ENERGY-EFFICIENT DRIVE SYSTEMS

GAME CHANGER FOR INDUSTRY AND CLIMATE PROTECTION

How optimized electric drive systems combine economic common sense and ecological responsibility.

Contents

Foreword

The world faces unprecedented challenges: with the "Paris Agreement," 196 countries to date have committed to the goal of limiting global warming to well below 2°C to combat climate change. At the same time, forecasts predict that today's global economic output will double by 2050. Reconciling this immense growth with the urgent need to protect the environment will require a huge commitment to reducing our global consumption of energy and resources.

Electric motors play a central role here: they account for 70 % of the total industrial electrical energy demand[1] and 38 % in commercial buildings[2]. And the trend is rising, because the demand for drive systems with electric motors will continue to grow significantly as living standards continue to rise.

Simultaneously, these figures already open an opportunity for enormous savings potential for the humble drive train through efficient and intelligent system solutions. For example, recent studies assume that energy costs can be saved by up to 30 % on average, both for new purchases and for the operation of electric drives. According to the target definition of the new Ecodesign Directive, which has become mandatory for new products in Europe on July 1, 2021, this means around 40 million tons of CO_2 reduction by 2030[3] for the EU alone. If this is extrapolated to a global savings potential, it is easy to see why the energy-efficient use of electric drive technology will play an important role in achieving the Paris climate targets.

At Siemens, we are extremely aware of this key role – and our responsibility as a global supplier of drive technologies and an innovation driver in industry. Years ago, we committed ourselves to a consistent sustainability strategy to ensure that our products, processes, and supply chains are set up and operated in a way that conserves resources and that our system solutions are as energy efficient as possible. With our environmental portfolio for industrial business, our customers saved almost 13.5 million metric tons of CO_2 in 2018 – as much as the emissions of around 1.5 million people in Germany or 900,000 people in the USA.

This responsibility is also what makes it essential for us to work on further increasing the efficiency of our drive solutions. The interplay of motors, converters, and smart digital solutions creates possibilities for us today that we didn't even dream of yesterday – and that will be a bit more efficient again tomorrow. That's why we get our drives ready to go every day: not just for next year's new regulations, but as game changer for a more sustainable future."

Yours,
Achim Peltz
CEO Motion Control Business Unit at Siemens

Potential for energy efficiency in the electric powertrain

In industry, electric drives are ubiquitous: in pumps, compressors, air-conditioning systems, cranes, elevators, and conveyor belts – there is virtually no industrial sector today that does not rely significantly on the use of electric motors.

Investing in greater efficiency and productivity goes hand in hand with greater environmental sustainability and economic benefit.

Since its invention a good 150 years ago, motor efficiency has risen continuously as a result of constant further developments. In recent years in particular, technical innovations and especially the possibilities of digitalization have once again provided a boost to innovation and efficiency, enabling a significant reduction in energy consumption. Modern energy-efficient electric motors and variable-speed drives (so-called "frequency converters"), which are also equipped with intelligent sensors, enable considerable savings in CO_2 emissions, use of resources, and lifecycle costs – particularly in the partial-load range.[4] Investing in greater efficiency and productivity therefore corresponds to greater environmental sustainability and economic benefit.

Efficiency gains reduce costs and emissions

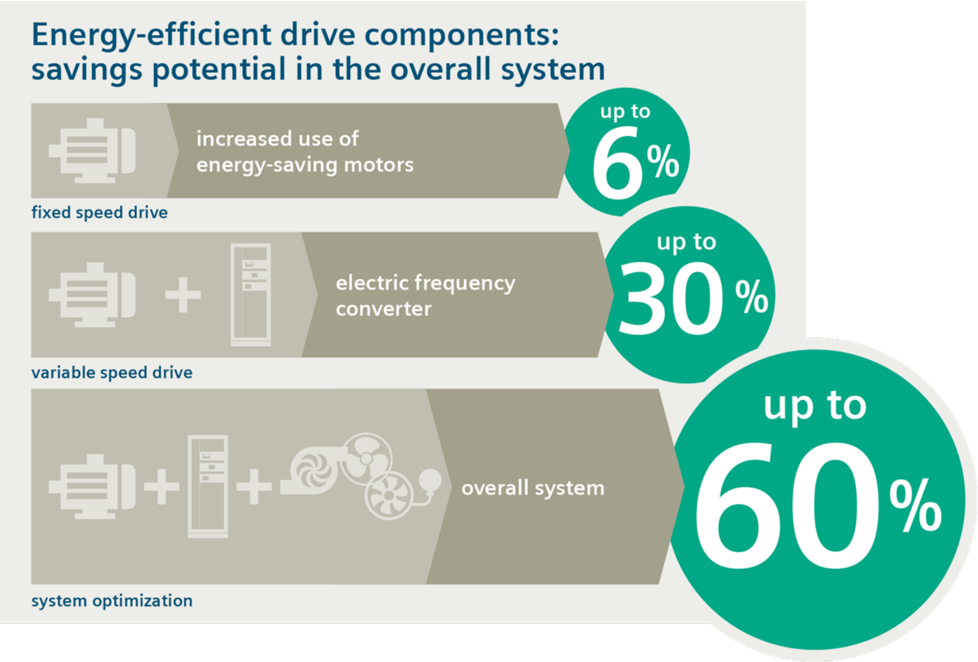
Current studies assume that an energy-saving potential of 20-30 % on average can be realized economically both in the purchase of new electric drives and in their operation.[5] According to estimates by the European Commission, there are around eight billion electric motors in use in the EU, consuming almost half of all electricity generated in the EU.[6] In the EU alone, the current Ecodesign Regulations for implementing the Paris climate targets are set to result in a potential saving of 40 million tons of CO_2 by 2030.

