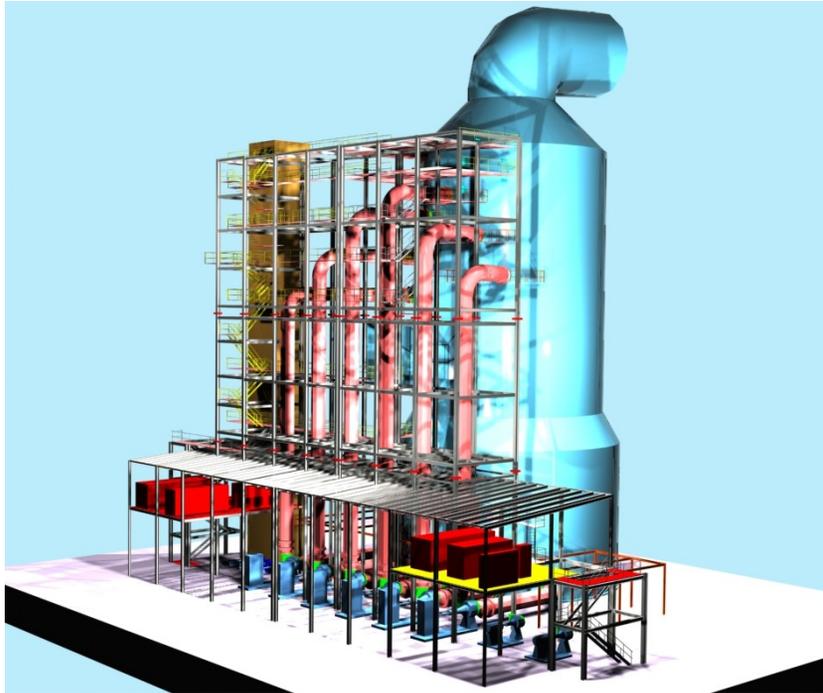


Wet Flue Gas Desulphurization (FGD) Optimization



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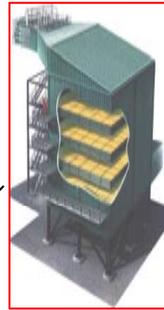
Outline

