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Greenhouse gas emissions from biomass heating systems

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Introduction

- Many policy drivers for biomass are focused on the ability of biomass to reduce greenhouse gas (GHG) emissions
- Decarbonisation of the UK energy system requires decarbonisation of heating

- ➢ Identify the best use of biomass from a GHG perspective
- ➢ Identify the GHG balances of different bioenergy pathways

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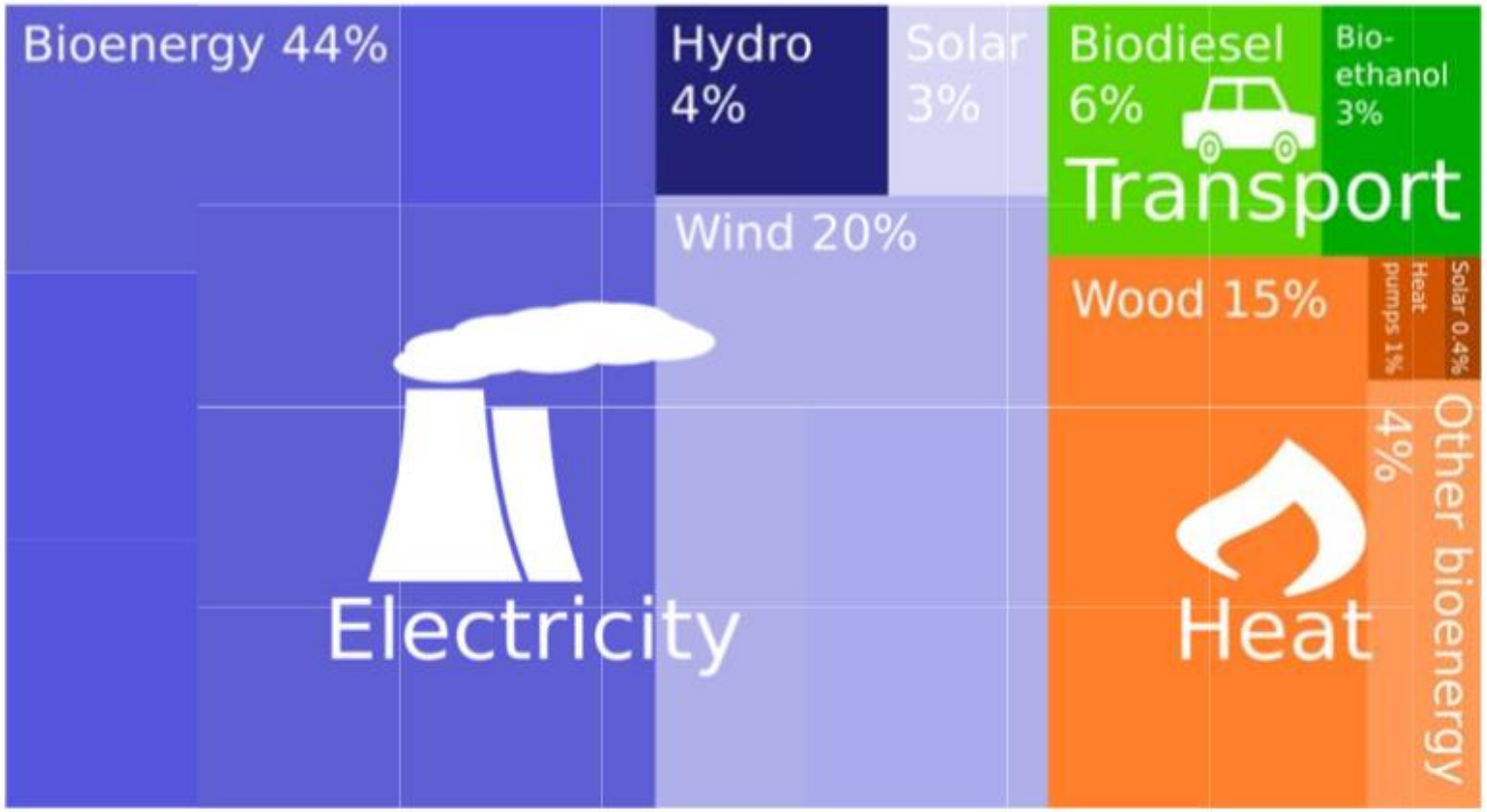
Renewable energy in 2014

7% of UK energy consumption from renewables



Decc, 2015. Digest of UK energy statistics (DUKES)