A look at practical applications shows that these targets are not just plucked from thin air: around 75 % of all industrial electric motor applications are installed in pump, fan, and compressor systems, a large number of which continue to be implemented with the IE1 or IE2 efficiency standards that are now outdated.

Here, for example, the current motor portfolio from Siemens in accordance with the European IE4 standard ("Super Premium Efficiency") allows motor losses to be reduced by 15 % compared to the previous IE3 efficiency class. In addition, there are digital components, in particular intelligent sensors, which save up to 10 % process energy through data analysis and the optimization of complex processes, increase the service life of the components in the system by up to 30 %, and increase productivity in the production process by 8-12 % as part of an Industrial Internet of Things (IIoT) network.

Savings potential is realized in the overall system

The real key to greater energy efficiency lies in the overall system: the interaction of all individual measures – from more efficient motors with variable-speed control, to digital system components and tools, to the use of electrically buffered energy in the motor network – can achieve savings of up to 60 % in the system network.



There is potential for savings of up to 60 % in the entire drive system through energy-efficient components and optimization solutions

It is precisely the consistent analysis of system data in a networked overall system that creates opportunities to raise energy efficiency to a new level – with significant savings in CO_2 emissions, resource use, and a serious reduction in lifecycle costs.

Efficiency continues to rise

At the same time, technological developments promise further efficiency gains in all systems that comply with the new efficiency standards. While only minor improvements can be expected from the future and more complex IE5 standard alone, the switch to variable-speed IE4 applications and so "super-premium efficiency" offers extremely efficient leverage for the overall optimization of existing systems for the foreseeable future. This is especially true regarding digital system components: the development of the capabilities of analysis tools and self-learning industrial-edge applications is far from complete, but has only just begun. With the data that modern motors and converters already collect today, it will be possible to achieve significant efficiency increases in the future simply by further developing the corresponding software – and this will also significantly increase the future viability and service life of systems that meet the current standards compared to legacy systems.

Efficiency standards and framework conditions

Energy efficiency regulations play a central role in the implementation of the Paris Agreement.
More than 50 countries worldwide already have regulations in place that focus specifically on the great potential of efficient technologies for electric motors, including the EU, China, and the USA.

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Europe

Europe has set itself the goal of reducing its greenhouse gas emissions by at least 55 % by 2030 compared to 1990 and achieving CO_2 neutrality by 2050. For electric motors, the regulation (EU) 2019/1781 with the energy-efficiency classes IE2 for motors with 0.12 to 0.75 kW and IE3 for motors of up to 1,000 kW power – has been in effect in the EU since 01.07.2021. From July 2023, the new IE4 efficiency standard will be mandatory for medium-sized motors in the power range from 75 to 200 kW.
The new rules are expected to save 110 TWh of energy in the EU by 2030 – a figure roughly equivalent to the electricity consumption of the Netherlands and a CO_2 saving of 40 million tons per year. [7]

China

As one of the world's largest economies, the People's Republic of China is also increasingly taking a pioneering role with ambitious targets around climate protection. At the UN General Assembly in 2020, for example, President Xi Jinping said China was planning "more vigorous measures" than the EU and wanted to reach the turning point in CO_2 emissions by 2030 at the latest and carbon neutrality before 2060.
Regarding electric motors, the national efficiency standard GB18613-2020 contains regulations that go beyond the EU requirements: IE3 represents the minimum standard, while IE4 is already mandatory for certain classes and IE5 is targeted as the future maximum standard.

USA

Under President Obama, the U.S. set a goal as part of the Paris Agreement to reduce its greenhouse gas emissions by 26-28 % by 2025 compared to 2005. Although a binding "nationally determined contribution" (NDC) from the current U.S. administration has yet to be made, President Biden raised the target to a 50 % reduction in greenhouse gas emissions by 2030 compared to 2005 at the Climate Summit in Washington in April 2021.
The premium efficiency standards of the National Electrical Manufacturers Association ("NEMA") for electric motors have been in force in the USA since 2007. The requirements essentially correspond to those of the European IE3 standard.

