White Paper

Gardner Denver

Energy-Efficient Compressed Air Technology

Basic Principles, Tips & Tricks

www.gardnerdenver.com/gdproducts

Introduction

Compressed air offers many opportunities for energy cost savings. This white paper explains all the individual steps in the optimization process–from production to air processing to improving the pipeline network. The process should start with an in-depth analysis of your current compressed air usage.

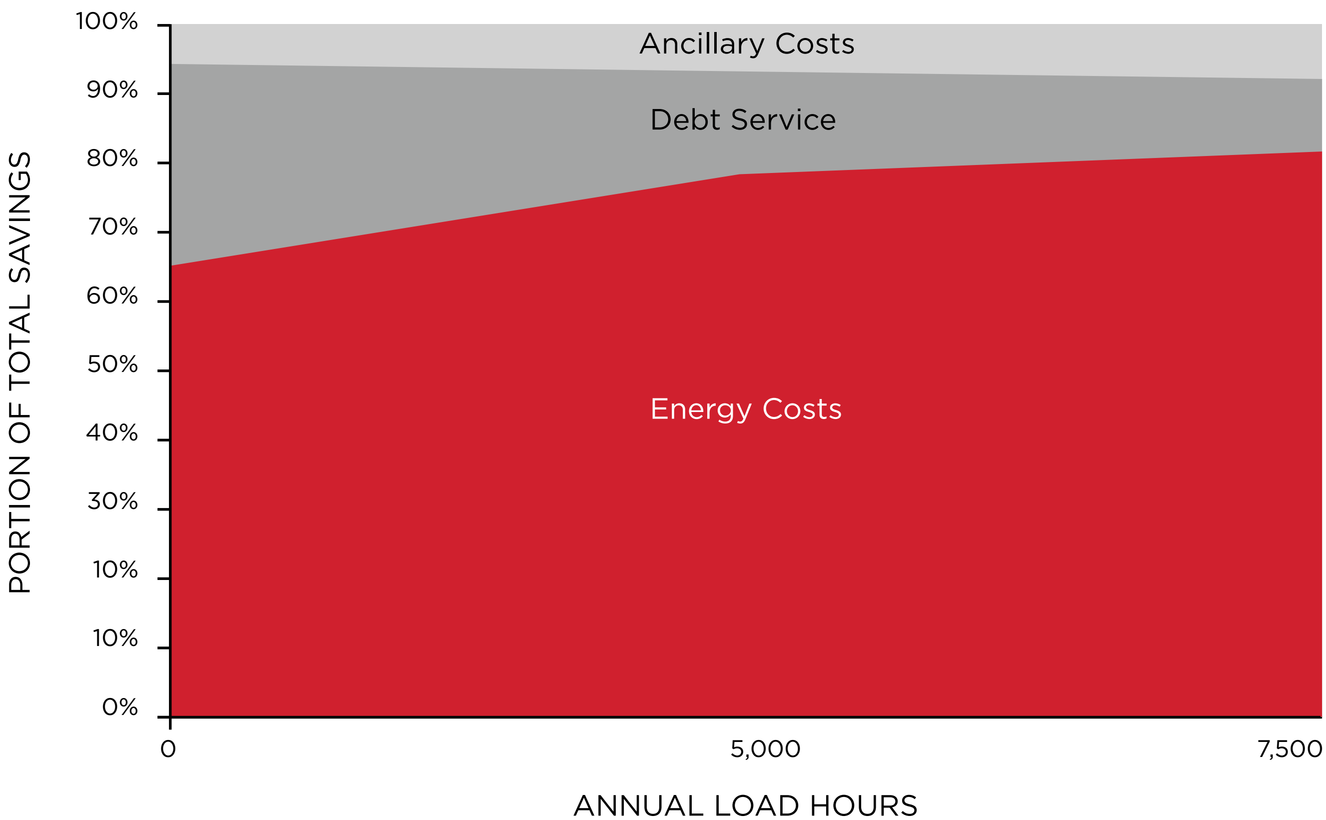
Here are the facts: Compressed air generation accounts for around 10% of industrial electricity consumption. Compressed air has many uses as stored energy or as a process medium. However, it is also true that compressed air can be a relatively costly form of stored energy if the opportunities for energy savings are not implemented properly. Previous documented examples and case studies show that energy consumption savings of up to 30% are possible, even if you think that your current system is running efficiently.

In summary, there is always room for improvement in every company that uses compressed air.

Energy Costs Account For More Than Two–Thirds of the Total Cost of Ownership

Energy consumption is such a highly factor especially when you consider that energy costs constitute the largest part of the total cost of a compressed air station. Various studies on this topic have all concluded that around 80% of the lifecycle costs are due to energy.

