Experiences with anaerobic digestion in the Czech Republic

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Abstract :

There are basic parameters of 50 biogas plants planned to be constructed in 2008 – 2009 presented in this article. The biogas plants are viewed from the aspect of structural design, installed electric power, annual production of electric energy and quantity and range of treated organic matter. The result of the processed data is an average biogas plant which is plant with two-stage fermentation and circular steel concrete fermenters. It produces 5,55 GWh of electric energy yearly at the average electric power of 690 kW and 8000 motohours of the year operation of cogeneration unit. During year it treats 22 000 tonnes of organic matter, especially corn and grass silage, livestock slurry and other waste of vegetable production or food processing industry

1. Introduction

According to the data of Ministry of Industry and Trade the total gross electricty production from renewable energy sources (RES) was 3,52 TWh in 2006 in the Czech Republic, which represents 4,91 % from the total gross domestic elektricity consumption [1]. The highest share from the total amount of electric energy produced in RES (100%) forms electric energy produced in hydroelectric power plants (72,5 %). 20,8% of electric energy is produced by combustion of biomass. Electric energy from wind power plants, from combustion of municipal wastes and solar energy power stations represent together less than 2% share. ***The production of electric energy from biogas had a 5% share in the total of RES in 2006.***

The Czech Republic set the target to cover 8% of gross domestic consumption of elektricity from RES by 2010. It means to increase production from RES by 3 TWh in comparison with 2006. State hepls the investors by the form of higher redemption price of elektricity produced from RES to achieve this objektive. In the case of biogas produced from agricultural materials the redemption price of electric energy is 3,90 CZK/kWh (0,15 Euro cent) for 2008 and for biogas from waste materials the price is 3,30 CZK/kWh (0,13 euro cent). In addition, investors have a posibility to obtain an investment grant up to 46%.

In the case of biogas plants the applications for grants for building about 100 biogas plants are expected. The plants should be built in 2008 – 2009. On the basis of personal discussions with potential investors and from accessible data [2] basic parameters of 50 planned biogas plants are described.

2. Characteristics of planned biogas plants

Structural design

In the most of plants their construction is intended to be with two-level fermentation with two or more cylindrical vertical fermentors. Except classical disposition of two independent fermentors connected in series also combinations 1+2, 2+1 or 2+2 are present.

Annular disposition „circle in circle“ in reinforced concrete is rather frequent. In this type lower self-consumption of heat and costs for izolation are pointed out. Gas holders are plastic, integrated on the second, eventually on the first level.

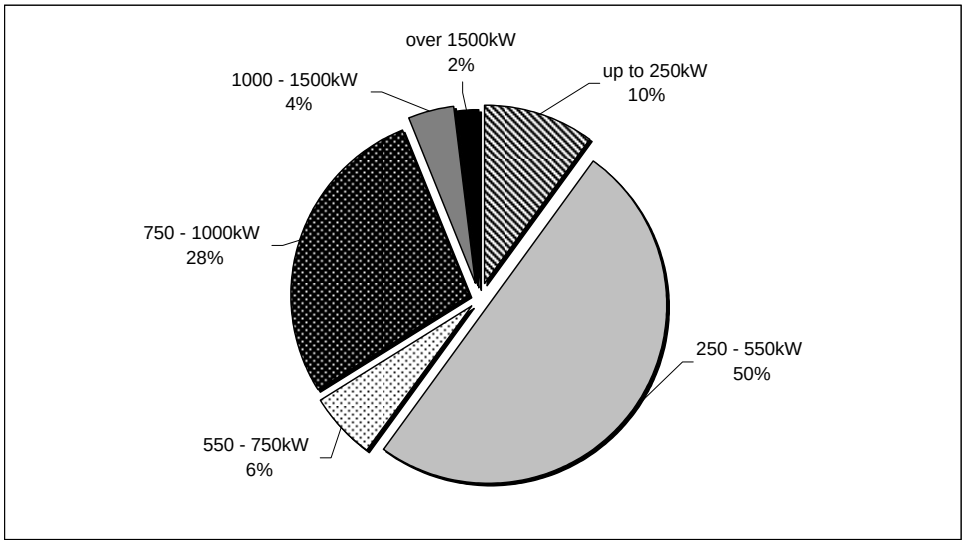
The second most intended type is two-level fermentation with horizontal lengthwise fermentor as the first level. These fermentors are stirred with slowly going stirrer placed lengthwise in the fermentor. In comparison with the previous type the suppliers mention lower elektricity consumption for stirring and a possibility of the higher material loading of the first level.