Impact of new efficiency standards on markets and customers

Against the background of global climate targets and the corresponding regulations, the German Federal Ministry for the Environment estimates in its "GreenTech-Altlas" from 2021 that the global market volume for environmental technology and resource efficiency will amount to 9,383 billion euros by 2030. At €2,246 billion, the "energy-efficiency" segment is the largest lead market in the entire green tech sector. [8]

Energy efficiency: An imperative of economic and ecological common sense

However, the requirements of users of electric motors increase not only with the number of binding climate protection regulations, but also regarding the availability, productivity, and investment and lifecycle costs of their machines.
Since the cost of an engine's energy consumption adds up to as much as 97 % of its total cost over its lifetime, the desire to find the most efficient solutions possible is as much a matter of economy as it is of ecological responsibility and common sense.

Since the cost of energy consumption of an engine during its service life adds up to 97% of the total cost, the desire for the most efficient solutions is as much a matter of economy as it is of ecological responsibility and common sense.

Cross-industry impact

In the process industry, electric motors mainly drive pumps, fans, and compressors. However, demand is also high for efficient and environmentally compatible motors in the infrastructure and manufacturing industries: for example, the energy efficiency of metal presses has been specifically promoted for years through the integration of short-term energy storage systems. And in intralogistics and materials handling technology, too, the interplay between productivity and resource and energy savings has top priority.

There are also industries for which the "green footprint" itself represents an economic necessity. For example, for battery production in the automotive sector, environmentally compatible production processes are part of the core of the business model. On the way to green e-mobility, it is not only the CO_2 reduction during operation of the e-car that counts, but also the footprint left by the vehicle during its production.

Success factors for an efficient drivetrain

The decisive factor for measuring the efficiency of a motor is the so-called "efficiency," which is calculated from the quotient of the power output to the power consumption. Efficiency ratings are based on the scale of the International Electrotechnical Commission (IEC), starting with the IE1 and IE2 categories for comparatively inefficient motors, up to the significantly more efficient IE3 and IE4 standards. These are currently mandatory for most motors under the ErP directives or soon will be. Since an IE4 "super-premium efficiency" machine is already remarkably close to the technically feasible optimum of efficiency, there is little room for improvement for a future "ultra-premium efficiency" IE5 line motor class.

High efficiency motors

In principle, even simple electric motors achieve high efficiencies of more than 90% due to their design – while drive types based on fossil fuels only achieve efficiencies of around 35 %. A modern 200 kW AC asynchronous motor complying with the IE3 standard achieves an efficiency of around 96 %. New motors such as Simotics low-voltage motors that meet the IE4 "Super-Premium Efficiency" standard reduce energy losses by a further 15 % and achieve the highest system efficiencies even in part-load operation.

Frequency converter for optimized partial load operation

Due to the now extremely high motor efficiencies, significant increases in energy efficiency can only be achieved through an expanded approach in the overall system. For example, it is often more efficient to use more and smaller motors that are precisely optimized for their specific tasks than to permanently maintain excess power with a larger motor. To ensure greater flexibility at the same time, converters are used that adjust the motor to suit each requirement so that the drive is operated in an energy-optimized way, even in partial load operation.

System approach realizes synergetic overall potential

However, the more specific and diverse the applications and components become, the more complex the overall system becomes. Therefore, especially in the industrial environment, solution approaches are needed that take the system with its interactions and synergy effects into account and always optimally align to it. The basis for this is provided by intelligent sensors and analysis tools that monitor, harmonize, and improve all processes – from control and automation, through energy management and maintenance with predictive maintenance, to digital planning and implementation processes with a digital twin – as part of a higher-level system approach.

