

Optimizing Boiler Efficiency

Fuel Savings & CO₂ Emissions
Reduction

Using TrendMiner's Monitoring and
Dashboarding Features

 **BASF**

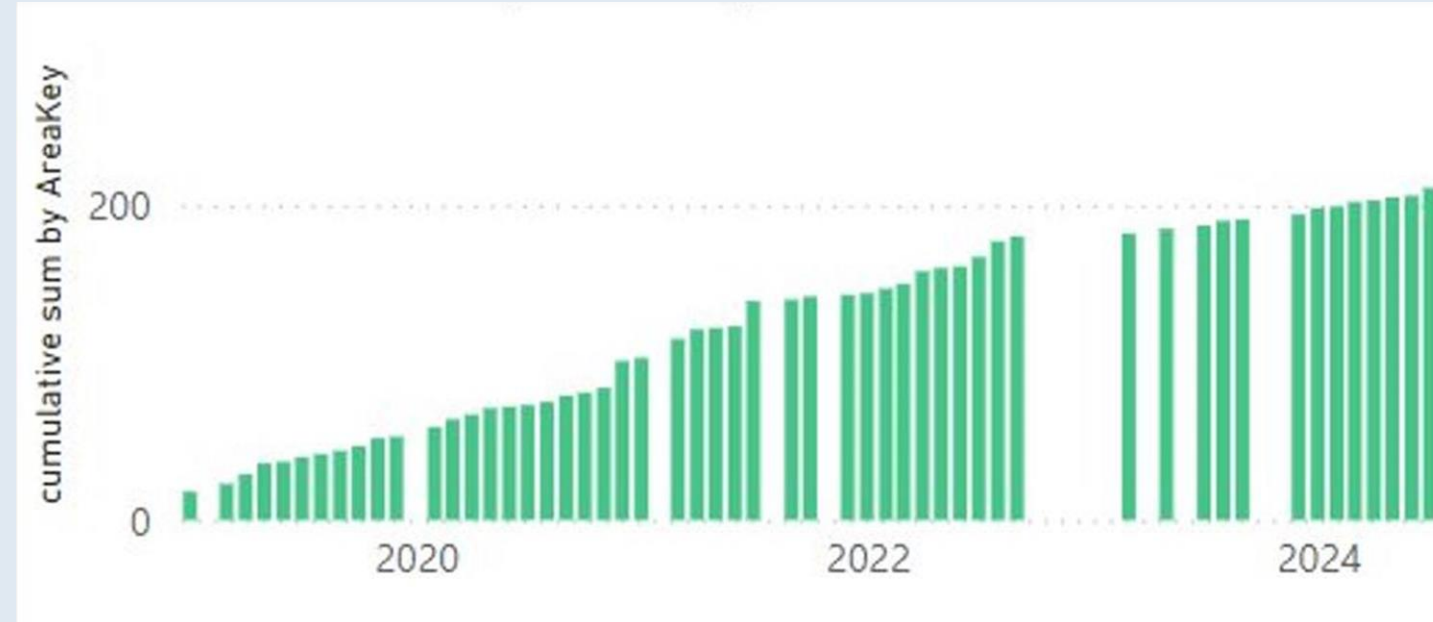
We create chemistry

BASF – We create chemistry

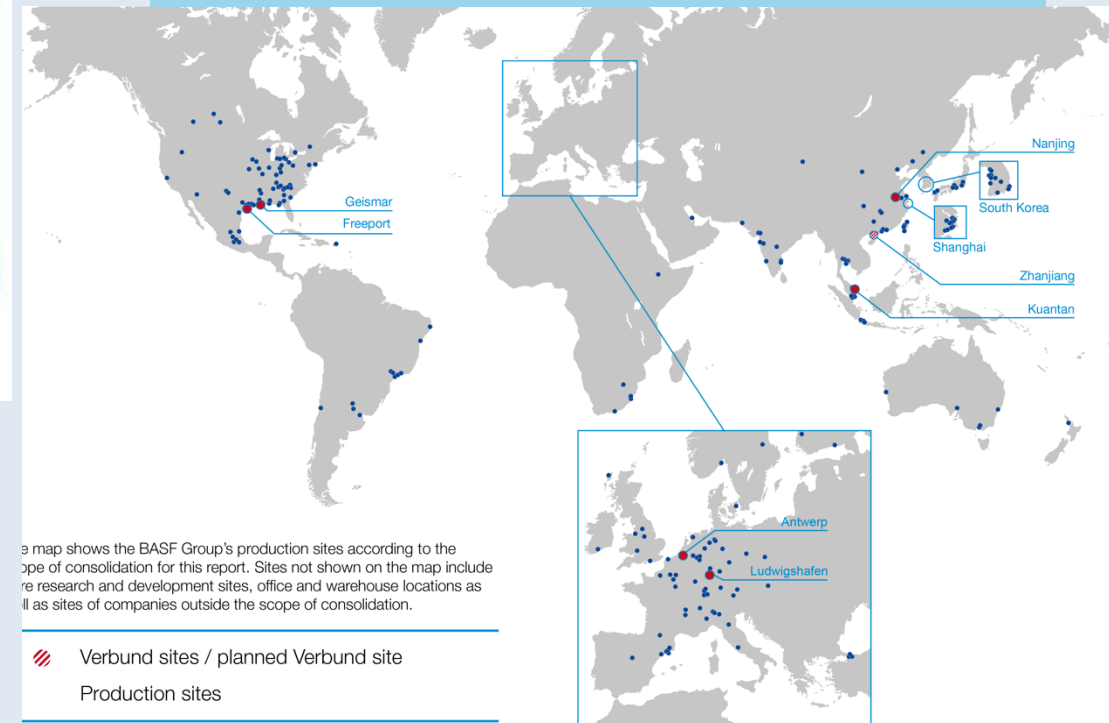
- Our chemistry is used in almost all industries
- We combine economic success with environmental protection and societal responsibility
- Sales 2024: €65.3 billion
- EBITDA before special items 2024: €7.9 billion
- Employees (as of December 31, 2024): 111,822
- 235 production sites including 6 Verbund sites
- Over 74,000 customers from various sectors in almost every country in the world



Cumulative Number of BASF Plants (globally) Using TrendMiner, 2019-2024



BASF operates 235 production sites worldwide; each production site has multiple plants.



Why Boiler Efficiency Matters

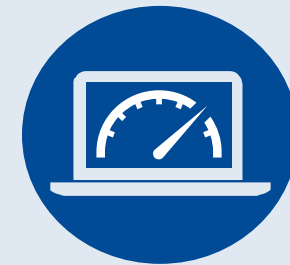
- Boilers are major consumers of fuel in industry
- Even small efficiency gains can save significant costs
- Reducing excess air minimizes wasted energy
 - A **15%** reduction in Excess air increases boiler efficiency by **1%**
- Lower fuel usage = reduced CO₂ footprint
- Compliance with environmental regulations



According to Data from late 1990's, Boiler counts was about 12,000 in the chemical industry in US.

