DESIGNING AN OPPORTUNITY FUEL WITH BIOMASS AND TIRE-DERIVED FUEL FOR COFIRING AT WILLOW ISLAND GENERATING STATION AND COFIRING SAWDUST WITH COAL AT ALBRIGHT GENERATING STATION

Type of Report: Quarterly
Report Period Start Date: April 1, 2003
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Principal Authors: K. Payette and D. Tillman

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Name and Address of Submitting Organization:

Allegheny Energy Supply Co., LLC.
4350 Northern Pike
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DISCLAIMER

ABSTRACT

During the period April 1, 2003 – June 30, 2003, Allegheny Energy Supply Co., LLC (Allegheny) proceeded with demonstration operations at the Willow Island Generating Station and improvements to the Albright Generating Station cofiring systems. The demonstration operations at Willow Island were designed to document integration of biomass cofiring into commercial operations. The Albright improvements were designed to increase the resource base for the projects, and to address issues that came up during the first year of operations. This report summarizes the activities associated with the Designer Opportunity Fuel program, and demonstrations at Willow Island and Albright Generating Stations.

TABLE OF CONTENTS

LIST OF GRAPHICAL MATERIALS

Page

INTRODUCTION

Cofiring—the firing of two dissimilar fuels at the same time in the same boiler—has been proposed for using biomass in coal-fired utility boilers. In practice, this cofiring introduces a family of technologies rather than a single technology. The family of technologies includes blending the fuels on the coal pile or coal belt, and feeding them simultaneously to any processing (e.g., crushing and/or milling) systems on their way to the boiler; preparing the biofuels separately from the coal and introducing them into the boiler in a manner that does not impact fossil fuel delivery; or converting the solid biofuels to some other fuel form (e.g., producer gas) for firing in a coal-fired or natural gas-fired installation. The Allegheny project is designed to demonstrate both direct combustion approaches to cofiring.

The Willow Island Demonstration

Allegheny Energy Supply, LLC is demonstrating blending wood waste and tire-derived fuel to create a new opportunity fuel for cofiring in cyclone boilers, and integrating this fuel combination with a separated overfire air system for maximum NO_x management. This project also is demonstrating the use of biomass-TDF blends to reduce SO_2 and fossil CO_2 emissions along with trace metal emissions. The demonstration is occurring at Willow Island Generating Station Boiler #2. It is a 188-MW_e cyclone boiler operated in a pressurized mode and equipped with a "hot side" electrostatic precipitator (ESP). This demonstration, located in Willow Island, WV, has numerous unique features to significantly advance cofiring technology. Allegheny Energy, using Foster Wheeler Development Corporation, has completed a feasibility study for the project and has moved into Phase II—construction and operation of the demonstration system.

Cofiring of wood wastes with coal has been demonstrated as an effective means for using biomass in cyclone boilers; demonstrations have occurred at the Allen Fossil Plant of TVA, the Michigan City Generating Station of NIPSCO, and the Bailly Generating Station (BGS) of NIPSCO. In these demonstrations, NO_x, SO_2, and fossil-based CO_2 emissions reductions occurred. In each case, the volatility of the wood waste created the mechanism for NO_x reduction, while the use of a sulfur-free fuel reduced SO_2 emissions. Testing at BGS opened a new area of investigation: designing blends of opportunity fuels to optimize the impacts of cofiring. At BGS, urban wood waste is mixed with petroleum coke at a specified blend to optimize NO_x emissions management while accomplishing the goals of fossil CO_2 emissions reductions. The NO_x emissions reductions at BGS are ~30 percent when firing the designed opportunity fuel blend.

The Willow Island demonstration blends sawdust with TDF to create a new opportunity fuel for cofiring in a cyclone boiler equipped with a separated overfire air system. This demonstration evaluates the creation of a second opportunity fuel blend that has potential to maximize NO_x emissions reductions from the combustion process. At the same time, SO_2 emissions are reduced along with fossil CO_2 emissions and heavy metal emissions. The Willow Island plant "hot-side" ESP requires the use of a sodium additive to enhance the resistivity of the flyash particles. This demonstration examines the potential of biofuel cofiring to obviate the need for such additives in the control of particulates and opacity—capitalizing upon the potassium and sodium content of the biomass ash.