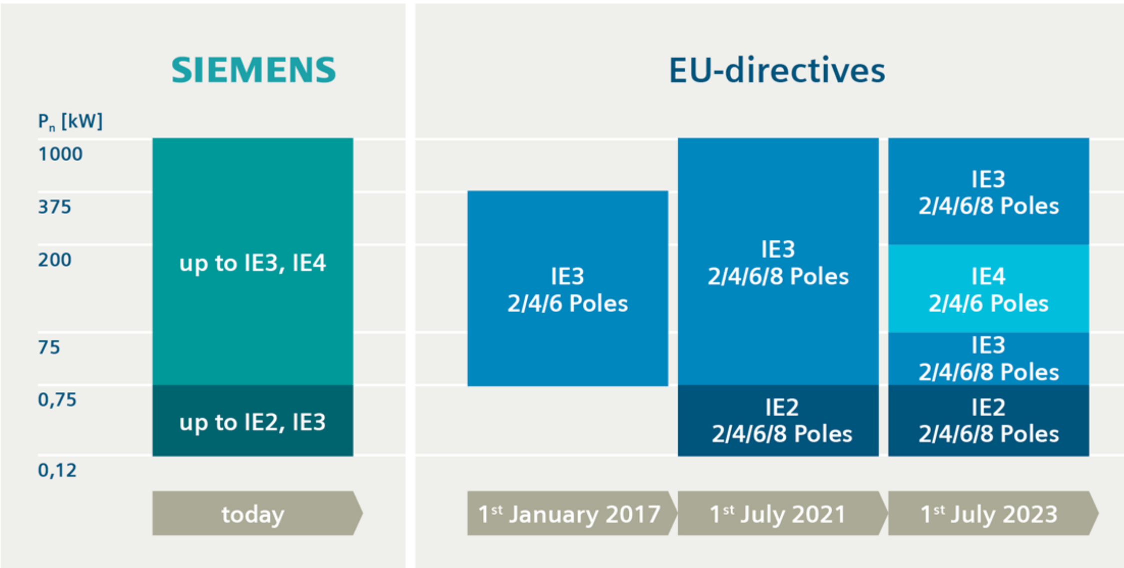
Efficient low-voltage motors

In many existing plants today, asynchronous motors can be found that correspond to classes IE1 or IE2 in terms of their energy efficiency. However, the proven and robust asynchronous technology has evolved just as much as the regulatory requirements for its energy efficiency. For example, according to the new ErP Directive (EU) 2009/125/EG, from July 2021 only motors of efficiency class IE3 may be placed on the market in the power range from 0.75kW to 1MW. For power ratings from 0.12 kW up to 0.75kW, efficiency class IE2 will become mandatory for the first time. In July 2023, there will be a further tightening when efficiency class IE4 becomes mandatory for motors in the power range 75kW to 200kW. In the long term, however, further efficiency improvements in asynchronous technology will reach their limits, as each further efficiency improvement in the individual motor component requires a disproportionate increase in the amount of material used.

The trend is moving toward optimized motor converter systems adapted to the application.

With a view to material economy, the trend is therefore clearly moving in the direction of optimized motor converter systems adapted to the application. These enable the use of more efficient motor technologies that are generally not capable of running on a pure sinusoidal network. Modern synchronous reluctance motors and permanently excited synchronous machines can therefore further push the efficiency limits for the motor itself, but also for the whole system. Against this background, it is to be expected that corresponding motor-converter systems will be considered in future regulatory provisions on energy efficiency and defined as mandatory.

In a comparison of the two motor technologies, the permanently excited synchronous machine has greater potential in terms of energy efficiency since it provides its excitation field without current via magnets. On the other hand, rare earths are required for its production, which can only be found in a few locations worldwide, are difficult to extract, and are correspondingly expensive. In this respect, the reluctance machine offers the advantage of a simple, robust rotor design that requires neither magnets nor a current-carrying winding or cage.



Today, SIMOTICS SD outperforms the efficiency of the future: Higher cost efficiency – less CO_2

PRACTICAL CASE

Efficiency gains through conversion from IE2 to IE3 in Asia

Since 2006, Siemens has been producing low-voltage motors locally at its Siemens Standard Motors Ltd. (SSML) motor plant in China – for the Asian and especially the Chinese market locally on site. The plant is currently producing mainly IE3 standard motors to replace the IE2 systems that have been common in Asia to date.

With an average motor life of eight years
and an average percentage energy saving of 3 %[9],
the SSML portfolio of energy-efficient motors alone generates
annual savings of 900 million KWh of electricity and 580,000 tons of CO_2.

Production of efficient IE3 low-voltage motors at Siemens Standard Motors Ltd. (SSML) China.

Speed control / frequency converter

Even though it is to be expected that the requirements for the efficiency of motors as individual components will increase even further with the next regulatory steps, a holistic system approach is required for further significant improvements. A essential lever for this is speed control, so that drive systems also function energy-efficiently in part-load operation. Corresponding converters are already mandatory for certain subsectors (e.g. fans).

Modern frequency converters and high-efficiency motors can be used in typical industrial applications such as pumps, fans, and compressors, compared to uncontrolled existing systems, saving up to 30% energy.

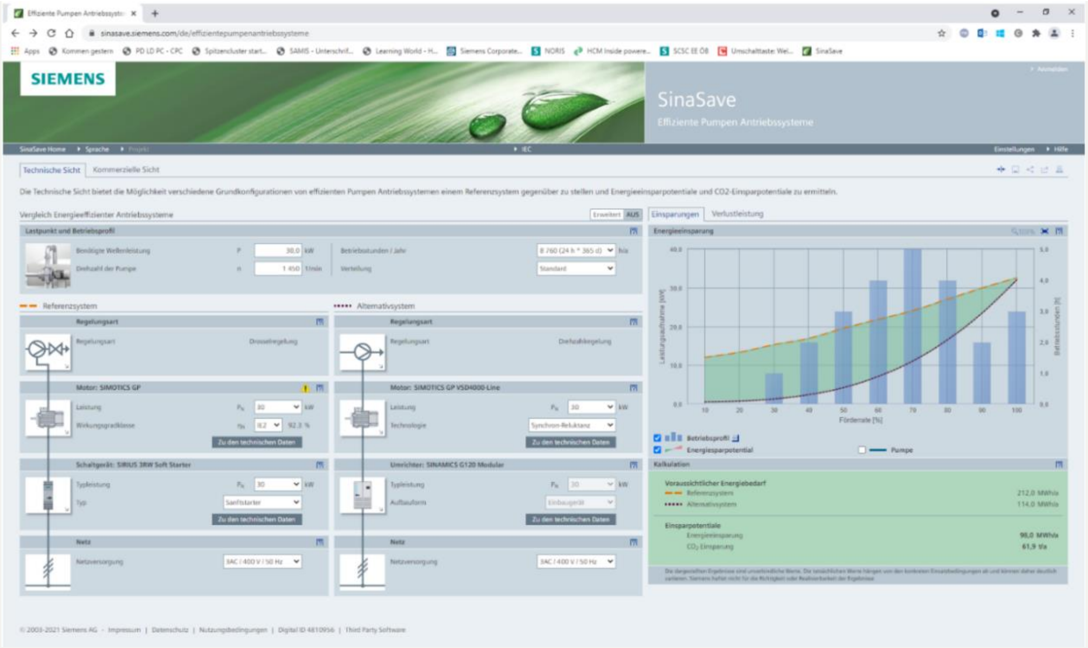
A variable speed drive is used to control the speed of a motor using the frequency and voltage of the supplied current. In this way, the operation of an electric motor can be optimized, even in partial load operation, so that the speed and torque are adapted to the load requirements of the respective system. This means that only the power actually required by the specific application is ever called up. Significant energy savings can therefore be achieved in the combination of high-efficiency motors with variable-speed drive systems. Variable-speed operation saves energy and at the same time increases process quality and availability due to the load that is held in reserve.

