5 Results and Discussion

Key issues affecting the economics of Biomass gasification cofiring include the capital cost of the gasification island, the costs of retrofitting the utility boiler, any potential boiler derating or loss of capacity as a result of the retrofit, the cost and reliability of the feedstock, and the opportunity costs associated with alternate fuels such as switching to natural gas. The costs of operating a relatively new technology such as the gasifier under cofiring arrangement may be influenced by potentially unforeseen maintenance or component replacement as well as the usual up-keep of such a plant. Similar uncertainties may be associated with the costs of maintaining the retrofitted boiler now being operated in a co-fired mode. With cofiring, there will be the need to integrate the controls for the gasification plant with those of the boiler operation in order to assure good performance and reliable operation from the gasifier and boiler integration. Unforeseen controls issues may also affect the operation of the combined plant and hence the costs of power production.

The broader market for commercializing this gasification technology includes other sites in the US, which have utility boilers and large concentrations of poultry litter production near by. These sites must be numerous enough to attract the industrial investment needed for a profitable business in this technology. The type of business model, varying from direct equipment sales to owning and operating the gasification plant [i.e., selling hardware versus selling product gas] will influence how attractive this market is to the industry. The prospect of more stringent environmental controls coupled with more complete deregulation of the utilities will also impact the economic benefits associated with the co-firing market since more or less utilities will consider converting their boilers to this mode of operation. Finally, the relative flexibility of this gasification approach will impact the extent to which other biomass feedstocks can be gasified in the same manner as poultry litter; the extent to which the gasifier and feedstock handling equipment need to be modified; the change in equipment capital and operating costs associated with such modifications; and the resulting shift in market opportunities associated with these issues.

5.1 Infrastructure/Fuel Supply and Alternative Fuels

Gasification has been applied to a wide variety of biomass materials including charcoal wood and wood waste, spent pulping liquor, pulp mill sludge, biosolids (wastewater treatment plant sludge), waste paper, rice hulls, rice straw, switchgrass, sugar cane, bagasse, poultry litter, and other animal wastes. Historically it has been used in close-coupled combustion applications to make steam, and in generation of electrical power largely through firing in internal combustion engines. In recent years efforts also have been made to couple biomass gasification to combustion turbines in integrated gasification-combined cycle (IGCC) applications.

A key feature of the fuel infrastructure is proximity of the biomass fuel source to the co-firing facility. This helps to reduce the costs of gathering and transporting the biomass fuel to its point of use. In other cases, where the fuel supplier is ready to pay for the haulage costs to avoid related processing and environmental problems, there may even be a financial credit associated with the use of the biomass. Depending on the nature of the feedstock, on-site storage and mass handling of the raw biomass feedstock also require attention in the facility design and maintenance considerations to avoid potential groundwater contamination and stream run-off, as well as odor and pest control.

Other fuel infrastructure problems include consistency of the feedstock properties and rate of delivery. Large fluctuations in either of these factors will require a more flexible design of the gasifier and co-firing features of the boiler with potential escalations in capital and operating costs.

5.2 Merits of the Project

Gasification-based co-firing has numerous inherent advantages. It increases the market potential of biomass co-firing. Not only is it applicable to both PC and cyclone boilers, but it is also applicable to many natural gas-fired boilers. If used in conjunction with duct burners between combustion turbine and a heat recovery steam generator (HRSG) it is applicable to combined cycle technology as well. The concept of gasification-based co-firing has the potential to accomplish the following objectives for boiler co-firing:

5.2.1 Energy Benefits and Impacts

- Maintain the ability to increase boiler capacity when firing wet coal by adding more Btu's to the primary furnace
- Minimizes the particle size reduction requirement for the biomass as gasifiers typically are capable of using 20 mm (¾”) minus size particles rather than the 6 mm (¼”) minus size particles associated with co-firing
- Minimize efficiency losses in the boiler by taking those moisture-related losses in the gasifier

5.2.2 Environmental Benefits and Impacts

- The gasification approach broadens the range of biomass that can be successfully co-fired with coal or with natural gas, including the use of zero cost and negative cost fuels (for example reduction in the size of biomass is not as stringent for gasification as it is for direct co-firing)

- Permits deployment with natural gas-fired reburn systems for possible NOx reductions when combusting the producer gas from the gasifier. The over fire reburn system in PC boilers has shown reduction in the NOx from the boiler.

- Continuing the reduction of emissions by reducing the sulfur content of the fuel in the high sulfur coal burning plants.

- Modifying the operating combustion mechanism with gas firing for NOx control, and reducing the particulate loading on existing boiler.

