Table 20. Central methane scenario (60% initial capture) minimum lifetime biogenic content required

	Minimum lifetime biogenic content required %						
Plant efficiency	Existing plant 1995-2020	Existing plant 2000-2025	Existing plant 2005-2030	Existing plant 2010-2035	New plant 2015-2040	New plant 2020-2045	New plant 2025-2050
30%	40.19	42.46	45.98	50.31	54.8	58.93	62.39
25%	43.47	45.51	48.63	52.46	56.44	60.08	63.12
20%	46.71	48.54	51.26	54.59	58.06	61.22	63.85
15%	49.93	51.53	53.87	56.71	59.68	62.35	64.57

170. Cells shaded green indicate where the lifetime biogenic content required is less than the 50% currently used for deeming of Renewables Obligation Certificates (ROCs). Orange indicates where the content falls in the 60-68% range currently considered likely for mixed municipal waste. This indicates that for the central set of assumptions all plants are viable for municipal waste with a biogenic content at the top end of the commonly used range. As might be expected the low methane scenario required higher biogenic content than the central scenario for a given plant while conversely the high methane scenario required lower biogenic content.

171. Once the plant reaches the end of its 25 year life it needs to still be providing a carbon benefit for that life to be extended. The minimum biogenic content to extend a plant's lifetime to a given year is shown in the table below. Higher biogenic content is required to justify extending a plant's lifetime beyond the initial 25 years under this set of assumptions.

Table 21. Central methane scenario (60% initial capture) Minimum biogenic content required to extend plant life beyond initial 25yr lifetime

	Minimum biogenic content required to extend plant lifetime beyond initial 25 year period %						
Plant efficiency	Existing plant 1995-2020	Existing plant 2000-2025	Existing plant 2005-2030	Existing plant 2010-2035	New plant 2015-2040	New plant 2020-2045	New plant 2025-2050
30%	47.12	52.86	59.67	61.93	64.53	66.48	67.61
25%	49.77	54.84	60.63	62.61	65.03	66.77	67.85
20%	52.4	56.8	61.59	63.29	65.53	67.06	68.09
15%	55.01	58.75	62.55	63.97	66.02	67.34	68.33

6.3. Treatment of biogenic CO_2

172. So far this analysis has ignored biogenic CO_2 emissions based on the assumption that it is short cycle and therefore has no net global warming impact. Impacts from factors such as changes in land use to grow the original plants are accounted for in overall carbon inventories elsewhere and are conventionally not considered as part of waste management or energy generation.

173. However, the model assumes that not all of the biogenic material decomposes in landfill but it is all converted to CO_2 in energy from waste. Landfill therefore acts as a partial carbon sink for the biogenic carbon. This is a potential additional benefit for landfill over energy from waste.

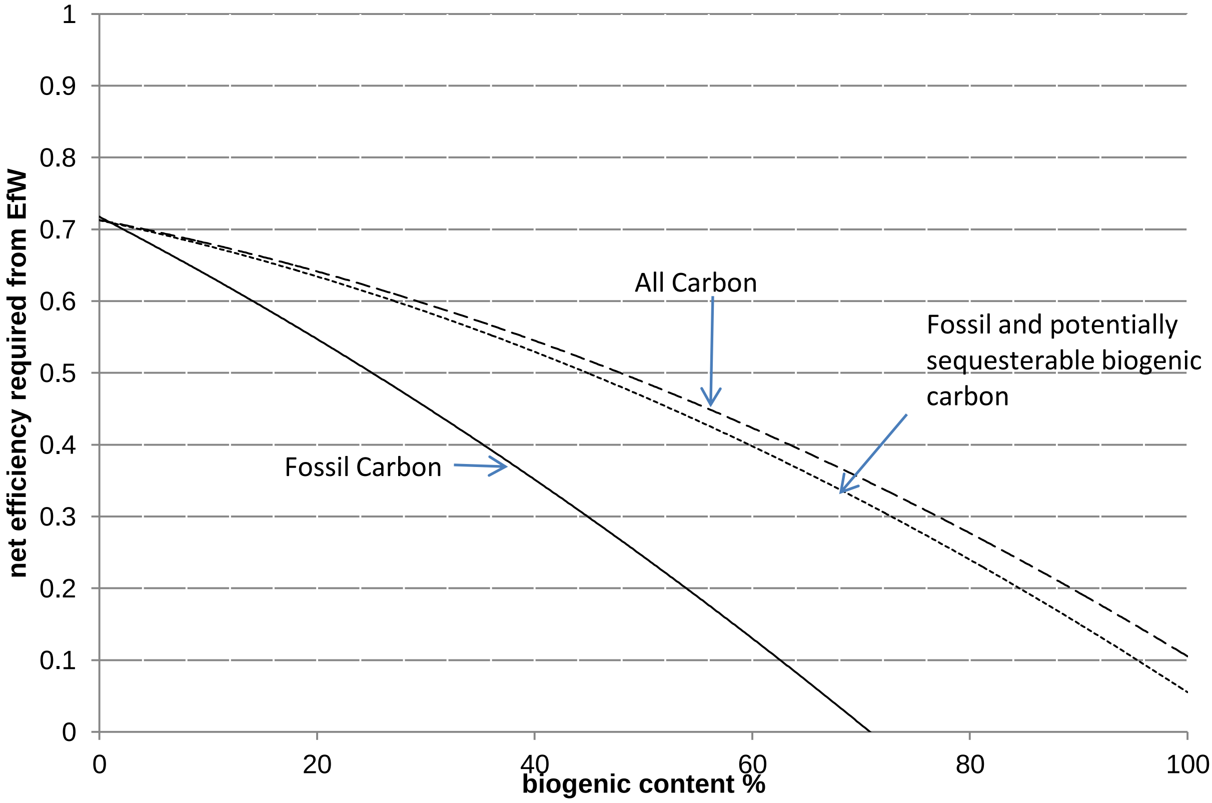
174. There are two ways to account for this additional effect:

- Estimate the amount of biogenic carbon sequestered and include the CO_2 produced from the same amount of carbon in the EfW side of the model (or subtract it from the landfill side)
- Include all carbon emissions, both biogenic and fossil on both sides of the model

175. While both approaches would address the issue of sequestered biogenic carbon the first would potentially be the better solution as it would avoid double counting carbon with other inventories.

176. Both approaches were examined in the model using the baseline set of assumptions (equivalent to the high capture low methane scenario) and the results are shown in Chart 15 below.

Chart 15. Net efficiency of EfW plant required with different biogenic content of waste considering EfW emissions of: only fossil carbon (solid line), fossil and potentially sequesterable biogenic carbon (dotted line) and all carbon (dashed line)



177. It can be seen from Chart 15 that both approaches deliver a very similar change with, as expected, EfW becoming more disfavoured relative to landfill with the greatest change at high biogenic content of the waste. Taking into account sequestered biogenic carbon in landfill will require greater EfW efficiency and/or biogenic content.

178. The similarity between the two approaches is unsurprising as biogenic carbon which is not sequestered in landfill or converted to methane becomes CO_2, as it would in EfW, so for that aspect the two sides of the model cancel out. The slight difference is due to the need for EfW to compensate for the CO_2 offset by electricity generation

from landfill gas when all emissions are considered. The small difference indicates how relatively small a contribution this energy makes to the overall balance. Given this similarity it may be better to consider only the sequestered biogenic C to avoid double counting with other inventories.

179. A range of different values exist in the literature for the amount of biogenic carbon that is sequestered in landfill. The baseline assumptions used in this model result in a very high level of sequestration, around 53% for the baseline composition. The outcome will be sensitive to the level of sequestration in two ways. Reducing the level of sequestration will require less biogenic carbon to be included in the EfW side of the model and will also result in more methane being emitted from the landfill side. Both factors will favour EfW over landfill. To examine the sensitivity of the model to changes in sequestration the baseline proportion of decomposable carbon in each waste type was increased by 50%. This changed the overall proportion of sequestered biogenic carbon from 53% to 29.5%. The values used are summarised in Table 22 below.