What is also surprising is that in many companies, compressed air consumption is a completely unknown concept (70% in one survey), and only 20% of the surveyed companies had already tried to implement a process of optimizing their networks.



Energy costs far and away account for the largest portion of the total costs of ownership.

To Begin: Measure Your Air Consumption

The process of finding potential savings starts by capturing air usage data and making it readily available for analysis. While doing so, it is also important to account for the compressed air-related energy costs, broken down into each production area's consumption. This important stage alone has led to savings of up to 30 even 40% in compressed air consumption and costs.

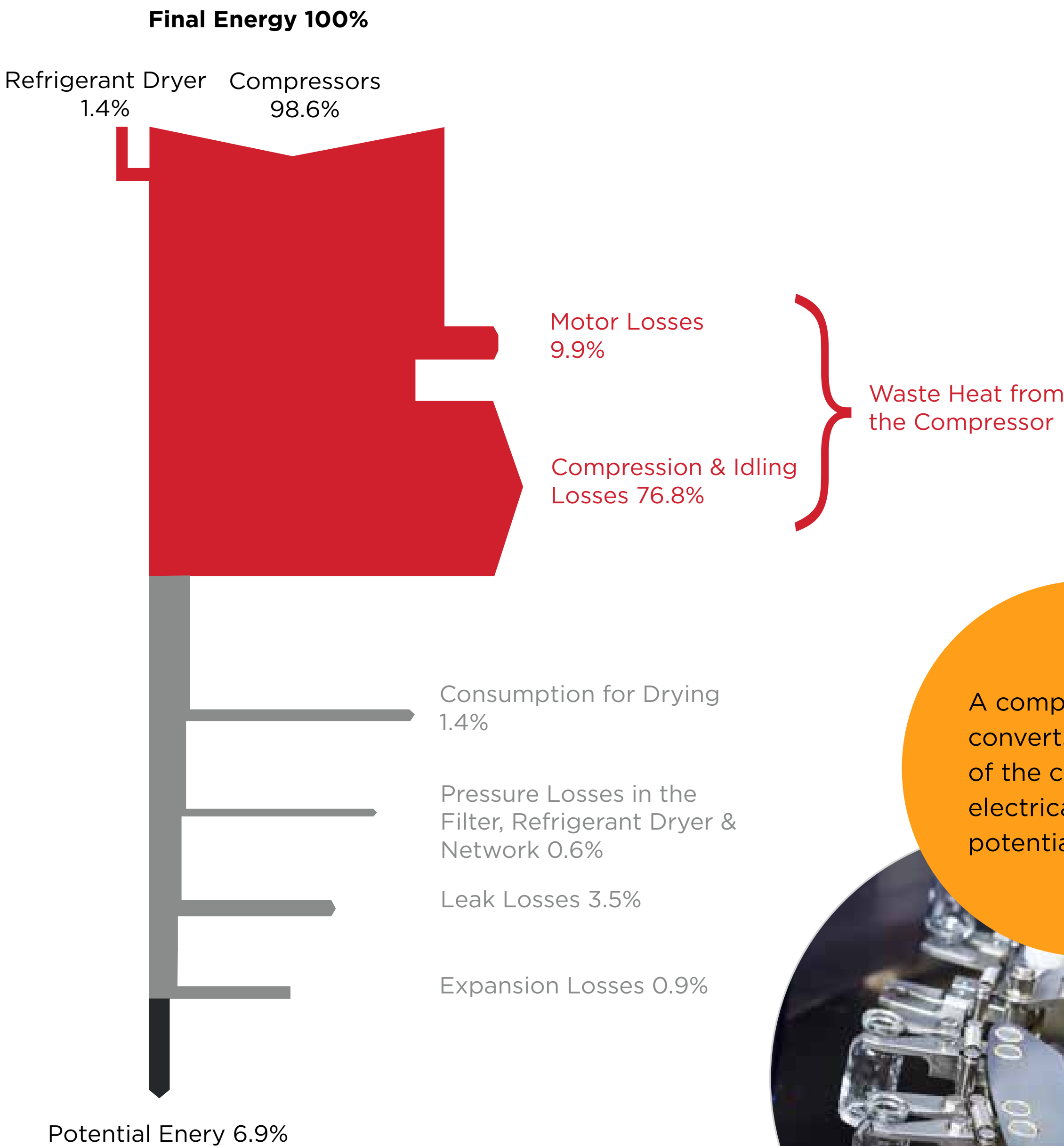
The Biggest Savings: Eliminating Leaks

The aim of this white paper is to highlight the possible compressed air savings, and when looking at all of the stages involved – eliminating leaks in the compressed air network is the most important part of the process. Even in companies that maintain their installations well, up to 30% of the compressed air generated can be lost through leaks. As an example just one single leak with a diameter of only 1/8 in would lead to a loss of 32 cfm in a 125 psi network. This would amount to additional energy costs of thousands of dollars per year. And yet, it's a simple process to investigate the network for leaks, & can be done using a ultrasonic acoustic leak detector. The payback time for fixing system leaks is typically six months.

