

# SULZER

## Sulzer CATS

A bespoke closed-loop combustion auto-tuning solution (CATS) developed by Sulzer- which reduces emissions and secures efficiency by balancing key operational parameters. This enables operators to have a cost-effective, dynamic solution to meet the more stringent NOx standards imposed by governments for a more sustainable energy future.



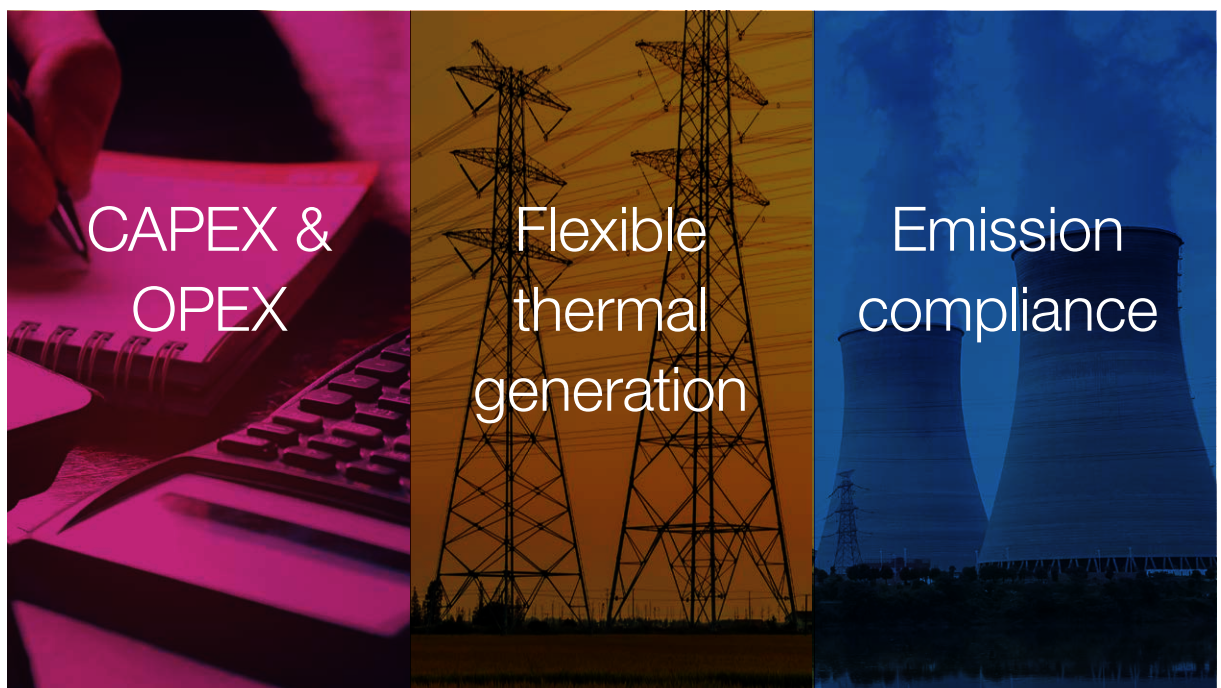
# Compliance challenges to the Power Industry

The energy transition with increasing integration of renewables is resulting in changing duty requirements for gas turbines, with operators striving to ensure efficiency against peak lopping and increased start/stop cycles. However, these efforts need to be balanced against meeting tightening emissions legislation.

As countries work towards a more sustainable future. Emissions regulatory guidelines are imposed on carbon intensive industries, including thermal power generation. Governments around the world are introducing new emissions standards to improve air quality. A key aspect of this effort is minimizing nitrogen oxide (NOx) emissions from gas turbines. For operators, especially those using legacy equipment, attaining these new emissions standards means investing in their equipment. To complete this while guaranteeing power generation uptime, improving efficiency and securing cost-effective operations is a delicate balancing act.

Carbon pricing, rigid standards and fines for non-compliance are being introduced across Asia to limit the release of greenhouse gases (GHG) into the atmosphere. Both Japan and South Korea have introduced mandatory national caps and emissions trade schemes for GHG in the 2010s.

## Power generation - Delicate balancing act



# Evolution of NOx control technology

There are multiple options to reduce NOx emissions for gas turbines, but they all have limitations. Adding steam or water into the combustion process (wet control) can lower the temperature of the burn and reduce NOx emissions. However, this can release additional carbon monoxide and hydrocarbons, increasing pollution.

