Incentive program for motor systems efficiency in industry

First experiences from Easy in Switzerland

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Abstract

In 2010 a tender by the Swiss Federal Office of Energy for national electric energy efficiency programs was launched. Among the 8 successful bids the program <Easy> for motor systems in industry was granted 1 million CHF for subsidies.

Easy ("Effizienz für Antriebssysteme") is focused on the renewal of mid-size Swiss industrial plants with an annual electricity consumption between 10 and 50 GWh. Cost-effective measures with short payback times are usually not implemented because of considerable barriers. The goal of Easy is to overcome the barrier of investing into the often expensive and time-consuming preliminary analyses identifying potential improvements in electric motor systems, upon which the new energy efficient system configuration can be determined.

To identify the motor systems to be optimized with the best cost-benefit ratio, the four-step Motor Check - developed earlier by Topmotors - is used. Industrial plants are invited for a free energy efficiency potential analysis using a standard top-down software tool. Plants with a sound efficiency potential are then analyzed in detail. For this, a motor list is created with a second software tool. From this motor list a decision maker helps to identify the largest efficiency potential in older motors with high running hours. The critical motors are then run through a standard measurement test to identify starting torque, average and variable load conditions. With this information a cost-benefit analysis of new, improved system components (motor, variable frequency drive, transmission, gear, driven application like pump, fan, compressor, industrial handling & processing) are made. The analyzed plant then receives an investment plan with dedicated milestones. Based on these recommendations the subsidy for the analytical part (50% - 75%) and the optimization (10%) is granted.

Easy (www.topmotors.ch/easy) was launched on 1 November 2010. By the time of EEMODS'11 the results of the participation of the first batch of industrial plants will be reported.

Introduction: Swiss energy efficiency policy

Switzerland runs a national energy efficiency program since 1991, SwissEnergy. It intends to both improve energy efficiency and build new renewable energy production capacity. Within the program a minor fraction deals with energy efficiency in the electricity field (the larger fraction focuses on CO_2 emission reductions through improved buildings and efficient cars).

The Swiss Agency for Efficient Energy Use (S.A.F.E.) was coordinating the Motor Challenge Programme in Switzerland from 2003. S.A.F.E. has successfully run the electric motor systems efficiency training & education program "Topmotors" since 2007. The program has launched a methodology for the improvement of existing motor systems in industry called Motor Check. Topmotors offers fact sheets and electronic tools for the calculation of efficiency potentials (SOTEA) and to compile an electronic Intelligent Motor List (ILI^+). Topmotors has been dealing with some 20 pilot projects in various industry sectors and has gained recognition from motor manufacturers, original equipment manufacturers (OEMs), service and maintenance providers and industries using electric motor systems. Topmotors maintains an information platform on the web (www.topmotors.ch) and has its own newsletter. It has regularly trained engineers and measurement technicians in workshops and published its findings nationwide. One of the key tasks of Topmotors is to inform on international standards, e.g. the new IEC standards for testing and efficiency classes, on Minimum Energy Performance Standards (MEPS) in the European Union and on experiences from other motor efficiency programs. This activity benefits from synergies with the global motor systems efficiency project 4E EMSA [3], where providing information on these issues on a global scale is even more present. Topmotors has also established a network of tertiary education institutions (universities) for motor testing.

The Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC) has launched an Action Plan for energy efficiency in the electric sector in 2007 [4]. In 2010, the Swiss Federal Office of Energy (SFOE) has issued specific proposals and projects to limit the increase of electricity consumption between 2010 and 2020 to 5% and to stabilize the demand thereafter. A first series of MEPS for appliances were decided and adopted by law. It has introduced MEPS for electric motors harmonized with the introduction of MEPS in the European Union. First results of international surveys were published for additional policy measures based on international experience to speed up market transformation towards efficiency in Switzerland more rapidly [5]. Then SFOE has set up an expert study group to come up with a program of financial incentives to be incorporated into the revision of the Electricity Supply Law. The program can benefit from the current revenue of 300 million CHF of the electricity grid charge (0.006 CHF per kWh), which is paid by electricity consumers. With annual revenues of some 250 million CHF both renewable energy installations and efficiency projects can be subsidized. Within the range of possible financial incentives a number of policy options have been tested and evaluated in further economic studies [6]. The goal was to define programs with low transaction costs and to steer the subsidies to the market segment most needed. Now incentive programs directed at large industry and commercial users are discussed that can eventually have subsidies available of some 100 million CHF per year for energy efficiency programs in industry and the commercial sector and through this lower existing barriers.

