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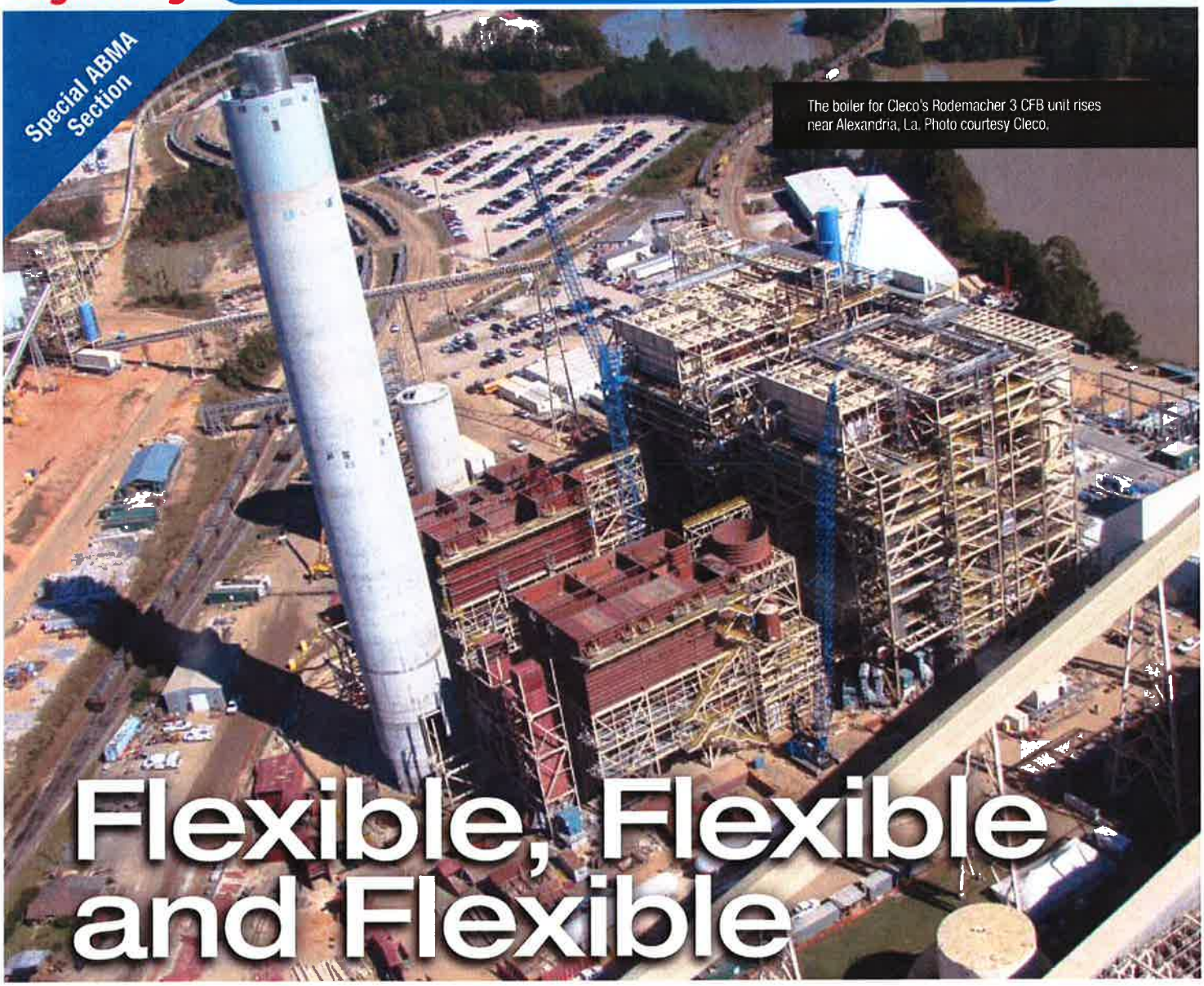

The boiler for Cleco's Rodemacher 3 CFB unit rises near Alexandria, La. Photo courtesy Cleco.

Flexible, Flexible and Flexible

CFB plants are gaining a reputation for taking advantage of opportunity fuel while providing other substantial benefits.

By Steve Blankinship, Associate Editor

The old adage about the three most important things in real estate being location, location and location has a corollary in the power generation business. In addition to other advantages, circulating fluidized bed (CFB) technology offers owners and operators flexibility, flexibility and flexibility.

