OVERVIEW OF BIOMASS USAGE IN COMBINED HEAT AND POWER UNITS

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ABSTRACT

This article deals with overview of biomass usage in combined heat and power units (CHP). The aim of the paper is to explain fundamentals and basic properties of these units and heat and power generation with these units. Article deals also with basic requirements for connecting these blocks into power grid and differences in operation between decentralised CHP units and centralised power plants. In beginning of article the authors devote about basic principles of extraction fuel from biomass and with processing of biomass. Decentralised units are introduced also on examples of on-site solutions of these units.

1. INTRODUCTION

The requirement for energy is for long time growing worldwide due to industry and economic development in many countries on one side and the growth of population on other hand. This has to be met with in an environmentally friendly solution. There is a rising interest to develop sustainable and renewable energy sources. Cogeneration is nowadays also receiving a great deal of attention worldwide to meet part of the energy demand due to its overall high energy utilization efficiency and reduced pollutants and greenhouse gas emissions. Dealing with the current global situation, there is no single energy source, which can satisfy this requirement. In this article are discussed contributions of combined biomass based power generation systems, cogeneration and its possible allowance to power generation. Due to the growing energy demand, there is a great role for sustainable energy systems, cogeneration systems and renewable energy sources to contribute and meet energy demand in an environmentally friendly way. [1]

Due to mentioned facts, one of base goals of energy policy of Slovak Republic is usage of renewable energy sources. The biggest potential of usage these sources in Slovakia has biomass. It uses almost any substance of biological origin for generation of thermal power or electric power. Combustion of pure biomass has advantages, that they does not pollute the environment, because low amount of carbon dioxide which is created by combusting is equal to amount which can same plants absorbs by their grown. In Slovakia is possible to obtain 40 453TJ by year from biomass and that is 46% of whole potential of renewable sources. [2]

Biomass is plant matter such as trees, grasses, agricultural crops or other biological material that can be used as a solid fuel, or converted into liquid or gaseous forms, for the production of electric power, heat, chemicals or fuels. Figure 1 clarifies the bio-energy chain from biomass origin to energy usage. [3]

Biomass energy, one type of renewable energy, is important from two perspectives: firstly, from the perspective of climate change and energy; and secondly, from viewpoint of a recycling society. Biomass energy is superior to other forms of renewable energy sources in its ease of storage and transportation. Promoting the use of biomass energy has potential to mitigate climate change, offer a sustainable energy supply, and achieve a sustainable and recycling social system for the future.[3] Cogeneration is the simultaneous production of electric power and process heat from the same fuel source in a system and is often also referred to as combined heat and power system. These systems can get very high overall conversions efficiencies. Cogeneration systems can result in a significant reduction in emissions including CO2.[1]

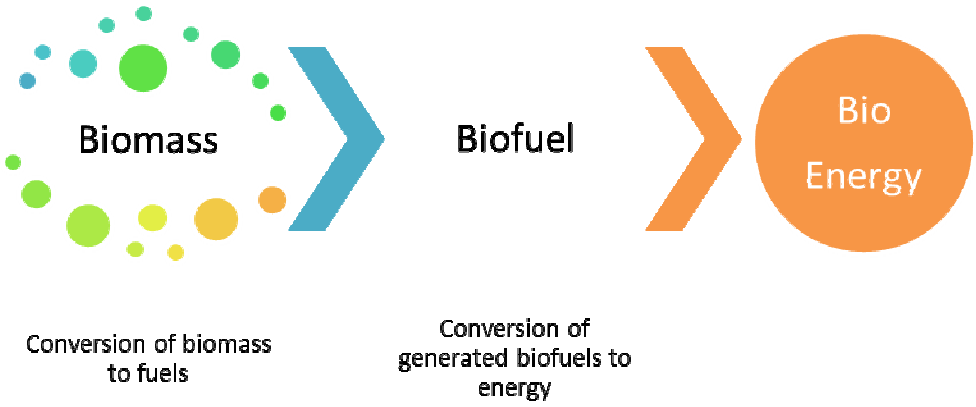

Figure 1 – Energy chain of bio energy.

2. TREATMENT OF BIOMASS

In general can be types of biomass divided into forest (lops, roots, bark, sawdust), agricultural (cereal straw, animal excrements etc.) and communal waste biomass (solid combustible waste, landfill gas, sewer gas). Biomass conversion is about converting solid biomass into form that is usable for energy generation. Biomass conversion technologies can be divided as is showed on figure 2.

These methods are used to convert solid biomass feedstock into a form usable for energy production, because solid biomass can be utilised in direct combustion methods only.