In 2010 a national tender for energy efficiency in electric applications was launched by SFOE with 9 million CHF for that year. The goal was to have an annual competitive bidding procedure that always allows selecting the most cost-effective projects and programs. Both small-scale projects and larger, bundled programs were accepted. In March 2010 S.A.F.E. won 1 million CHF for the three-year motor subsidy program Easy, intended for industry to overcome existing barriers and subsidize investments into efficiency.

After the nuclear accident in Fukushima Japan on 11 March 2011 the efficiency programs in DETEC have been hastily stepped up. The question raised now is whether Switzerland can abandon nuclear power in the next decades and reduce electricity consumption to a level it can cover with existing hydropower plus new renewable electricity from wind, PV, biomass or other sources. For this debate, S.A.F.E. provided an updated efficiency plan for SFOE that profits from its experience in Topmotors and Topten (www.topten.info) [7]. On 25 May 2011 the Swiss government decided to become nuclear-power-free by 2035. The lower chamber of the Swiss parliament backed up this decision on 8 June 2011.

Easy: program overview

Electric motor systems are responsible for over 40% of Swiss electricity use. The industry uses over 70% of its electricity for motor systems in pumps, fans, compressors and industrial handling and processing.

The goal of the financial incentive program Easy ("Effizienz für Antriebssysteme" - efficiency for motor systems) is to reduce energy consumption of industrial motor systems used in Switzerland with energy efficiency measures. Easy follows a system approach. This means that it does not only deal with the motor only but assesses the complete motor system, including the driven application (pump, fan, compressor) and any auxiliary components (variable frequency drive, gear, transmission belt, brakes, etc.). It deals as well with closing of compressed air leaks, downsizing of oversized motors, stopping operation during time of no use, introducing coordinated controls with factory automation systems, etc. Subsidies are paid for any new equipment installed to improve system efficiency, thus, not the motor only.

Why to introduce a motor systems efficiency program?

Based on experience from Topmotors and international research [8], S.A.F.E. identified the following elements as the main barriers for not undertaking cost-effective investments into motor systems efficiency in industry:

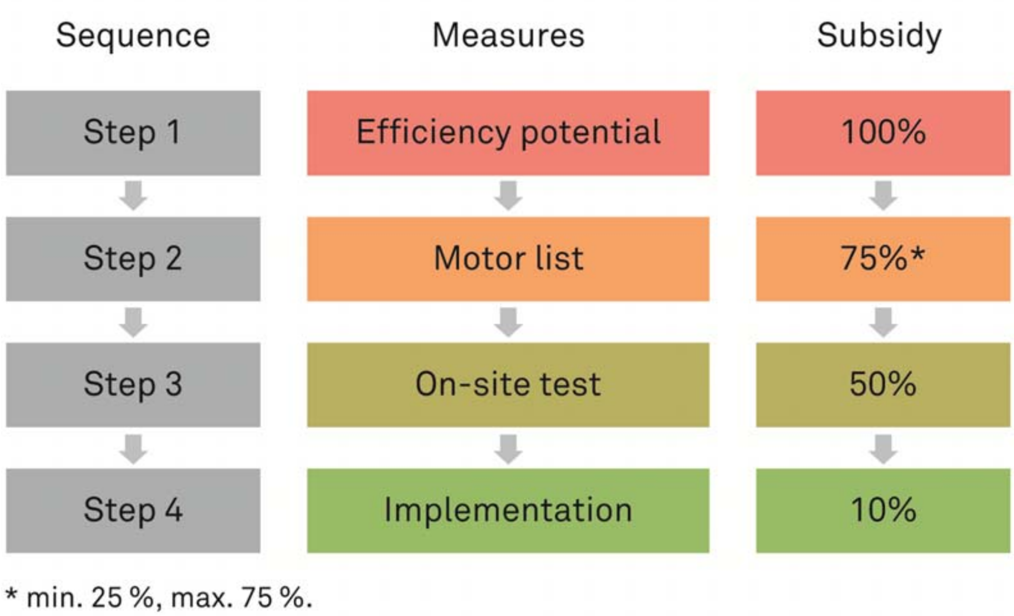
- Electricity costs are relatively low, hence motor systems efficiency is not a topic of core business.
- Motor systems are the physical drivers of the production process. Any interference jeopardizing continuous and smooth production (e.g. measurements, changing motors or system components) is to be avoided.
- Third parties getting acquainted with the production process are avoided, so as to keep production processes an internal matter (business secret).
- Resistance towards new, unproven technology.
- Motor systems are complex. Qualified people understanding motor systems are often not represented in senior management or even on the technical staff level.
- Even if there is sufficient knowledge on motor systems, knowledge on efficiency potentials and ways to exploit them is not widespread.
- Cost-effective investments may not be approved because of stringent payback period criteria and because purchase decisions and technical decisions are made by other departments within the company, creating a conflict of interest (better, more efficient technology vs. short payback time criteria).
- If eventually a decision to undertake efficiency measures is made, a considerable amount of time and financial resources need to be invested into preliminary assessments. Only based on the results of the preliminary assessments is it possible to quantify savings potentials, analyze investment profitability and identify and decide upon specific measures to be implemented.

