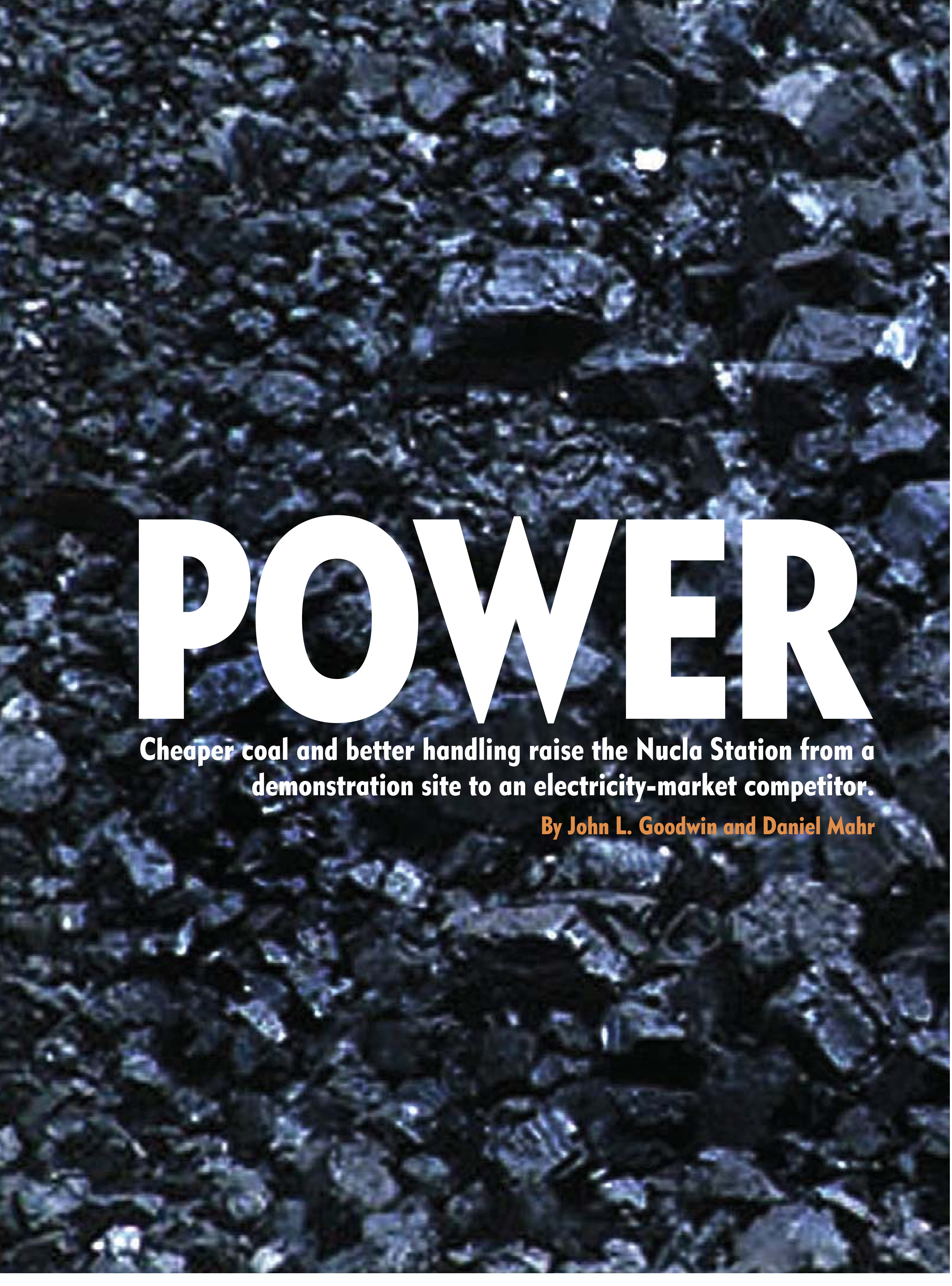

POWER

Cheaper coal and better handling raise the Nucla Station from a demonstration site to an electricity-market competitor.

