The Possibility of Combined Production of Heating and Electric Energy by Burning Wooden Residues

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CONFERENCE ON POWER PLANTS

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Introduction

- Biomass is the oldest and the first renewable energy source used by mankind. The fact is that wood biomass still has a significant place in the global energy balance. It is used equally in developing and developed countriesa.
- Wood biomass (wood residues) is traditionally used as fuel in boilers at the wood processing plants, and generated heat is used in the technological processes (drying, steaming and pressing).

The conversion of wood waste to energy

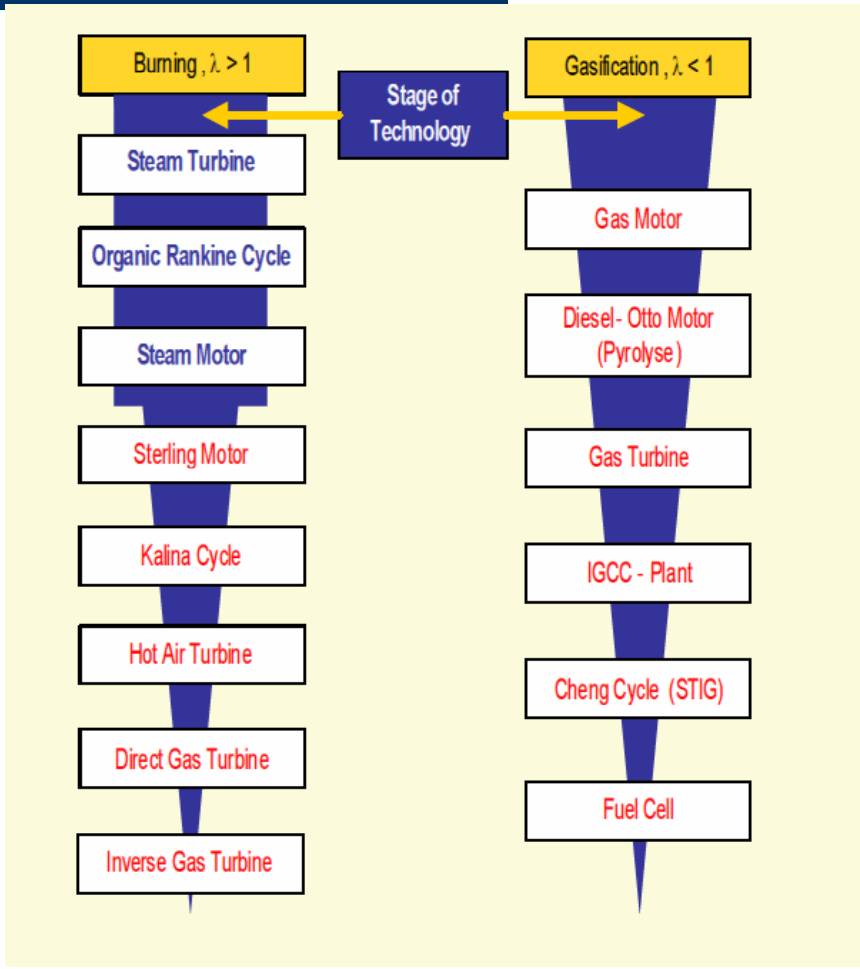
- Wood biomass can be directly burned in furnaces and boilers alone or with some other energy source (typically used with coal).
- Another possibility is gasification of wood biomass and production of heat or mechanical energy in engines or turbines using “singas”- product of the gasification;
- Wood biomass can be used for producing methanol or other motor fuels too.

The conversion of wood waste to energy

- Wood biomass can be indirectly used for producing the electricity.
- There are a number of different technical solutions for this purpose.
- Production of electricity from renewable sources has appropriate financial incentives, given in the Regulation adopted by the Government of Serbia last year.

The conversion of wood waste to energy

- Technologies for the conversion of heat into electricity can be classified according to:
- mode conversion including:
  - steam cycle process,
  - gas engines and turbines processes,
  - combined processes,
- and according to technical maturity.



The conversion of wood waste to energy

- The efficiency of heat to electricity energy transformation is relatively small, regardless of the applied technical solution.
- The production of electricity from woody biomass can be economically justified only if it is possible to find heat energy consumer for heating, cooling or technology needs nearby.

The conversion of wood waste to energy

- There are three necessary conditions to be justified before you start CHP project in the wood processing plant:
  - to have enough raw materials – wood residues,
  - to have a sufficient and balanced heat consumers in the facility or nearby, and
  - to have long-term contract to sell electricity, and that there are technical possibilities to make it happen.

Wood residues in sawmills

Input material - logs	Percentage	
	Hardwoods	Softwoods / Conifers
Main product: Dry limber	50	65
Residues:		
Large pieces	24	12
sawdust	16	14
Wood dust	3	2
Shrinkage	5	5
Measuring erorros	2	2
Total residues	50	35
Altogether (lumber & residiues)	100	100
Bark	5	5

Energy needs in sawmills

Product	Energy used*	The participation of certain types of energy [%]	
	[GJ/m^3]	Toplotna energija	Električna energija
Limber (Naturally dried lumber)	0,06 – 0,20	0	100
Limber (Artificial dried)	1,00 -2,88	87	13

CHP plant selection

When selecting CHP technology should be appreciated relevant recommendations:

- For small CHP power plants of up to 100 kW of electricity most appropriate available technology is Stirling engine (still under development);
- For medium CHP plants with power output of 200-2000 kW of electricity steam turbines and particularly ORC process are suitable. This technologies are commercially available in the market;
- For large CHP plant with capacity greater than 2,000 kW of electricity most appropriate solution are steam turbines.

