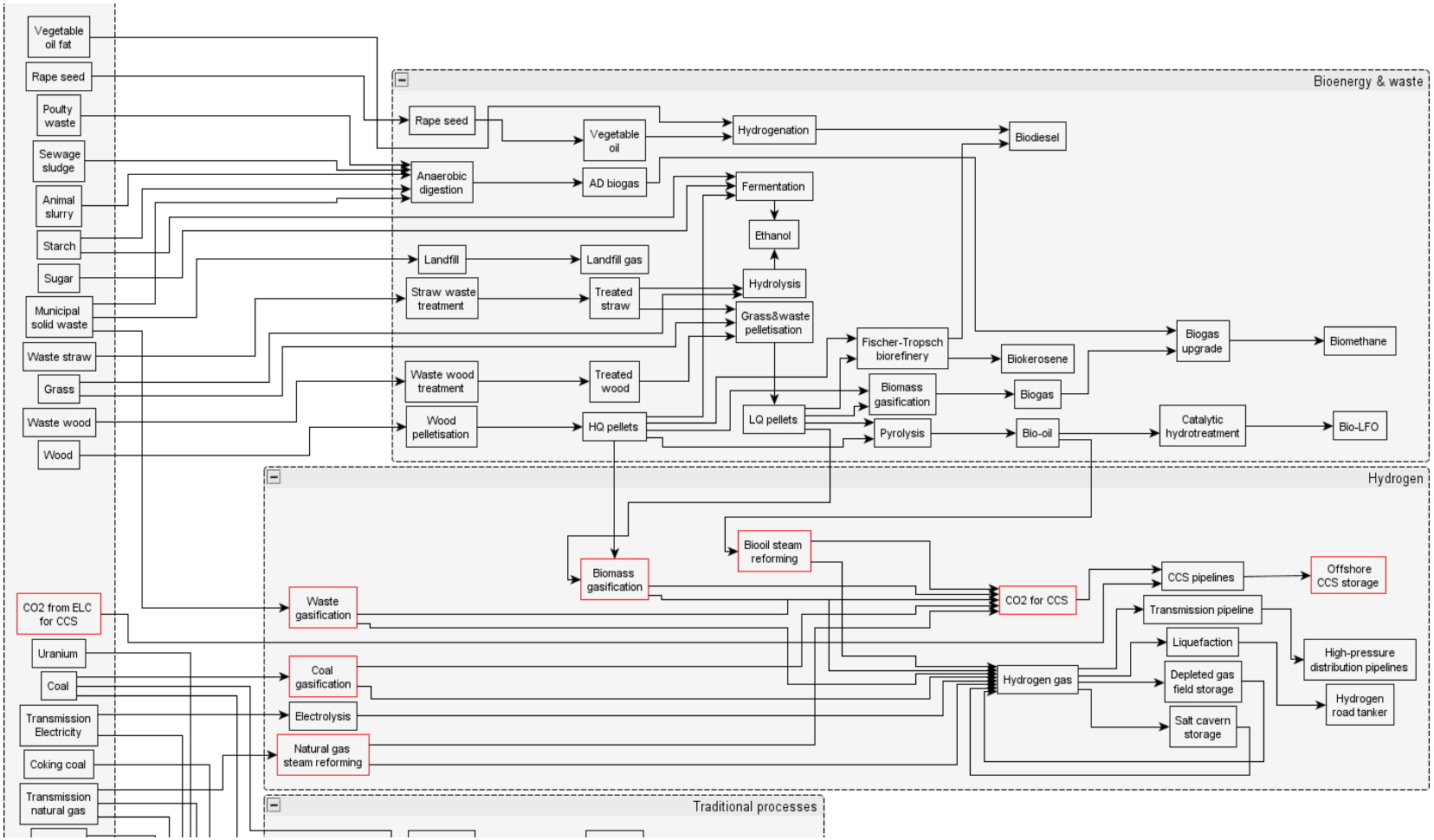
UK TIMES (UTKM)

- Developed by UCL Energy Institute with BEIS in wholeSEM project
- A whole energy systems model
- Technology-rich, Minimum cost
- Adopted by UK government (BEIS, CCC) for policy making (5th Carbon Budget, Clean Growth Strategy), National Grid (Future Energy Scenarios), consultancies, universities



