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ECO-TENDENCIES OF PELLETS

Abstract: Our rapidly changing world is characterised by globalisation, industrialisation and growing environmental problems, which gives rise to new areas such as eco-materials and eco-design. As a result of global warming and different ecological disasters, a more responsible attitude has increasing significance. The eco concept makes it possible to keep the most important corporate foundation stones such as sustainability and economic viability, while increasing environmentally friendly uses of the economy and boosting social harmony. From a sustainable energy point of view, pellets are an eco-friendly solution with optimal effects as they cause minimum harm to the environment and are suitable for recovering energy.

Key words: Eco tendency, environment protection, waste reduction

1. Introduction

There is increasing concern in the world today about environmental problems, climate change, the decrease of resources with limited availability. Therefore there is an increasing need to adopt a responsible sustainable attitude and to tighten environmental measures. Global warming is caused by human activity and our life style, which demands production, consumption that harm the environment, pollute the air, the waters, the soil, and produce so much rubbish and waste that we are slowly becoming unable to manage it on the planet. Our most important task is to retain our quality of life and protect our environment. In order to do this we must reduce environmental damage and mitigate and /or eliminate the harm caused.

Unfortunately, despite the world addressing climate change, its effects and the damage done to the environment are increasing, and it seems there that very little progress has been made by companies to solve the problem apart from some obligatory and expected tasks and regulations. Different services and production facilities, multinational companies are not really obliged to make fewer products and generate less packaging waste or at least to use recyclable materials or to put the typical circular economy into practice. There are general regulations and statutory obligations concerning waste and waste management such as Act 185 of 2012 on waste management that focuses on the reduction of energy and raw materials as well as on human health and the reduction of burdens caused by waste materials. However, companies cut costs using cheaper materials that produce more waste. One of the most probable reasons for this is that companies are not really under pressure to replace their cost-cutting thinking with the more comprehensive use of eco-friendly or eco materials. The other reason is that companies concentrate on survival forced on them by the ever-changing socio-economic circumstances and their prices and sensitivity to costs. Most companies have short-term goals and cut costs. Therefore the use of more expensive eco materials is not on the table. Some companies consider sustainable development and cost cutting as a disadvantage, while some other companies try to benefit from the use of eco materials and take it as a competitive advantage.

2. The significance of eco

Interestingly, based on data published in *Top Ten of Everything* by Russel Ash (London: Dorling, Kindersley, 1996) Hungary ranked 7th among the 10 biggest garbage producers per capita. Obviously, the USA was in the first place was and surprisingly, considering their small population, Finland was second. In the past decade there have been many changes including different improvements and developments even in Hungary, such as the implementation of renewable energy sources, standards, and regulations. As a result, on the Waste Management List of 2016, Hungary occupies the 25th worst place out of the 28 countries under examination in Europe, which is 1624 kg/year per capita waste. According to the 2016 data on waste management / waste statistics it is Finland that in the first place. Despite the population of 5-5.5 million, Finland produces 22,359 kg waste per year per capita. It is exactly these scary numbers that show to need to introduce eco materials and recyclable, reusable materials. As an example, if people co-operate, the ratio of plastic collection can reach 3-40%[1], out of which the ratio of recovery is even lower so it hardly reaches 50%. Therefore it has a high environmental impact. Based on the 2017 data by the European Association of Plastics Manufacturers[2] not even 45% of plastic is collected, and presumably most of the plastic is dumped into waters or nature, even forests. Recovery is even worse, below 20%, the rest is dumped in landfills or incinerated. This is the main reason why plastic should be excluded from production, from all manufacturing processes and packaging or at least should be replaced with biodegradable versions.

Methods for companies to reduce their ecological footprint in production and services by using fewer raw materials and/or by the adoption of environmentally friendly technologies already existed in the 20th century. Eco design was introduced because of our destructive lifestyle and its adverse effects on the environment required a new strategic thinking. The eco concept is an attempt which takes into consideration the ecological context from the start, from the purchase of raw materials, through production to delivery to the end-user, thus covering the whole life cycle of the product (Table 1).

