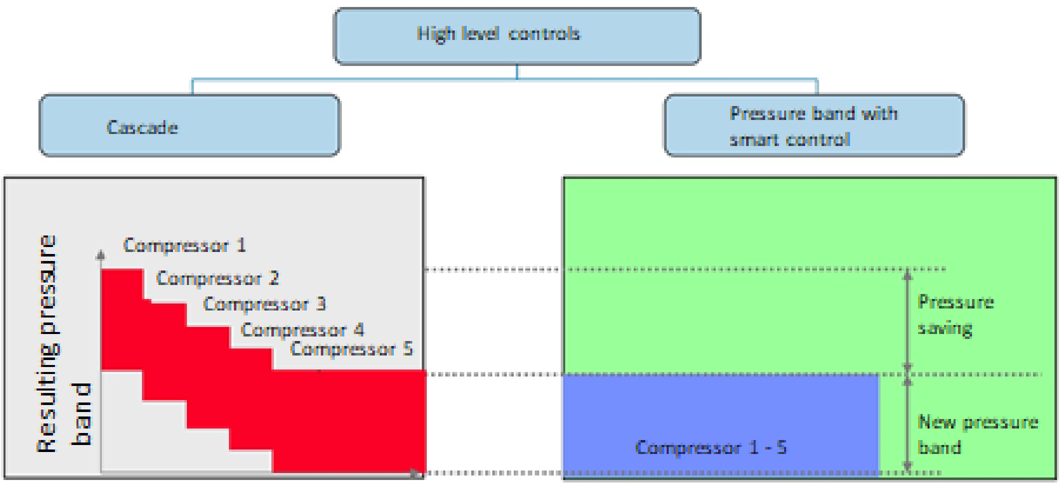
This project has received funding from the European Union's H2020 Coordination Support Action under Grant Agreement No. 894356.

Best Practice	HIGH LEVEL CONTROL	CAIR-04
Application	Compressed Air Systems	
SME sector	Industrial	
SME Sub-sector	All	
Technical description	In most compressed air systems, more than one compressor unit is needed to cover the demand. Different sized compressors are used for different purposes. Usually big compressors, which can provide a large volume flow, are used to cover the base load. The peak loads are covered by smaller compressors. In many factories the composition of several compressors in one system is often planned very poorly, either due to increased costs in the planning stage or compressors being added later to the system. Controlling air compressors with only their on-board controllers can cause one or more of the following problems: • Too many compressors running • The wrong combination of compressors is running • Pressure higher than demanded by the system Also operating times, concentrated on the upper or lower end of the flow rates the compressor is capable of, can occur. Further influencing the control scheme is the amount of differential pressure (or pressure drop) measured between the discharge of the compressors and the receiver tank. Usually, the pipes and treatment equipment between those components are different in each branch, causing the pressure drop to vary. This leads to mismatched signals in the controlling units, causing too many compressors to run, wasting energy and increasing maintenance intervals needlessly. The resulting bandwidth for the pressure leads to an elevated energy consumption of about 6 % to 10 % per bar system pressure. Systems with more than one compressor need some sort of high-level controls. The simplest and common is the cascade control scheme. If the compressors are fixed speed, each compressor gets set points to switch between load/no load. Multiple compressors in local control, then form a cascade of those set points, causing the first compressors to operate at elevated pressure to maintain the set point cascade control scheme.	
Recommendation for optimisation	A high-level control can already provide energy savings in a system with 2 compressors. Smart control systems align the signals, differentials and set points to respond to one common pressure band. The advantages are: • Harmonising of the workload between several compressors • Reduction of energy wasted by operating the compressors within a narrow pressure band	

	• Even distribution of operating hours between the compressors and thus more efficient maintenance and higher availability A smart system controller improves the harmony of the compressor units by accounting the rated capacity of each compressor, as well as adding purposeful delays and iterative checkpoints to ensure it is responding to what is happening in the system. This leads to the supply being dynamically matched with the demand and increases functionality, ensuring improved efficiency and fewer compressors running. Moreover, for systems with mixed load/no load and Variable speed compressors, advanced controllers dispatch the compressor smartly between those compressors and take generally the compressors efficiency into account. The used pressure sensors usually are capable of measuring pressure differences down to 0,2 bar.
Relevant technical considerations	An additional influence on the control scheme is the amount of differential pressure (or pressure drop) measured between the compressor exhaust and the receiver tank. Usually, the piping and treatment equipment between these components are different in each branch, causing the pressure drop to change. This leads to matching signals in the control units, causing too many compressors to operate This type of control system can already be used by a two-compressor system.
Schemes and diagrams	 Control of compressed air system: pressure difference by using high level control
Economics	Starting from 3.000 EUR per compressor
Energy savings	With efficient compressor control there is a saving potential of 20-25%
Economic savings	About 20%

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Average Payback Time	3÷6 years	
Emissions	0.702 $kgCO_2/kWh_{el}$ (CO_2 emitted by production for one hour of 1 Nl/min of compressed air)	
Environmental benefits	Reduction of CO_2 emissions due to a reduction in electricity requirements	
Main NEBs (Multiple benefits)	☒ Environmental benefits ☒ Increased productivity ☒ Work environment/ Health/Safety ☐ Increased competitiveness ☒ Maintenance	A more stable pressure supply can lead to an increase in the quality of products. Future system expansions can be added more easily. You can also have an increase in productivity.
Replicability	Medium	
Related measures	• CAIR-01: Optimisation of compressed air users/equipment • CAIR-02: Optimisation of the pressure in the system • CAIR-03: Switch-off of appliances in non-operational times • CAIR-05: Sizing and type of compressor • CAIR-06: Network Optimization • CAIR-07: Reduction of leakages • CAIR-08: Heat recovery	
Case study	Control system installation (Austria, 2016) • Initial Situation: 4 blasting machines are used in a hardening shop to blast material onto gear parts to harden the surface. This is done using compressed air. Each shot blast machine is powered by its own compressor, which runs 5 days a week. If there is no need for air on the blast machine, the compressor switches to vacuum operation, leading to higher energy consumption. • Description of the optimisation: to reduce idle running times of each compressor, a smart high-level control, controlling all 4 of the compressors was installed. This leads to a reduction of idle running times and saves energy. Implementation costs: 16,300 EUR • Payback time: 4 years	
References	Kulterer, K., Huber J., Ruthner H., Oetiker H., Pucher C., Steinbrugger, C.: Leitfaden für Energieaudits zur Optimierung von Druckluftsystemen, klimaaktiv energieeffiziente betriebe, Wien 2015	

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	Larrabee C.: Managing Multiple-Compressor Systems: Utilizing Controls to Improve Performance 3E Strategy, Department of Mechanical engineering, University of cape town: How to save energy and money in compressed air systems

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