PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Environment and Water Resources

10/2000

LOCATION

Willow Island, West Virginia
Albright, West Virginia

PARTICIPANTS

Allegheny Energy Supply Co., LLC
Greensburg, Pennsylvania
Biomass Power Program, U.S. Department of Energy
Washington DC
National Energy Technology Laboratory, U.S. Department of Energy
Pittsburgh, Pennsylvania and Morgantown, West Virginia
Foster Wheeler Development Corporation
Livingston, New Jersey
Reaction Engineering International
Salt Lake City, Utah
Cofiring Alternatives
Ebensburg, Pennsylvania

DURATION

9/21/00-7/20/03

COST SHARE

DOE	$2,970,619
Participant	$3,795,245

DOE Funding from the Office of Energy Efficiency and Renewables Biomass Power Program

BIOMASS COFIRING PROGRAM

Designing an "Opportunity Fuel" from Biomass and Tire-Derived Fuels for Cofiring at Willow Island Generating Station

Summary

Cofiring of wood waste-sawdust- and Tire-Derived Fuel (TDF) with coal into existing power plants reduces the emissions of sulfur dioxide, nitrogen oxides, and fossil-based carbon dioxide. Wood wastes and Tire-Derived Fuels (TDF) are "opportunity fuels" for electric power generating systems because they are inexpensive and environmentally friendly.

Allegheny Energy Supply, LLC will demonstrate the blending of wood waste and Tire-Derived Fuels (TDF) with coal in the cyclone boiler at Willow Island Generating Station Boiler #2. This is a 188-megawatt cyclone boiler operated in a pressurized mode and equipped with a "hot side" electrostatic precipitator (ESP) and a separate overfire air system. The overfire air system reduces NO_x from power plant emissions.

Allegheny Energy and Foster Wheeler Development Corporation completed the feasibility study for the project and will now move into construction and operation of the demonstration system.

Description

The Willow Island Demonstration will blend sawdust and Tire-Derived Fuel (TDF) with coal and cofire this mixture into the Willow Island Generating Station Boiler #2. This demonstration will examine the potential of biomass cofiring to eliminate the need for additives to control particulate emissions with a hot side electrostatic precipitator. Wood waste ash contains potassium and sodium, and the level of these elements may be sufficient to replace commercial additives used to increase the efficiency of the hot side electrostatic precipitator. Optimizing the use of the Overfire Air system will help control NO_x emissions.

Waste wood and Tire-Derived Fuel will be the second opportunity fuel blend used in electric power generating plants in the DOE Biomass Cofiring Program to maximize the reduction of NO_x emissions. The first opportunity fuel, waste wood and petroleum coke, was used at the Bailly Generating Station of the Northern Indiana Public Service Company (NIPSCO). In addition, this new fuel will reduce SO_2, fossil-based CO_2 emissions, and the heavy metal content of the ash.

TERMS

Opportunity Fuel

A nontraditional fuel burned in powerplants for economic and/or environmental reasons.

Electrostatic Precipitator

A device to remove dust and particulate matter from a flue gas stream using electrically charged plates to attract the particles. These devices are usually placed after an heat exchanger to keep the temperature of the gas low.

Hot Side ESP

A device to remove dust and particulate matter from a flue gas stream using electrically charged plates to attract the particles. The term "hot side" indicates that the precipitator is placed before the heat exchanger and runs at high temperature. Hot Side ESP requires the injection of sodium to enhance the resistivity of the flyash particles and increase the efficiency in the electrostatic precipitator.

Tire Derived Fuel

Fuel derived from processing of waste tires. Currently, the tires are shredded and the steel belts removed.

The results of these tests, focusing upon NO_x reduction achieved by sawdust cofiring, will be compared to results of a similar size and outfitted pulverized coal (PC) boiler at the Albright Generating Station. Albright boiler #3 is a 150 megawatt tangentially-fired boiler also equipped with a separated overfire air system. Albright #3 will operate with a biomass fuel for a sufficient period of time (720 test hours) to determine the interrelationships between cofiring and a separated overfire air system in a PC boiler. Comparison of the performance of both boilers will provide valuable operating experience and validate the efficacy of cofiring opportunity fuels to reduce NO_x, SO_2, and fossil-based CO_2 emissions.

Allegheny Energy will construct the biomass fuel handling and storage system at the Willow Island Station. The Tire-Derived Fuel delivery system is already in place. After construction, short-term testing will be done to determine the optimum blend of TDF/biomass/coal feed to the burners. Following this, Allegheny Energy will perform a two-year demonstration period will the opportunity fuel. If the results are successful, Allegheny Energy will continue to cofire the opportunity fuel blend.

