SEP (ISO 50001) and Motor Driven Systems

Knowledge Brief

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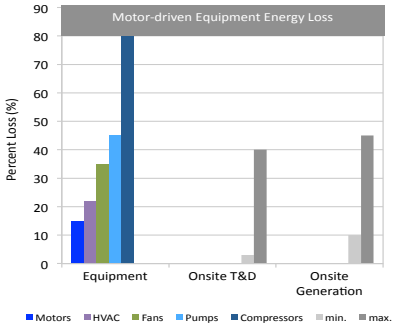
Introduction

Today over 24 trillion kWhs of electricity is consumed worldwide. This is projected to grow to 39 trillion kWhs by 2040. There are over 350 million motors in use in industry, infrastructure and large facilities which consume over 6.75 trillion kWhs or a little over 1 out of every 4 kWh generated in the world is consumed by electric motors and driven systems. Typically, motors and driven systems consume in excess of 65% of an industrial sites' electrical energy (approx. 30% in commercial facilities). In primary manufacturing, process loads predominate and motor driven systems may constitute more than 90% of a site's electrical consumption. The motor driven consumption will continue to increase proportionate to the electricity consumption projections represented in the 30 million electric motors sold annually today for replacement and new applications, which as a market, is projected to grow at 19.67% over the next 5 years. Conservatively by 2040 we will be looking at over 600 million electric motors in use in the Commercial and Industrial (C&I) sectors consuming over 13.5 trillion kWhs. At $.1 per KWh this is equivalent to $1.35 trillion per year. Of this motor-driven equipment consumption the D.O.E estimates that 15% to 80% of the motor-driven energy consumed is wasted.



It would seem obvious then that motors and driven systems must be a major focus of attention in any energy efficiency program. But that is not the case.

Today, in spite of an ever growing adoption of Energy Management Systems (EnMS) in the industrial, infrastructure and large commercial industry sectors, estimated to be in excess of 65%, there is a low awareness of motor driven systems efficiency savings potential. There is a poor, if existent, identification of "significant energy use" motor driven systems as being an integral part of an energy and asset management program and the need for connecting the two. Adding to this there is the misperception that having a EnMS in place is synonymous with utilizing the full potential efficiency of motor driven systems. These factors all contribute to more focus being needed on connecting motor driven systems at the asset structure level to the implementation of an energy management program whereby systematically developing the awareness and intelligence on the operational benefits and savings potential, particularly with respect to motor driven systems energy consumption analysis, operations and maintenance, procurement, and planning and design.

Implementation of the ISO 50001 framework offers the opportunity of realizing the potential efficiency of motor and driven systems by encouraging; 1) the adoption of more efficient motor driven system components, 2) design change modification of motor driven systems alignment with end use, 3) efficiency optimization of motor driven systems, and 4) better in-field management of motor driven systems through the convergence of energy and asset management.

Motor-Driven System (MDS) Approaches Defined

Motor-Driven Systems (MDS) management approaches afford the User varying levels of potential efficiency gains. Each approach builds upon the predecessor and entails a higher degree of complexity and discipline on the User's part. Aside from doing nothing, which hopefully we have ruled out as a viable option, the three approaches are defined as:

- Electric Motor
- Core Motor System (motor + pump + drive)
- Total Motor System (Core Motor System + transmission + gears)

Alignment of the approach utilized with a specific MDS should be dependent on the potential operational and energy efficiency impact ranging from 15% for Motor efficiency management to potentially 65% increase in efficiency for Total Motor System efficiency management.

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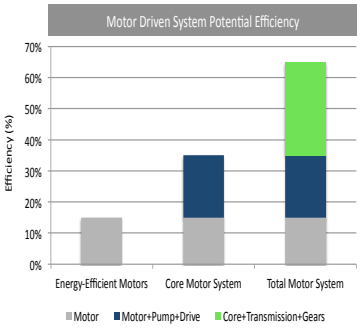
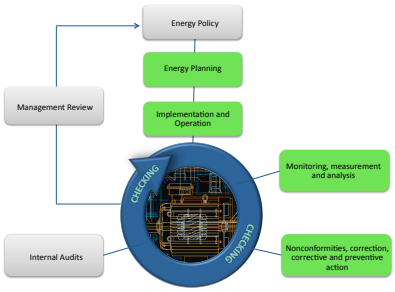


ISO 50001 Standard & SEP

ISO 50001 provides a framework for the setting of energy objectives and energy targets, it defines organizational alignment; provides for formal energy review mechanisms; establishes baseline measurements; highlights energy performance indicators; lays out energy objectives and targets; details action plans; lists operating controls and procedures; establishes guidelines for the measurement, verification, and documentation used to evaluate the program; and lists the management controls needed to keep the program sustainable. The U.S. Department of Energy's Superior Energy Performance (SEP) program will independently validate this process compliance and certifies the results.

