Politechnika Wrocławska

CONCEPTUAL PROJECT OF BIOMASS FIRED DISTRICT HEATING POWER PLANT

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Briefly about the biomass boiler

Biomass boilers are a remarkable alternative to the traditional heat sources. Biomass is widely available and it is cheap fuel.
Wood, wood briquettes, pellets, energy crops, straw, vegetable oils and biogas are successfully used.
Biomass boilers are becoming more and more popular because they provide low heating costs and what is the most important nowadays, they are friendly to environment (reduced emission of sulphur and CO_2).

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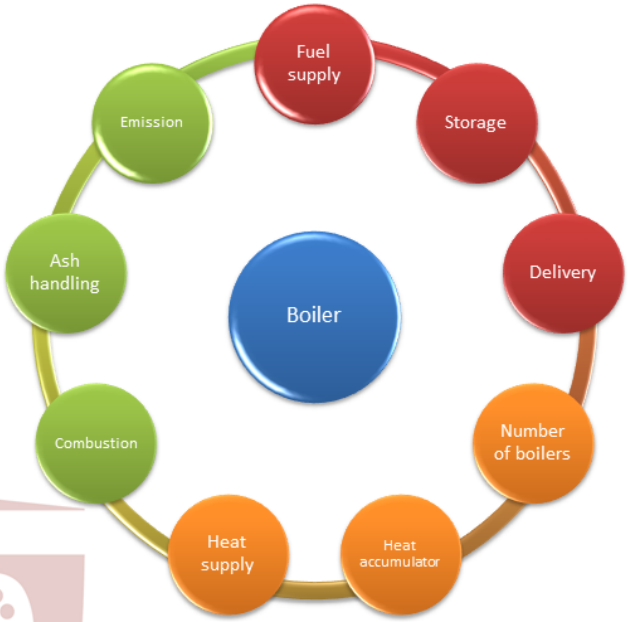
Connection systems for biomass



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Our project

Group no. 1

- Thermal power output: 1 MW
- Fuel type: wheat straw (pellets)

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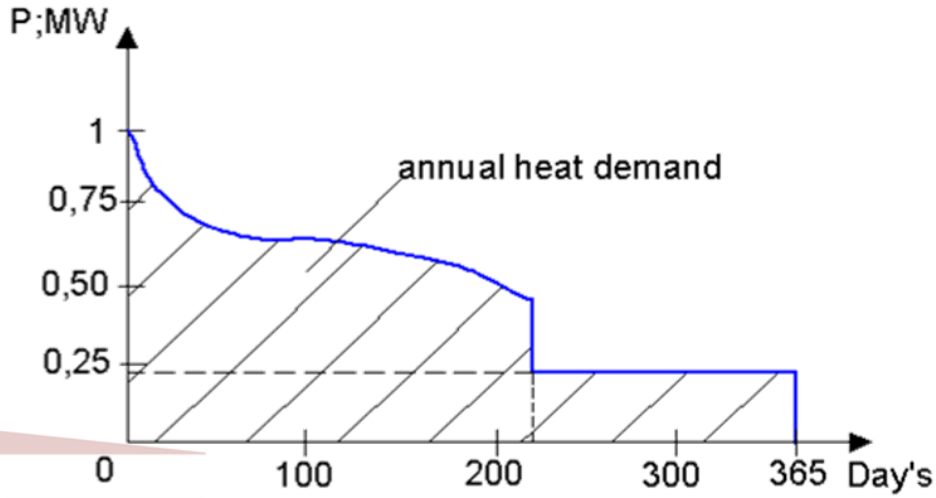
Heating load duration curve



