Motor Summit China 2015

Summaries

Welcome to the first Motor Summit China - Why energy efficiency matters

Conrad U. Brunner
Impact Energy Inc.
Gessnerallee 38a, CH-8001 Zurich
cub@impact-energy.ch
www.motorsystems.org

Welcome

This is the first Motor Summit in China. It follows the experience and the success of the 5th Motor Summit that was held in Zurich Switzerland in October 2014. The idea of the Motor Summit is that experts and users, representatives from industry that use motors and manufacturers that produce motors, together with government members, university professors, and experts of Non Governmental Organizations meet in an open atmosphere to discuss new technological developments and best practice from policy programs. The goal of each Motor Summit is to make efficient motor systems a success in the market place and a contribution to the economy and the environment.

China needs more energy efficiency

China has recognized already in its last three 5-Year-Plans that energy efficiency is the key to the future development of the country. The economy of China is growing so fast that the increase of energy demand cannot be satisfied anymore just with an increase of energy supply without large damage to the economy and the environment. The time has gone when China could supply its energy needs from its own national resources of coal, oil and gas. Now it is continuously depending on imported energy and the expansion of the renewable energy gained from wind, solar, etc. Air quality in many big cities has shown that there is an urgent need to improve energy use. The economic success of China has made its carbon dioxide emissions the largest contributor to climate change in the world.

Energy efficiency is the key element. It means to lower the input of resources to gain the same output of production. Industrial use of electric motors plays a big role in this because:

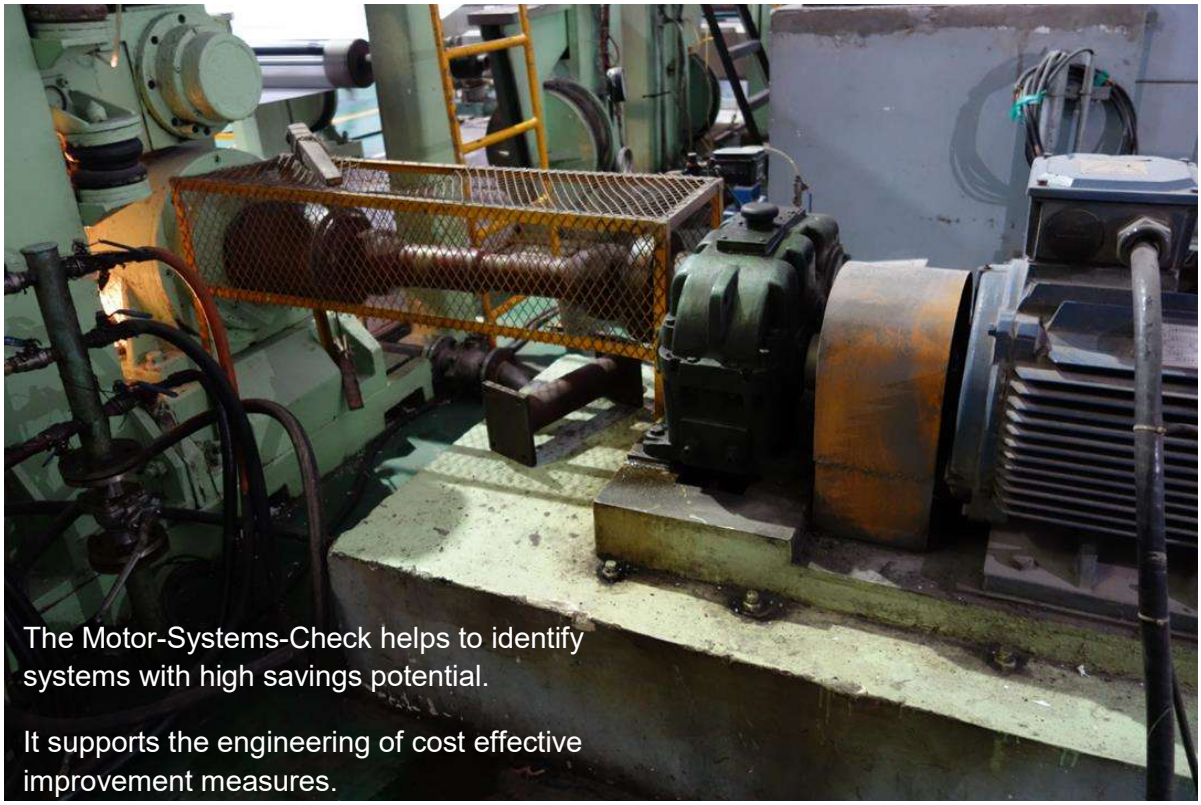
- China produces still almost 70% of its electricity by coal,
- Chinese industry uses more than 70% of the entire electricity of the country,
- Much more than 70% of the electricity consumption of each industrial plant goes to motors that drive pumps, fans, compressors and mechanical process machines.

To conclude, highly efficient electric motor systems in existing and new factories throughout China are a strong contribution to relieve China's climate and environmental concerns.

Motor-Systems-Check

The successful methodology to improve motors is to look at the entire system: with the combination of efficient motors and properly sized applications, with the use of good transmission belts and gears, without inefficient throttles and dampers, and with the applications of converters if needed. Together, these components will lead to large and sustainable energy savings of 20 to 30% on average. Therefore, every factory in China needs

to go through a systematic *Motor-Systems-Check* and learn how to improve all of its applications. The focus is on old machines with long hours of operation without converters. Here, improvements can be made easily with a payback time of less than 3 years for the investment in efficient technology.



The Motor-Systems-Check helps to identify systems with high savings potential.

It supports the engineering of cost effective improvement measures.

Learning from Zhenjiang - Learning from Switzerland

The Topmotors program for efficient electric motor systems has a 10 year history of development in Switzerland, supported by Swiss government. It has shown to be a successful learning platform, serving the needs of industry with training and tools.

The Topmotors China Pilot Program started in 2014 with the support of the city of Zhenjiang. It has already made big progress. It has shown that many of the problems of electrical energy use in industry are the same as in Europe: many machines are too old, inefficient, oversized and run without load control. Topmotors has succeeded to bring a number of industries to account for their electric equipment, to start audit procedures with the *Motor-Systems-Check*, to take load measurements and to consider energy efficiency improvements. It has also trained skills of company members to be able to lead energy improvement projects in the future.

In the short period since its launch on 4 July 2014, the Topmotors China Pilot Program has made big steps and led to new insights on technical and economical improvements that the Swiss Topmotors program can benefit from.

Swiss energy policy: efficient motor systems, voluntary and mandatory instruments for the industry sector

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Swiss Federal Office of Energy SFOE

Richard Phillips
Responsible for electric motor systems
Swiss Federal Office of Energy, 3003 Bern
richard.phillips@bfe.admin.ch

Introduction

The Swiss electricity production mix mainly comprises hydropower and nuclear power (58 and 37 percent respectively). [1] In 2011, the Federal Council and Parliament decided that Switzerland is to withdraw from the use of nuclear energy on a step-by-step basis. In view of this, the Federal Council developed a long-term energy policy ("Energy Strategy 2050").[2] And at the same time, it produced an initial package of measures containing three instruments for the promotion of energy efficiency: a) regulation, b) voluntary measures without subsidies, and c) voluntary measures with subsidies. This paper contains a brief description of the three instruments for enforcing, promoting and encouraging the reduction of electricity consumption in the industry sector.

Electric motor systems

Electric motor systems account for up to 43 percent of Switzerland's total annual electricity consumption[3]. The average savings potential has been estimated at between 20 and 30 percent.[4] This means than at least one-third of the output from nuclear power plants can be substituted by consistently implementing electricity efficiency improvement measures in electric motor systems. An electric motor system is not just a pump, fan or compressor. It encompasses everything: variable speed drive (optional), motor, mechanical equipment (gear, belt, clutch, and brake), application (pump, fan, compressor, transport) and process[5]. Significant electricity savings can only be achieved by optimising all components of a system. The level of electricity efficiency that can be reached depends on the initial state of the system and the depth of the analysis, as well as on subsequent implementation of the improvement measures related to the regulations and the voluntary measures.

Regulations

The minimum energy performance standards are specifically defined in the Swiss Energy Ordinance in the form of efficiency provisions. There are at the moment four such provisions governing electric motor systems: electric motors, circulation pumps, water pumps and fans. The Swiss efficiency provisions for motor systems are mainly based on those in effect in the European Union in order to avoid any commercial barriers arising between the EU and Switzerland. The provisions governing electric motors are based on IEC Standard 60034-30, which makes it compatible at the international level. The other provisions (governing pumps and fans) are based on the European Energy Efficiency Index, which makes it difficult for them to be compatible with other international standards. The transition period between the existing and the new minimum energy performance standards is normally two years, and enforcement becomes immediately effective at the end of this period through random controls (including

[1] Swiss Electricity Statistics 2013, Swiss Federal Office of Energy, July 2014, p. 3.

[2] Dispatch to Parliament concerning the initial package of measures for Energy Strategy 2050. Swiss Federal Office of Energy, September 2013.

[3] Analysis of Swiss energy consumption, 2000 to 2013, by intended purpose. Swiss Federal Office of Energy, September 2014.

[4] Global effort for efficient motor systems: EMSA, R. Werle et al. EEMODs'11, September 2011.

[5] Policy Guideline for Electric Motor Systems. Part 2: Toolkit for Policy Makers. K. Kulterer et al. EMSA, October 2014, p. 8.

measurements in accredited laboratories). The impact of the last revision of the regulations on the reduction of the electricity consumption of motor systems was assessed at 0.5 percent of the annual total Swiss electricity consumption by 2020. In other words, the minimum energy performance standards are important, but they are not able to attain the full energy efficiency potential on their own, and thus need to be combined with voluntary measures.

Voluntary measures

The implementation of energy efficiency improvement measures is strongly influenced by a variety of players (manufacturers, industrial consumers, electricity supply companies and standards organisations), as well as by national policies. As already mentioned, the regulatory measures are specified in the relevant legislation in the form of mandatory minimum energy performance standards. Voluntary measures are also regulated in the Swiss Energy Act and its associated Ordinance, and are defined as voluntary measures with or without financial incentives.

Voluntary measures without incentives

Voluntary measures without financial incentives are carried out by the national programme called SwissEnergy, the main objective of which is to raise awareness through information, consulting, education and training[6]. SwissEnergy therefore promotes communication as well as energy efficiency campaigns at the national level. For electric motor systems, three main promotion campaigns were launched in recent years: efficient compressed air (in 2005 with a re-launch in 2015), efficient cooling (in 2010) and efficient pump systems (in 2015). All these campaigns are carried out by professional associations and are also sponsored by industrial companies (original equipment manufacturers, motor systems producers, engineering companies, end users). This structure is very important for ensuring the acceptance and success of campaigns, as well as for bringing the associated products onto the market. In addition to the three campaigns for motor systems, SwissEnergy has also been operating the topmotors.ch platform since 2007, which provides basic and detailed information, as well as advisory services. Topmotors.ch also organises events (e.g. workshops, motor summits) aimed at enabling original equipment manufacturers, suppliers, engineering companies and end users from the industry sector to get together and exchange information as well as experiences. Unfortunately, it is difficult to quantify the impacts of the SwissEnergy programme.

