

Multiple benefits of energy efficiency in industry

The five main findings concerning multiple benefits are:

1. Energy cost savings and reductions in CO₂ emissions
2. Efficient systems run cooler: reduced need for cooling
3. Repair and maintenance costs are lower with energy-efficient systems
4. More stable operation with less production interruptions
5. It is difficult to monetize additional benefits, but an order-of-magnitude estimate is possible.

Background

Electric motor driven systems account for over 50% of electrical energy consumption in Switzerland and worldwide. In industry, this share is more than 70%. [1] Optimising the entire motor system can lead to energy savings of 20-30% on average. [2] What are the benefits? In addition to the obvious energy and cost savings, there are other benefits which, albeit very relevant, are more difficult to quantify.

Goal and target group

This Fact sheet is designed to underscore that, in addition to the profitability assessment of pure energy cost savings, other important multiple benefits arise that can positively influence a decision to invest. Significant new findings from research are assessed and processed to provide arguments for investment decisions.

This Fact sheet is aimed specifically at energy advisers and operating technicians who assess new and replacement investments in machines used in industry and services, and justify and explain them to decision-makers.

What are the multiple benefits of energy efficiency measures?

The advantages of improving energy efficiency have not only energy aspects but also non-energy aspects and are referred to collectively as «multiple benefits». Non-energy benefits or additional benefits can be more important than pure energy-related benefits. In the final analysis, they can help convince management to invest in energy efficiency, with a positive overall impact on the company's competitiveness. Accordingly, multiple benefits, which cover both energy aspects and non-energy aspects, have considerable potential for driving the optimisation of existing equipment.

The **multiple benefits of energy efficiency measures** consist of the following:

- **Energy benefits:** e. g. reduced energy demand, decreased greenhouse gas emissions.
- **Non-energy benefits:** All kinds of positive ecological, environmental or social effects in all of a company's areas of activity that may arise in addition to energy benefits. These are often difficult or impossible to quantify.

What is the relative importance of energy costs and energy efficiency?

Energy costs generally account for a small share of an industrial company's overall costs. Recent research results were used in an effort to better identify and understand these costs.

As part of the annual Swiss Manufacturing Survey 2018, 186 production firms from 11 sectors in Switzerland were asked about their challenges and decisions. Some three quarters of the companies surveyed are SMEs (small and medium-sized enterprises) and around one quarter are large firms. Around one-third of all production firms surveyed are active in the mechanical engineering sector (see Figure 1). In the companies surveyed, energy costs account for only 5% of overall costs on average (see Figure 2). Two-thirds of company costs are personnel and material expenses.

This confirms that energy costs account for a small share of overall costs. So, it is hardly surprising that energy costs are not given the greatest attention in the companies.

Barriers

According to a survey of 302 Swiss companies as part of the research programme M_Key (Management as a Key Driver of Energy Performance), the main barriers to the introduction of new energy-saving technologies are other priority investments. Another barrier is the fact that not enough importance is attributed to energy costs (see Figure 3). [3]

What can be done to increase the relative importance of investments for optimising motor systems so that management will opt to implement such investments rather than other priority investments? Here, presenting the multiple benefits could be useful.

With efforts to improve energy efficiency, there is a clear emphasis on reducing energy consumption and thus contributing to a sustainable future. For companies, considerations such as competitiveness are on top of the agenda. However, there are many other considerations, in addition to cost and energy savings, which can be strategically significant for companies and are linked to efficiency gains.

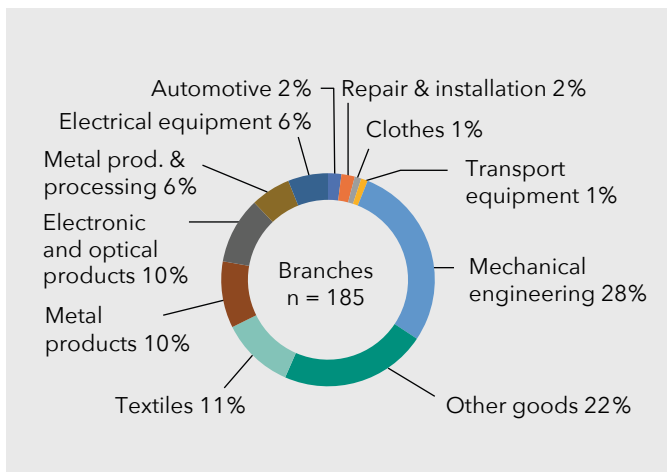


Figure 1: Activity branch of the production companies surveyed within the Swiss Manufacturing Survey 2018. Source: [5]