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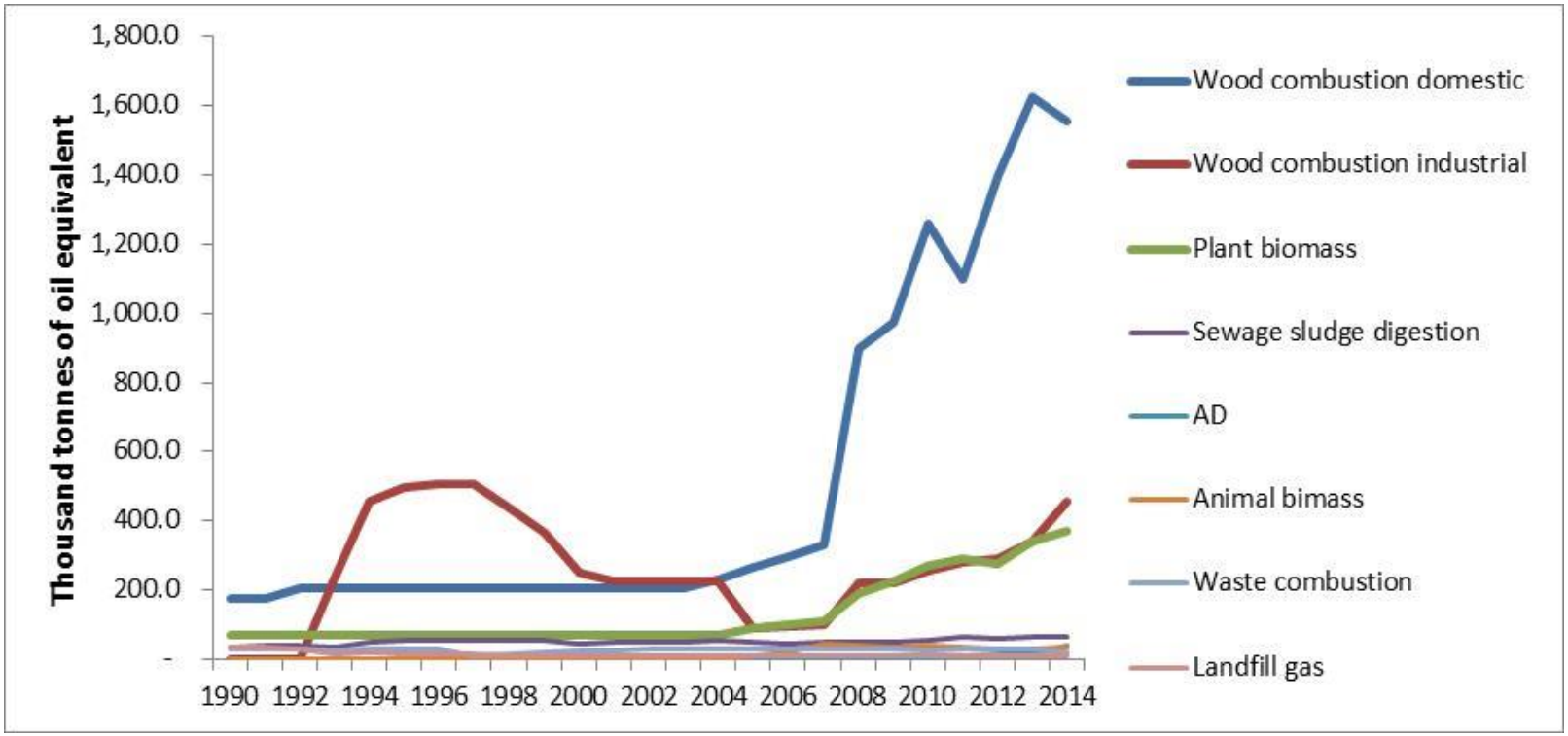
Heat generated from biomass



Data from Decc, 2015. Digest of UK energy statistics (DUKES)