Voluntary measures with incentives

Voluntary measures with incentives are defined in Swiss legislation as competitive tenders, which are also part of a federal government programme focusing on efficient electricity use. The objective of competitive tenders is to reduce electricity consumption by industrial and services companies with the best possible cost-benefit ratio. Applications for projects (measures inducing electricity savings) and programmes (efficiency measures that programme managers are implementing for third parties) may be submitted by private or public sector entities. Only projects or programmes that could not be realised without the financial incentives may be considered. The selection of projects and programmes to be granted financial support is effected via an auction procedure in which all the accepted applications are included. Those projects with the best cost efficiency will be granted support until the budget for projects has been exhausted. In principle, the realised electricity savings should be demonstrated through monitoring. Competitive tender programmes such as efficient electric drives (EASY), efficient compressed-air systems (ProEDA) and energy checks for water supply installations have been relatively

[6] Further information: www.energieschweiz.ch

Promoting Motor System Efficiency Improvement Support Green Industry Transformation Development

Xue Feng
Director
Zhenjiang Economic and Information Technology Commission
68#, Nanxu Avenue, Zhenjiang

Zhenjiang is a history city with more than 3000 years. It is one of the “Low Carbon Pilot Cities”. Zhenjiang is the first city which proposed the goal of reaching peak carbon emission in 2019, which aims at forcing the economic and social transformation to low carbon development. In 2014, the total electricity consumption of Zhenjiang was 20.94 TWh and industry sectors consumed 16.24 TWh electricity, which accounted for 80% of total electricity consumption. Electric motors are widely deployed and used in industry sectors, which consumes about 70% of total electricity consumption. However, the average system efficiency is 20 to 30 percent lower than international advanced systems, which means significant saving potentials.

MIIT and AQSIQ announced to implement “National Motor Efficiency Improvement Plan (2013-2015)” from June 2013. According to practical situation, Zhenjiang carried out this national plan in Zhenjiang in time. Zhenjiang Economic and Information Technology Commission (ZEITC) and Bureau of Quality Supervision jointly announced the local implementation of national plan in August 2013. ZEITC actively disseminated policies and standards, fully investigated motor usages, developed in-efficient motor phasing out road-map and inspected energy efficient standards implementation of motor manufacturers.

Problems in policy implementation and promotion:

- Limited efficiency improved by only replacing high efficient motors. Although national motor efficiency subsidy program gave rebates to high efficient motors, energy using enterprises were not active in replacing in-efficient old motors due to limited efficiency improvement.
- Most enterprises have no full-time energy management staff working on motor system conservation. Energy efficiency documents and data are absent. And enterprises have no plan to conduct motor system efficiency projects in sustainable way.
- Motor system efficiency improvement should be incorporated with enterprises’ awareness, capacity and production. How to convince and motivate enterprises to conduct projects scientifically is a major subject.

Taking the opportunity of building “Sino-Swiss Zhenjiang Ecological Industrial Park”, Zhenjiang carries out international cooperation actively. Sino-Swiss motor system efficiency improvement pilot project was launched in July 2007 and introduced Top10 China to work in Zhenjing. Taking the system energy conservation concept from “Motor-Systems-Check”, factories from paper, chemical and iron&steel industries were selected as the pilots to develop scientific motor system efficiency retrofit plan. 30 factories were investigated and evaluated and management and technical representatives in total 200 person-times from 50 factories were trained. The average efficiency improvement of pilot motor system is more than 15% and average pay back time is between 2 to 3 years. Factories were motivated to transfer to autonomous, systematic, detailed and sustainable project management.

Zhenjiang tries motor system efficiency improvement new pattern in front of China. It is set the principle of “government leading, enterprise following, professional planning, and market operating”. It involves government agencies and institutes, third party consulting institutes, professional energy service companies, energy using enterprises, investing funding and technologies to share and reduce the risks to explore the full energy potentials. It forms a new

pattern that policy, technology, capital and service work together to promote motor system efficiency improvement, which is verifiable, duplicable and sustainable.

Approved by MIIT, Zhenjiang becomes the pilot cities of green industry transformation, which is the only city from Jiangsu province. The energy consumption per unit GDP in 2014 was 0.55 ton standard coal per 10 thousand RMB, which decreased by 7.961% than 2013 and 2% lower than provincial average. Motor system conservation is one of the important measures to promote green industry transformation. MIIT and Jiangsu Economic and Information Technology Commission (JEITC) encourage Zhenjiang to explore further in motor system energy conservation and put Zhenjiang pilot project into MIIT's program in 2015.

Zhenjiang has published local regulation to promote motor system energy conservation regularly. Local finance department has allocated specific funds to support the enlargement of "Sino-Swiss motor system energy conservation pilot project", which focuses on the top 50 electricity consumption enterprises. For the new construction project, all the motors purchased by enterprises should meet the efficiency requirements of IE3 at least. The process of phasing out of inefficient motors will be accelerated. "Energy conservation loan" will be tried to provide financing support for motor system energy conservation. It is expected that in next two years 80MW motor efficiency will be improved, 0.12TWh electricity will be saved which equalizes to 39'500 tons standard coal.

Update on Global Motor Energy Efficiency Programs

Dan Delaney
Regal Beloit
Fort Wayne, IN USA
dan.delaney@regalbeloit.com

Summary

This presentation will provide updates on three key energy efficiency topics.

- Latest DOE Energy Efficiency Regulations
- NEMA Premium License Revision
- IECEE Global Motor Energy Efficiency Program (GMEE)

The latest US DOE (Department of Energy) motor and motor-driven system energy efficiency regulations will be presented and will include updates on the following DOE Rulemakings:

- IHP (Integral Horsepower) Rule,
- Small Motor Rule,
- Pumps Rule
- Fan and Blower Rule.

An update on the NEMA Premium License will be provided which includes the expansion of scope including small and large AC induction motors.

Lastly an update on the latest efforts between NEMA (National Electrical Manufacturers Association) and IECEE (IEC System for Conformity testing and Certification of Electro technical Equipment) to jointly develop a global motor energy efficiency (GMEE) program.

This joint proposal between NEMA and IECEE is intended to address the multitude of trade barriers that motor manufacturers face when complying with the various global country regulations for motor efficiency. Many countries (US, Canada, Mexico, Brazil, Argentina, European Union, India, China, Russia, Australia, Japan, Korea, etc.) have existing motor efficiency regulations but can vary greatly when it comes to the Certification and Compliance requirements such as test standards, laboratory accreditation, sampling and test process and labeling requirements.

This program has determined the consistencies in these requirements and established a global set of harmonized requirements from the laboratory accreditation to the test standards and finally the certification process. This international working group consists of members of both NEMA and IEC standards organizations along with an international list of motor manufacturers. The GMEE program is on schedule to launch in September of 2015.

successful for motor systems. Since its introduction in 2010, the competitive bidding procedure has induced accumulated electricity savings (over the average life cycle of the respective measures) equivalent to 5 percent of Switzerland's annual electricity consumption, with funding totaling 79.6 million euros, resulting in a cost efficiency of 2.6 euro cents per kWh. Although the competitive bidding procedure has had a positive impact by promoting and encouraging (through financial incentives) the implementation of measures aimed at increasing efficient electricity use, the projects and programmes nonetheless only address a small proportion of the overall potential (well below 10 percent).

Conclusions

Electric motor systems account for up to 43 percent of Switzerland's annual electricity consumption, with an estimated savings potential between 20 and 30 percent.

Energy efficiency is enforced through minimum energy performance standards and promoted through voluntary measures with and without subsidies.

Minimum energy performance standards are defined in the Swiss Federal Energy Ordinance as efficiency provisions governing components (electric motors) and subsystems (fans, circulating and water pumps). The most recent revision of the Ordinance will induce a 0.5 percent reduction of annual Swiss electricity consumption by 2020.

Voluntary measures without subsidies are carried out by the SwissEnergy programme, the objective of which is to raise awareness. A quantitative evaluation of the impacts of this programme is difficult.

Voluntary measures with subsidies are defined in Swiss legislation as competitive tenders which are part of a federal government programme focusing on efficient electricity use. Since 2010, competitive tenders have induced accumulated electricity savings equivalent to 5 percent of Switzerland's annual electricity consumption.

A combination of mandatory and voluntary measures is required in order to maximise the electricity savings potential.

Opportunity for China: Leading the World to Higher Electric Motor Efficiency

John Petro
Petro and Associates
Los Altos, CA 94024, USA
johnpetro@comcast.net

Energy efficiency is by far the most cost-effective approach to solving energy supply issues and improving a nation's economy. By using less energy to produce goods and services, the economy benefits in many ways. First, greater energy efficiency results in lower costs for products and services, by reducing the energy cost to produce the same output. Second, greater energy efficiency reduces the total demand for electricity, and thereby also reduces the detrimental pollution caused by the production of electricity. This then enhances human health and the environment. Energy efficiency also enables economic development to continue in dense urban areas where additional energy infrastructure is difficult and very expensive to develop. By reducing the need for additional energy infrastructure, increased efficiency can free up capital and resources that can then be applied to better uses.

Given this, energy efficiency measures should receive the highest priority from both private industry and governmental policies. Electric motors consume about one-half of all electricity produced. Further, this percentage is likely increasing for two major reasons: electric lighting efficiency is improving rapidly, which reduces the percentage of total electricity being consumed by lighting, and there is a significant move towards electrified transportation, with electric motors propelling bikes, cars, and buses. Therefore, measures to improve electric motor efficiency are of the utmost importance.

While electric motors are relatively efficient, there is still much room for improvement. International standard bodies have established the IE code (IEC 60034-30-1:2014) as targets for energy efficiency, ranging from IE1 to IE4 - and soon IE5 - with the higher numbers indicating higher efficiency. However, national governments so far have only required motors to meet IE2 and IE3 levels. In addition, even when these standards are adopted, very little strict enforcement of these regulations has been established. As a result, despite their advantages, conversion to highly efficient motors has been fairly slow in most parts of the world.

The necessary technologies for much more efficient motors already exist and are available for adoption in the marketplace. All the major electric motor manufacturer companies have motors that perform to IE4 levels of efficiency, and they can meet this efficiency level with any of the three major motor types: induction, synchronous reluctance, and permanent magnet (PM) motors, using either ferrite or neodymium iron boron type magnets. In fact, a number of companies have motors that can perform at the IE5 level of efficiency -- and even higher. Motors capable of operating at IE5 or higher levels, however, are almost exclusively permanent magnet (PM) motors. With PM motors, levels equivalent to IE6 and IE7 are possible, even though these efficiency levels have not yet been formally defined.

In addition, there are many additional improvements that can still be made to electric motors that will further increase their overall efficiency and reduce costs. Some of these include amorphous and nano-crystalline soft magnet materials, better permanent magnet formulations, better power semiconductor devices, better bearings and numerous others.

With the rise of the electrified transportation market, the use of high power, highly efficient permanent magnet motors is rapidly growing. The same technology that is used in electric cars can be applied to the industrial and commercial motor markets, and would result in significant improvements in motor efficiency and energy savings. China is uniquely positioned to both lead and take advantage of this highly important market transformation.

This is true for a number of reasons. First, permanent magnet motors are clearly the motor technology that has the best energy efficiency. This is confirmed by the fact that when a company that makes synchronous reluctance motors wanted to increase the motor's efficiency, they added magnets to the rotor. While they may still call it a synchronous motor, it is almost identical in design to an interior permanent magnet (IPM) type motor. Given the outstanding performance and efficiency of PM motors, and the high cost of batteries, it is no surprise that most of the world's automobile manufacturers have chosen PM motors for their electric vehicles.