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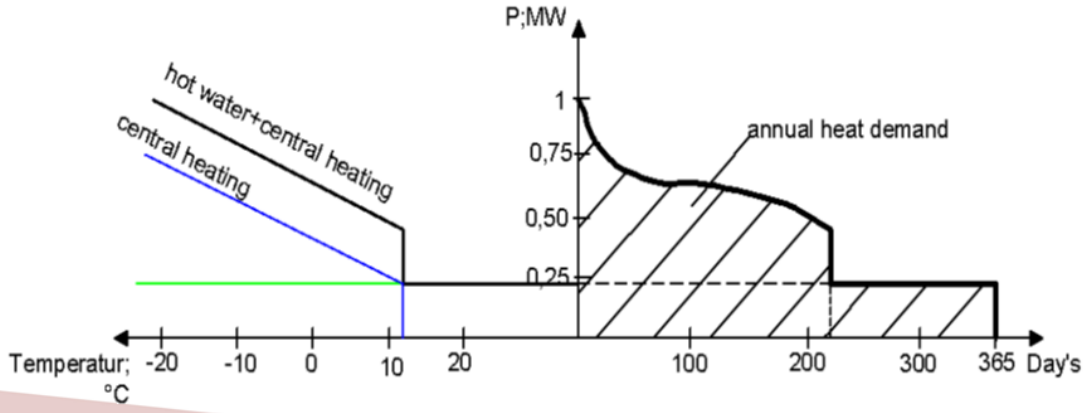
How is it made?



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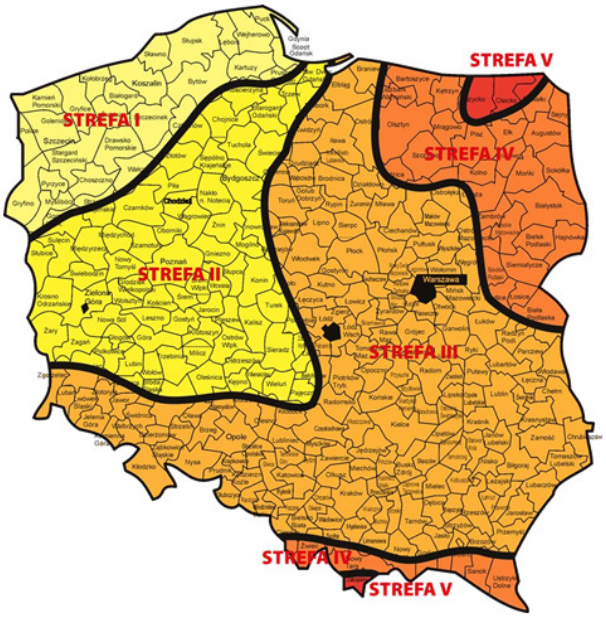
Location of our boiler

Our boiler is designed to work in Warsaw, which is located in the third climatic zone.

The average Polish home consumption amounts to 30kW.
Our project includes 1MW so our boilers can deliver heat and hot water for one housing estate.



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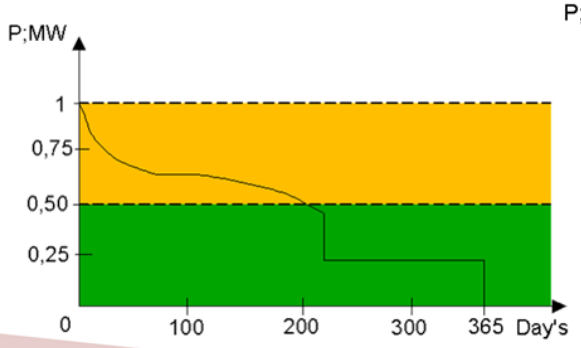
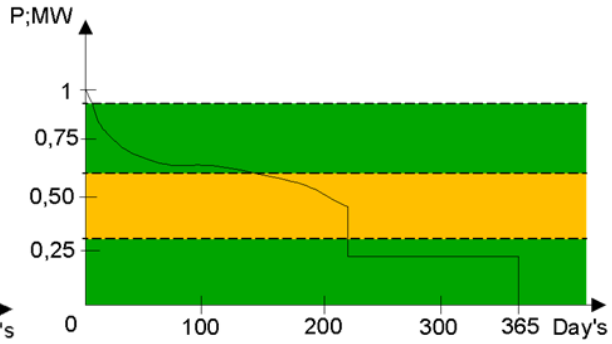
Selection of boiler units

2 boilers:



3 boilers:



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Selection of boiler

According to us, the most important criterion is the efficiency. We choose 3 boilers of 300 kW each one.
It does not give us 1MW, but we can observe the difference in the fact that that we usually consume less hot water in winter.

