Best Practice	MINIMISE EXCESS AIR	STEA-04
Application	Steam systems	
SME sector	Processing and manufacturing industries	
SME Sub-sector	Food processing, paper, and cardboard manufacturing sectors, pharmaceutical, chemicals, distilleries, etc.	
Technical description	In combustion a fuel is converted chemically to generate heat. This conversion requires a certain amount of oxygen, commonly provided via air. When fuel and oxygen are in perfect balance, the combustion is called stoichiometric. The minimum required oxygen is depending on fuel and composition. For an ideal combustion the theoretical minimum amount of oxygen can be determined. However, as the combustion is commonly not ideal (varying fuel composition, mixing problems, issues with residence time of fuel in combustion chambers, etc.) additional oxygen is provided to completely burn the fuel. This increases the fuel usage and flue gas stream which results in heat losses, lowering the overall boiler efficiency.	
Recommendation for optimisation	The required oxygen amount needs to be adapted to the currently used fuel. The exact fuel composition is often unknown and sometimes changes over time (e.g. different supplier, variation within known concentration borders). Additionally, seasonal effects like differences in humidity and temperature affect gas related properties like density and composition. This results in differences in the actual provided amount of oxygen (in case environmental air is used). To determine the optimal excess oxygen (O_2) content, the flue gas oxygen and carbon monoxide (CO) content needs to be analysed. A high carbon monoxide (CO) content indicate that more oxygen is required, as the fuel is not fully converted to carbon dioxide (CO_2). Otherwise, if the CO content is very small and the O_2 is high, too much air is provided. In this case the overall efficiency is reduced due to heat losses (increased flue gas flow). When high O_2 and high CO contents are detected the boiler design needs to be investigated. Jet streams or air leakage (air is sucked into the system) might be an explanation. Typically used excess air levels are: - Natural gas: 1.5-10% - Fuel oil: 2-20% - Biomass: 6-10% - Coal: 15-60% For an efficient implementation a flue gas analysing system (lambda sensor/probe) should be installed and integrated into the process control system to provide the optimal amount of oxygen for the currently used fuel. The gas sensors should be	

	installed close to the combustion chamber to avoid contamination with environmental air (e.g., leakage, reverse flow through chimney, etc.).
Schemes and diagrams	 Scheme of steam generation and distribution
Economics	Depending on the size of the boiler, the price of an integrated oxygen control system varies between 6,000-10,000 EUR and is currently most cost-effective for installations above 200 kW.
Energy savings	By applying a gas flow analysis system to the existing control system, efficiency can be increased by reducing fuel demand by up to 0.5%
Economic savings	Cost savings are closely linked to lower fuel consumption Annual savings = fuel consumption * fuel costs * (1 – old efficiency / new efficiency) – maintenance costs
Average Payback Time	The payback time depends to a large extent on fuel economy and the price of fuel. Therefore, no average payback time can be given.
Emissions	To be assessed on a case-by-case basis.
Environmental benefits	Energy savings (e.g., reducing exhaust gas temperature) often lead to a reduction in emissions of pollutants such as CO_2
Main NEBs (Multiple benefits)	☒ Environmental benefits ☒ Increased productivity ☐ Work environment/Health/Safety Depending on the chosen measures the global performance increases which leads to an increase of competitiveness. Sustainability marketing can be increased

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	☒ Increased competitiveness ☐ Maintenance	by energy savings through reduced emissions. This might lead to increases in sales.
Replicability	Not available	
Related measures	• STEA-03: Burner optimisation	
References	Blessl and Kessler, 2017, Energieeffizienz in der Industrie, Springer Vieweg, DOI: 10.1007/978-3-662-55999-4 Bosch, 2018, Planungshandbuch für Dampfkesselanlagen, TT/MKT-CH_de_Planungshandbuch_Dampf_01 Cres and Isnova, 2019, SteamUp - WP4 Training Material prepared by CRES Kulterer, K.: klimaaktiv Leitfaden für Energieaudits in Dampfsystemen, Österreichische Energieagentur im Rahmen des Programms des Lebensministeriums, Wien, 2017 Statistik Austria, 2019, Nutzenergieanalyse für 2017 Wünning, 2007, Handbuch der Brennertechnik für Industrieöfen: Grundlagen, Brennertechniken, Anwendungen, Vulkan-Verlag GmbH, ISBN: 3802729382	