Being aware of these barriers, S.A.F.E. developed the motor systems efficiency program Easy to stimulate industry overcoming these barriers.

Four steps

In the framework of Topmotors, S.A.F.E. developed a method, Motor Check, as a systematic approach for determining and exploiting efficiency potentials in motor systems. In the framework of Easy, S.A.F.E. leaned on the Motor Check method and defined four distinct steps for this process (see Figure 1).

Figure 1 Easy method: four steps and subsidy



The four steps are described in more detail in the section “Four steps: purpose and tools” below. The following is a brief summary:

- Step 1 is an estimation of the efficiency potential. It is a face-to-face meeting of the Easy program management and the program participant. During a discussion of 1 – 2 hours data is fed into the software tool SOTEA ("Software Tool für effiziente Antriebe" – software tool for efficient motor systems). The result is a rough percentage number, indicating the order of magnitude of potential savings in the motor systems of the participant. Participants are referred to as "objects", representing the physical (production) plant under assessment.

- Step 2 is creating a motor list. The motor list is a compilation of large-power, old, long running motors in operation, covering 70% of the electricity consumption of all motor systems in the object. The result of step 2 is a sub-list of the entire motor list with motors chosen for optimization.
- Step 3 is an on-site test of motors chosen for this purpose. Based on the sub-list of motors chosen for optimization, motor groups with similar applications are created (e.g. pumps, fans, compressors). These application-groups may be divided into further subcategories, e.g. groups of motors from the same size or from the same manufacturer. From each such group one motor is chosen, considered to be representative of the whole group, and tested on-site.
- Step 4 is the actual implementation of measures. After the on-site test, efficiency potentials are verified and cost-effectiveness of measures is calculated and compared. Measures with the best investment/savings ratio are then chosen to be subsidized.

Financial subsidy

The financial subsidy is 100% for Step 1, up to 75% for Step 2, 50% for Step 3 and 10% for Step 4.

The Easy subsidy principle is based on the assumption that preliminary assessments are time-consuming and expensive, thus program participants shall be foremost stimulated and subsidized to overcome this barrier. Once they arrive at the point of comparing cost-effective measures, they are more prone to implement efficiency measures. The practical implementation of Easy will show whether this assumption is valid.

Other factors taken into consideration when determining the subsidy structure were the actual amount of subsidies to be paid and keeping program management costs and risks at a minimum.

Since the costs for each step are increasing, even if subsidy rates become smaller over the sequence of steps, actual subsidies paid are increasing (see Table 1). To give an example: the average cost for Step 4 is 200 times more than the average cost for Step 1. The subsidy rate for Step 4 is 10% and the average subsidy for Step 4 is only 20 times more than for Step 1.

Another reason for decreasing subsidy rates in the sequence of steps is to encourage participants to take over more (financial) responsibility for their project with each step. In the end, participants are supported at each step by the program management, but eventually they have to realize their *own* project.

Table 1 Average cost and subsidy per program participant*

Sequence	Measures	Average cost k CHF	Subsidy k CHF	Subsidy rate %
Step 1	Efficiency potential	5	5	100%
Step 2	Motor list	30	22.5	75%
Step 3	On-site test	50	25	50%
Step 4	Implementation	1000	100	10%
Total		***1085***	***152***	***14%***

*An optimization of 40 motor systems is assumed on average per program participant.
Source: S.A.F.E., 2011