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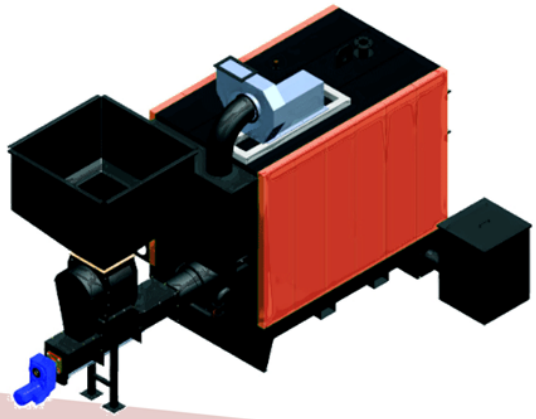
Boiler **Granpal Medium 300kW** [1)]



Boiler equipment:

- Type of fuel: dry biomass(e.g. wheat straw pellets)
- automatic ash removal system,
- automatic control,
- Fuel feeder(Stoker type),
- protection against fire,
- lambda sensor.

1) http://www.granpal.pl

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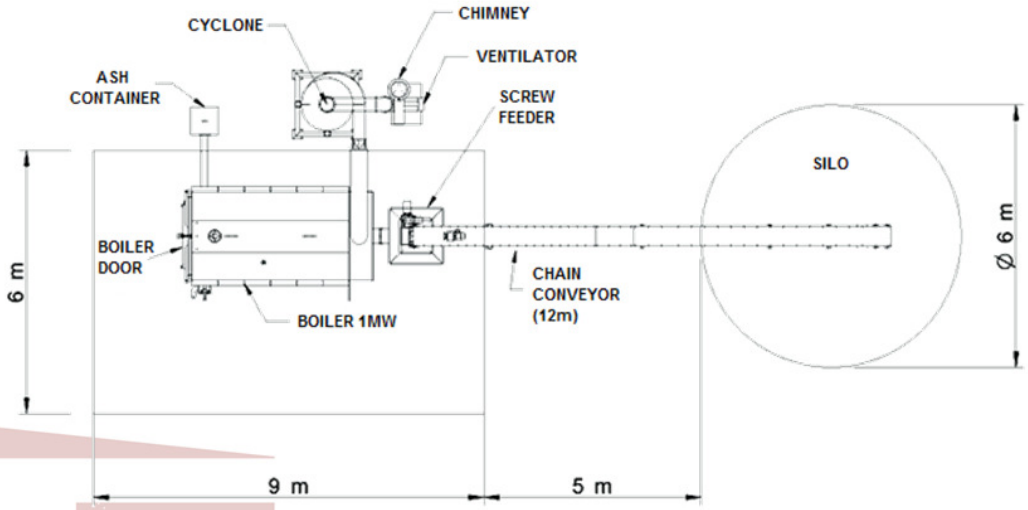
Examplary installation of boiler Granpal Medium



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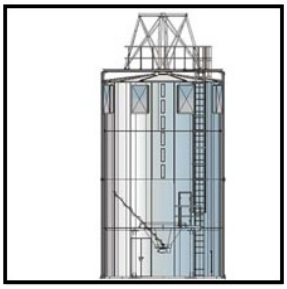
Fuel storage







Zaadaptowano z O.Ö. Energiesparverband

Fuel warehouses:
1. Direct access
2. Delivery is blown with horizontal screw feeder and vertical discharge to the boiler
3. Indirect access with pre-drying
4. Direct discharge to the outside of the cellar
5. Silo