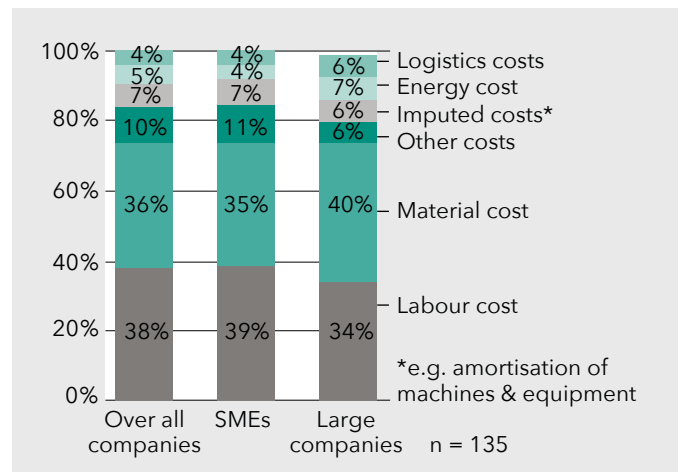


Figure 2: Cost structure of the production companies surveyed within the Swiss Manufacturing Survey 2018. Source: [5]

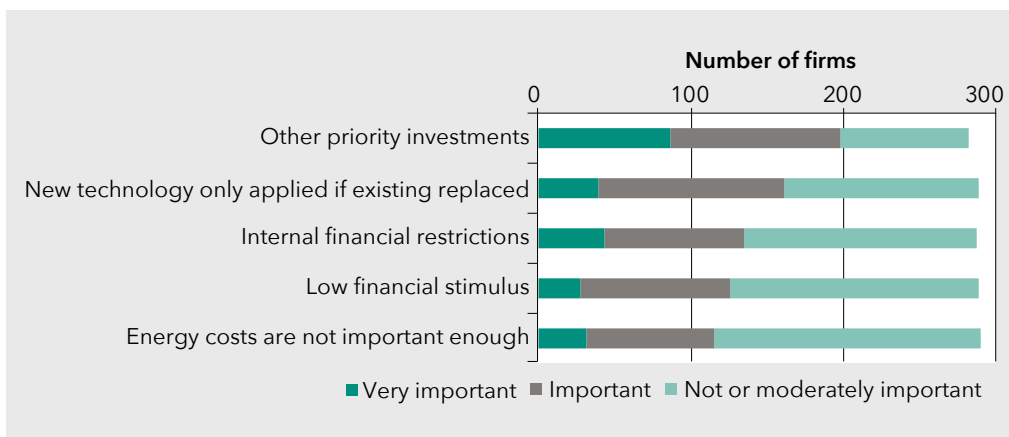


Figure 3: Factors hindering the introduction of new energy-saving technologies. Source: [3]

For example, if it is important for a company to obtain environmental certification and inform its customers thereof, it will implement measures making it possible to achieve this goal. This could entail, inter alia, steps to boost energy efficiency.

The International Energy Agency (IEA) has identified a broad range of multiple benefits in five main categories deriving from the implementation of energy-efficiency projects in industry (see Table 1).