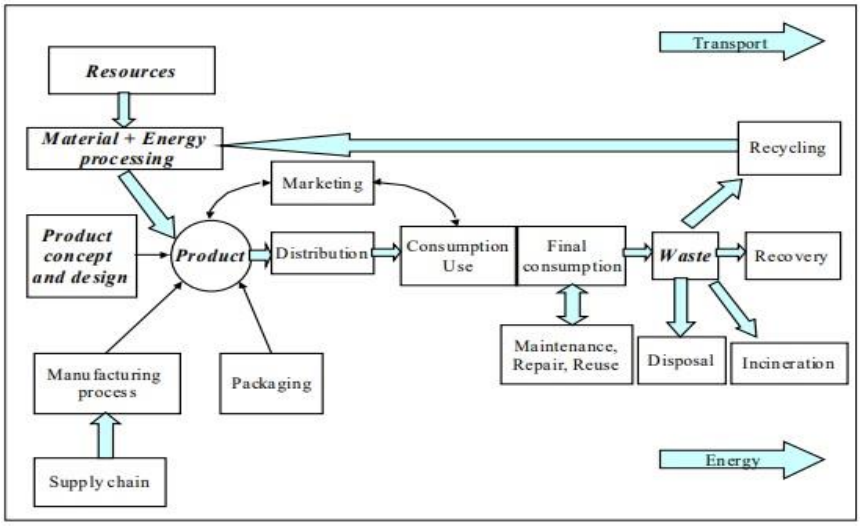

Table 1: The schematic life cycle of products[3]

[1] Forrás: Dr. Nagy Béla: Újrahasznosítási ismeretek, 2011 Szent István Egyetem, 24. oldal
[2] Forrás: Plastics – the Facts 2017 An analysis of European plastics production, demand and waste data, https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf
[3] Forrás: Green Paper on Intergrated Product Policy (2001)

Eco design creates a vital and environmentally friendly economy, as it takes into consideration the impact on the environment throughout the whole life cycle of the product and reduces it to a minimum. Therefore one of the most important steps is the examination of the product life cycle and seeing through it so that we can calculate how many raw materials, processing aids and energy were used to make, use and eliminate the particular product and to what extent these materials impacted the environment. On other words how big the ecological footprint of the particular production is. It is not only quantitative data that we can extract from such an examination, but we will have chronological information as to the type of environmental impact in a given time period. The relevant standard when examining the life cycle of a product is ISO 14040:2006, but there is different software available too that makes it easier to analyse the processes (e.g. GaBi[4], Carboncheck[5]).

3. The significance of pellets and their production process

In order to demonstrate the eco concept, wooden pellets and briquettes are really good examples because they are environmentally friendly, since waste is made into a valuable material, thus protecting the forests and rediscovering already proven materials from a renewable source with a wide range of possible applications. Pellets are compressed fuels that are produced using recycled materials (biomass) that is made from the recovery of trees, plants, fruits or by-products, with a diameter of 6-12 mm. The compressed material is produced at high pressure, usually between 800 and 900 bar. When compacting, the raw material is always taken into consideration, which can be a by-product, wood chips or some other wood waste. Their density is increased during the process. Wooden briquetets are similar products but they are bigger. Their form can vary, either cylindrical or rectangular, and their diameter can also vary, between 4 cm to up to 35 cm. Their advantage is that they can be used in traditional wood-burning stoves. They are environmentally friendly their smoke does not contain sulphur dioxide and they have low moisture content their heating value is high, there is no need for further processing at home, such as splitting, chopping. Apart from their use, for the production of thermal energy, they can be used to produce electricity or even as (motor) fuel. They have an exceptionally good burning rate and the carbon dioxide they emit is less harmful to the environment. Their energy comes from the burning of the carbon content of cellulose. Cellulose is made when the chlorophyll of the plant, as a result of its exposure to solar energy, produces glucose molecules from the carbon-dioxide found in the air and the water taken by the root, simultaneously emitting oxygen. The glucose molecules (usually thousands of them) polymerise into cellulose fibres while releasing water molecules. This is wood. When we burn it with oxygen, the combustion product becomes carbon dioxide and water and the energy that the plant took at its creation from the sunlight is released. Petroleum is also burnt into carbon dioxide and water, but it is produced much more slowly it is runnings out. This is one major difference between pellet and oil burning as to time and environmental impact.