	Current	Proportion %	Red Factor	Target	Proportion %	Difference
Compresses Air Consumption						
Compressed Air Consumption with Leaks (ft³/yr)	715,246,835		0.88	632,865,205		82,381,630
Compressed Air Consumption Without Leaks (ft³/yr)	601,221,921		1	601,221,921		0
Leak Calculation for a Year						
Leak Quantity (ft³/yr)	114,024,913		0.37	31,643,247		82,381,630
Portion of Consumption Accounted for Due to Leak	0.16		0.05			
Cost Calculation for a Year						
Energy Cost with Load ($/yr)	$222,850.65	73.2	0.60	$133,727.32	66.3	$89,123.33
Energy Costs Idle ($/yr)	16,799.53	5.5	0.25	4,135.90	2	12,663.63
Load Cost Ratio (%)	0.93		0.97			
Capital Costs ($/yr)	50,073.91	16.4	1.10	55,081.30	27.3	-5,007.39
Maintenance Costs: Internal ($/yr)	8,356.63	2.7	0.60	5,013.98	2.5	3,342.65
Maintenance Costs: External ($/yr)	6,488.61	2.1	0.60	3,893.17	1.9	2,595.44
Sum of Costs ($/ft³)	30,569,33		0.66	201,851.66	50,555.003	102,717.67
Compressed Air Generation Figure ($/ft³)	0.000426		0.75	0.000320		0.000106
Cost of Leaks ($/yr)	48,554.55		0.21	10,092.58		38,461.97

Compressed Air Generation Efficiency

When planning and optimizing compressed air systems, always consider that a compressor converts approximately 7% of the electrical energy consumed into potential energy. The majority of the energy is released as waste heat, resulting in a very low efficiency rating. It is, therefore, all the more important to use the available energy effectively and maximize all possible energy saving options.

