COMMERCE DEPARTMENT
DIVISION OF ENERGY RESOURCES

A mechanic uses a pneumatic tool to fix an automobile. (Photo courtesy of MnTAP)

Tool up for savings: Swapping pneumatic for electric tools can improve efficiency and lower manufacturing costs

Minnesota's industrial sector relies on using the right tools to support its processes. Compressed air systems are found in most manufacturing environments and are generally considered crucial to their operations. For many sites, investment in these systems results in the selection of compressed air to operate pneumatic power tools. However, while compressed air has many viable uses within industrial sectors, it is a notoriously inefficient source to power mechanical equipment. The Compressed Air Challenge System Performance Sourcebook from the U.S. Department of Energy indicates that, on average, only about 10% of the electrical energy used to generate compressed air is converted to mechanical work.

Pneumatic tools can help Minnesota's manufacturers get the job done, but in terms of energy efficiency, are they the right tools for the job compared to electrically powered tools?

The Minnesota Technical Assistance Program (MnTAP) at the University of Minnesota sought to answer this question and estimated the statewide potential for industrial sector energy savings through tool switching during a recently completed CARD grant research study. MnTAP concluded that opportunities

to decrease demand-side compressed air used by pneumatic tools can enable industrial facilities to optimize their compressed air systems for the most critical uses and save energy and operating costs in the process.

Potential state impact

MnTAP estimated that the annual cost to run pneumatic power tools by Minnesota industry is approximately $10.5 million, equating to about 148.8 million kWh of electricity. The estimated annual cost of using equivalent electric-driven tools is estimated to be about $0.8 million, equating to about 11 million kWh of electricity, representing a potential annual savings of approximately 138 million kWh, or $9.6 million, if all pneumatic tools were replaced by electric alternatives. Conserving this energy would also significantly reduce the amount of greenhouse gases (GHG) emitted due to energy-generation. These results are summarized in Table 1.

Table 1. Annual energy, cost, and greenhouse gas emissions by tool type, with savings potential

	Energy Consumed (kWh)	Energy Cost ($)	GHG Emissions (ton-CO_2e)
Pneumatic Tools	148,800,000	$10,450,000	123,200
Electric Tools	11,000,000	$770,000	9,100
Savings Potential	137,800,000	$9,680,000	114,100

To help businesses realize these savings, MnTAP generated a Facilities' Guide to Tool-Switching document that compares and contrasts tool types and what to know when considering a switch. MnTAP also developed a spreadsheet-based Pneumatic-to-Electric Tool Cost Calculator that allows sites to estimate their unique savings potential and simple payback period by making the switch. A project overview and demonstration of how to use the calculator were presented during a CARD webinar recorded on February 22, 2018, that is now available as an on-demand webinar.

Study methodology

To estimate the electricity used by pneumatic tools, MnTAP first determined which industrial sectors make use of pneumatic tools. Significant industries were identified through review of existing data and through interviews with representatives from industry, utilities, and compressed air and pneumatic tool experts. Representative samples of respondents' information was averaged for a number of industries and the information obtained from existing data and interviews was used to mathematically model estimated energy use by both tool types to determine existing energy consumption and anticipated savings achievable through tool switching.

Seven subsectors were identified that make up the majority of power tool usage in Minnesota. These subsectors, their estimated populations, total energy consumption due to pneumatic tool use, and the average energy use per facility due to pneumatic tool use are displayed in Table 2.

Table 2. Estimated population, energy use, and average per-facility energy use for seven major pneumatic tool using subsectors

NAICS	Manufacturing Description	Estimated Count of Subsector Facilities with Opportunity	Estimated Annual Energy Use by Pneumatic Tools (kWh)	Average Annual Energy Use (kWh) by Pneumatic Tools per Facility
331xxx	Primary Metal	325	67,200,000	206,800
336xxx	Transportation Equipment	750	38,100,000	50,800
333xxx	Machinery	2,392	17,900,000	7,500
332xxx	Fabricated Metal Product	2,421	12,500,000	5,200
321xxx	Wood Product	1,534	6,700,000	4,400
337xxx	Furniture and Related Product	1,018	3,200,000	3,100
339xxx	Miscellaneous Manufacturing	3,753	3,200,000	900
		Total: 12,193	**Total: 148,800,000**	**Mean: 12,200**

Companies from subsectors with North American Industrial Classification System (NAICS) codes appearing in Table 2 should be the focus of outreach and programming with regards to helping businesses save energy by switching from pneumatic to electric tools. The first priorities for utility programs offering such assistance are the Primary Metals and Transportation Equipment subsectors, which respectively have average per-facility pneumatic tool use of nearly 17 times and four times the mean average for all facilities identified in the study.

Other considerations about tool selection

Use of either pneumatic or electric tools present their own unique safety considerations, and each have trade-offs. For example, pneumatic tools are often selected in environments where a spark from an electric tool may cause an explosion/fire, however flexible compressed air hoses may then present a trip hazard. Battery-powered cordless tools can alleviate trip hazards, but are potentially more likely to produce a spark than a pneumatic equivalent. Another example is that the use of corded electric tools in damp environments may require additional safety equipment, such as ground-fault circuit interrupters. Every working environment should be considered carefully in the context of switching tool types and what hazards may be present.

Other issues related to safety can make it dangerous—or illegal—to switch out pneumatic power tools with anything electric. Using electric tools near combustible dust hazards, combustible chemicals/materials/coatings, or in very damp environments may cause fires, explosions, or electric shocks. Many businesses may technically be able to replace their pneumatic hand power tools with electric safely and legally, but they may face some of the other barriers mentioned. These barriers reduce the amount of realistic savings attainable in Minnesota. It is difficult to estimate how many tools and/or facilities may be affected because working environments vary considerably by facility.

The Facilities' Guide to Tool-Switching covers additional comparisons between tool types including relative performance, ergonomics, and cost.

Pneumatic-to-electric tool cost example

MnTAP has developed a spreadsheet-based Pneumatic-to-Electric Tool Cost Calculator to help industrial facilities compare current costs of running pneumatic tools to the new costs associated with running electric tools. The tool shows how much energy and money the facility spends on pneumatic tools, and how much energy and money would be spent on replacement with electric tools. It provides an annual savings as well as an estimated payback period associated with making a change.

The purpose of the tool is to show shop managers the costs and potential savings associated with their tool options. Running tools with compressed air tends to be much more expensive and resource-intensive than using electric tools.

Take a look at the inputs and results from the following example in, then try the calculator for yourself!

Table 1. Pneumatic-to-Electric Tool Cost Calculator example inputs and results

Inputs	Results
Tool type: **5-inch Sander/Grinder**	Annual energy savings: **42,164 kWh**
Quantity in use: **3**	Annual cost savings: **$2,930**
Hours used per day: **4**	Simple payback period: **3 Months**
Days used per year: **250**	
Replacement type: **Corded Electric**	

Detailed results on this project are available in the final report, "Replacement of Pneumatic Tools with Electric Alternatives: A study to quantify Minnesota's opportunity for industrial energy conservation." For more information, contact project manager Adam Zoet or CARD program administrator Mary Sue Lobenstein.