Table 2 shows that the significance of pellets in the world has grown considerably over the past two decades. At the same time, the energy consumption of the world is also

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http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0068:FIN:EN:PDF 6. oldal

[4] software with a big database to analyse life cycle.

[5] manages data ragarding sustainability and energy management.

growing continuously. As energy sources as well as raw materials become scarce, there is a growing need for alternatives.

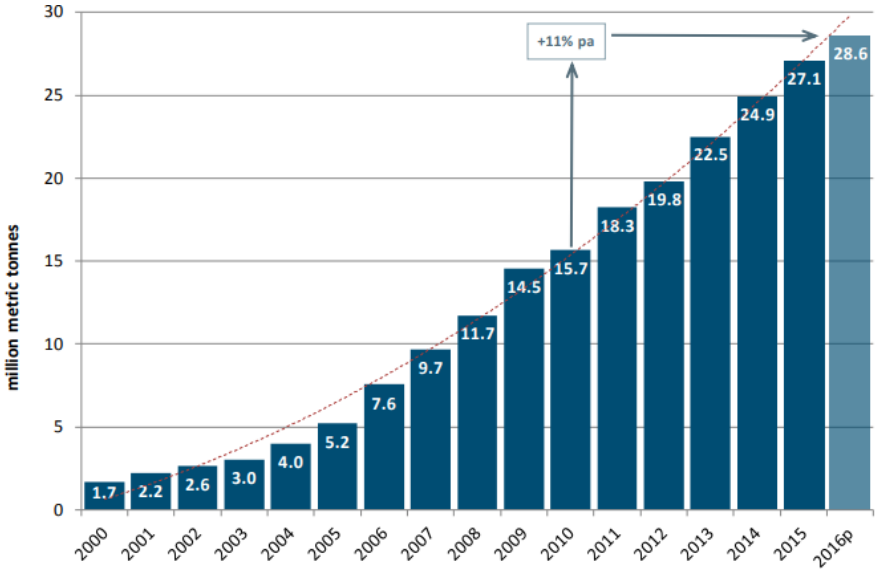

Table 2 Amount of pellets produced in the world in million tons between 2000 and 2016 [6]

Despite the growing significance of pellets, they can only support a small part of energy consumption as the demand for energy is growing continuously. The growing demand, the finite availability of wood and the processing of timber justify the need for the use of alternative raw materials in production (of pellets or other products). These can be in the form of agropellets that are not wood-based materials but herbaceous and other alternatives. The production technology is also important as it reduces the ecological footprints.

Due to the wide variety of raw materials used to produce pellets, they can contain impurities, or undesirable substances such as metal, other waste, or stones. Therefore, especially during the recovery process great emphasis should be put on the cleansing process that is carried out with different isolating and magnetic devices. In Austria wood pellets are generally made from sawdust, wood shavings and chips. The first step before compression is checking the moisture content of the raw materials and drying, if necessary. For pellet production the ideal moisture content is between 10-12% (Burján Z. 2010). Drying is a significant process as raw materials too high moisture content make it impossible to carry out the pelleting process, thus worsening the quality of the end product, making production more difficult, and causing higher energy consumption during production. Drying requires energy that could be replaced or complemented and supported with an energy generator working with biomass. After drying and chopping, the chips are compressed under high pressure to produce the pellet. To make compression easier, additives might be necessary, which in Austria are complemented with natural materials, for example corn starch. Pellets made by compression heat up during the process, so they must be cooled down, sieved and prepared for storage.

[6] The global outlook for wood pellet markets WPAC Annual Conference, Ottawa, September 2017, 4. pdf