Excess Air Optimization at BASF a Low Hanging Fruit for Net Zero

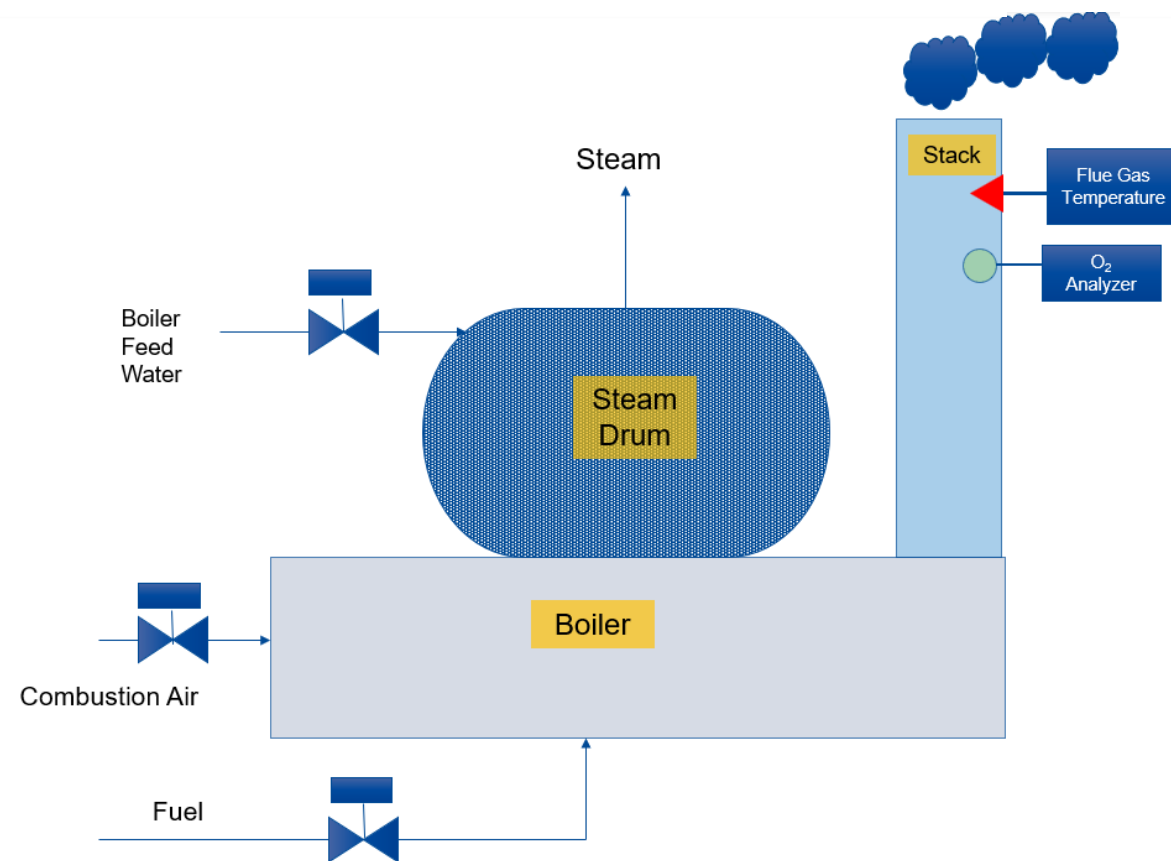
- At BASF, we strive to achieve net zero CO₂ targets
- One of the simplest and most impactful measures:
 - ✓ **Optimizing excess air: a low hanging fruit that requires no capital investment.**
- By creating a real-time “TrendMiner” dashboard, operators gain live view of:
 - ✓ Operating conditions
 - ✓ Boiler efficiency KPI's
 - ✓ CO₂ emission impact
 - ✓ Reduction in fuel cost



The dashboard guides operators to maintain optimal excess air levels.

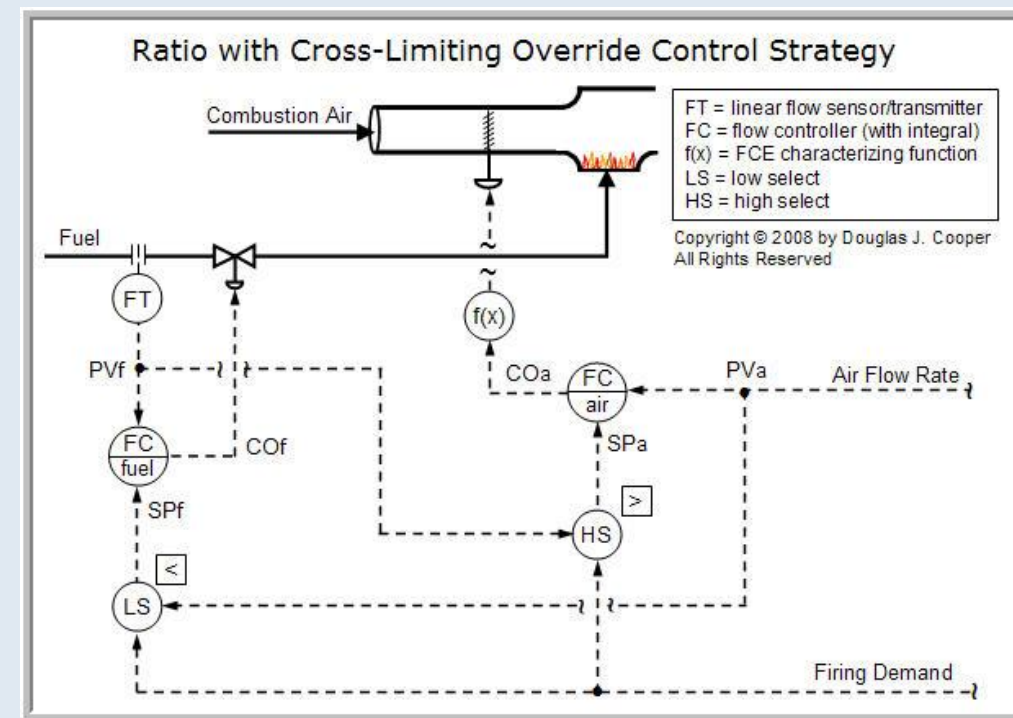
Impact of Excess Air

- Excess oxygen = extra air supplied beyond stoichiometric needs
- Too much excess air → heat loss through stack gases
- Too little → incomplete combustion, CO formation
- Optimal O₂ levels improve combustion efficiency
- The optimal excess oxygen target: 2% – 4% in flue gas but may vary depending on the boiler design
- To maintain 4% excess oxygen in flue gas, the excess air over stoichiometry for natural gas as fuel is ~125%



