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MANAGEMENT TECHNOLOGY OF WOOD WASTE FOR ENERGETIC PURPOSES

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Management of biomass as an energy source has become a practical and reliable way of providing heat and warm water in the last decade in the countries, such as Austria, Germany, Denmark, or Sweden. Wood biomass is also cleaner, and regarding the permanently maintainable way of life, it is a source of energy, which does not burden environment by CO_2, and on the other hand if compared with natural gas, it is a more ecological fuel. It substitutes coal management as a source of energy, provides a healthier and cleaner local environment, and does not contribute to the increase of atmosphere pollution by CO_2 and other gases. For gradual achievement of this goal it is necessary to make the prices for fuel and energy real, create a suitable legislative, economic, and financial background, and systematically support business activities. From the performed research the potential possibilities of the development of the management of renewable use of energy will result by 2010.

Key words: *renewable sources of energy, wood waste, technology of waste processing, economic effectiveness of investments*

Upravljanje tehnologijama drvnog otpada s ciljem korištenja energije. U zadnjem je desetljeću upravljanje biomasom kao izvorom energije postalo praktičan i pouzdan način osiguranja topline i tople vode u zemljama kao što su Austrija, Njemačka, Danska ili Švedska. Biomasa je čišća, a glede permanentnog održavanja života to je takav izvor energije koji ne opterećuje okoliš ispuštanjem CO_2, s druge strane, ako ga usporedimo s prirodnim plinom on je ekološki puno prihvatljiviji. Biomasa zamjenjuje ugljen te kao izvor energije osigurava zdraviji i čišći okoliš, odnosno ne povećava zagađenost atmosfere plinom CO_2 i drugim plinovima. Za postupno ostvarenje tog cilja potrebno je osigurati realnu cijenu goriva i energije, pripremiti odgovarajuću zakonsku, gospodarsku i financijsku pozadinu, te sistematski podržavati takve poslovne aktivnosti. Obavljeno istraživanje potencijalnih mogućnosti razvoja gospodarenja obnovljivom energijom urodit će rezultatima do 2010. godine.

Ključne riječi: *obnovljivi izvori energije, drvni otpad, tehnologija obrade otpada, ekonomska učinkovitost investiranja*

INTRODUCTION

Often repeated argument that energy received from renewable sources is more expensive than energy from fossil fuels has a limited validity, and that is only in conditions when the damage of environment due to the burning of fossil fuels is free of charge, what is, unfortunately, characteristic for the present. Moreover, the prices of energies from renewable sources do not include other than positive influences on economy and social area. In this connection it is necessary to mention that the situation is not fixed and develops slowly in favor of renewable sources. Some of these fuels, such as wood, biogas, wind-power energy, are nowadays capable of competing with classical fuels in several developed countries (Germany, Austria, Sweden, etc.). It shows that the most expensive ways of energy production, e.g. photovoltaic elements, would, after including external costs to prices and at their mass use, become cost comparable with these fuels, which we use nowadays.

ENERGETIC POLITICS OF THE RSE REGARDING THE PRESENCE OF BIOMASS AND WOOD WASTE

Renewable sources of energy (RSE) are perspective energetic sources of domestic origin, particularly energy from water, biomass, and geothermal energy with minimum impact on the environment. The use of a technically usable potential of renewable sources in 1997 is stated in Table 1.

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Table 1. **Management of RSE in Slovakia in 1997**
Tablica 1. **Upravljanje obnovljivim izvorima energije u Slovačkoj u godini 1997.**

Source	Production of energy total			Electricity
	GWh/y	TJ/y	%	GWh/y
Biomass	2727	9817	39,7	5
Water energy	3800	13680	55,3	3800
Small water power station (to 10 MW e.)	202	727	3,0	202
Geothermal energy	338	1217	4,9	0
Solar energy	7	25	0,1	0
Wind-power energy	0	0	0,0	0
Total	6872	24740	100,0	3805

Technically usable potential of renewable sources of energy in Slovakia is shown in Table 2.