The Dry Low Emission (DLE) approach relies on making combustion lean. This is achieved by increasing the amount of air compared to fuel and carrying out staged combustion. However, sizeable, costly modifications to the turbine are needed. Changes to combustion can also cause acoustic instability, which can damage components such as nozzles, liners, transition pieces and even blades.

Selective Catalytic Reduction (SCR) relies on introducing a urea solution into the gas stream. Also known as flue gas denitration, the process converts NOx into harmless nitrogen and water. This works best with a DLE set up – which still entails the associated CAPEX and lead time compromises.



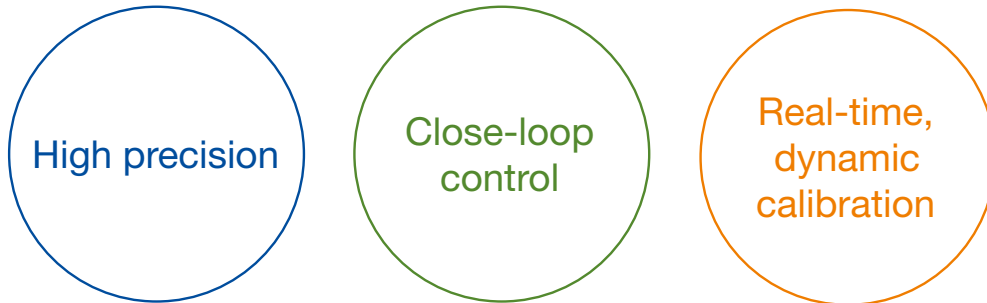
# Sulzer CATS

## Maximum performance with precise dynamic calibration

Sulzer has developed a bespoke combustion auto-tuning solution (CATS) - which reduces emissions and secures efficiency by balancing key operational parameters. Consequently, operators have a cost-effective, dynamic solution to meet the latest NOx standards.

CATS provides real-time, dynamic closed-loop control of the combustion process to reduce NOx emissions by balancing parameters within the gas turbine. CATS offers:

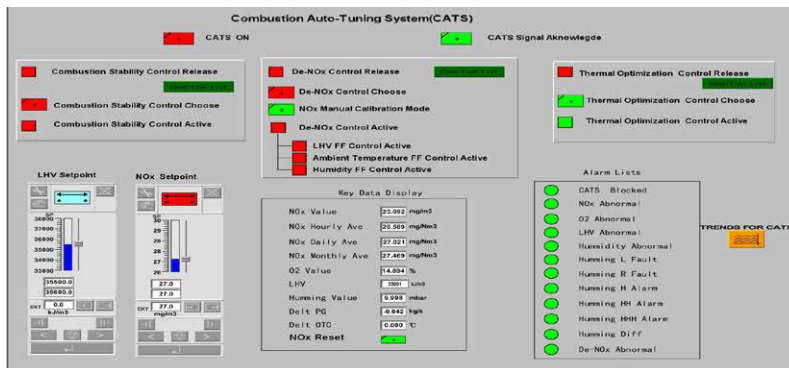
- Increased cost-effectiveness
- Much lower CAPEX and OPEX
- Reduced lead times
- Minimal disturbance to operations
- Improved power generation uptime



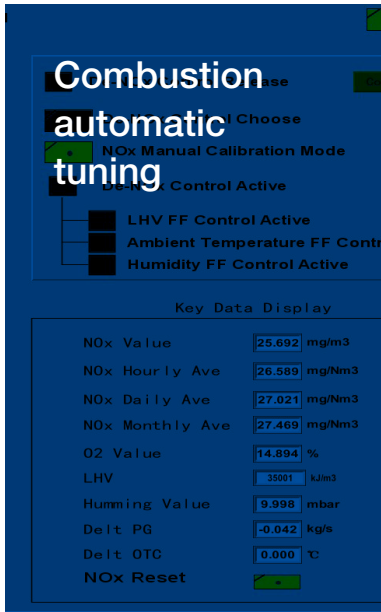
While auto-combustion tuning has been available for more than a decade, Sulzer CATS is closed-looped, enabling the dynamic balance of four key operational parameters with high precision:

- Emissions
- Combustion dynamics
- Power output
- Efficiency

Closed-loop control offers higher precision compared to auto-tuning systems, which are open-loop. The system also promotes overall operational efficiency while reducing NOx emissions. It is suitable for use with selective Siemens, General Electric and Mitsubishi heavy duty GT models.



