CHP Case Studies in the Pacific Northwest

52 MW Wood-Chip Fired Steam-Turbine Generator

Kimberly Clark Mill in Everett, Washington

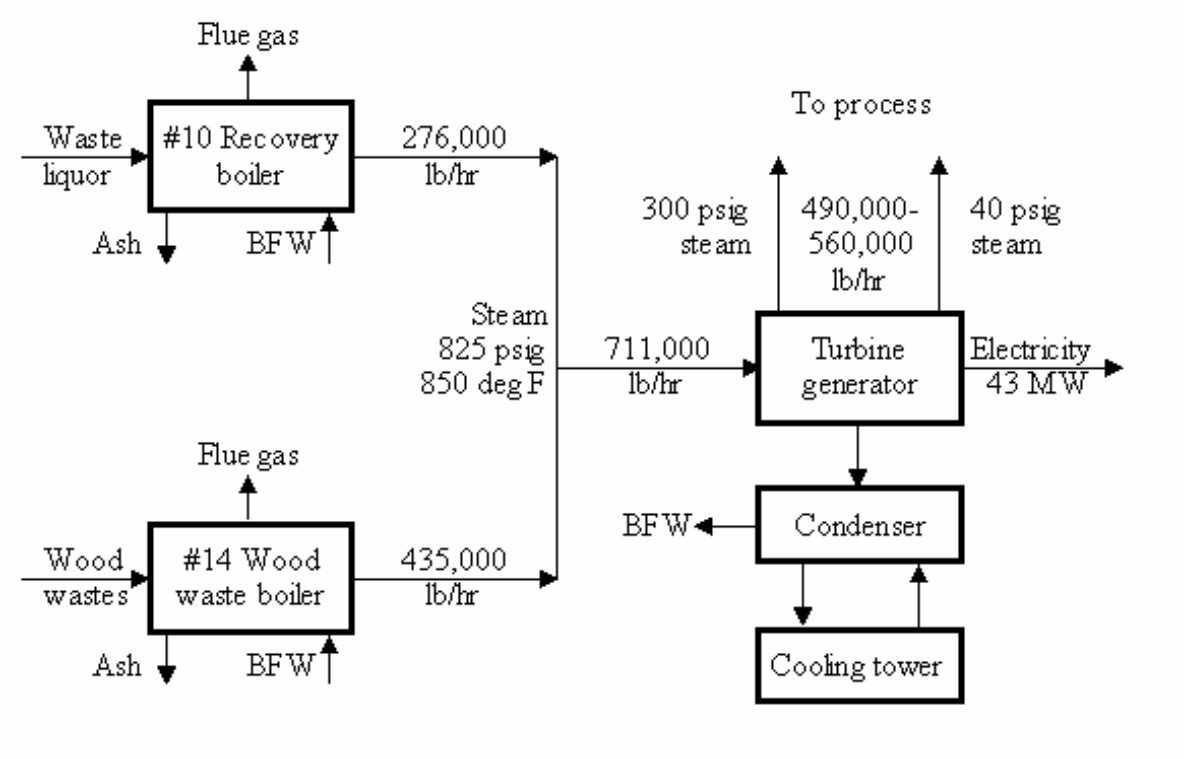
Site Description

Kimberly-Clark is a global health and hygiene company, with annual sales in excess of $14 billion. Well-recognized brand names include Kleenex®, Huggies®, Cottonelle®, Scott®, and Viva®. Its mill in Everett, Washington manufactures pulp and a variety of consumer and business-to-business tissue products. The Utilities operation includes a cogeneration boiler with a 52 MW generator, a recovery boiler, and three auxiliary boilers. The mill employs 850 people.

The Snohomish County PUD and the mill (then owned by Scott Paper) jointly began construction of the $115MM cogeneration facility in 1993. The PUD provided the capital and owns the project in addition to receiving the electrical output. KC provided construction management and operates/maintains the facility, receiving steam for its tissue mill processes.

The mill initially approached PUD in December of 1990. A memorandum of understanding was executed in April of 1992, and construction & operating contracts executed in October 1993. Ground breaking began that same month. The project was commissioned and began limited operation at the end of 1995 with full commercial operations in August 1996.

By working cooperatively with the local utility, Kimberly Clark was able to upgrade the mill with the latest technology boiler and thereby enhance the economics and stability of mill operations. Snohomish PUD acquired a generating resource near a large urban load center powered by renewable energy.