Table 2. **Technically utilizable potential of RSE in Slovakia**
Tablica 2. **Tehnički iskoristiv potencijal obnovljivih izvora energije u Slovačkoj**

Source	Production of energy total			Electricity	
	GWh/y	TJ/y	%	GWh/y	%
Biomass	9178	33041	39,9	1270	12,6
Water energy	6607	23758	23,7	6607	65,6
Small water power station (up to 10 MW e.)	1034	3722	3,7	1034	10,2
Geothermal ener.	6300	22680	22,6	60	0,6
Solar energy	5200	18720	18,6	1537	15,0
Wind-power ener.	605	2174	2,2	605	6,0
Total	27890	100400	100,0	10079	100,0

States with the comparable geographic conditions (Austria, Switzerland, south Germany) supply with energy from forest biomass of 2 to 3 %, regionally up to 5 % out of total energetic consumption. In the states with small forest coverage and the surplus of agricultural land the projects of the so-called "energetic forests" are realized. Among the neighboring countries the non-energetic management of biomass is most spread in Hungary where it is utilized together with agricultural biomass, which, regarding natural circumstances, does not predominate [1].

In the area of energetic economy the critical place is the problem of CO_2 creation from burning and transformation of fuels. Regarding regulations in the Slovak Republic, mainly the following are considered:

- re-structure of industry, intensification of technology penetration with a lower energetic intensity and higher grade of final evaluation of products,
- adoption of the program for the decrease of energetic intensity (decrease of final energy consumption),
- support of programs for better use of renewable sources (CO_2 creation at the use of biomass as fuel according to the methodology of Intergovernmental panel for climatic changes of IPCC is not included in the balance of greenhouse gases),
- increase of the share of fuel consumption with a lower volume of carbon per energy unit (exchange of fuels),
- adoption of the program of the use of natural gas as a propellant in transport,
- at the support of programs for the decrease of greenhouse gases it is possible, according to Kyoto protocol, to use also so-called flexible mechanisms.

BIOMASS

Biomass is all material in nature - it is a preserved solar energy, which is absorbed by trees and other green plants. They also produce from it simple sugar (from CO_2 in the air and water in soil) and change these materials into more complex and organic materials, such as cellulose and lignin. This process is called photosynthesis, and the material created from it is released in the form of heat and light. The amount of a produced biomass on earth is about $2 \cdot 10^{14}$ kg per year what corresponds with an energetic equivalent of approximately 90 TWr.

Solar energy absorbed in biomass can be converted to a utilizable form of energy - heat, electricity or driving fuels for motor vehicle by several ways, e.g. burning, fermentation, anaerobic rotting, etc. As suitable fuels wood, straw, biogas, or specially grown plants with a short rotation cycle are mainly offered.

WOOD MATERIAL

For burning it is possible to use traditional wood, including various wood wastes, which at present are further processed to bio fuels. The simplest process of wood waste is splitting. Wood split is usually used in larger boiler rooms, local or business. More perfect fuels are wood briquettes produced by pressing from a dry and fine ground biomass (usually wood). Briquettes are suitable for all grid hearths, boilers and furnaces, however, mainly for family fireplaces. Their solid pressing enables clean and comfortable firing, and will last for up to 10 hours [2].

Another stage of using biomass are pellets. They are produced similarly as briquettes but they must go through a matrix, which sets their diameter. Commonly pellets are produced with diameters from 6 to 18 mm; the diameter is usually increased always by 2 mm. The biggest advantage of pellets is the possibility of their automatic feeding to furnaces. Pellets are fed continuously according to the set-up temperature in advance, what minimizes manual work. The comfort of a boiler operation can be at this type of fuel compared with the comfort of the gas boiler operation. In Cen-

tral Europe pellets are used mainly in households or small plants; however, northern countries, such as Sweden, Finland and Norway, use pellets largely at centralized deliveries of heat, as well as production of electricity [2].

