

# Biogas from sugar beet



Biogas is a mixture of methane and carbon dioxide produced by fermenting organic material in the absence of oxygen. The volume of gas generated and the operating reliability of the production plant are significantly influenced by the type, quality and quantity of the substrate (feedstock) used.

The substrate costs make up around 40% of the total expenditure for biogas production, so the choice is also an important factor in plant profitability.

The ultimate aim is to achieve the highest possible biogas or methane yield per unit area. Sugar beet provides higher comparable yields and energy levels than energy maize with other valuable characteristics for biogas production.

## Sugar beet as a biogas substrate

- Higher energy levels than maize
- Stable yields across seasons
- Good fit in rotation
- High dry matter yield
- Excellent fermentation characteristics
- Rapid fermentation
- Faster plant restart

Sugar beet has excellent substrate and fermentation characteristics, which stabilise the microbial conversion and improve the technical processes in the fermenters.

Beet dry matter primarily consists of directly fermentable carbohydrates (sucrose) which are quickly converted into energy. Sugar beet is often completely decomposed in

less than 15 days (cf. maize: approximately 90 days). It therefore has a shorter fermentation time than other field crops and, in good agricultural regions, sugar beet achieves a methane yield per hectare which, in favourable conditions, is 20 % or more higher than the yield from silo maize (at 45 t/ha for maize compared with 80 t/ha for beet).

## Stable yields

Due to its stable yields, sugar beet provides consistent energy yields over long periods of time. It also offers high yield security, even under difficult weather conditions, and it compensates for long dry periods without problems. Additionally, sugar beet eases the burden of close crop rotation of maize and so can provide a valuable contribution in widening the biodiversity in our agricultural landscape.

Practical experience has shown that biogas plants that use beet as a proportion of their feedstock can be restarted much faster after disruptions. This is linked to the speed of decomposition of the substrate. Furthermore, a decline in acid production can be observed, which has a stabilising effect on the entire conversion process. If using beet is abruptly stopped, the biogas plant requires some time to be brought back up to full capacity.

The amount of sugar beet being cultivated specifically for biogas production continues to grow, as ever more plant operators discover the advantages of beets as a substrate.

## Comparison of fresh root yield, dry matter yield and gas yields

	Fresh yield t/ha	Dry matter % of Fresh yield	Dry matter t/ha	Biogas yield Nm <sup>3</sup>	CH <sub>4</sub> yield Nm <sup>3</sup>	CH <sub>4</sub> yield Relative
Sugar beet	80	20.7	16.6	10.400	5.760	121
	70		14.5	9.100	5.040	106
	60		12.4	7.800	4.320	91
Maize silage	50	31.3	15.7	10.000	5.300	111
	45		14.1	9.000	4.770	100
	40		12.5	8.000	4.240	89
Fodder beet	90	17.1	15.4	8.100	4.500	94

Table: Biogas from maize and beets; data sources: FNR; Leitfaden Biogas – Von der Gewinnung zur Nutzung [Biogas Guidelines – From production to usage], Gülzow 2010; Statistical Offices of Niedersachsen, Schleswig-Holstein, Bayern, Rheinland-Pfalz: Actual yields of silo maize, sugar beet and fodder beet from harvest reports 2003-2012. Danmarks Statistik, [www.statistikbanken.dk](http://www.statistikbanken.dk); HST6; Harvest by Crop and Unit; Fodder Beets; Average yield per hectare; 2003 - 2012, Limagrain UK Pocket Guide to Forage Crops Trial Results: Limagrain UK Fodder Beet Trials 1998 - 2011

# Biogas from sugar beet

## Sugar beet biogas substrate – more energy per hectare

### Sugar beet varieties

The requirements of a sugar beet variety as a potential energy source for gas production differ from those for the sugar industry. The high juice purity required for sugar is less important and breeders are working with different targets:

- High dry matter content
- Ease of lifting
- Low dirt tare
- Good storage characteristics

Producing an improvement in the ease of lifting as well as a lower soil adhesion, by means of roots with a smoother exterior, is being taken into consideration in the selection in our proprietary breeding programme.

### More sugar, more methane

Energy beets must have a high biomass yield and a high dry matter content. But it is quite clear from the experiments at the Institute for Sugar Beet Research in Göttingen, Germany (IfZ) that sugar beet varieties that are most suitable for sugar production are currently also best for the fermentation.