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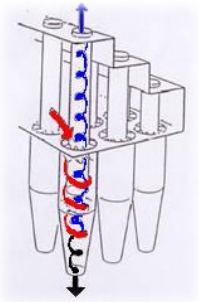
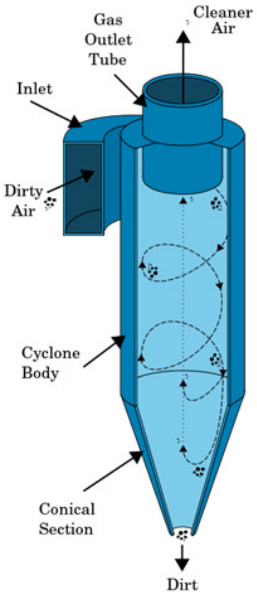
Multicyclone

Cleaning with a multicyclon is removing particulates from an air, gas or liquid stream through vortex separation without the use of filters.

Rotational effects and gravity are used to the separate mixtures of solids and fluids.

The method can also be used to separate fine droplets liquid from a gaseous stream.





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Hot water tank

In order to reduce the costs of heat production and increase the efficenty hot water tank was added to the system.

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Ash

Important is what is placed in a boiler but also important are the products of combustion. Ash characteristics vary depending on the type of fuels; generally, fuels of better quality leave less ash. For the pellets of the best quality, the ash content should be lower than 0.7% of the mass.

Automatic ash removal is a standard feature of all modern boilers; a screw conveyor is usually used to removing. It removes ash into an airtight container what considerably simplifies maintenance.

Manual cleaning is still recommended at specified intervals. The ash can be used as a fertilized because it contains large amounts of potassium. Larger particles can be effectively removed using a cyclone or multicyclone, through which the exhaust fumes are let in. However, the ash should be not used as a fertilizer because it contains heavy metals.

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Central heating fuel demand

$$B_{CO,W} = \frac{(86400\ s/d)\cdot Sd \cdot Q_{CO}}{(t_i - t_e)\cdot H \cdot \eta_k \cdot \eta_p} = 236\ [t/year]$$

S_d – heating degree-days (assumed Sd = 3050 d·°C/year according to www.ogrzewnictwo.pl)

Q – demand for thermal energy for district heating (assumed Qco=660 kW)

t_i – the internal temperature (assumed t_i = 20°C)

t_e – the outside temperature (Warsaw is located in the third period of the winter climatic zone in Poland so we asssumed t_e = -20°C)

H – calorific value (assumed that fuel is pellets for which H = 19 200 kJ/kg)

η_k – boiler efficiency (usually η_k = 0,96)

η_p – transmission efficiency (assumed η_p = 1 beacause of insulated wires)

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Fuel needed to heat water

$$B_{CWU} = \frac{(86400s/d) \cdot 365\ d/year \cdot Q_{CWU}^{hśr}}{H \cdot \eta_k \cdot \eta_p} = 97\ \text{[t/year]}$$

$Q_{CWU}^{hśr}$ – average hourly demand for thermal energy for the purpose of hot water ($Q_{CWU}^{hśr}$= 240kW);
H – calorific value (assumed that fuel is pellets for which H = 19 200 kJ/kg)
η_k – boiler efficiency (usually η_k = 0,96)
η_p – transmission efficiency (assumed η_p = 1 because of insulated wires

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Minimum volume boiler house

According to the Polish norm, for every 4,65 kW, there is one cubic meter volume.

$$K_{min} = \frac{Q}{4{,}65\ kW/m^3} = \frac{900kW}{4{,}65kW/m^3} = 194\ m^3$$

Assuming that the height of the boiler house equals to 2,7 metre,
we get the (surface) area of 64,6 square metre.

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Thank you for your attention!

Dziękujemy za uwagę!

Ďakujem za pozornosť!

Děkuji za pozornost!

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