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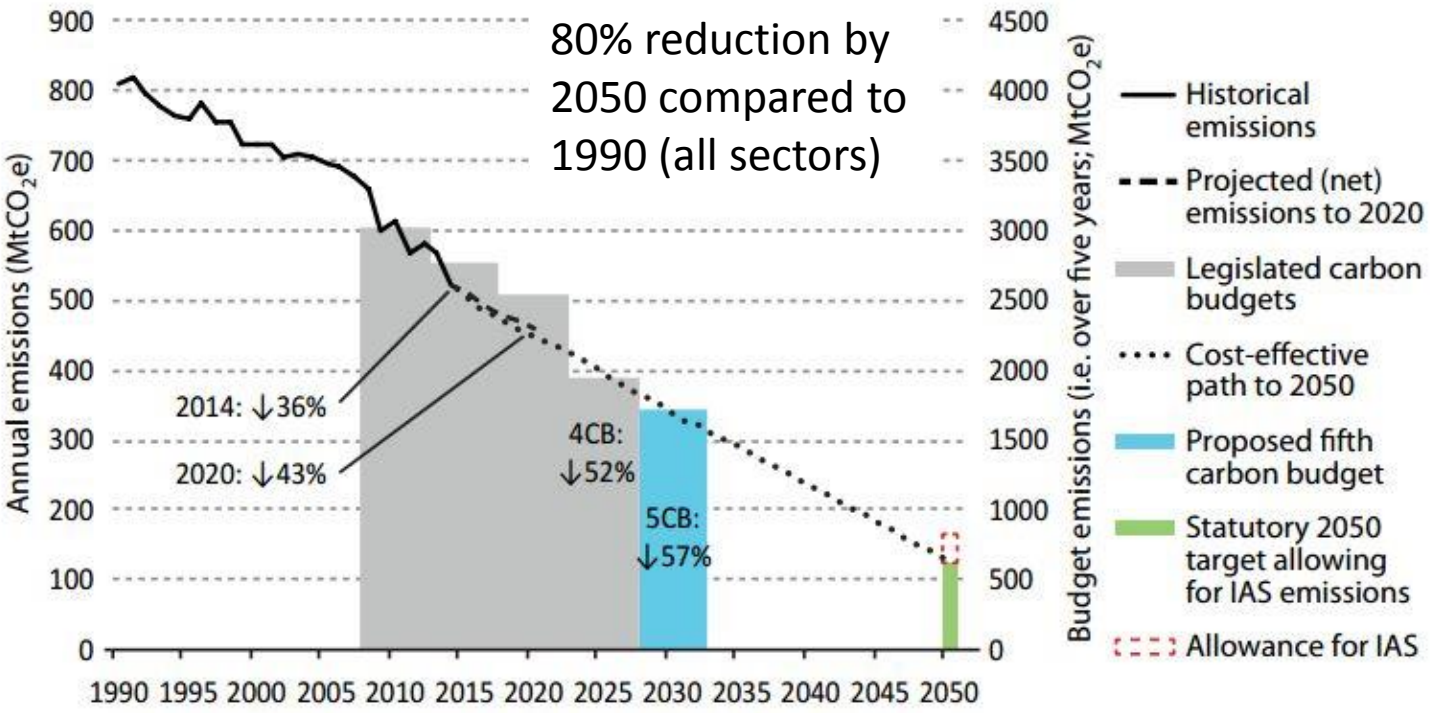
Total UK carbon budget and emission reductions until 2050

Figure 1: The recommended fifth carbon budget would continue emissions reduction on the path to the UK's 2050 target



Source: DECC (2015) *Final UK greenhouse gas emissions national statistics: 1990-2013*; DECC (2015) Provisional UK greenhouse gas emissions national statistics; DECC Energy Model; CCC analysis.

Notes: Data labels show reductions in annual emissions relative to 1990. Historical emissions are on a 'gross' basis (i.e. actual emissions). Projections and carbon budgets are on the current budget accounting basis: net carbon account excluding international aviation and shipping (IAS), but allowing for IAS to be included in the 2050 target.

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Best use of biomass for energy

- UoM has evaluated the GHG balances of heating systems compared to other uses of biomass
- This is LCA work framed at addressing the question **“What is the best us of our biomass resource”**

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Heating vs. other uses of biomass

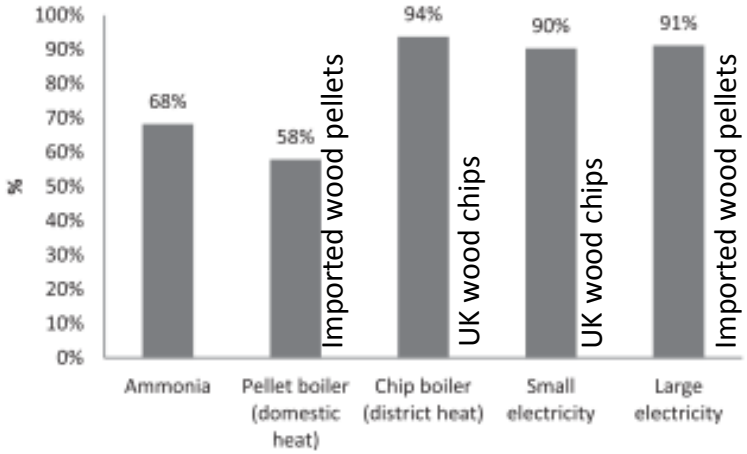

Fig. 3 – Relative greenhouse gas reductions compared to the reference case.

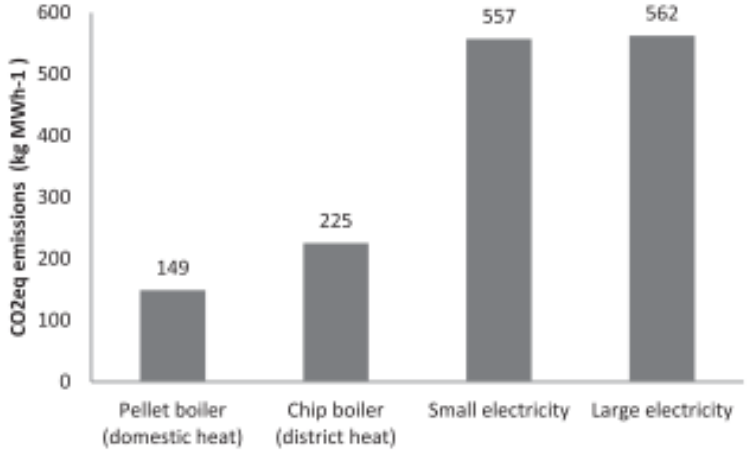

Fig. 2 – Absolute greenhouse gas savings per unit of energy delivered.