- Review of Wet FGD
- FGD Optimization
- Results
- Benefits



Power Plant Optimization Systems

NOx Control

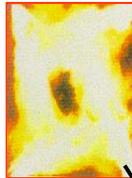


- SCR Systems
- SCONOx

Boiler

Burner Systems

- LNCFS
- TFS 2000™
- Fuel Switching



Steam Turbine and Generator

Substation Systems

Coal Pile

Pulverizer

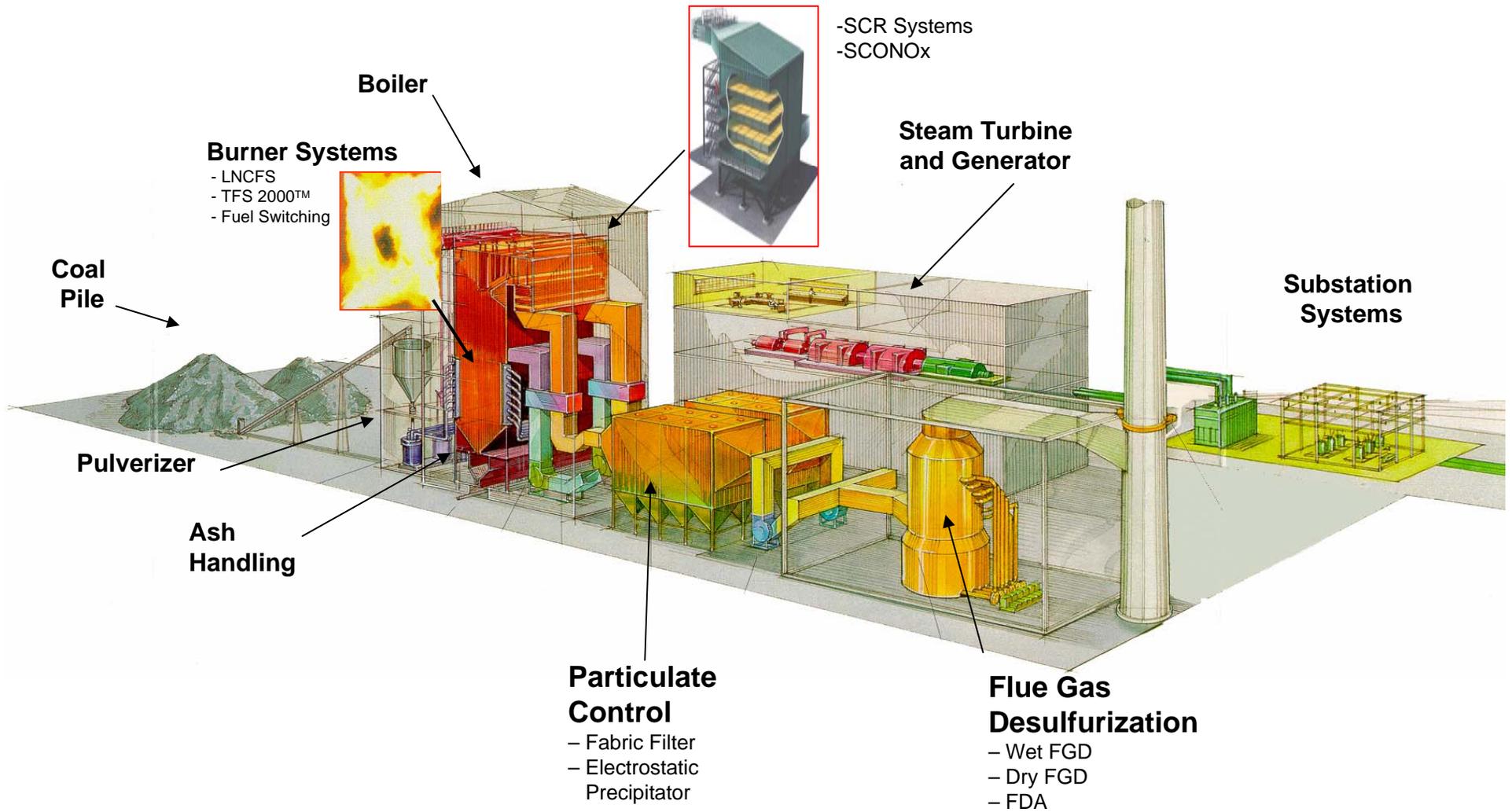
Ash Handling

Particulate Control

- Fabric Filter
- Electrostatic Precipitator

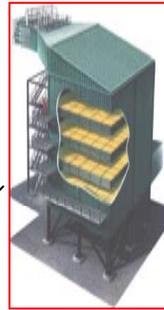