Bio fuels generally have favorable properties from an energetic point of view, as well as ecological point of view, as seen in Table 3.

Table 3. **Overview of basic properties of phyto-fuels compared with brown coal**
Tablica 3. **Pregled osnovnih svojstava fito-goriva u usporedbi s smeđim ugljenom**

Fuel	Fuel value / MJ/kg	Water content / %	Sulphur content / %
Brown coal - energetic	10,6 - 12,7	34 - 36	1,1 - 1,8
- for household	11,4 - 17,0	25 - 30	0,8
Logs dry	13,0	< 25,0	0,0
Sawdust and chippings	< 16,0	< 15,0	0,0
Skin of coniferous trees - fresh	5,0 - 6,0	56 - 63	0,05
- stored	9,0 - 12,4	30 - 46	0,1
Split - coarse	12,5 - 14,0	25 - 30	0,0
- small	6,0	< 60,0	0,0
Bark briquettes	18,5	appr. 10	0,1
Wood pellets	17,0 - 19,0	10 - 12	0,0
Straw - grain	14,0	appr. 20	0,1
- cole-seed	15,0	appr. 20	0,2

PRODUCTION OF ENERGY FROM FOREST BIOMASS

Forest biomass has a rather great dimensional variety. For a better transportation, manipulation, and increase of energy production it is necessary to dimensionally process raw material by cutting (branches, trees) and grinding (manipulation and processing wastes, trunks).

In the conditions of the SR there are following perspective forms of energy production:

Direct burning of damn, dimensionally processed raw material (boilers, front-fireplace, etc.):
- warm-water heating of objects (family houses, forest house, local buildings, etc.),
- production of technological steam,
- production of electricity (steam, gas turbines), including heating of objects,
- hot-air drying in agriculture and at wood processing.

Energetic gasification of dried, dimensionally processed raw material:
- production of electricity (gas motor + generator),
- production of electricity + heating of objects (waste heat).

Briquetting and pelletizing of dried, fine grained wastes:
- heating of houses, recreational objects, etc.

Direct burning of forest biomass is at present energetically and economically the most effective way of its energetic use in forest areas for heating of facilities by central sources of heat (CSH) or individually and it larger concentrations of fuel also the production of electricity.

Energetic gasification with the production of electricity can be used at wood processing plants or outside of public electro-distribution networks.

Briquettes and pellets are an ecologically favorable substitution for coal in classical hearths without the necessity of their processing where a continuous feeding by wood fuel is not possible.

TECHNOLOGY PROPOSAL FOR THE PROCESSING OF WOOD WASTE

It is the following procedure:
- receipt of sawdust and its classification,
- transport of material to a drying plant and drying,
- granulation, cooling, and dispatch.

The main production program is the processing of sawdust by granulation to pellets. Production technology starts by the receipt of sawdust on the place where a worm heaper, is situated: the sawdust is classified, dried, granulated or briquetted, and prior to the dispatch, cooled.

Cooled pellets are dispatched through a packaging line, which is a part of the whole palletizing line. During the production the pellets will be discharged from a dispatch feeder by an elevator, taken out to bales by a conveyor, and weighed for a required weight. Then, plastic bales will be closed by sealing of a feeding opening [1].

DESCRIPTION OF PRODUCTION

The worm heaper transports the sawdust to a feeding conveyor and a return, and then to a sorter. At the sorter the sawdust is assorted. Rough waste (skin and cuttings) from the assortment are ground in a grinder and transported by the conveyor to a holder at a heating boiler of its own drier. The transport of fuel to the boiler is managed by a rake conveyor, which leads to a pre-holder of heating. Fuel feeding to the boiler is managed by the worm heaper feeding the conveyor.

Classified fine sawdust is transported by the worm conveyor through a cell feeder (turnstile) to a drum drier BS-6. To prevent the burning of dried sawdust, the boiler is connected to a drier through an afterburning cell, which only consequently leads to a drier cell BS-6. The drier is equipped with an electro-motor with a gear, which turns the drum.