- Pellet boiler pathway results in largest GHG burden; chip boiler pathway has substantially lower emissions
- Both of the electricity systems give very much higher GHG savings than the heating ones
- The district heating system gives the highest percentage reduction of greenhouse gases compared to the reference system

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Heating vs. other uses of biomass

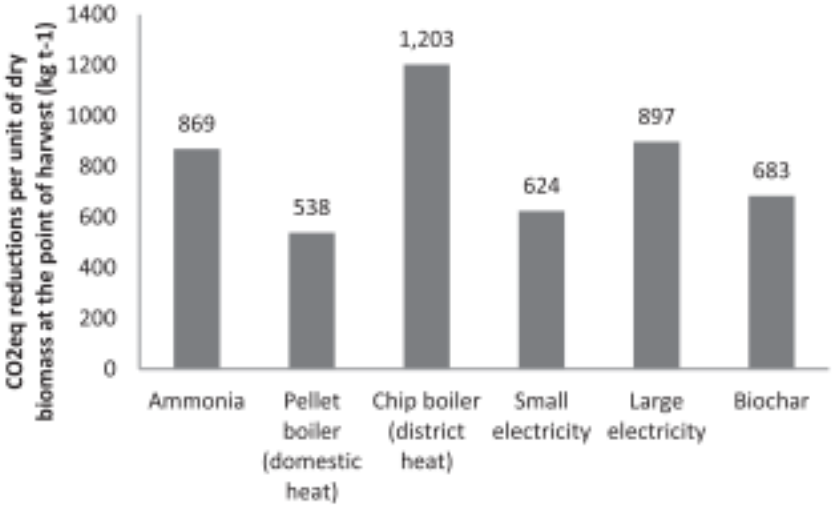

Fig. 4 – Greenhouse gas reductions per unit of biomass.

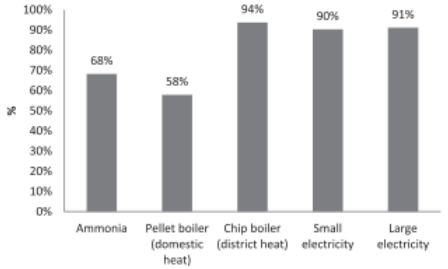

Fig. 3 – Relative greenhouse gas reductions compared to the reference case.

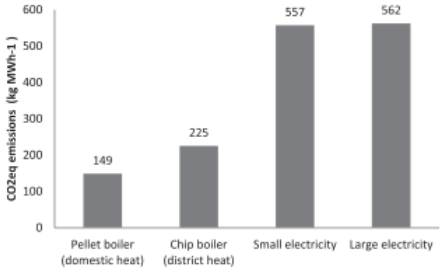

Fig. 2 – Absolute greenhouse gas savings per unit of energy delivered.

- Wood chip boiler for district heating delivers the greatest GHG reduction impact per unit of biomass; followed by large electricity systems

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GHG balances of biomass pathways

- UoM has carried out evaluation of different bioenergy pathways
- This is LCA work framed at addressing the question **"What is the GHG impact of biomass resource-technology combinations compared to other ways of managing the resource and other ways of delivering energy?"**