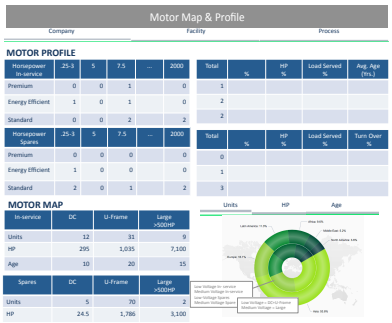
The ISO 50001standard inherently calls for organizations to establish a systematic and reliable way to investigate the relationship between energy usage and managing assets, from policy to the plug. It specifies requirements for "establishing, implementing, maintaining and improving an energy management system", whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use, and consumption. It also addresses energy cost issues as a way to demonstrate both the financial and environmental benefits which can be realized through systematic energy management. MDS, comprising over 65% of the energy consumed, are clearly integral to ISO 50001 certification and considerations should be taken into account within the Energy Planning; Implementation and Operation; Monitoring, Measurement and Analysis; and Nonconformities, Correction, Corrective and Preventive Action elements of the ISO 50001 framework.

ISO 50001 MDS Framework



Considerations:

1. The energy planning should identify the MSD in an energy review. ISO 50001 characterizes significant users also as users with significant efficiency potential. An enterprise Motor System Map and Motor Profile can provide a basis for making "significant use" determinations and alignment of approaches.

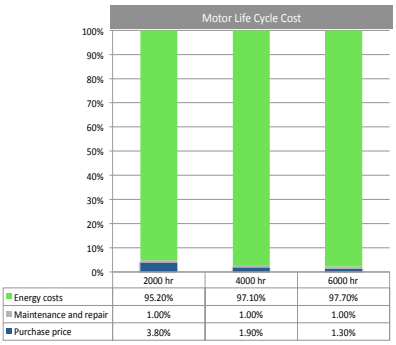


2. Operation, implementation and monitoring planning should ensure MDS management is identified and described as a business function activity. Additionally the planning should assess if there is adequate domain knowledge to implement this activity as well as defining the accountability and responsibility within the organization. 3. The maintenance & repair planning should define how the data, technical, process, and technology dependencies are organized and intelligence enabled. Procedures should be identified and management controls defined for MSD management (e.g. for rewinding or replacement, for redesign or adjustment of drives and for efficiency replacement instead of run-to-failure). Additionally, Total Cost of Ownership (TCO) should be established as a standard element in MSD change management business cases.

4. Procurement and design planning should incorporate minimum efficiency requirements for MDS motors.

	CEMEP	USA	IEC 60034-30
Super Premium Efficiency			IE4
Premium Efficiency		NEMA Premium	IE3
High Efficiency	Eff1	EPAct	IE2
Standard Efficiency	Eff2		IE1
Below Standard Efficiency	Eff3		

Considerations should be to ensure the efficiency requirements are specific to the application, e.g. processing equipment or pump systems. Design and procurement responsibilities planning should be clearly defined between engineering, maintenance, energy management, and procurement. Given energy consumption comprises over 97% of the MDS life-cycle cost of ownership the systematic adoption of TCO principles and training of responsible personnel in the use of TCO principles should be considered and management controls defined.



These considerations should manifest themselves within the ISO 50001 framework and certification process in the ability to:

- Maintain a comprehensive and current inventory of all MDS, including all motors and system components, name plate data, specifications, organizational hierarchy (Facility, process, and system), OEM data, pricing, operating and maintenance history (e.g. installation, rebuild and rewind), previous application performance by motor and location, available rebates and incentives, and applicable regulations,
- Determine the MDS and components efficiency design basis. And ensure adherence to the appropriate motor energy efficiency class based on regulations and efficiency performance requirements,
- Understand within operating & maintenance context a MDS's and it's components energy performance vs. design. Benchmarking against inter and intra company and market current high efficiency performance standards is an extremely useful analytical tool,
- Ensure power supply quality standards are maintained to meet MDS motor rated efficiency and performance levels. Particularly harmonic distortion and voltage unbalance.
- Prioritize MDS component maintenance and replacement efforts and resources with highest run times and potential operational, financial, and environmental impact,
- Identify MDS component efficiency upgrade opportunities and determine repair vs. replace economics, and planning for future capital appropriations based on alternative's market availability, pricing, and life-cycle operating costs (TCO),
- Identify MDS component non-conformity performance, and notify the right person at the right time at the right place to mitigate the non-conformity,
- Document, verify and validate MDS energy efficiency measures taken and results attained,
- Manage MDS components and available spares for energy efficiency and not only emergency repairs, and uptime or run to failure,
- Apply applicable preventive (PM), predictive (PdM) and condition based (CdM) maintenance strategies based on both direct and indirect MDS component energy efficiency determinants.