The heating of the drier is performed by a boiler for wood waste. In order to reach full capacity of the line in the future, thre is considered the purchase and installation of a wood grinder, which will grind also another transported coarse material, and by a conveyor transport it to a feeder at the boiler set for the heating of the drier.

Dried sawdust is pneumatically transported from the drier by a pipeline with a fan to the main cyclone of the drier. The fan is connected to a dust-removing cell, and consequently to a chimney. From the cyclone of the drier the sawdust is transported through turnstiles to a vibration classifier.

From the classifier, fine sawdust goes through the worm conveyor to an adjustment storage bin of a granulator. The filling of the granulator is managed by the feeding worm conveyor.

Produced pellets are led from the granulator through a double-wave valve, a conveyor belt, and a correction elevator to a cooler. From the cooler the pellets are transpored by a conveyor belt and a correction conveyor to a dispatch feeder. Out of this the pellets are transported by the conveyor belt to packaging equipment. A fan, which leads to a separator brings cooling air to a cooling string.

A roll from a cooler returns to the production process by the worm conveyor, which leads to the worm conveyor.

Cooling air is sucked from the cooler, which means that the cooler works under pressure.

Pellet dispatch is performed from a dispatch storage bin through a manual barrier to the conveyor belt. The pellets are thrown to sacks by a conveyor, and at the same time weighed according to a required weight on a semi-automatic scale. Packaging, which can be set up within a limit of 15 to 25 kg, is finished by closing and sealing sacks from various materials.

Coarse sawdust is transported from the classifier by the worm conveyor to an adjustment storage bin, which adjusts momently fluctuations of a drier capacity in the fraction of coarse sawdust and own palletizing press. From the storage bin, the palletizing press (34) is filled by the feeding worm.

A roll of sawdust produced at the output of the pellets is returned from the press to a heaping worm at the receipt of raw material. All the waste from the pressing of the sawdust is hence returned to the production, and is fully processed.

The control of the whole line will be transferred from a new electro-distribution, which is built of bricks and embedded inside a hall.

ECONOMIC ANALYSIS

Investments necessary for the realization of the project for the processing wood waste are in the volume of SKK 10 055 560. SKK 205 800 means the volume of working capital necessary for a project provision.

The analysis of an economic aim is realized based on the calculation of input data, which are stated at the beginning of the part “Comprehensive Budget”. In case of a credit, a short-term credit could be considered with maturity of 5 years and credit rate of 12 %. The rate of investment is set so that already in the first year the whole volume is to be re-invested and in the first year the production starts in the first year as well.

Production costs are stated on the basis of a detailed calculation. As it is a rather simple technology and assortment of products is at the moment limited to one, production costs are calculated in units, and in economic evaluation they are stated as variable.

RESULTS OF ECONOMIC ANALYSIS

The result of the economic analysis is the statement of several characteristics; Cash Flow, net profit, value of net profit, period of return, and internal profit percentage.

The results are summed up in Table 4.

Table 4. **Results of economic analysis**
Tablica 4. **Rezultati ekonomske analize**

	Net profit	Value of net profit	Period of return	Internal r. percentage
Variant 100 % - 0 %	SKK 23 019 904	SKK 10 184 814	4,5 years	50 / %

CONCLUSION

In comparison with larger facilities, which are realized mainly in a plant sphere, there exists a very interesting possibility also for the owners of family houses to replace classical coal or natural gas heating by ecologically clean and cheap wood, or wood waste. Also there is a change in thinking of the owners of houses and decision for this kind of heating. At current modern boilers classical burning is replaced by a three-stage process of wood gasification with electric regulation. Modern technologies of wood gasification and the consequent burning of wood gas mean a significant increase in comfort, and wood heating does not have the character which the older generation remembers. Wood gas is much cleaner fuel than an initial biomass, and at its burning most of impurities, including smoke, will be removed. Moreover, such gas is a universal fuel because it can be used also in motors with internal burning, e.g. in gas turbines.

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