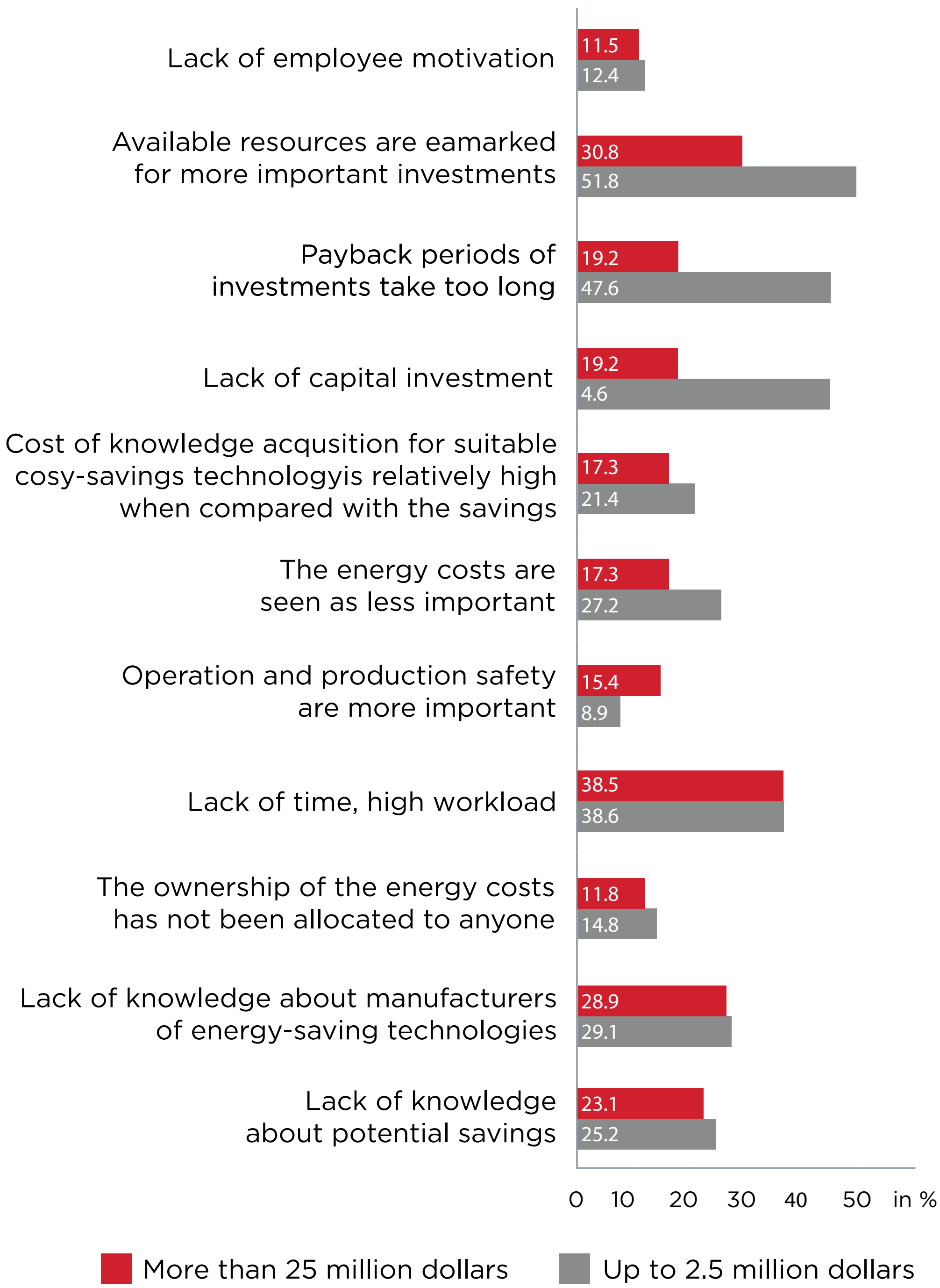


A compressor only converts around 7% of the consumed electrical energy into potential energy.

Inaction Costs
More in the Long Run

In practice, there may be many reasons not to take action & look for cost savings, however this should not prevent decision makers from considering the points raised in this white paper.

There are many reasons why the energy optimization of a compressed air network may be neglected.



The Basics of Planning
Compressed Air Station

When planning (expanding or modernizing) a compressed air station, the user can choose between different types of compressors. There are a number of factors to consider regarding the system performance needed, especially the pressure (psi) and flow (cfm). Important parameters like the air quality required and the overall energy consumption will dictate whether "oil lubricated" or "oil-free" options should be used. It's also important to consider that each processing component requires additional energy, either directly or indirectly (caused by the pressure differential—read more on this below).

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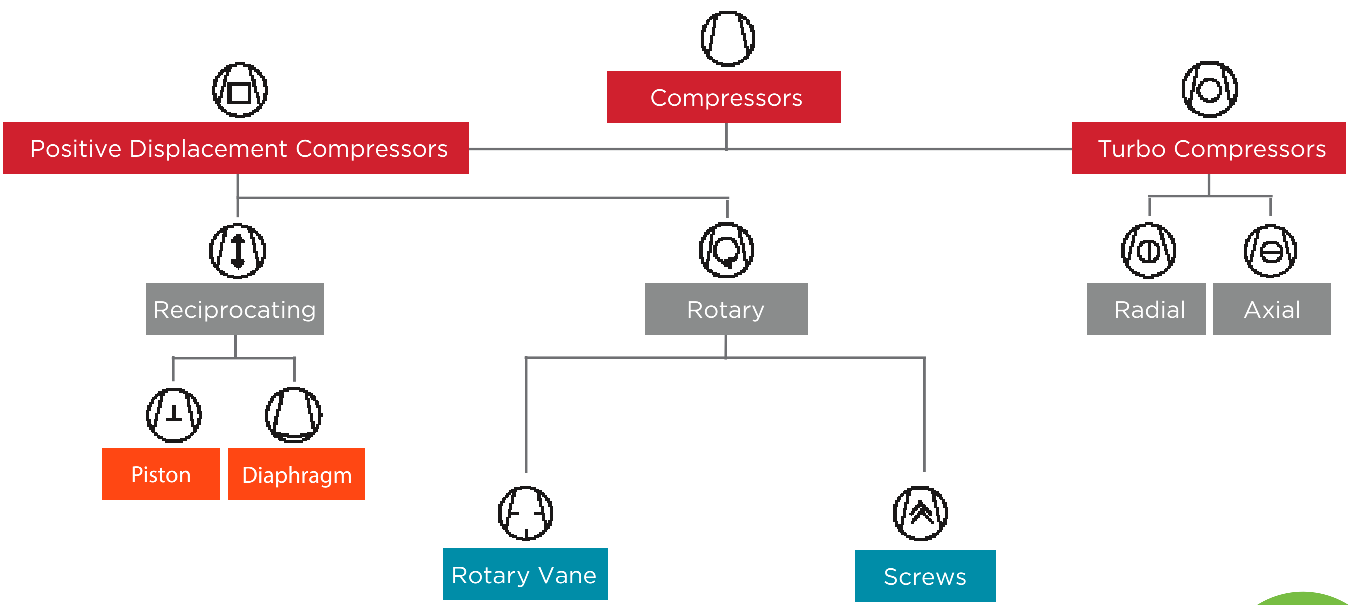


Oil-Free or Oil-Lubricated?