### Cultivation, preparation and storage

Biogas beet is cultivated in broadly the same way as beet for sugar production. However, higher nitrogen fertiliser applications can be used to increase yield. Also, when harvesting, the tops

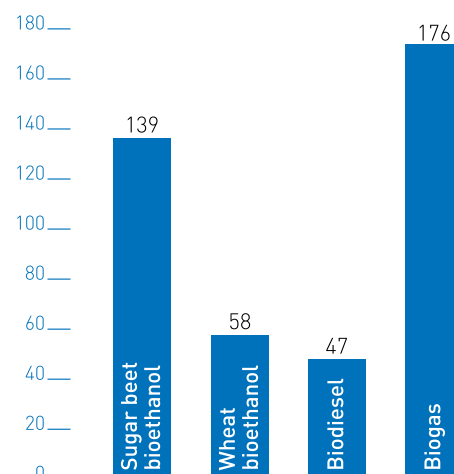
can be cut higher or be defoliated, instead of crowning the beet. Defoliation leads to an increase in yield of up to 10% in comparison with cutting the tops flat. Complete removal of stones and sand particles is essential as they can damage or degrade the processing plant. Stones caught up in the process can cause severe mechanical damage. Sand particles wear plant components and build up as a sediment in the fermenter, reducing efficiency and requiring more frequent cleaning.

Fine components of soil, such as clay and silt, remain in suspension and are delivered with the digestate. They may even be beneficial for the process, since the fine soil particles constitute additional area for colonisation by the microorganisms that are involved. Specialist cleaners such as the "Waschbar" from Doppstadt have been developed which can process up to 100 tonnes of beet per hour.

### Storage

Sugar beet can be successfully harvested fresh for more than 6 months of the year and the best place to store the beet is in the ground.

The preferred form of the beet for storage appears to be as a pulp, either in elevated containers or in lagoons. In that way, the beet is available as a substrate throughout the year.



Energy yield in GJ/ha of various bioenergy sources.  
Source: Own calculations

High-powered shredders from the municipal or forestry sectors, such as the Doppstadt AK 235 can also process large volumes of beet like those required for filling a lagoon.

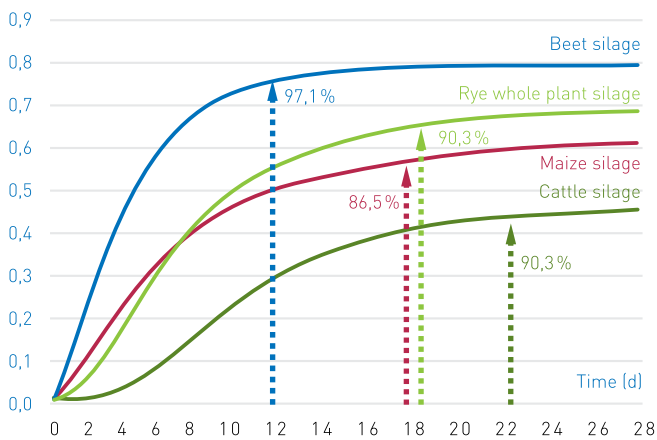
The beet pulp has a consistency similar to coarse apple sauce and remains stable for a long period when stored. A further advantage is that it can be pumped, which enables the substrate supply to the fermenter to be largely automated.

Other techniques are selected in plants where beet is only wanted as a feedstock for a small part of the year, such as storing roots in a storage clamp from which they can then be removed in portions, shredded and added to the substrate mix. Again, stone and sand removal is an important requirement.

**More energy per hectare with sugar beet varieties from Strube.**

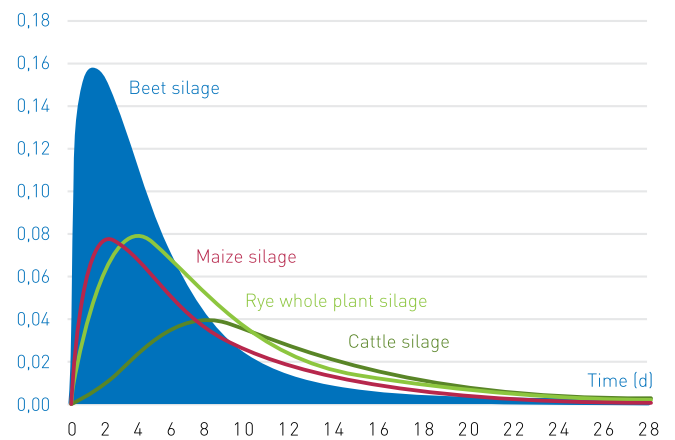


Fermentation rate, total biogas (m<sup>3</sup>/kg)



Source: Linke, Institut für Agrartechnik Bornim

Rate of biogas generation (m<sup>3</sup>/kg/d)



Source: Linke, Institut für Agrartechnik Bornim

## The Strube difference – high seed quality

Strube is a leader in the development of high quality beet seed. All seed is produced with the aid of 3D X-ray computer tomography to control processing, ensuring high emergence, vigorous plants and profitable yields.

We scan all our seed lots with our unique 3D plus technology, so only the best seeds come to your field. After scanning, all our seed lots are primed. During priming we simulate, in the course of a week, spring moisture and heat in specially-designed machines that we have developed over the last 25 years. 3D plus technology ensures a rapid and uniform emergence, which will give you an edge throughout the growing season and a good result on the bottom line.

We also use our 3D plus technology not only to scan our seeds, but also as an important part of our research and development. Using our 3D technology

we select those varieties that develop the most optimal leaf cover, which both generates a high percentage of sugar in the root, but also quickly cover the weeds in the field.

