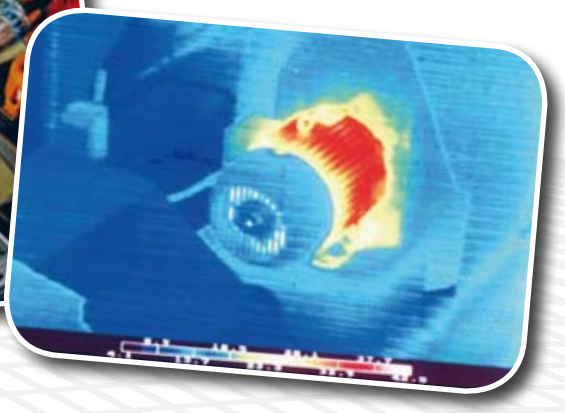
Leonardo ENERGY



Energy efficient motor systems

Major potential for energy savings

Electric motors are available with a wide range of characteristics and power outputs, making them the ideal drives for a very broad range of applications. Motor driven systems account for approximately 65% of the electricity consumed by EU industry.

Consequently, even a relatively small gain in electric motor system efficiency can result in a significant reduction in the electricity consumption of individual companies, as well as EU industry as a whole.

- **Switching to energy efficient motor driven systems can save Europe 202 TWh in annual electricity consumption (EU-25)**
- **This excess energy consumption represents an annual €10 billion operating cost and an unnecessary 79 million t/yr of CO_{2eq} emissions**
- **In the large majority of the cases, energy efficient motor systems have a lower Life Cycle Cost — a reduction that can rise to 35 percent**

The European Copper Institute (ECI): a long tradition in promoting energy efficient motor systems

The European Copper Institute supports the European Motor Challenge Programme, launched in February 2003. This is a voluntary programme of the European Commission focused on improving the efficiency of motor driven systems.

In 2004, ECI published a study, targeted at EU policy makers, on the benefits available through the use of energy efficient motor driven systems.

The Leonardo ENERGY blog, managed by ECI, regularly reports on the latest developments in motor efficiency standards, regulation, and technology.

HOW ENERGY LOSSES CAN BE MINIMISED

ENERGY LOSSES OF ELECTRIC MOTORS FALL INTO VARIOUS CATEGORIES:

- Electrical losses (Joule losses): due to electrical resistance of the windings, conductor bars, and end rings
- Magnetic losses: due to hysteresis and eddy currents of the magnetic field in the steel laminations
- Stray load losses: due to imperfections in the flux (leakage, harmonics, irregularities, etc.)
- Mechanical losses: due to friction
- Brush Contact losses

Moreover, the percentage of energy losses increases when the motor's load is further away from its nominal value.

SEVERAL TECHNICAL SOLUTIONS EXIST TO IMPROVE THE ENERGY EFFICIENCY OF A MOTOR SYSTEM:

- Reducing the electrical losses in the windings, by increasing the cross sectional area of the conductor or by improving the winding technique
- Reducing the magnetic losses by using better magnetic steel
- Improving the aerodynamics of the motor to reduce mechanical losses
- Minimizing manufacturing tolerances
- Using an electrically commutated system to eliminate brush contact losses
- Using a Variable Speed Drive (VSD) if the motor operates regularly at other than its nominal speed/torque

By combining those techniques, the Best Available Technology motor system can be built, which also has, in the large majority of cases, the lowest Life Cycle Cost (LCC).

CASE: A PAYBACK PERIOD OF 1.6 YEARS

At a UK brass mill, five motors were replaced with higher efficiency units. Three were running continuously, with the other two running on a five day/three shift pattern. Measurements showed that the five new motors saved 12 MWh/year. The overall payback for the investment premium was 1.6 years. This is just one of the many examples of a profitable investment in high efficiency motor systems by an industrial company

A NEW INTERNATIONAL STANDARD FOR MOTOR EFFICIENCY

A new international standard for electric motor efficiency labelling was introduced in 2008. This standard, IEC 60034-30, will improve the transparency between American, European, and Asian motor markets. The new labelling numbers go up with increasing efficiency (IE 1, IE 2, IE 3, IE 4), which has the advantage that new, higher efficiency categories can be created when technology improves. This system is in contrast with European labels, whose numbers go down with increasing efficiency (Eff 3, Eff 2, Eff 1). The lowest efficiency category of the international label (IE 1) corresponds approximately with the middle efficiency category of the European label (Eff 2).