The demonstration program involves optimizing the sawdust-TDF-coal blend for maximum impact in the cyclone combustion process. Further, it involves optimizing this blend to capitalize upon the overfire air system for NO_x management. It is estimated that the project will fire at least 10 percent wood waste, along with about 10 percent TDF in the project.

While this demonstration involves integrating past successful programs, it provides a significant enhancement of cofiring and the use of biomass. If successful, it will be the first demonstration where cofiring has been explicitly integrated into an overall NO_x control strategy as a significant contributor. Further, if successful, it provides a means for cyclone boiler owners and operators to consider NO_x management strategies other than end-of-pipe solutions or expensive fossil-based combustion strategies to achieve compliance with current and proposed regulations.

Further, this will be the first cofiring demonstration where the boiler is equipped with a "hot side" electrostatic precipitator—an ESP installed between the economizer and the air heater rather than after the air heater. Such "hot side" ESP's conventionally use sodium additives to improve the resistivity of the flyash and enhance its capture. Biomass, with its concentrations of potassium and sodium, may reduce or eliminate the need for such additives. This demonstration will address that condition and, as a consequence, advance the use of cofiring in coal-fired boilers.

The Albright Demonstration

The Albright Generating Station demonstration provides a means for comparing the NO_x reduction results obtained at Willow Island Generating Station—in a cyclone boiler—to those that can be obtained in a pulverized coal boiler. The Albright Generating Station Boiler #3 is a 140 MW_e boiler, comparable in capacity to the Willow Island boiler. It burns a similar eastern bituminous coal. Of critical importance, the Albright boiler is equipped with a low-NO_x firing system including a separated overfire air system.

The Electric Power Research Institute (EPRI) has developed a demonstration of sawdust cofiring in a PC boiler at the Seward Generating Station. A favorable biomass fuel supply potential and the favorable technology potential has led Allegheny to decide to relocate

the cofiring demonstration to the Albright Generating Station. The relocation of the separate injection demonstration from Seward Generating Station to Albright provides opportunities to extend the knowledge base concerning cofiring—capitalizing upon the configuration of Albright Boiler #3. Specifically cofiring has not been applied to a generating station equipped with low NO_x firing separated overfire air system. In relocating the demonstration from Seward to Albright, Allegheny Energy and USDOE have capitalized upon such an opportunity.

The Combined Results

The combination of the Willow Island demonstration at the cyclone boiler and the comparative data developed at the Albright demonstration in a tangentially-fired pulverized coal boiler will provide definitive data concerning the emissions reduction potential of biomass cofiring in units already equipped with low NO_x firing systems. As such, these data will help define the potential, and limits, of biomass cofiring as an emissions reduction strategy. At the same time these demonstrations will provide a means for evaluating biomass cofiring as a cost-effective strategy for voluntary fossil CO_2 emissions reductions. Finally these projects will demonstrate additional environmental benefits of cofiring.

EXECUTIVE SUMMARY

The Twelfth Quarter of the USDOE-Allegheny Energy Supply Co., LLC (Allegheny) Cooperative Agreement, April 1, 2003 through June 30, 2003, was characterized by demonstration operations at the Willow Island site and continuous improvement at the Albright cofiring site. Technical work that proceeded during the twelfth quarter of the cooperative agreement included the following:

- At Willow Island Generating Station, improvements were completed and demonstration operations commenced again. A new fuel supplier—Mills Pride—was evaluated and their fuel characterized.

- Allegheny, after evaluating the sawdust supply for the Albright Generating Station and determining the need for an oversized material grinder, completed detailed engineering and procurement for the installation of a new grinder. The grinder selected was a 2-stage grinder, to be installed at the discharge of the oversized particles from the screen. The grinder was delivered by Industrial Biomass, Inc., and prepared for installation.

- Progress anticipated for the thirteenth quarter of this cooperative agreement—July 1, 2003 through September 30, 2003—includes continuation of the demonstration phase of the Willow Island project, installation of the 2-stage grinder at Albright, and the start of new testing at the Albright Generating Station. Progress also will include presentation of a paper summarizing progress at the Pittsburgh Coal Conference.

