A Case for

MOVING DRY SORBENT INJECTION UPSTREAM

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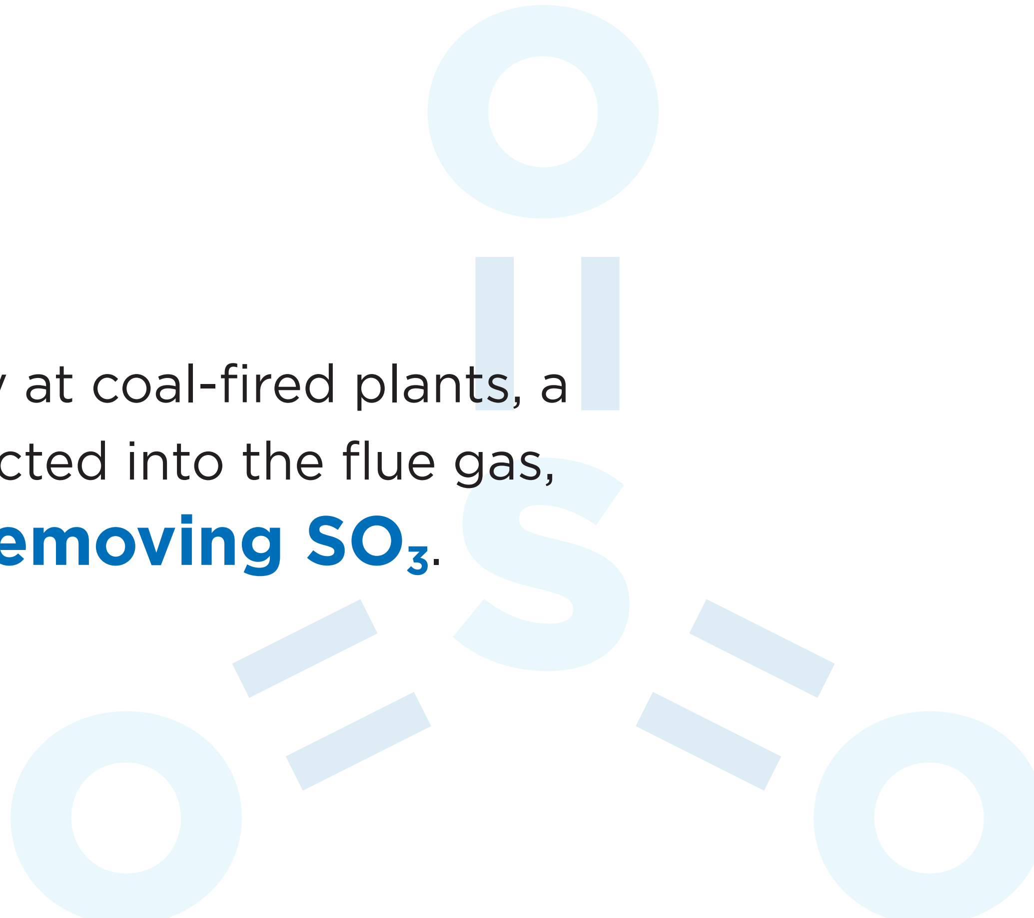
Dry sorbent injection (DSI)

is a process used to mitigate air pollution.

Used primarily at coal-fired plants, a sorbent is injected into the flue gas, **primarily removing SO_3**.



FACT: Sulfur trioxide is a gaseous pollutant emitted from coal-fired power plants and is the primary agent in acid rain, which damages vegetation, wildlife and water sources.

Traditionally, sorbents are **injected downstream of the air heater** to remove SO_3 and its characteristic blue plume exiting the stack.

Beyond helping utilities **comply with regulations**, traditional thinking is that the DSI process generally offers no other economic benefits.

Coal-fired units were originally intended for baseload operation. To be more cost competitive in the current power market they need to cycle more often, improve turn-down and improve heat rate (plant efficiency). But there are barriers to making this happen.