While dozens of pulverized coal projects face delay or cancellation amid uncertainty about the future of national policies regarding carbon capture among other issues, several CFB projects are moving forward in the U.S. and elsewhere. Rarely, if ever, mentioned by the mainstream news media when addressing clean coal technologies and future coal-fired baseload generation, existing CFB plants continue to operate reliably, economically and cleanly while providing owners and customers with several advantages. None of these advantages may be bigger than freedom from fuel price volatility, which stems from CFBs' ability to burn a wide range of fuels and do so cleanly.

"We continue to see penetration of CFB into the solid fuel market but we also see, at least here in the U.S., the general trend that large coal-fired projects are encountering delays," said Scott Darling of Alstom Power. "There continues to be interest in CFBs for the same reason there has always been interest—the ability to handle the more challenging fuels and keep current with all the emission requirements."

CFB technology offers an alternative to pulverized coal plants through its ability to use a wide range of fuels, including wastes from other fuel processes that might otherwise create environmental concerns. CFB plants are ideal for co-firing conventional coals with waste coal as well as renewable biomass fuels such as wood and forestry products. CFB allows the efficient removal of many coal emissions. And it can readily be combined with in-combustion oxy-firing to capture carbon dioxide (CO_2). What's more, new designs are improving CFB economies of scale by allowing larger units—upwards of 800

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MW—and even supercritical boiler temperatures.

Pollution control is inherent to the CFB combustion process. By introducing low-cost limestone into a CFB boiler, SO_x is captured and removed at the point where it is formed as the fuel burns. Low combustion temperature (about 1,000 F lower than a conventional pulverized coal unit's peak temperature) minimizes NO_x formation. By injecting ammonia into the CFB, NO_x can be further reduced by half.

Conventional coal plants use pulverized coal, ground to the consistency of facial powder, and burn it at temperatures between 2,200 F to 2,400 F. In contrast, CFBs use coal and other fuels in chunks about 3/8-inch in size mixed with limestone and burn it at lower temperatures, from 1,500 F to 1,650 F. Air blown into the boiler suspends, or fluidizes, the mixture. Heat in the boiler converts the limestone to lime that absorbs SO_2, removing most of it in the furnace.

A CFB's lower burn temperature also produces less NO_x. Overall, the CFB process removes some 98 percent of SO_2 and produces roughly half the NO_x compared with conventional coal plants. A cyclone turbulent air system returns ash and unburned fuel to the boiler to be burned again, making the combustion even more thorough and reducing the volume of flue gas pollutants. CFB reduces or eliminates entirely equipment that conventional coal plants need to capture SO_2 and NO_x.

Power Engineering magazine spoke with several U.S. utilities building new CFB units, and their enthusiasm is readily apparent as they describe how they chose CFB over all alternatives.

Louisiana-based Cleco Corp. owns 1,360 MW of regulated generating capacity, manages an additional 691 MW through Cleco Power and has about 1,355 MW of unregulated capacity. Bill Fontenot, vice president of regulated generation development for Cleco, explained how the company came to build its Rodemacher 3 CFB unit, near Alexandria, La., which is scheduled for commercial operation this summer.

"The fundamental decision to build Rodemacher 3 was fuel diversity," said Fontenot. The company's portfolio is primarily natural gas with 70 percent of the energy delivered to customers tied to natural gas prices.

Rodemacher 3 is all about augmenting this heavy gas dependence with 600 MW of solid fuel capacity. Cleco's goal is to shift from 70 percent gas and 30 percent coal to a 50/50 gas/coal mix. The solid fuel will be a lower cost and more stable fuel because its cost is typically not as volatile. Plans call for Rodemacher 3 to be fired by petroleum coke delivered by river from the Gulf of Mexico.

Cleco expects to secure three to four petcoke suppliers, which produce the fuel as a byproduct of their oil refining processes. "We expect to burn about 1.5 million tons of petcoke per year when in full production," said Fontenot. The plant will likely consume another half million tons of limestone, depending on the fuel's sulfur content. He said that good local markets also exist for the by-product ash waste, which can be used for road base and soil stabilization.

Cleco engaged in a competitive bid process and regulators determined the 600 MW CFB was the lowest-cost alternative for future electricity generation. Among the considerations was the fact that the Rodemacher site already has a 425 MW gas unit and a 525 MW unit that burns Powder River Basin (PRB) coal delivered by rail. It also has transmission capable of supporting an additional 600 MW of generation and a 3,000 acre lake capable of providing cooling water for another 600 MW steam turbine. Cleco factored all of that into its decision-making process along with the fact Rodemacher has an operating staff with 25 years of experience in running a solid fuel plant.

