**TRIESKOVÉ A BEZTRIESKOVÉ OBRÁBANIE DREVA,** 8(1): 247–253, 2012
Zvolen, Technická univerzita vo Zvolene, ISBN 978-80-228-2385-2


# ENERGY BALANCE OF PELLETING OF WOOD BASED BY-PRODUCT

**Gábor Németh – Mihály Varga – Zoltán Kocsis**

## Abstract

*Because of the depleting and increasingly expensive fossil fuels, today the energy derived from renewable energy sources is getting increasingly important. Because of the specificity of our country we can count on smaller or larger expansion of five main renewable energy sources on longer and shorter term: biomass, geothermal, solar, wind and water. Out of these biomass which currently has the largest share will continue to have the largest share, however it should be emphasized that it should be classified as finite renewable energy source in contrast with the wind or the sun. Among other things, that is why it is necessary that we extract at the right time and with the right efficiency as much energy as possible from wood-based by-products- if we cannot extract any other valuable product, or only at a price of great energy and economic investments - available in the domestic wood industry plants in large quantities and we use the thus obtained energy with the corresponding efficiency.*

**Keywords**: *Pelleting / Briquetting / Energy demand / wood based by-product*

## 1. INTRODUCTION

In Hungary, several major "industry" of the production of briquettes and pellets has evolved, so we split the basic manufacturing facilities in three groups:

1. First wood processing plants, the by-product in situ,
2. Second after the acquisition of by-products of wood-product plants and the collection of agricultural by-products (eg straw, corn stover) (dedicated specialist companies)
3. Third energy plantations can be obtained "raw materials" breeding power.

Through the production of briquettes and pellets referred to in the list with completely different energy investment we can obtain a fuel which has higher energy density, smaller footprint and comfort like natural gas compared to the starting materials. In all three cases we can talk about non-drying and after drying energy breeding. Of course, we can find a number of individual enterprises, where raw material drying is not possible, therefore these enterprises need dry raw material, which restricts the possibilities (for example they cannot receive wet raw material from sawmills, thus have to purchase raw material from distant places, which will increase their raw material input costs). We can see that through the briquetting and pelleting process we have to count with heat and also with electricity use,

University of West Hungary, Bajcsy-Zs. Str. 4, H-9400 Sopron, Hungary
email: ngabor@fmk.nyme.hu

the ratio of which is determined by the applied technology and the properties of raw material.

Our aim was – within the cases in the first and second point – to investigate the energy use of pelleting of wood-based by-products generated through wood machining.

Considering a complete pelleting machine line the following units have to be present (in case of each raw material some units do not need apply )

1. Cleaner of the raw material (removing stones, metal, etc)
2. Primary chipper (with pre-store)
3. Dryer. The aim is to reach and maintain 8-10% moisture content (conditioner)
4. Secondary chipper, refiner (usually with cyclone separation and dry chip silo). Aim is a particle size of 0,5-1,5 mm
5. Sieve and vibrating table because of the possibly bigger particles
6. Pelleting equipment(s)
7. Cooler (Counter-flow cooling is recommended. Through cooling the strength of the pellet is increasing, and the formation of dust is decreasing)
8. Sieve (Removing of fine dust which is necessary both for medical reasons and for the sake of heating technology)
9. Bagging (sacking)
10. Auxiliary equipment. Transport equipment for the whole line and an exhausting, which feed back to the cyclone separation.

Typically enterprises specialized in this field invest into machine lines consisting of the machines described above (in Hungary machine lines with a capacity of 1-2 tons/hour are the most frequent). In enterprises in the secondary wood industry, where the main by-product is the dry dust or sawdust, the dryer and connected containers are omitted and the pelleting machine is connected directly to the silo of the suction system with a transporting system, possibly complemented with a secondary chipper, refiner. Of course this way we get a cheaper energy source, but the lower quality product can cause problem at the sales.

*Figure 1. Master unit of the pelleting equipment: ring die and roller shells*

Besides of the type of the raw material the moisture content plays an important role in the energy consumption of the process. This is the ultimate determining factor of the energy investment, because according to our experiences 30-70% additional energy needed in the form of heat when the raw materials has a moisture content of 50% compared to that with 10-12% moisture content (provided that the technology is the same except for the drying). With different raw materials completely different energy demands are connected during the process, for example for straw the starting moisture content is usually less, than 20% while

with wood chips this value can be over 50%. Of course with proper pre-storage these values can be reduced.
When operating the machines the straw contains materials (in this case mainly substances containing silicon of course except the soil rests) which increase the wear of the machine parts, and it has a fiber structure it requires more energy to grind. Also in the case of straw the smaller amount of lignin (which has the function of "natural glue") requires a higher pressure thus a higher energy consumption.

