Carbon balances of green gas supply chains - Digestion and gasification

Summary

CE Delft

Committed to the Environment

The well-to-usage carbon emissions of green gas supply chains reported in commonly used sources like www.CO2emissiefactoren.nl are currently incomplete or based on outdated practical data. Co-digestion, for example, is cited as giving a reduction of 'only' 33% relative to natural gas. Current practice for green gas is now fundamentally different, in terms of both digestion processes and new processes like gasification. This study provides a complete and up-to-date picture.

The emission reduction achieved with ***digestion* chains** varies from 50 to 80%, depending on feedstock and application; see Table 1. When the impact of avoided emissions from manure storage is also factored in, in line with the European RED calculation methodology, the CO_2-eq. emission reduction for manure digestion is 183% points higher. If use is made of Carbon Capture and Storage or Utilisation (CCS/CCU) this rises to 90-136%[1]. If the carbon emission reduction associated with by-products is also included, the range goes up to 149-223%[2].

The emission reduction achieved with ***gasification* chains** varies from 75 to 97%; see Table 1. The highest of these values is for supercritical water gasification[3].
If CCS/CCU is assumed, this figure rises to 121-160%.
The key results are reported in Table 1.

Table 1 – Carbon emissions and emission reductions of green gas chains (excl. impacts of CCS and avoided products/processes)

Green gas production technology and feedstocks	Carbon emissions according to RED methodology (kg CO_2-eq./GJ)			Emission reduction; no CCS, no avoided products/processes		
	LNG production	H gas for MTG[4]	G gas for distribution grid	LNG production	H gas for MTG	G gas for distribution grid
Conventional mesophilic digestion						
Domestic biowaste	23.4	16.8	14.6	**68%**	**78%**	**80%**
Pig slurry						
Excl. impact of avoided emissions from manure storage	41.7	34.2	32.9	**42%**	**52%**	**54%**
Incl. impact of avoided emissions from manure storage	-89.8	-97.3	-98.5	**225%**	**236%**	**237%**
Effluent treatment plant sludge	36.0	28.6	27.2	**50%**	**60%**	**62%**
Supercritical water gasification						
Seaweed after protein extraction[5]	8.5	1.9		**88%**	**97%**	
Effluent treatment plant sludge	9.1	3.0		**87%**	**96%**	
Allothermal gasification						
Logs	17.4	11.7		**76%**	**84%**	
Industrial by-products	16.4	10.6		**77%**	**85%**	
B-grade wood	17.8	12.1		**75%**	**83%**	
Carbon emission baseline	72	72	72			

1 278% if the impact of avoided emissions from manure storage are also included, as per the EU RED methodology.
2 401% if the impact of avoided emissions from manure storage are also included, as per the EU RED methodology.
3 With supercritical water gasification, the carbon emission reduction estimated by SCW-Systems can in principle be 150-200% points higher if the CO_2 present in the synthesis gas post-methanisation can be fully utilised as a feedstock for e.g. 'green concrete' by reacting it with olivine. This does not factor in use of reaction heat in the synthesis process.
4 MTG = main transporation grid.
5 For seaweed, only the energy component was considered, with the additional emission reduction associated with e.g. cultivation and short-cycle CO_2 capture not being factored in. The emission reduction due to protein extraction was also excluded (i.e. substitution of animal by vegetable protein from seaweed); this issue requires further study.