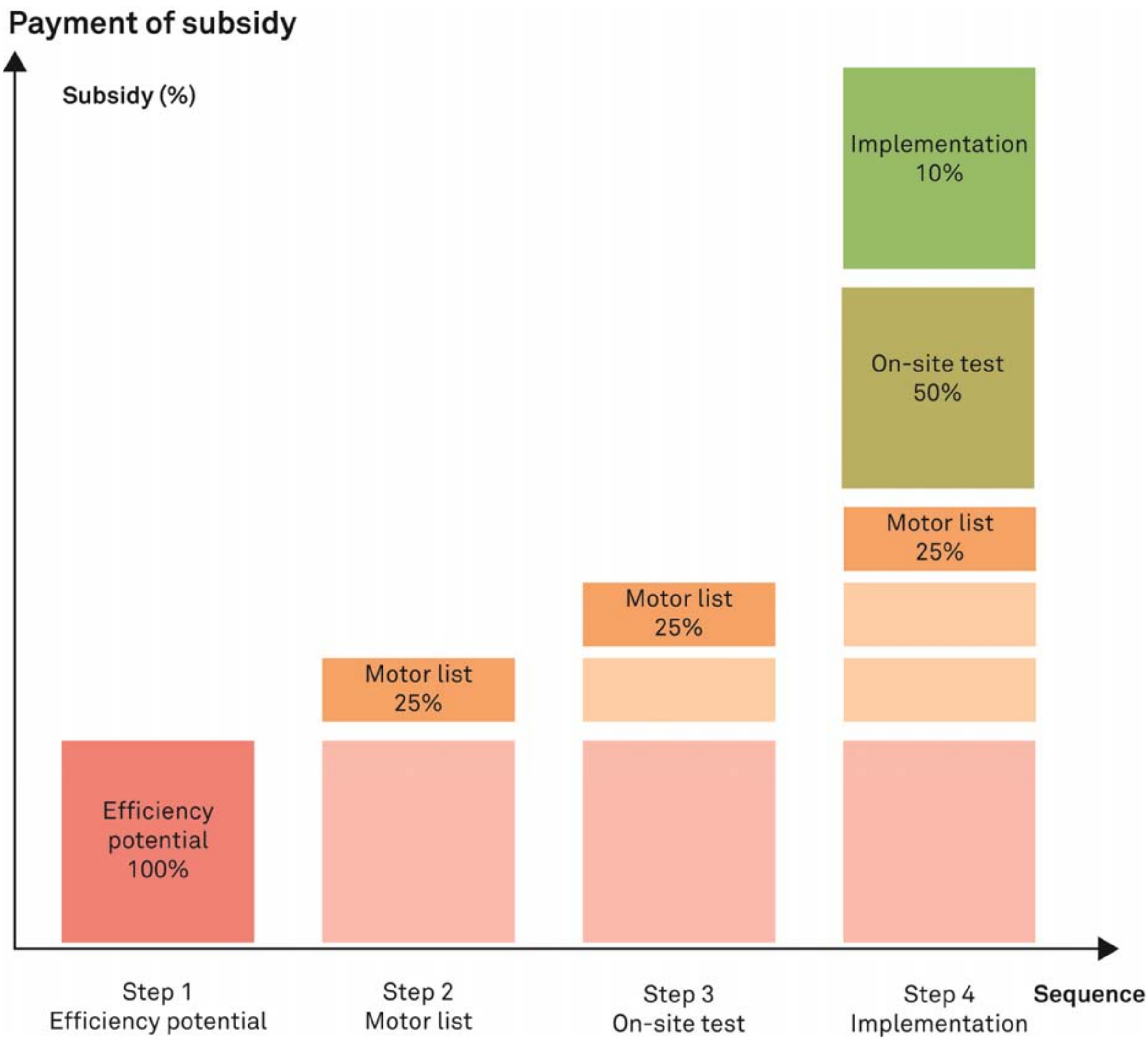
After each step, program participants are free to decide whether to go further in the program and make the next step or to stop. On the other hand, program management analyzes the results after each step and advises on whether all criteria are met by the participant to go on to the next step (see Table 2).

Table 2 Criteria for next steps

Step	Sequence	Criteria for next step
1	Efficiency potential	efficiency potential > 7% of motor systems' electricity consumption
2	Motor list	payback on investment < 5 years
3	On-site test	downsizing, frequency converter for load variation
4	Implementation	cost-effectiveness

To stimulate participants in continuing their efforts and to reduce program management risks, the payment of subsidies is partially delayed in time (see Figure 2). Program participants receive a certain amount of subsidy after each step, but most of the financial assistance is only paid after participants already have implemented measures.

Figure 2 Easy subsidy structure



Boxes are not proportionate of the actual amount of subsidy paid.