Flue Gas Desulfurization

- Wet FGD
- Dry FGD
- FDA



Post-Combustion Systems

NOx Control

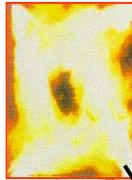


- SCR Systems
- SCONOx

Boiler

Burner Systems

- LNCFS
- TFS 2000™
- Fuel Switching



Steam Turbine and Generator

Substation Systems

Coal Pile

Pulverizer

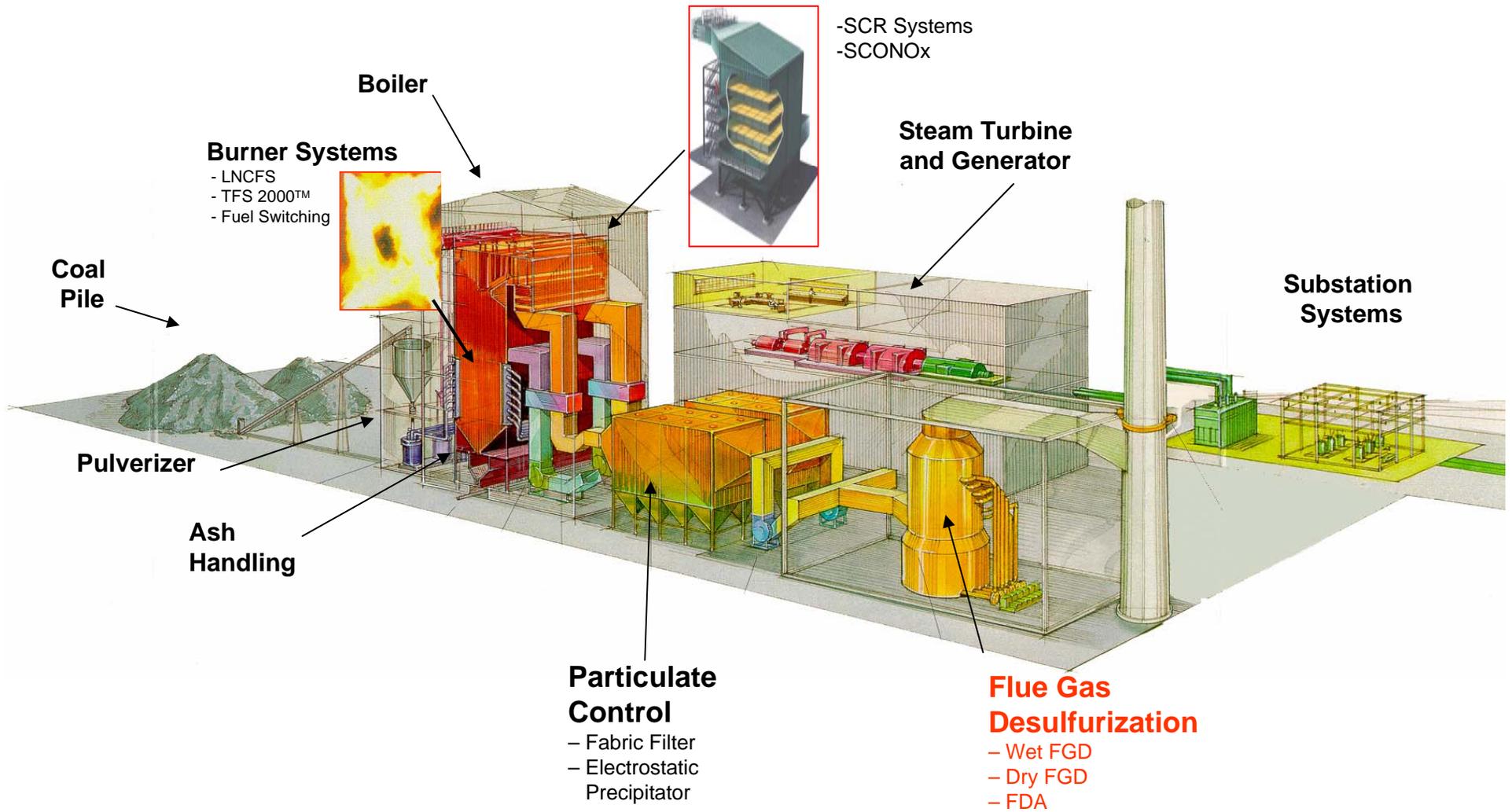
Ash Handling

Particulate Control

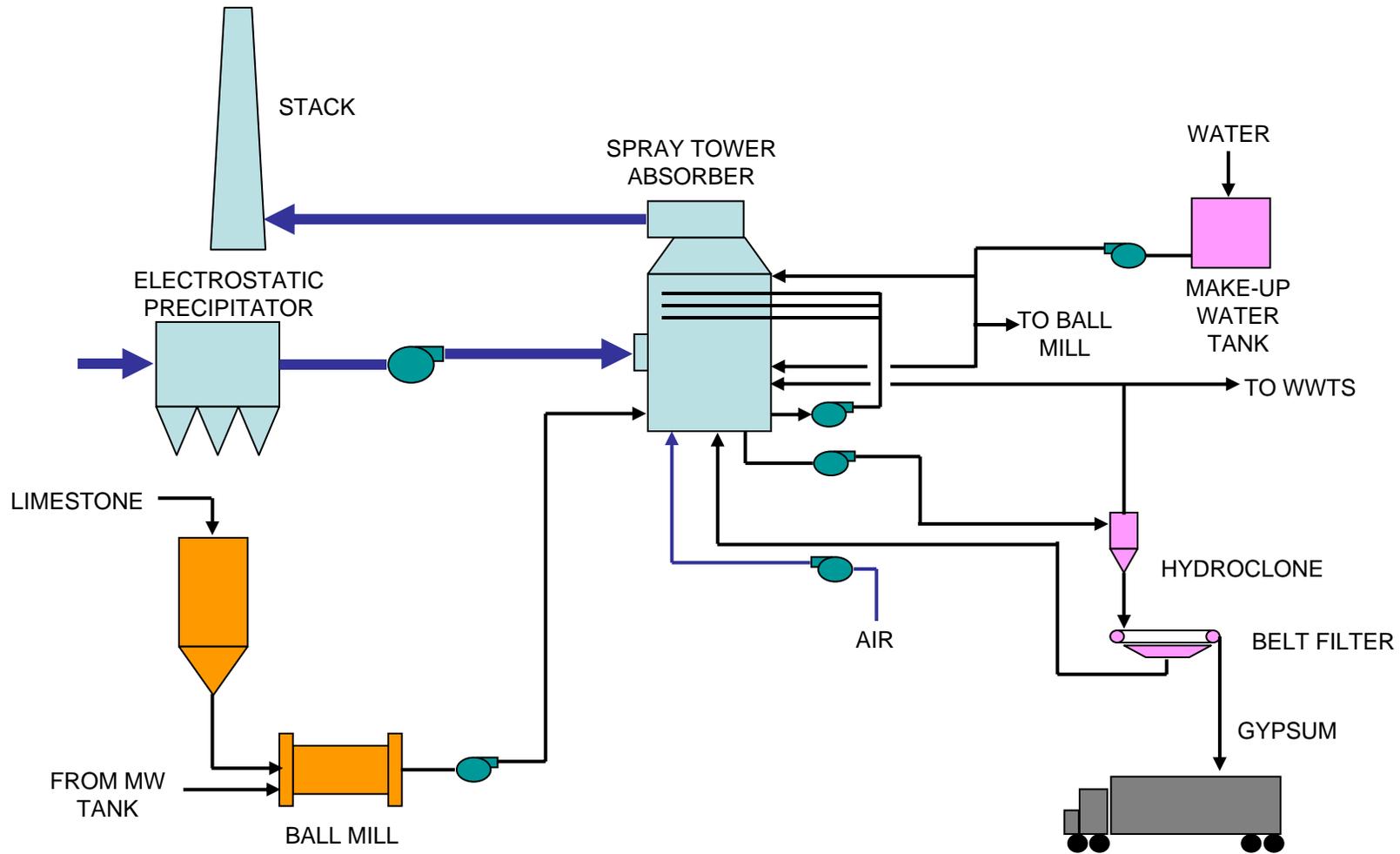
- Fabric Filter
- Electrostatic Precipitator