1. The selective catalytic reduction (SCR) has a minimum operating temperature (MOT), which limits the units to turn-down capability.

By limiting turn-down, the utility is missing out on revenue to be realized at lower operating loads.

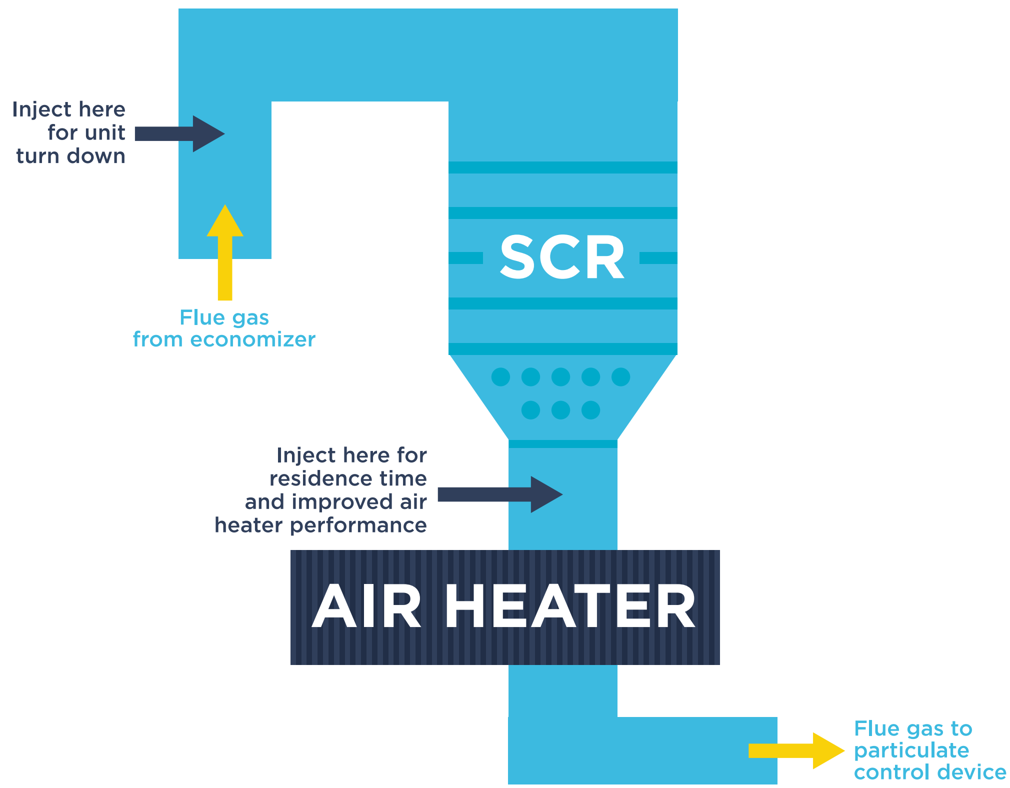
2. The air heater, which is a heat transfer device to improve plant efficiency, also has a minimum operating temperature below which corrosion and fouling occur.

If the air heater out temperature can be decreased, heat rate can be improved.

While utilities use sorbent to mitigate pollution and meet regulatory standards, **the process can be costly**.

What if there were a way to continue to mitigate pollution using DSI, and get a return on the investment?

Implementing DSI ahead of the SCR and the air heater lowers the SO_3 enough to allow units to lower minimum load, in some cases more than 30 MW, and lower the air heater flue gas exit temperature, resulting in heat rate **improvements of approximately 1%**.



Why hasn't this practice been widely used before?

It was originally thought that moving the DSI upstream would plug the SCR and air heater.

Through experimentation, utilities found that **DSI has not negatively impacted** SCR or air heater operation.

IS THE NEW PROCESS AS EFFECTIVE?

Yes. A long-term full-scale demonstration showed that injecting DSI upstream of **SCR can reduce SO_3 to 5 parts per million** or less, which is as good or better than when DSI was used downstream of the air heater.