A Competitiveness	
Benefit	Description
Ability to enter new markets/ increased market share	Overcoming technical barriers to trade or overcoming market perceptions or resistance (e.g. perception about CO ₂ footprints). Expanded capacity or new product features that enable entrance in new markets.
Reduced production costs	Reduced costs per unit or enabling the company to access and capitalise on a new complementary or substitute factor of production and in doing so opening up new opportunities for growth.
Deferred plant capital investments	Optimising processes or upgrading equipment or extended equipment lifetime can defer the need for capital costs in replacing equipment. Optimising processes for energy efficiency can also lead to situations where certain equipment is redundant.
Corporate risk reduction	Mitigation of corporate risk through reducing liabilities and helping to achieve or go beyond current regulatory requirements.
Improved reputation, corporate image	Improved corporate image through publicising energy efficient (sustainable) business. Improvement of corporate image through CSR (Corporate Social Responsibility) that incorporates the wider range of benefits (both private benefits and public benefits). Better brand reputation through product or service quality improvements.
B Production	
Benefit	Description
Capacity utilisation	More efficient equipment or processes can lead to shorter process times and use of lower cost factors of production (labour and materials), which can lower production costs and enable higher product output.
Improved product quality	Downstream improvements in reductions in product defects and warranty claims as well as contributing to enhanced brand reputation.
Increased product value	Improved quality and consistency contribute to added value which in turn can contribute to enhanced brand reputation.
C Operation and maintenance	
Benefit	Description
Improved operation	Improved operation and process reliability leads to reduced equipment downtime, reduced number of shutdowns or system failures and can entail reduced process time (which can contribute to increased productivity), process optimisation can also reduce staff time required to monitor and operate a processing plant, which reduces overhead costs.
Reduced need for maintenance	Energy efficiency projects can lead to investments in new equipment, system optimisation, optimisation or change of processes which in turn can lead to lower maintenance requirements (or avoidance of extraordinary maintenance), reduced costs for maintenance, reduced cost for maintenance materials.

D Working environment	
Benefit	Description
Improved site environmental quality	Improved work environment from improved thermal comfort, lighting, acoustics and ventilation. Improved conditions can help retain and attract skilled staff. Improved work conditions and work environment can increase labour output.
Increased worker health and safety	Process improvements and equipment upgrades implemented as part of energy efficiency projects can reduce the risk and incidence of work-related accidents or negative impacts on worker health. Such improvements can lead to reduced health insurance costs and medical expenses (as well as reduce corporate risk - liability in case of accidents).
E Environment	
Benefit	Description
Reduction of air pollution and emissions	Reducing energy use or optimising processes can reduce sulphur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), as well as CO ₂ emissions and associated credit or reduced compliance costs. Process changes reduce combustion and process emissions can be important to industry when there are regulatory or compliance issues and associated cost savings include avoiding fines or taxes.
Solid waste reduction	Reducing waste streams through e.g. production improvements, product redesign, improved operation result in less waste, which reduces waste disposal/abatement costs and input materials purchase cost.
Waste water reduction	Process optimisation, improved operation, improved maintenance can reduce water needed to run processes or water needed for cleaning purposes. Reducing wastewater has environmental benefits but can also entail reduced costs for wastewater treatment.
Reduction of input materials, e.g. water	Reduction of input materials reduces upstream environmental impacts from extraction, processing and transport.

Table 1: Company-level benefits from industrial energy efficiency projects (Source: OECD/IEA 2014 [6]) Categories and benefits are not listed in order of importance. The list is not exhaustive.

Various actors - different viewpoints

Arguments for improving the efficiency of motor systems can vary considerably depending on the actors involved in the decision-making process. Accordingly, various actors can be convinced by different arguments for energy opti-

misation, depending on their primary motives (see Table 2). Energy efficiency and/or reducing consumption and energy costs are not necessarily the key arguments.

Actors	Primary motive	Possible arguments for optimising drive systems
Technical manager	<ul style="list-style-type: none"> ■ Machines work smoothly ■ No losses/failures 	<ul style="list-style-type: none"> ■ Increased reliability of production processes ■ Less production interruptions and downtime
Company management	<ul style="list-style-type: none"> ■ Company profitability ■ Market position ■ Competitiveness 	<ul style="list-style-type: none"> ■ Improved product quality ■ Greater product value ■ Increased productivity ■ Enhanced work performance due to better work environment ■ Lower material costs ■ Improved company image
Finance & Procurement	<ul style="list-style-type: none"> ■ Low costs 	<ul style="list-style-type: none"> ■ Fewer replacement equipment due to failures ■ Delay in making new investments thanks to reliable machines ■ Reduced maintenance costs