The Foster Wheeler CFB unit is a 10 percent upscale of twin 300 MW CFB units built earlier by Jacksonville Electric Authority. The 2 x 1 configuration uses two 330 MW CFB boilers. Rodemacher can also receive fuel by river barge and the project included building an unloading facility with a crane and a 1.5-mile-long conveyor belt from a Red River ox-bow to the plant's coal yard.

The Quest for Stable Fuel Costs

During the height of the oil price run-up, petcoke prices shot up dramatically, then fell.

"We had seen petcoke selling for more than $100/ton," said Fontenot, "but now

COAL-GEN TO FEATURE CFB USERS' GROUP EVENT

Recognizing the increased interest in circulating fluidized bed plants, COAL-GEN 2009, August 19-21 in Charlotte, N.C., will include a special CFB event held concurrently with other sessions. COAL-GEN's concurrent CFB track will focus on CFB technology, projects, prospects, suppliers and users. It will feature presentations on the latest CFB projects and technology offerings from major original equipment manufacturers and engineering firms engaged in the CFB sector, including Foster-Wheeler, Alstom Power, Babcock-Wilcox, Metso as well as Shaw Group, which is building Rodemacher 3 for Cleco, the Virginia Hybrid Center for Dominion and the Little Gypsy 3 repowering project for Entergy.

Power plant owners, managers and superintendents as well as employees engaged in operating and maintaining existing CFB plants are invited to attend this special event. Registration for the CFB Mega-Track also admits delegates to the entire COAL-GEN event, which draws 4,000 attendees and more than 350 exhibitors.

Check the COAL-GEN 2009 website at http://www.coal-gen.com/index.html for more details. And remember that COAL-GEN's Energy Provider package allows utilities and other providers of grid power to send an unlimited number of employees for a single COAL-GEN registration fee. To learn if your company qualifies for the COAL-GEN Energy Provider Program or to learn more about the CFB Mega-Track at COAL-GEN 2009, contact COAL-GEN Conference Committee Chairman Steve Blankinship at steveb@pennwell.com or COAL-GEN Event Manager Libby Smith at libbys@pennwell.com.

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it's back to our original expectations." Cleco forecasts its petcoke will be delivered in the range of $1.00mm/Btu to $2.00mm/Btu, a break from more than $4.00mm/Btu a few months ago. Fontenot said the CFB unit can burn a variety of products including Illinois coal, Appalachian coal, petcoke and even biomass. "We expect petcoke to be our low-cost fuel, but should it increase in price, we can always access other fuels with lower prices," he said.

Pointing to CFB's flexibility, Fontenot said that while PRB is a low-sulfur and Illinois Basin is a high-sulfur coal, the CFB boiler "doesn't care." And while petcoke is a high sulfur fuel, the CFB unit is more than capable of accepting it. "It's just a matter of how much limestone you inject," he said.

The area surrounding the plant has a variety of renewable resources from which to choose for co-firing. Should a federal renewable portfolio standard mandate be imposed, the Rodemacher CFB would be the unit Cleco would deploy to meet it. The biggest challenges in using renewables are transportation logistics and fuel storage.

Waste Coal and Wood Chips

Another CFB unit currently under construction will use 20 percent biomass from the first day it goes into service. Dominion's Virginia City Hybrid Energy Center will burn a mixture of 80 percent waste coal and 20 percent forestry wood chip product when it begins operating in 2012. Mark Mitchell, director of fossil and hydro for Dominion, said Dominion wanted to build a plant in the Virginia coal fields to burn the waste coal that had been accumulating for decades. "The old piles especially have pretty high heating values because the separation processes in those days weren't as good," he said.

Dominion already operates pulverized coal (PC) units (plants) as well as CFB units in West Virginia and Pennsylvania. The Hurt Plant in Pennsylvania runs 100 percent chipped wood from the lumber industry to produce 88 MW of power.

"We looked at supercritical and ultra-supercritical PC," said Mitchell. "But you need a steady diet of a certain Btu coal." Dominion also believed it would need a wet scrubber for a PC unit, which meant using more water. As a result, the company ruled out PC based on water use and lack of fuel flexibility. Dominion also considered integrated gasification combined cycle (IGCC) and completed water use comparisons on IGCC with and without air-cooled condensation.

