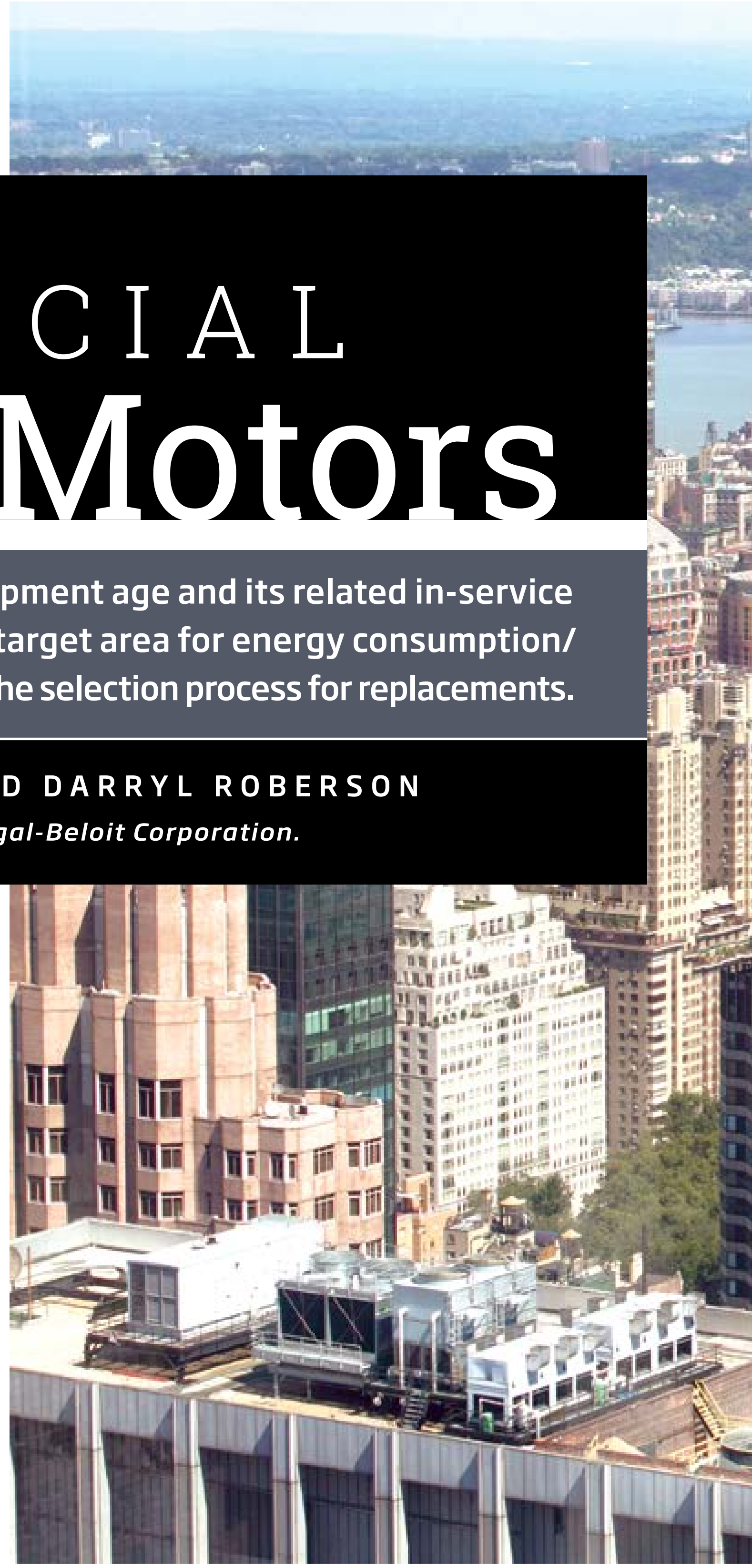
COMMERCIAL HVAC Motors

Understanding that the facility/equipment age and its related in-service motor inventory can be a significant target area for energy consumption/ maintenance reduction can help with the selection process for replacements.