Overview of Willow Island Generating Station

Boiler and cyclone in Unit #2

Site of new biomass feed system

Rear view of Willow Island Generating Station

Background Tests

Cofiring of wood wastes with coal is an effective means for using biomass in cyclone boilers. Three projects were completed on cyclone boilers in the DOE Biomass Cofiring Program: The Bailly Generating Station of NIPSCO, the Michigan City Generating Station of NIPSCO and the Allen Fossil Plant of the Tennessee Valley Authority.

Each demonstration showed reduction of NO_x, SO_2, and fossil-based CO_2 emissions. 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. Less coal was fired for the same heat load, which resulted in lower fossil-based CO_2 emissions.

Testing at the Michigan City Generating Station of NIPSCO showed that cofiring up to 10% by mass (6% by heat) wood waste achieved 9.5% reduction in NO_x and up to a 6% reduction in SO_2.

Similarly, testing at the Tennessee Valley Authority's Allen Fossil Plant showed that cofiring from 2-1/2 to 10% waste wood (by heat) achieved up to a 15% NO_x reduction and a 10% SO_2.

Tests at the Bailly Generating Station of NIPSCO were conducted with a specially blended mixture of urban wood waste and petroleum coke. This combination was designed to optimize the impacts of cofiring on NO_x and CO_2 emissions. A 30% reduction in NO_x emissions was achieved.

BIOMASS COFIRING IS AN EMISSIONS REDUCTION TECHNIQUE

1) Blending of sawdust with Tire-Derived Fuels, rather than petroleum coke, to create a new designer opportunity fuel.

2) Integrating cofiring with separated overfire air system for enhanced NO_x management.

3) Cofiring in a boiler with a "hot side" electrostatic precipitator using the biomass to minimize and potentially eliminate the use of additives to enhance precipitator performance.

Biomass Cofiring Program

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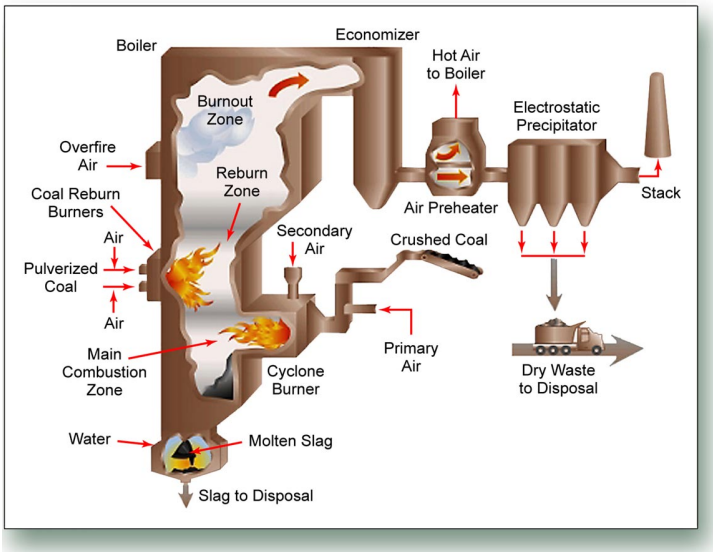

Schematic of cyclone boiler equipped with overfire air system showing combustion zones and cold side electrostatic precipitator

Schematic of Cyclone Boiler and Reburning

Reburning involves the staged addition of fuel into two combustion zones: (1) the primary combustion zone where coal is fired; and (2) the reburn zone where additional fuel is added to create a reducing condition that converts NOx produced in the primary combustion zone to nitrogen and water. Above the reburn zone is a burnout zone in which **overfire air** is added to complete the combustion. Each zone has a unique ratio of the air as determined by the flows of primary fuel, burner air, reburn fuel, and **overfire air**.

Primary Combustion Zone

Coal is fired under normal-to-low excess air conditions and at a rate corresponding to 70-90% of the total heat input. The amount of NOx created in the primary combustion zone is reduced by about 10 percent. There are three reasons for this. 1) Less coal is fired which lowers production of NOx from the fuel. 2) The heat release rate is lower and therefore the thermal production of NOx is reduced. 3) Excess air supplied to the burners is reduced which provides a lower oxygen concentration and consequently lowers NOx formation.

Reburn Zone

Willow Island is not equipped with reburn capabilities. Reburn fuel injection creates a reducing region (oxygen deficient) where the burning fuel reacts with nitrogen oxides to produce carbon oxides and gaseous nitrogen.

Burnout Zone

Overfire air is injected downstream of the reburn zone to complete combustion. **Overfire air** is typically 20% of the total airflow and the injection rate is chosen to minimize carbon monoxide emissions and unburned carbon in the fly ash. Thermal NOx formation in the burnout zone is low because of the lower temperature of the burnout.