"IGCC was getting a lot of attention while our site selection was underway in 2005," said Mitchell. One claim in favor of IGCC was its flexibility. But Dominion found that flexibility disappearing once the fuel and design were chosen. "IGCC is very inflexible so far as what fuel you can use," Mitchell said. There also was a reliability issue because so few IGCC plants have been built.

"And there is definitely a price premium in building an IGCC," he said.

In addition to CFB's fuel flexibility, Dominion saw it could operate with low water consumption. The CFB could be equipped with an air-cooled condenser and a dry scrubber. Emission levels also looked favorable. "We looked at PC boilers and even new generation IGCC and believed we could get the same emission numbers with CFB. The configuration chosen was almost identical to that used by Cleco at Rodemacher: two Foster Wheeler CFB boilers feeding a single Toshiba steam turbine, with an expected net output of 585 MW using a blend of waste coal and wood chips.

Mitchell pointed to the ease with which biofuels can be blended with coal or petcoke in a CFB. "We will burn biomass from day one and while you can co-fire a small amount of biomass by just blending it with the other fuel, we have built a complete fuel handling system that will transport it from the unloading point all the way to the boiler."

In addition to the chipped waste wood Dominion plans to use as the primary fuel

for the Virginia City CFB unit, it can also access waste from paper mills and other industrial sources. And although mercury is not much of an issue with any of the fuels Virginia City will use, Dominion is installing an activated carbon injection system on the CFB unit.

East Kentucky Power Cooperative (EKPC) placed its first CFB into service at its Spurlock station in 2005 and is about to begin operating an identical twin unit in April. Both are 1 x 1 configurations utilizing Alstom Power CFB boilers and a GE steam turbine to produce 268 MW. Even in EKPC's case, despite its location in the heart of coal country, fuel diversity helped tip the decision to build CFB.

"CFB allowed us to open up the markets for lots of lower quality coals that were either being blended off or couldn't be sold at all," said Craig Johnson., vice president of operations. "It opened up that market and also gives us the potential to try alternate fuels including waste fuels, biomass, tires and petcoke. EKPC was also pleased with the technology's emissions profile, including no SO_3 formation, low concentrations of particulates, low NO_x and good mercury capture. Johnson said unit 3 at Spurlock probably achieves above 90 percent mercury capture with no mercury-specific control equipment on the back end.

The Spurlock Power Station is on the Ohio River and all the CFB coal is delivered by barge from Southern Ohio, Kentucky, West Virginia and Illinois. The plant can take cal down to about 9,500 Btu/pound and 30 percent ash and 10 pounds sulfur per ton. And because there are no fusion specs on it, the plant enjoys access to coals that would not be suitable in a PC.

When market conditions warrant, the plant can also burn tires, petcoke and biomass. EKPC recently completed a successful switch grass burn in its first CFB unit. Alstom has told the operator it can go up to about 10 percent biomass and maintain full capability on the unit.

Carbon Capture

Alstom's Scott Darling says the big trend in new generation CFBs is an oxy-firing CO_2 mitigation strategy, one of which also happens to be Alstom's Oxy-CFB.

"We are chasing some fairly significant sized demonstration projects," he says. "Oxy-firing makes it easy to capture carbon compared to air-firing because you get a concentrated stream of CO_2 which can be cooled, compressed and sequestered."

Alstom is pursuing oxy-firing on the PC side with a 30 MW thermal (10 MW electrical) demonstration with Vattenfal in Germany. The company is also pursuing the CFB side of oxy-firing on a larger scale, although it declined to reveal details. Even so, Darling said the company has done a lot of bench scale and pilot testing in the U.S. and in Europe to support this technology. "So this is something that has the fundamentals pretty well worked out," he said.

Oxy-CFB incorporates all the advantages of CFB air-fired combustion while also producing a concentrated CO_2 stream that enables sequestering. Darling added that unlike oxy-PC, oxy-CFB offers the opportunity to remove some heat via an external heat exchanger. That allows a reduced furnace size, meaning potentially lower cost for a major component.

Alstom is now performing economic comparisons of the cost for an oxy-CFB using synthetic air of about 21 percent oxygen content in the feed going to the boiler. "If you increase the oxygen content up to 30, 40 or 50 percent, you cut back on the recycled CO_2, and by doing that you can shrink the size of the furnace," Darling said. "That too could offer some economic advantages."

Not to mention further enhance CFB's reputation for flexibility, flexibility and flexibility. pe