Budget and expected results

The total budget of the program is CHF 1 million for a period of three years. The budget consists of three main parts:

1. Subsidies paid for preliminary assessments
2. Subsidies paid for implementation

3. Other costs, such as program management, monitoring and reserves.

Subsidies paid for preliminary assessments include both assessments after which the participant implements efficiency measures (leading to implementation) and after which the participant does not implement efficiency measures (extra, see Table 3).

Table 3 Easy budget

	Program costs k CHF	%
1. Subsidies for preliminary assessments	*348*	*35%*
leading to implementation	220	22%
extra	129	13%
2. Subsidies for implementation	*444*	*44%*
*3. Other**	*208*	*21%*
Total	**1000**	**100%**

*program management, monitoring, reserves

Based on an evaluation of the energy consumption of Swiss companies in the industrial and services sector, program management made assumptions on the number of possible program participants and their energy consumption. As a result, program management anticipated 5 program participants: three with a total electricity consumption of 10 GWh/a and two with a total electricity consumption of 40 GWh/a.

To calculate possible savings, assumptions were made on the efficiency of relevant motor system components and the whole motor system, before and after the optimization. The following optimization measures were assumed: better motor, gears, transmission, no throttle, use of variable frequency drive, optimized pump/fan/compressor. For each such measure, the number of affected motors was also estimated (e.g. better motor in each case, use of VFD for 70% of the motor systems under optimization). As a result, an efficiency improvement of 15% was assumed per motor system.

On the basis of these assumptions and the available budget, program management projected to achieve a total saving of 69.2 GWh within 11 years[1]. This means an annual saving of 6.3 GWh (see Table 4).

Table 4 Total savings and program cost effectiveness

Total savings	GWh/a	6.3
	GWh/11 a	69.2
Cost effectiveness	CHF subsidy/kWh saved	0.0145

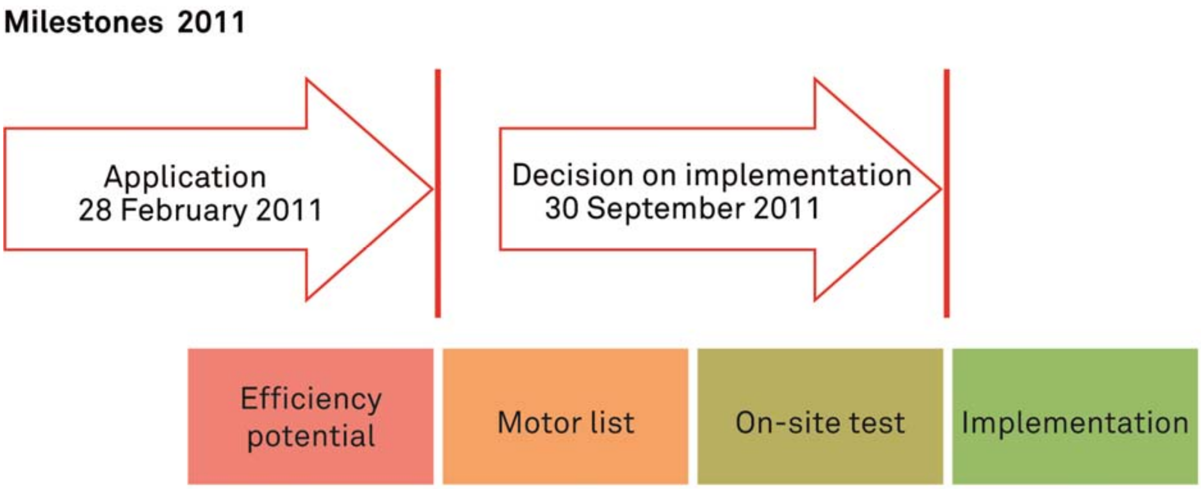
The cost effectiveness of the program was the most important criteria for the Swiss government when selecting winning bidders of the tender for efficiency programs and projects. S.A.F.E. contracted to deliver savings at CHF 0.0145 subsidy per kWh saved. Thus, a subsidy of 1.45 Swiss centimes is meant to bring a saving of 1 kWh.

Timeline

The Easy program management defined two milestones for the first program year. The first as a closing date for applications, the second as a deadline for completing the preliminary assessments (see Figure 3). The reasons for this were to create competition amongst program participants and to harmonize the progress of participants in time.

