

## Biogas and biofertilizer from a ton of raw material

The table below illustrates possible resource management for methane fermentation of Renewable Organic Material in a local high-tech biogas plant. The method is called OSAD (Optimum Solids Anaerobic Digestion) and uses substrates with a water content of about 70% instead of 90 - 97%. The method is included in SBRS (Sustainable Biological Recycling System) together with BIO-H<sub>2</sub>O for biological treatment of greywater.

Energy losses during methane fermentation are estimated at 30% and can be reduced with technical improvements. The losses in internal combustion engines, on the other hand, are permanent.

Due to lack of real data, estimates are used. All data need to be substantiated with documented experiments. Then innovations will be used that will reduce losses throughout the chain from the origin of the raw material, collection, transport, pre-treatment, treatment, and handling of two valuable products: biogas and biofertilizer adapted for cultivation.

Digitization of SBRS is necessary for resource efficiency.

Substrate	Energy	Biogas	Biofertilizer	Losses	Combustion engine	Electric motor
kg	kWh	35%	35%	30%	35% in biogas	30% electricity
1 000	3 000	1 050 kWh	1 050 kWh	900 kWh	1 050 kWh	315 kWh
		30% electricity	NPK		30% efficiency	90 % efficiency
		315 kWh	104 SEK		315 kWh	315 x 0,9 = 283,5 kWh
		65% heat	org. carbon		70% losses	65% heat
		682,5 kWh	97 kg		735 kWh	682,5 kWh
		5% losses	CO <sub>2</sub>			5% + 3% losses
		52,5 kWh	356 kg			52,5 + 31,5 kWh

Table 1: Resource efficiency at a high-tech biogas plant. Estimates and assumptions need to be verified. With the help of methanogens, biogas is produced with 1,050 kWh of bioenergy in methane and the same amount of bioenergy remains in the biofertilizer that is adapted for cultivation.

The bioenergy in the methane of the biogas is converted into electricity and heat. The heat can be converted to cooling if needed. Electricity can be used throughout society. Community planners must ensure that the heat / cooling is utilized to the maximum with minimal losses locally.

Internal combustion engine is compared with electric motor. Upgrading of biogas to vehicle fuel is missing in the table. During the upgrade, a small part of the biogas' energy is lost, at the same time external energy must be added.

Electric cars have a high efficiency and therefore 65% of the biogas' energy can be used for heating and / or cooling, depending on the need.

Material recovery can be estimated as follows: 97 kg of organic carbon is returned to cultivated land, which corresponded to 356 kg of carbon dioxide. Only the value of nitrogen, phosphorus, and potassium (NPK) in the biofertilizer can be calculated.

The value of other plant nutrients, microorganisms that increase biodiversity and the value of soil fertility should be included in ecosystem services by environmental economists.

Investments in SBRS are costly in the short term but very profitable in the long term.