By John L. Goodwin and Daniel Mahr

PLAYER

What do you do with a successful test power facility once the demonstration program is completed? You reduce operating cost and upgrade plant systems to meet the economic realities. For the Nucla Station in Nucla, Colo., that meant a new fuel source and a major upgrade of the coal handling system, to trim production costs and enable the plant to process more of a lower-grade fuel.

Nucla had modest beginnings in the Rural Electrification Authority program, when Colorado Ute constructed it in 1959. The station had three stoker-fired boilers, each serving a 12-megawatt steam turbine. The plant provided reliable power to a scenic, but remote area on the western slope of Colorado.

In 1988, the plant became a focal point of the Electric Power Research Institute's atmospheric fluidized bed combustion demonstration program, designed to show the technology's commercial potential. The stokers were replaced by a dual-combustor AFBC boiler. A new 74 MW steam turbine/generator, with extraction to the existing turbines, was installed at that time.

The plant was revamped specifically for test purposes, with silo storage of coal for the AFBC unit limited to an eight-hour supply. Existing plant auxiliaries that were adequate for test purposes, like most of the existing coal handling system, were not upgraded.

The threefold increase in Nucla's power rating from 36 MW to 110 MW of electricity quickly consumed design margins that were originally built into the plant. This was clearly the case for the coal handling system. The capacity of the original 24-inch belt system was not increased with the AFBC demonstration. As a result, the equipment and people were working harder and longer.

Rather than filling the bunkers within a few hours on the day and evening shifts, plant fueling became a 20-hour-per-day activity. There was little time for scheduling preventive maintenance and cleanup. To ensure the plant's long-term ability to meet its production objectives, Tri-State Generation & Transmission Association (which acquired the plant following Colorado Ute's bankruptcy) investigated different fuel options as a way to reduce operating costs.

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A primary advantage of AFBC technology is its ability to use lower-grade fuels that would perform poorly in other boilers. Tri-State reviewed Nucla's fuel requirements and potential sources. The plant was trucking in coal from more than 100 miles away, which added a considerable cost. That expense could be trimmed if a local coal source were available.

The lowest-cost approach was to open a new surface mine. Western Fuels Colorado, a subsidiary of Tri-State, developed this new mine and began production in 1992. Fuel cost was reduced from $1.26 per million Btu to $0.80 per million Btu.

Although the new mine cut the cost of fuel, it introduced its own problems into the equation. The coal varied in size from fines (silt- and sand-size particles) to large boulders measuring up to 30 inches across. Thin clay layers separated some of the coal seams. This clay interburden mixed with the mined coal. While the clay was not a problem for the AFBC boiler, it made the coal sticky and difficult to handle.

The result was that the coal handling system suffered from variable feed rates, difficulty in crushing the large boulders, plugging, spillage, and excessive maintenance.

The variation in feed rates reduced system capacity and increased demands on the operators. The intermittent arrival of trucks, alternating wet/dry coal, and the buildup of fines on the vibrating feeders all caused the truck unloading rates to vary, as well.

In addition, oversize coal and occasional sandstone boulders would sometimes choke the primary roll crusher at the truck hopper, stopping flow. In this case, the operator had to physically remove or break the boulder. This resulted in nonproduction time and higher handling rates during the operating periods. The operator would be delayed and then catch up by boosting the unloading rate. This increased the amount of spillage that would occur and the resultant cleanup.

Because the hopper would often empty between truckloads, coal would flood the primary crusher as the truck dumped its load. The coal would flush unobstructed through the feeder and choke the primary roll crusher.

The vibrating feeders were fitted with level switches to prevent this, but large boulders were difficult for the switches to detect.

Tri-State decided to upgrade the coal handling system in three stages. The staged approach allowed the company to spread the capital cost over several years and limit the potential for disrupting plant operations.

The first stage, which began in 1994, included the addition of two variable-speed truck hopper belt feeders to replace the vibrating feeders, a new 150-horsepower primary crusher, and faster conveyor drives with higher-horsepower motors to increase the capacity of the conveyor system.

Belt feeders would provide a more consistent feed rate to the system. Their feed operation wasn't affected by moisture and excessive fines present in the coal.

