Biomass Plant Design and Operation

A biomass energy system can supply any heat consumer with sufficient heat using biomass for base load purposes and natural gas for peak coverage and as a back-up.

The overall supply process can be illustrated by following the path of the fuel and its conversion into heat:

1. Fuel is delivered by truck (dump truck or walking floor trailer) to site and tipped into a below-grade concrete bunker.
2. Fuel is reclaimed from the bunker. Floor scrapers on the bottom of the hopper push the material into a trough were its conveyed further either by a hydraulic ram or a chain conveyor.
3. Dropping into a chute and passing an air lock fuel is finally stoked into the firebox by yet another hydraulic ram.
4. A reciprocing flat grate moves the wood forward without disturbing the firebed too much. In a first stage moisture is driven out of the fuel. Next the wood fuel is gasified using primary air supplied by a set of fans blowing in from underneath the grate. At the end of the grate all fuel is gasified leaving behind nothing but ash that drops into a chute and is automatically removed from the firebox and deposited in ash dumpster.
5. Wood gases are finally burned ("oxidized") under the influx of secondary air and are turned into hot fluegases at 950 to 1050°C. The combustion temperature and oxygen content in the air supply is controlled by recirculating some of cold fluegases from downstream of the boiler.
6. Hot fluegases are drawn by a suction fan through a three-pass water boiler, transferring their heat to the water in the boiler. The efficiency of the boiler ranges between 83% and 92%, depending on the moisture content of the fuel. Water, heated up to as much as 120°C – or steam - is now piped to the various consumers in a closed loop. Returning "cold" water (60 to 80°C) is constantly reheated to the temperature required by the consumers at any given time.
7. After leaving the boiler, flyash is removed from the flue gases using a mulicyclone: A series of cyclones create a vortex that forces the flyash and particles to the outside, sucking the clean air from the center, the "eye of the tornado". This system allows taking approximately 90% of the particulates out of the fluegases.

8. Before releasing the fluegases to the atmosphere a further clean up is done using a baghouse with a temperature resistant filter bag or an electrostatic precipitator. The filtering equipment allows meeting local standards for particular matter emissions.

9. The entire process is computer controlled using a touch screen PLC. The energy system may also be controlled via computer, including the internet. A modem sends alarms as a text message to the cell phone of the operator. Alternatively a pager can be used.

10. The energy system is equipped with various safety devices that close air tight gates or flood equipment in case temperatures rise above a safe threshold. Sprinklers as well as "deluge systems" are operated independently of electric power.