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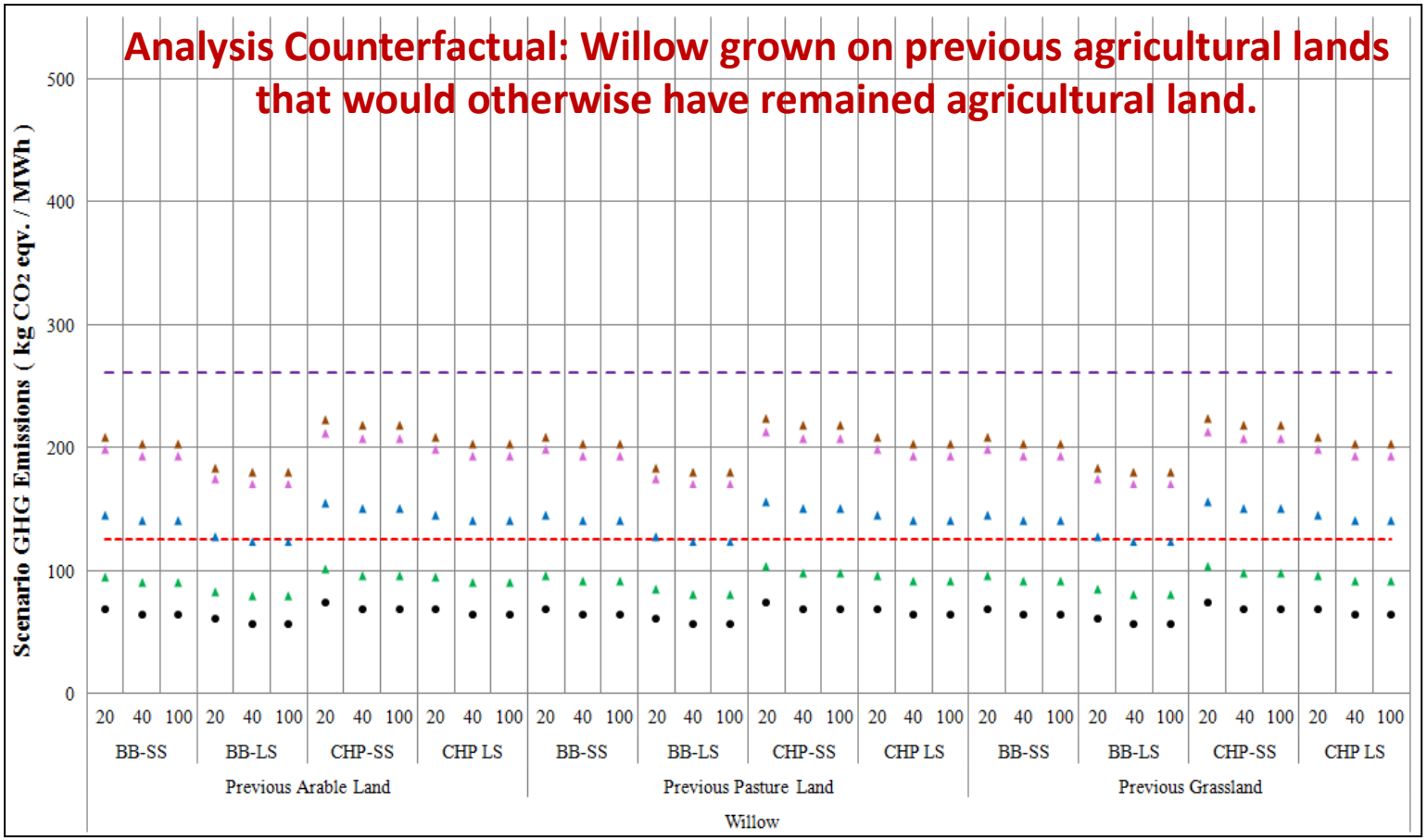
UK willow heat bioenergy pathway



Analysis Comparators:.		
-----	Sustainability Target	Comparator, the UK's heat bioenergy GHG intensity target ($CO_2^{eqv.}$ / MWh) [20].
- - -	Natural Gas GHG Impact	Comparator, the GHG intensity ($CO_2^{eqv.}$ / MWh) of generating heat from natural gas [16].

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Key drivers of bioenergy GHG balances

	Embodied emissions associated with agrochemical inputs	Land emissions	Role of co-products	Carbon stocks	Land-use change emissions	Indirect land-use change emissions	Accessible yield of crop
Annual crops	++	++	++	-	+	+	++
Perennial crops	-	-	-	+	++	++	-
Forestry systems	-	-	+	++	-	-	-
Waste and residue systems	-	++	++	++	-	-	-
Algal systems	++		+				++

