IOP Conf. Series: Earth and Environmental Science **159** (2018) 012038 doi:10.1088/1755-1315/159/1/012038

Technical Problems of Wood Chips Utilization

I Czupy[1], F Szűcs[2] and A Vágvölgyi[3]

1 Associate Professor, University of Sopron, Sopron, Hungary
2 Sales Manager, Vértesi Erdő Ltd, Tatabánya, Hungary
3 Lecturer, University of Sopron, Sopron, Hungary
E-mail: czupy.imre@uni-sopron.hu

Abstract. The Hungarian renewable energy potential based on biomass. Wood biomass constitutes the large part of the raw material of operating heating plants. A significant part of raw material comes from forestry as firewood and harvesting losses. A lower part stems from short rotation energy plantation (currently only a few thousand hectare energy plantation are in Hungary), and attempts were made to utilize biomass production of non-conventional areas, as well (e.g. biomass from abandoned land, or located next to line-based facilities). The wood based biomass is utilized by the heating plants mainly as wood chips. This technology proposes more challenges: moisture content decisively influences the fuel value; optimization of moisture content depends on storage; combustion technique respect is important the fraction distribution etc. Our research based on the examination of these factors and the demonstration of the problems of wood chip management.

1. Introduction

The energy demand has shown a slow growth in Hungary. The country's dependency on energy import is quite high: in 2016th year, the domestic energy production was 424 436 TJ, while the import was 804 160 TJ, which means that the value of energy import is more than 65%. The share of the renewable energy consumption is around 9% and the solid biomass is around 82% (Figure 1) [1].

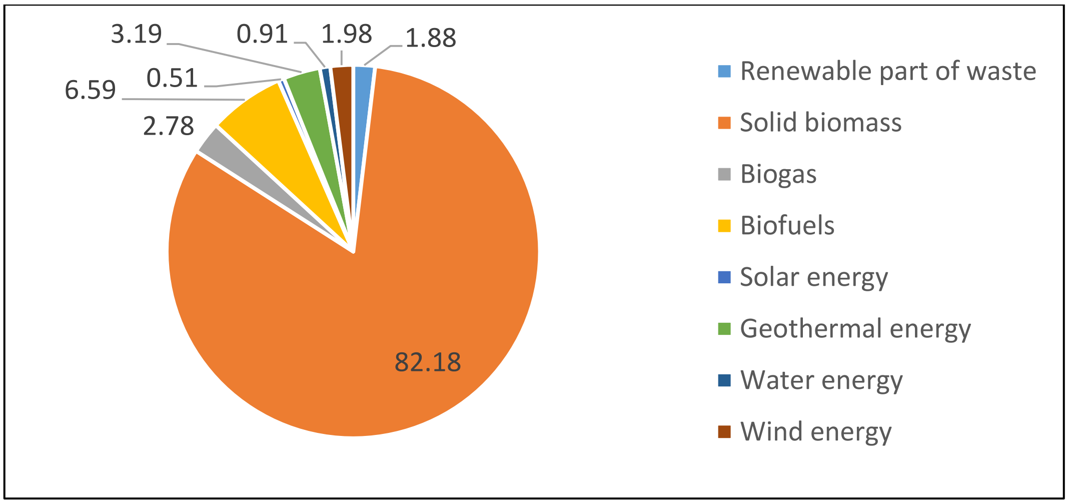

Figure 1. Primary renewable energy utilization in Hungary (%, in 2014) [1].

The Hungary's policy on renewable energy based on the EU strategies. The European Union aims to achieve three main goals by 2020:

- reducing the greenhouse gas emissions by 20%;
- reducing the energy consumption by at least 20%;
- achieving a 20% share of renewable energy in the global energy mix.

Hungary expected to reach at least 13%. In 2010th year the Hungarian Parliament adopted Hungary's Renewable Energy Utilization Action Plan extending the minimum required value of the share of the renewable energy in the global mix from 13% to 14.65%.

The main aim is to increase the use of renewable energy sources in Hungary to 186.3 PJ by 2020, including biomass with the target of 130.8 PJ [2].

Hungary’s biomass resource estimated at 350-360 tonnes, representing two thirds of the renewable energy sources. Only one sixth of this resource currently utilized. Dendromass, i.e. wood-based biomass, constitutes a large part of biomass [3].

According to *Molnár* et al. [4], wood used for energy purposes may originate from four sources:

- the firewood of the traditional forest management (public or private sector);
- harvesting losses produced during tree utilization;
- wood industry by-products;
- timber of energy tree crops that is primarily utilized as wood chips (Figure 2).

Figure 2. Dendromass sources (Photo *F Szűcs*).