Flue Gas Desulfurization

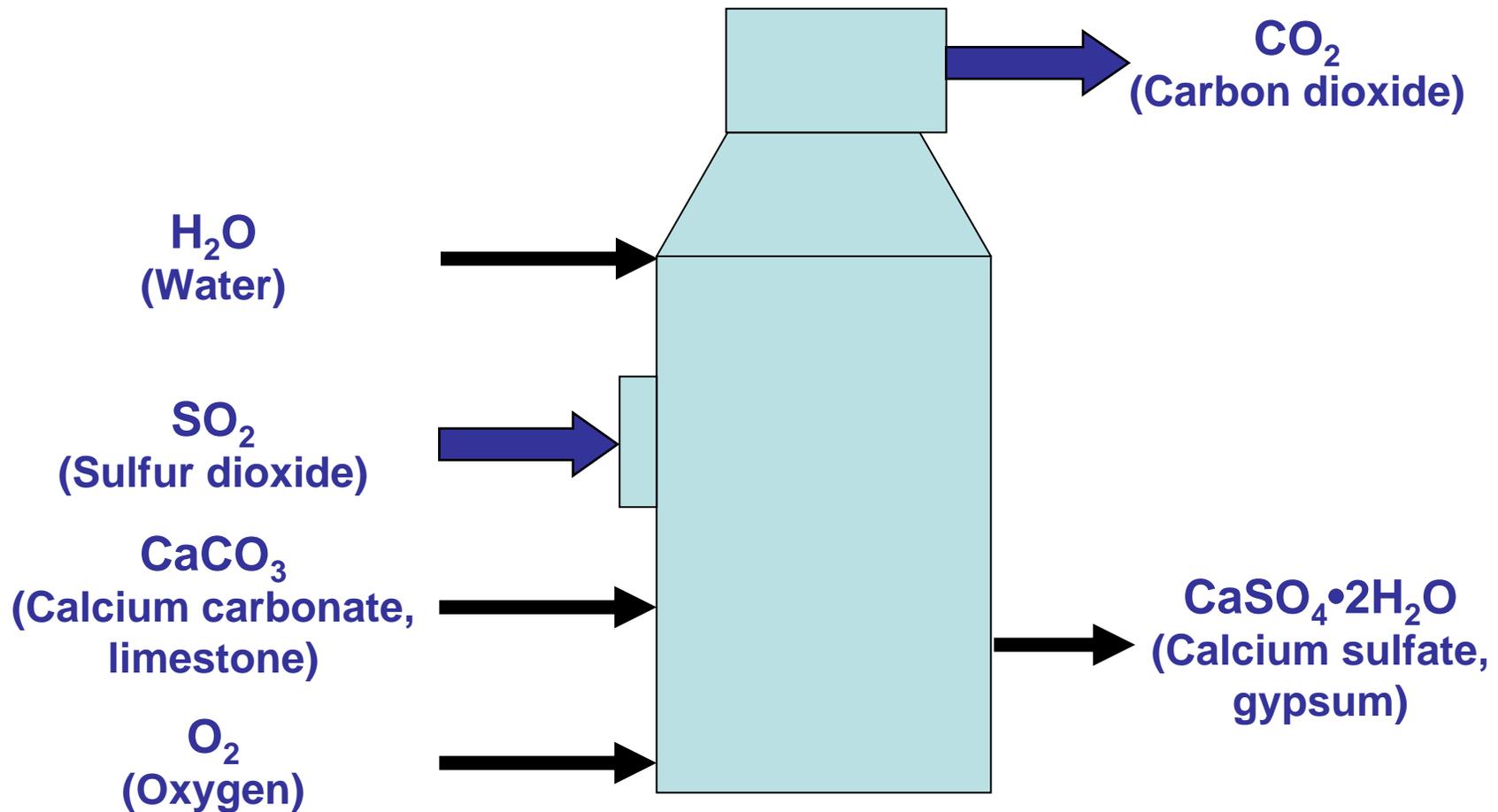
- Wet FGD
- Dry FGD
- FDA



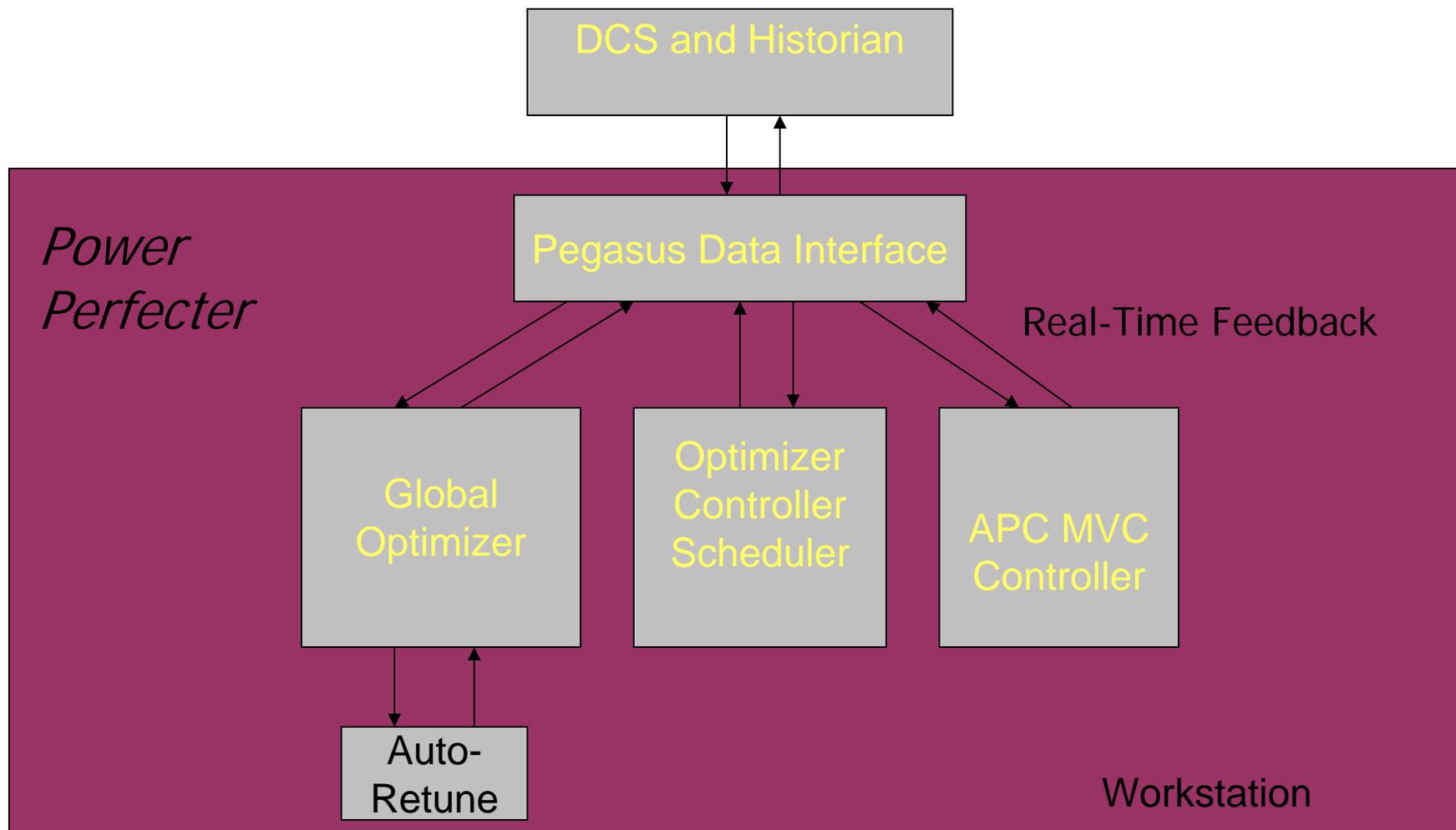
FGD Process Diagram



FGD Process Chemical Reaction



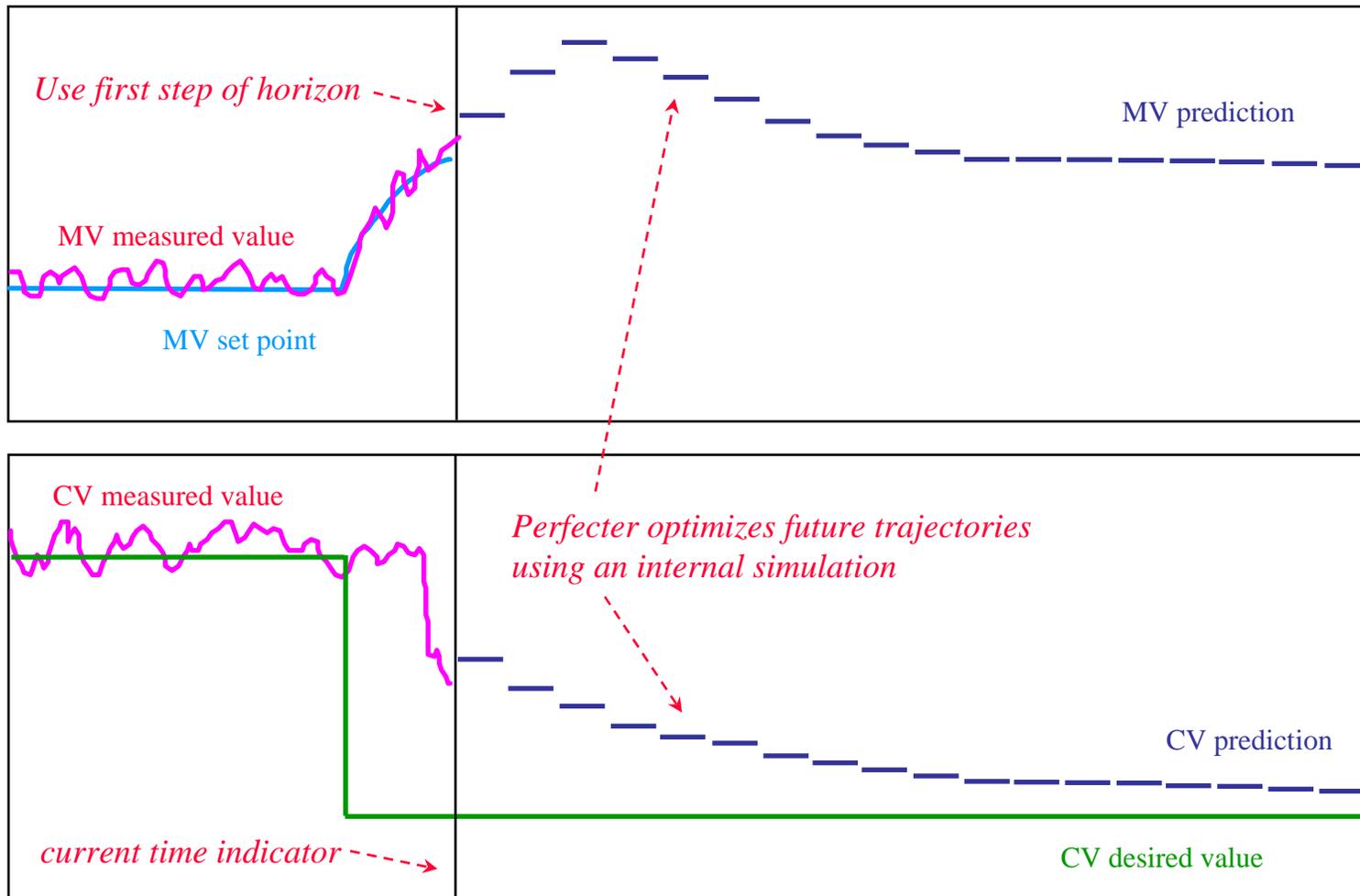
Power Perfecter™ Implementation



MPC Functionality

- **Advanced Process Controller:** Used to reduce variability on a high frequency (minute by minute or faster) basis due to external factors, thus, driving the manipulated variables to optimal settings.

