Gear@SME
Saving energy together

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

Best Practice	OPTIMISATION OF COMPRESSED AIR USERS/APPLIANCES	CAIR-01
Application	Compressed Air Systems	
SME sector	Industrial	
SME Sub-sector	All	
Technical description	Compressed Air is an essential part of modern industry used by nearly every branch of production. In some sectors compressed air can take up to 20% (glass industries even 40%) of the electrical energy used. On average about 7% to 11% of the electrical energy in industry is used for compressed air. Due to its bad efficiency, compressed air is the most expensive form of energy in industry. Typical fields of application are: • Automatization: cylinders, engines, valves, conveyor belts, weaving • Active air: transport (e.g., bulk transport) • Process air: drying process, fermentation process, ventilation of sedimentation tanks • Vacuum: wrapping, drying, sucking, lifting, positioning The main advantages of compressed air are availability, precision, downscaling, safety and the low weight of the tools used. Fields of application based on the pressure used: • Ultra-high pressure (over 40 bar pressure): testing for leakages, power plants, oxygen bottles • High pressure (17-40 bar): pipe pressure tests, blow moulding of plastic components • Middle pressure (10–17 bar): heavy vehicles, special manufactures • Low pressure (under 10 bar pressure): most industrial applications The compressors power lies about 45% above the value, needed for ideal theoretical compression.	
Recommendation for optimisation	It is possible to increase the efficiency of the production process by reducing the use of air and reducing air losses through the optimization of distribution channels and connected components. In many systems, the working pressure is much higher than needed. Several studies have shown that the pressure level can be reduced by up to 1 bar without affecting productivity. By decreasing the pressure required for the proper operation of the system, it is possible to use compressors of a smaller size and increase the energy efficiency of the entire system.	

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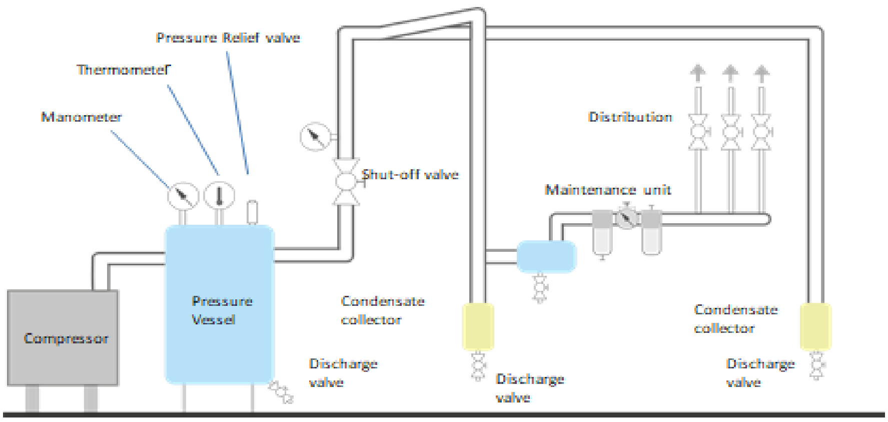
	• Sizing of pneumatic motors: in many systems pneumatic motors are oversized and exceed the needed power by a lot. This leads to a higher demand of air flow which must be provided by bigger compressors. Studies show that almost half of the used pneumatic motors can be downsized by at least one size segment. • Maintenance**:** insufficient maintenance led to abrasive and corrosive wear of the components which leads to an increase of leakages and thus air demand. Wearing parts in pneumatic systems which are maintained regularly don't lead to an increase in air demand. • Change of filter cartridges: compressed air can never be 100% particle free. Pneumatic appliances therefor need a filter element. Often those filter elements get changed too infrequently. This leads to clogging and an increase of pressure losses after a certain time of usage. Approximately the filter should be changed once a year. Alternatively, at a pressure loss of 0,35 bar. • Avoiding open pipes for blowing applications: in industrial processes compressed air is often used for cleaning parts, removing debris, cooling, or aspirating. Often a simple pipe ranging in diameter from 2mm to 32mm is used. This causes turbulences, enhanced energy consumption and potential dangers. In most industrial appliances air guns can be used for manual blowing to clean, dry, move, sort and cool objects. Also, silencers and air nozzles can increase safety and reduce energy consumption. There are many sorts of nozzles regarding air consumption and power which can use the surrounding air to increase their effectiveness. • Controlled vacuum ejectors: vacuum ejectors use the Venturi principle to create a vacuum using compressed air. In many factories unregulated vacuum ejectors are still in use, causing unnecessary costs. The unregulated ejectors should be replaced by controlled ones, which work with air saving regulation and need a lot less volume flow. • Single acting air cylinders: many applications only depend on one direction of the cylinder to be done fast or powerful. The other direction can be travelled much slower or with much less power. But a lot of factories always use double acting cylinders. Switching to single acting cylinders, which uses spring force to return to the base position, saves the compressed air needed for the non-time/power dependent way. • Avoiding of dead-volume: high distances between users, providers and regulators often occur in large systems. The excess of pipes and valves must fill and empty during every control cycle. Unnecessary long pipes, unused branches and unnecessary no-load cycles should be avoided. Existing excesses in systems can be reduced while new systems can be planned accordingly. • Substitution of compressed air: it's not always necessary or recommended to use compressed air. It can often be replaced, at the same productivity, by other