China is blessed with good natural resources and currently controls a very large percentage of the raw materials used for making permanent magnets. China also is home to almost all of the world's magnet manufacturers that take this raw material and construct and sell working magnets. Unquestionably, China also has a dominant position in the realm of cost-effective manufacturing. In addition, China has a large number of skilled engineers to design new products. With all of these factors, making permanent magnet motors is a natural extension for Chinese industry. This shall be especially attractive as China looks to move up the value chain from selling product components to fully completed products and integrated systems.

Brushless PM motors require an electronic drive to operate the motor. The cost of this drive is one of the major factors holding back wider adoption of PM motors in industry. These drives are constructed with microprocessors controlling high power electronics. This industry has historically been controlled by large European, American, and Japanese companies, but because of the need for these drives in the automotive industry, this is changing. Given China's electronic manufacturing capabilities, it would be natural for Chinese companies to enter this market on a worldwide basis. China's entry into the electronic drive market could result in significant progress in increasing the cost-performance ratio of these drives.

How could China rise to the position of predominance in electric motor efficiency? A first step could be to energize its large domestic market by adopting IE4 efficiency standards quickly. This could be done in stages, with these standards applying first to motors under 50 kilowatts where permanent magnet motors already are available and excel, and then later extending the standard to higher power ranges. By being the first country to require IE4 efficiency, China can reap the benefits of improved energy efficiency and also lead the world to a better future and inspire other countries to keep up with this technological change.

China can also use its expertise to drive down the cost of PM motors and, especially, the electronic drive for these motors. This would make the already attractive payback from this technology irresistible, based purely on economic factors. As this occurs, a vast worldwide export market would open up for the replacement of induction motors.

Following the adoption of IE4 standards, a move to IE5 should be scheduled. This level of efficiency is clearly obtainable with PM motor technology, and adoption of the IE5 level of efficiency would serve as a further catalyst for the transition to PM motors, thereby enhancing China's advantage from permanent magnet sourcing.

Such actions by China would be good for both China and the entire planet, as energy consumption could be reduced while cleaner, renewable sources of energy are brought on line. China could be a leader in this grand goal of a more efficient, cleaner and healthier world.

Modern motor markets are demanding a variety of new features in electrical motors

Power and productivity for a better world™

LIN Ranran
Technology Center Manager
BU Motors and Generators
ranran.lin@cn.abb.com

Modern motor markets are demanding a variety of new features in electrical motors. Here are some of them:

1. Efficiency
   There is a global trend towards better energy efficiency. While primary energies are now cheaper than in the near past, this does not necessarily reflect to electricity. Different taxes and emission trade schemes are maintaining high electricity prices.
2. The trend for higher efficiencies is getting a concrete form in regulation for minimum energy performance standards (MEPS). While in the beginning of MEPS-era the minimum level was typically IE2, now regulation is making a step upwards to IE3. In coming MEPS – reviews IE4 is coming into consideration, together with a target to expand regulation to cover also high voltage motors.

3. Reliability
   Another increasingly important element is reliability. This is interrelated with improved efficiency thanks to reduced temperatures in active parts of the motor and thus, in bearings. Direct drive systems help also increasing reliability by reducing need for gearboxes and belt systems.

4. Higher power density
   Need for more power coming from smaller frame size is a trend which might be in contradiction to efficiency. New technologies provide opportunities to choose between higher power density and higher efficiency.

ABB's IE4 induction motor series covers today powers between 75 and 1 000 kW. To extend IE4 induction motor power range below 75 kW or to exceed IE4 efficiencies while maintaining economical restrictions, new technologies are needed. Induction technology is clashing with its limits. Therefore ABB has developed motor technologies, which are available for Direct Online (DOL) and Variable Speed Drive (VSD) applications. These technologies can offer more cost efficient ways to reach the IE4 level. In some cases it is even possible to decrease losses by 20% compared to IE4 requirements, giving a good reason to call them IE5 motors. These technologies are also aligned with other requirements discussed above.

Typically small IE4 motors are Permanent Magnet motors, now available both for VSD and on-line applications. They provide many advantages for users but demanding service operations due to magnetic forces. This has set the demand for other technologies that fulfil the same efficiency requirements but are not exposed to material price volatility. In the European Union also recyclability has been under discussion: Rare Earth based PM motors need a special recycling process.

Synchronous Reluctance motors fulfil these requirements. This motor technology provides high efficiency and power density without Rare Earth based permanent magnet materials. The combination of high power density and high efficiency gives two options for applications:

1. High efficiency (IE4) or
2. Up to two-frame sizes lower shaft height for the same output power compared to conventional induction motors without compromising on efficiency.

High system efficiency is reached by building a package, containing a synchronous reluctance motor and a VSD. This feature makes synchronous reluctance technology highly attractive for any application where energy efficiency is important. ABB provides measured efficiency curves for standard ABB synchronous reluctance + ABB Drives packages.

The next step is to use Ferrite Magnets to boost efficiency, power factor and power density. This new generation is under development with selected Original Equipment Manufacturers (OEM).

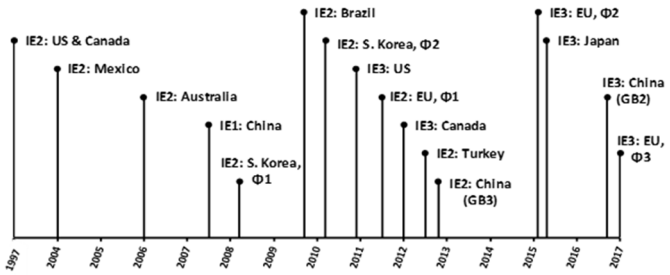
Markets are requesting synchronous reluctance motors also for Direct On Line (DOL) applications. The DOL synchronous reluctance technology is under development.

Systems Efficiency and the World Market for Low Voltage Motor

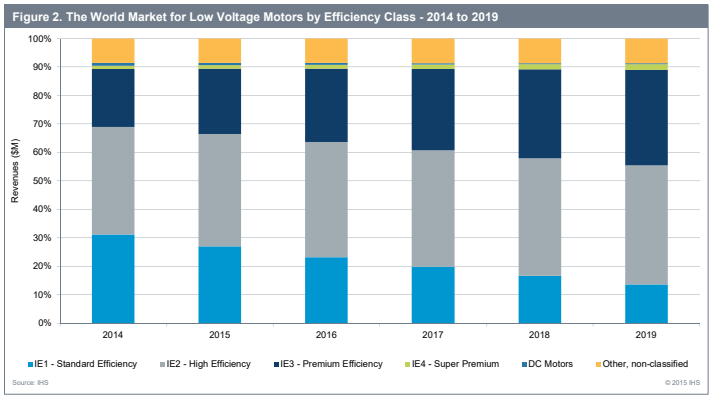
Preston Reine
Analyst, IHS
Preston.reine@ihs.com
+1 (512) 582 2059

The low voltage motor market was valued at more than $14 billion in 2014. Revenues have grown more rapidly than unit shipments due to various motor efficiency legislations being enacted around the world (Figure 1). As a result of these legislative initiatives, motors that are more energy efficient and more expensive are being mandated to manufacturers, OEMs and end-users alike. This substantially inflates the revenue growth of the low voltage motors market, particularly when compared to other industrial automation product markets.

Figure 1 w Voltage Motors
997 to 2017



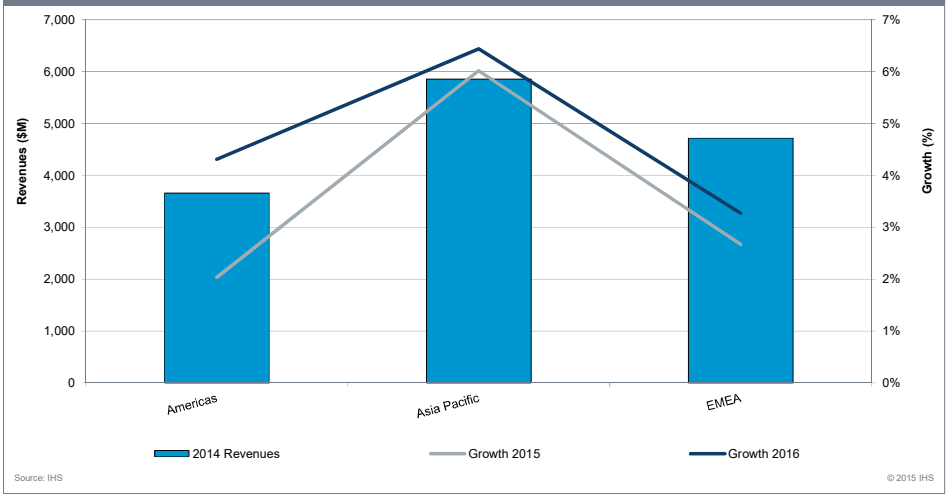
After accounting for 55% of the global market's revenues in 2013, IE1 (Standard Efficiency) motors made up an estimated 51% of the market in 2014, and are expected to comprise less than 25% of market revenues by 2019 (Fig 1). IE2 motors represented an estimated 19.5% of market revenues in 2014, but are expected to account for more than 45% of total market revenues by 2019. IE3 motors accounted for only 2% of global revenues in 2010, but made up 15% of market revenues in 2014 and saw another rapid uptick in demand this year due to the European Union's move to implement the next phase of its motor efficiency legislation, coupled with the US and EU initiatives to close loopholes that allowed for less efficient motor sales. The world market for industrial IE4 motors was estimated to be worth $158.8 million in 2014 with nearly 300,000 units shipped. This represents an almost tripling in revenues and more than a quadrupling in units since 2009.



The low voltage motor markets in North and South America accounted for nearly 26% of global market revenues in 2014. The US was the second largest individual country market for low voltage motors in 2014, with revenues greater than 16% of the worldwide total. The EMEA region comprised 33% of global revenues during the year. China was the largest individual

country market for low voltage motors in 2014, with revenues comprising more than 21% of all sales in the world and more than 29% of all global unit shipments.

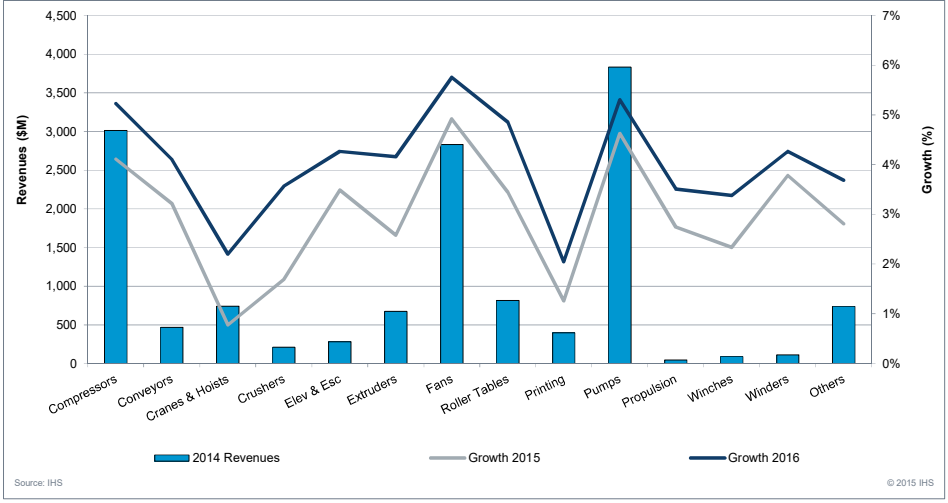
Figure 3. The World Market for Low Voltage Motors By Region - Revenue Growth Profiles - 2014 to 2019



The top industry sectors for low voltage motors include Commercial HVAC, food, beverage and tobacco, mining, utilities, material handling, packaging, plastics and oil & gas. The leading suppliers of low voltage motors on a global level include ABB, Siemens, Regal Beloit, WEG, Teco, Leroy Somer, Toshiba, Huali (China), Hyundai, Hyosung and Nidec.