CHP plant selection

- In sawmill in Serbia small and medium enterprises are the most numerous.
- The need for heat in these firms is small and installation CHP up to 0.6 MW of electric power would be sufficient.

Economic justification for the application of CHP in sawmill wood processing

Typical sawmill technologies

Case	Description
I	Sawmill with an annual single-processing 10,000 m^3 of spruce/fir
II	Sawmill with an annual single-processing 10,000 m^3 of beech
III	Sawmill with an annual two phase-processing 10,000 m^3 of beech

Economic justification for the application of CHP in sawmill wood processing

Quantities and the energy potential of wood residues

Case	Processed	Wet wood residiues	Dry wood residues	Potential energy of wood and bark residues
	m^3/year	m^3/year	m^3/year	MWh/year
I	10,000	3,100	0	4,957
II	10,000	4,500	0	11,934
III	10,000	2,500	2,000	13,063

Economic justification for the application of CHP in sawmill wood processing

Energy consumption in drying

Case	The amount of wood to be dried	Heat consumption	Potential energy of wood and bark residues	The ratio of available and required amount of wood residues
	m^3	MWh_{th}/year	MWh_{th}/year	–
I	6,500	2,730	4,000	1.46
II	5,000	3,500	9,550	2.73
III	8,000	5,600	10,500	1.87

Economic justification for the application of CHP in sawmill wood processing

Characteristics of selected CHP plant

Technology	Input energy	Working hours	Electricity	Available heat
	MWh_{th}/year	h/year	MWh_{el}/year	MWh_{th}/year
ORC 650	27,857	6,000	3,900	20,057
DD-Gas 600	13,090	6,000	3,600	4,740

Economic justification for the application of CHP in sawmill wood processing

Electricity production in sawmills - ORC 650

Case	The amount of wood to be dried	Energy for drying	Available energy	Efficiency of CHP	Amount of limber to be dried	Needed sawmill capacity
	m^3/year	MWh/year		%	m^3/year	
I	6,500	2,711	4,740	14	48,098	73,997
II	5,000	3,470	4,740	17	28,901	57,801
III	8,000	5,552	4,740	28	28,901	36,126

Economic justification for the application of CHP in sawmill wood processing

Characteristics of selected CHP plant – DD Gas 600, Pyroforce Technology

Case	The amount of wood to be dried	Energy for drying	Available	Efficiency of CHP	Amount of limber to be dried	Needed sawmill capacity
	m^3/year	MWh/year		%	m^3/year	
I	6,500	2,711	4,740	57	11,367	17,488
II	5,000	3,470	4,740	73	6,830	13,660
III	8,000	5,552	4,740	117	6,830	8,537

Economic justification for the application of CHP in sawmill wood processing

Ekonomski parametri korišćenja CHP

Technology	Electricity	Income[1]	Wood residue consumption	Fuel cost[2]	Other costs[3]	Total cost	Profit
	MWh/year	€/year	t/year	€/year			
ORC 650	3,900	526,500	1,125	45,034	365,622	410,656	115,844
DD Gas 600	3,600	486,000	1,783	71,324	598,378	669,702	-183,702

[1] The sales price amounts to € 0.136 kWh / kWh, adopted fuel price is 40 € / t Atro.
2 This is the price which, according to available information obtained from the sawmill factory plywood.
3 Other expenses include depreciation costs, maintenance costs, operating and other expenses.

Economic justification for the application of CHP in sawmill wood processing

In our example – ORC 650

Case	Electricity	Income	Fuel cost	Total cost	Profit
	MWh/year	€/year	€/year	€/year	€/year
I	591	79.801	6.825	372.447	-292.646
II	1.423	192.126	16.432	382.054	-189.928
III	1.558	210.298	17.987	383.609	-173.311

Economic justification for the application of CHP in sawmill wood processing

In our example – DD Gas 600

Case	Električna energija	Prihod	Troškovi goriva	Ukupni troškovi	Razlika
	MWh/year	€/year	€/year	€/year	€/year
I	1.281	172.944	27.009	598.378	-452.443
II	3.084	416.373	65.025	598.378	-247.030
III	3.376	455.756	71.176	598.378	-213.798

Conclusions

- **Beech wood is most processed species of wood in Serbia. Conifers are processed in a lesser extent, fir wood at most. The average sawmill in Serbia processes less than 10,000 m3 of round wood per year.**
- **Domestic mills have a surplus of available wood waste**

Conclusions

- **Cost of wood waste is reasonable. In Austria wood biomass average cost is from 0.020 € to 0.025 per kWh, in Serbia this price is about 0.011 € per kWh.**
- **In Serbia there are favourable conditions to generate electricity from renewable energy sources including wood waste;**
- **Incentives rates are offered to prospective manufacturers similar to those in Europe.**

Conclusions

- **Everywhere in Europe sawmills are a target group where the installation of CHP plants should be reasonable and cost-effective. But, according to our research, this is not same for Serbia.**
- **The results show that the offered incentives are not sufficient simulative to build CHP plants in sawmills with capacity of about 10,000 m3 per year.**

Conclusion

- **Cogeneration capacity of 650 kWel based on ORC technology could make a profit only if the condition would be included in the system for heat supply in sawmill with annual production at least 36,000 m3 of round wood.**

Thank You for Your Attention!