Model Predictive Control



Power Perfecter™ Advantages

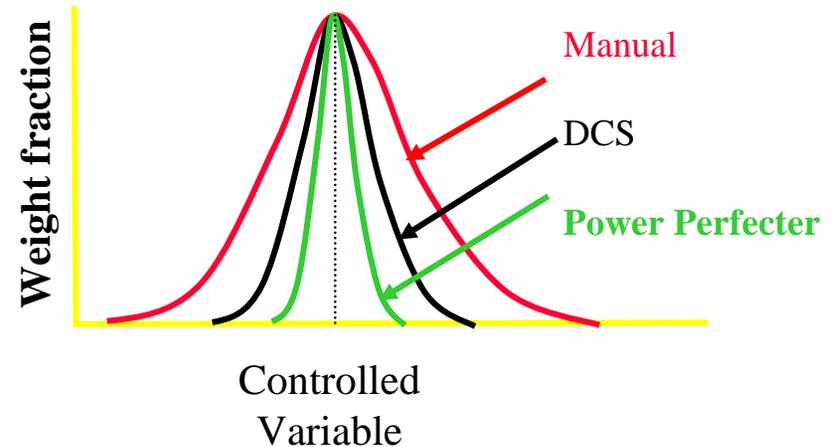
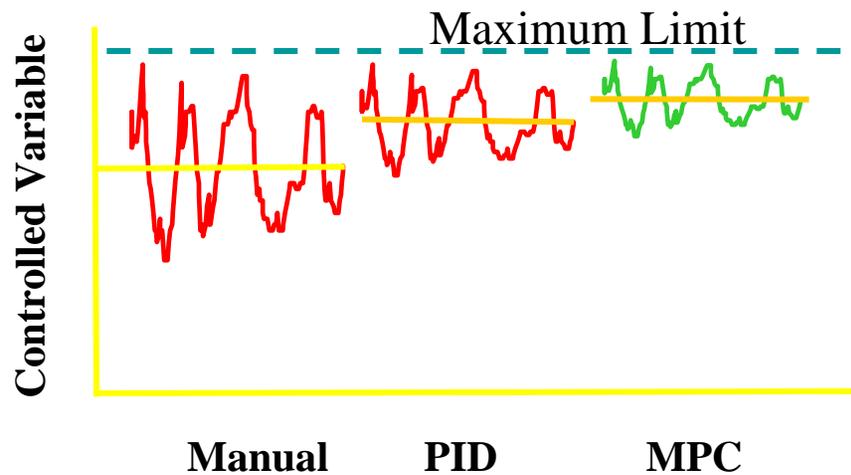
❑ Reduced Variability

- By Moving the Manipulated Variables at the right time and right amount so that CV's stay close to their setpoints

❑ Optimal Allocations of the resources (MV), to achieve better objective

- Calculating the optimal combination among Manipulated Variables trajectories for minimizing the overall cost function

