

**Possibilities of the diversification of fuels for district heating boilers
for condition of Lviv Oblast**

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Based on data of local Lviv boiler house technical and economical analysis of revamping of existing boiler fueled by gas has been carried out. Nine different options of boiler retrofitting were considered, they are summarized in the table 1. Study also includes analysis of fuel substitution - high methane Natural Gas (LHV=35.2 MJ/m³) by biomass pellets (LHV=15,58 MJ/kg, DAF – Dry Ash Free) and coal from Lviv – Volhynian Basin (LHV=33.46 MJ/kg, DAF). Calculations were carried out for 4 MW_{th} allowing to cover heat demand amounting to 33807 GJ/year as it was evaluated for the Lviv Oblast model-year. In the study technical and cost data of commercially available for Polish and Ukrainian technologies of the energy conversion and two cases of prototype solutions enabling the use of local energy sources updated for the year 2016 have been used in the study.

Table 1 . Analyzed spectrums of technical options

Lp.	Variant of modernization												
	Ia	Combustion control change											
Ib	Combustion control change, new economizer, new boiler control devices												
Ic	Combustion control change, new economizer with condensation ,new boiler control devices												
II	Change of a existing boiler from gas to biomass pellets burner												
III	Change of a existing boiler from gas to Lviv-Volyn oblast type of coal												
IV	Adding of a pregasifier system feeding by Lviv-Volyn oblast type of coal to existing boiler												
V	Erection of the new boiler with retort burners feeding by the biomass pellets												
VI	Erection of the new boiler with retort burners feeding by the coal												
VII	Erection of a small bubbling fluidized bed boiler with in situ desulphurization												
Scope of modernization													
	M.pal	M.aot	Mk	Me	BK	BE	BKon	BP	BZ	BO	BPR	BRet	
Ia	■	■											
Ib	■	■											
Ic	■	■											
II	■	■						■		■		■	
III	■	■											
IV	■	■						■					
V	■	■						■					
VI	■	■											
VII	■	■											

Legend: M.pal - modernization of the burner; M.aot - modernization of automation; Mk - modernization of existing boiler; Me - modernization of the economizer; BK - boiler with automation construction; BE - economizer construction; BKon - construction of condensation and small SO_x adsorption system; BP - construction of the reservoir pellet / carbon and coal handling systems; BO - construction dust collector (multicyclone); BPR - construction dutch oven; BZ -pregasifier construction; BRet- retort burner.

For each option - energy and efficiency indicators, emissions of CO₂, NO_x and SO_x and basic economic indicator – pay-back period have been calculated. In the case of options focused on limited retrofitting of existing boiler, the most economic feasible option turns out the option relaying on improvements of burners and control system (option Ic). While considering more complex revamping of the boiler, the most economical solutions is option III relying on the replacement of Natural Gas and additional modification allowing combustion of the coal (adding coal burner to boiler). In case of deep reconstruction of the boiler, the best economic indicators have been achieved by option V - characterized by 6 months pay back period and thermal efficiency amounting to 90.8 %. All environmental and economical finding of study are summarized on four charts allowing to make an investment decision.