Review of 2050 pathways analysis with a focus on Bio-SNG and Bioenergy and optimum conversion routes

The model implies that the conversion of the biomass to gas products is significantly less advantageous than converting biomass to solid fuel.

Using the model in its default (reference) state, the total emissions are 635 Mte CO_2e (2050).This presumes biomatter is converted to a mixture of solid, liquid and gas. Converting biomatter mainly via:

- Solid hydrocarbon vector gives 634 Mte CO_2e (2050) including 46 Mte CO_2e bio credits
- Gaseous hydrocarbon vector gives 651 Mte CO_2e (2050). including 28 Mte CO_2e bio credits

The reason for this is two fold:

1. The model assumes certain process conversion efficiencies to transform biomass from its raw state to a usable solid, liquid or gas. In general these conversion efficiencies are reasonable baseline assumptions (although the AD conversion efficiency assumption is unclear, see comments below). The use of gasification and methanation to convert a solid biomass into a gas does represent a real and more significant conversion efficiency loss than simply refining a solid. The efficiency loss across the basket of biomasses and conversions represents 5Mte of loss of credits (11%) in the gas case compared with the solid case.
2. The model assumes certain emissions factors for solid, liquid and gaseous fuels based on coal (0.308te C_{O2}/TWh), oil (0.250te C_{O2}/TWh), and gas (0.184te C_{O2}/TWh) respectively. Therefore it assumes that the converted bioenergy product displaces its analogue fossil fuel. This assumption represents 13Met loss of credits (28%) in the gas case compared with the solid case

This analysis shows that whilst there is a real emissions saving penalty of converting solid biomass to gas, the main reason for the gaseous vector appearing significantly worse depends on assumptions about the type of fuel displaced. In both cases the same raw biomass was used to displace fossil fuel and avoid CO2 emissions. Just because the biomass is upgraded to a higher quality fuel should not be a reason *per se* to disadvantage it – indeed it may well be used more effectively in this form. There is also assumed to be unlimited access to any type of fossil fuel resources and a presumed consumption of unabated solid hydrocarbons in 2050 which solid biomass could displace.

The reason to adopt biomass conversion to gas is twofold:

- To enable penetration of biomass /renewables into markets which could not otherwise be accessed, by converting to a fungible fuel. This is particularly the case for waste derived biomasses; there are only limited applications where this type of fuel can be used. Once converted to methane any appliance suitable for natural gas can utilise the fuel.

- To enable production of a potentially constrained high quality fuel such as gas; ie to address the issue that natural gas may not be a long term supply secure fuel, both in terms of volume and price.

Therefore the model would only attribute the benefit of this route if (a) the market-side constraints of utilising solid biomass were recognised (and so conversion to gas enabled greater biomass penetration) and/or (b) constraints on fossil fuel resources were recognised (such that for example natural gas were a limited resource and shortfalls in gas availability had to be accommodated by the use of other fossil fuels unless biogas could be supplied). In these cases the absolute level of emissions could well decrease by adopting the gas vector.

In summary, by not accounting for these factors, the tool would suggest that conversion of biomass to gas is not an appropriate pathway, whereas there are significant and tangible reasons to do so.

	V.a trajectory 2 biomass to solid vector 2050	**V.a trajectory 4 biomass to gas vector 2050**
Total input Biomatter (TWh)	**230.0**	**230.0**
Converted bio-solid (TWh)	113.6	0.0
Converted bio-liquid (TWh)	0.5	0.5
Converted bio-gas (TWh)	57.9	151.9
Total bio vector (TWh)	**172.0**	**152.4**
Net conversion efficiency (%)	75%	66%
Fossil assumptions		
Coal export (import) TWh	222.5	108.9
Oil export (import) TWh	-707.5	-707.5
Gas export (import) TWh	-1675.7	-1580.7
Total fossil fuel export (import)	**-2160.8**	**-2179.3**
Bioenergy credits		
Solid (0.308) MteCO2e	35	0
Liquid (0.250) MteCO2e	0	0
Gas (0.184) MteCO2e	11	28
Total	46	28
Overall 2050 emissions (MteCo e)	**634**	**651**

Other comments regarding the 2050 pathway analysis for biomass.

1. It is not clear how the different catagories of waste proportions have been derived from the source data. The waste arising figures quoted in the table are wrong (see below).

2. There is no clear source data for the biomass and waste arisings of the different types nor basis of conversion between tonnage and calorific value of the raw material.

3. The AD conversion to gas assumption of 80% is unclear. The biomethane potential of a given material is not the same as its calorific value. Without further data it is not clear what is

meant by this figure. Whilst this figure may be appropriate for eg animal slurry (which seems to be that assumed from the reference quoted), the AD Degradation potential for most components of *waste* is below this figure (typically 40% across a basket of residual waste streams for AD: food putrescibles, green putrescibles, paper and card, miscellaneous fine materials)

counting with C&I and

254 Efficiency = (energy con
Syngas = gas of approxi
Biogas = gas of approxi