The key applications in which motor-driven systems efficiency is a key focus include pumps, fans and compressors. IHS estimates that these products account for more than 2/3 of low voltage motor applications (Fig 4). Because these applications account for so much electricity consumption (roughly 25-30% annually), many nations are governing efficiency standards for these. The end result has been an increased focus on full system efficiency (motor + drive + pump/fan/compressor).

Figure 4. The World Market for Low Voltage Motors By Application - Revenue Growth Profiles - 2014 to 2019



A Cost-effective Approach to Motor Efficiency Upgrading and Refurbishment

Victor ZHOU
Director, International Copper Associate (China)
Victor.zhou@copperalliance.asia

For years, International Copper Association has been closely monitor the development of China motor market, in terms of market data, energy efficiency and compliance, technology development and application.

According to the latest market study conducted by International Copper Association, the total electric motor production reached 198.31 GW in 2013, among which 188.72 GW were alternating current (AC) motors. The production for exported motor was 25.56 million kW while motors for domestic use reached 172.75 GW. More specifically, the small and medium three-phase induction motor takes the highest market share of 70.45% in terms of power. Rare-earth magnet motor and switched reluctance motor has developed rapidly this years, their production volume reached 3.41 GW and 0.2 GW respectively.

In 2013, China total electricity consumption reached 5322.3 TWh, which increased by 7.5%. Industry sectors consumed 3847.1 TWh electricity, which accounted for 72.3% of total electricity consumption. Motor systems consumed 3406.271 TWh, which accounted for 64% total electricity consumption. Industrial motor systems consumed 2547.891 TWh electricity, which accounted for 74.8% of all industrial electricity.

In terms of motor efficiency, IE3 and IE4 motors only took 8% of the total market in 2013, among which only 3.4% were for domestic use. The main barriers for the adoption of high efficiency motors are the lack of awareness of top managers among end-users. Few of them know that the investment in high efficiency motors has a short payback time. More importantly, not all the supply chain is motivated to purchase high efficiency motors. In the Original Equipment Manufacturer (OEM) industry, such as fans, pumps, compressor etc. their main operating goal is to lower the cost due to their shrinking revenue. Therefore, it is crucial to introduce a cost-effective solution to increase the competitiveness of OEMs and guarantee the potential savings of end-users.

To promote cost-effective copper die-cast rotor solution would dramatically increase the competitiveness of motor manufactures and OEMs, therefore accelerate the upgrading of motor efficiency in new build market. For a given efficiency level, manufactures can deliver a significantly smaller motor than competitors by adopting copper die-cast rotor, which also enables the company to produce motors with high electric conductance and minimized heat, higher peak and continuous power density and lower cost. Applications such as compressors, pumps, fans and gear boxes equipped with copper rotor motor are inherently lower cost than competitors, suitable for a wide range of applications, and excel in the toughest environments where weight and space are critical for the end-user.

Copper die-case rotor replacement is the most easy and economical way to increase efficiency of installed motor by simply replacing an aluminum rotor with a copper rotor and guarantee efficiency increase from IE2 to IE3.

Check-testing experience of motors and controllers in Europe – The Ecopliant program

Sandie B. Nielsen
Danish Technological Institute
Kongsvang Allé 29
DK 8000 – Aarhus, Denmark
sbn@dti.dk

Check testing of motors, fans, circulators and water pumps

The Danish Technological Institute has been conducting compliance check testing on numerous products covered by European Ecodesign requirements for energy using products.

Danish authorities requested the first assignment in the fall of 2011 following the introduction of the first step of Ecodesign regulations for electric motors (European Commission Regulation (EC) No 640/2009), which went into force on 16 June 2011. In this first step, the requirement for the Minimum Energy Performance Standard (MEPS) was an efficiency level of not less than IE2 for motors in the power range 0.75 kW – 375 kW (1 hp – 500 hp). On 1 January 2015, the next step of this regulation went into force, with increased MEPS for European motors sized 7.5 kW or higher to IE3 or use of IE2 motor with a variable speed drive.

Since the first step of European MEPS, also Swedish and British authorities have been contracting the Danish Technological Institute to perform both motor tests, fan tests, circulator tests and water pump tests under the European Ecopliant project.

As of spring of 2015, the Danish Technological Institute has performed accredited tests in terms of compliance with the Ecodesign regulation for motors, fans, circulators and pumps on the following products:

- 75 electric motors (0.75 kW – 18.5 kW)
  - 44 ≥ IE2 class
  - 28 = IE1 class but pass on the allowed tolerance
  - 3 failed but subsequently passed on three apparatus test
- 8 fans (separate motor test included)
  - 5 passed
  - 3 failed
- 23 circulators (6 non-regulated)
  - 13 passes own (Energy Efficiency Index) EEI declaration (4 using tolerance)
    - *11 of these would pass next EEI level*
  - 4 failed, 2 of these went to three apparatus test
  - 6 non-regulated: all failed
- 13 water pumps (separate motor test included)
  - 100% pass – with good distance!
    - *85% would pass next Minimum Efficiency Index (MEI) level*

Of the 75 motors only 59% passed without having to take advantage of the allowed tolerance in the Ecodesign regulation, but this number increases from year to year indicating an improved overall tendency toward better motors.

European minimum energy performance standard (MEPS) on circulators (no 641/2009) states both an upper limit for the energy efficiency index (EEI ≤ 0.27), but also a relation to the declaration made by the manufacturer of the circulator.

Of the 23 circulators 6 were of the non-regulated type (fixed speed pump) and therefore without a realistic chance of passing the European MEPS for circulators. Of the remaining 17 circulators 13 passed by their own declaration and 11 of these would even pass the next level of MEPS. Two of the four failed circulators went into a three apparatus test. One circulator since passed and one failed.

The European MEPS on circulators goes to the next level (EEI ≤ 0.23) by 1 August 2015.

The 13 water pumps all passed the European MEPS (no 547/2012) - MEI 0.1 valid until the end of 2014. Eleven of the tested pumps would even pass the next level of MEPS for water pumps (MEI 0.4) which enters into force by 1 January 2015.

This presentation will show the methods used and results of the tests performed including the tendency of the involved products, but also raise questions in terms of actual laboratory testing vs. document control and on-site testing.

Motor test facility, M-Lab - Danish Technological Institute, Taastrup

The Top runner Program for efficient motors in Japan

Takeshi Obata
Chairman of JEMA High-efficiency motors Promotion Committee
Hitachi Industrial Equipment Systems Co., Ltd.
1-1, Higashinarashino 7-Chome, Narashino-shi, Chiba-ken, JAPAN
obata-takeshi@hiatchi-ies.co.jp

Introduction

The Top runner scheme is applied to industrial induction motors from 1 April 2015 in Japan, as one of the operation of The Energy Conservation Law (hereinafter referred as “ECL”). The purpose of this law is efficient energy use. This paper shows the obligation that Top runner motors should have their estimated effect for energy saving.

The obligation of Top runner motor (for manufacturers and importers)

The obligation of Top runner motor is different from that of MEPS (Minimum Energy Performance Standards). Every motor manufacturer (importer) must report the average efficiency value of the products they sell during one fiscal year on each category, to METI (Ministry of Economy, Trade and Industry). The regulated efficiency of each category is defined on IE3 4 pole motor efficiency (Figure1 and Table1). As regards 2 poles or 6 poles motors, the evaluation shall be made using the value calculated by a coefficient. Every report is checked by METI. If the manufacturer could not fulfill regulated efficiency, legal action would be imposed on them.

Table 2 shows an example of an annual energy report that every motor manufacturer (importer) must report to METI including detailed data of each category. The judgement must be clear for all the categories from 1 to 36.

The obligation of Energy Users based on the ECL

Energy users are requested to make reasonable efforts to reduce, energy consumption intensity of their company as a whole or for each factory etc. by 1% or more on an annual average in the medium- and long-term.

They have to submit medium and long term plans to reduce energy use, and there are many plans to use efficient facilities (motors) and VSD.

Next step

The rules for Top runner products have to be revised every 3 to 4 years; the rules can be improved for efficiency or can expand scope of products. Top runner motor's sales will be monitored after 2015.

Conclusions

Japan will continue energy conservation, and the Japanese government starts to study a 30% reduction of greenhouse gases against 2013, until 2030. Top runner motors could be one of the effective means for the goal.

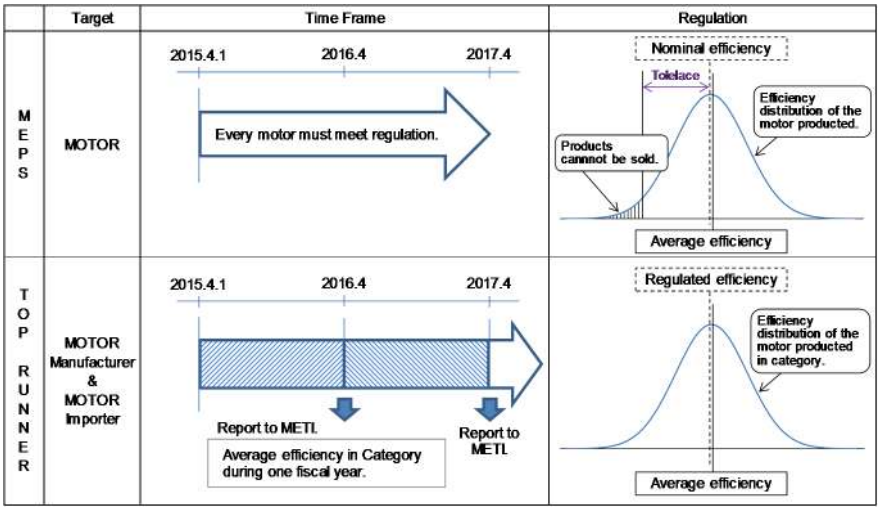


Figure 1 The obligation of Top runner motor

60Hz

Category	Rated output power		Regulated efficiency [%]
	from	to	
1	0.75kW	< 0.925kW	85.5
2	⩾0.925kW	< 1.85kW	86.5
3	⩾1.85kW	< 4.6kW	89.5
4	⩾4.6kW	< 9.25kW	91.7
5	⩾9.25kW	< 13kW	92.4
6	⩾13kW	< 16.75kW	93.0
7	⩾16.75kW	< 26kW	93.6
8	⩾26kW	< 33.5kW	94.1
9	⩾33.5kW	< 41kW	94.5
10	⩾41kW	< 50kW	95.0
11	⩾50kW	< 100kW	95.4
12	⩾100kW	< 130kW	95.8
13	⩾130kW	⩽375kW	96.2

50Hz

Category	Rated output power	Regulated efficiency [%]	Category	Rated output power	Regulated efficiency [%]
14	0.75kW	82.5	27	37kW	93.9
15	1.1kW	84.1	28	45kW	94.2
16	1.5kW	85.3	29	55kW	94.6
17	2.2kW	86.7	30	75kW	95.0
18	3kW	87.7	31	90kW	95.2
19	4kW	88.6	32	110kW	95.4
20	5.5kW	89.6	33	132kW	95.6
21	7.5kW	90.4	34	160kW	95.8
22	11kW	91.4	35	200～375kW	96.0
23	15kW	92.1	36	Others	Defined by eguation
24	18.5kW	92.6			
25	22kW	93.0			
26	30kW	93.6			