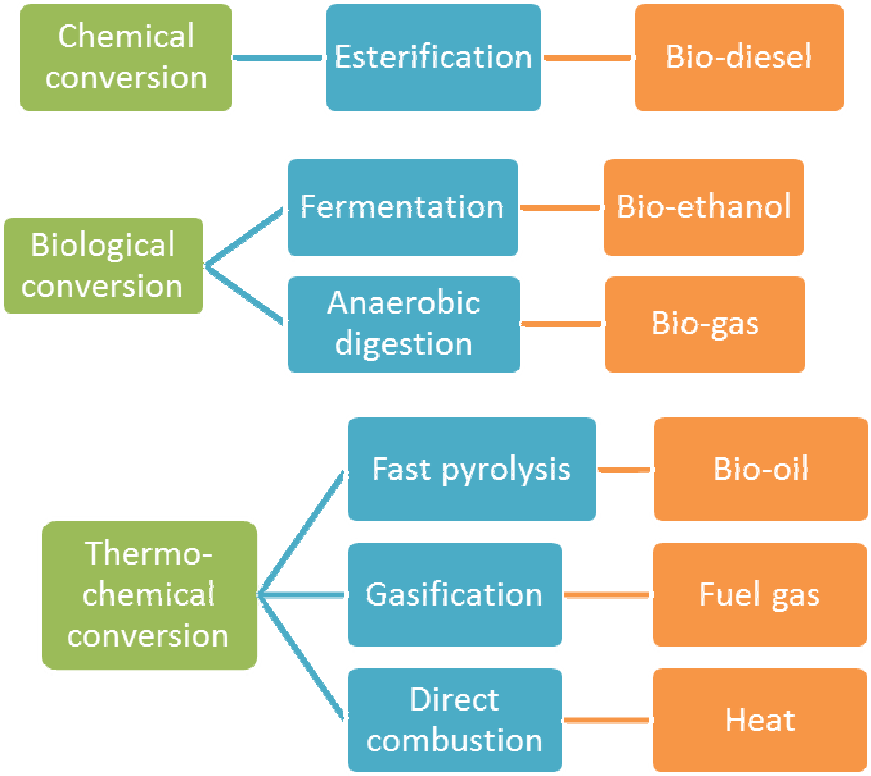

Figure 2 – Overview of main technological routes [3]

3. USAGE OF BIOMASS IN COMBINED HEAT AND POWER UNITS

Combined heat and power generation units can produce heat and power in same time. As a fuel can be used natural gas or bio gas. Except these units based on gas combustion engines can be for process of combined heat and power generation used also other technologies. For centralised sources with higher installed power are often used turbines. Less used are technologies based on organic Rankine cycle or steam engine [2][4][5].

CHP unis are suitable for distributed generation. Power of these units can be from 10 kW to few MW. Chemical energy of biogas is changed in CHP unit to 30% of electric power and to 50% of heat.

It has to be noted, that from this reason is important to use this units only for combined generation. By optimal consumption of generated electricity power and heat we can obtain efficiency of these units over 80%.

4. ON-SITE APPLICATION OF CHP UNIT

As was mentioned before, due to possibility of small size of combined heat and power units it's possible to use these units on-site directly at plant (for example lumber mill). The plant process begins at truck dump ramp, where the wood slash from truck is dumped at 60 degree angle. For operation of generator it takes about 30 trucks of biomass daily. Storage system was designed to hold biomass to power generator up to 12 days. After biomass enters the system, the material is moved via conveyor to the fuel storage building. Another covered conveyor delivers residual material created by lumber mill and his manufacturing process. Included materials are barks, sawdust and planer shavings from the milling process which are transported to storage. Material is divided by his humidity and held separately. It is necessary for mixing of efficient combination for combusting. Except this, it is also necessary to filter certain size of wood bark, which can be sold separately and more viable on open market. [7]

This biomass used in power plant travels on transport belts from storage to the boiler. Energy created by combustion process creates steam used to spin steam turbine generator. Problem of decentralised CHP units can be that they are often remotely located from urbanised areas. [7]

Figure 3 – Truck dump at CHP plants [7]

Therefore overall efficiency is raised by secondary exhaust steam, which is extracted from the steam turbine and transported to wood dryers. Standard dryers are powered by natural gas so overall efficiency is raised. In case of usage CHP unit in other area it is considerable usage of this steam to heating for residential zones. [7]

Except usage of biomass in plants it is also possible to use landfill gas. In community areas, municipal solid waste which is collected and processed by the municipality is mostly owned by this municipality. Landfill gas is the gas that is released when waste is decomposed over time. By this process substances like carbon dioxide, methane, benzene, vinyl chloride and toluene are created.

Main factor which affects this production are temperature, composition of waste, pH and age of waste. Mechanism of processing of this landfill gas in CHP units is similar to other types of biomasses, because combustion of these bio fuels is principally same. Difference is only at transportation of fuels. [8]

5. CONCLUSIONS

One of biggest advantage of biomass is that can be obtained not only by targeted production of crops, but also like waste of livestock production, wood production and many other agricultural types of production. Biomass can be processed for specific use by some ways, such as biological, chemical and thermo-chemical conversion. So we can obtain fuels like bioethanol, biogas, biodiesel, bio oil and fuel gas. Every this product can be used in specific device like fuel and so we can get optimal efficiency of device.

One of possibility how we can utilize fuel products from biomass is combined heat and power unit. Advantage of these units is high efficiency up to 80%, which can be obtained by combined heat and power generation. This is also one of disadvantages, because usage CPH unit only like source of electric power is ineffective. So CPH unit must be placed near by some heating circuit where can be this heat energy used. These units are thus suitable for heat plants, where heat circuits are located nearby heat plant.

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