Table 2: Various multiple benefits are paramount depending on the actor

In the autumn of 2019, Topmotors invited Swiss companies to assess multiple benefits as part of the project «Multiple benefits for electric motor systems» (see Chapter 6 Projects underway in Switzerland). For this, 15 companies (industrial companies, energy consultants, service companies, manufacturers) were interviewed by phone. Participants evaluated a list of various multiple benefits associated with the optimisation of motor systems. The first aspect concerned the importance of the specific benefits for the interviewee compared to other benefits. The second aspect was related to how satisfied the respondent was with regard to how these benefits were handled within the company and taken into consideration during decisions. Figure 4 shows the various multiple benefits as seen by interviewees from different companies. It is encouraging that the multiple benefits were generally considered important, and that the majority of those surveyed were satisfied as to how such benefits had been handled within the company and factored into the decision-making process.

Figure 4 shows a high concentration of satisfaction/importance among energy consultants, low importance/satisfaction for service companies and high dispersion of importance for industrial companies and manufacturers, the latter category being the most satisfied.

These preliminary findings, which are not yet representative, could be important for further substantiating multiple benefits and should be considered when formulating arguments for energy efficient investments.

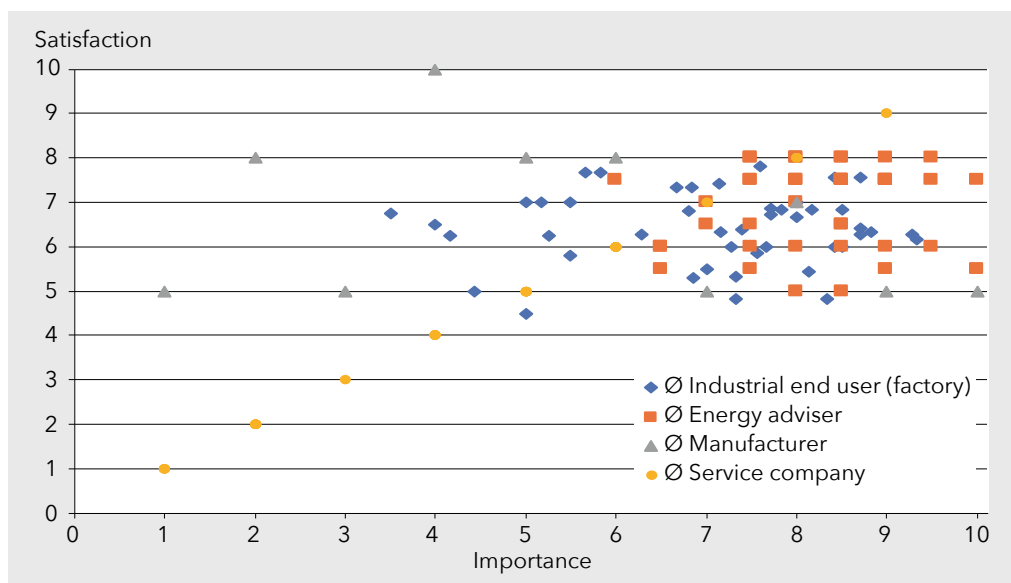


Figure 4: Evaluation of the various multiple benefits through different actors by company (on average). Source: Project «Multiple benefits for electric motor systems», 2019 Evaluation: 0 = not at all important or not satisfied / 10 = very important or very satisfied

Non-energy benefits

In the above-mentioned survey conducted within the research programme M_Key, the companies surveyed indicated whether they factored non-energy benefits into their energy efficiency investments. Around one half of the firms usually or almost always took non-energy benefits into consideration, while the other half did so sometimes or very seldom to never.

When asked about the non-energy benefits considered, companies most often mentioned the reduction of maintenance costs, followed by an improved company reputation and better safety and working conditions. Another important benefit is exemption from the carbon tax. This demonstrates that the various measures taken by the public sector have a clear leverage effect.