Although this type of modern drive control has been available for years, only just under a quarter of all industrial motors worldwide are currently equipped with appropriate converters. The economic and ecological savings potential using variable-speed drives is therefore enormous: modern frequency converters and highly efficient motors can save up to 30 % energy in typical industrial applications such as pumps, fans, or compressors compared to uncontrolled existing systems.

PRACTICAL CASE

Savings potential of motor-converter combinations in pump systems

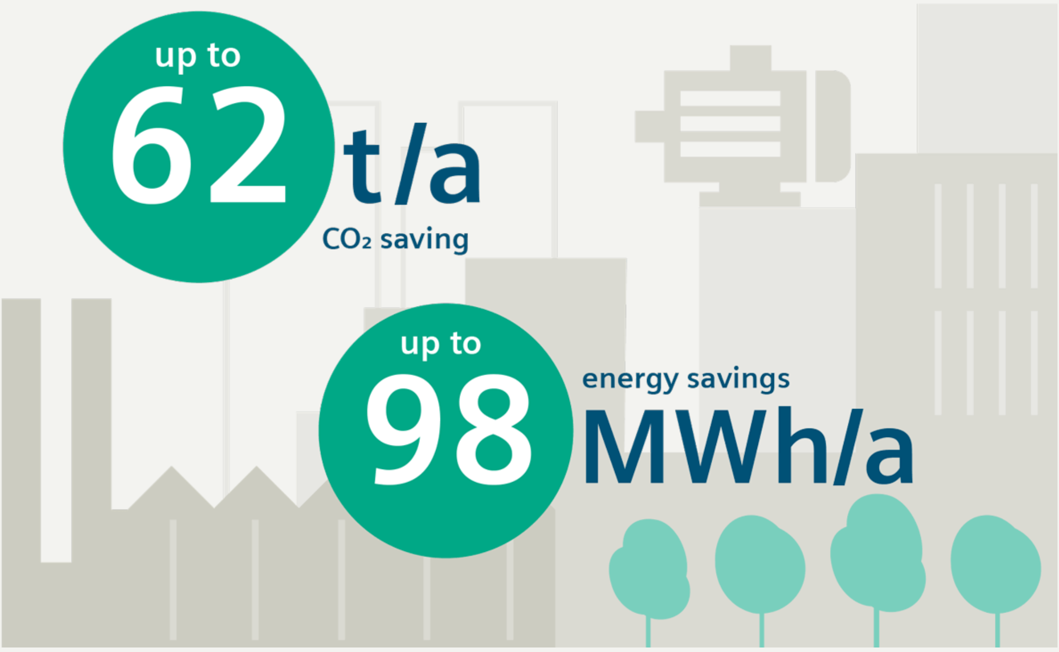
Many of the existing pump systems still installed around the world today are at best in efficiency class IE1 or IE2. The motors of this efficiency class usually work in conjunction with a throttle control of the hydraulic system, which produces a high level of waste heat and so high energy losses. According to the new efficiency standards, the construction of such systems will soon no longer be approved in many countries – for good reason, as the following example calculation shows:
Two systems are compared, each with 30kW shaft power with permanent operation of the pumps. The first system motor is defined with an existing motor in an old system, since IE2 motors in this power range may no longer be (newly) placed on the market. The second system consists of a modern synchronous reluctance motor of efficiency class IE4[10] and a suitable converter for speed control[11] .



Example calculation with Siemens SinaSave: motor of efficiency class IE2 with throttle control compared to a synchronous reluctance motor (IE4) and suitable converter

The diagram shows the distribution of the flow rate during operation of the pumps with the curves of the power consumption of both systems. The green area between the curves corresponds to the energy saved by the efficiency-optimized motor converter system.