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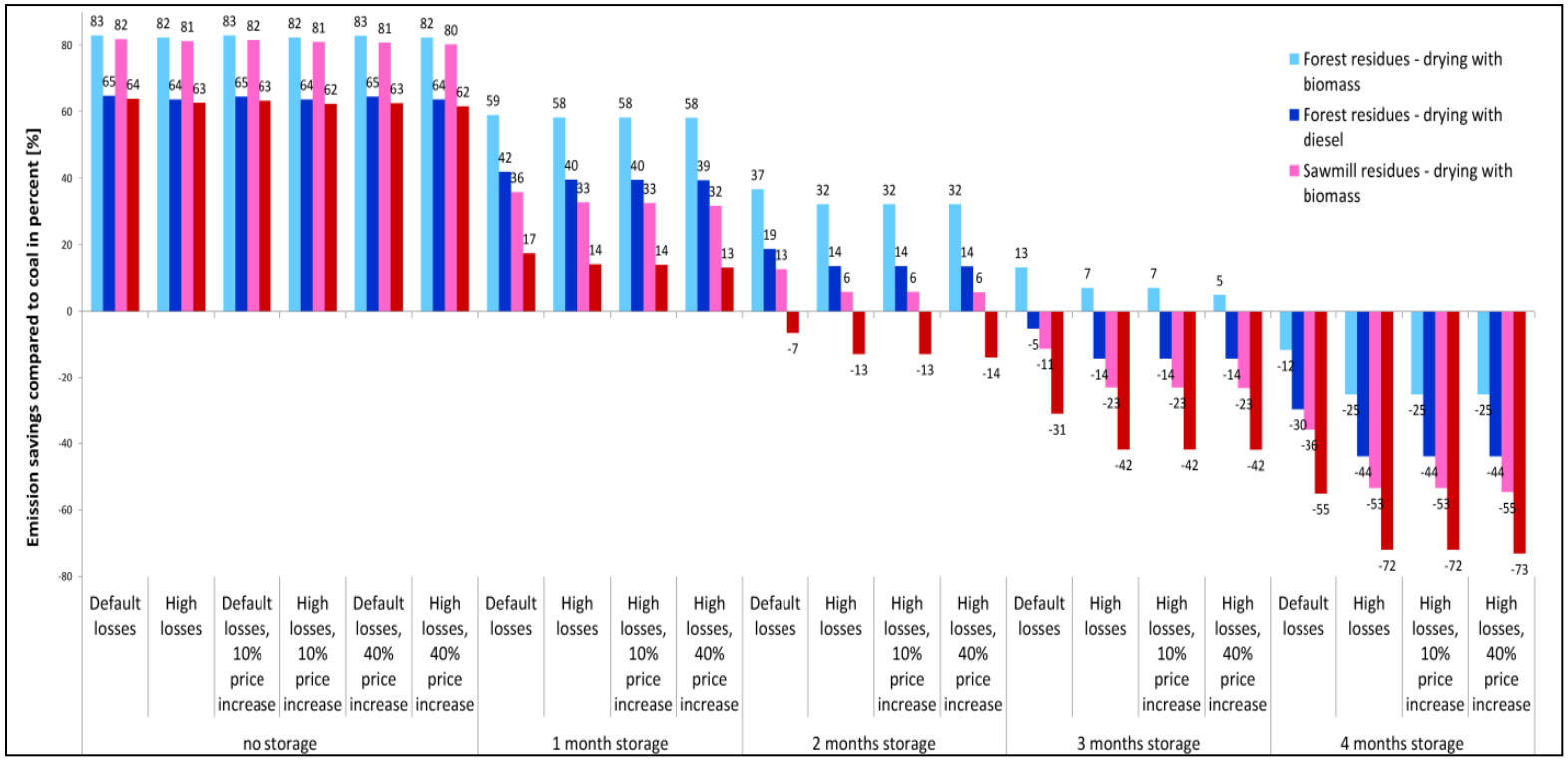
Emission uncertainties



Röder M et al. (2015) "How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues." Biomass and Bioenergy 79:50-63

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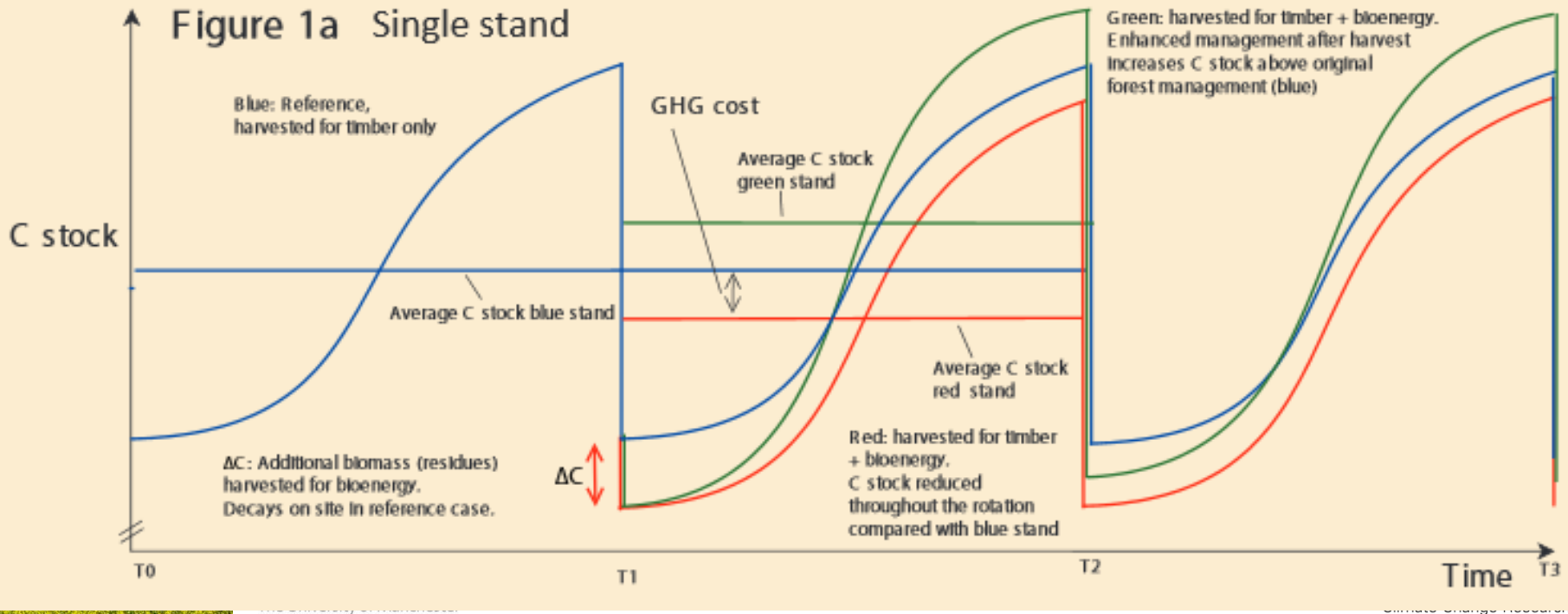
Temporal aspects