Regulated efficiency : IE3

Table 1 Categories of Top runner motor

Term : 2015/4/1～2016/3/31

Category	Freq.	Rated output power		Production number	Total efficiency	Averaged efficiency	Regulated efficiency	Judgment
		From	To					
1	60Hz	0.75kW	< 0.925kW	225	20,132.1	89.5	85.5	OK
2	60Hz	⩾0.925kW	< 1.85kW	0	0.0	0.0	0.0	-
3	60Hz	⩾1.85kW	< 4.6kW	0	0.0	0.0	0.0	-
4	60Hz	⩾4.6kW	< 9.25kW	0	0.0	0.0	0.0	-
5	60Hz	⩾9.25kW	< 13kW	0	0.0	0.0	0.0	-
6	60Hz	⩾13kW	< 16.75kW	0	0.0	0.0	0.0	-
7	60Hz	⩾16.75kW	< 26kW	0	0.0	0.0	0.0	-
8	60Hz	⩾26kW	< 33.5kW	0	0.0	0.0	0.0	-
9	60Hz	⩾33.5kW	< 41kW	240	22,965.8	95.7	94.5	OK
10	60Hz	⩾41kW	< 50kW	0	0.0	0.0	0.0	-
11	60Hz	⩾50kW	< 100kW	0	0.0	0.0	0.0	-
12	60Hz	⩾100kW	< 130kW	0	0.0	0.0	0.0	-
13	60Hz	⩾130kW	⩽375kW	0	0.0	0.0	0.0	-
14	50Hz	0.75kW		175	15,285.0	87.3	82.5	OK
15	50Hz	1.1kW		0	0.0	0.0	0.0	-
16	50Hz	1.5kW		0	0.0	0.0	0.0	-
17	50Hz	2.2kW		0	0.0	0.0	0.0	-
18	50Hz	3kW		0	0.0	0.0	0.0	-
19	50Hz	4kW		0	0.0	0.0	0.0	-
20	50Hz	5.5kW		0	0.0	0.0	0.0	-
21	50Hz	7.5kW		0	0.0	0.0	0.0	-
22	50Hz	11kW		0	0.0	0.0	0.0	-
23	50Hz	15kW		0	0.0	0.0	0.0	-
24	50Hz	18.5kW		0	0.0	0.0	0.0	-
25	50Hz	22kW		0	0.0	0.0	0.0	-
26	50Hz	30kW		0	0.0	0.0	0.0	-
27	50Hz	37kW		200	19,000.0	95.0	93.9	OK
28	50Hz	45kW		0	0.0	0.0	0.0	-
29	50Hz	55kW		0	0.0	0.0	0.0	-
30	50Hz	75kW		0	0.0	0.0	0.0	-
31	50Hz	90kW		0	0.0	0.0	0.0	-
32	50Hz	110kW		0	0.0	0.0	0.0	-
33	50Hz	132kW		0	0.0	0.0	0.0	-
34	50Hz	160kW		0	0.0	0.0	0.0	-
35	50Hz	200～375kW		0	0.0	0.0	0.0	-
36	50Hz	Others		260	23,393.0	90.0	89.4	OK

Table 2 Example of annual energy report

Old for New, Old for Refurbishment

Drive Motor System Energy Saving

Chen Weihua
National Engineering Research Center of Small and Medium Motor and its System
Shanghai Engineering Research Center of Motor System Energy Saving
Shanghai, China

1. Increasing motor stock and its power consumption in China

According to the statistics, the estimated power of motor stock in China was about 2.1 TW, and the total power consumption was about 3'400 TWh which accounted for 64% of total electricity consumption in 2013. The total motor power consumption in industrial sectors was 2'900 TWh in 2013 which accounted for 75% of total industrial electricity consumption. However, over 95% of low voltage motors in use are low efficient motors whose average efficiency is lower than IE2 by 3.0% and IE3 by 4.5%.

2. Promotion of high efficient motor

3.7 GW high efficiency motors were promoted in 2011, which accounted for 4% of all motors sold in the same year. 11.30 GW high efficiency motors were promoted in 2012, which accounted for 12.79% of all motors sold. 16.04 GW high efficiency motors were promoted in 2013, which accounted for 17.25% of all motors in use. Until May 2014, 16 GW high efficient low voltage motors, 13 GW high efficient high voltage motors and 4 GW permanent magnet motors were promoted, which are 33 GW in total. The market share of high efficient motors increased from 4% in 2011 to 17.25% in 2013.

3. Concept of motor high efficient Refurbishment

Motor high efficient refurbishment is to rebuild the low efficient motor to a high efficient motor or a motor under specific working load or operation condition, by redesigning, rewinding or replacing components. Motor refurbishment uses most parts of the original motor. It is an important method of resources conservation and recycling.
The problem of unreasonable matching among motor, driving gear and working load should be resolved by combining “Old for new, old for Refurbishment” and motor system energy conservation retrofit. “Old for new, old for Refurbishment” drives motor system energy conservation retrofit to improve motor system efficiency.

4. Techniques of motor system energy conservation by load matching

Basing on motor system loading characteristics and working load, corresponding system matching technologies are proposed to achieve optimized system efficiency. The main system matching technologies include:

4.1 High efficiency motor energy conservation:

Apply to constant torque load with load rate higher than 50% and long annual operating time. Using high efficiency motor can improve average efficiency by about 3% ~ 5%.

4.2 Permanent magnet synchronization motor energy conservation

It can be applied to frequent changing load, which runs often at no-load and part load, which typically are lathe, punching machine, chemical fiber, textile, wire drawing equipment. It can improve efficiency by more than 10%.

4.3 Pole-changing speed control energy conservation

This technology is to rebuild the single high speed and power motor to dual speeds motor. The rebuilt motor keeps the same performance at high speed, which was kept as backup. Motor is operated at low speed at normal load. 10% to 50% system efficiency improvement can be achieved on quadratic torque load such as fans and pumps system.

Example 1: By rebuilding one power plant pump motor (3'800 kW/6 kV) from 16 poles to 16/18 dual poles, 2.37 GWh electricity saving has achieved, which means 30% efficiency improvement.
Example 2: By rebuilding one power plant (2×330 MW) pans motor (3500 kW/6 kV) from 6 poles to 6/8 poles and 3'000/1'950 kW, 20% system efficiency improvement was reached. At the same time, the speed of a rebuilt motor can be adjusted by a switch set on-site, which can change the speed on-line.
Basic measures of rebuilding dual speeds motor:

1) Only the motor is rebuilt.
2) Only by replacing the stator windings, single speed motor is rebuilt to dual speeds.
3) The speed switching is normally conducted off-line by changing the connector manually. A speed switch is needed if on-line speed adjustment is needed.
4) The frame size of motor remains unchanged after rebuilt, except one pole changing box attached on the frame.
5) The function and performance of rebuilt motor keeps the same at its original speed.
6) During dual speed rebuilding, the motor performance at original speed can also be improved with system operating load.

There are also other energy conservation methods, including variable frequency speed adjusting, phase-controlled rectifying, inner feeding cascade speed adjustment and motor power reduction (or increase), etc.

5. Outlook and recommendation for motor high efficient Refurbishment

Six companies have obtained motor refurbishment qualification by Ministry of Industry and Information Technology at present, while other related companies are applying the qualification actively.
Recommendations: A national industry alliance of motor high efficient refurbishment should be established. It can initiate communication and cooperation in motor high efficient refurbishment design, process technology and motor system energy conservation optimization, etc. Based on national “motor efficiency improvement program”, a motor recycling system and mechanism should be established. Incentives including rebate scheme and tax deduction for “Old for Refurbishment” should be developed and implemented.

Economic considerations of motor systems improvements

Rita Werle
Impact Energy Inc., CH-8001 Zurich
rita.werle@impact-energy.ch
www.impact-energy.ch

Introduction

Electric motor systems with pumps, fans and compressors in industrial plants, infrastructure applications and buildings are responsible for 45% of the world's total electricity consumption. New and existing technologies offer the potential to reduce the energy demand of motor systems across the global economy by 20% to 30%. 错误!未找到引用源。 The know-how to exploit efficiency potentials exists but is not widely applied.

Financing for analyses

The major barrier in industrial plants is securing the necessary resources to find motor systems with the highest savings potential and identify the improvement measures and associated costs. This needs time, know-how and financial resources which is often scarce in factories.

Within the framework of the Swiss audit and financial incentive program Easy (www.topmotors.ch/easy), the Swiss Motor-Systems-Check audit methodology[7] was applied, an analysis in four steps. Financial incentives were higher for the first three steps, to motivate companies for analyzing their motor systems.

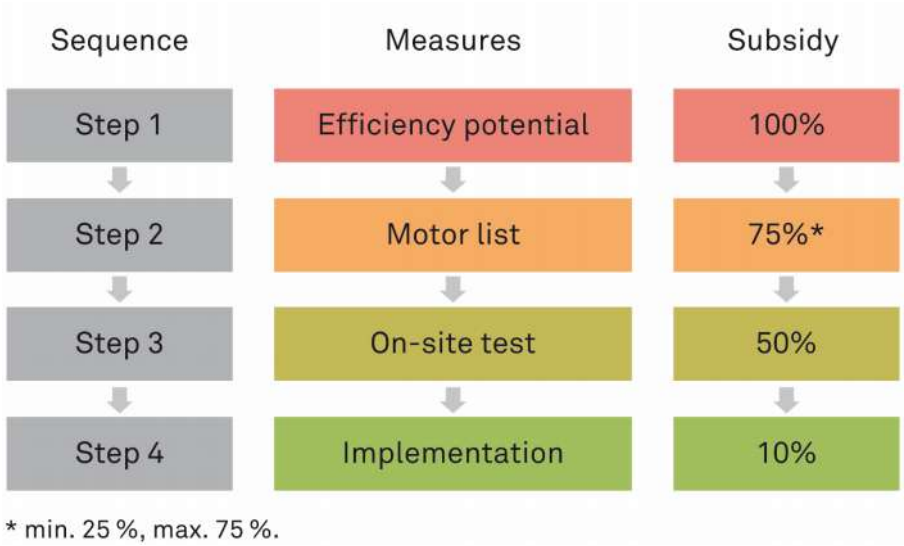


Figure 2 Four steps of the Motor-Systems-Check and associated subsidies within the Swiss audit and financial incentive program Easy

After the first three steps, potential improvement measures are identified. 错误!未找到引用源。 shows the results for a machine producing factory, with improvement measures identified for 39 motor systems. The cumulated payback for all 39 motor systems is 2.7 years. This is much more favorable than the 12 years of the least profitable measure. This example shows that it makes sense to bundle measures into an improvement package: this way a low payback period can be achieved for the entire package of measures.

[7] See also the Motor Summit China summary of Rolf Tieben: Motor-Systems-Check methodology.