The reduction of maintenance costs is the most mentioned non-energy benefit, which is linked to the fact that these costs are the most quantifiable. [17]

Multiple benefits can increase investment value by 40 to 250 % - but how can they be quantified?

According to various sources, multiple benefits can increase the profitability or value of an energy efficiency investment by 40% to 250%. [8][12][18][19]. This is a significant increase in value. The biggest challenge is to make the multiple benefits visible, preferably via quantitative inclusion in the investment profitability calculation. This is not always an easy, rapid process, due to incomplete information or low reliability of data. [17] In addition to a quantitative inclusion, it is also possible to factor in qualitative considerations, for example whether some benefits contribute to the company's strategic goals.

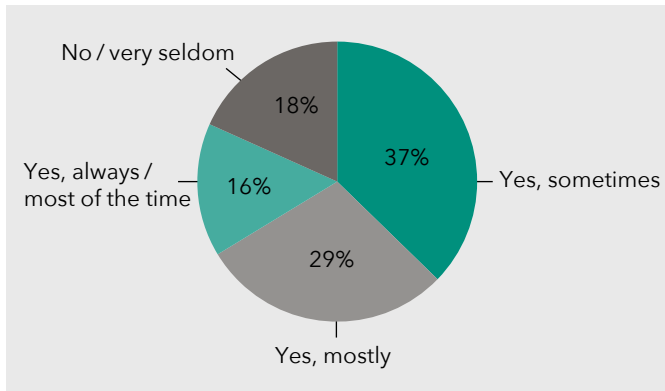


Figure 5: Consideration of non-energy benefits when investing in energy efficiency (according to 279 companies). Source: [3]