- Point in time of CO_2 release and sequestration can be significantly different
- Forest management / biomass production is likely to be a another main driver of carbon emissions and overall emission budget



IEA Bioenergy 2013

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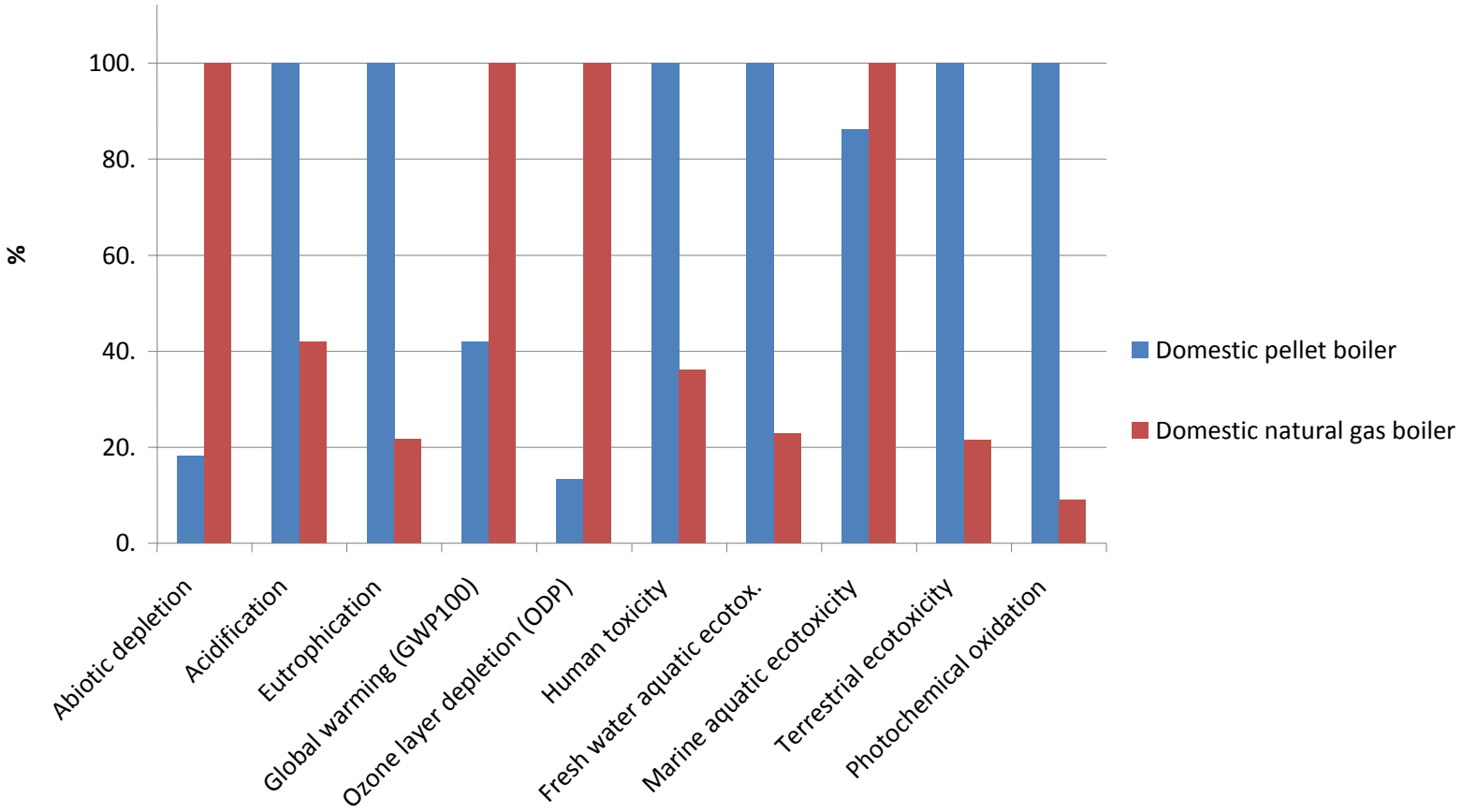
Beyond GHG emissions
Environmental lifecycle impacts of domestic heating