The benefits of dendromass utilization:

- sustainability;
- stability of the generation capacities;
- low production costs;
- easy manageability and industrial use;
- high calorific value (on average 13 MJ/kg, in case of water content of 25-30%);
- low ash and sulphur content;
- increase in rural employment.

The available quantity of dendromass examined several times. According to Molnár et al. [4], in Hungary ca. 3.5 million tonnes per year provided for energy purposes. The data of National Food Chain Safety Office showed that in recent years the amount of woodcut was 7.5 million gross m3 per year on average, which is 60% of the current growth (Figure 3).

IOP Conf. Series: Earth and Environmental Science **159** (2018) 012038 doi:10.1088/1755-1315/159/1/012038

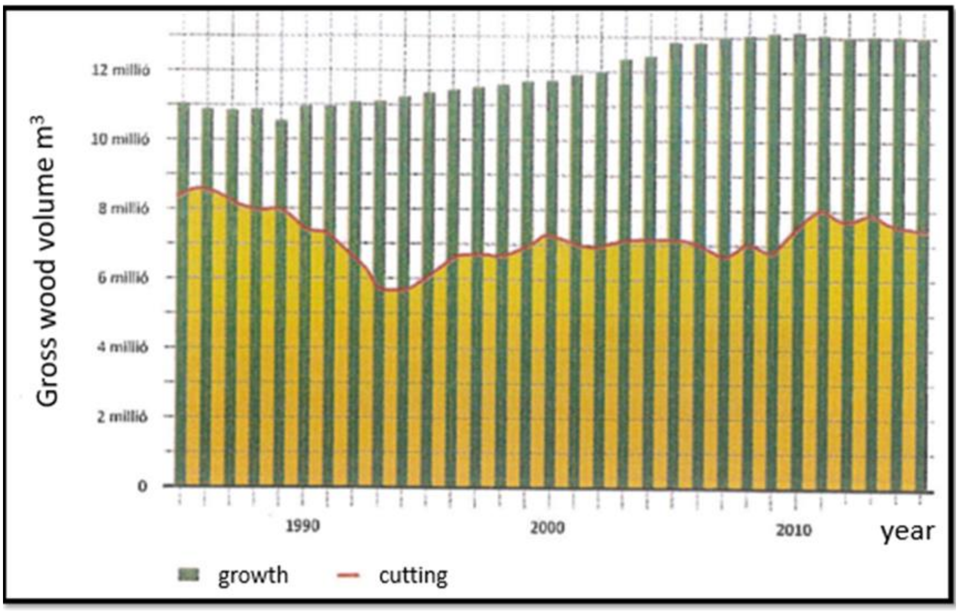

Figure 3. Growth and gross wood cutting in 2015 [5].

2. Utilization and problems of dendromass at Tatabánya power plant

The natural gas-fired power plant was converted to a wood chip-fired one in 2015-2016. The net value of the investment was HUF 6.2 billion. The total capacity of the fluidized bed technology is 94 MW. A 20 MW hot water boiler and two 37 MW steam boilers produce renewable energy. The power plant provides heat and hot water to 23 500 households and 2000 institutions. The plant utilizes 100 000 tonnes of wood chips as fuel per year on average. Dendromass utilization can reduce greenhouse gas emission by 67 000 tonnes per year. 1 m3 natural gas can be replaced with 2.5 kg wood chips.

In order to make the power plant sustainable, the adequate supply of raw materials has to be provided. Between 01.11.2016 and 04.30.2017 the quantity of wood chips was 69 636.52 lutro tonnes delivered by 2798 trucks to the power plant; the average weight of the trucks was 24.89 lutro tonnes/truck as illustrated in Figure 4.