Environmental, economical, and geopolitical advantages

Fully implementing Best Available Technologies for electric motor systems could save the EU 202 TWh per year in electricity consumption. This corresponds to a generating capacity of 45,000 MW, equivalent to

- 45 nuclear power stations (1,000 MW)
- 130 fossil fuel power units (350 MW)
- 3.8 times the EU's total 2007 wind capacity (56.531 MW with an average capacity factor of 0.21%)

EU advantages are environmental, economical, and geopolitical:

- A 79 million tonne annual reduction in CO2eq emissions
- Significant reductions in NOx, SO2, heavy metal, and dust emissions
- An annual €10 billion saving in operating costs, increasing the competitiveness of European industry
- A €50 billion reduction in capital investments for new generating capacity
- A reduced dependency on fossil fuel imports

Barriers to adopting energy efficient motor systems

High efficiency motors (Eff1) represent only 12% of the market in the EU. If energy efficient motor systems have in the large majority of the cases the lowest Life Cycle Cost (LCC), why is the adoption rate so slow? Studies show that a whole spectrum of barriers exists:

- **Priorities:** the energy efficiency differences between individual motor systems appear to be modest. Another point is that replacing just one or two motors is a relatively minor decision and therefore calling for the most expedient solution, in the absence of a standing company policy. It is easier to replace what you already have than to re-specify or redesign a more efficient alternative. Moreover, motors are often perceived as a low priority item at non-technical decision making levels.
- **Lack of information:** the definitions of motor efficiency are ambiguous. This has recently been improved by the new international standard.
- **Split budgets:** the budget owner of the motor purchase is often different to the one paying the annual operating costs. That is, in part, because most industrial motors are purchased by OEMs that integrate them into larger production systems. Minimising the initial purchase cost is more often than not their primary concern. Also within an individual company, the budgets for equipment purchasing and life cycle energy consumption are often split.
- **Existing stocks:** even when a motor fails, most companies have back-up spares of the same type and efficiency in their warehouses. For practical reasons, the failed unit is often repaired instead of replaced — even if a replacement would have a lower LCC.
- **A long life cycle:** the typical operating life of a motor can be 20 years and substituting old motors that are still operational is rarely economical. This also means that a poorly-reasoned purchasing decision will have a negative impact lasting for 20 years.

How to promote energy efficient motor systems

Labelling, information and education

While the new IEC standard on labelling makes the energy efficiency of electric motors more consistent, information campaigns remain necessary to keep the benefits of energy efficiency in the spotlight.

Minimum efficiency standards and other regulations

In the USA, the combination of Minimum Efficiency Performance Standards (MEPS) by EPAct and voluntary labelling by NEMA has proved successful. Up to now, the EU has only established voluntary programmes, resulting in a significantly lower percentage of high efficiency motors on the market. This situation could be improved by introducing MEPS that phase out the lowest efficiency categories (IE 1 and some types of IE 2). It is estimated that such a policy will save Europe 12 to 18 TWh annually. It would stimulate innovative manufacturers as they will profit from R&D investments, and create employment in this industry.

Financial support mechanisms

Indirect financial support mechanisms that stimulate the more rapid adoption of energy efficient motor driven systems could be cost-effective for national governments. Examples include tax allowances, support for distributors allocating shelf space to energy efficient motors, special leasing contracts, take back schemes for old motors, and the introduction of a trading system for efficiency improvement credits.

Supporting R&D of manufacturers

The creation of Product Procurement Groups is a good practice for stimulating R&D. Such groups of users offer manufacturers a guaranteed market if they are able to develop a new product according to certain specifications.

Shop floor assistance

Government support mechanisms for independent energy audits can have a high return. Another type of shop floor assistance is the promotion of a decision making tool, such as the EuroDEEM electronic motor database. Such a tool is particularly relevant for SMEs.

Promote Life Cycle Costing

Promoting Life Cycle Costing (LCC) as a best practice for equipment purchasing will indirectly promote energy efficient motor systems, since the latter have, in most cases, the lowest LCC. To spread 'life cycle thinking' as a general company policy, could be included in the requirements for EMAS certification (Eco-Management and Audit Scheme). The LCC practices of the company would then be verified during the EMAS certification audit. Similarly, the ISO 50001 for Energy Management could also include a chapter on LCC practices.

If you are interested in receiving ECI's report on Energy Efficient Motor Driven Systems, please contact

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