BY DON SULLIVAN AND DARRYL ROBERSON

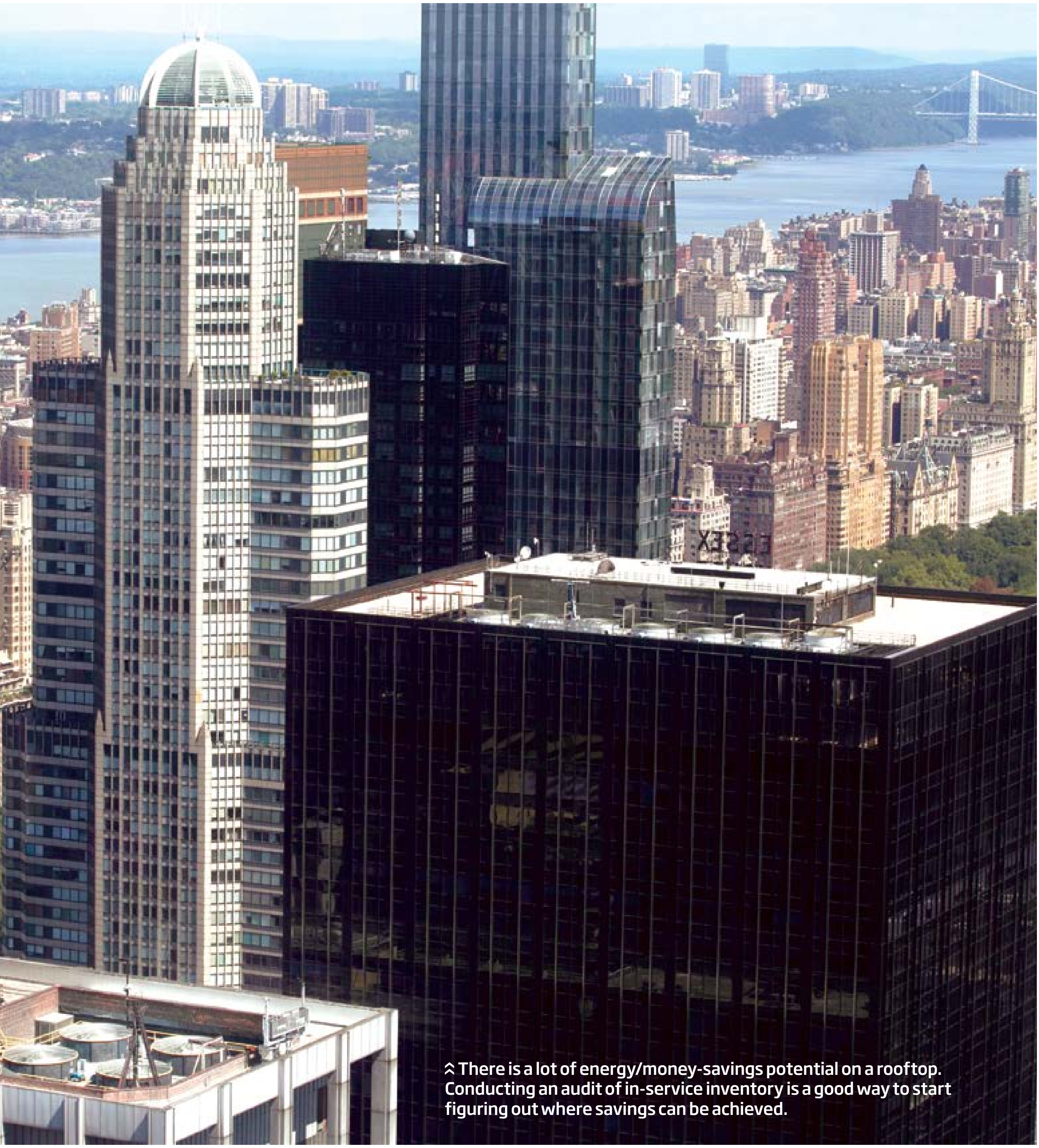
Images courtesy of Regal-Beloit Corporation.



Many building owners and facility managers do not give much thought to the electric motors used in their commercial HVAC equipment; its replacement or repair is simply part of the maintenance budget. It is generally a surprise for them to learn that after lighting, ventilation equipment is typically the largest consumer of electricity in a commercial building. According to the 2012 U.S. Energy Information Administration's *Annual Energy Outlook*, simply moving the air accounts for 11.7% of the total energy consumed, while the cooling and heating equipment represents about 26.4% of electricity used in a commercial building. It is important to recognize that commercial HVAC motors are actually performing two functions: converting electrical energy to mechanical energy; and transmitting mechanical energy to the fan or blower shaft. For this reason, the facility/equipment age and its related in-service motor inventory can be a significant target area for energy consumption/maintenance reduction.