- Biomass co-firing reduces the amount of coal or other fossil fuel used and thereby reduces the net amount of CO_2 emission to the atmosphere since the use of biomass is considered to have zero impact on the CO_2 atmospheric budget (i.e. plant feed for poultry with subsequent production of poultry litter implies that the CO_2 absorbed by the plants is transmitted in part to the litter and in part to the production of meat – consequently more CO_2 is absorbed than is released from the biomass during gasification and combustion). This can be considered a CO_2 *credit* under this form of accounting).

5.2.3 Economic Benefits and Impacts

The potential hurdles to economic acceptance of the proposed technology include a capital cost commitment to the biomass gasification co-firing technology, uncertainties of the maintenance and operations cost in this application, and the degree to which the reliability and consistency of the feedstock can be assured. The following items represent economic benefits that can potentially offset some of these cost hurdles:

- Keeping the biomass ash separate from the coal ash by gasifier design protects the ability for the plant operator to make ash sales as potential fertilizer.

- The zero or negative cost of biomass (including the benefits of tipping fee avoidance) may lower the cost of plant operation, off-setting to some degree overall cost of electricity (COE) from the biomass gasification plant.

- An actual demonstration of this technology in the future will provide necessary capital and operating cost data to support an accelerated commercialization of the proposed biomass gasification co-firing technology for utility boilers

5.2.4 Infrastructure/Fuel Supply Benefits and Impacts

Biomass gasification projects depend upon availability of cheap fuels. Biomass by itself is a cheap source of fuel and it is generated on year round basis. Therefore supply of biomass is normally not a problem. However, logistics and associated cost of gathering such biomass and delivery to a central location for gasification is the challenge and normally a high cost item. With the low Btu value of the biomass transportation costs can quickly escalate to become a major cost factor.

The WKE application provides a good resolution to all of the infrastructure/fuel supply issues. The Reid plant is ideally located from the fuel supply perspective because of its proximity to large-scale chicken processing plants and the existence of an infrastructure to deliver chickens from area farmers to a central location for processing. Preliminary estimates from the processing plants put the poultry litter in the 50 miles radius of the Reid plant at 180 000 to over 200 000 tons per year. Further, there is a high degree of consistency and rate of delivery of the litter because of the mass production farming features and growth uniformity of chickens farmed in this manner.

The disposal of the poultry litter has been a significant problem for the local farmers and they have been requesting a regulatory relief from US EPA and US Department of Agriculture. At present the farmers do a partial clean up of the bedding material every 16~18 weeks and go through a springtime cleanup, whereby they completely remove the litter and dispose of it as landfill. If these farmers can find alternatives to land-based disposal, it may be possible to set up long-term fuel supply contracts at low or no cost to the Reid plant. The benefit to the local farmers will be an outlet for their poultry waste as well as more flexibility in scheduling clean-up and removal of the bedding material from their farms.

5.3 Project Sustainability and Opportunities for Replication

The chicken processing and other food processing industries are recession proof activities. Hence the supply of poultry litter is assured for the Reid plant as long as nearby chicken processing plants stay in operation. Alternatively, Primenergy gasifiers have been successfully tested with variety of other biomass fuels, such as sawdust pulp mill sludge, rice hulls, biosolids, etc. This flexibility allows the gasifier operators to secure and switch to alternative bio-fuels if poultry litter supply problems develop.

The operation of the co-firing project at the Reid Plant also meets a primary requirement of sustainability; that is WKE already has established a maintenance organization for its switchgrass biomass power plant and plans to generalize their services to include the proposed gasification facility at their Reid plant.

This project also addresses problems faced by local poultry farmers. The increasing appetite for poultry in North America has increased the concentration of poultry farms and associated litter. Poultry litter has become a disposal problem and runoffs from the fields over-fertilized with litter may carry excessive nutrients to nearby waterways potentially hurting water quality and aquatic life. The proposed gasification system at WKE's Reid Plant will reduce the litter volume while supplying biomass-based energy to the boiler. The greatly reduced volume of ash from the poultry litter will be more economical to transport and sell as high quality fertilizer. Thus the proposed gasification plant will turn a liability into a potential profit center.

This project can also demonstrate excellent replication opportunity throughout the country. The food industries in general and perishable food processors in particular are widely distributed due to the market they serve. The processors have well-established supply and delivery systems for their products as well as for the waste they generate. With these premises, it is safe to assume that there are many other utility power plants that can serve as hosts to gasification systems. With Federal Tax credit under Section 29 for renewable energy, which includes poultry litter, we believe that many utilities will be interested in setting up cooperative agreements with the poultry processors/poultry farmers and in evaluating gasification-based co-firing of biomass.

As a result of these potential benefits we believe that the technology and siting approach proposed here can lead to commercialization of this particular application of biomass co-firing in the future compared to other concepts currently being considered for biomass. However, at present, the economic evaluation based on current price of coal does not lead to commercialization of this technology in North America.