Plant Configuration

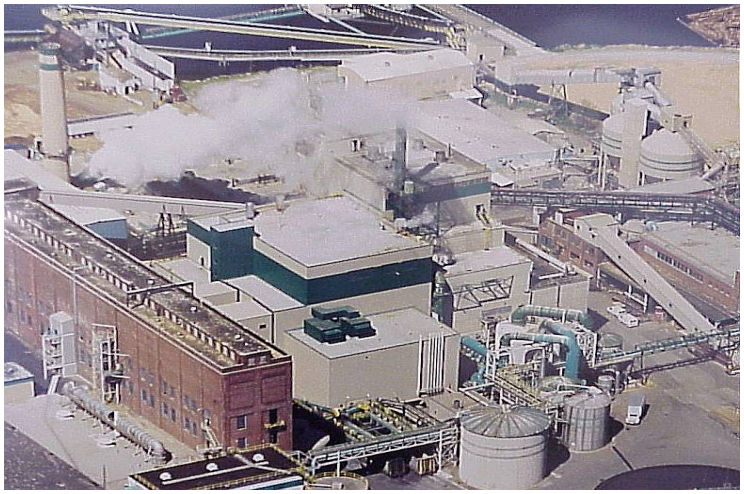
The new wood boiler (#14) is a screw-fed, sloping grate design by Gotaverken (now Kvaerner) that is based on a mass burn design used in Europe and at a few other locations in North America. This configuration was selected over the more common stoker grate or fluidized bed designs in order to handle the wide range of fuel sizes expected at the plant and to achieve very low NOx emissions.

At design conditions, 435,000 lb/hr of 825 psig, 850°F superheated steam from the wood-fired boiler is combined with 276,000 lb/hr of high-pressure steam from the mill's recovery boiler burning waste liquor. The condensing steam turbine drives the generator and produces low-pressure steam for process use in the mill.

The 16-stage, General Electric extraction steam turbine has a rated capacity of 46.9 MW. Steam enters the turbine at about 800 psig and is extracted at 300 and 40 psig. The generator has a rated capacity of 52.2 MW. The condenser normally condenses 150,000-220,000 pounds/hour of exhaust steam from the turbine (the difference between the amount of steam generated in the two boilers and the amount of steam used in the mill). However, the condenser is capable of condensing 350,000 pounds/hour of steam; this allows the wood-fired boiler to operate as a stand-alone power plant when the mill is down. The capacity of the wood-fired power plant when operating in a stand-alone electric generating mode is about 39 MW.

The plant has a fuel receiving and storage system that can handle wood wastes in a range of sizes. Five groups of three screws each feed the wood wastes into the boiler.

The fuel consists of both mill residues and urban wood wastes. Mill residues – bark and hogged wood – are supplied by mills located in Puget Sound, Olympic Peninsula, and British Columbia. Urban wood wastes consist of wood wastes such as pallets and land clearing debris. The share of urban wood waste, and especially the land clearing debris, increases during the summer. The fuel mix has been running about 40% mill residue and 60% urban wood waste during the summer and a greater proportion of mill residue during the



Everett Mill Utilities Complex

winter. As logging operations in the region decline, the proportion of urban wood waste in the mix will increase.

At times, in order to maintain steam production or to adjust to fuel or ash handling upsets, it is necessary to supplement the wood fuel with natural gas.

Energy/Financial Analysis

KC and PUD signed a 21 year contract, renewable every 5 years thereafter. PUD provided the capital and KC built and operates the plant. During the first fifteen years of operation, the paper mill buys the fuel, operates and maintains the facility, and uses the steam. Starting in year 10 the utility will pay an increasing portion of the fuel cost. Starting in year 16, the utility will also pay part of the O&M cost.

The mill has rights to 6,000,000 MMBtu of steam from the plant. PUD has rights to 325,000 MWh/year of the power output. Penalties for under-delivery of power are based on the Mid Columbia Electricity Wholesale Price Index.