Commercial buildings and energy consumption

The age of commercial buildings in the U.S. and the potential age of the motors in them are very telling. The U.S Energy Information Administration's 2012 *Commercial Buildings Energy Consumption Survey* stated about one-half of commercial buildings in the U.S. were constructed before 1980. On the surface that might not seem very old for the building structure, but in scope of motor efficiency it is highly significant. A 25-hp motor manufactured in 1980 has an efficiency rating of 88%, while the same motor produced in 1994 has an efficiency rating of 89.3%. In 2004, the energy efficiency rating increased to 92.4% and in 2012, a new NEMA Premium® Efficiency elevated the rating to 93.6%. The energy savings in kilowatt-hours (kWh) is approximately 5,160 annually. Assuming an electricity rate of $0.12/kWh, and 8,000 hours per year at 75% load, that is an annual electricity savings of about $615. Obviously, the decision to repair a less-efficient 25-hp motor in this scenario could prove very costly in the overall cost of ownership.



There is a lot of energy/money-savings potential on a rooftop. Conducting an audit of in-service inventory is a good way to start figuring out where savings can be achieved.

Cost to operate a commercial HVAC motor

According to the U.S. Department of Energy (DOE), a 75-hp motor at 75% load running 6,000 hours a year at a rate of $0.08 per kWh uses $21,900 annually in energy consumption. Upgrading to a NEMA Premium Efficiency motor under the same operating conditions can result in an energy savings of 10,112 kWh and $809. If demand charges are based on electricity usage in a particular market, the charges can be even higher. The DOE also reports that just a 1% motor efficiency gain at $0.08 per kWh with a 75-hp motor is a reduction of 4,865 kWh a year in usage, or $390 a year in savings.

Consider a real-world example of a hotel casino operation with a total installed motor hp of approximately 3,000 in their HVAC air-moving equipment. While motor hp ranges in these types of buildings vary, assume that it is the equivalent of 120 motors at 25 hp each. By replacing a 1994 standard

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efficiency motor with a new NEMA Premium, the efficiency gain is 4.3%. Upgrading in this scenario would result in annual energy savings of $580.50 per motor. Total savings on all 120 motors would result in $69,660 a year in energy. In just 12 years of normal operation, that totals $835,920 in savings at just $0.08 per kWh. The typical payback period for upgrading to a premium efficiency motor is two to four years, depending on equipment usage hours and electricity rates per kWh. Other factors, such as rebate incentives or a reduction in demand charges can accelerate payback.

Getting started with an audit

A critical first step in managing a facility's in-service commercial HVAC motor inventory is to conduct an audit. Most facility personnel have an estimate of the number of commercial HVAC motors in service. A much smaller percentage actually know the installed horsepower, and very few know the efficiency rating of each motor. An effective audit of the commercial HVAC motors and drives will help provide the information to identify not only what's in place, but also potential areas of improvement. An audit often reveals equipment with worn sheaves (pulleys), low belt tension, lower efficient belting types, misalignment, inoperable motor bases, etc. These conditions can deteriorate efficiency significantly. The general steps to begin an audit should include:

→Confirm if a thorough audit has been previously performed. If so, when? If there is confidence audit records are up to date, a new audit may not be required. (*Note: Thorough audits are generally the exception and not the rule*.)

→Ensure strict lockout-tagout procedures are in place and all maintenance employees or contracted resources are trained on the procedure.

→Determine a schedule for auditing. Commercial HVAC equipment run times are generally frequent, and building occupant comfort must be considered. Always consider the local temperatures, time of day, day of week, etc. in your audit timing.

→Build accessibility into your lockout-tagout timeline. A guard may need to be removed and reinstalled for access.

→The DOE states: "Inventory all in-service and spare motors in your plant. Focus on general-purpose, low voltage, standard efficiency motors between 10 and 500 hp that are in operation 2,000 or more hours/year."

What to document

Fortunately, commercial HVAC motors typically have a nameplate which contains much of the necessary information. Typical nameplate data includes:

→MODEL – The I.D. number

→DATE CODE – The month and year manufactured

→FRAME – The size and mounting

→PART NO. – Customer part or catalog number

→SER – Serial number

→TYPE – Electrical type

→DES. – Code by NEMA or IEC

→PH – Electrical phase, usually 1 or 3

→INS CL – Insulation class

→DUTY – Time rating under load

→MAX AMB – The allowable surrounding air temperature

→ENCL – Enclosure (i.e., TEFC)

→EFF – Efficiency

In addition to motor nameplate data, it is also advisable to inspect and record the following:

→What is the condition of the motor base? Is it operable? Is it a spring-loaded automatic adjusting base or standard adjusting?