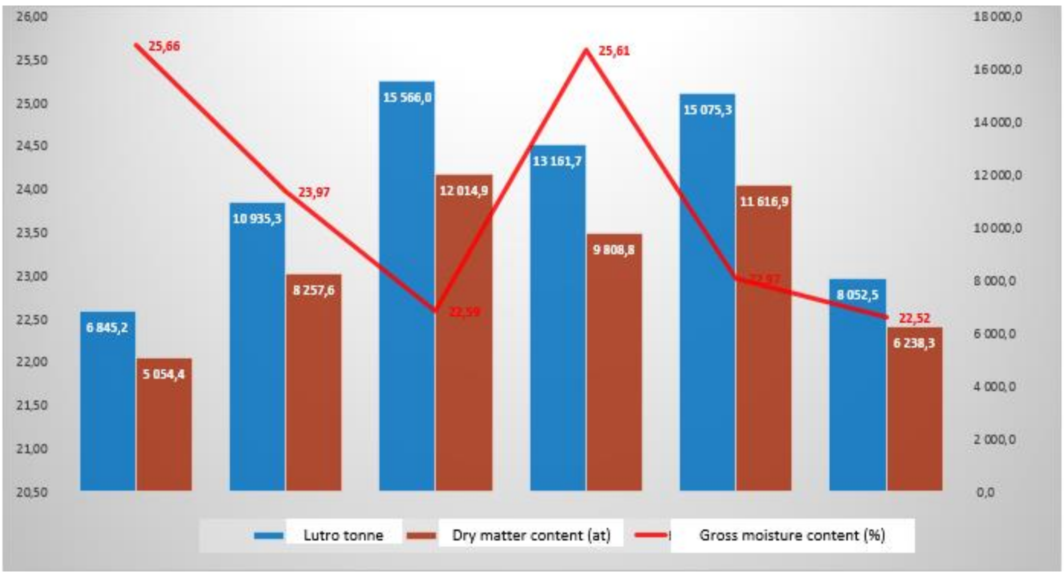

Figure 4. Tatabánya plant delivered dendromass volume and moisture content.

The basic condition of firewood supply is biomass integration. There are 12 members of the integration. In 2005 Vértes Erdő Ltd. launched its biomass program which provides renewable fuel for

Tatabánya Power Plant and Dunaújváros Power Plant in 2017. Thanks to biomass integration, the quantity of wood-based energy fuel marketed by the national forestry is 150 000 tonnes. The integration has currently 27 members, including private and public forestry sectors, out of which 12 are involved in the delivery to the Tatabánya Power Plant. The integration has long-term business benefits for both Vértes Erdő Ltd. and its partners. The supply of materials may come from several sources, e.g. energy tree crops.

The article demonstrates the qualities of acacia as well as the operation. The crop is three years old (2nd sprouting), the average number of sprouts is 5/per stem, the size of the area is 13.28, the production quantity is 609.52 tonnes, the yield is 45.89 t/ha, the average gross moisture content is 27.26%, and the dry matter content is 443.9 atro tonnes.

Figure 5 illustrates the machines and fuel consumption of energy plantation harvesting.

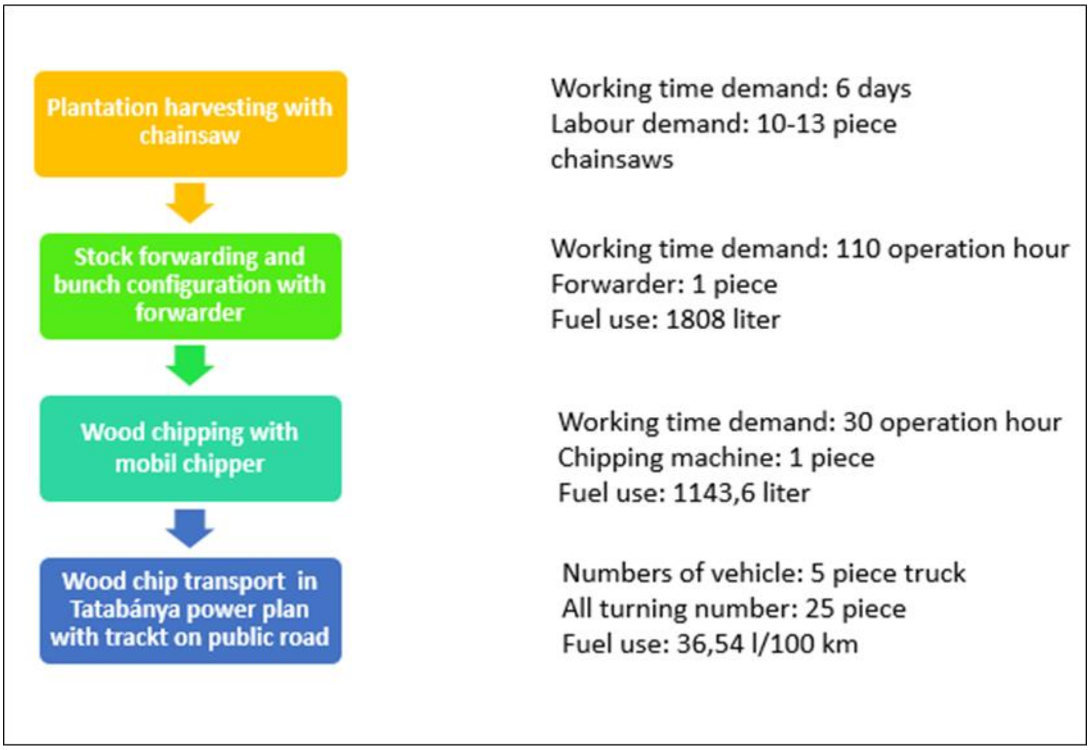

Figure 5. Operations, machines, fuel consumption of energy plantation harvesting.