Incorporating these considerations into an ISO 50001 framework will further support addressing the current market adoption barriers:
1. Recognizing MDS as significant energy users,
2. Providing detail MDS energy use visibility,
3. Enabling a systematic plan for MDS management beyond simply implementing sub-meters to gain more insight in the energy use of the MDS,
4. Systematic integration of MDS energy efficiency into widely adopted maintenance and component replacement schemes in place today,
5. Awareness and enforcing minimum efficiency MDS component standards, and
6. Adopting Life-cycle Costing principles

Dollars & Sense

The ISO 50001 complaint MDS efficiency program business case is very compelling. To illustrate let's do a comparative MDS analysis of 4 different alternatives with greatly varying results. We will start by defining a typical 10 year old MDS comprised of a motor (85% eff.), drive (96% eff.), gear box (75% eff.), transmission (90% eff.), and load (98% eff.). As defined the system would have a Total Motor System efficiency of 54%. Changing out the Standard Efficiency motor for a 92% Premium Efficient motor would increase the motor efficiency by 7%, but the Total Motor System by only 4%. If we then installed a 95% gear box the Total Motor System efficiency would then be 68%, an increased efficiency of 10% as compared to simply changing out the motor. And finally an increased efficiency of 14% when considering both MDS modifications, a new Motor and gear-box, resulting in a 26% increase in the Total Motor System efficiency.

So let's do the math. The life-cycle (10 yr @ 8,000 hrs./ year and $.10/kWh) energy cost of a 100HP MDS as described:

MDS @ 54% efficiency (before modifications) = $1,105,189

MDS @ 58% efficiency (change out only motor) = $1,028,965;
LCC savings = $76,219

MDS @ 68% efficiency (change out motor and gear box) = $877,647
LCC savings = $227,538

The MDS holistic system approach compounds the efficiency impact leading to the greatest potential energy savings. Now translate these potential savings to 10s of millions of MDS in operation around the world. Others are doing just that such as The City of Des Moines Water Reclamation Facility who noted; *"Motor energy intelligence has value by itself but significantly more value when combined with the Motor Driven System components. Without the convergence of energy and asset management this potential value typically goes unrealized".* – Mr. Bill Miller, The City of Des Moines (WRA) Risk & Reliability Manager

Conclusion

Electric motor driven systems consume large amounts of electrical energy and can provide an opportunity for significant energy savings. Energy represents more than 97% of total motor operating & maintenance costs over the motor's lifetime. However the purchase of a new motor driven system components or the maintenance of an existing MDS often tends to be driven by price or performance, not the electricity it will or is consuming or the potential efficiency improvement. Even a small improvement in efficiency could result in significant energy and cost savings while also reducing the greenhouse gases that contribute to climate change. ISO 50001 and the D.O.E. SEP independent certification provide a framework and systematic discipline to realize this potential.

References

1. International Standards Organization; ISO 50001
2. US Department of Energy; AMO Superior Energy Performance (SEP)

About the Author

Rod Ellsworth has over 30 years of related energy and enterprise asset management experience. Prior to founding Asset Sustainability @ Work Rod lead the convergence of the energy and asset management markets, "Global Asset Sustainability", through the first commercially available energy and asset management offering.

Rod founded Asset Sustainability @ Work to develop certified Best Practice software tools to enable Customer business transformation with organizations having a focus on promoting energy conservation and sustainability by delivering the financial and physical controls for an enterprise to be in full control of their sustainability, energy consumption, and the asset and operating infrastructure that underpins them. Asset Sustainability @ Work's initial offering is Motors@Work™, a SaaS solution based on certified best practices for managing commercial and industrial motor-driven equipment for optimum energy efficiency.

To learn more how your Company can adopt a comprehensive electric motor driven system energy efficient program contact:

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