Evaluation of Biomass-based Technologies for Substitution of Natural Gas in a Combined Cycle CHP Plant (to be submitted).

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Abstract. This paper presents and evaluates options for substitution of natural gas with biomass in a combined cycle plant (CCGT) with supplementary firing, operated in combined heat and power (CHP) mode. Such options should be of interest, since there have been large investments in CCGT units over the last decades and it is likely that there will be a need to reduce CO2 emissions from these units. The options investigated are indirect atmospheric gasification of biomass to Synthetic Natural Gas (SNG) for firing in the CCGT, biomass firing in a stand-alone boiler (CHP) and integration of a solid fuel combustion unit in a biomass/natural gas hybrid combined cycle. These options are compared to an existing 600 MWfuel CCGT reference plant by means of simulations. The comparison is made quantitatively (thermal efficiencies) and qualitatively (risk and flexibility of the options).
The simulations show that the hybrid scheme will have significantly higher (41.7%/97.9% electric/total) efficiency than both the gasification option (26.0%/91.9% electric/total) and the stand-alone biomass boiler (32.4%/98.6% electric/total). The gasification scheme offers the highest load factor and flexibility (in fuel and energy carrier), but suffers from lower efficiency and higher risks compared to the hybrid scheme. The biomass boiler option is a low-risk technology with high total efficiency, but with lower flexibility than gasification and lower electric performance than the hybrid option. Choice of the most suitable option is dependent on factors such as risk willingness, fuel access and the revenue from selling heat, power and gas. Applying the results on the Gothenburg case study, it is concluded that options based on solid combustion (Bio, BioHyb) are more attractive (due to higher efficiency, lower risks and better compliance with local district heating demand) than a gasifier solution (Gasif). For other energy systems the conclusion may differ, i.e. local conditions should be considered when evaluating various options.

Keywords. Biomass, Gasification, Co-Firing, District Heating, Energy efficiency.