A review of biomass combustion devices

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Aims

- Presentation of devices used for biomass combustion and applied technologies.
- Calculation of production 1 kWh of thermal energy.

Biomass

- Biomass is biodegradable fraction of products, waste and residues from agriculture (including plant and animal), forestry and related industries including fisheries and aquaculture, as well as biogass and the biodegradable fraction of industrial and municpal waste.
- Burning biomass is well known for human being from the moment he learnt how to kindle a fire.

Classification

Biomass boilers could be classified into categories such as:

- Size (or rated power)
  - Small- up to 50 kW of rated power,
  - Medium- up to 1 MW,
  - Big- over 1kW
- Fuel- Mono- and multi fuel; type of fuel

Classification (2)

- Way of loading, (e.g. periodic straw boiler)
- Furnance type.
  - Grate
  - Retort
  - Fluidized bed

Costs calculation

There are some costs which must be taken in account:

- Cost of boiler (lifetime- 14 years, used 151 days a year, 21 hours a day),
- Fuel costs,
- Maintenance costs- higher factor for boilers with automatic feeder,
- Electricity costs,

Presuppositions

- Coal is analysed only for comparison- it is not a biomass fuel,

Fuel prices and electricity price (January 2013)

Fuel type	Heat value (kJ*kg^{-1})	Comments	Price (PLN*kg^{-1})
Straw	15		0.3
Oats	16,6		0.55
Pellets	20,5		0.68
Wood (hornbeam)	15	Density= 770kg*m^{-3}	0.286 (0.22 PLN*m^{-3})
Coal	24		0.739

Electricity	**0.5337 PLN for 1kWh**

Average exchange rate in January 2013 was about 0,23€ for 1 PLN

Devices parameters

Type of fuel	No.	Rated power (kW)	Fuel consumption ($kg*h^{-1}$)	Elecricity consuption (kW)	Device price (PLN)
Wood	1	21	6.7	0.08	7700
	2	32	10	0.08	12500
	3	38	11.5	0.08	14500
Straw	1	25	10	0.55	12239
	2	40	15	0.55	16113
	3	70	20	0.55	21833
Pellets/oats (A)	1	16 (14)*	3.6 (3.7)*	0.35	14338
	2	24 (21.6)*	5.4(5.5)*	0.40	14830
	3	32 (28)*	7.3 (7.4)*	0.45	17049
Pellets/ Coal (B)	1	15	3.5 (2.3)**	0.14	15480
	2	25	5.8 (3.9)**	0.14	16490
	3	40	9.3 (6.2)**	0.14	19750
	4	75	17.4/11.7	0.20	29850