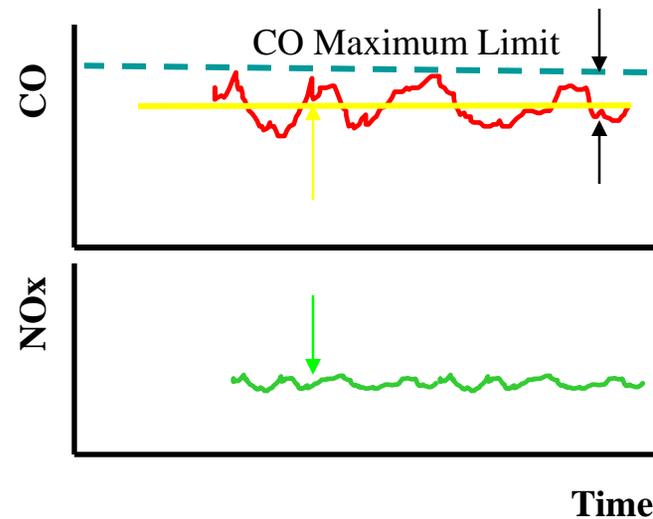
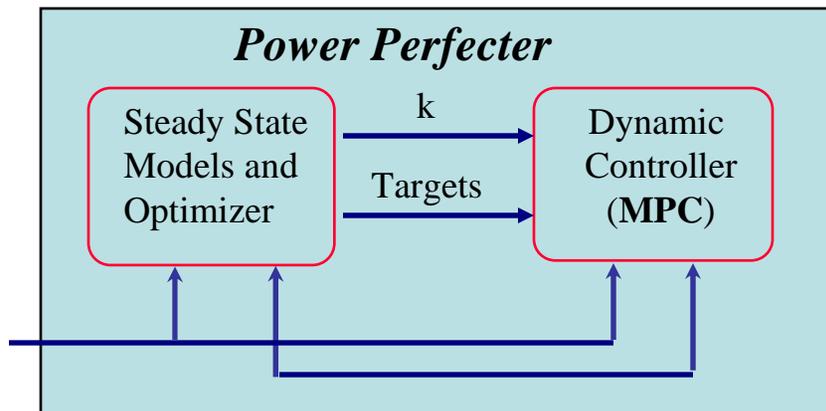
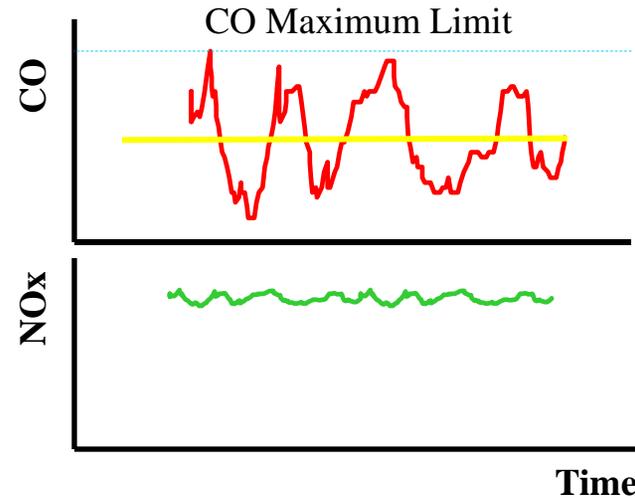
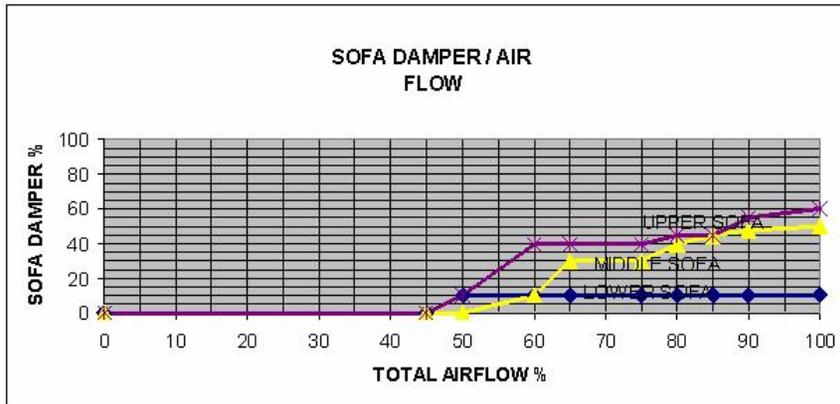
Power Perfecter™ Advantage – Reduced Variability



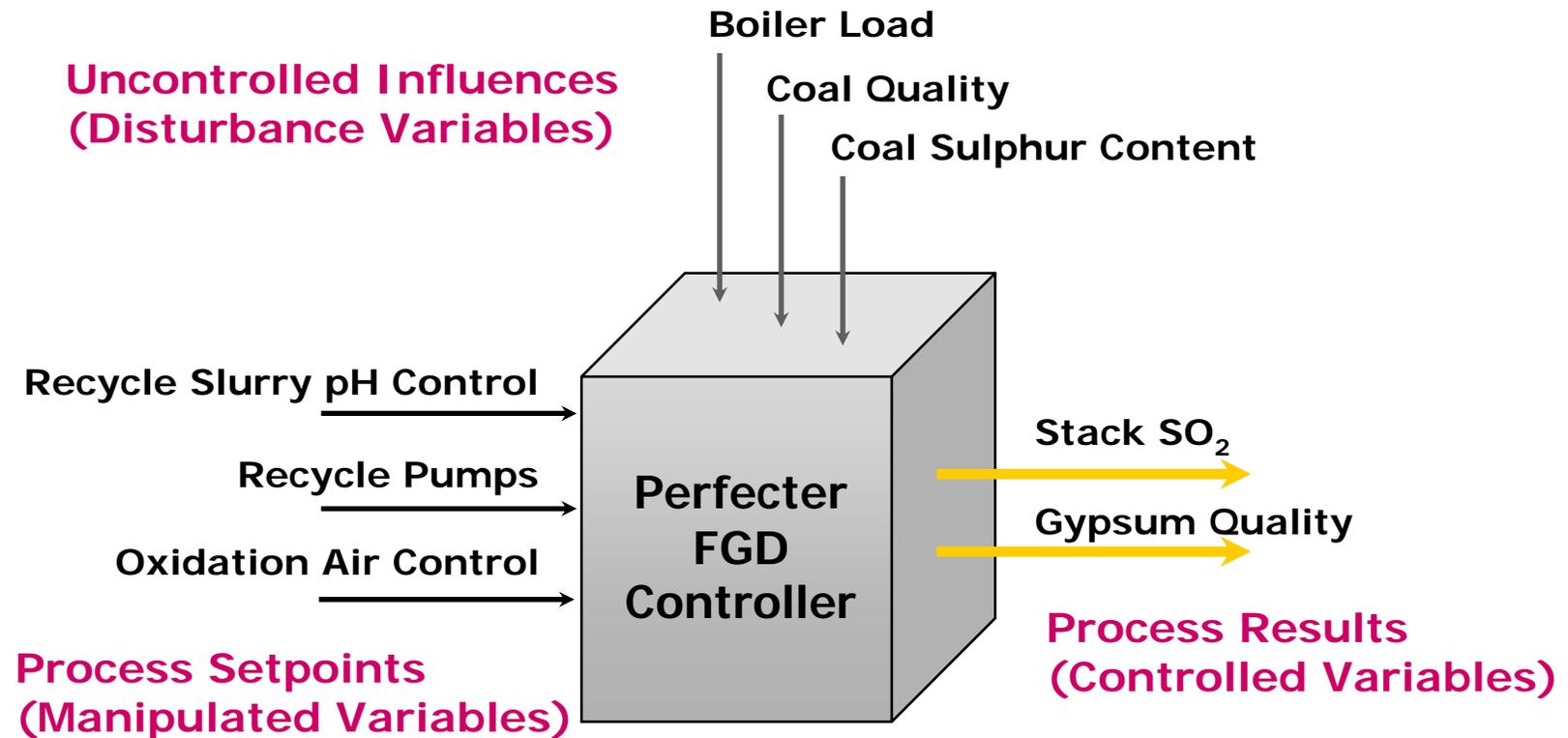
- ❑ Reduced Variability Results in
 - Reduced maintenance
 - Safe operation
 - Increased efficiency