In terms of energy, a single-stage, oil-injected screw compressor offers advantages, since it operates at a lower temperature and therefore at a higher degree of efficiency. This type of compressor is probably the best choice for many companies that need a compressor up to 100kW. If you require compressed air of the highest quality, you could also consider a two-stage screw compressor – especially when thermally combined with an adsorption dryer, which uses the heat from the compressor to regenerate the drying agent. Two-stage, oil-free piston compressors would also be suitable in this case, as the are 5 to 10% more efficient than screw compressors and work with a lower no-load loss.

New Technologies Unlock Potential Efficiencies

When making your selection, consider that there are new compressor technologies, which offer clear advantages in terms of energy efficiency. Among these are the oil-free/oil-less range of compressors, developed by Gardner Denver:

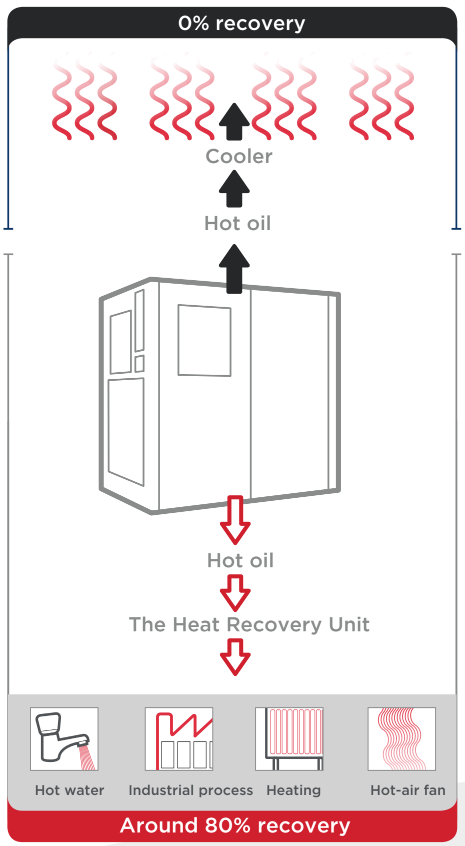
- The water-injected, oil-free screw compressor of the EnviroAire VS Series
- The variable speed, oil-less, two-stage Quantima turbo compressors
- The Ultima series with two oil-free compressor stages, each driven by a single, variable speed, synchronous, permanent magnet high speed motor.

PureAir
ISO CLASS: ZERO PLUS SILICONE FREE

Innovative compressor principles in the oil-free/oil-less series provide more efficient compressed air generation.

What About
Waste Heat?