Monitoring and Dashboarding Objectives

- Boilers typically measure excess oxygen or CO_2 in the stack using analyzers.
- Some systems use feedback controllers to maintain the air:fuel ratio, optimizing fuel efficiency
- Many older boilers at smaller sites lack this feature, so operators manually set higher air:fuel ratios than design, leading to excess fuel usage and higher CO_2 emissions





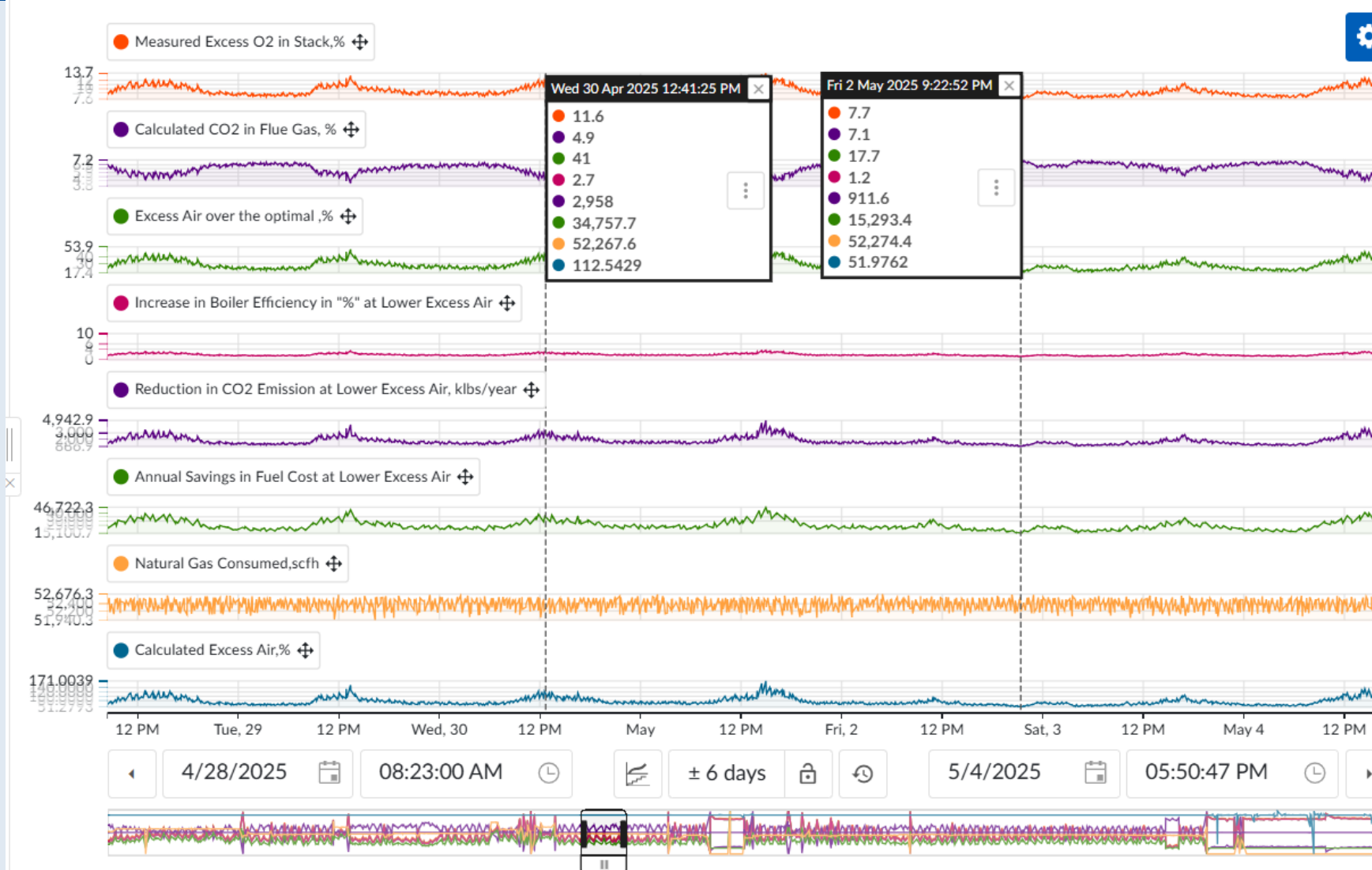
Monitoring and Dashboard Initiatives

To support and encourage operators in maintaining the optimal Excess Air, we developed and are piloting a TrendMiner dashboard for one boiler at a BASF site.