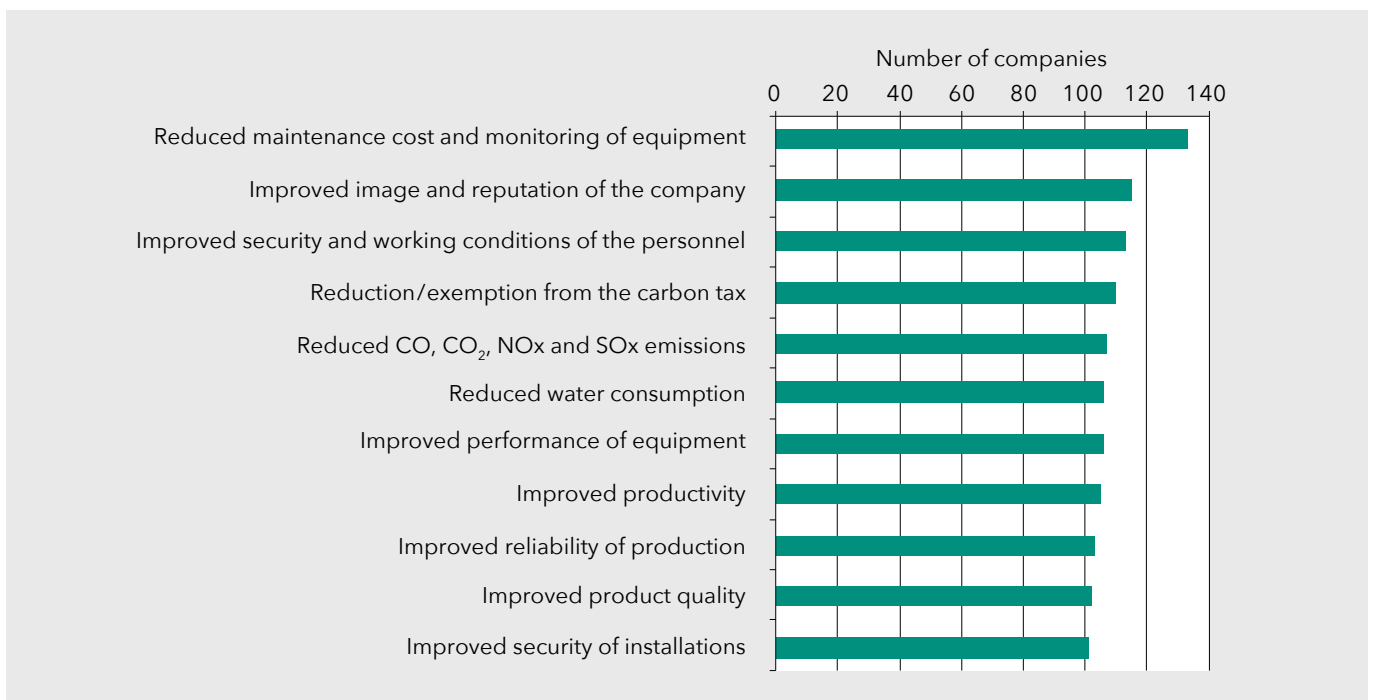


Figure 6: Consideration of non-energy benefits in companies. Source: [3]

Example

Figure 7 shows an example illustrating the multiple benefits of optimising a motor system.

The overall investment of some CHF 15 000 (dark orange bar) for the optimisation of a motor system consists of the following elements (light orange bars):

- Purchase of a new motor: IE3 30 kW, instead of an old 55 kW motor (27%)
- Purchase of a new 30 kW frequency converter (24%)
- Purchase of a new pump (27%)
- Planning, dismantling and assembly (22%).

The total value of all multiple benefits is approx. CHF 13 000 (dark green bar). The individual benefits (light green bars) were each calculated for a duration of one year:

- Energy saving (55%)
- Less CO₂ (7%)
- Less cooling (12%)
- Less waste (6%)
- Less noise (6%)

- Less unplanned downtime (5%)
- Increased productivity (4%)
- Better working conditions (4%)
- Less maintenance (1%).

The following assumptions were made when quantifying the multiple benefits:

- System optimisation can save 57 MWh per year of electrical energy
- This corresponds to an emission reduction of 10 t CO₂ per year
- The more efficient motor allows 30% less waste heat
- Using modern, adapted technology and optimised operation can halve the need for maintenance during the new motor's life cycle (15 years at 30 kW)
- The other benefits correspond to an overall increase of 65% of the investment value in relation to pure energy benefits (energy savings and CO₂-reduction), attributed to the different multiple benefits with estimated shares.