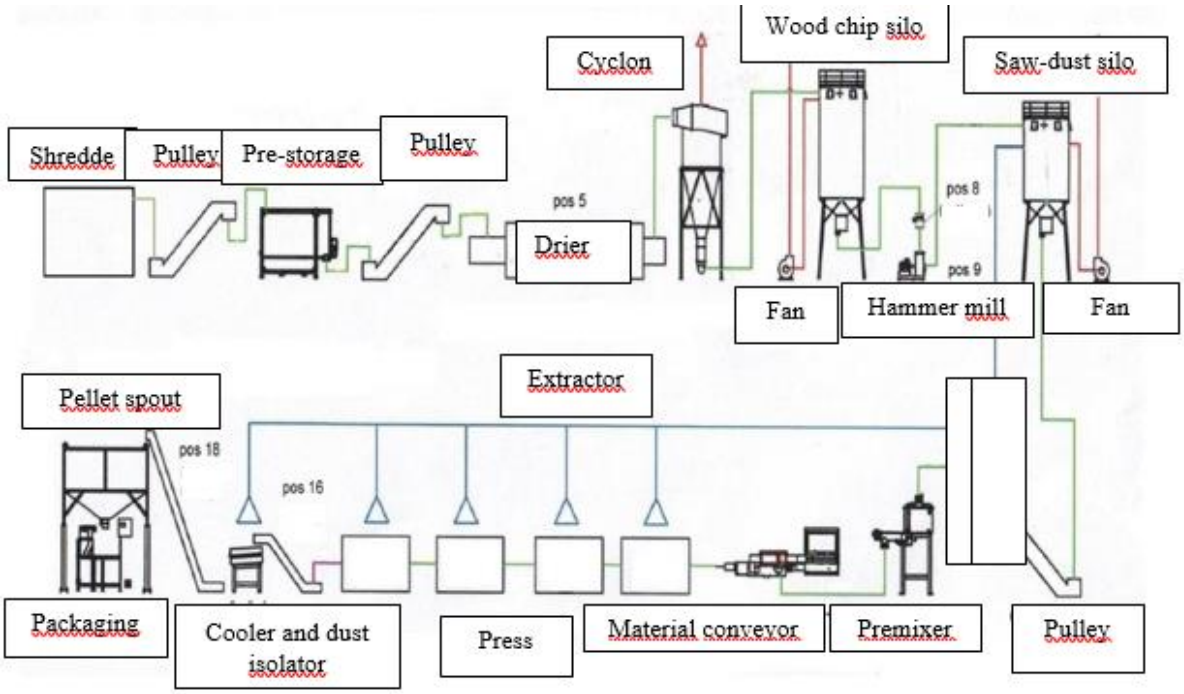

Table 3 Technology of pellet production[7]

When the raw materials chosen for pellet-making are not suitable, they must first be put into a shredding machine, from which a pulley delivers them to the pre-storage facility. Then with the help of a pulley they are delivered to the drier where materials are to dried and turned over with a cyclone fan. After this they are put into the chips silo, where they are put into the isolator and then into a mill reduces them to suitable size. The pieces from here are put into the pre-mixer then delivered to the compression process. Actual pelletization takes place here where materials are treated under high pressure and heated over 100 ˚C. Materials from here are put into the cooling and isolating machine. That is one of the most important parts since the small pellet pieces are very fragile at a high temperature. If they break, their quality declines and there are material losses. It is important to cool down the products as slowly as possible because sudden cooling might cause the deterioration of their quality. After this process, the pellets are packaged into plastic sacks (Table 3).

4. The possibilities of reducing the ecological footprint regarding pellets

From an environmental and climate protection point of view, the use of pellets made from eco-material contribute to environment protection. When an older stove is replaced by a pellet-burning one, the emission of carbon-dioxide is reduced significantly. Heating oil is not beneficial from the point of view of environment protection as the use of 1 litre heating oil burdens the environment with approximately 2.4 kilograms[8] of CO_2 emission.

The energy of 1 kilogram of pellets are 4.7 kWh which equals to 5.0 kWh energy[9] (which is influenced by quality to a great extent), while 1 litre heating oil contains circa 10.3 kWh primary heating energy, 1 m^3 natural gas 10 kWh. 1 litre heating oil thus has the same

[7]Forrás: Burján Z. (2010): Pelletfűtés II. Pelletgyártás-Víz- Gáz- Fűtéstechnika áprilisi szám, http://www.pannonpellet.hu/publicistica.php?newsid=978

[8] Forrás: Comenius Gimnázium https://gimnazium.comenius.hu/page/menu/3 kémiai anyagok

[9] https://futespiac.hu/az-energiahordozok-futoerteke.html

heating energy as 1 m^3 natural gas. What matters is the extent of carbon dioxide emissions, the aggravation of the greenhouse effect and the harming of the environment. There are political guidelines aimed at the reduction of the greenhouse effect because it has a great impact on triggering climate change along with global warming. Pellets are suitable for the reduction of greenhouse gases and it supports the use of renewable energy sources (thermal energy, etc.). It is an advantageous alternative since it promotes the replacement of other fuels, e.g. coal. Based on the data listed it is clearly visible that about 2 kilos of pellets to replace 1 m^3 of natural gas and 1 litre of heating oil. Projected on larger numbers it means that 1000 litres of heating oil can be replaced by about 2 tons of pellets. Table 4 below summarizes the differences between the different types of fuel.