- Monitor Excess Oxygen in Flue Gas (Live from IP-21)
- Monitor Fuel Consumption (Live from IP-21)
- Convey the Target for Optimized Air:Fuel Ratio
- Display the Increase in Boiler Efficiency (%) at lower Air:Fuel Ratio
- Display the Calculated Cumulative Fuel \$Savings (annually)
- Display the Calculate Cumulative CO₂ Reduction (annually)

There are 3 boilers at the site, and we plan to develop a dedicated dashboards for all boilers

Benefits by Operating at the Optimal Excess Air of 125% (Air:Fuel Ratio)



The Dashboard

Real-Time Excess Air (%), Excess Oxygen (%), Fuel Usage, SCFH

Realtime Excess Air, %



165.2

8/26/2025 9:40:29 AM

[BMT]BAN_ACB410EA.PV



13.5 PCT

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[BMT]BAN_FCB410EA.PV

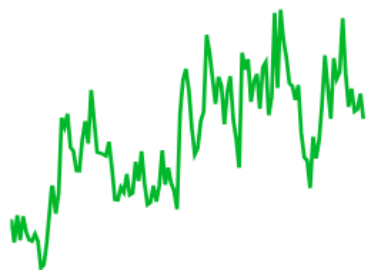


49,642.8 SCFH

8/26/2025 9:25:28 AM

Increase in Boiler Efficiency when Air:Fuel Ratio is Lowered to 1.25

Increase_in_BoilerEfficiency, %



3.7

8/26/2025 9:49:59 AM

If Boiler Status Shows "0", Boiler is out, If Value "1", Boiler Running

[BMT]BAN_Boiler_Status_BF

1

8/26/2025 9:36:29 AM

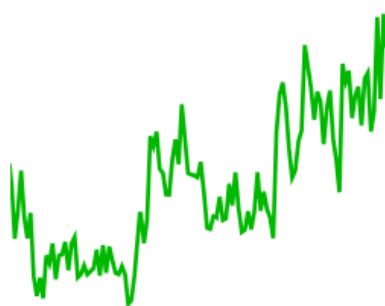
Excess Oxygen-Monitor



Lower Air:Fuel Ratio to 1.25 or 125%

Decrease in CO2 Emission when Air:Fuel is lowered to 125%, klbs/year

Annual_Reduction_in_CO2_Emissions_klbs



1,864.1

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Annual Savings in Fuel Cost when Air:Fuel Ratio is lowered to 1.25

Savings in Fuel Cost at Lower Excess Air, \$/year



47,797.2

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Monitoring: Alert- Emailed to the Production Engineer and Shift Supervisor



Monitoring alert: Excess Oxygen is too much

Please lower Air:Fuel Ratio to 125%

Condition detected: **Excess Oxygen**

Starting at: **Aug 21, 2025 21:13:00 CDT**

Monitor owner: **Bita Fillipi**

[View in TrendHub*](#)

Statistical Analysis(TrendMiner) For a 75-Day Time Span for One Boiler

TAGS & ATTRIBUTES ?	AVG	STDEV	MIN	MAX
● Measured Oxygen in Boiler Stack, %	9.8	1.9	6.6	24.8
● Increase in Boiler Efficiency in "%" at Lower Excess Air	2.1	0.745	0.808	8.4
● Savings in Fuel Cost at Lower Excess Air, \$/year	29,192.7	12,301.2	0	98,104.2
● Reduction in CO2 Emission at Lower Excess Air, klbs/year	1,138.5	479.7	0	3,826.1

- Estimated Savings for 3 Boilers = \$90,000/year
- Estimated Reduction in CO₂ Emissions for 3 Boilers = 3600 klbs/yr

Path Forward

- There are at least 10 other boiler systems at various BASF sites that could benefit from a similar Excess Oxygen Dashboard
- Comparable benefits can be realized when Air:Fuel (Excess Air) is lowered to the optimal values based on the design of the boiler.

You can do the math.





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