# NOx control solutions-cost comparison



- One-time CAPEX, short turnaround lead time.
- Zero OPEX and no negative impact on gas turbine efficiency

- Fitting of SCR reactor and catalyst
- Estimated US\$2.1 million CAPEX and US\$1million OPEX

- Requires flame tube/burner upgrade
- US\$500k CAPEX and US\$200k OPEX
- Low NOx burner replacement: US\$400k CAPEX and US\$110k OPEX

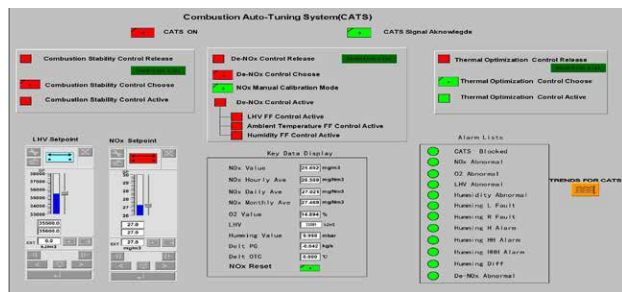


# Sulzer CATS user interface

## 9 modular operational parameters

Customizable modular control that gives operators an overview of the key operating health and performance of your gas turbine.

- Automatic fuel adjustment
- Combustion stability control module
- NOx emissions reduction module
- Performance optimization module
- Calorific value manual input function
- Feed-forward function status display
- Key data display
- Alert alarm function
- Historical data charting



## Real-time monitoring



Graphical representation of NOx emissions in high ambient temperature conditions

# Key benefits



## Dynamic balance

Of 4 key operational parameters- emissions, combustion dynamics, power output and efficiency



## Eliminates manual tuning

requirements, in turn, cuts on manhours and costs



## One-time cost

Zero OPEX across rest of utilization cycle



## Cost effective solution

25% relative difference with OEMs' solution



## Higher precision

over open-loop combustion auto-tuning systems



## Lower CAPEX

for hardware by 80%



## Fuel flexibility

compatible for natural gas, ammonia, hydrogen & more.



## Integrative solution

that monitors more than 20 operating parameters



## Short implementation

lead-time, 30% faster than OEM solution








## Better performance

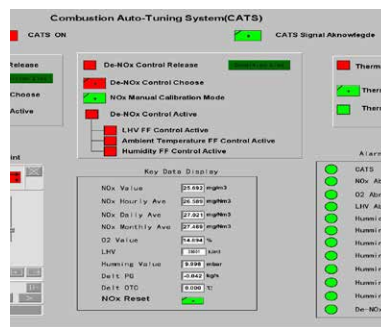
over-time for gas turbine leading to lower maintenance costs and equipment longevity

## Technical features

- Closed-loop system
- Single signal-based control system
- Modular-based solution with 9 system modules
- Redundancy design
- Feed-forward plus feedback control
- More than 20 operational data parameters monitored

# Application

	Category	Variability
	Industry	Utility-scale Power Generation
	Plant type	Gas, Combined Cycle
	Fuel	Natural Gas, Ammonia and Hydrogen Etc
	Gas turbine OEM	Siemens, General Electric and Mitsubishi etc
	Load-range	100-220 MW



20%

Average NOx emissions reduction

+20

Operational feed-in data parameters

25%

Average reduced cost difference with GT OEMs' solution



# Overcoming challenges

Modern power generation operations face a slew of operational challenges categorized by internal and external influenced factors. Sulzer CATS is engineered to support and ease operators' pain points ranging from combustion dynamics, grid requirements to efficiency and more.

## Challenge



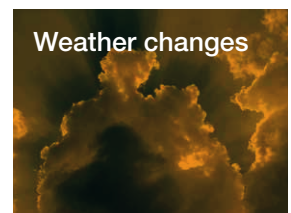
Flame stability



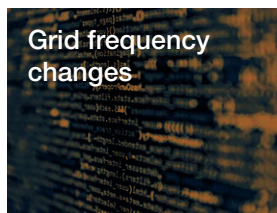
Emissions compliance



Low combustion dynamics



Weather changes



Grid frequency changes



Efficiency- high fuel consumption

### How Sulzer CATS resolves?

Dynamic calibration with precision, in a closed-loop system, supported through individual gas turbine's field data and operating characteristics



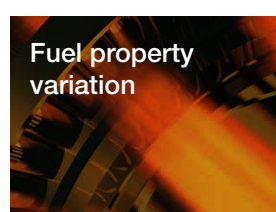
Equipment longevity

Enhanced performance with operational parameters from combustion through flame stability drives down requirements for irregularity which increases equipment fouling and subsequently equipment's longevity