BECCS in UKTM

- **Bioenergy resource:** import, domestic production, transformation and transport (supply chain)
- **BECCS:** majorly for electricity generation and hydrogen production



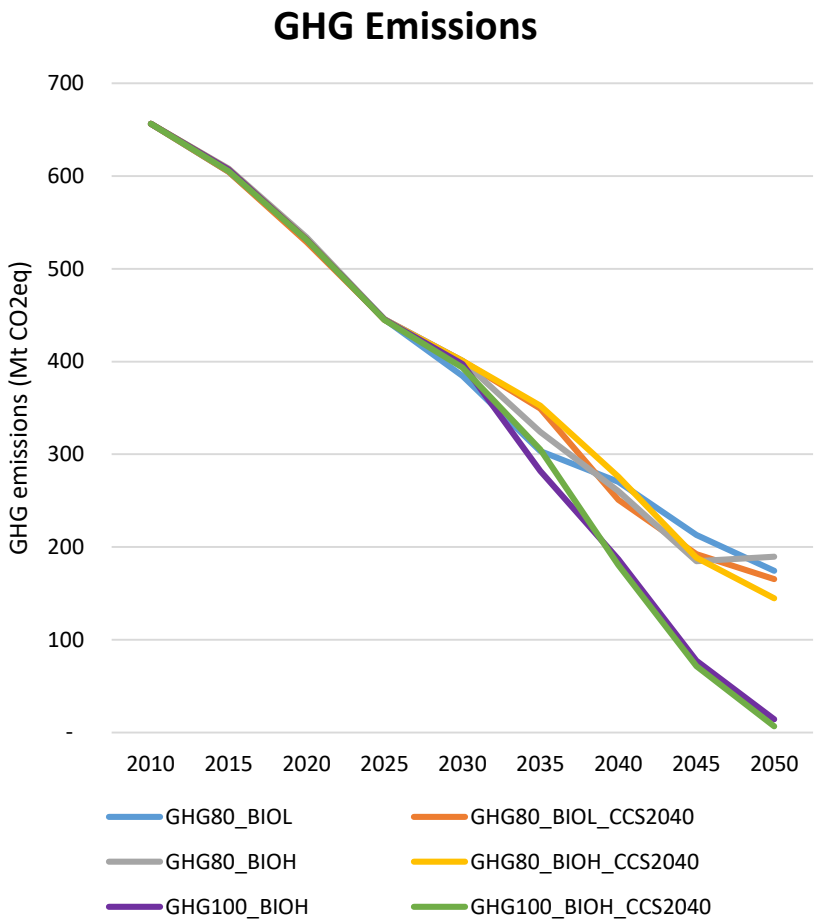
Scenarios for uncertain BECCS

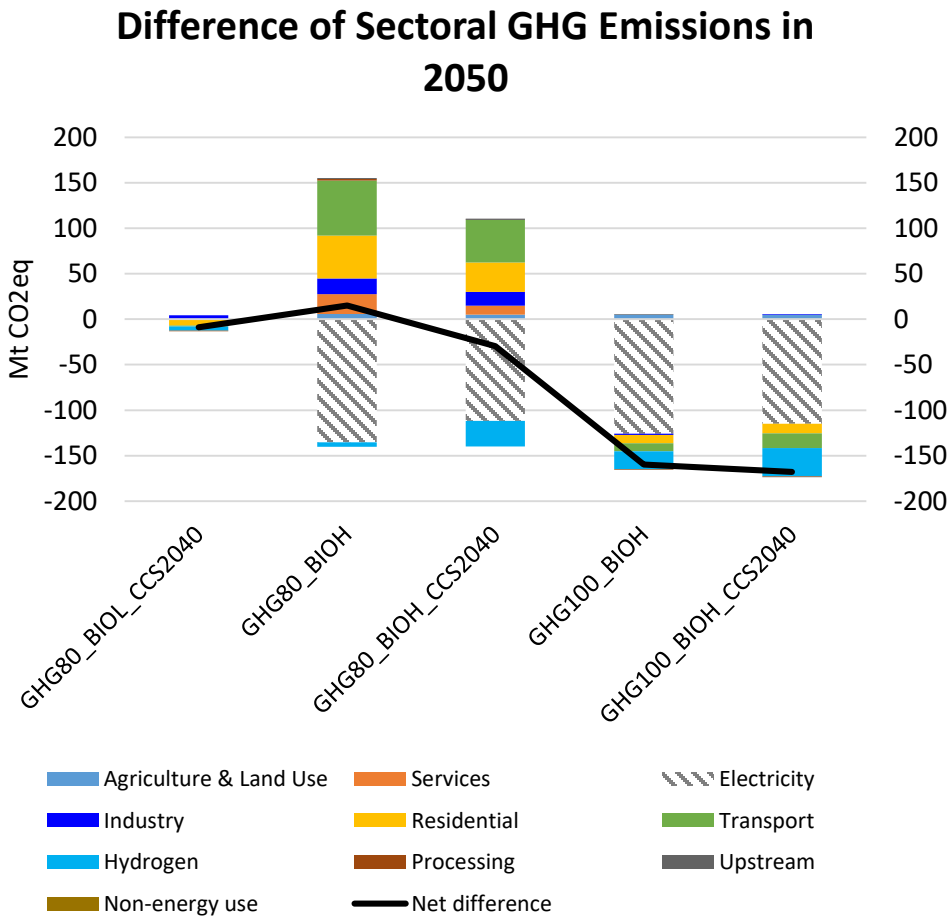
- **Bioenergy availability (low and high)**
  - According to **AEA Ricardo report** on UK biomass feedstock availability
- **GHG targets:**
  - **The Climate Change Act 2008**: 80% reduction on 1990 level by 2050
  - **5th Carbon Budget:** 57% reduction on 1990 levels by 2030
  - Constraint on **cumulative GHG emissions** during 2032~2050
  - For net zero scenarios, net GHG emissions should be **0 in 2050**

GHG targets	Low bio CCS from 2021	Low bio CCS from 2040	High bio CCS from 2021	High bio CCS from 2040
80% reduction by 2050	GHG80_BIOL (Reference)	GHG80_BIOL _CCS2040	GHG80_BIOH	GHG80_BIOH _CCS2040
Net zero by 2050	*Infeasible*	*Infeasible*	GHG100_BIOH	GHG100_BIO H_CCS2040

Results: GHG Emissions

- **Higher BIO:** Much lower emissions from ELC generation and H2 production
- **GHG80 + higher BIO:** More emissions from residential and transport sectors
- **Delay of CCS:** less emissions from H2 production