## 2. MEASURING THE ENERGY CONSUMPTION OF THE PELLETING

For measuring the electric power we used the power meter C.A 8230 which is also capable of measuring the power of alternate power.
The handheld meter is not suitable for measuring the machine line units separately at the same time. An electric power consumption measuring and evaluation system would be suitable for this purpose, but this would mean a fixed installment in the plant. We could separate the chipping part with our measurements in the pelleting systems. The simultaneous measurement on several spots would have the advantage that we would be able to monitor the chipper and the pellet press, the two spots with the highest consumption at the same time. These are the places where the actual power consumption changes continuously as a function of the load.
The particle composition (fraction size) and the kind of raw material (pine, hardwood, softwood) have a considerable effect on the effective power consumption of the main motor of the pelleting machine (rotational motion between the ring die of the pelleting and the roller shells)
During our industrial research we did not have the possibility to analyze the particle composition of the material, we intend to do this in a more complex subsequent research. In the following we present the summarized values of our measurements in one pelleting plant.
<u>The main characteristics of the machine line</u>

- Maximal capacity of the line 1200 kg/hour (during the measurements there was a production of about 1 absolute dry tons/hour)
- Average capacity 1000 kg/hour
- Mixing ratio of the chips 2 $m^3$ oak + 1 $m^3$ pine
- Content of moisture: 10%

<u>Total capacity of the line without chippers</u>

- 108-115 kW (effective power)
- 90 kVAR (reactive power)
- $\cos\varphi$ = 0,75-0,82

<u>Values measured on the main motor:</u>

- 64-66 kW (effective power
- 33 kVAR (reactive power)
- $\cos\varphi$ = 0,87-0,89

<u>A separate measurement for the primary and secondary chipper</u>

- 18,5-20,3 kW (effective power)
- 39 kVAR (reactive power)
- $\cos\varphi$ = 0,48-0,50

The effective total power of the production line is about 180 kW, while the built-in power is 250 kW. The technology and the built-in powers are demonstrated on the following graph.