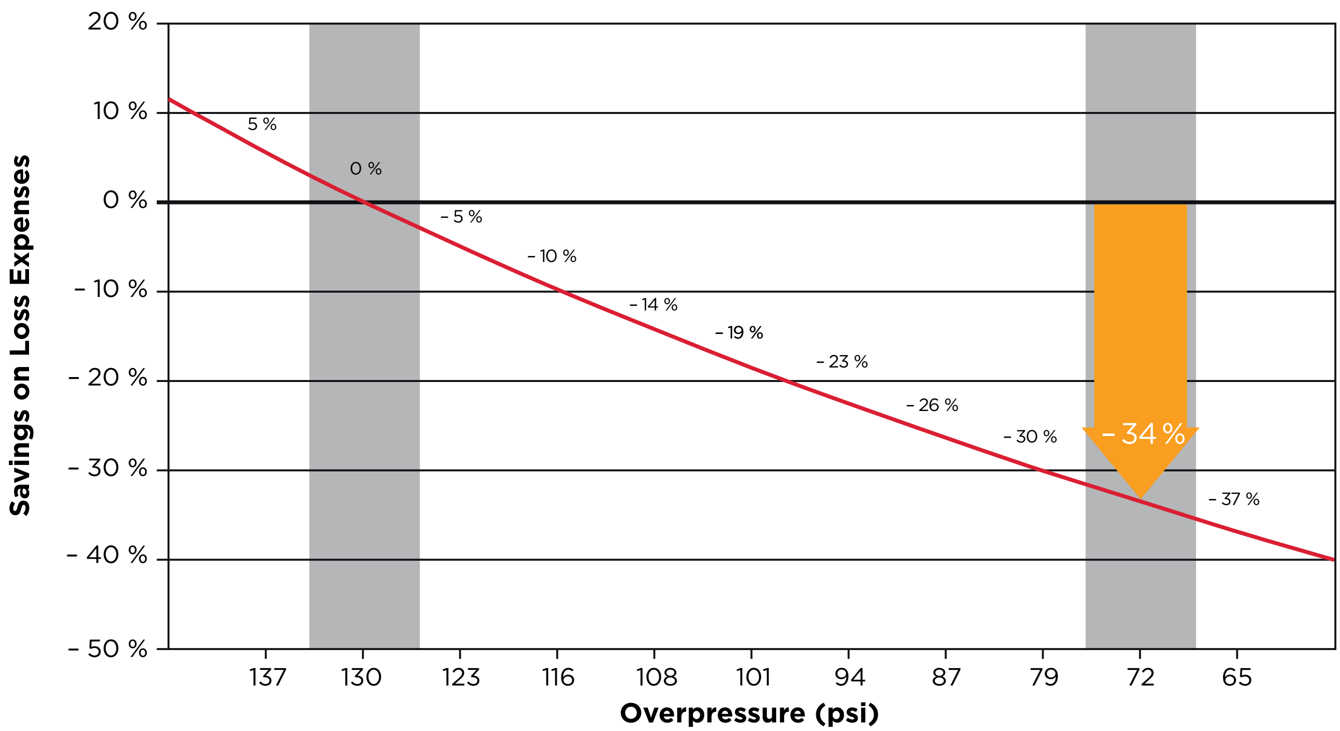
As mentioned at the beginning, the majority of energy consumed in generating compressed air goes into waste heat, not into compressed air. However, if you can exploit this waste heat, the efficiency of compressed air generation will increase considerably, as the energy is reused elsewhere. There can be many heat-driven processes in a company or factory which can utilize this available heat source, for example thermal drying as well as heating buildings and the supply of heated consumption water or processing water. Due to the variety of its functions, the heat can be used all year round and not just during colder weather. Such heat recovery systems are comparatively easy to install and offer high energy-savings potential.



Gardner Denver's heat exchanger utilizes excess energy and is available factory-fitted as a retro-fit kit.

What About
Waste Heat?

An additional parameter that should be carefully checked to ensure energy efficiency is the network pressure. For example: if a company operates a network at 125 psi and is able to lower this to 100 psi, it can expect savings of around 12.5% on energy. In the best cases, this can be done without major technical changes, since the required system pressure has often been established arbitrarily, without testing if the maximum pressure level is really necessary. However, there are also other methods to reduce system pressure, for example, a suitably sized pipe cross-section and storage tank as well as a modern, appropriate control system.



The user can save on energy by lowering the network pressure.