Example: Steam Temperature and Pressure Control
50% Reduction in Variability is Typical

Power Perfecter™ Advantage Optimal Resource Allocations



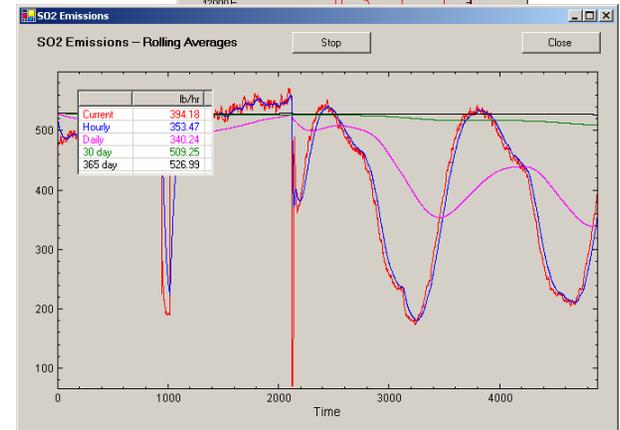
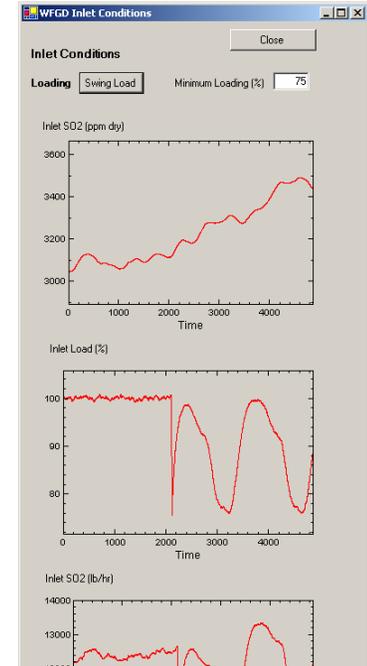
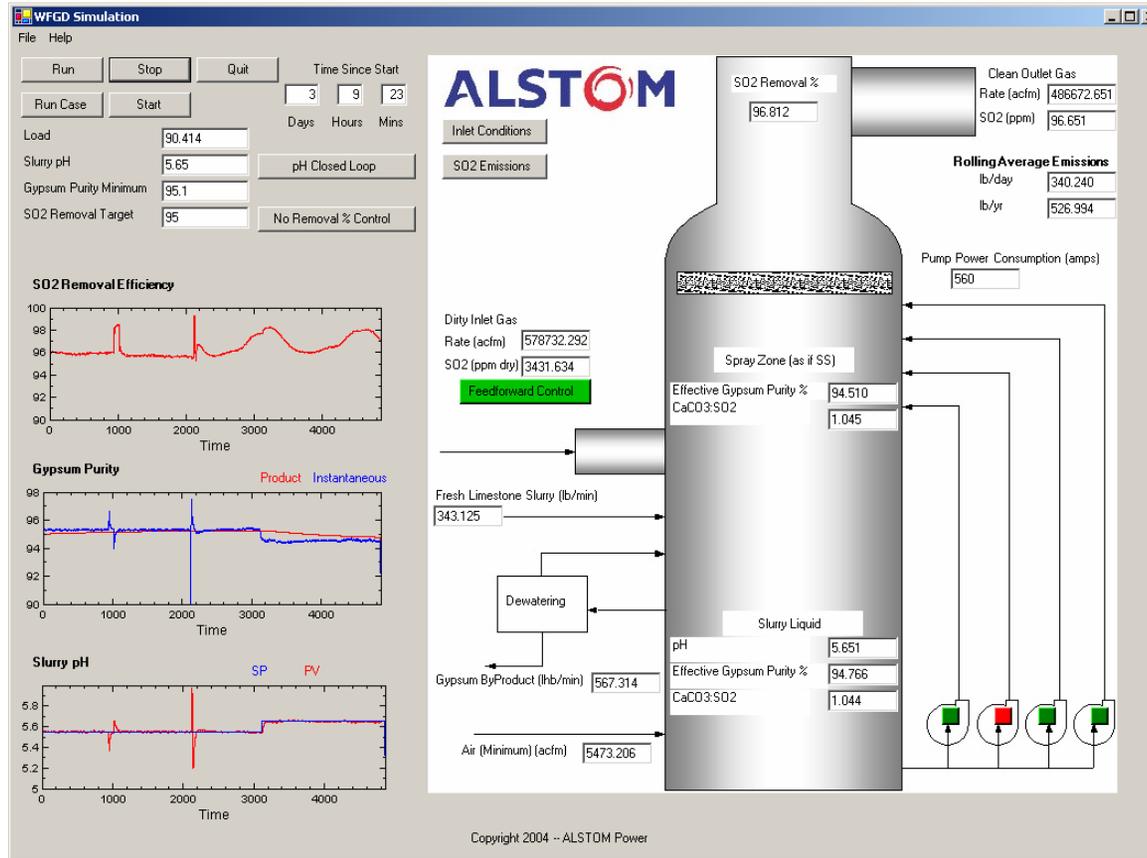
Wet FGD Optimizer



Goals:

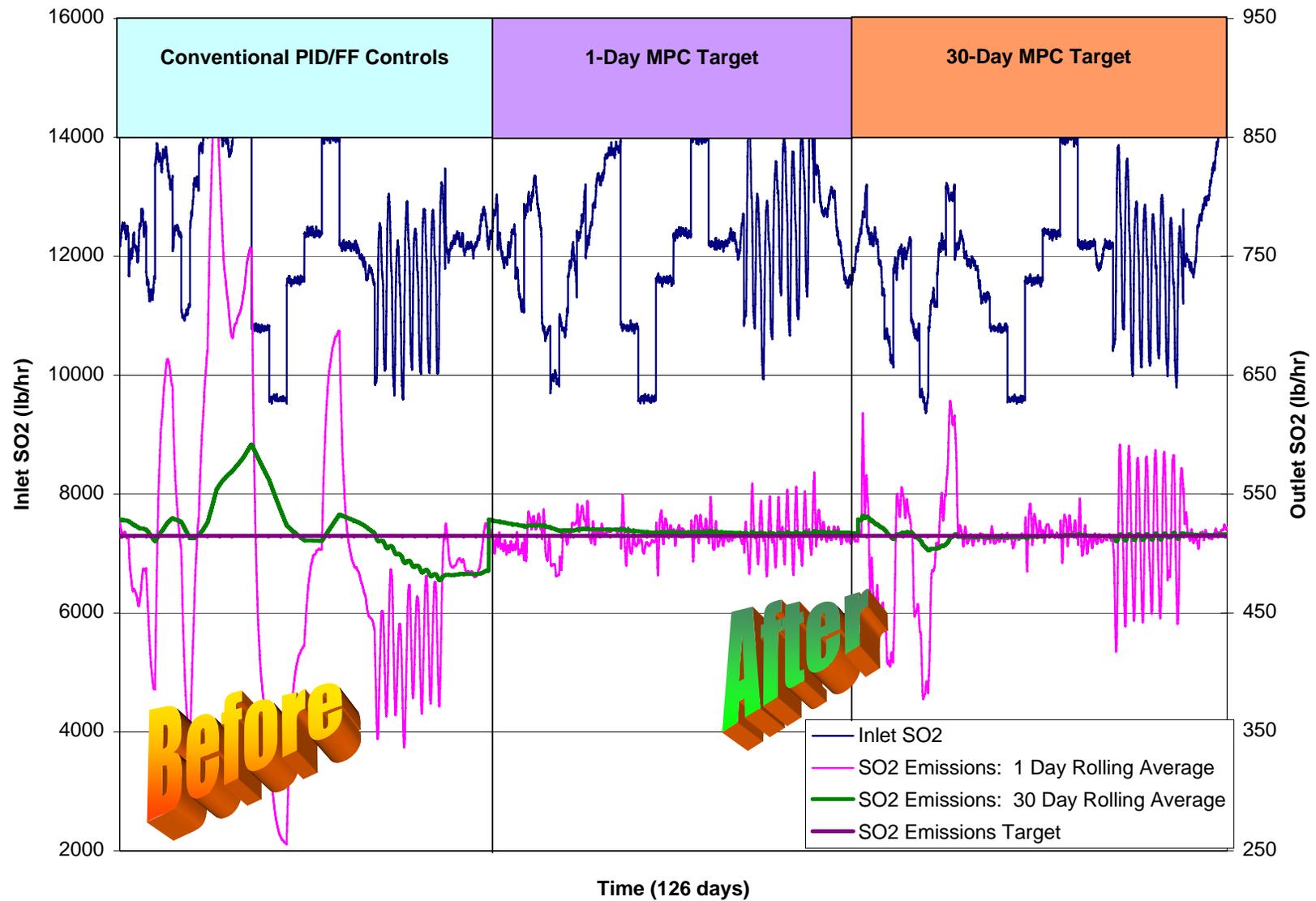
- Use Power Perfecter to maximize SO₂ removal
- Maintain gypsum quality
- Minimize power usage

WFGD Simulation:



Basis: Dynamic simulation of WFGD process based on proprietary ALSTOM WFGD spray-tower steady-state design techniques and empirical dynamic observations.

Comparison of Control Schemes



Operational Summary of Control Schemes



Rolling Average
Target: 515 lb/hr

SO ₂ Emissions (lb/hr)	Average	Median	Standard Deviation	Maximum	Minimum
Instantaneous					
Conventional PID/FF	504.8	488.7	153.2	1331.4	114.6
MPC: 1 Day Target	515.1	512.1	58.2	1225.1	122.0
MPC: 30 Day Target	510.5	511.5	99.0	1166.0	143.0
1 Hour Rolling Average					
Conventional PID/FF	504.9	488.0	151.8	983.0	213.2
MPC: 1 Day Target	515.1	512.5	53.4	708.9	338.0
MPC: 30 Day Target	510.4	511.7	95.8	964.6	233.7
1 Day Rolling Average					
Conventional PID/FF	505.0	485.1	129.0	919.8	255.2
<i>MPC: 1 Day Target</i>	515.3	514.8	13.0	568.3	480.6
MPC: 30 Day Target	510.5	514.2	41.0	628.2	377.3
30 Day Rolling Average					
Conventional PID/FF	520.2	519.2	28.3	591.9	477.4
MPC: 1 Day Target	519.3	518.1	2.8	528.7	515.6
<i>MPC: 30 Day Target</i>	514.9	514.8	4.4	532.0	502.5

All Cases: Average Gypsum Quality: 95.2%

FGD Optimizer Benefits

- Increased SO₂ removal efficiency (2-5%)
- Decrease operation cost for limestone and power (2-5%)
- Maintain by-products quality
- Consistent operations
- Improved operations
- Improved maintenance



FGD Benefits for a 600 MW Unit*

Benefit	Savings per Year
SO ₂ Credit (2.5% improvement due to absorber control)	\$400,000
Operational Savings for Power (4% reduction)	\$67,000
Operational Savings for Limestone (2% reduction)	\$87,000
Prevention of Limestone Blinding (2 incidents)	\$182,000
Maintenance (Replacement of pH probes)	<u>\$65,000</u>
Total	\$801,000

* 600 MW unit, 0.8 capacity, sulfur content of 2%, SO₂ credit of \$165/ton.