Characteristics	**Wood**	**Gas**	**Oil**	**Coal**	**Electric**	**Pellets**
Heating value	12 MJ/kg	34 MJ/m^3	42 MJ/kg	19 MJ/kg	3,6 MJ/kWh	16-18 MJ/kg
Unit price (Depending on type and quality)	2500 -3500 Ft/q	110 Ft/m^3	250-270 Ft/l	4500-8000Ft/q	50 Ft/kWh	5500-8000 Ft/q
CO2 equivalent	20-70g/kWh	254g/kWh	318g/kWh	285gkWh	375 g/kWh	70g/kWh
Extraction, raw material	Minimum cost, renewable	Minimum cost, limited fossil	High cost, limited fossil	Demanding, limited	High cost fossil, nuclear, renewable	Minimum cost, renewable
Burning	Demanding	Problem-free	Simple	Demanding, complicated	Simple	Normal

Table 4[10]

Based on the energy balance sheet of a pellet factory in Austria (Table 5) the most energy is consumed to the dry sawdust. This is presumably the same at each pellet factory. This is followed by the actual production of the pellets where pellet compressors and cooling use the second-highest amount of energy. Transportation is negligible as energy consumption is projected within a 100 km radius.

[10] Self-made, https://www.matkeramia.hu/egyeb-hu/futesi-modok-oesszehasonlitasa/
https://kreativlakas.com/epitkezes/tuzeloanyagok-futoolaj-gaz-fa/
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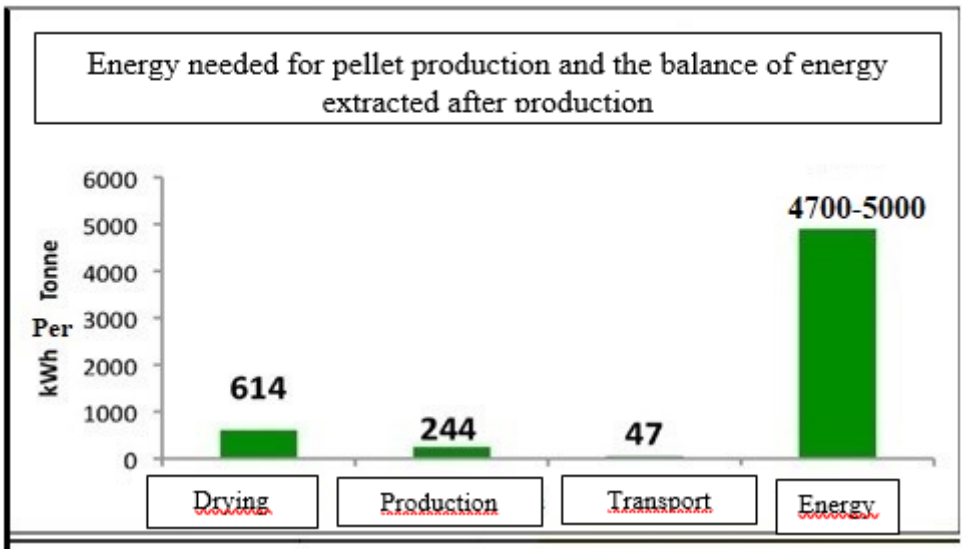

Table 5 Energy balance sheet of pellets[11]

Pellet production requires 905 kWh per ton and the energy gained is between 4700 and 5000 kWh per ton, which means that the actual production of the pellet accounts for **18-19%, while the rest is clean energy.**