The power rating of the primary crusher was increased threefold, from 50 to 150 hp. The new crusher was able to handle the large sandstone boulders that were sometimes mixed with the coal. The momentary "choking" of the crusher when it encountered one of these boulders was eliminated.

The conveyor belt speed and horsepower rating were increased to provide some of the "design margin" that was consumed when the plant's power rating was increased. One of the original conveyors was underpowered in comparison to the later additions, and its capacity was increased to provide a better, more balanced coal handling system. System redundancy was also improved.

In 1996, during a second round of upgrades, the in-plant portion of the conveying system was revamped. This part of the coal handling system consisted of Stephens-Adamson Redler conveyors and tertiary crushers. The Redler conveyors are an en-masse conveying design that can elevate coal at a 66-degree incline. They drag coal along steel troughs. However, the plant was experiencing wear and other problems with these conveyors, which were operating 20 hours per day.

Conventional belt conveyors would be more reliable, but there were problems in using them. Conventional belts cannot operate at steep inclines, and there was no way to fit them within the boiler building.

Tri-State chose to add a high angle conveyor, or HAC, from Continental Conveyor Co. of Winfield, Ala. With HAC, coal is loaded on the horizontal portion of the conveyor, which uses a typical trough belt configuration. To incline the conveyor steeply, a top cover belt is added to sandwich the coal between two belts.

The company chose a semi-circular "C" configuration for the new HAC, which replaced one of the 66-degree inclined Redler conveyors. The second inclined Redler conveyor was retained for redundancy. The HAC uses a conventional conveyor belt and other components, and the belt can be cleaned with conventional scrapers.

In the upgraded system, the HAC elevated coal above the original stoker boiler building and into a new rooftop extension to the stoker boiler building, which was built to enclose the HAC. The existing sample system that was wedged into the discharge chute of the old belt conveyor was replaced with a cross-belt design fitted to a horizontal section of the HAC. The AFBC surge bin was replaced with a pant leg chute.

Conventional belt conveyors replaced two other horizontal en-masse conveyors with multiple outlets that discharged to the two coal silos. The belt conveyors were equipped with an intermediate V-plow discharge, like the original bunker conveyor for the stoker-fired units. In this case, the plant operators determined that this "vintage" technology was the most reliable option.

Third Stage

In the third, and final, stage of improving the coal handling, a rotary breaker was installed. This breaker, from Pennsylvania Crusher Corp. of Broomall, Pa., was needed to eliminate the sandstone rocks that were mixing with the coal. These rocks were accumulating at the base of the fluidized bed, obstructing the directional nozzles that induce bed ash to flow to the side ash coolers.

One solution would be to add processing equipment at the mine site, which used blast and reclaim techniques. Tri-State determined, however, that the best method of reducing boiler problems posed by rock accumulations was to separate the rock from the coal at the plant.

Nucla uses a rotary breaker (left) to prepare coal and a high-angle conveyor (right) to carry it to a rooftop extension of the stoker boiler building.

In the 1940s and '50s, rotary breakers were commonly used at power plants. Advances in mining techniques and coal preparation facilities eliminated the need for this equipment at most plants, although rotary breakers are still used at some mines and mine-mouth plants. Though Nucla originally was not a mine-mouth plant, the new surface mine only five miles away changed its status.

The rotary breaker was able to crush material and separate the tough-to-crush refuse rock from the product coal. In the new configuration, coal from the truck hopper and primary crusher was routed to the breaker. The receiving conveyor was extended outside the existing transfer, so the previous below-grade secondary crusher could be bypassed.

The breaker functioned as the new secondary crusher, reducing the 7-inch lumps to under 2 inches. The crushed coal was then discharged to the next conveyor, while the harder rock lumps cascaded through the barrel of the breaker and discharged at the far end into a refuse pile. This reduced boiler tube erosion and allowed far fewer rocks to accumulate at the base of the fluidized bed.

The combination of a new, cheaper source of fuel, and a better, more economical coal handling system now enables the 40-year-old Nucla Station to thrive as a competitive power generator. ■