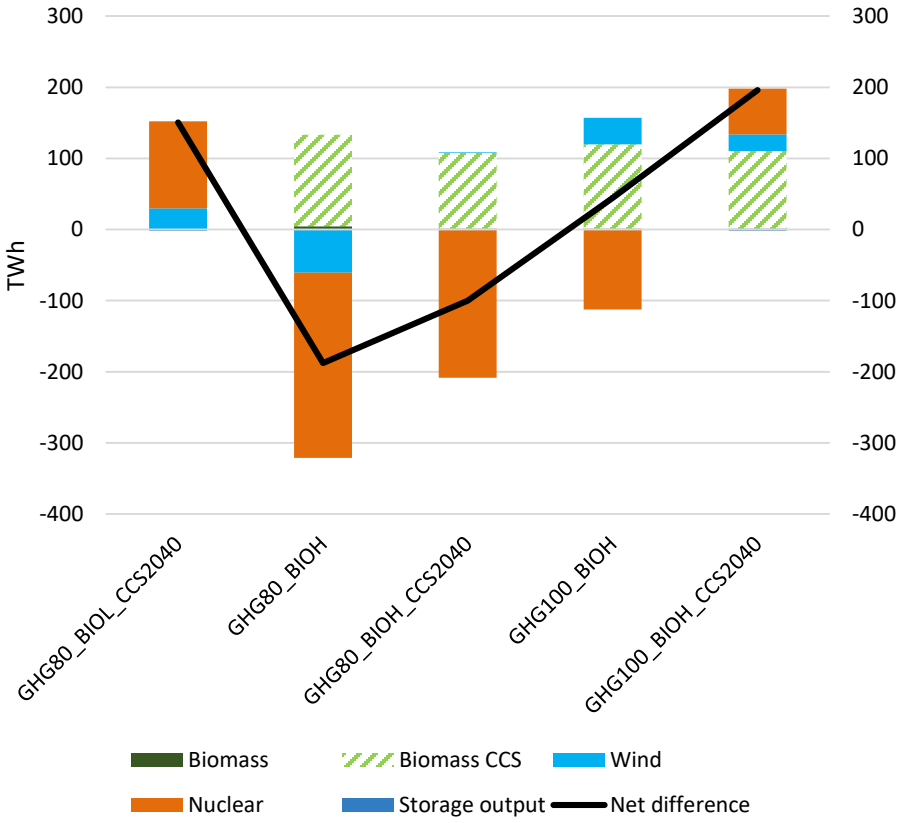




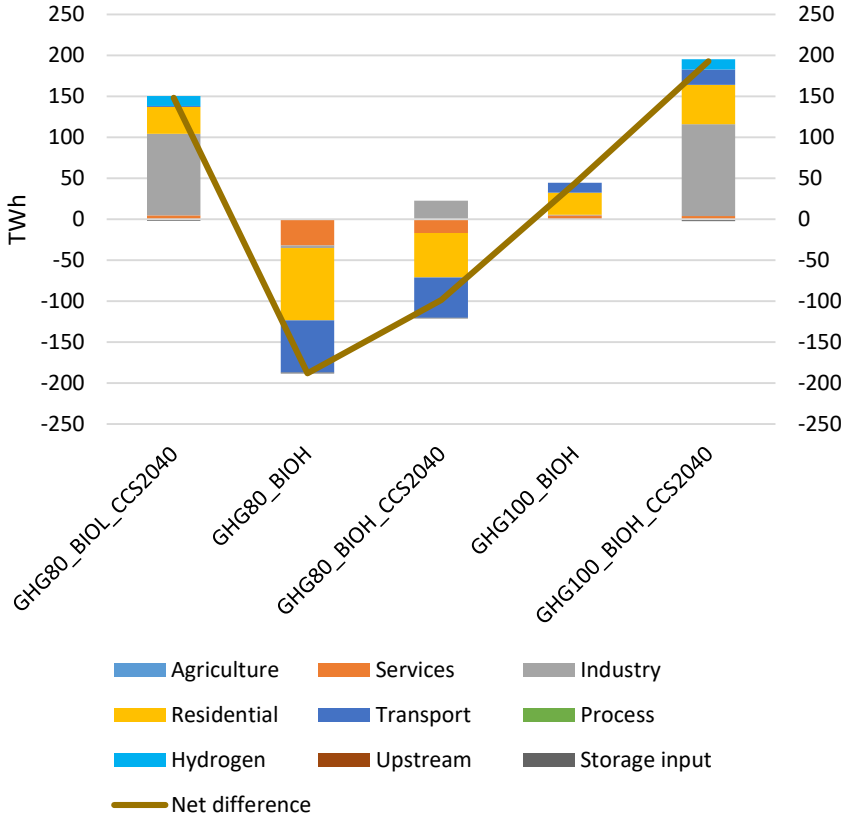
Results: Elc Supply & Demand

- **Higher BECCS:** negative emissions
- **Extreme cases:** more nuclear power, higher electrification in the industrial and residential sectors