Air Treatment:
Use Only What is Needed

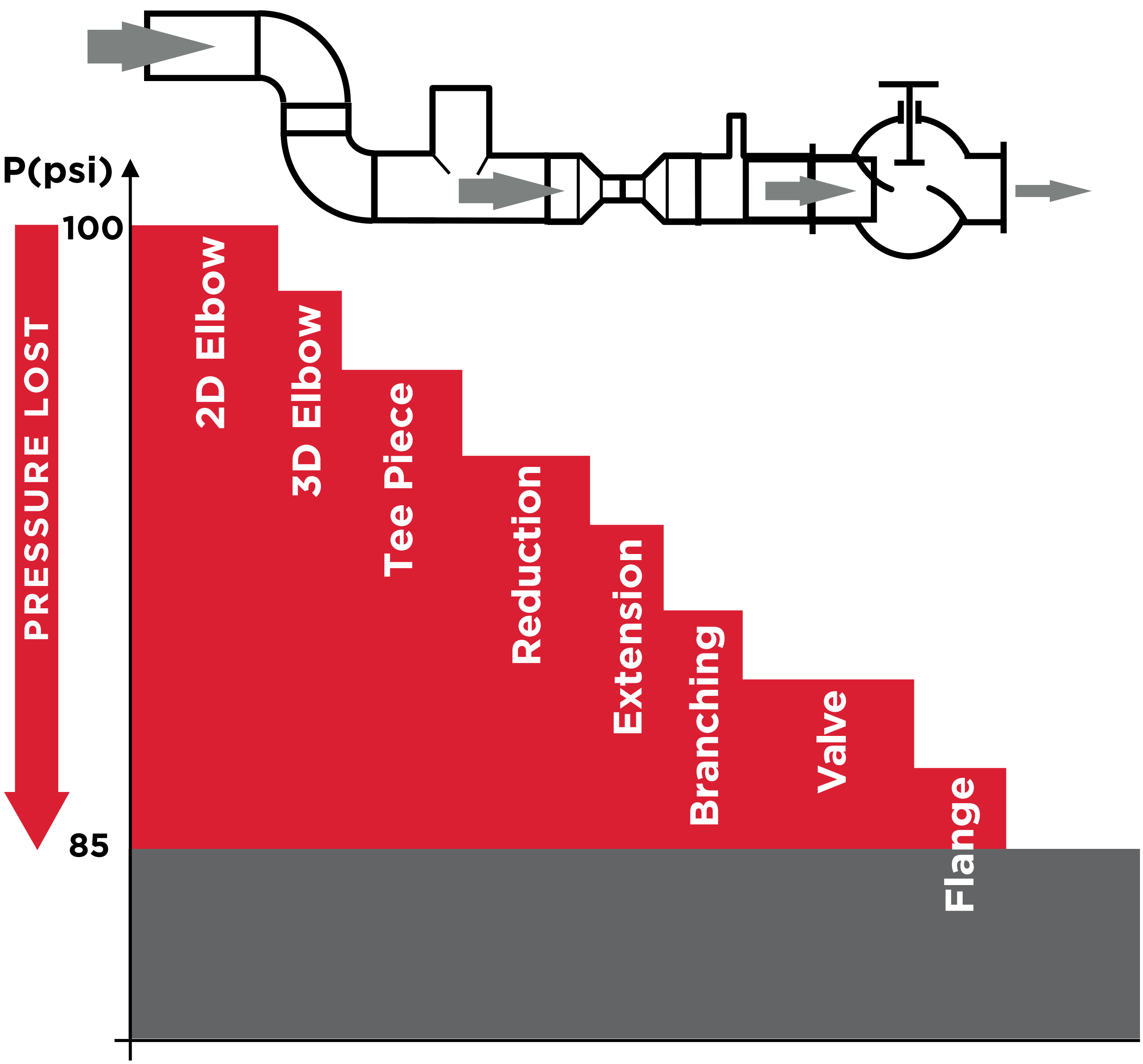
Closely linked to compressor selection is the choice of air treatment tools. If you choose a more efficient oil-lubricated compressor, when what you need is quality compressed air, you will end up spending any savings made in energy cost on additional air treatment. This is because, whether a processing component requires electrical power or not, the differential pressure raises the energy required for the treatment of compressed air. Adsorption dryers use some compressed air as scavenging/ regeneration air, which increases the air consumption and negatively affects your energy balance sheet. The pressure differential is a critical parameter for selection when it comes to air filters. The user should ensure that their network performance has been calibrated using standard methods and that the operating differential pressure stays consistently low for as long as possible.

In summary, various components like prefilters, dryers and microfilters, quickly lead to a reduction in system pressure of 10 psi or more, resulting in increased energy consumption of 8 to 11%. This also means that the user should monitor the pressure differential and, should it increase, change the filter element or search for the cause.

	dp (psi)		
Pipeline Network	1.5		
Connection Accessories	7	After-Filter 1 pm	
Each Dryer (without filter)	1.5-4	Heat-Generated Absorption Dryer Without External Energy	dP = 13 psi
Pre-Filter	1.5	Microfilter 0.01 pm	+ 8 - 11% Additional Consumption
High-Performance Filter	1.5	Cyclone Separator	
Activated Carbon Filter	1.5-4		