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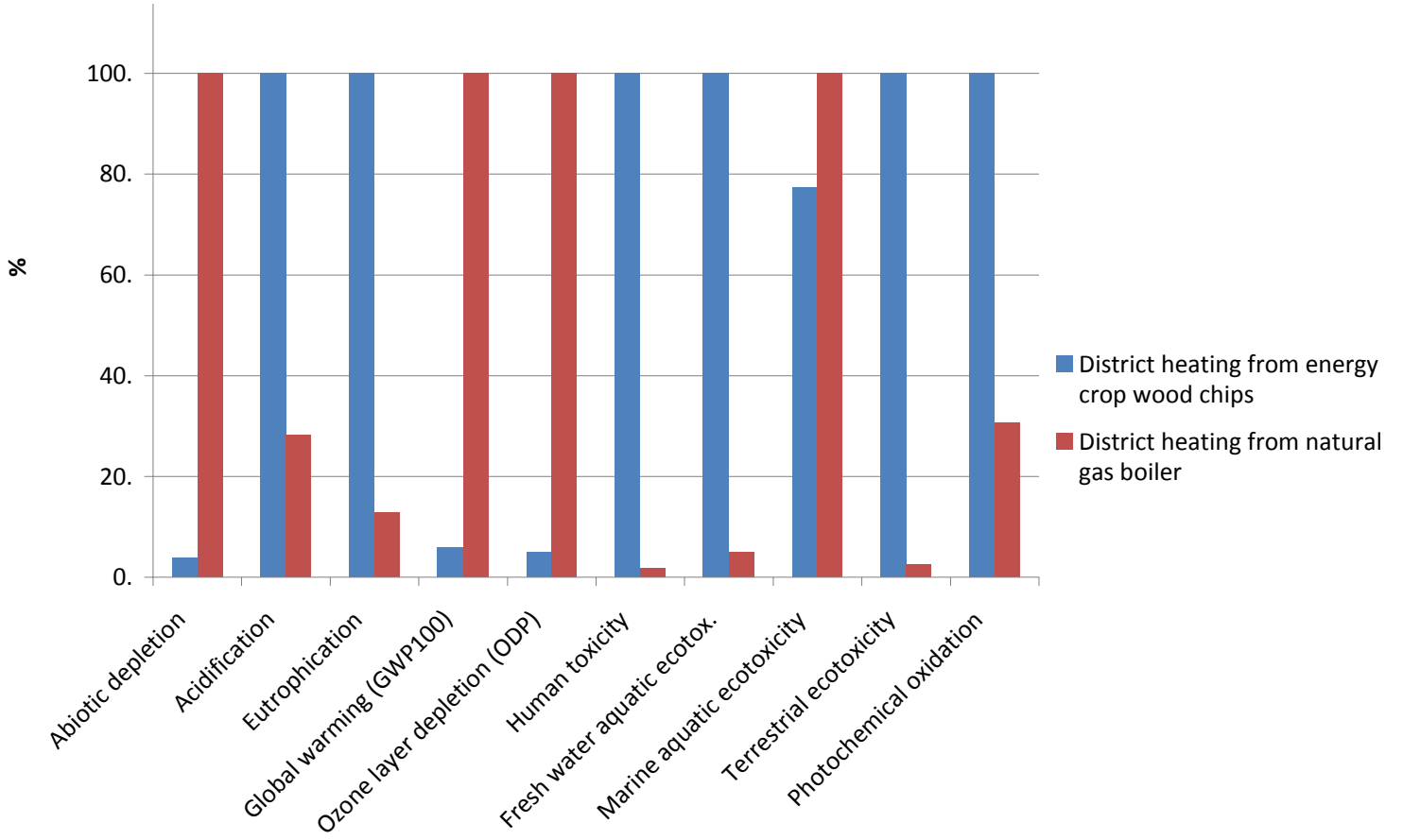
Beyond GHG emissions
Environmental lifecycle impacts of large scale heating



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Implementation advice 1

- Biomass heating systems can deliver significant GHG reductions
- GHG reductions can be lower particularly if there is a low carbon counterfactual
  - e.g. high efficiency natural gas boiler or domestic heat system or high intensity production or processing/supply chain emissions
- Other environmental impacts may increase even when GHG impacts reduce

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Implementation advice 2

- Not possible to accurately benchmark categories of biomass resource by their potential GHG performance
- Possible to identify specific processes/activities that enhance or reduce the GHG performance
- Pelleting improves combustion performance but reduces GHG savings

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Implementation advice 3

- Important to fully understanding the climate mitigation policy objective when considering how to make the best use of bioenergy
- Climate policy focuses on relative GHG reductions when domestic heat and small and large scale electricity perform well, but for absolute emission reductions electricity is favoured rather than heat
- Important to appropriately frame the LCA research question – “off the shelf” calculators may give a “fair” technology comparison, but fail to take into account alternatives or interfaces and may result in inappropriate prioritisation

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