EXPERIMENTAL

Does not apply

RESULTS AND DISCUSSION

Overall results include significant operational testing at Willow Island, and the initiation of modifications to the Albright Generating Station Cofiring System.

Results at Willow Island

During the second quarter of 2003, the 12th quarter of the project, Willow Island received approximately 1,000 tons of biomass for cofiring, and burned what it received. Year-to-date totals for biomass consumption were over 1,700 tons of sawdust. Additionally, Willow Island received and burned over 2,400 tons of TDF in the second quarter, and about 5,000 tons of TDF YTD. During this quarter, biomass was burned on 34 days out of a total of 74 operating days; cofiring was practiced 46 percent of the time.

Willow Island continuously seeks new suppliers for biomass, and entered into discussions with Mills Pride. Mills Pride supplies cabinetry to numerous large discount hardware and home improvement chains. Detailed fuel characteristics were determined for this fuel, largely as a consequence of the use of medium density fiberboard (MDF) and plywood which includes urea formaldehyde glue as a constituent. The material safety data sheets (MSDS) for these materials were examined. Additionally, two fuel samples were obtained from Mills Pride and sent to Hazen Research, a commercial testing laboratory, for fuels characterization. Table 1 summarizes the results of the Mills Pride fuel characterization. Table 2 summarizes the ash analysis.

Table 1. Summary of Characteristics of Mills Pride Fuel

Parameter	**Fuel Sample**	
	Sawdust	Chips
Proximate Analysis (wt %)		
Moisture	42.15	36.86
Ash	0.59	0.91
Volatile Matter	47.35	50.72
Fixed Carbon	9.91	11.51
Ultimate Analysis (wt % as-received)		
Carbon	30.43	---
Hydrogen	3.46	---
Oxygen	21.76	---
Nitrogen	1.59	---
Sulfur	0.02	---
Moisture	42.15	---
Ash	0.59	---
Higher Heating Value (Btu/lb as-received)	4959	5382
Mercury (mg/kg in air-dried fuel)	<0.1 mg/kg	---
Ammonia (wt % in as-received fuel)	0.37	0.42
Formaldehyde (mg/kg in as-received fuel)	158	179

Table 2. Ash Elemental Analysis for Mills Pride Fuel

Compound	Wt % in Ash
SiO_2	16.76
Al_2O_3	19.90
TiO_2	19.04
Fe_2O_3	2.51
CaO	13.50
MgO	3.74
Na_2O	10.20
K_2O	4.88
P_2O_5	1.69
SO_3	4.17
Cl	1.10
CO_2	0.73

The fuel characterizations showed favorable results. The fuel has reasonable heat content and characteristically low sulfur and ash contents. It is high in fuel nitrogen, as would be expected from the use of urea formaldehyde glues; however it is not unacceptably high in either ammonia or formaldehyde. The ash is uncharacteristically high in titanium oxide, indicating the use of this compound as a filler and extender in the glues and possibly the coatings. The alkalinity comes largely from calcium oxide and sodium oxide. The sodium oxide may help the hot side electrostatic precipitator marginally.

The testing during the 12th Quarter of the project, then, reinforced previously experienced operational outcomes (see Report 40894R10). Willow Island continues to demonstrate the utility of cofiring sawdust in a cyclone boiler.

Results at the Albright Demonstration

During the 12th quarter, Industrial Biomass completed fabrication of a two-stage grinder designed to enhance operations at the Albright Generating Station. The grinder was delivered towards the end of the second quarter (see Figures 1 and 2). Foster Wheeler and Industrial Biomass began discussions regarding unique features of installing the grinder.

During final fabrication and check-out at the manufacturing plant, Foster Wheeler sent a representative for on-site inspection and witnessing of the grinder testing. Dust generation was noted. Foster Wheeler and Industrial Biomass began discussions concerning the capture and management of that dust, pursuant to safe and successful operation of this grinder.