Difference of Electricity Generation by Fuel in 2050



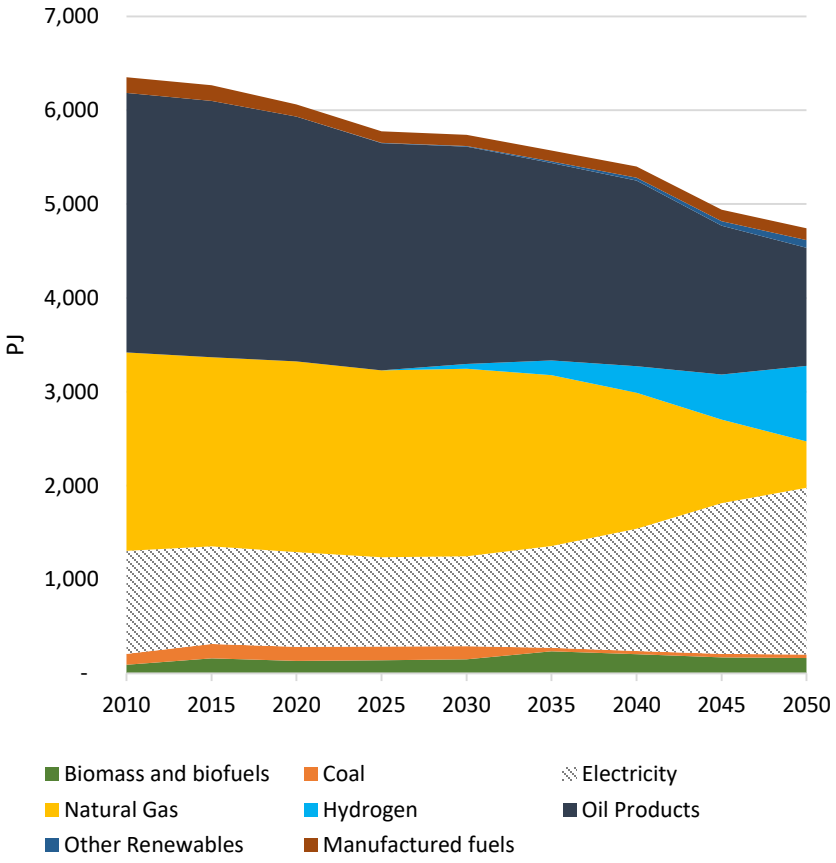
Difference of Sectoral Electricity Consumption in 2050



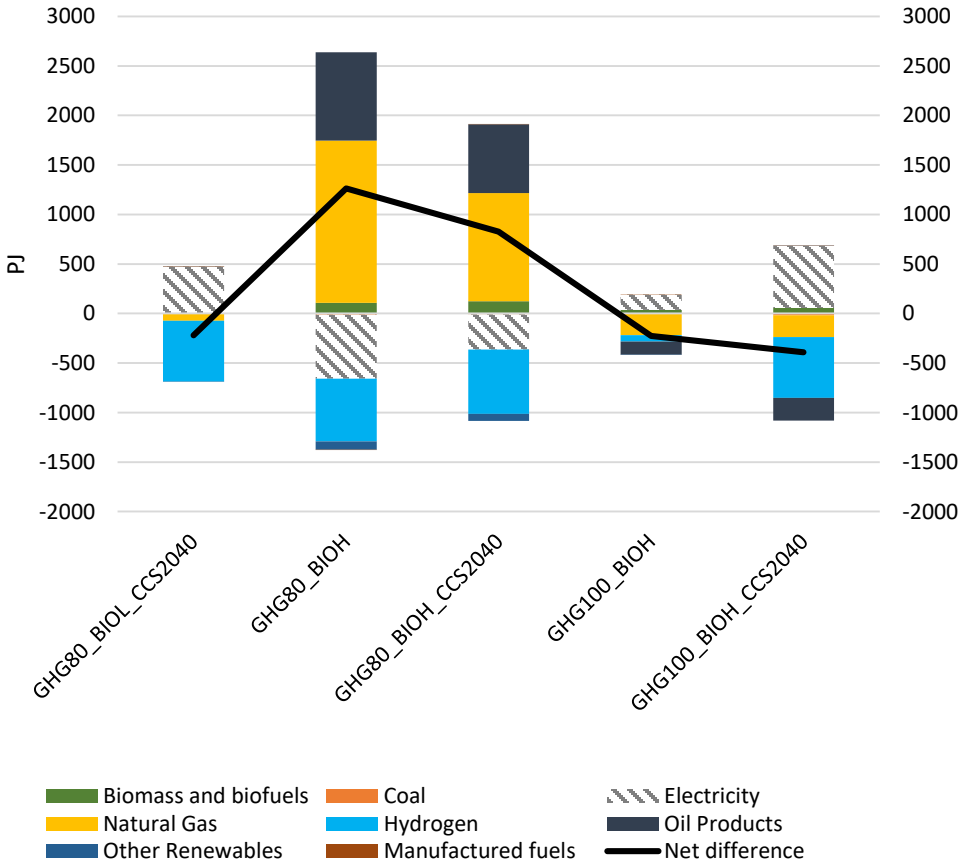
Results: Final Energy Consumption

- **Delay of CCS:** less hydrogen
- **GHG80 + high BIO:** more fossil fuels, less electricity, less hydrogen
- **GHG100:** higher electrification levels