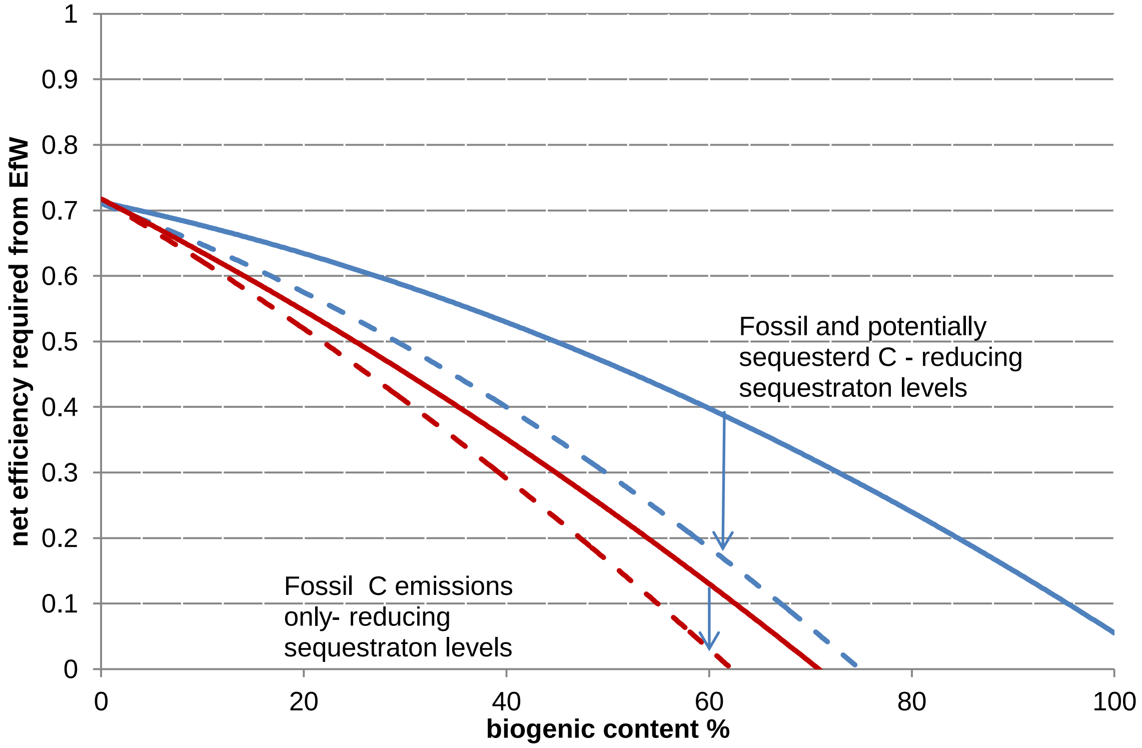
Table 22. Changes in modelled sequestration levels for each component by increasing the proportion of biogenic C considered sequesterable

Material	High sequestration % (model baseline)	Reduced sequestration %
Mixed Paper and Card	50.63	25.94
Plastics		
Textiles (and footwear)	66.65	49.98
Miscellaneous combustibles	53.21	29.82
Miscellaneous non-combustibles	100	100
Food	39.36	9.04
Garden	48.71	23.06
Soil and other organic waste	96.43	94.64
Glass	100	100
Metals, White Goods and Other Non-biodeg Products		
Non-organic fines		
Wood	71.52	57.28
Sanitary / disposable nappies	71.33	57
Total	53.00	29.50

180. By taking this approach materials which already have a high proportion of decomposable carbon are most greatly affected, i.e. Food, Paper and garden waste.

181. The impact of these changes on the model outputs is shown in Chart 16 below.

Chart 16. **Impact of reducing the assumed level of carbon that decomposes on model outputs for fossil emissions (red) and fossil and potentially sequestered biogenic C (blue). Baseline model (solid line) and reduced sequestration (dashed line)**



182. As noted above, changing the level of sequestration impacts on both the amount of biogenic carbon that needs to be counted on the EfW side of the model and the amount of methane emitted on the landfill side. As a consequence changing the sequestration level impacts not only when considering both fossil and sequestered carbon but also when considering fossil carbon alone.

183. In the example above for the baseline composition (61% biogenic) reducing the amount of sequestration of biogenic carbon from 50% to 30% results in a drop of 10% in the efficicncy required if just considering fossil carbon and 20% if considering both fossil and sequestered biogenic carbon.

184. There is an additional complicating factor regarding the assumptions around sequestration levels. The proportion of landfill gas captured is difficult to measure directly so assumed levels have previously been derived from a combination of measurement of the amount of landfill gas captured as a proportion of the amount modelled as being produced. However, the modelling for this also contains assumptions on sequestration, Therefore any lowering in the sequestration assumptions will also inherently reduce the assumed level of landfill gas capture. This interaction has not been captured in the above analysis. As a result the scenarios outlined above will be particularly sensitive to sequestration levels with any drop in assumed sequestration significantly favouring EfW over landfill. Given all of these interactions there is a high degree of uncertainty and further work is required.