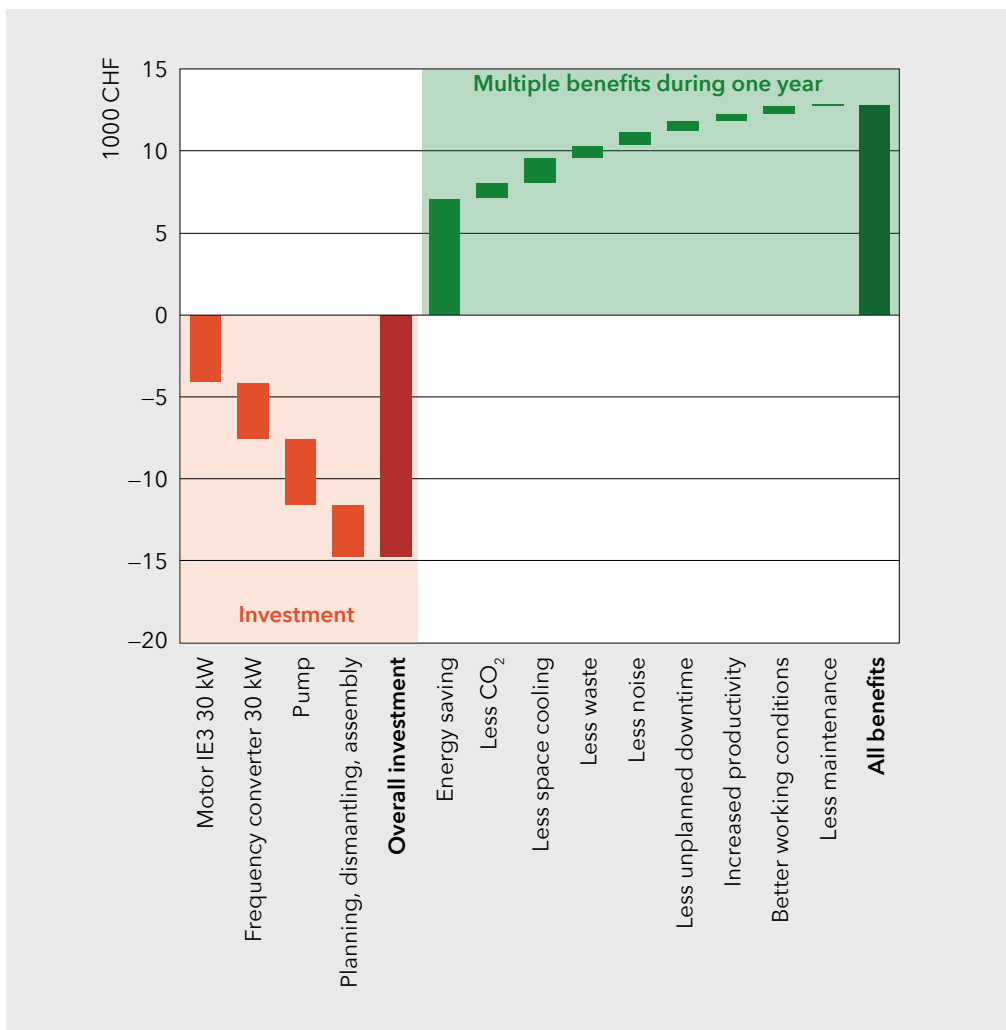


Figure 7: An example illustrating the multiple benefits of optimising a motor system

Ongoing projects in Switzerland

The question of multiple benefits is being further researched, both nationally and internationally. The following projects are currently underway in Switzerland with regard to the multiple benefits of energy efficiency measures:

1. Multiple benefits for electric motor systems: This project, which runs between 2019 and 2020, is being implemented under the lead of the Cleantech Agency Switzerland act and in cooperation with Impact Energy, Lucerne University of Applied Sciences and Arts (HSLU) and Zurich University of Applied Sciences (ZHAW). The goal is to provide companies a planning tool enabling them to capture, with little data, the multiple benefits of optimising their motor systems. In autumn 2019, 15 companies were interviewed by phone, followed by an online survey (still ongoing).

Planning tool

By mid-2020, a decision-making tool for companies will be available in German and French. The tool will present the multiple benefits of optimising motor systems.

2. The Competence Centre Power Economy at HSLU develops procedures and tools which are specially adapted to the needs of industry partners and which serve to evaluate the additional benefits of energy efficiency measures. The comprehensive identification, quantification and monetization of these additional benefits can support the decision-making process with regard to investments aimed at boosting energy efficiency in companies. The Competence Centre Power Economy is part of the SCCER «Efficiency of industrial processes» (www.sccer-eip.ch). For further information: www.hslu.ch/de-ch/technik-architektur/forschung/kompetenzzentren/energiewirtschaft/efficiency-in-industrial-processes

3. M-BENEFITS: «Multiple benefits of energy efficiency» (M-BENEFITS) is a European project running from 2018 to 2021. The 15 project partners from 11 European countries will develop a training platform. The aim is also to create instruments and work directly with organisations in order to propose energy saving projects while at the same time evaluating their operational and strategic impact. Case studies, project examples and results will be compiled in parallel, to support the business case for projects. The project is financed by the European Union. There are three project partners from Switzerland: Lucerne University of Applied Sciences and Arts (HSLU), the University of Applied Sciences of Western Switzerland (HES-SO) and the University of Lausanne (UNIL). Further information: www.mbenefits.eu

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Editorial remark

The Fact sheet «Multiple benefits of energy efficiency in industry» was produced by Impact Energy in the framework of the Topmotors program. Topmotors is the information platform for efficient motor driven systems in Switzerland and is supported by the SwissEnergy programme of the Swiss Federal Office of Energy. This Fact sheet was compiled by Rita Werle (iE), Conrad U. Brunner (iE) and Petar Klingel (iE). Layout: Faktor Journalisten AG. This Fact sheet is available in English, French and German at www.topmotors.ch.

Additional information

The video of a Topmotors webinar on the multiple benefits of efficiency measures in industry is available at: www.topmotors.ch/de/Webinar11