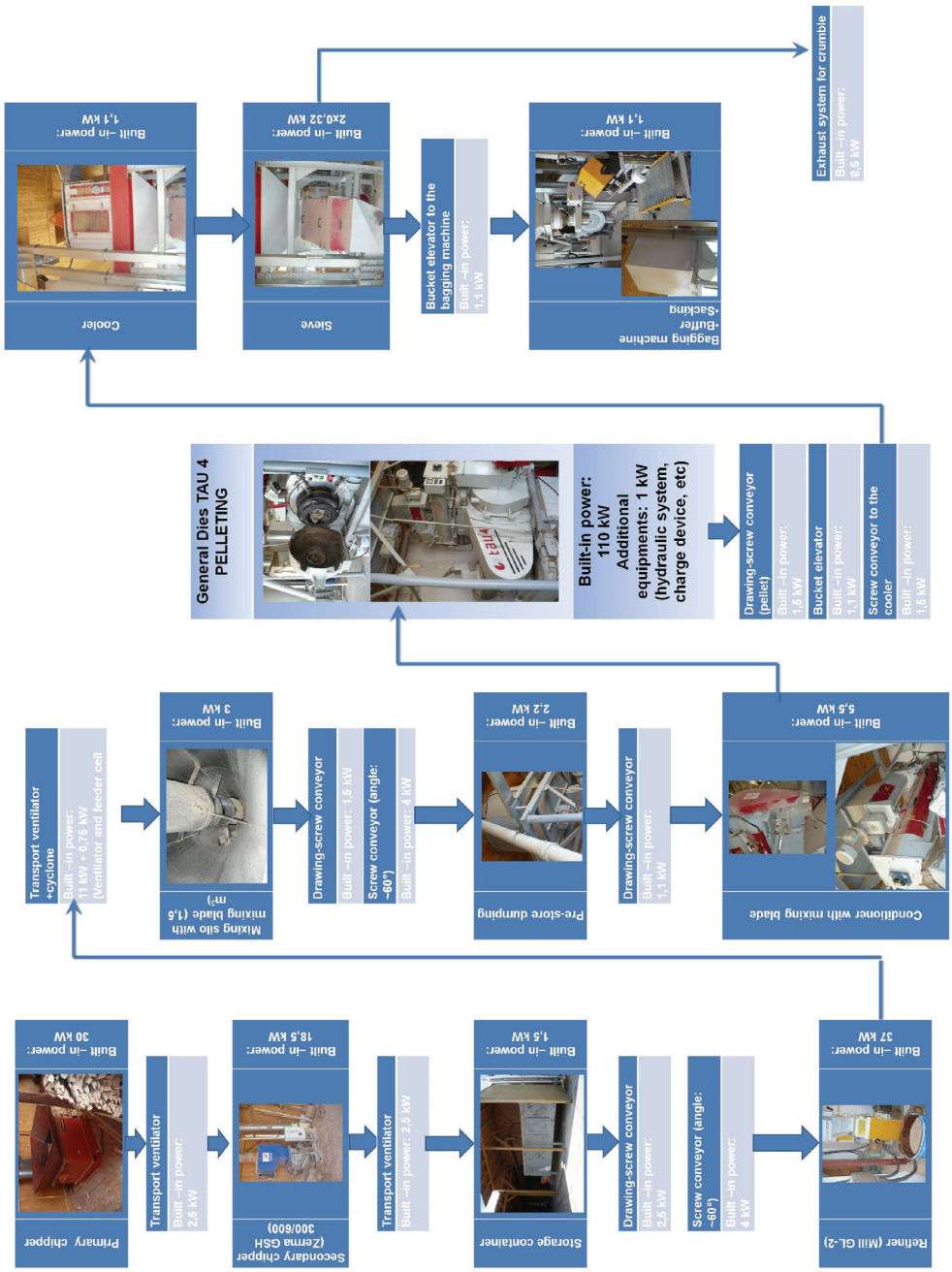


*Figure 2. Process model and built-in powers of the pelleting process*

## 3. TOTAL ENERGY DEMAND OF THE PELLETING PROCESS

By the production of any energy raw material one should not forget about the additional energy demands. Here we have to consider the energy use related to the preparation of the raw material and to the transport of the raw material and of the product.

