CASE STUDY

Solutions in practice

A power-packed sustainability makeover

The University of Missouri's combined heat and power (CHP) plant serves heat and electricity to the campus.

In 2015, the Environmental Protection Agency announced the Clean Power Plan, a policy that mandated power plants reduce their carbon dioxide footprint significantly by 2020.

While the Supreme Court issued a stay on the plan, the University of Missouri power plant decided to continue reducing its carbon dioxide emissions and dependency on fossil fuels through co-firing woody biomass. In October 2016, the university took the No. 4 spot on the EPA's Green Power Partnership Top 30 for consuming and generating 36 percent green power on-site as a result of its sustainable practices.

Making a sustainable investment

In 2013, Gregg Coffin, the director of energy management for the University of Missouri power plant, and his team decided to expand the plant's use of renewable energy. The team wanted to provide reliable steam to produce heat and electricity for the campus by using a sustainable energy source. The move was part of a long-term climate commitment to reduce reliance on coal and eventually achieve a net zero carbon footprint.

Coffin and his team collaborated with several researchers in the forestry department to find sustainable fuel options that could be sourced regionally. They found three potential sources of fuel: woody biomass, corn stover and switchgrass. They spent more than a year evaluating the sources before concluding that woody biomass was the most effective fuel option. Based on that, the university decided to invest in a boiler that would burn only biomass, reducing the plant's reliance on coal.

"We had been co-firing biomass with coal since 2006 and needed to replace one of our existing coal fire burners. We did a life-cycle cost analysis on using a 100 percent biomass-fired boiler, and this proved to be the best ownership cost for the university, in addition to providing sustainability and local economic benefits," said Coffin.

After the sourcing analysis, Coffin and his team set out to find adequate resources before investing in the new equipment as there was not an established biofuel market. The team sought a viable company that could provide the plant's need for more than 100,000 tons of woody biomass annually. After receiving several proposals, they decided to partner with Foster Brothers Wood Products Inc., which now provides wood residues from milling and logging operations.

Adopting biomass to fit big energy needs

The power plant then set forth on its plan with its new bubbling fluidized bed boiler supplied by Babcock and Wilcox of Barberton, Ohio. Coffin notes that the 150,000 pounds per hour boiler delivers steam to an existing turbine generator to provide the university with heat and electricity, and the plant had little to no problems with the boiler after it was installed.

Wood residues are unloaded into the biomass receiving hopper.

A drag conveyor delivers wood residues to storage silos.

"We got the plant up to a pretty good load and capacity factor. We forecasted to burn a minimum of 100,000 tons of woody biomass a year, and we were at [an estimated] 109,000 this past year," says Coffin.

The plant also upgraded its fuel handling system to deal with the new material, adding a truck unloading building, fuel storage silos to hold two days' worth of fuel, and a fuel receiving system that includes a magnetic separator and disk screen to strip out all oversized material for reprocessing.

"The balance of the material is stored at the Foster Brothers' site about 35 miles away. Then we convey it to the boiler all the way up to the metering band that actually regulates the wood residues going into the furnace [for combustion], so it's all process controlled," Coffin said.

When the new equipment was fired up, the team ran into some challenges with material handling. Coffin explained that woody biomass has roughly half the weight density of coal and has about a fourth of the energy by volume than coal, and they were moving a lot of the material to get the British thermal units necessary.

Coffin said moving the woody biomass took a small toll on the lightweight equipment, which had volume limitations. For the first few years, the team modified and adjusted to get the reliability and throughput they needed, adjusting their scales and the frequency with which they filled the boiler bunker, according to *Wood Energy in Developed Economies: Sustainable Resource Management, Economics and Policy*, a book by associate professor of forestry Francisco Aguilar.

Coffin said he and his team used 2008 as the base year for calculating the results of the project, which included conservation and other renewable energy efforts. The plant reduced its dependency on coal by 73 percent and increased its renewable fuel mix (woody biomass) from less than 2 percent up to 31 percent (with a remaining balance of 30 percent coal and 39 percent natural gas). And 27.2 percent of the plant's total fuel was sourced from biomass. Coffin said prices on woody biomass are similar to the costs of coal.

"There hasn't been any added operational cost other than the investment that had to be added anyway despite the fuel," he said.

Research influences policy and partnerships

This project has influenced research from different departments at the university, including industrial engineering, in efforts to influence environmental policy.

Francisco Aguilar researched the availability of biomass throughout the U.S. and how power utilities and plants can form partnerships to maximize bio energy production on a state level in his book referenced previously.

Ronald McGarvey, assistant professor in the Department of Industrial and Manufacturing Systems Engineering, has researched and identified optimization models that can be used to achieve selected emission targets for the least amount of cost in his study, "Identifying Optimal Multi-state Collaborations for Reducing CO2 Emissions by Co-firing Biomass in Coal-burning Power Plants." Researchers continue working with the university power plant on various projects, and, in turn, Coffin and his team act as consultants for their work.

For the University of Missouri power plant, Coffin said he believes there's an opportunity for continuous improvement with the biomass boiler system, and he is working on reducing the plant's dependency on coal and cutting emissions even more. That will be the focus moving forward.

— *Cassandra Johnson*

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If you have been involved in implementing a project and can share details, we'd like to interview you for a case study. Contact Web Managing Editor Cassandra Johnson at (770) 449-0461, ext. 119, cjohnson@iise.org.