→What is the condition of the motor sheave and driven sheaves (pulleys)? Groove wear greater than 1/32 in. causes belts to slip and erodes efficiency up to 5%. (*Note: Video training is readily available for proper sheave and belted drive inspection and maintenance.*)

→Which style of V-belt is being used? Is it wrapped or notched (cogged)? Notched belts area roughly 2%–3% more efficient than wrapped belts. Wrapped V-belts are identified by a cross-section such as 4L, 5L, A, B, C, D, 3V, 5V (i.e., B38). Notched belts are identified with an "X" following the cross-section identifier (i.e., BX38).

What to do with audit findings

By conducting a thorough commercial HVAC audit and understanding all the condition, age and efficiency dynamics, much of the data for accurate downstream calculations for return on investment (ROI) or payback will be complete. The next step is to conduct a review of the findings with the motor supplier. Audit support or interpretation is also generally available through these sources.

The DOE has several publications and online tools that will be beneficial and appear in the sources listed at the end of this article.

Assuming standard efficiency motors were discovered in the audit, research the potential for any applicable energy rebates being offered by a local energy provider or government body. Any qualifying rebates will accelerate payback/ROI.

Tips for selecting the right motor

Once the audit is complete and/or motors to be replaced have been identified, choose the right type for the commercial HVAC application. Motors come in several enclosure types and need to be aligned with the operating environment. In many cases, because of the critical nature of having the equipment up and running, some original motors get replaced with a different enclosure simply because of availability. In addition, selecting the wrong enclosure type can increase the motor purchase price or it could lead to premature failure because it was not suitable for the environment. Motor manufacturers can easily assist in selecting the correct motor for an application.

→**Open Drip-Proof (ODP)** motors have venting in the end frame and/

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or main frame, situated to prevent drops of liquid from falling into the motor with a 15-degree angle from vertical. These motors are designed for use in areas that are reasonably dry, clean, well-ventilated and usually indoors. If installed outdoors, ODP motors should be protected with a cover that does not restrict air flow. This is the most popular enclosure type for commercial HVAC.

→**Totally Enclosed Non-Ventilated (TENV)** motors have no vent openings. They are tightly enclosed to prevent the free exchange of air, but are not air-tight. TENV motors have no cooling fan and rely on convection for cooling. They are suitable for use where exposed to dirt or dampness, but not for hazardous locations or applications having frequent hose downs.

→**Totally Enclosed Fan Cooled (TEFC)** motors are the same as TENV, except they have an external fan as an integral part of the motor to provide cooling by blowing air over the outside frame. This enclosure type is popular for outdoor commercial HVAC equipment.

→**Totally Enclosed Air Over** motors are specifically designed to be used within the air flow of the fan or blower they are driving. This provides an important part of the motor's cooling. This enclosure type is popular for cooling towers.

→**Totally Enclosed Hostile and Severe Environment** motors are designed for use in extremely moist or chemical environments, but not for hazardous locations.

→**Explosion-Proof** motors meet Underwriters Laboratories or CSA standards for use in the hazardous (explosive) locations shown by the UL/CSA label on the motor. Locations are considered hazardous because the atmosphere contains or may contain gas, vapor or dust with explosive qualities.

With a thorough audit of in-service motors and a basic understanding of calculating payback with improved motor and drive efficiency ratings, it is possible to accurately project energy savings. The payoff is well worth the effort involved to carefully evaluate existing conditions and select the best replacement motor for optimal performance. As facility managers and building owners are increasingly expected to reduce energy consumption and operate more efficiently, implementation of comprehensive commercial HVAC motor maintenance and energy reduction is the first step in a clear path to achieving those expectations while realizing cost savings in the short and long terms.

References/Resources:

- *Audit information and resource library. U.S. Department of Energy – Office of Energy Efficiency & Renewable Energy. www.energy.gov/eere/amo/information-resources%20*
- Premium Efficiency Motor Selection and Application Guide – *U.S. Department of Energy – Advanced Manufacturing Office. DOE/GO-102014-4107. February 2014.*
- Continuous Energy Improvement in Motor Driven Systems – *U.S. Department of Energy – Advanced Manufacturing Office. DOE/GO-102014-4357. February 2014.*
- Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment. *U.S. Department of Energy – Building Technologies Office. DOE/EE-0975 – November 2013.*
- When to Purchase Premium Efficiency Motors – *U.S. Department of Energy – Advanced Manufacturing Office. DOE/GO-102012-3743. November 2012.*
- Annual Energy Outlook 2012 *Early Release – U.S. Energy Information Administration – January 2012.*
- *U.S. Energy Information Administration*, Commercial Buildings Energy Consumption Survey – *www.eia.gov/consumption/commercial.*

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