LOCAL RESOURCES IN THE SYSTEM OF POWER SUPPLY TO THE RURAL REGION

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Abstract. At the moment, the potential of energy resources has been studied substantially; however, the extent of their utilization is rather small. The complex approach in research on the optimization of the system of power supply provides the possibility to assess ways to improve the issues regarding the safety of power supply, energetic independence, and economic effectiveness. With the help of such traditional, thermal and up-to-date bioprocesses as gasification, bio-gasification – the extraction of biogas and cogeneration, this paper evaluates the utilization of biomass of various origins and solar energy within the scope of the regional energy centre.

Keywords: biomass, biogas, cogeneration, energy centre.

Introduction

In Latvia, similarly to other Central and Eastern Europe countries that have experienced transition to the market economy, the consumption of energy to a unit of gross national product is too high compared to the developed countries. The goals of the Basic Statements of Latvian Energetic Development 2006-2016 are to facilitate self-provision of the primary energy resources, ensure access and sufficiency of energy to the citizens by improving the infrastructure of the energy supply and by widely implementing energy efficiency efforts in the consumer sector; maintain and increase the effective utilization of renewable energy resources and energy production in the process of cogeneration; support further research in the directions indicated in the Basic Statements. Latvia has ratified the UN Framework Convention on Climate Change as well as signed the Kyoto Protocol assuming the obligation that gas emissions of the greenhouse effect from 2008-2012 will not exceed 92 % of the level in 1990. Increasing the energy effectiveness through wider utilization of the renewable resources is the main means to achieve these goals.

The exploitation of the local renewable resources (biomass, sun, wind) is currently influenced by their seasonal availability – the vegetation period for plants, sun – in the warm period of the year, wind – the regional climatic conditions. Biomass is one of the most essential local resources that for a long time has traditionally been used in heat supply. Latvia is endowed with substantial wood resources that can also be utilized for energetic purposes. As the issue concerning the local energy resources is becoming more discussed and also due to the restructuring of agriculture, the potential utilization of grass plant biomass (the "green mass") and the mass from daily waste is currently being evaluated.

Matherials and methods

The research has employed statistical material [1], the findings of other authors [2-6], expert opinions and our previous findings [7-9], as well as Government documents [10, 11]. As the technology for obtaining energetic wood and its utilization in the production of heat and electric energy have been widely researched, we focused our attention on the problems of obtaining the green mass and utilizing it in the rural regions. For this reason, conventional calculation methods that yield numeric results are used.

Results and discussion

Compared to wood mass, the fraction of the dry matter in the biomass of grass plants is significantly smaller, it changes from 12-25 % depending on the climatic conditions in the vegetation period, in the harvest period and on other environmental factors. In the plantations of energetic wood, the biomass of the main cultures (sallow, willow, asp, poplar) forms within a cycle of 2-4 years, the average growth of the dry matter in the biomass ~10 t ha^{-1} per year, for the one of grass plants – it can reach 10-12 t ha^{-1} per year as it is available several times during the vegetation period. The waste from cattle-breeding, food manufacturing and communal households forms gradually throughout the year. The effectiveness coefficient for grass plant biomass (the energy generated with the biomass over the energy spent in producing the biomass) is within the range of 2-6, for instance, 2.9 for corn grain, 4.0 for corn ensilage, and 5.0 for grass plant biomass.

Table 1

Mass and the power-intensity of grass plants

Green mass, t	Dry matter, t	MWh
Min 14	2	14
Max 60	9	60
On average 40	6	40

The low content of the dry matter is one of the reasons that require new technologies, therefore the energetic potential and availability of this "green mass" is currently not entirely appreciated.The effective utilization of biomass can be achieved through the preliminary mechanical treatment – fractioning, separating the "green juice" (water) and refining it into the biogas process, but the leftovers with the dry matter ~50 % is an intermediate product for further processing which will yield the fuel of the nearest future – agro granules.

Table 2

The comparison of the local fuels

	Humidity, %	Ashes, %	Power-intensity, MJ kg^{-1}	kWh kg^{-1}
Wood granules	11	1 ..2	16.9	4.69
Wood briquettes	8 ….12	<1	17.0	4.72
Green woodchip	50	2 ….5	8.2	2.27
Straw	15		14.3	4.00
Daily waste			15.0	4.17

The results of our laboratory experiments and the previous experience regarding the utilization of the green mass to produce plant protein allow us to conclude that utilizing the green mass to create local energy sources is a more simple way from the perspective of both technology and the choice of devices, and no difficult problems are expected in the respective process of power generation. There are certain energy losses in the process of creating the energy sources – utilizing forest biomass to produce granular fuel will results in losses of 5-10 %, producing second generation bio-fuel – 50-55 %; currently several of the biogas devices do not utilize the second energy source, heat, which is obtained during the cogeneration process. For instance, the waste deposit area "Getliņi" is utilizing only 20 % of the generated heat. A similar situation concerns the final product of the process – the organic manure that is environment-friendly and easily applied to plants.

