Retrofit biomass co-firing option for combine heat and power production in Belarus

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Objective and Approach

The main objective is to evaluate technological, economical and environmental provisions for the biomass-based fuel conversion of the existing heat/power generation facilities currently operated with fossil fuel in Belarus. In Belarus, the bioenergy has the doubtless perspectives in conditions of the barest necessity to achieve a certain energy safety level. The intermediate approach to be realized in the nearest decades is a retrofit biomass co-firing that would allow upgrading the existing power units and provide their simultaneous life-extension, efficiency improvement, and fossil fuel displacement. In most of the cases, the existing old facility does not need complete replacement of the gas-fired boiler being retrofitted. The rehabilitation can be provided by means of assembling an external wood-fired combustor. The distinctive feature of application of any bioenergy option in Belarus is the fact that about 25% of wood fuel resources are contaminated with radionuclides as a result of Chernobyl Accident. This requires special approach to technology selection for retrofit.

Biomass Resources and Energy Sector

Belarus is ideally suited to bioenergy due to large area of productive industrial forest, flat landscape, well-developed power distribution and district heating infrastructure, and technically competent society. The actual data were collected by regions, focusing on quantification of forestry debris, fuel wood and woody waste generated as a result of different types of felling and lumber processing. The results of the present evaluation show that bioenergy in Belarus may have annually available about $1.5 \cdot 10^6$ t.e.c. by now and up to $2.7 \cdot 10^6$ t.e.c. by 2015. If the technologies of fast rotation energy crops/coppices are applied, this may provide additionally about $1.2 \cdot 10^6$ t.e.c. per year.

In Belarus, about 85% of fuel and power resources are imported from Russia. In addition, most of the installed power units (60%) will reach the end of lifetime by 2010. In spite of this, the situation in energy sector is not entirely hopeless today. The demand of all kind of energy resources decreased from 63.1 millions t.e.c. to 34.0 millions t.e.c. in 2000 against 1992 due to difficulties in Belarus economy resulted from transition period from plan to market. Within the same period, electric energy consumption decreased by 24%, thermal energy - by 37%, diesel fuel and gasoline - by 15%. On the other hand, in accordance with prognosis, the peak demand in near future will begin to rise forming an acute deficit of capacity of about 5 GW(e) by 2010.

The intermediate solution for the nearest decades is, therefore, a retrofit biomass co-firing at the existing power units rather than “green field” option. The retrofit approach would allow upgrading the existing power units and providing simultaneous life-extension of the existing old boilers, efficiency improvement, and fossil fuel displacement. This would be the most cost-effective alternative, and as such, would stand a better chance to obtain financing from multilateral or bilateral development sources. The long-term opportunities are related to the most optimal plan of the future expansion of electricity generating system when construction of about 10 wood-fired power units, each with capacity of up to 20 MW(e), would cover a certain part of base load in the regions with intensive power/heat demand and woody waste concentration.

Retrofit Technology and Its Siting

In some cases, the complete renovation by installation of a new wood-fired boiler is necessary while rehabilitating an old power unit. In most of the cases however, the existing old facility does not need complete replacement of a gas-fired boiler. The retrofit can be provided by means of assembling an external wood-fired combustor. All the old gas/oil-fired facilities appropriate to retrofit were screening. The following main criteria were suggested to select the project sites:

?? Boilers of the 50-150 MW(th) capacity range should be considered for retrofit option.
?? The co-firing and heat/power-combined scheme should be envisaged.
?? A boiler should be placed at a power plant that formerly used to operate with solid fuel.

Several technologies were considered: stoker-grate, fluidized bed, suspended wood dust combustor, and Vortex combustor. In view of possible delivery of contaminated wood fuel, the special approach to technology selection for retrofit is required. The design guidelines emphasize well-established technology, high reliability of flue gas cleaning system and rigid control of construction standards. As for flue gas treatment system, the evaluation of aerosol capture efficiency for two conventional techniques was done: electrostatic precipitator and baghouse filter.

Results of Evaluation

As a result of screening, four gas-fired units have been chosen as the candidates for installation of the first medium capacity power-generating biomass-fired boiler in Belarus according to the above criteria. They are: Svetlogorsk Power Plant, BelGRES, Zhodino Power Plant, and Polotsk Power Plant.

It was evaluated that the biomass-fired stoker-grate combustor is the most sound for retrofit co-firing in view of the above criteria and specific requirements, formulated for design performance taking into account possibility of contaminated biomass conversion. The flue gas control based on a baghouse filter is suggested as the most effective system providing about 99.9% of total capture efficiency in terms of volatile radionuclides. Two possible options for assembling of a stoker-grate combustor were evaluated: (i) separate furnace extension to an existing boiler unit; (ii) complete replacement of an existing boiler unit. The results of economical assessment (for Belarussian conditions) are presented in Table 1.

Table 1. Comparative economical analysis of different retrofit options

Technology	Svetlogorsk	BelGRES	Zhodino	Polotsk
	NPV at the end of the 10th year, in thousand US dollars			
i	30142.0	8005.1	47399.0	14335.0
ii	24334.4	1892.3	44039.6	12614.4
	Internal Rate of Return, %			
i	55	37.0	100.8	56.5
ii	36	13.6	71.9	42.6

Conclusion

The current situation in energy sector of Belarus promotes introduction of the retrofit biomass co-firing technology that is feasible enough to successfully compete in energy market during the nearest decades. Both ecological and economical goals are achieved, since the renewable resources, mainly biomass waste of low commercial value, are involved in energy conversion process. It is shown that a biomass-fired stoker-grate boiler is a reliable and environmentally sound commercial system that can provide safe

valorization of unclaimed and contaminated biomass in Belarus. The suggested biomass co-firing retrofit scheme allows achieving internal rate of return of more than 30% with payback period of 2-5 years.