By using the converter-controlled synchronous reluctance motor to IE4 standard, energy savings of over 46 % and 62 t CO2 per year can be achieved compared to an IE2 existing system (bottom right in the picture).



The speed-controlled IE4 drive achieves savings of up to 98 MWh and 62 t CO_2 compared to the existing system. per year

Efficient individual solutions

Modular system solutions such as the Simotics motor and Sinamics converter portfolio are designed to offer numerous starting points for industry- and application-specific individual solutions. In the paper industry, for example, energy storage systems and energy networks are used to absorb the braking energy released at the unwinders of paper machines and convert it into kinetic energy for the drives. Similar solutions are used wherever large masses are moved in opposite directions by electric motors during storage and retrieval processes.

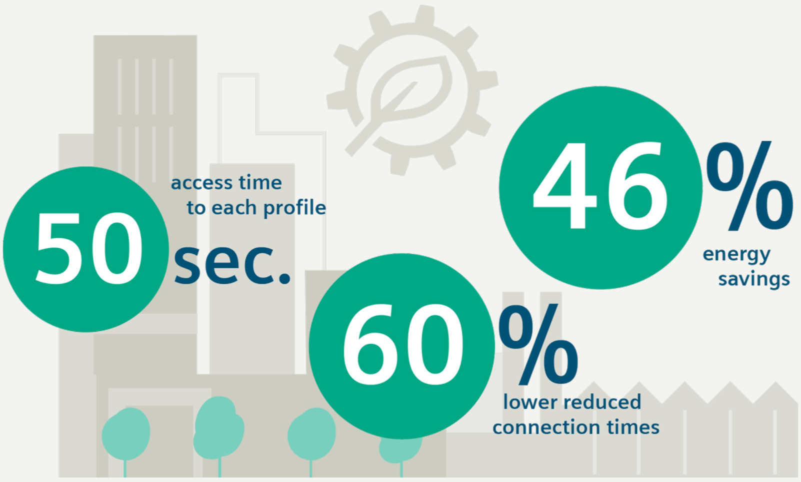
A look at the overall system in which electric drive solutions are used is worthwhile for all industries.

PRACTICAL CASE

Energy storage in the high-bay warehouse

Another component for increasing energy efficiency in the overall system is the use of energy storage systems. Erfeba lngo Kneer GmbH, for example, is setting new standards in energy efficiency with the innovative energy storage system of its high-bay warehouse system: the storage and retrieval machine from Erfeba is completely equipped with controlled electric SINAMICS S120 drives from Siemens and can so repeatedly use energy once introduced into the system during the storage and retrieval of the cassettes through parallel lifting and lowering processes. This is possible because the regenerative braking energy can be used and converted for kinetic acceleration energy: like a mountain railroad with one gondola going up and one going down – only much more flexible.

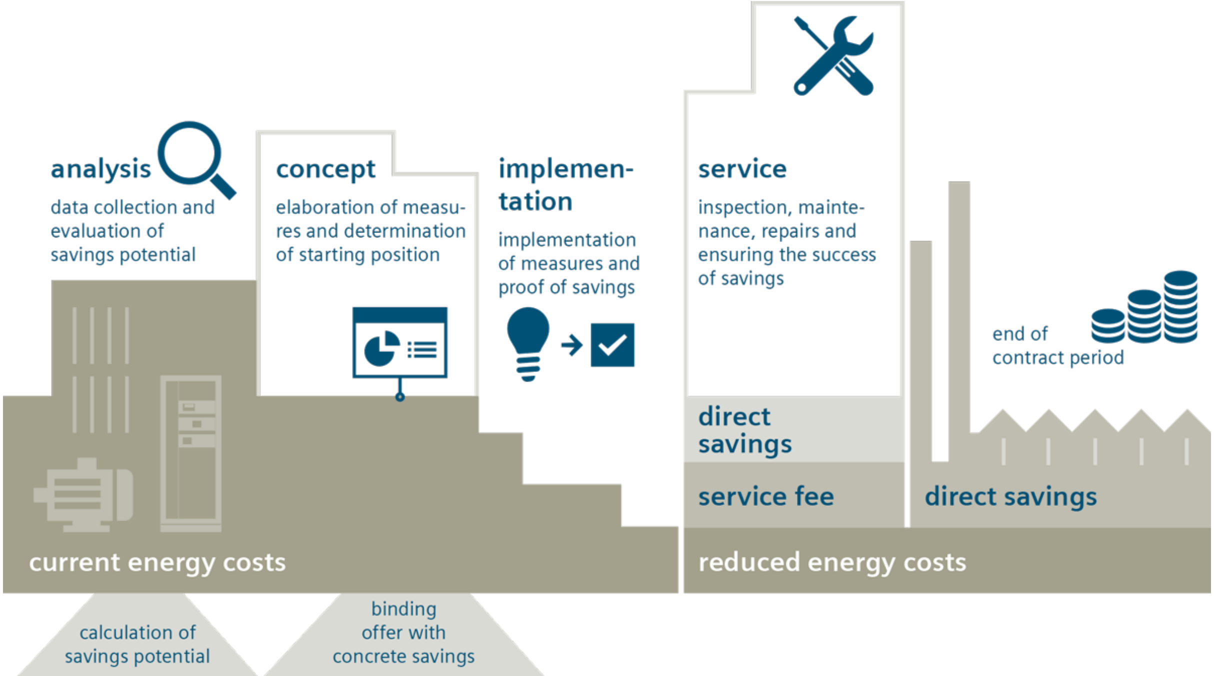
At the heart of the solution is an electric motor module[12] that controls all charging and discharging processes, not only cushioning peak loads but also ensuring full utilization of the energy generated by the generator. The core of the energy storage system is a network of several double-layer capacitors (DC caps)[13]. The combination of DC caps and frequency converters allows fast-occurring high currents to be optimally stored and distributed. In this specific example, the energy requirement of the plant was reduced by 46 % and the connected load by 60 %.