DOES THE PROCESS INVOLVE USING MORE SORBENT?

Injecting dry sorbent to control blue plume and improve unit flexibility typically means increasing the amount of sorbent used.

However, the increased operating cost is quickly offset by the cost savings realized from increased turn-down and improved heat rate.

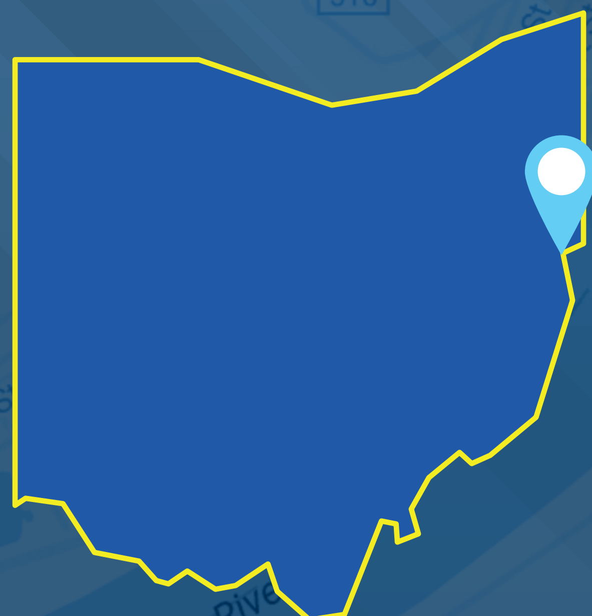
The result is a higher rate of return for the utility.

Case Study:

BUCKEYE POWER CARDINAL UNIT 2

Location:

Brilliant, Ohio, in the eastern part of the state, on the Ohio River



Project specs:

The Cardinal Unit 2 is a 590-MW, 6.8 lb/MMBtu coal-fired unit with an SCR system.

TESTING AND RESULTS

Trial testing of upstream DSI in 2017 used SBS, trona and hydrated lime upstream of SCR — each achieved **~5 ppm SO_3 rates** at the SCR inlet.

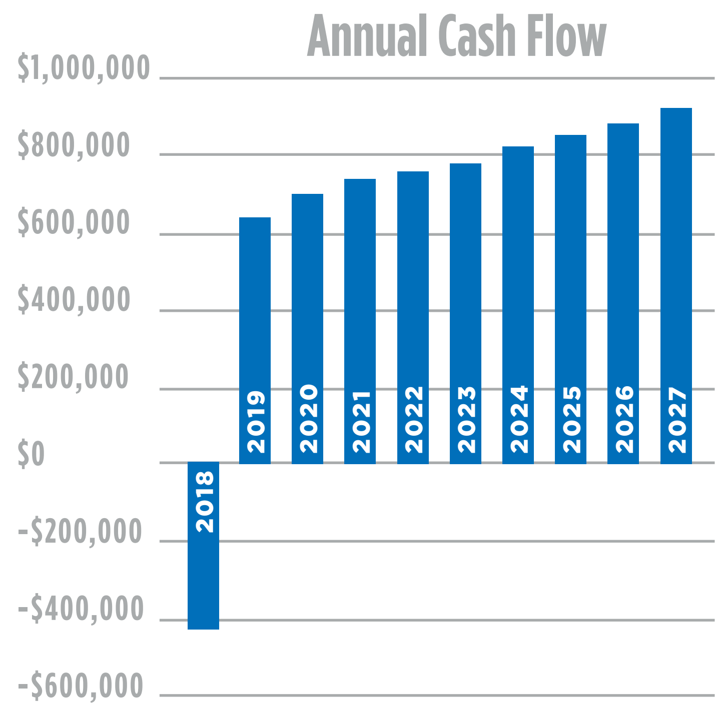
Using cost comparisons of sorbents, Buckeye Power should use **hydrated lime exclusively**.