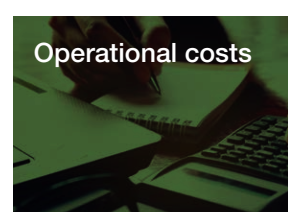
Safety

Stable combustion and enhanced performance correlate with safety while reduced maintenance requirements drives down probability of safety incidents



Fuel property variation

Deployable for turbines using different gas types such as natural gas, ammonia and hydrogen etc



Operational costs

Eliminates substantial manpower and maintenance costs prevalent via conventional solutions such as SCR and DLE

# Case study: Future-proofing gas turbine operations with 120 tons of NOx emissions shaved

**Location:** Tongzhou, China  
**Industry:** Power Generation  
**Customer:** 500MW Combined-cycle Power plant  
**Service:** Sulzer CATS

## Project key facts

**CAPEX savings per gas turbine** US\$2million  
**NOx emissions reduction/gas turbine:** 120 Tons  
**OPEX cost savings/gas turbine:** US\$41,000  
**Annual NOx tax savings/gas turbine:** US\$45,000



## Challenge

In 2021, Jiangsu Province in China announced its “Stationary Gas Turbine Air Pollutant Emission Standard”, which stipulated that by March 2023, all gas turbines in the area will have to attain a NOx emission limit 30 mg/m<sup>3</sup> (standard state, dry basis, 15% O<sub>2</sub>). This presented a powerplant in Tongzhou with a challenge. The plant’s Siemens V94.2 gas turbine was found to be emitting between 35 to 45 mg/m<sup>3</sup> of NOx during normal running. To meet the new emissions standard, it was clear the turbine required a retrofit solution.

## Solution

Conventional approaches such as Selective Catalytic Reaction (SCR) and Dry Low Emission (DLE) were explored. However, they are not cost competitive and will incur relatively long lead times and associated downtime

- SCR would require a CAPEX of around USD 2 million and an annual operating expenditure (OPEX) of USD 685’000.
- For DLE, A low NOx burner cartridge replacement would still equate to a US\$342’000 CAPEX

and an annual US\$137’000 OPEX.

- Sulzer instead proposed a more advanced solution- Combustion Automatic Tuning Solution, built entirely in-house. By balancing the parameters of combustion within the gas turbine, it was possible that the emissions standard could be met. which could provide real-time, dynamic control of the process.
- For over six months, Sulzer collected and analyzed tens of thousands of sets of unit operating data, discerning the characteristic values for thresholds.
- Large quantities of data regarding turbine combustion, NOx generation and existing controls were gathered
- Extensive research was conducted on the turbine itself. Combustion tuning testing was carried out in varying operational conditions, allowing for parameters to be assessed.
- Throughout all testing, continuous NOx emissions monitoring was conducted to show how certain parameters affected emissions.

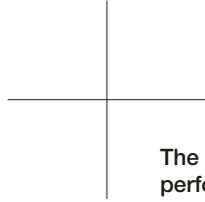
- The key was to achieve the emissions standard without reducing the efficiency of the gas turbine.

## Impact

Across a range of loads, gas calorific values, humidity and ambient temperatures, the CATS was able to deliver average emissions below the 30 mg/m<sup>3</sup> standard. Since its installation, the highest instantaneous value of NOx emissions from the turbine is lower than 28.5 mg/m<sup>3</sup>, with an hourly average of just 27 mg/m<sup>3</sup> – 25% to 30% lower than the average NOx emission value in 2020. This ensures that the turbine now meets the “Stationary Gas Turbine Air Pollutant Emission Standard” coming into effect in Jiangsu Province.

This breakthrough CATS solution has provided the power plant with a one-off CAPEX savings of US\$1.4 million, while delivering OPEX savings of over USD 41’000 per turbine annually. The system has reduced emissions by 120 tonnes in its first year of operations, unlocking annual NOx tax savings of nearly US\$ 45’000.





**The Sulzer Services division is your partner for uptime and enhanced performance for your rotating equipment and more. Our dedicated people provide unrivalled service and expertise to meet your operational needs – anytime, anywhere.**

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Through a network of over 100 service sites around the world, Sulzer provides cutting-edge parts as well as maintenance and repair solutions for pumps, turbines, compressors, motors and generators. We service our own original equipment, but also all associated third-party rotating equipment run by our customers, maximizing sustainability and life cycle cost-effectiveness. Our technology-based solutions, fast execution and expertise in complex maintenance projects are available at our customers' doorsteps, ensuring minimal downtime.

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