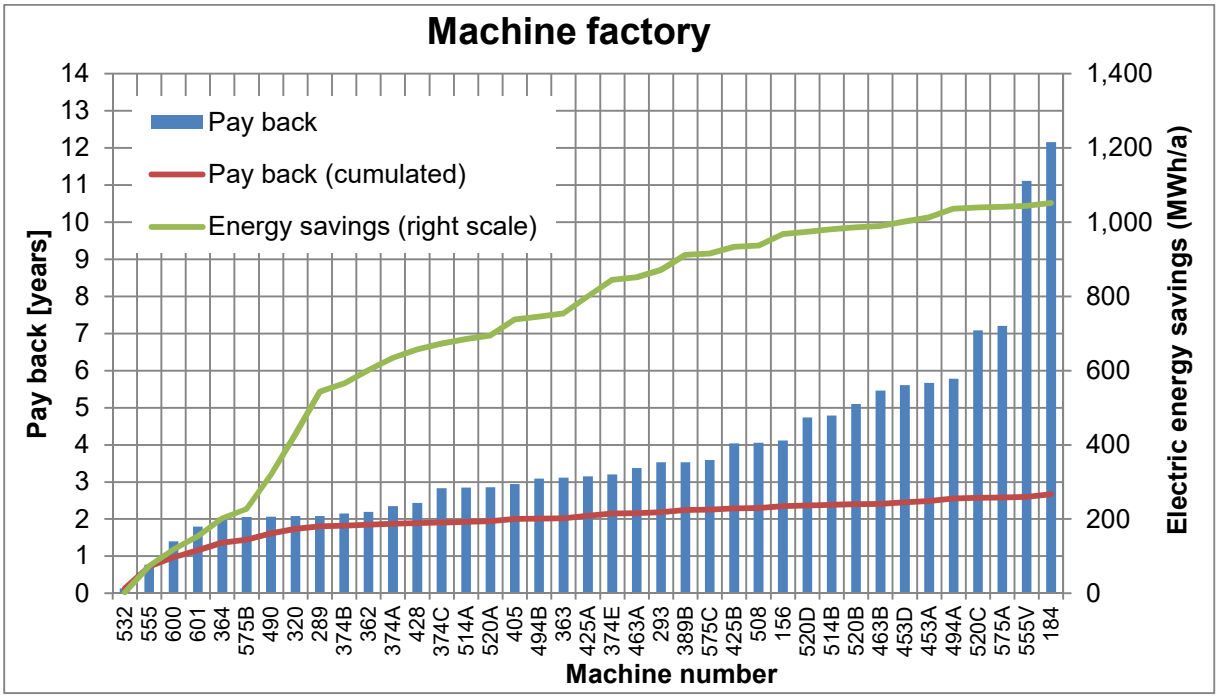


Figure 3 Package of measures with a cumulated payback of 2.7 years.
Explanation: The blue bars show identified improvement measures. The green line shows the cumulated energy savings, the red line the cumulated payback of measures.

4E Electric Motor Systems Annex (EMSA)

International collaboration is a very useful way for learning from the experience of other countries, like the lessons learned through the implementation of the Swiss Easy program.

The 4E[8] Electric Motor Systems Annex is an international collaboration program that raises worldwide awareness of the efficiency potential of motor systems. It serves as a platform for technical and policy exchange, disseminates best practice information and aims to support standards and policy development processes to improve the energy performance of new and existing motor systems. Its goal is to help governments develop and implement policies that increase the energy efficiency of motor systems by 20% to 30%.

More information: www.motorsystems.org

References

[1] Paul Waide, Conrad U. Brunner, et al.: Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems, IEA Working Paper, 2011, Paris.

[8] 4E is the Energy Efficient End-use Equipment (www.iea-4e.org) Implementing Agreement of the International Energy Agency.

Opportunities for International Collaboration in Motor System Efficiency

Pengcheng Li
China National Institute of Standardization
No.4 Zhichun Road, Beijing, 100191, P.R. China
lipch@cnis.gov.cn

Motor system is important energy-consuming equipment with a large number of applications. International collaboration is an effective way to save energy consumed in motor system and achieve efficiency improvement and carbon emission reduction. The development of IEC 60034-30 standards and work of IEA 4E Electric Motor Systems Annex (EMSA) are the good examples of international collaboration in this field.

In the future, the harmonization of energy efficiency standard and label program as well as the enhanced implementation of relevant policy will be the key area for international collaboration in motor energy efficiency. For instance, the United for Efficiency Initiative (U4E) conducted by United Nations Environment Programme (UNEP) may change the global policy environment for motor efficiency. Furthermore, the cooperation in Monitoring, Verification and Enforcement (MVE) scheme and information sharing will be promoted in APEC region. The opportunities for international collaboration in motor efficiency may include:

1) Harmonization of energy efficiency standards for motor globally. It means the collaboration of energy efficiency requirements as well as timetable of energy efficiency regulations;

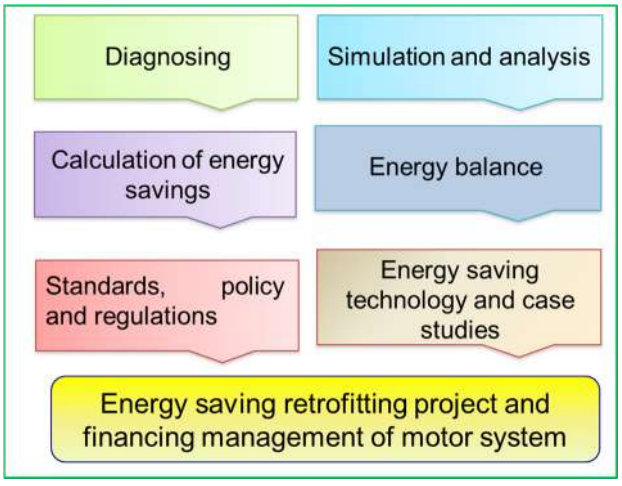
2) Collaboration in mandatory or voluntary label scheme for reducing the cost of compliance for manufactures;

3) Improvement of Monitoring, Verification and Enforcement (MVE) scheme for energy efficiency standards and labeling program;

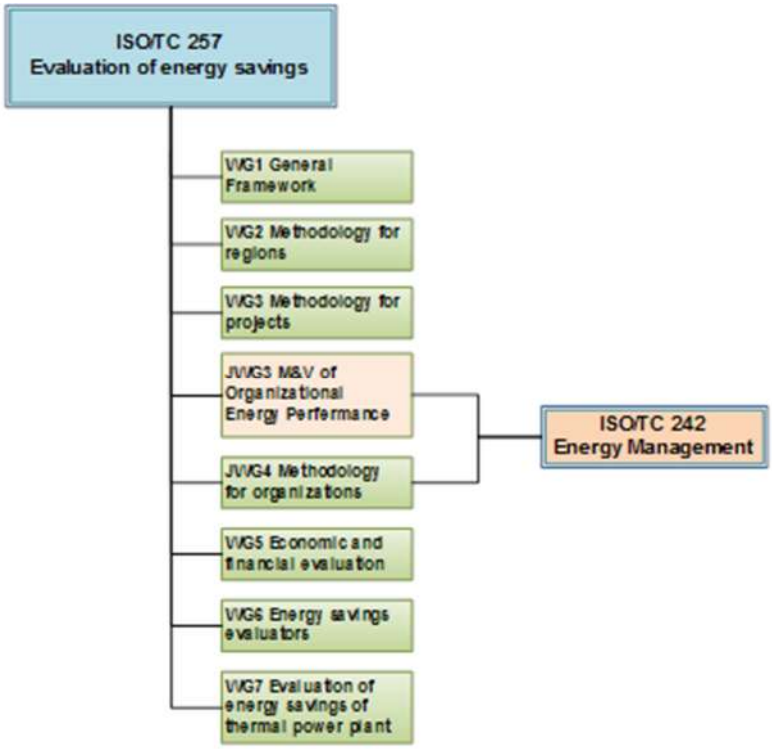
4) Reduction of life-cycle environmental impact of motors.

For motor system, it is anticipated to identify the best practice of energy saving retrofitting through international collaboration. Users, system designers, Energy Service Companies (ESCO) and manufactures should be mobilized to improve the system efficiency collaboratively. The key outputs may be:

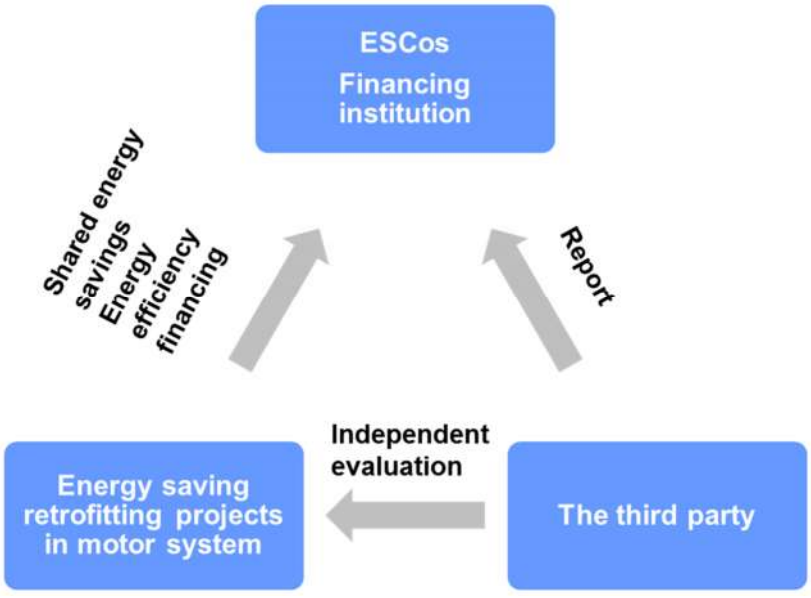
1) Evaluation tools for motor system efficiency in operation;



2) International standards for evaluation of energy savings of motor system;



3) Practical financing model for energy saving retrofitting projects of motor system.



China has the biggest group of manufactures for motor and relevant system. Manufactures and ESCOs are encouraged to join the international collaboration actively to improve energy efficiency of motor system. It will be helpful for them to understand the policy environment timely and communicate with stakeholder for their efforts in energy conservation and emission reduction.

Motor-Systems-Check Methodology

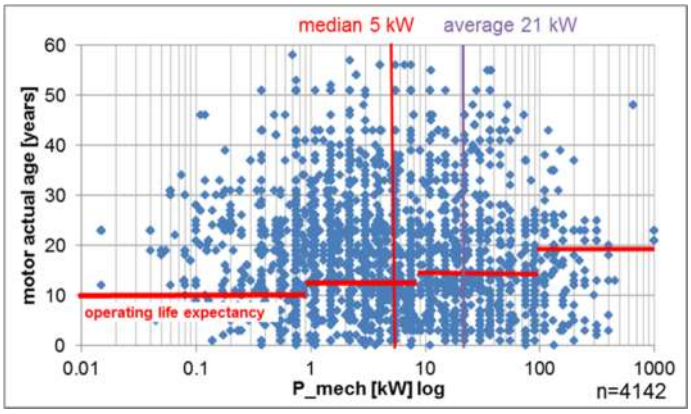
Rolf Tieben
Impact Energy Inc.
Gessnerallee 38a, CH-8001 Zurich
rolf.tieben@impact-energy.ch

Background

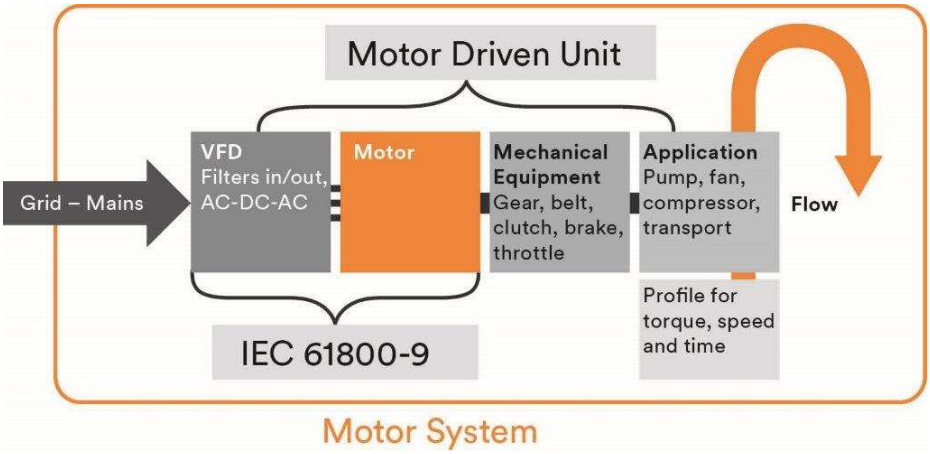
During the last eight years, the Motor-Systems-Check was developed and improved in Switzerland. During this time, more than 4000 motors haven been captured and a lot of them have been part of a whole systematic analysis process including measurements, operating optimization and implementation. Important key findings about motors in industry have been found over the years. Since the "Kick-off Meeting of China Swiss Cooperation on Topmotors Pilot" in July 2014, the Motor-Systems-Check was also applied in Zhenjiang to a various type of companies. Especially chemical and paper companies with lots of motor driven pumps are very interested because of their big potential.