With modular and energy-efficient drive components, Erfeba Ingo Kneer GmbH achieves significant increases in productivity and energy savings in its high-bay warehouse

A look at the overall system is therefore worthwhile for all industries in which electric drive solutions are used. In order not only to optimize the electric drive, but above all to effectively utilize the synergies between the components and therefore achieve the greatest benefit for environmental protection and entrepreneurial success.

Through energy performance contracting for drive applications, the savings in energy costs can in turn be used directly to refinance the optimization measures. Projects at Siemens are handled according to a four-stage process that reduces the user's investment risk to a minimum with binding savings promises. The investments are therefore self-financing from the energy cost savings achieved – without restricting cash flow or requiring additional borrowing.



With Energy Performance Contracting, efficiency improvements are translated into a direct return on investment, so ensuring economic success

PRACTICAL CASE

Energy efficiency assessment in engine design

At its Nuremberg site, Siemens AG manufactures high-performance converters and motors on well over 70 machines and systems. To evaluate and optimize energy consumption based on the operating status of the machines and so reduce the CO_2 footprint as early as during the production of components for the drive train, Siemens relies on its own digital portfolio: the in-house solutions for energy efficiency monitoring[14] and energy management[15] detect and evaluate energy consumption in "value-adding" (e.g. ramp-up and setup times) and "non-value-adding" times (e.g. standby operation) and enable the targeted optimization of production processes via clearly prepared data analysis.

The production of the energy-efficient converters and motors at the Siemens Nuremberg site is also carried out in an energy-optimized manner.

At the same time, the energy efficiency data is made available via a secure cloud-based solution[16], where it can be accessed by other authorized users in the company at any time via app[17] and combined and matched with data from other sources for conclusions and optimizations on other systems.

The [18]next step is to further simplify and automate energy efficiency assessment with industrial-edge applications. By integrating artificial intelligence, the app will automatically detect the machine status based on the energy data, so eliminating much of the hardware and wiring required for energy management at the machine level.

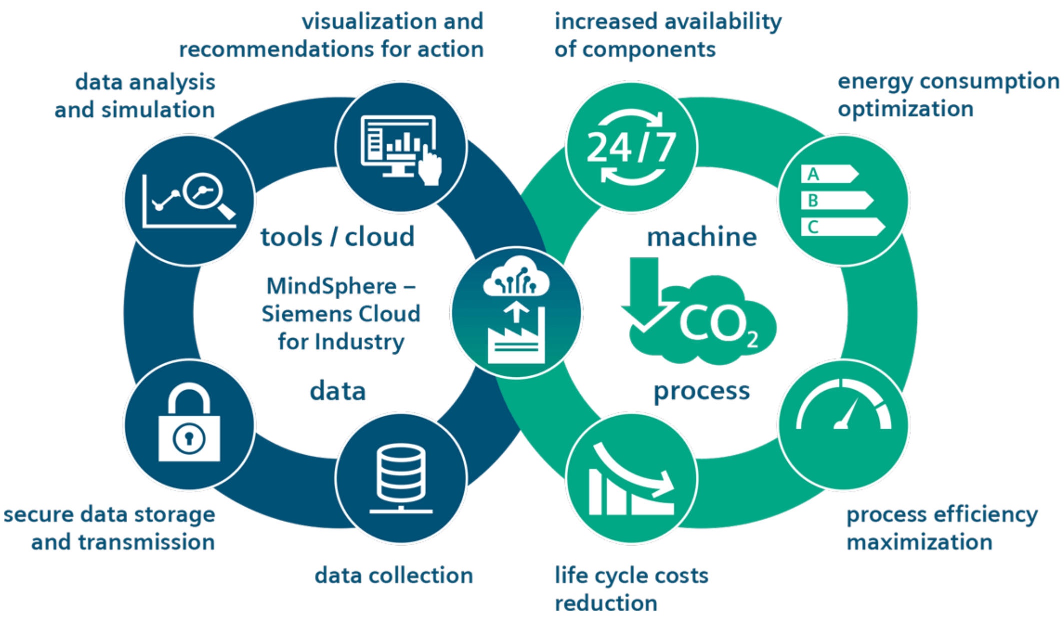
With digital energy-efficiency assessment, the share of value-added energy consumption increases – while costs, resource consumption, and emissions decrease.