Final Energy Consumption (GHG80_BIOL)

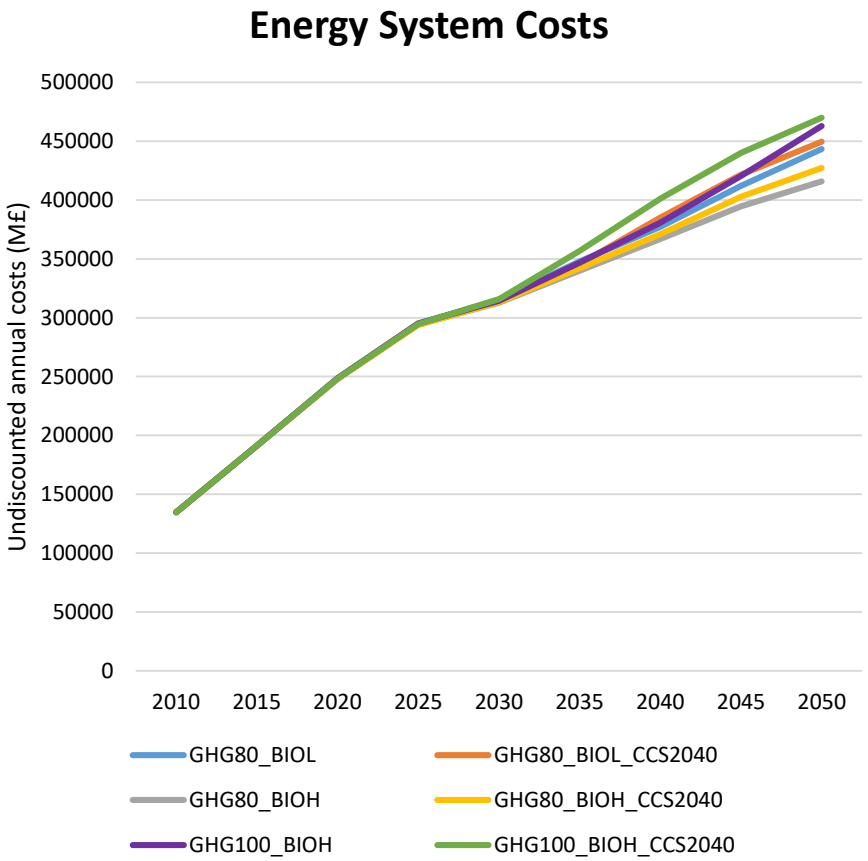


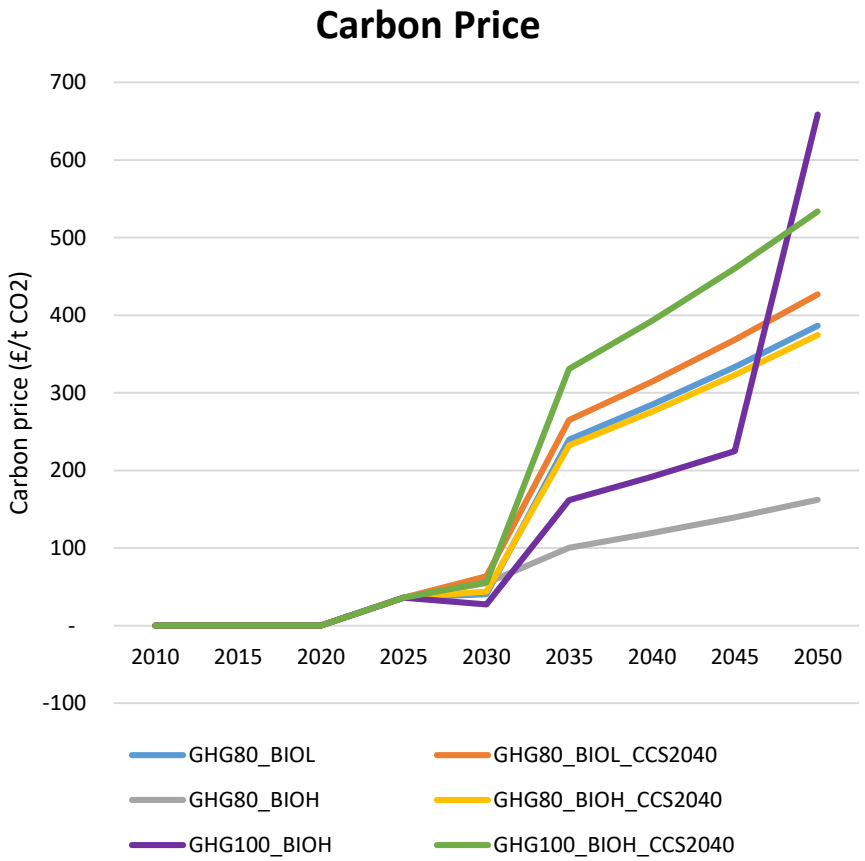
Difference of Final Energy Consumption in 2050