Key findings

1. 56% of existing motor systems were older than their technical life expectancy.
2. 68% of the systems were highly oversized.
3. Only 20% had a variable speed drive.
4. System integration does not exist: big savings are not used.
5. Qualified industry staff – but no energy efficiency experience.
6. The electricity savings will be between 20% and 30% depending on the existing situation.



What is a motor system?
A motor system is the sum of all components from the grid to output of the application (flow).



The Motor-Systems-Check methodology

The Motor-Systems-Check is a 4-step audit process to analyze and improve electric motors systems in industry. The systematic procedure makes it easy to identify the most energy efficient and cost effective measures for improvement. Every step is supported by software tools which are available for free on www.topmotors.ch.

Step 1: **Efficiency potential**.

The tool **SOTEA** is providing a rough estimation based on some basic data like total amount of electric energy consumption, energy costs, motor age, VSD application, etc. It also gives a first calculation of the potential saving and the necessary investment costs.

Step.2: **Motor list**

The tool **ILI+** is an intelligent motor list which contains (in ideal case) all electric motor systems of a company. With the data of their motor rating plate and empirical values, ILI+ is calculating an expected saving potential for each motor depending on their actual efficiency class, age, size, operating hours per year, etc. The decision maker is creating a list of all motors with potentially the largest savings potential. The criteria for this list like minimum size, minimum age, minimum operating hours per year etc. can be chosen manually.

Step 3: **On-site testing**

After creating the list in ILI+, these motors have to be measured over a useful period. The measurement of the input power during start and operation gives a first overview of the load factor and dimensioning of the motor system. Together with information about the necessary need of the process, a **Standard Test Report** (STR) can be created. It is calculating the current electric energy consumption and energy costs of the motor system and also shows a possible optimized state with lowered costs, energy savings and payback.

Step 4: **Implementation**

The last step is the implementation of the best possible solution in cooperation with the manufacture or external engineers. An implementation contains best available technology, smart regulations with Variable Frequency Drives (VFD) and process/output optimization of the application. The whole system efficiency can also be calculated with the **Motor Systems Tool** (MST) before the implementation.

Energy Saving Standardization and Motor System Energy Efficiency Improvements

Lin Ling
Director of Resource and Environment Branch of China National Institute of Standardization
No 4, Zhichun Street, Haidian District, Beijing, China
linling@cnis.gov.cn

Introduction

Energy saving standardization is the basis and guarantee of the implementation of the energy conservation laws and policy. This paper shows the progress and result of the energy saving standardization work in China, the necessity of motor system energy efficiency improvement and the problems lying in it. The targeted solutions are also proposed.

Energy saving standardization

Till now, our country has carried out more than 240 national energy saving standards, including energy efficiency standards, energy-saving product standards, economic operation standards, energy system optimization standards, energy-saving technology evaluation standards, energy-saving evaluation standards. These standards support national energy conservation work respectively from the product, system, organization, regional level.

Based on the mandatory energy efficiency standards, energy efficiency label system has been implemented since 2005 in China. There are 29 implemented energy efficiency label products. Most products have a high record rate and in good situation of implementation. According to the record data, the overall efficiency of motor and fan industry is low, with only 20% energy saving products. What is more, some product's energy efficiency label is higher than its actual level.

On the basis of the energy efficiency standards and energy efficiency label system, energy saving products long-term mechanism has been established gradually, such as marketing leader list project, energy saving products people-benefit project, energy top runner system, etc.

Motor system energy efficiency improvement

Motor system accounts for about 60% of the country's total electricity consumption. Energy-saving potential is large. It plays an important role in field of energy saving in China. A series of motor energy saving incentive policies and technology policies have been launched. In 2013, Ministry of industry and information technology of the People's Republic of China, together with General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China issued "The notice about to organize the implementation of motor efficiency plan (2013-2015). Motor energy-saving projects reached the climax. For the implementation of the energy-saving policies, a batch of motor efficiency standards have been set, such as energy efficiency standards, economic operation standards, optimization design standards, etc.

The problems lying in the motor system energy efficiency improvement include several aspects: the energy saving potential of monomer equipment is limited, while the systems have great potential in energy saving, transformation method is single, energy-saving effect is not good, efficient equipment market access supervision means are lack, etc. Therefore, the amount of energy saving(kWh) has been proposed as the reference of examination and evaluation, instead of quantity of motors(kW). The energy saving mechanism of the third-party evaluation has also been proposed to solve these problems.

In order to realize the mechanism, China National Institute of Standardization put forward a set of motor system energy saving solution, including an information platform for motor system

energy-saving design, evaluation and optimization, a software for efficiency curve regression, motor system energy efficiency testing instruments and motor system load rate online analyzer.

Next step

In the future, lots of work for motor system about energy-saving standardization will be carried out, including research on energy saving standards, preparing the best practice cases of motor system energy efficiency improvement, promotion of energy-saving technologies and standardization demonstration, etc.

Jiangsu Helin Cement Motor System Energy Conservation Experience

SHENG Xinjun
Assistant CEO of Helin Cement

Jiangsu Helin Cement LLC was established in September 2003. It has 3 new dry process cement clinker production lines, 2 waste heat power plants, 5 kilometers of environment friendly tubular belt conveying verandah. Helin has total asset of 3 billion RMB with two main businesses of construction material and logistic. Helin's annual production reaches 8.5 million tons that ranks at industry top position in Jiangsu province. It is one of the largest cement producers in China. In 2014, Helin Cement consumed 0.6 TWh electricity, which ranked at the 5th biggest electricity consumers of Zhenjiang.

As one of the top electricity consumers, Helin Cement pays high attention to motor system energy conservation. Cascade speed regulation, high-voltage variable frequency speed regulation for fan systems and fluid pressure intensifier for circulating pumps have been implemented in recent years. Those projects cost 35.6 million RMB and result in power reduction of 6MW, annual energy savings of 42 GWh, which equals 7623 tons of standard coal equivalent and annual energy cost saving of 23.1 million RMB. Not only economic but also social benefits were gained.

To explore motor system energy saving potential, Helin employed professional energy service company to test the current, voltage, power and flow of motor system and identify the most energy efficient potential motor systems, which are 31 fans and 9 circulating pumps. Selected motor system are 30.6MW in total, which accounted for 22.5% of total power; and consumed 220 GWh per year, which accounts for 36% of total electricity consumption.

One big problem of Energy Performance Contracting (EPC) project is the calculation and verification of energy savings. Besides credible third-party certification institutes, company management decides the implementation of EPC project. Helin Cement has complete energy management system. All retrofitted motor systems have been installed individual power meters, which avoids the conflicts of energy saving verification between Helin and energy service company.

In Helin's motor system EPC projects, the saving share is decided by the operating hours of the retrofitted motor system, which avoids the fluctuation of company operation and production. Taking high-voltage variable frequency device project for example, the contracting time is 15,000 hours. The savings are shared by Helin and energy service company at the ratio of 20:80 and electricity price was set at 0.55 RMB/kWh. Based on bilateral trustee, energy service company finished the project on time and Helin paid the saving benefits on time to ensure the smooth and sustainable implementation of the project.

Helin also focuses on new energy conservation technologies and new equipment. By recycling low pressure high temperature steam from production process, two waste heat power plants were built in recent years. 180 GWh electricity per year is generated, which cut the total energy cost significantly. From January to May 2015, the market demand of cement is not enough and company profit reduced. Although cement price has been cut by 50%, Helin's profit reaches 11.06 million RMB, which accounts for 15% of all cement industry profit in China.

Barriers and Problems of Promoting Motor System Energy Conservation- Experiences and Lessons from Zhenjiang Pilot

Hu Bo
Technical director
Zhenjiang Scinergy Energy Conservation Technology LLC
Sino-Swiss Zhenjiang Ecological Industrial Park, 345#, Gangnan Road, Dagang, ZETDZ Zhenjiang
hu.bo@scinergy.cn

Supported by Zhenjiang Economic and Technical Development Zone (ZETDZ) and Zhenjiang Economic and Information Technology Commission (ZEITC), Sino-Swiss motor system energy conservation project was launched in July 2014. This project takes the concept from Swiss motor system energy audit and rebate program-EASY and applies Swiss Topmotors Motor-Check methodology. In the first stage, by conducting questionnaire survey, interview and on-site investigation, 19 top electricity consuming factories covering chemical, paper, new energy, iron and steel, construction material and mining industries, were investigated. Stage 1 aims at assessing energy saving potential and willingness of pilot project involvement of factories. The main findings and problems from stage 1 are listed below:

- Motors consume more than 85% factory electricity
- Motor annual operating hours are longer than 6000 hours
- Small and medium motors takes more than 90% of all motors
- VSD application is about 15%
- More than 70% factories have no capacity in motor system testing
- Most factories are not trained in motor system energy conservation
- Most factories have no full-time energy management staff

Factories implemented some motor energy conservation projects more or less. However, most of them did not conduct energy project in systematic and sustainable way, which means only small proportion of saving potential which is easiest to tap was explored. Most factories relies on replacing old equipment with new ones and install new devices to explore potentials. However, saving potentials from management and maintenance are not explored. The phenomenon of wasting energy is widely witnessed during on-site investigation.

3 factories were chose as pilot, whose engineers were trained in on-site system test and Topmotors tools. A training workshop was organized for all investigated factories in September.

Most factories were quite interested in pilot projects and welcome trainings on motor system energy conservation. Some factories even needed individual training. However, credit absence problem between energy using enterprises and energy service companies exists widely. Energy service companies even have difficulties in knocking the door of enterprises. Energy using enterprises do not want to pay for consulting service, which is very cost-effective. All the earlier stage consulting cost from energy service companies is recovered by implementing retrofit projects and selling equipment, which leads unnecessary equipment replacement and installation.

Taking the experience from Swiss EASY program, rebate program for energy consulting could be a good option. Government agencies and institutes can play the coordinating role in organizing motor system energy conservation and building healthy energy service market. The training for factory management and engineers should be widely organized.

Current Status and Expectation of China High Efficiency Motor Energy Saving Technology

Wu Xuandong
Chief engineer and director of technical & test center
Wolong Electric Nanyang Explosion Protection Group Co., Ltd

Summary

Nanyang Explosion Protection Group Co., Ltd. (hereinafter referred as “Nanyang”) obtained the SEAD international efficiency medal in 2014. This is an embodiment that Nanyang has committed to the development of high efficiency motors based on internationalization and standardization, also shows the technical strength on efficiency promotion and energy reduction of China motor enterprise to the world.