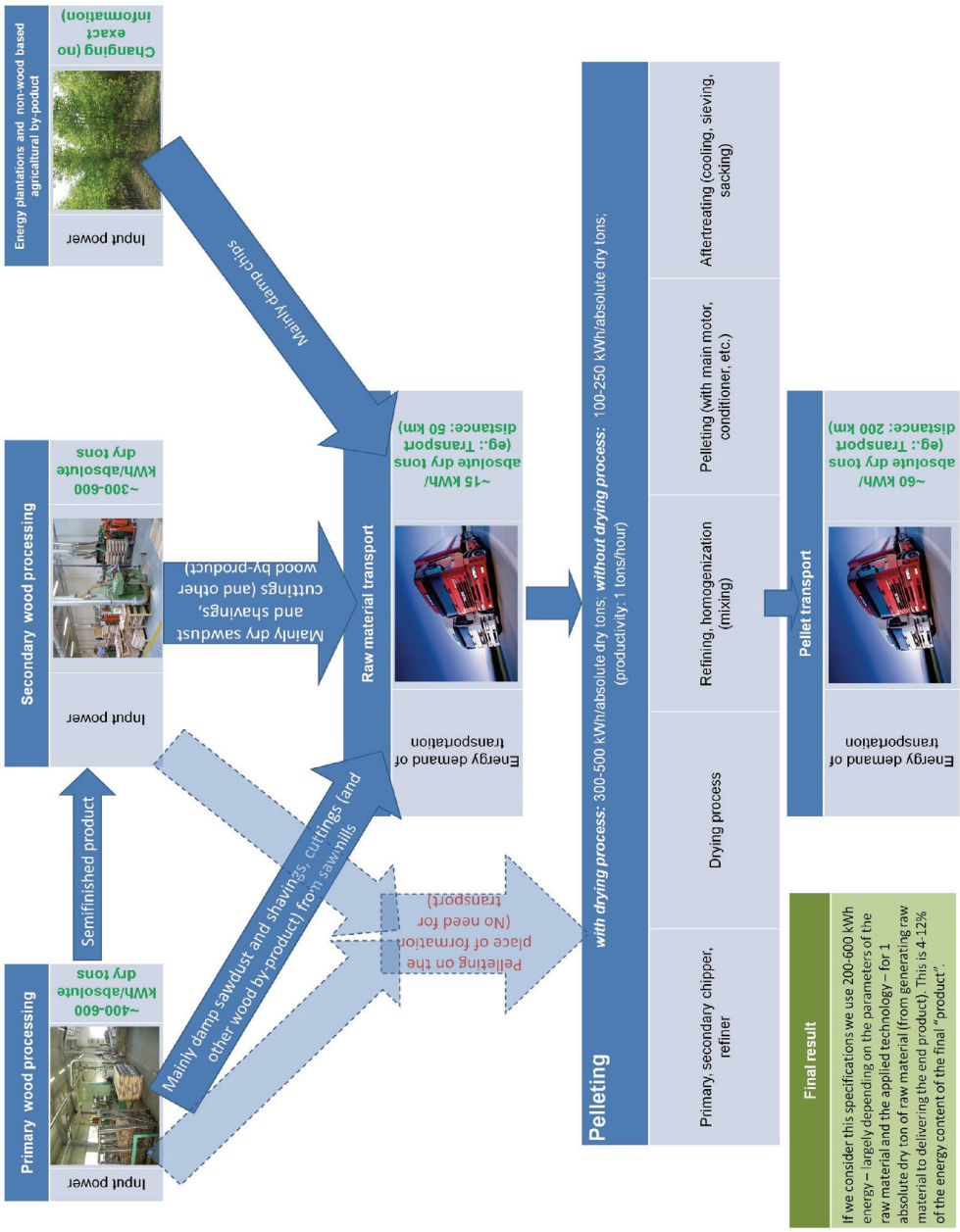


*Figure 3. Total energy consumption of pelleting*

## 4. SUMMARY, RESULTS

There is an interesting question in practice that the given companies should produce briquettes or pellets. It is difficult to give a clear answer. Based on our research up to date we can generally state that if we want to produce energy raw material for our own use the briquetting is suggested, but if we produce for sale then pelleting has the priority because of the higher comfort grade. If we plan a plant specifically for this purpose it is reasonable to install machines both for briquetting and pelleting, so we can largely adopt to the demands of the raw material and the market.

According to our measurements the energy use and the costs of pelleting are as follows:

1. At present 1 ton of good quality chips (12-14 MJ/kg, 20-30% content of moisture) can be purchased for about 20-22 thousand HUF/absolute dry tons (ADT) (1,1-1,2 HUF/MJ). Of course in the case of different chips or if there are wood processing plants nearby then in an optima case this price can be as low as 6 thousand HUF/tons.
2. Considering heating value 2 kg briquette or pellet is equivalent to 1 $m^3$ natural gas (the present price of natural gas is 3,8 HUF/MJ, while the price of pellet or briquette is 2,7-3,4 HUF/MJ)
3. The average electric power need of pelleting – without drying – is 100-250 kWh/ADT (360-900 MJ/ADT) which means a cost of 3000-7500 Ft/ADT. In the case of drying this cost is increased by the heat demand of the drying. If we have to dry raw material with a moisture content of 30% to 10-12% we need 200-250 kWh heat energy (depending on efficiency) which can be produced by using 20-25 $m^3$ natural gas (2600-3300 HUF). Of course we can produce this heat from our raw material, but in this case we use approximately 60 kg chips of 30% moisture content to dry every ton of pellet.
4. If we consider this specifications we use 200-600 kWh energy – largely depending on the parameters of the raw material and the applied technology – for 1 ADT of raw material (from generating raw material to delivering the end product). This is 4-12% of the energy content of the final "product".

   If we express the specific energy values in terms of money (HUF) then we get different proportions (obviously primarily depending on the price of the purchased electric energy). The purchase price of a good quality raw material is about 1,1 HUF/MJ, while the selling price of pellets is about 2,7 HUF/MJ. If we consider an average electric energy consumption in technologies without drying – like in our example – then the specific consumption calculated on the basis of the energy content of the end product will be 0,01 kWh/MJ, which is equivalent to 0,3 HUF/MJ. This is about 27% of the specific of the raw material price based on the energy content, while 11% of the specific sale price of the pellet. These proportions can even be doubled in case of raw materials which need drying.
5. In case of briquetting – according to our measurements and calculations – 50-100 KWh energy is needed to produce this energy raw material.

Of course to these costs we have to add overhead, maintenance, loan and other costs. In the case of pelleting the production cost can reach 20-28 thousand forints (in case of the economic production: 1-1,5 tons/hour)

These figures are of course completely different if we have raw material from our own wood processing, because in this case we don't have to buy the raw material.

We will have possibility for experiments with raw material and technology parameters with the NOVA Pellet N-Micro B laboratory pelleting machine installed at the beginning of 2012. These experiments are still in preparation.

**Acknowledgements**: We wish to thank for TÁMOP 4.2.1.B-09/1/KONV-2010-0006

## REFERENCES

FENYVESI, L. - FERENCZ Á. - TÓVÁRI P. (2008): A tűzipellet, CSER kiadó, Budapest

VARGA, M. - NÉMETH, L. - CSITÁRI CS. (2011): Fa, mint megújuló energiaforrás, Örök társunk a fa című kiadvány, szerk: Molnár S. (pp: 38-43).