Results: Costs

- **Higher costs**
  - Lower availability of bioenergy
  - Stricter GHG targets and delay of CCS
- **GHG100_BIOH:** sharp increase of levels of electrification in final years

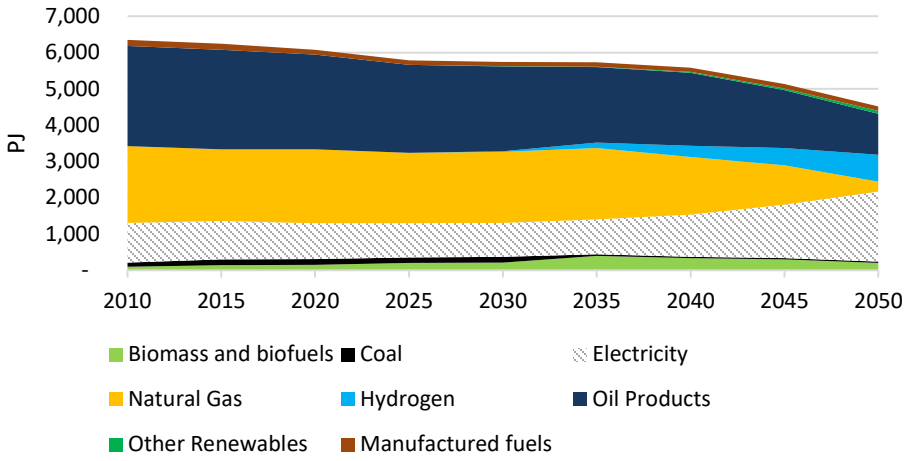




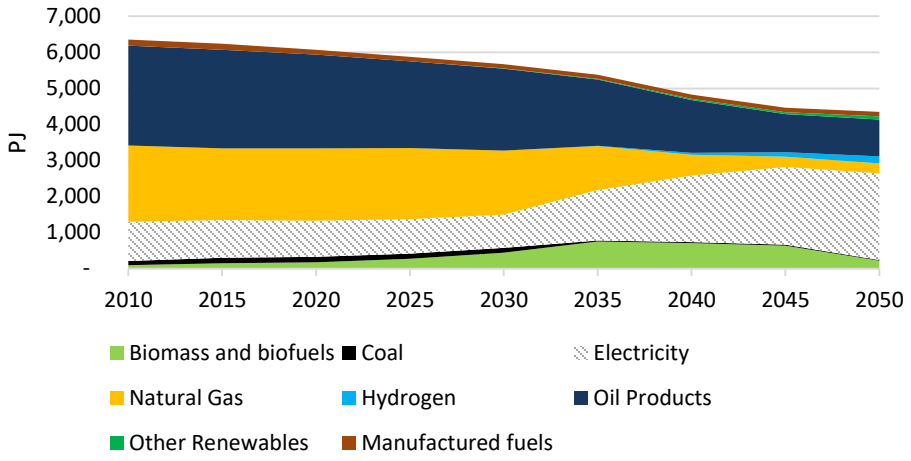
Results: Net Zero

Final Energy Consumption

GHG100_BIOH

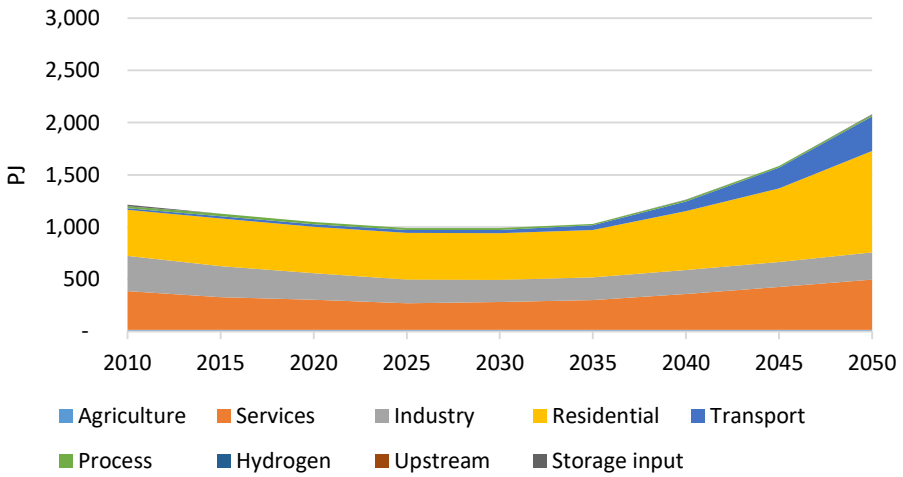


GHG100_BIOH_CCS2040

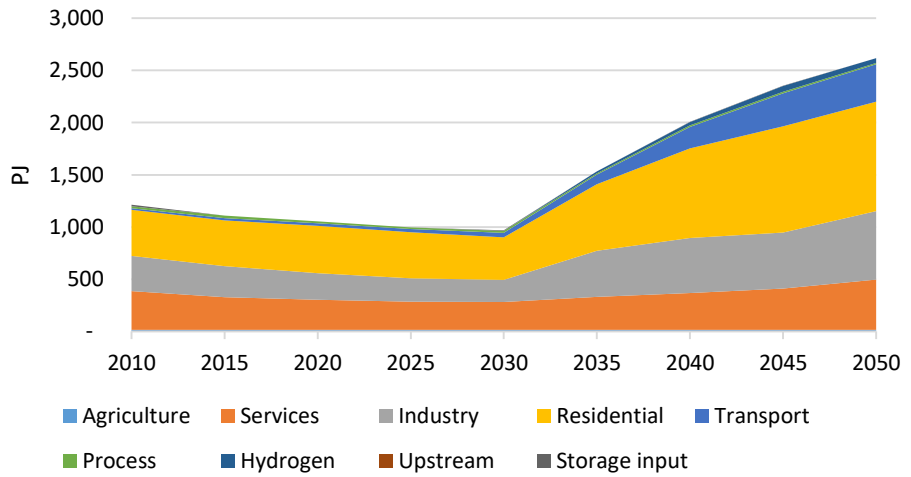


Sectoral Electricity Consumption

GHG100_BIOH



GHG100_BIOH_CCS2040



Conclusions and Future Works

- Influences on decarbonisation costs
  - **GHG targets > Bio availability > delay of CCS**

Difference of undiscounted costs in 2050 (GHG80_BIOL as base)

GHG80_BIOL_CCS2040	GHG80_BIOH	GHG80_BIOH_CCS2040	GHG100_BIOH	GHG100_BIOH_CCS2040
1.4%	-6.2%	-3.6%	4.4%	6%

- BECCS
  - Especially important to decarbonise the Elc sector
  - Create rooms for other sectors
- Usage of bioenergy is flexible
- **Net zero by 2050**
  - Impossible without BECCS (or CCS after 2040)
  - Delay of CCS:
    - Extremely high level of electrification (esp. industrial sector)
    - Bioenergy is required in the transport sector before 2050
  - **Consumers' participation** becomes extremely critical

Conclusions and Future Works

- Link with **global energy system model** (**TIAM-UCL**) to explore the availability of bioenergy from international trades for the UK
- Evaluate the **environmental impacts** of high bioenergy production
- Incorporate **consumers' technology choice** into account (UK nationwide survey carried out for H2020 REEEM project)
  - Heating technologies
  - Vehicle technologies
- Consider other NETs

Thanks for your attention!

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