Digitization & Services

Integrated digital solutions offer a variety of starting points for significantly increasing energy and resource efficiency in the overall system through the connectivity of individual components. For example, through the targeted use of artificial intelligence, smart sensors, and business intelligence, it is possible to continuously optimize numerous production processes via IIOT applications, thereby simultaneously reducing environmental impacts and cutting costs. With the help of intelligent and integrated drive technologies, energy savings of up to 60 % can be realized in the overall system. At the same time, savings in process energy and in production, product lifecycle, and product service life in complex systems - such as industrial plants or the technical equipment of larger buildings – quickly add up to noticeable double-digit percentages.

The basis for this is provided by intelligent sensors and analysis tools that monitor, harmonize, and improve all process sequences as part of a higher-level system approach. For example, smart sensors such as Simotics Connect enable direct analysis of the connected electric motors, while modern converters can directly evaluate and forward specific plant parameters. The data obtained, including visualizations, simulations, and recommendations for action, is evaluated via close links to the appropriate tools in the Siemens portfolio, such as SiDrive IQ Fleet or Analyze MyDrives.

Efficiency gains are also realized
in the avoidance of plant downtime,
increases in process efficiency and a reduction in lifecycle costs.



Digital tools provide opportunities throughout the powertrain to curb CO_2 emissions - while reducing lifecycle costs

Virtual simulations make it possible to select and optimize drive components for a precise fit and to prevent over-dimensioning or planning errors in advance. During operation, operating data can be read out and analyzed via cloud and industrial-edge applications and converted into optimization measures. In production, digitization solutions help with the early detection of product problems and the avoidance of consequential errors: indirect effects that are not related to the drive can also be identified via the sensors of the drive components, so that the entire operation in the integrated system can be optimized in an uncomplicated way on an ongoing basis.

As one topic meshes with another in complex plants, far more benefits can be achieved in total than would appear possible at first glance. In addition to reduced energy consumption, the efficiency gains are also realized in the avoidance of expensive and unwanted plant shutdowns, the general increase in process efficiency, and therefore also in a reduction of the total lifecycle costs.

Outlook

The global challenge of climate change and the implementation of the Paris climate targets increasingly require holistic solutions that are not limited to individual components and subsectors, but address the respective systems in the overall context.

There are currently more than 300 million electric motor-driven industrial plants in use worldwide: If all these applications were replaced by efficiency-optimized equipment, their power consumption could be drastically reduced. To leverage this potential and at the same time realize the respective national and international targets, not only technical solutions that are best tailored to customer requirements and needs are needed, but also the political will to drive technological change.

A look at the global climate targets – and the ambitious targets in particular in China, the USA and also the EU – clearly shows that the political will to shape binding regulations on energy efficiency is steadily increasing. Against this background, too, it is worth taking an approach that is related to the "overall system" of global challenges: in times of scarce resources, increasingly strict regulations and rising energy prices, any increase in efficiency is just as much an imperative of ecological as of economic common sense.

[1] Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems," International Energy Agency working paper, Paris, 2011; Bayerischer Industrie- und Handelskammertag (BIHK) e. V. "Energieeffizienz- und Klimaschutzwegweiser für Unternehmen in Bayern," 2018 (p. 10).

[2] Omdia Low Voltage Motors Intelligence Service 2020.

[3] European Commission - Energy label and ecodesign, https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/electric-motors_en, retrieval date: 6/21/2021.

[4] European Commission, ICT Impact Study, July 2020.

[5] Bayerischer Industrie- und Handelskammertag (BIHK) e. V. "Energieeffizienz- und Klimaschutzwegweiser für Unternehmen in Bayern", 2018 (p. 10).

[6] European Commission - Energy label and ecodesign, https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/electric-motors_en, retrieval date: 6/21/2021.

[7] European Commission - Energy label and eco-design, https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/electric-motors_en, retrieval date: 6/21/2021.

[8] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, "GreenTech made in Germany 2021 - Environmental Technology Atlas for Germany", https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/greentech_atlas_2021_bf.pdf.

[9] Research Institute of Resources and Environment, Chinese Academy of Standardization.

[10] Concrete calculation based on Siemens Simotics GP VSD4000.

[11] Concrete calculation based on Siemens Sinamics G120.

[12] Concrete calculation based on Siemens Sinamics S120.

[13] Concrete calculation based on Siemens Sinamics DCC.

[14] Siemens S7-1200/S7-1500 and TIA Portal.

[15] Siemens Simatic Energy Manager PRO.

[16] Siemens MindSphere.

[17] Siemens Simatic Energy Manager MindSphere App.

[18] The basis for this will be an Edge App of the Siemens S7 energy efficiency monitor.

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