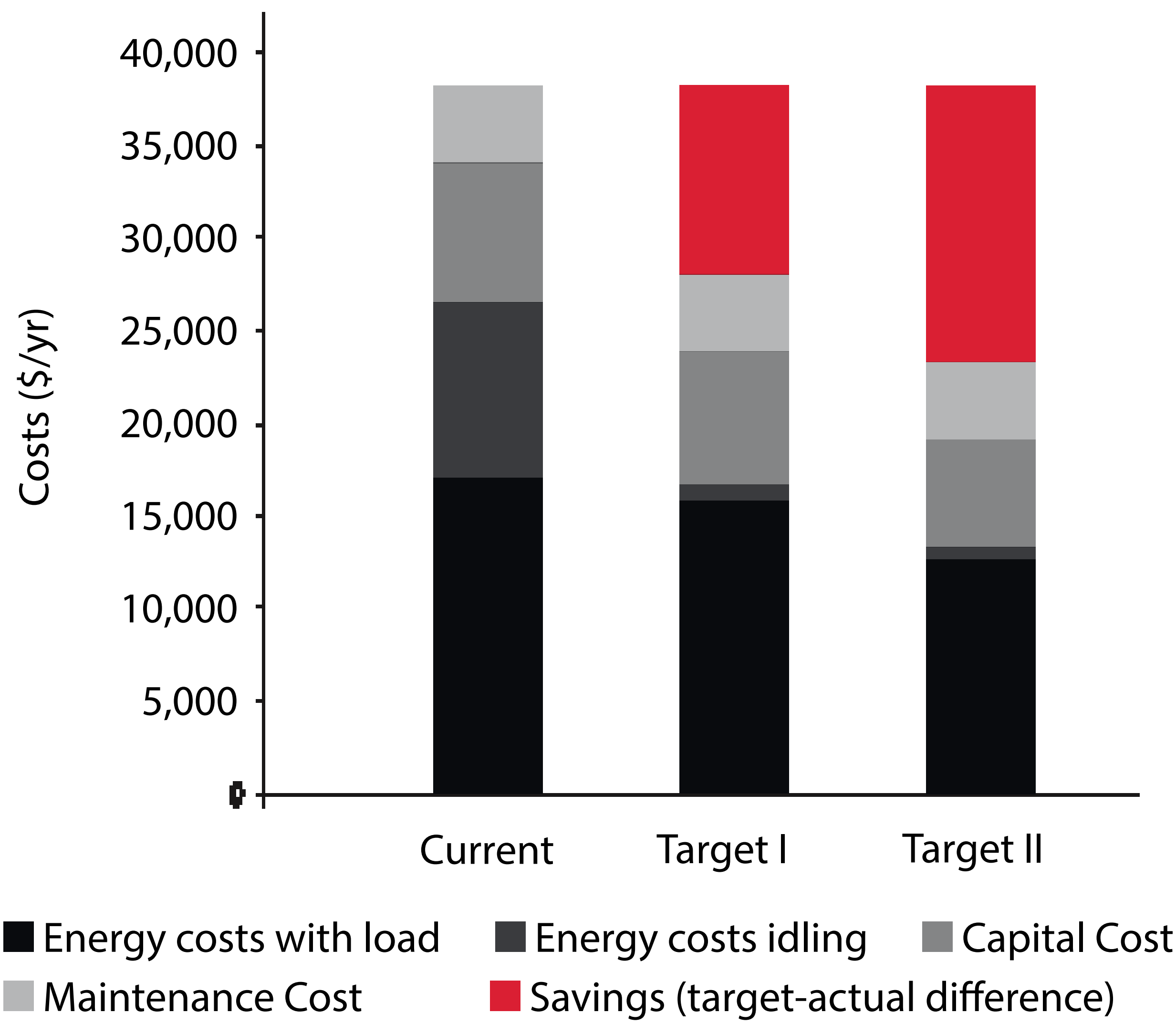
Pipeline Network:
Avoiding Bottlenecks

A pipeline network is like a chain – it is only as strong as its weakest link. This means that every narrow point causes a line loss and increases energy consumption. This makes it necessary to check the pipe cross-sections and connecting elements, replacing them if necessary, following regular leak inspections. Before doing this, it is recommended that you turn off unnecessary pneumatic tools using ball valves, since leaks can form in the tools if they are not maintained.



Control System
Optimization

Another key component we've not yet looked at is the control system for the compressed air network. The control system has a huge influence on the energy consumption and is therefore a critical part of the optimization process. It's best to start with a full analysis of the existing installation, from which the ideal control mechanism can be derived. Each individual customer setup will need to be analyzed to decide whether a variable speed compressor is a sensible energy-saving option and which control concept is the most economical: base load control, cascade control, demand dependent control & so on. The aim should be to avoid idling costs and to run the individual compressors in the optimal load range. You should also take the size of any compressed air reservoir into consideration.



The control concept has a large influence on the energy consumption of a compressed air system.

About Gardner Denver Industrials Group

Gardner Denver Industrials Group delivers the broadest range of compressors and vacuum products, in a wide array of technologies, to end-user and OEM customers worldwide in the industries we serve.

We provide reliable and energy-efficient equipment that is put to work in a multitude of manufacturing and process applications.

Products ranging from versatile low- to high-pressure compressors to customized blowers and vacuum pumps serve industries including general manufacturing, automotive, and waste water treatment, as well as food & beverage, plastics, and power generation.

Our global offering also includes a comprehensive suite of aftermarket services to complement our products. Gardner Denver Industrials Group, part of Gardner Denver Inc., is headquartered in Milwaukee, Wisconsin, USA. Gardner Denver was founded in 1859 and today has approximately 7,000 employees in more than 30 countries.

For further information please visit www.gardnerdenver.com/gdproducts

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WP-GD-EE 11/17