In addition our focus on leaf health provides you with an additional increase in sugar percent throughout the season. All our varieties are the outcome of this development strategy, and will have the optimal leaf mass, which provides both a high yield and security in the field.

The combination of our technologies gives you the security of cultivation and a top yield when selecting Strube varieties. Uniform establishment gives you benefits throughout the growing season and during harvesting. With crowns of beet in the same location and the same height above the ground, crop losses are reduced significantly.

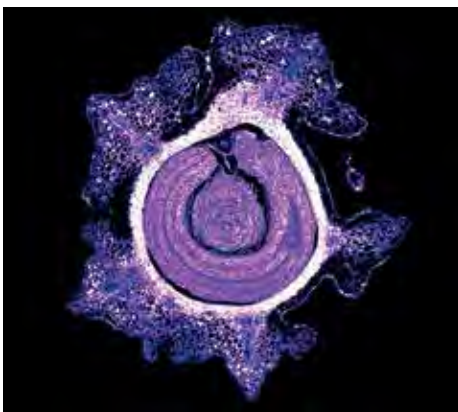
### World class breeding

Strube is one of the world's leading sugar beet breeders supplying seed of more than 170 varieties of sugar beet to more than 35 countries around the world.

In Germany, where there are now some 7500 biogas plants, Strube supplies more than 40% of the sugar beet seed required for the National crop and AD use.

In the UK, Strube supplies the leading varieties Haydn and Pasteur.

With a long-standing reputation for innovation, backed by our strong and continual investment in research and development, the aims of our research are not only to continue to increase crop yields, but also to develop improved tolerances to diseases, drought and environmental stresses.





# BARENTS - The ideal beet for biogas

## – combining high yield and high quality

Barents is the first Strube sugar beet for biogas to be introduced to the UK because it offers the ideal characteristics for energy production.

- High dry matter yields of high quality substrate for gas production
- High quality plants with very large tops
- Clean well-shaped low-tare roots for easier harvesting
- High quality seed for the best results

The tables below show the performance of BARENTS against the leading energy beet varieties in Danish National trials 2013 of Beet for Bioenergy.



### Barents delivers high dry matter from roots and tops with superior sugar content

Variety	Tolerance <sup>(1)</sup>	Root Dry matter (%)	Root Dry matter yield (T/ha)	Relative Sugar Content (%)	Yield of Fresh tops (T/ha)	Top Dry matter yield (T/ha)	Dry matter yield of Root + Top (T/ha)
Gerty KWS	RT	21.4	21.36	90.4	42.5	5.80	27.16
<b>BARENTS</b>	<b>RT</b>	<b>22.5</b>	<b>20.20</b>	<b>100.0</b>	<b>48.3</b>	<b>6.73</b>	<b>26.93</b>
Cindy KWS	RT	21.9	20.59	96.9	40.6	6.22	26.81
Debby KWS	RT	22.3	20.15	98.4	47.1	6.63	26.78
Leony KWS	RT	19.9	21.49	87.5	38.1	5.29	26.78
Danny KWS	RT	22.3	19.74	95.7	46.0	6.88	26.62
Becky KWS	RT/NT	22.6	19.71	98.0	38.8	5.81	25.52
Magnum	none	19.7	19.66	82.3	43.1	5.83	25.49

<sup>(1)</sup> RT: Rhizomania tolerant

NT: Nematode tolerant

Red indicates less favourable

### Barents offers well shaped low-tare roots for easier harvesting

Variety	Dirt tare (as % of fresh weight)	Dirt tare (g/kg root dry matter)	Root groove (1-9) <sup>(2)</sup>	Tendency to branch (1-9)	Root above ground (mm) <sup>(3)</sup>	Bolters per thousand plants	Rust infection
Gerty KWS	4.1	191	4.3	5.8	69	0.0	0.8
<b>BARENTS</b>	<b>3.1</b>	<b>146</b>	<b>4.3</b>	<b>6.4</b>	<b>64</b>	<b>0.1</b>	<b>0.5</b>
Cindy KWS	2.8	129	4.3	6.0	77	0.0	1.5
Debby KWS	4.9	230	3.9	5.7	56	0.6	2.0
Leony KWS	2.9	137	3.5	6.3	87	0.1	1.0
Danny KWS	3.8	175	3.9	6.6	51	0.0	0.3
Becky KWS	5.0	232	4.5	6.5	61	0.0	0.0
Magnum	3.5	162	4.5	6.2	90	0.1	0.5

<sup>(2)</sup> Scale 1-9: where 1 = deep root groove / greater tendency to fanginess, 9 = no root groove / no root branching

<sup>(3)</sup> It is Strube's contention that the optimal crown height above ground is 60-70 mm which can give reduced harvest losses. More than 80 mm will often have an adverse effect that can lead to crop losses.

Red indicates less favourable

Seed supply by Elsoms



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