	technologies. For example, a 6,5kW pneumatic motor needs a 132kW compressor while it could be possible to simply use a 6,5kW electric motor. • Other possible substitutions are: - Alternative electric solutions instead of air cushions for - Airless paint sprayers, which pressurise the paint directly for atomisation, instead of compressed air sprayers - Electric vacuum ejectors instead of using the Venturi principle Modern and light electric grinding machines instead of pneumatic ones
Technical considerations	In many cases the compressed air pressure is reduced by the regulators before reaching the user. It is necessary to provide an excess of pressure that causes additional costs due to increased leakages within the pipes.
Other energy/ material flows	About 7-20% of the electricity invested is transformed into mechanical energy to produce compressed air. The remaining 80-93% is transformed into heat and it is stored in the medium or emitted directly by the compressor. 50 to 90% of this heat can be recovered in heat exchangers.
Schemes and diagrams	 Scheme of an industrial compressed air system

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<table>
<tr><td>Economics</td><td>Investments vary from the type of intervention that is carried out on the line.

For the replacement of a compressor, costs start at 3,000-4,000 EUR.</td></tr>
<tr><td>Energy savings</td><td>In general, saving potentials in compressed air systems:
<table>
<tr><th>Businesses</th><th>Percentage of compressed air depending on the overall consumption</th><th>Potential energy saving</th></tr>
<tr><td>Manufacturing, commerce, service</td><td>Up to 20%</td><td>30-50%</td></tr>
<tr><td>Industry</td><td>On average 20%</td><td>Up to 50%</td></tr>
</table>
For this EE measure the saving potential is:
• Replace low quality components: 15%
• Reduction of components: up to 15%</td></tr>
<tr><td>Economic savings</td><td>• Sizing of pneumatic motors: 40% based on the initial need
• Maintenance: depending on the size of the leakage (1mm ca. 150 EUR/year)
• Change of filter cartridges: several thousand EUR/year
• Avoiding open pipes for blowing applications: above 10,000 EUR/year
• Controlled vacuum ejectors: several thousand EUR/year
• Single acting air cylinders: several thousand EUR/year
• Avoiding of dead-volume: 7% per bar of reduced pressure</td></tr>
<tr><td>Average Payback Time</td><td>3-6 years</td></tr>
<tr><td>Emissions</td><td>0.702 $kgCO_2/kWh_{el}$

(CO_2 emitted by production for one hour of 1 Nl/min of compressed air)</td></tr>
<tr><td>Environmental benefits</td><td>Reduction of CO_2 emissions due to lower energy requirements</td></tr>
<tr><td rowspan="2">Main NEBs

(Multiple benefits)</td><td>
<table>
<tr><td>☐ Environmental benefits

☒ Increased productivity

☒ Work environment/ Health/Safety

☐ Increased competitiveness

☒ Maintenance</td><td>Many efficiency measures regarding blowing applications, tools and valves reduce the noise level in working conditions. In some cases, the quality of the product can also be increased using efficient blow applications. (e.g., metal descaling)</td></tr>
</table></td></tr>
<tr><td>MBenefits pilot case study:

Optimizing compressed air improves safety, sparks new line of business</td></tr>
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	https://www.mbenefits.eu/static/media/uploads/site-6/library/Cases%20and%20examples/mbenefits_pilot_case_study_a4l_501_peg.pdf
Replicability	High
Related measures	• CAIR-02: Optimisation of the pressure in the system • CAIR-03: Switch-off of appliances in non-operational times • CAIR-04: High Level Control • CAIR-05: Sizing and type of compressor • CAIR-06: Network Optimization • CAIR-07: Reduction of leakages • CAIR-08: Heat recovery
Case study	Component replacement (Austria, 2011-2013) • Initial Situation: - High leakages. - Infrequent filter changes intervals. - Open pipes for blowing applications. - No heat recovery. • Description of the optimisation: - Optimization of maintenance intervals. - Reduction of leakages. - Use of air saving air pistols. - User optimization. - Implementation of heat recovery. • Implementation costs: 108,000 EUR • Payback time: 3 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 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

This Best Practice was developed by the Impawatt Project (GA No. 785041) and adapted for the GEAR@SME Project (GA No. 894356)