An important assessment is needed for the research regarding the resources in the rural region: the optimal territory of the region is 4-5 thousand ha, inhabitants ~ 5 thousand, and the distance from the processing centre to the extraction sites of the biomass resources is 20-30 km. It is essential to evaluate and determine a stable consumer for the created energy sources in a period of twenty-four hours, a season and a year.

One of the optimal solutions is a regional energy centre with a device for the thermal gasification of the hard/dry biomass, with bio-gasification of liquid organic waste in a biogas device, and the utilization of the solar thermal energy in the processes of the production of fuel granules and organic manure.

The turnover of the products and energy in such a regional energy centre is demonstrated in Fig. 1-4.

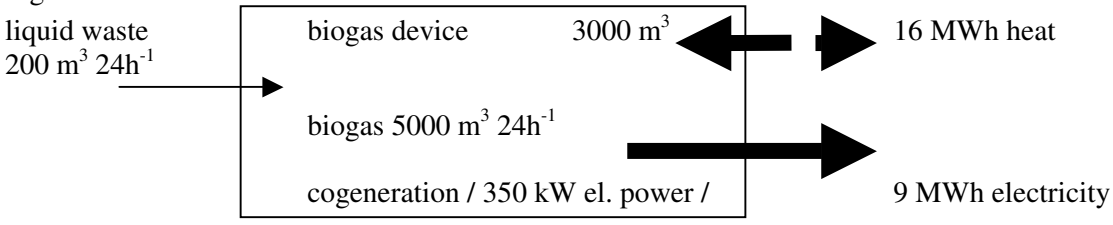

Fig. 1. **24-hour turnover of the products and energy in the procession block of liquid waste**

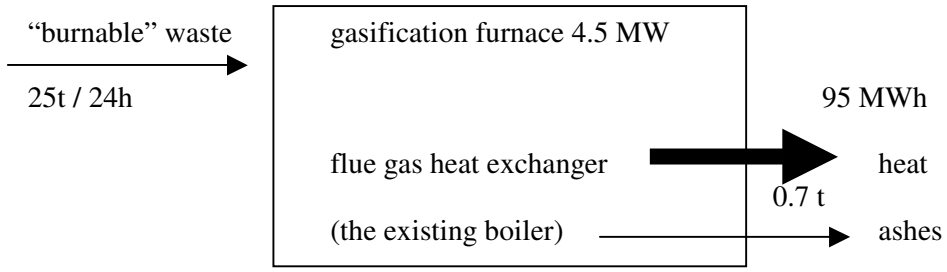

Fig. 2. **24-hour turnover of the products and energy in the procession block of burnable waste**

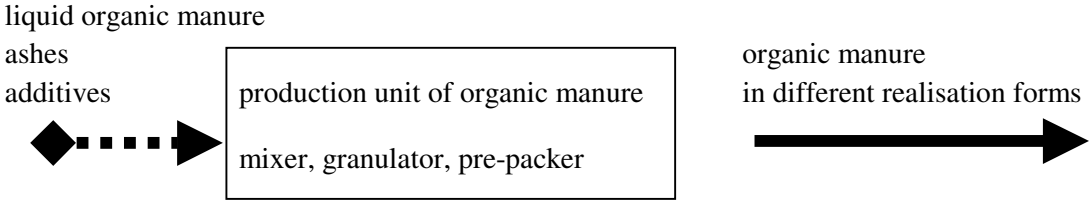

Fig. 3. **Scheme of the procession block of organic manure**

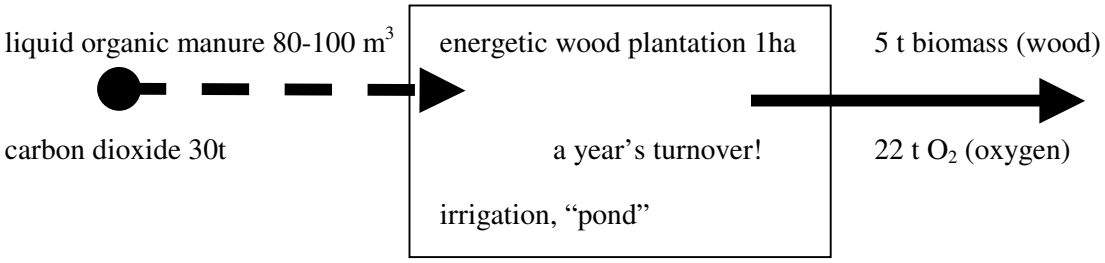

Fig. 4. **Recyclization of biogenic elements and the extraction of new biomass 1 ha in a year's turnover**

Conclusions

1. The energetic effectiveness of biogas and thermal processes is enhanced by their combination in an integrated power supply system.
2. Regional energy centre – the utilization of local resources to create energy sources, a power system that is decentralized and independent from external suppliers.
3. An energy centre is an essential element for the local infrastructure and sustainable regional development with a respective contribution to finding the solutions to environmental and social problems (new job places).
4. With the help of the new generation technologies, one can effectively utilize also various agricultural, cattle-breeding and communal household waste – dung, straw, daily waste and other available material of organic origin, apart from the traditional forest biomass.

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