Fermentation temperature in the first level is maintained in the mesophilic range of 38-41°C. The heat from cogeneration is used for heating of fermentor. The heat transfer in the reaction mixture is executed by internal exchangers – heating serpents (stainless steel, plastic). The share of heat from cogeneration represents 40 - 50 % from the energetic value of biogas. The self-consumption of heat of biogas plants is indicated between 20 and 30 % from the available amount. In some cases the use of excessive heat is envisaged to be used for heating of near service or administrative building. Only in two cases higher than 70% use of heat is planned to be used for heating of improper entities (for example spa).

Installed electric power

Biogas plants were divided into several groups according to supposed electric power (graph 1). Planned electric power varies in the range of 100 – 3200 kW at these analysed biogas plants. Half of the plants are intended to have performance from 250 to 550 kW. The second most frequent plants are ones with performance of 750 – 1000 kW. In the most of cases the production of electric energy is aimed to be in cogeneration units on the basis of spark ignition gas engines. Cogeneration units with compression ignition engines using ignition flash in the form of rape oil for burning initiation are the minority part.

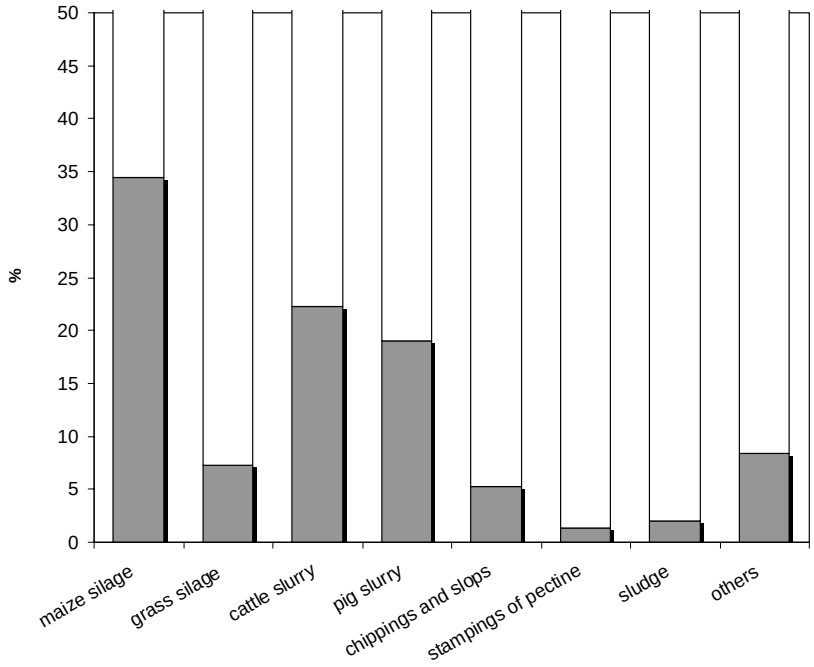
Efficiency of biogas conversion to electric energy varies in the range of 36 – 41,5 %. The use of cogeneration unit for 8000 motohours yearly, i.e. 91% use of the annual fund, is considered to be the most frequent. The self-consumption of electric energy of the biogas plants is 4 – 8% of the produced electric energy.



