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

Best Practice	NETWORK OPTIMISATION	CAIR-06
Application	Compressed Air Systems	
SME sector	Industrial	
SME Sub-sector	All	
Technical description	About 15% of energy losses happen in the distribution network (without leakages) Energy losses in the distribution network happen mainly because: • Pressure losses due to wrong pipe dimensions • Condensate, which damages components and increases pressure loss • Design mistakes in the concept of the network	
Recommendation for optimisation	• Component Optimisation It is important to look for good quality in components such as T-pieces, flanges, valves or connection pieces for tools. This ensures that the pressure loss in those components is kept to a minimum. For example, couplings and connectors with valves have many different types available. It is recommended to choose the ones with the best flowing profile. • Condensate separation Water condenses at every spot, where the ambient temperature around the pipelines below the temperature in the compressor rooms. To avoid pressure losses due to condensate in the pipes, special separation devices have to be built into the system. The positions of these devices depend on the design of the network and the structure of the building. It is important that the main pipe shows a slight slope of about 1% and the distance between the separators is 30m. • Avoid/correct design misconceptions The concept of a main ring system is always better than big branches because of reduced flowing velocities in the ring, which lead to less pressure losses because of turbulences. Furthermore, automatic valves can be installed to isolate certain parts of the network when necessary. Ring systems also provide the possibility to add parts or change the system relatively easily. This measure often leads to high investment costs and cannot always be done. • Check pipe sizes Pipe dimensions depend on the volume flow and the velocity of the medium. To avoid excess pressure losses due to turbulences, it is recommended that the velocity does not exceed 6m/s.	

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<table>
<tr><td>Technical considerations</td><td>Approximation of pressure losses due to incorrect pipe dimensions (DENA, 2004)
<table>
<tr><td>Pipe diameter [mm]</td><td>Pressure drops at 100m [bar]</td><td>power loss [kW]</td></tr>
<tr><td>50</td><td>2,6</td><td>18</td></tr>
<tr><td>65</td><td>0,9</td><td>5</td></tr>
<tr><td>80</td><td>0,2</td><td>0,8</td></tr>
<tr><td>100</td><td>0,1</td><td>0,4</td></tr>
</table></td></tr>
<tr><td>Schemes and diagrams</td><td>Correct pipe dimensions as a function of flow rate
<table>
<tr><td colspan="2">Airflow</td><td colspan="7">Distance between compressor and furthest user</td></tr>
<tr><td>L/min</td><td>cfm</td><td>25m</td><td>50m</td><td>100m</td><td>150m</td><td>200m</td><td>300m</td><td>400m</td></tr>
<tr><td>230</td><td>8</td><td>20</td><td>20</td><td>20</td><td>20</td><td>20</td><td>20</td><td>20</td></tr>
<tr><td>650</td><td>23</td><td>20</td><td>20</td><td>20</td><td>20</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td>900</td><td>32</td><td>20</td><td>20</td><td>20</td><td>25</td><td>25</td><td>25</td><td>32</td></tr>
<tr><td>1200</td><td>42</td><td>20</td><td>20</td><td>25</td><td>25</td><td>25</td><td>32</td><td>32</td></tr>
<tr><td>1750</td><td>62</td><td>20</td><td>25</td><td>25</td><td>32</td><td>32</td><td>32</td><td>40</td></tr>
<tr><td>2000</td><td>71</td><td>25</td><td>25</td><td>32</td><td>32</td><td>32</td><td>40</td><td>40</td></tr>
<tr><td>2500</td><td>88</td><td>25</td><td>25</td><td>32</td><td>32</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td>3000</td><td>106</td><td>25</td><td>32</td><td>32</td><td>40</td><td>40</td><td>40</td><td>50</td></tr>
<tr><td>3500</td><td>124</td><td>25</td><td>32</td><td>40</td><td>40</td><td>40</td><td>50</td><td>50</td></tr>
</table></td></tr>
<tr><td>Economics</td><td>Several factors affect investment costs, and a case-by-case assessment is necessary.</td></tr>
<tr><td>Energy savings</td><td>Optimizing the network allows energy savings linked to the reduction of losses (at least 15%).</td></tr>
<tr><td>Economic savings</td><td>About 15%</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)
This measure does not involve further emissions.</td></tr>
<tr><td>Environmental benefits</td><td>Reduction of CO_2 emissions due to lower energy needs.</td></tr>
<tr><td>Main NEBs
(Multiple benefits)</td><td>☒ Environmental benefits
☒ Increased productivity
☐ Work environment/ Health/Safety
☐ Increased competitiveness</td><td>The more stable pressure supply can lead to an increase in the quality of the products. The increased effort in planning makes adding new branches and components easier in the future.</td></tr>
</table>

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	☒ Maintenance	
Replicability	High This measure can be replicated for each compressed air system.	
Related measures	• CAIR-01: Optimisation of compressed air users/appliances • 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-07: Reduction of leakages • CAIR-08: Heat recovery	
Case study	Reduction of electricity consumption for compressed air production (Modena, Emilia-Romagna, Italy) • Initial Situation: a measurement campaign has been undertaken to quantify the consumption of electricity absorbed by the compressed air production plant, equal to 10,193 kWh/month. The consumption was due to the handling of the oven doors (more than 8,000/month). • Description of the optimisation: - Redesign air distribution network layout, refurbishment with high-performance piping - On/off compressor replacement with inverter-equipped compressor - Electricity consumption monitoring system for the compressed air system - Optimisation of user work pressures - Rescheduling and maintenance optimisation 6 months after the intervention, the first cycle of improvement was verified. The intervention led to a 33% reduction in electricity absorbed by the compressor sector with the achievement of 100 TEE/year (Energy Efficiency Certificates or White Certificates) • Implementation costs: not available • Payback Time: 5 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	

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	Oetiker, 2017

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