When the pellets are to small, the use of the shredding machine is not necessary. The drying process require the highest amount of energy. This energy in the eco concept could be a biomass plant that could reduce the environmental impact. One solution could be to satisfy the energy demand with renewable energy fuels (solar panels, wind turbines among others) and the energy necessary for drying could be supplied with the steam released during the use of renewable resources. Both alternatives could reduce the environmental impact and the demand for energy consumption since they would be satisfied from renewable sources. At the same time both the energy consumption and the environmental impact can be reduced as well as the emission of harmful materials. With the help of these two solutions the processes requiring the most energy could be replaced by alternative energy supplies. The dust remaining on the pellet and later removed has a lower material use during the next round of production. Another alternative for reducing the environmental impact is in packaging. Most pellets are packed into plastic sacks, the environmental impact of which must be reduced. The fine dust, on the plastic sacks make it difficult to load them onto pellets since the sacks tend to slide. The film can stretch, which also hinders loading them safely. When pellets are compressed during transportation and loading, the straps loosen, leading to transportation losses and damage. Anti-slip pads that are also recyclable are a solution for the next delivery. Even protection from collision will protect the sacks of pellets and eliminate damage. Companies should not consider only the price but companies should also take into consideration the potential mechanical stress. If this packaging is replaced with paper sacks, the user could burn them or even better, reuse them. This way there would be no unnecessary waste ending up in incinerators or landfills. If we speak about the sale of a bigger quantity of pellets, recyclable big bags are also a good solution because they are reusable. When packaging, biodegradable sacks (made from corn, starch, bamboo, etc.) which are environmentally friendly and compostable could be used and yet their quality is adequate for the purpose. Recycled materials have another advantage that they are cheaper than packaging

[11] Energy balance sheet of a pellet manufacturer in Austria

materials made from plastic. It is highly recommended for manufacturers to lead consumers into this direction by providing products packed in an environmentally friendly way at a lower price. This way slowly but surely. The use of non-biodegradable plastic materials could be reduced or even eliminated.

Table 6 demonstrates the life cycle of pellets, which clearly shows the circular use of materials and energy.