Figure 1. First Stage of 2-Stage Grinder Delivered at Albright Generating Station

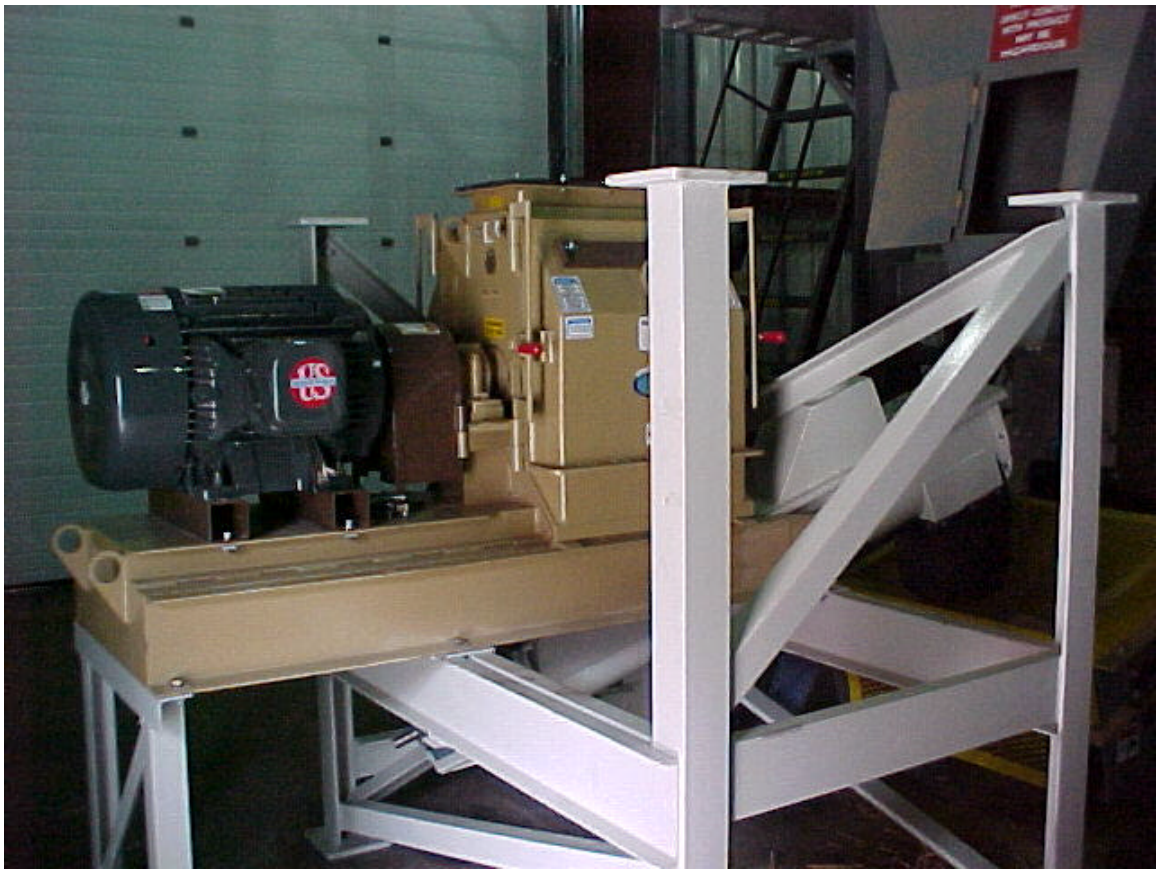

Figure 2. Second Stage of 2-Stage Grinder Delivered at Albright Generating Station

CONCLUSION: Expected Technical Progress During the 13th Quarter

The thirteenth project quarter, from July 1, 2003 through September 30, 2003 is expected to see the following progress, as shown in Table 3.

Table 3. Anticipated Progress at Willow Island and Albright Demonstration Sites

Progress at Willow Island	Progress at Albright
Demonstration of cofiring to continue, and data analysis associated with the demonstration also to continue	Completion of the dust management system and complete installation of the grinding system
Presentation of a paper at Pittsburgh Coal Conference	Resumption of cofiring testing
	Presentation of a paper at Pittsburgh Coal Conference

REFERENCES

None