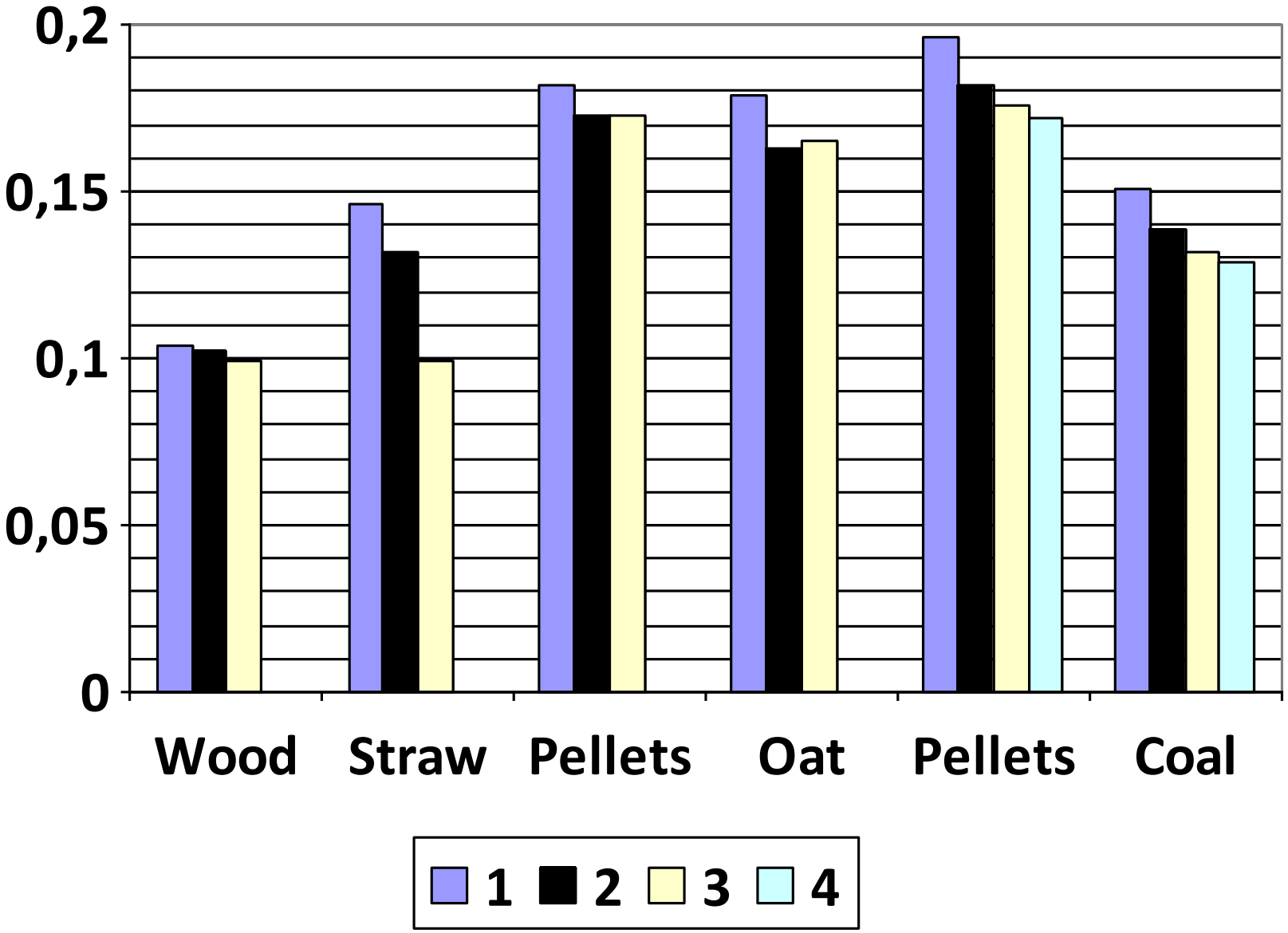
Results

Costs of generating 1 kWh heat energy.

Fuel	No.	Rated power (kW)	C_d (PLN)	C_f(PLN)	C_e(PLN)	C_m(PLN)	C_{1kWh}(PLN)
Wood	1	21	0.008	0.091	0.002	0.002	**0.104**
	2	32	0.009	0.089	0.001	0.003	**0.102**
	3	38	0.009	0.087	0.001	0.003	**0.099**
Straw	1	25	0.011	0.12	0.012	0.003	**0.146**
	2	40	0.009	0.113	0.007	0.003	**0.132**
	3	75	0.007	0.086	0.004	0.002	**0.099**

Fuel	No.	Rated power (kW)	C_d (PLN)	C_f(PLN)	C_e(PLN)	C_m(PLN)	C_{1kWh}(PLN)
Pellets (A)	1	16	0.02	0.153	0.001	0.008	**0.182**
	2	24	0.014	0.153	0.001	0.006	**0.173**
	3	32	0.012	0.155	0.001	0.005	**0.173**
Oats (A)	1	14	0.023	0.145	0.001	0.009	**0.179**
	2	21.6	0.015	0.14	0.001	0.006	**0.163**
	3	28	0.014	0.145	0.001	0.005	**0.165**
Pellets (B)	1	15	0.023	0.159	0.005	0.009	**0.196**
	2	25	0.015	0.158	0.003	0.006	**0.182**
	3	40	0.011	0.158	0.002	0.004	**0.176**
	4	75	0.009	0.158	0.001	0.004	**0.172**
Coal (B)	1	15	0.023	0.113	0.005	0.009	**0.151**
	2	25	0.015	0.115	0.003	0.006	**0.139**
	3	40	0.011	0.115	0.002	0.004	**0.132**
	4	75	0.009	0.115	0.001	0.004	**0.129**

Costs of generating 1 kWh heat energy.



Conclusion

- Wood was confirmed as the cheapest fuel,
- Costs for straw were comparable but only for biggest- most powerful devices,
- What is more straw is more convenient fuel for farms or municipal heat plants,
- Electricity costs are the highest for straw combusting device.

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Thank You