PUD has a long-term contract with Sacramento Municipal Utility District (SMUD) to sell an average of about 33 MW through the year 2007. This was done to eliminate any early-year rate impacts on Snohomish County PUD customers. Under terms of the contract, SMUD will purchase energy and capacity at a levelized real rate of 4.1¢/kWh through September 2007. This contract price is higher than the prevailing wholesale rates in the Northwest. The power purchase agreement allows SMUD to purchase up to 36 MW during summer months and 26 MW at other times of the year. SMUD has the option of shifting a portion of the available winter capacity and energy, and using it for summer delivery. Summer scheduling is capped at 42 MW. After the SMUD purchase period concludes, PUD intends to bring the power back to serve local customers.

The Kimberly-Clark Everett mill is a retail customer of Snohomish County PUD, and consumes nearly as much electricity as the cogeneration plant produces. There is an average of about 5 MW of export power available from the mill.

Operating Experience and Results

Actual power output during the plant's operating history has been consistently somewhat lower than the contracted amount due to reduced mill operations and underperformance of the boiler.

Approximately 25 different vendors supply wood waste for the boiler. These multiple supply sources cause a variation in fuel composition that needed to be addressed by fuel blending. The average heat content of the wood waste fuel input is 19,000 Btu/kWh.

The boiler generates 425,000 pounds/hour of steam with 55% moisture fuel, compared to the design values of 435,000 pounds/hour with 60% moisture fuel. When 60% moisture fuel is received (in the rainy season, which typically peaks in January

and February), the auxiliary natural gas, burner must be used.

There were a variety of startup problems including fuel slides, slagging, failure of superheater tubes, fuel and ash handling problems, pressure parts, and other performance issues. Several changes have been made to the boiler design and in operating procedures. Changes were made in air nozzle locations, grate design, and other areas. The unit now operates more reliably and with higher output.

Environmental Profile

On start-up and initial operation, the boiler was unable to meet the original guarantees on NOx emissions and carbon carryover. The wide variation in fuel types, sizes, and moisture content, created control problems which were addressed by improved fuel blending in the yard, and by adjusting the grate and the feed systems. Attempting to control NOx with additional ammonia injection caused a visible plume. These problems were reduced by increasing the secondary (overfire) air injection rate to increase turbulence, and by decreasing the ammonia injection rate.

The higher NOx emissions were addressed by installing an ammonia injection system on the older recovery boiler. Ammonia injection into the flue gas at the wood-fired boiler was discontinued. The recovery boiler has a better profile than the wood-fired boiler, so the reduction of NOx emissions by ammonia injection is much more efficient in that boiler. All permit requirements are being met.

An existing bag-house serving the old wood waste boilers was upgraded to provide particulate control for the new boiler.

Lessons Learned

There were both positive and negative lessons learned from this project.

On the positive side, cost reductions were achieved by the project by cooperative cost sharing between Kimberly Clark and Snohomish PUD. Each of the partners focused on their strength. KC had

General Electric Steam Turbine Generator

experience constructing and operating boilers, while PUD had access to inexpensive capital and the ability to market the electrical output. The use of an existing site meant that the infrastructure was already in place – water, gas, electrical interconnection, and water treatment. PUD's existing power supply portfolio simplified integrating the plant electrical output into the resource mix.

There were some harder lessons learned. Technically, the boiler never performed up to its specifications, resulting in lowered output and the need to burn natural gas to maintain steam output during certain periods.

In addition, the mill and the utility had very dissimilar general business activities and institutional environments. There was little common understanding of each party's accepted business practices such as risk tolerance, environmental decision-making process, duration of contractual requirements, and public disclosure requirements.

Future Plans

PUD is currently engaged in an integrated resource plan to determine the most cost effective options for meeting future power needs. There are no immediate plans to expand production at the site or to seek additional CHP projects.

Organizational Profile

Snohomish PUD – Owner, Financing, Marketing of Electrical Output
Kimberly-Clark – General Contractor and Site Host
Major Subcontractors:
HA Simons – Engineering and Procurement
Gotaverken – Wood-Waste Boiler & its Facilities & T/G Building
Fletcher General – Construction of Substation, Underground Piping, and Electrical Distribution System within the KC mill.
General Electric – Manufacturing and installation of Turbine Generator and auxiliaries:

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Case study based on presentation made by Cross and Zwaller at *The Northwest CHP Roundtable*, June 23, 2003 and by an evaluation by G. Wiltsee, *Lessons Learned from Existing Biomass Powerplants*, NREL/SR-570-26946, 2000.

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