Renewable Energy from Crops and Agrowastes

Crops for biogas production; yields, suitability and energy balances

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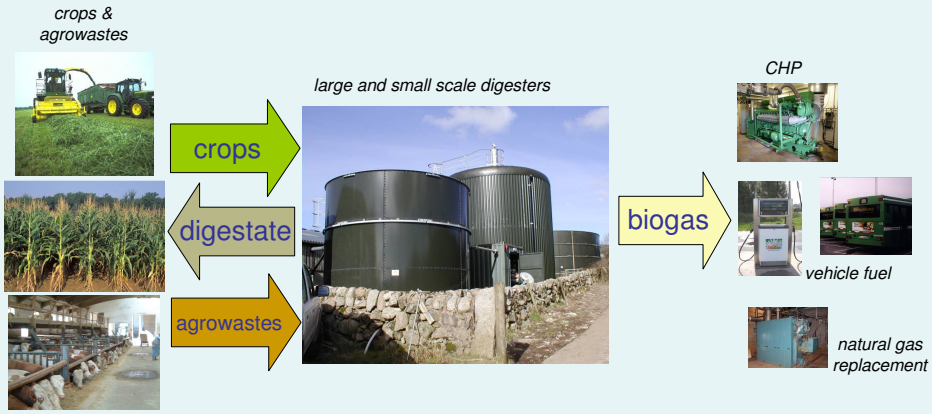
Anaerobic digestion (AD) can be used to provide renewable energy from most organic material.

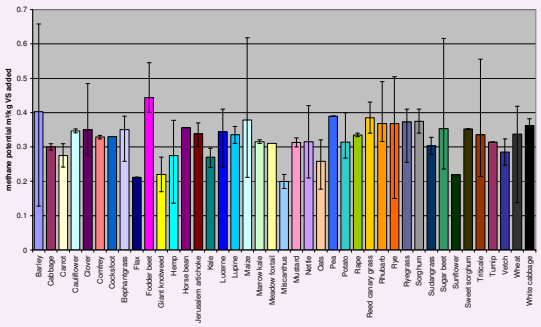
AD produces 2 outputs:

- energy in the form of biogas
- digestate a source of organic fertiliser.

Crop based AD for energy:

- provides alternative employment
- can increase diversity through the use of a wide range of crops
- produces a fuel which is clean, environmentally friendly and has multiple uses.





There are many recorded values for methane potential from different crops. The values vary according to the experimental method used and in particular the growth stage at point of harvest. It is not necessary to maintain a mono-crop for fuel production and crops can therefore be selected to enhance a cropping system.

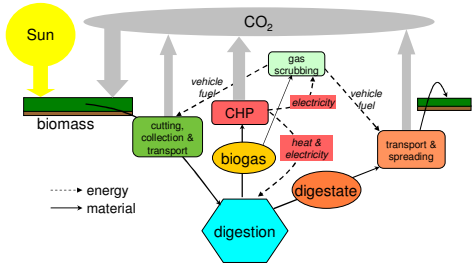
fuel	biodiesel	bioethanol		methane				methane
crop	OSR seed	sugar beet	wheat grain	sugar beet	wheat grain	maize	whole crop triticale	whole crop triticale
fertiliser (N kg/ha)	195	147	150	147	150	150	160	80
crop yield (fresh yield t/ha)	3	56	8	56	8	40	38	38
crop yield (t DM/ha)	3	11.5	6.9	11.5	6.9	12.6	15	15
energy for crop production (GJ/ha)	12.7	11.9	12.8	11.9	15.5	16.7	16	11.6
energy for processing (GJ/ha)	9.2	41.4	13.2	10.8	8	8	8.3	8.3
energy of fuel produced (GJ/ha)	40.4	117	61.1	124.8	89	157.1	166	166
energy ratio (output/input)	**1.84**	**2.20**	**2.35**	**5.50**	**3.79**	**6.36**	**6.83**	**8.34**
net energy produced (GJ/ha)	**18.5**	**63.7**	**35.1**	**102.1**	**65.5**	**132.4**	**141.7**	**146.1**
potential electricity generated MWh/ha				9.4	6.1	12.2	13.1	13.5
energy to convert to vehicle fuel (GJ/ha)				5.3	3.7	6.6	7	7
energy of vehicle fuel produced (GJ/ha)				96.8	61.8	125.8	134.7	139.1
equivalent litres of diesel.	**517**	**1779**	**980**	**2704**	**1726**	**3514**	**3763**	**3885**

Elsayed, M. A., Matthews, R. and Mortimer, N. D. (2003) Carbon and Energy Balances for a Range of Biofuels Options - report for DTI, Sheffield Hallam University, Sheffield.

digestate replaces 1/2 of mineral fertiliser

Compared to 'first generation', liquid bio-fuels crop based biogas can lead to an increased yield in energy per hectare. The ability to use whole crop increases the amount of material which can be used per hectare and returning the digestate reduces the requirement for fossil fuel based fertilisers. (Diesel equivalents are net values after energy for crop production and fuel processing are removed).

The use and benefits of anaerobic digestion at farm scale have been demonstrated at the Kalmari farm in Finland. The farmer digests cattle slurry and crops produced on the farm, with some imported chocolate waste. The biogas is used in CHP to provide electricity and heat for use on the farm plus providing vehicle fuel used by the farmer and sold locally. Legume and cereal crops are combined in fields for reduced fertiliser requirement. The ability to use a wide range of crops mean that as conditions change so can the materials used as feedstock. As the weather has become warmer in Finland the farmer is changing from grass to maize as an energy crop for digestion.



Anaerobic digestion of crops can result in both CO_2 and energy cycles which are closed. Energy, produced in the form of biogas, can be converted to heat and electricity (CHP) used in the process, and to vehicle fuel used in crop production and digestate distribution. CO_2 released in the production and use of the fuel was initially absorbed by the crops used making the process carbon neutral.

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