The adequate water content (under 30%) can be guaranteed only by the management of wood chips.

The storage conditions (the size of chip, the size of the pile, the storage method, the aeration, etc.) affects the quality of wood chip. The moisture content of wood chips is a significant factor, which affects the calorific value and whose quantity has a relation to the temperature of the pile. At the beginning of the storage the moisture content of wood chips is high (ca. 55% in case of poplar chips), which results in a sudden temperature increase in the first phase of the storage. Due to the temperature increase, thermophilic and mesophilic fungi proliferate causing damage to wood and further increasing the temperature (a maximum of around 60% in case of poplar chips) [5].

The fungi can significantly impair the energy content and the quality of wood by the dissimilation of lignin; therefore, despite the decrease of the moisture content that improves the calorific value, wood will not be more beneficial in terms of energy utilization [6]. The fungi damage wood and may be harmful to human health during the storage. These problems cause dry matter and energy losses and have impact on the quality.

Austrian standard ÖNORM M 713 is applied for size classification of wood chips, which distinguishes fine-grade (G30), medium (G50) and coarse wood chips (G100). The most common storage method is G50 due to the simplicity of its utilization. However, research has shown that in case of poplar chips, mainly this size of wood chip generates the above mentioned problems [4].

It is expedient to store wood chips in piles for a short time (maximum 3 months) and to turn the pile roughly every two weeks.

The basic conditions of fuel supply were the increase of delivery capacity and the establishment of a logistics centre. For this purpose, Vértes Erdő Zrt. purchased delivery devices, increased storage capacity and established a logistics centre in Gánt. In the centre, there is a 4000 m2 depot which allows to meet the demand for safe fuel at Tatabánya Power Plant, even under unfavourable weather conditions. The logistics centre is 30 km far from the plant. The conditions of the production and management of wood chips, and of the water content measurement are given; moreover, a 60 tonnes weighbridge is also available.

Quality problems occurred mainly due to the fraction size of the wood chips. The heating system is technologically unsuitable for selecting wood chips that are longer than 120 mm. These separated with Doppstadt SM 620 plus type mobile star riddle (Figure 6). The output of the grading equipment is 1 ton/minute providing safe fuel to the heating plant. The selected oversized wood resized and utilized for energy purposes. Over the period under examination, the share of oversized wood chips covers the 2.2% of the total quantity.

Figure 6. Doppstadt SM 620 plus type mobile star riddle (Photo *F Szűcs*).

3. Conclusion

Hungary currently imports 65% of its energy needs. Renewable energy sources, including biomass utilization, play an essential role in reducing dependency on import. Dendromass, i.e. wood-based biomass, constitutes a significant part of biomass.

The authors of the article demonstrated the experience gained in the first heating season of the dendromass heating system, with a total output of 94 MW, established in 2015-2016 in Tatabánya, considering fuel supply and quality of fuel (wood chip). Creating an effective logistics system and guaranteeing the quality of wood chips are key factors: moisture content of less than 30% and the standard size of fraction.

4. References

[1] www.mekh.hu *(Electronic Materials).*

[2] Vágvölgyi A 2013 A fás szárú energetikai ültetvények helyzete Magyarországon napjainkig, üzemeltetésük, hasznos fásuk alternatívái (Sopron) Doctoral thesis p 195.

[3] Czupy I, Vágvölgyi A and Horváth B 2012 The Biomass Production and its Technical Backgorund in Hungary. *Proc. Int. Conf. on Forestry Mechanization: "Forest Engineering: Concern, Knowledge and Accountability in Today's Environment"* ed T Pentek, T Prosinsky and M Sporcic (Zagreb: University of Zagreb) DOI 10.13140/2.1.4711.5207.
[4] Molnár S, Pásztory Z and Komán Sz 2013 A faenergetika minőségi fejlesztésének szakmai megalapozása (mire elég a magyar dendromassza?!) *(Electronic Materials*: www.fataj.hu).
[5] Horváth Zs, Marosvölgyi B, Idler C, Pecenka R and Lenz H 2012 Storage problems of poplar chips from short rotation plantations with special emphasis on fungal development *Acta Silv. Lign. Hung.* **8** pp 123-132.
[6] Barkóczy Zs 2009 A dendromassza alapú decentralizált energiatermelés alapanyagbázisának tervezése (Sopron). Doctoral thesis Reference lists.

Acknowledgments
The described article was carried out as part of the „Sustainable Raw Material Management Thematic Network – RING 2017", EFOP-3.6.2-16-2017-00010 project in the framework of the Széchenyi2020 Program. The realization of this project is supported by the European Union, co-financed by the European Social Fund.