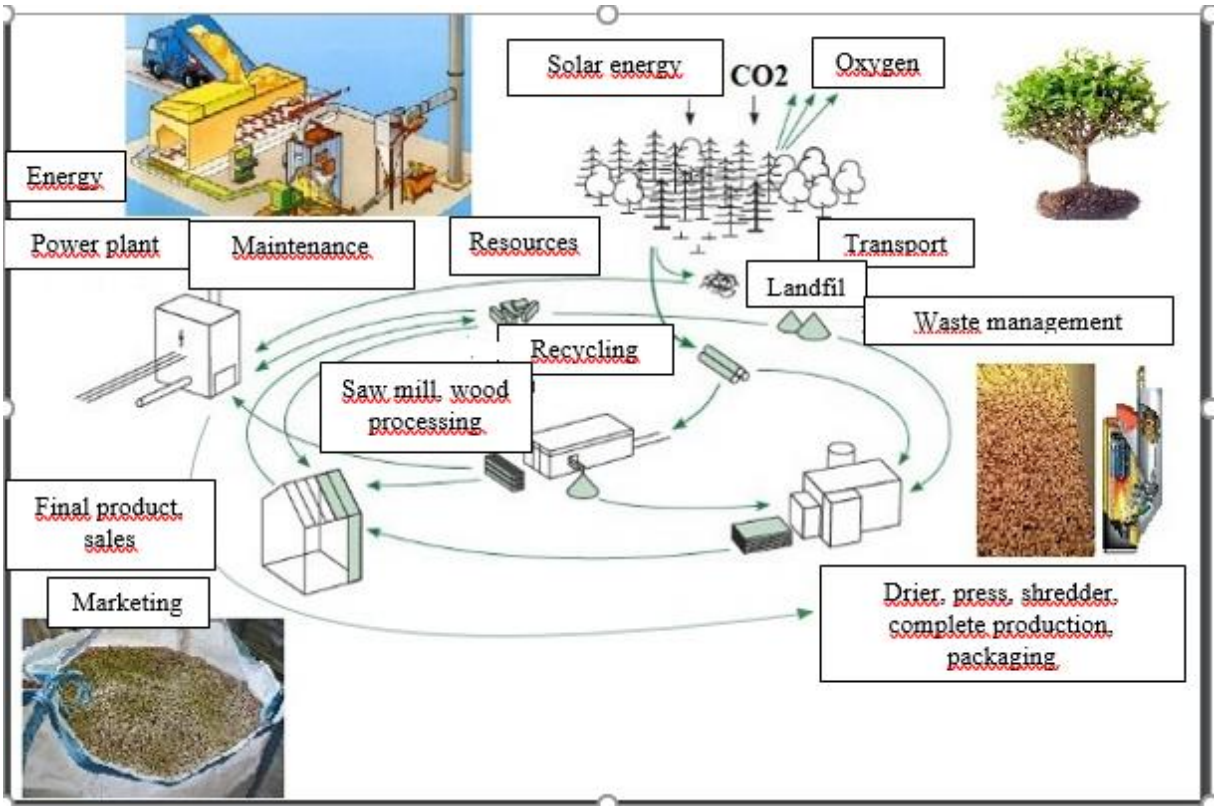

Table 6 Pellet cycle[12]

The point of the process is that it ends in a closed system. The main advantage of the circular system is that during the extraction of the resource, nothing is taken from the environment but instead the materials available are put to use and at the end of the process so no waste impacts the environment. Companies using the circular model all manage to save energy. By recycling, the transportation is reduced and the planning of the energy resources becomes more predictable. By using recyclable materials and renewable energy sources, these companies also manage to reduce the damage to the environment, thus increasing their competitive advantage, retaining a sustainable economy, and promoting innovation through improvement.

The environmentally friendly and efficient circular model has plenty of potential as the future to process and recycle waste materials that can reduce the burden on the environment and use of scare energy sources. To ensure the implementation of the circular model it is advised to turn wood over as many times as possible and produce new products and/or use it for energy, as long as it is not to contaminated. Therefore, it is worthwhile either to recycle the by-products of the timber industry or use them as energy fuels unless they have been

[12] Source: self-edited

treated with hazardous substances. The eco concept and the circular model contribute to the reduction of useless materials or the decrease of chemicals, thus making it possible to use them multiple times. Naturally, the profitability of the company also plays a role here, since the process of recycling can only be profitable if the price of the recycled material is lower than the price of raw material. It is our goal that most materials and by-products should be recycled or further processed to minimize waste. When recycling not possible due costs or contamination the materials should be used as a renewable energy source could still be addressed.

5. Summary – Conclusion

Companies should concentrate on sustainable management. Companies should look around for greener technologies and materials and they would certainly find alternatives with smaller ecological footprints. If they have a higher price, the processes would definitely allow cost-cutting that could compensate for their higher cost. Marketing should have an important role in promoting sustainability on as wide a scale as possible. With the help of a well-executed marketing strategy, extra costs could be built into the price. With good marketing, products could be sold in a wider circle to conscious consumers because they are produced in an environmentally friendly way. For a conscious consumer, their health and thus the protection of the environment are paramount, so products could reach a wider circle of potential customers. The most important purpose of eco tendencies is sustainability that ensures the quality of the environment the satisfaction of basic needs and the realization of social well-being. The reduction of waste, the large-scale exploitation and utilisation of natural resources are indispensable for sustainable development. By taking advantage of eco tendencies we can reach energy efficiency when production processes use environmentally friendly processes, environment- and health-related harm is reduced, and technology and the materials are used more efficiently.

The use of pellets to produce electricity and heat is increasing in industry. Thus, energy efficiency can be achieved. Recycling makes their use environmentally friendly, their carbon dioxide emission becomes lower than other energy generators. Agricultural by-products could also be used in this pelletization technology. The production of pellets can be easily automated, thus increasing efficiency. The wider use of pellets (e.g. residential pellet furnaces) would reduce the import of heating fuels, ensuring energy efficiency, making it more economical and burden the environment less because importing conventional fuels, uses energy impacts the environment and emits harmful substances when burned. Contrary to gas, the price of pellets is independent of global markets, which would be another advantage for consumers. With the help of renewable energy sources, the country could develop a sustainable energy system, which would be beneficial for the economy. A security of supply and a balanced energy structure could be achieved if the pellets are produced in this country and not intended for export. The comfort from heating with pellets is the same as fossil fuels, so this would not mean any changes either. It is already necessary to supply a certain percentage of energy globally from renewable sources, and this situation will certainly intensify in the future, so there is great potential in the production of biomass-related products as renewable sources. It is for this reason that these technologies should constantly develop and for their production capacities should be increased.

6. Acknowledgements

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