In motor promotion, Nanyang always recommends IE3 motors which can meet the requirements of tier 2 efficiency class of China Energy Label to customers. Nanyang also actively cooperates with customers to conduct energy saving projects. Nanyang has undertaken several old motor system refurbishment projects for Chinese enterprises. 90% of promoted motors are directly improved to IE3 from IE1, which can meet the MEPS, help customers to obtain energy saving subsidies and show more interests in high efficiency motors.

Based on the research and development experiences of IE4 motors, Nanyang believes the efficiency of induction motor can reach IE5 by specific techniques. The interest for IE4 industrial motors from domestic customers keeps increasing. However, it should be rational to face this trends, because it is not the fact that the higher efficient of the motor is, the more energy should be saved. In some cases, energy saved is not as high as expected after the application of high efficient motors. In some worse cases, energy consumption even increased. Therefore, motor system energy efficiency improvement is better than motor efficiency improvement.

Nanyang has conducted system energy saving test internally. Its method is to carry out on-site intelligent compensation to motors and compare the different efficiency before and after compensation. The result shows that improving power factor by on-site intelligent compensation or improving the coefficient of centralizing compensation will significantly improve energy performance.

Nanyang focuses on integrated energy saving solution of high efficient motor and converter. Adjusting the speed with different loads is one of the best solutions for system energy saving. Converter has been widely used in US, Canada and Australia. The design of high efficient motors have been changed from normal high efficiency design to integrated design of motor and converter. The product design and improvement of impulse withstand index of variable frequency electromagnetic wire and the stability and diversification of converter will be the technique difficulties of system energy saving development.

Basing on the energy performance analysis of high efficiency motors such as PM synchronous motors, switched reluctance motors and induction motors, combining with high efficiency motor application on international market, Nanyang advises the customers to scientifically assess system energy saving potential, and accordingly select motor and converter to achieve the best energy-saving results. Meanwhile, it suggests that the central government publish and implement more scientific and effective motor system energy saving mandatory measures, evaluation methods and incentive policies.

In future product marketing, Nanyang will work with customers and energy service companies to develop best system energy saving solutions, and actively support the healthy development of China energy saving industry.

An Energy-saving Technology-Permanent magnetic adjustable speed drive through coil induction

Xu Junfeng
Chairman of the board
Jiangsu Magnet Valley Technologies Co., Ltd.
10#, Sipingshan Road, High-tech Development Zone, Zhenjiang
jiangkuang001@163.com

Permanent magnetic adjustable speed drive through coil induction is a kind of new motor power saving technology, whose performance is beyond the variable-frequency drive.

There is no temperature rise caused by eddy current, which completely solves the bottleneck of technology. Meanwhile, it can convert eddy heat to electricity to be fed back to supply terminals. There is no water cooling device or adjustable gap device.

The advantages are as follows:

1. The function of clutch with no mechanical action, non-contact or no friction and abrasion
2. Powerful functions of soft start under heavy load with the starting torque up to 220%
3. Non-contact transmission, effective isolation of vibration and noise, low requirements for centering during installation
4. Best comprehensive energy-saving performance, even 2%～4% higher than frequency converter
5. Little harmonic pollution and impulse to electric power systems
6. Low procurement, use and maintenance cost and there is no variable frequency motor
7. Employ non-contact slipping to realize non-damage overload protection
8. Highest reliability: even better than that of permanent magnetic motor under normal work
9. Comparable to Variable-frequency drive on control accuracy, range of speed adjustment, stepless and smooth speed adjustment, automatic balancing load, torque control, automation control modes, etc.
10. Simple mechanism, small size and low environmental requirements

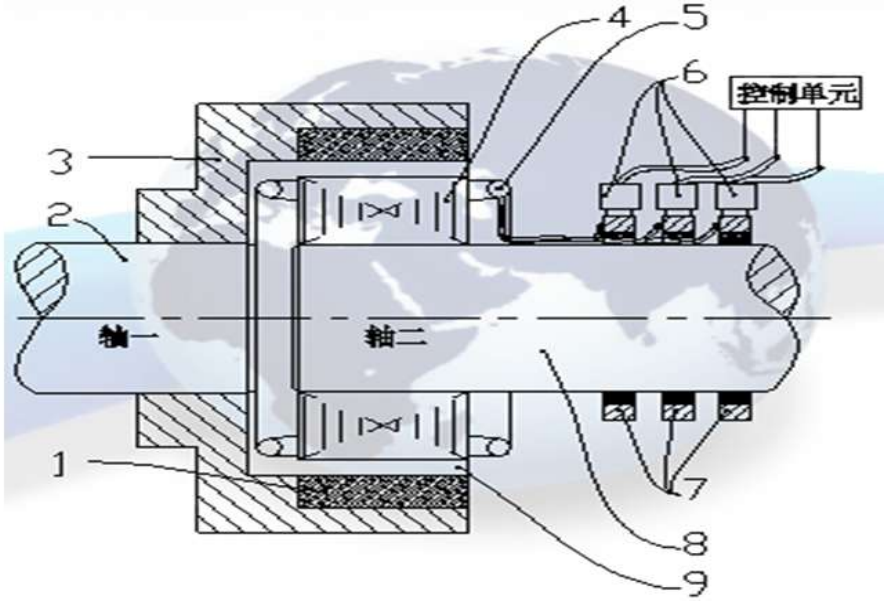


Figure1 : schematic diagram

Regulate Energy Service Market, Strengthen Competitiveness of Energy Service Companies

Sun Xiaoliang
ESCO Committee of China Energy Conservation Association
Director Assistant, director of consulting department
sxl@emca.cn

EMCA introduction

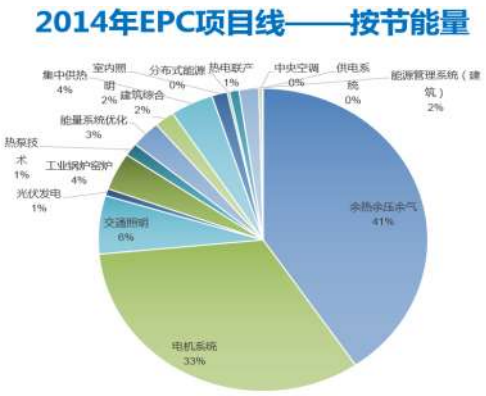
ESCO Committee of China Energy Conservation Association (EMCA) was established in December 2003. Supported by National Development and Reform Commission (NDRC), Minitry of Finance (MOF), World Bank (WB) and Global Environment Facility (GEF), EMCA devotes to promote “Energy Performance Contracting”(EPC) and energy service industry development in China.

Current status of China energy service market

According to statistics, there were 5125 energy service companies employing 562 thousands staff in China at the end of 2014. Total energy service production value reached 265.036 billion RMB, which increased by 22.95%. The investment of EPC projects reached 95.876 billion RMB, which increased by 29.16%. Annual energy conservation reached 29.9615 million tons of standard coal and emission reduction reached 74.9038 million tons.

Importance of motor system energy conservation in energy service industries

In 2014, the number of motor system energy conservation projects accounted for 42% of all EPC projects, investment accounted for 18% of all and saved energy accounted for 33% of all.



Regulate energy service market and carry out rating energy service company

To improve the performance of energy service companies, maintain competition order of market and promote the healthy development of energy service industry, EMCA started to rate its members.

The rate criteria includes company establish time, registered capital, number and quality of human resources, project experience, products&technology, company management (especially finance management) and assessment from clients and third parties. The companies are comprehensively evaluated by those criteria set above and granted with certificate. The business fields include industry, building and public infrastructures (streen light and heating, etc) and 3 classes are rated, which are AAAAA, AAAA and AAA.

EMCA started pilot rating at the end of 2014 and published the 1st list of rating results, which includes 59 energy service companies and 64 certificates. EMCA is rating the 2nd batch of energy service companies.

Introduction of Green Loan of Bank of Jiangsu

Fang Min
Manager, Corporate Business Department, Bank of Jiangsu
Zhidi Plaza, No.55 Hongwu North Road, Nanjing, China
fangmin777@gmail.com

1. Current status of China green loan

In recent years, green loan development has been promoted rapidly from government supervision and commercial banks. In energy conservation industry, the promotion of energy efficiency credit and loan was intensified. Energy efficiency credit and loan means banks provide loans for energy efficiency improvement and energy reduction projects in energy using enterprises. It includes energy using enterprise energy efficiency loan and energy service company contract energy performance loan, which means banks provide loans for both energy using enterprises and energy service companies.

Enlarging loan support for energy conservation industry is also a good opportunity for banks. National Development and Reform Commission (NDRC) estimated that totally 2'370 billion RMB in key energy conservation and emission reduction projects in 12th five year plan period. The number of energy service companies registered by NDRC is more than 3000. All the data above shows that energy conservation industry has stepped into rapid growth stage.

2. Current status of green loan of Bank of Jiangsu

Bank of Jiangsu (BJS) started green loan business from 2013, via cooperating with Ministry of Finance (MOF) and International Finance Corporation (IFC) on energy efficiency loan to share risks as the starting point.

Until the end of June 2015, BJS green loan balance is 19 billion RMB, which increased by 5 billion RMB than the beginning of 2015. It is estimated that more than 10 billion will be increased this year. The loan balance of industrial energy and water conservation and environment protection reaches 4 billion. In energy conservation and renewable energy fields, 3 products have been developed:

2.1 IFC energy efficiency loan risk sharing program:

This program provides loan for energy conservation and renewable energy projects invested and implemented by private enterprises in Jiangsu. The energy conservation projects supported by this loan have to improve the efficiency by 15% or cut the carbon emission by 25'000 tons per year.

2.2 Project loan for energy service company

Guaranteed by the receivables pledge of contract energy performance projects of energy service companies, together with other guarantee methods, loan is provided for energy conservation project implementation. 10 energy service companies have been supported by this loan, which reach total amount of 0.2 billion RMB.

2.3 Photovoltaic loan

Photovoltaic loan supports photovoltaic power station projects, which are repaid by the power generation income and national rebate.

3. Advantages of Bank of Jiangsu

3.1 Mechanism advantages

BJS is a provincial bank, which has the advantages of short decision-making chain, fast market reaction and timeliness of policies.

3.2 Profession advantages

A professional green loan team was built in headquarter of BJS, which specializes in green loan business research and promotion. BJS gives high priority for energy conservation and environment protection in credit granting process and also give green loan projects “green” approval process.

4. Internet+, data sharing in green loan

BJS is currently considering integrate energy Internet technologies into the whole loan process. By applying advanced sensors, control programs to monitor and analyze PV power station construction, actual electricity generated and sent to grid, better loan services can be provided.

There is one example. Based on big data and internet technology, BJS and Jiangsu State Administration of Taxation (JSAT) developed a loan service. Based on its tax paying record, tax paying enterprises can apply BJS loan via internet. BJS gets instant tax paying data from JSAT and system approves application on-line automatically. Client can get the loan application results in minutes. This service has operated for 3 months and 300 enterprises has got total loan of 0.2 billion RMB.

Top Runner Project from Japan is introduced at this summit, which states that motor manufacturers have to report motor sales and application to government agencies. It might initiate government agencies or associations study the data and application of motor in demand side management on energy internet platform. If possible, those data can also be shared with commercial banks, which can solve the problem of information asymmetry between banks and enterprises.