Graph 1: Biogas plants according to the installed electric power

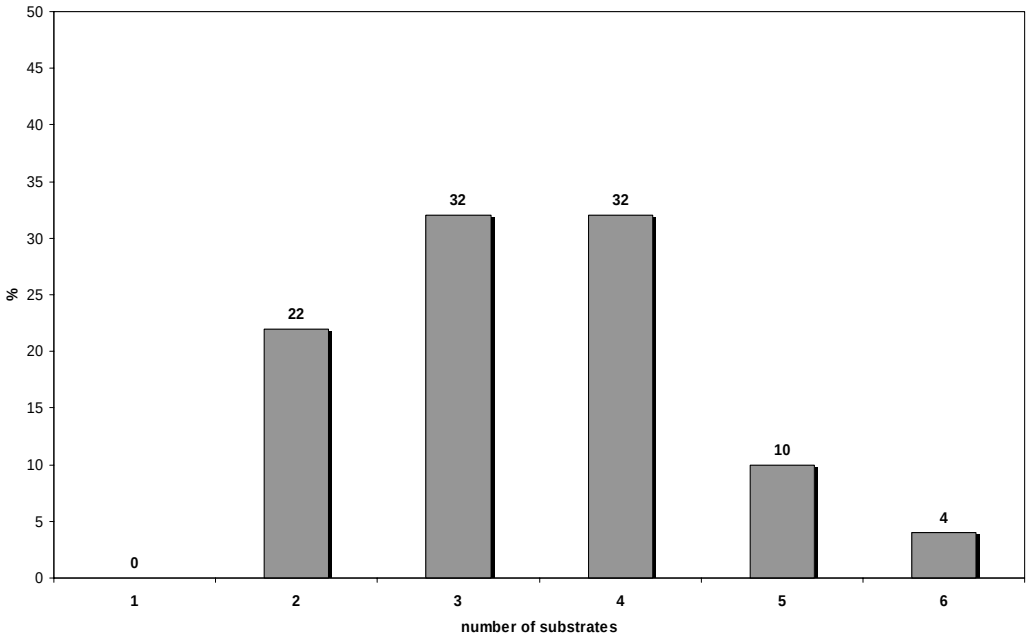
Used materials

The survey shows that 28 types of materials – substrates are intended to be treated. The highest weight share has maize silage (35%) followed by cattle slurry (22%), pig slurry (19%), grass silage (7%) and chippings and slops constitute 5%. These 5 substrates represent 88% weight of all the treated substrates. The rest comprises various wastes especially from the food processing industry and vegetable production. ***Except for the maize silage exclusively waste materials are treated.***



Graph 2: Intended treated materials

None of the planned biogas plants intends treating only one material, but always cofermentation of two and more materials is planned. Treating of three substrates (1+2) is expected at 22% of the plants, four and five 64% plants and five and more 14%. The most important material is maize silage, completed by grass silage, cattle slurry and pig slurry.



Graph 3: Number of the treated substrates - cofermentation

3. Conclusion

A sample of investment projects of 50 biogas plants planned to be built in 2008 – 2009 was treated. ***From the technical point of view it will be standard "west" technologies.*** On the basis of obtained information it is expected that suppliers of the technologies will be mostly companies from Germany and Austria either directly or via representation. Except for building operations domestic producers of cogeneration units have high competitive advantage in comparison with foreign producers with regard to price/ performance proportion.

Installed electric power of the plants varies in the range of 100 – 3200 kW. Almost half of plants evisages performance about 500 kW. An average electric power of all the plants is 690 kW. Compared to Germany where an average electric power of biogas plants was 310 kW in 2006 it is more by 100 % [3]. Higher average power is done by greater size of agricultural farms in the Czech Republic in comparison with western Europe.

An average biogas plant with electric power 690 kW produces more than 2,5 millions Nm3 of biogas annualy at an average methan concentration of 55%. It corresponds to 13,9 GWh of energy per year. It is production of 5,5 GWh of electric energy per year in condition of 8000 motohours of the run of the cogeneration unit with electric efficiency about 40%.

An interesting finding is a ***high coefficient of an annual use of energy source (Ky)*** at the planned plants. Coefficient indicates share of produced elektricity in the year to the installed electric power and it is relative to 8760 hours. The coefficient was calculated from the statistic data [1] of Ministry of Industry and Trade for particular RES for 2006. It varies in dependence on its size in the range of 0,28 – 0,43 in the case of hydraulic power plants and it is 0,11 – 0,13 at wind power plant and solar energy power stations.

The coefficient is 0,92 for the planned biogas plants, which is 92% use of the power during the whole year. For comparison, in the case of nuclear power stations the value is 0.82.

2006 [1]	**Installed electric power (MWel.)**	**Year electricity production (GWh)**	**Ky**
Hydro power plants in total	1028,5	2 550,7	0,28
From that up to 1 MW	106,4	333	0,36
1 - 10 MW	169,3	631,4	0,43
over 10 MW	752,8	1 586,3	0,24
Solar energy power stations	0,2	0,2	0,11
Wind power plants	43,5	49,4	0,13
Biomass	40,0	175,8	0,50
Biogas – planned plants	**0,69**	**5,55**	**0,92**
Nuclear power plants			***0,82***

The running of an „average“ biogas plant with the performance of 690 kW needs 22 000 tons of material yearly. In all the cases cofermentation, i. e. treatment of more than one substrate, will be used. In 88% 2 – 5 types of substrates will be treated. In total 28 various types were mentioned. Maize silage is the most frequent substrate and it is the only one grown with this aim. Waste materials from the livestock breeding, vegetable production and food processing industry are treated as well.

Year consumption of the planned construction of 100 biogas plants is 2,2 millions tons of substrates, from that 760 000 tones of maize silage. At the average yield of 35 tons maize silage per hectar it represents about 22 000 hectars of silvicultural areas, i.e. about 10% of the existing land area used for the production of maize silage. In the case of the other substrates it is the best economical ans energetical valuation.

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4. References

[1] Statistika využívání OZE v ČR v roce 2006, MPO ČR 2007 http://www.mpo.cz
[2] http://eia.cenia.cz
[3] Hauthal T., (2007): Aktuální aspekty využití bioplynu v Německu. In: Sborník konference: Výstavba a provoz bioplynových stanic, 25. - 26. 10. 2007, Třeboň (ISBN 978-80-254-0422-5)