	Capital Cost	Annual Sorbent Cost
Sodium-Based Solution	$10M	$750K - $950K
Trona	$3M - $4.7M	$650K - $950K
Hydrated Lime	$3M	$550K - $850K

The capital cost to convert the existing DSI system from trona to hydrated lime and move the injection location upstream of SCR was approximately **$3 million**.

Capital Cost	**$3M**
Annual Savings	
Min. Load Benefits	$350K
Heat Rate	$600K
Maintenance	$150K
Annual Savings Total	**$1.1M**

Annual savings include benefits from lower loads, improved heat rate and reduced maintenance costs.

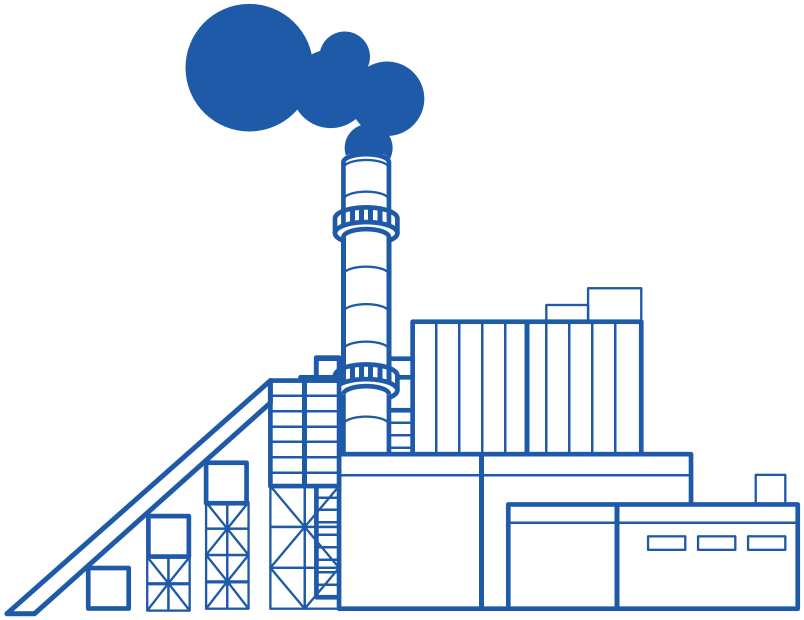


Unlike with most coal plant modifications, Buckeye Power will experience a **quicker rate of return**.

September 2018

Startup and turnover for Cardinal Unit 2.

Unit 3 is a hot-side precipitator and, at **630 MW**, is larger than Unit 2. Modeling is underway and testing for DSI ahead of SCR will follow.



Results on performance and testing for both units will be **available for evaluation**.

CONSIDERATIONS FOR MAKING THE SWITCH

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- Existing DSI systems will likely need their existing feed train equipment to be **modify or replace**.

- Before adding DSI upstream of SCR consider how well your electrostatic precipitator (ESP) or baghouse can handle the increased particulate loading from the **higher injection rate**.

- **Sorbent selection** is an important factor. There are advantages and disadvantages to using either calcium- or sodium-based sorbents.

- Computational fluid dynamics (CFD) modeling helps provide a well-mixed and **evenly distributed injection**, which is critical.

- Trial testing at each site promotes a smooth transition to the **new DSI system**.

MOVING YOUR DSI UPSTREAM OF SCR COULD BE AN OPTION WORTH EXPLORING.

See our perspective: **burnsmcd.com/EnergySolutions**

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Donald Wolf is an associate mechanical engineer with experience in air pollution control technologies. Wolf has served as a project manager and as a project engineer on a variety of coal-fired boiler air pollution control projects. Wolf's experience includes responsibilities for system analysis, capital and operating cost estimates, economic analyses, writing of reports and technical specifications, and contract negotiations for air pollution control systems. In addition, Wolf has demonstrated experience in particulate, NOx, SO_2, and mercury control technologies, and computer performance modeling of electrostatic precipitators.