[1] Savings were calculated for the assumed duration of the life cycle of the newly installed motors. Program management opted for conservative assumptions and took 10 - 12 years as the life cycle of newly installed motors, with an average life cycle of 11 years.

Figure 3 Easy milestones 2011



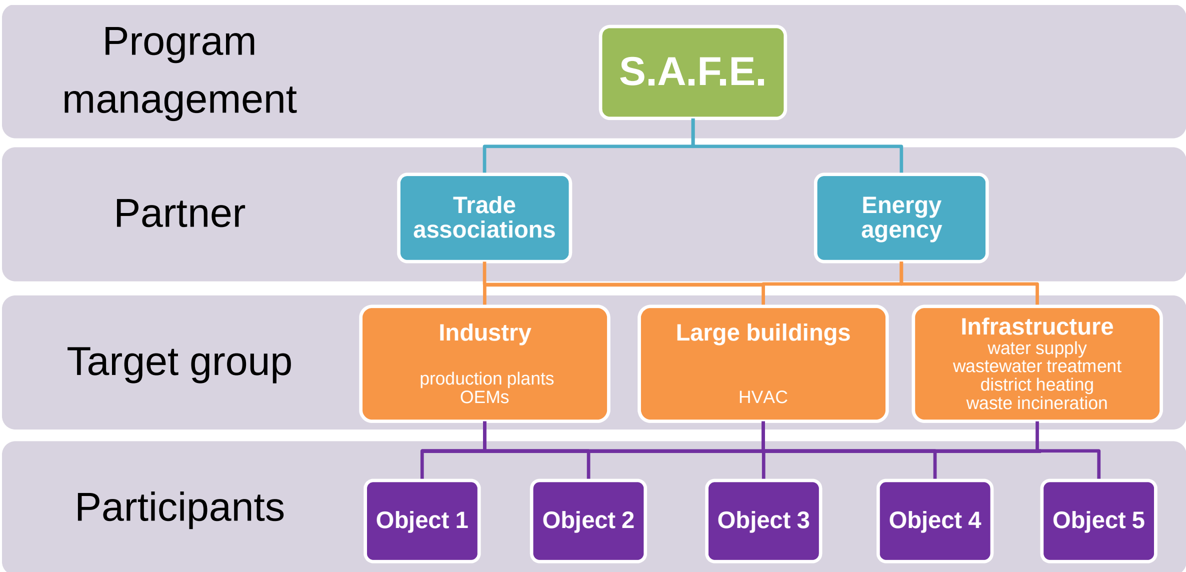
Applying for Easy meant Step 1 had to be completed. The second milestone was set to be a few months after the first, to prevent a sluggish pace of participation. The results of the cost-benefit analyses of the planned efficiency measures need to be ready at the second milestone, enabling program management to compare the cost-effectiveness of planned measures and to subsidize the most cost-effective measures.

As S.A.F.E. won a tender with Easy and contracted to deliver savings at 1.45 Swiss centimes subsidy per kWh saved, the program had to be designed accordingly. Therefore, those measures shall be selected to be subsidized, which result in an average cost-effectiveness of maximum 1.45 Swiss centimes subsidy per kWh saved. This does not mean that there would be participants who do not receive any subsidies for measures they implement. Rather, instead of choosing between participants (which program management considers counterproductive) the choice has to be made between proposed measures.

Organization

The Easy program management reaches potential participants with the help of the program partners, such as trade associations and a local energy agency. The program targets participants in the following groups: industry, large buildings (typically in the services sector) and infrastructure facilities.

Figure 4 Easy program organization



Four steps: purpose and tools

Step 1: efficiency potential

The purpose of Step 1 is to meet the participant and have a first impression of existing potential on the one hand, and the willingness and possibilities of the participant to exploit this potential on the other hand. Since at the end of the sequence (Step 4: implementation) investments are easily in the range of CHF 1 – 2 million per program participant, this meeting is also important to build trust and credibility in the program management.

The costs of this step basically consist of the costs of the program management who provides energy consulting on site. The costs of participants are marginal: sending data on the annual energy consumption and peak loads (which can be easily obtained from the utility) before the meeting and participating in the meeting. As the costs of Step 1 are 100% covered by the subsidy, this gives the chance for participants to decide after Step 1 on their continued participation in the program, after having obtained the results of the efficiency potential at almost zero cost on their side.

SOTEA: software tool for efficient motor systems

The analysis of the efficiency potential is done with the software tool SOTEA - developed under Topmotors.

There are three key data inputs needed for SOTEA:

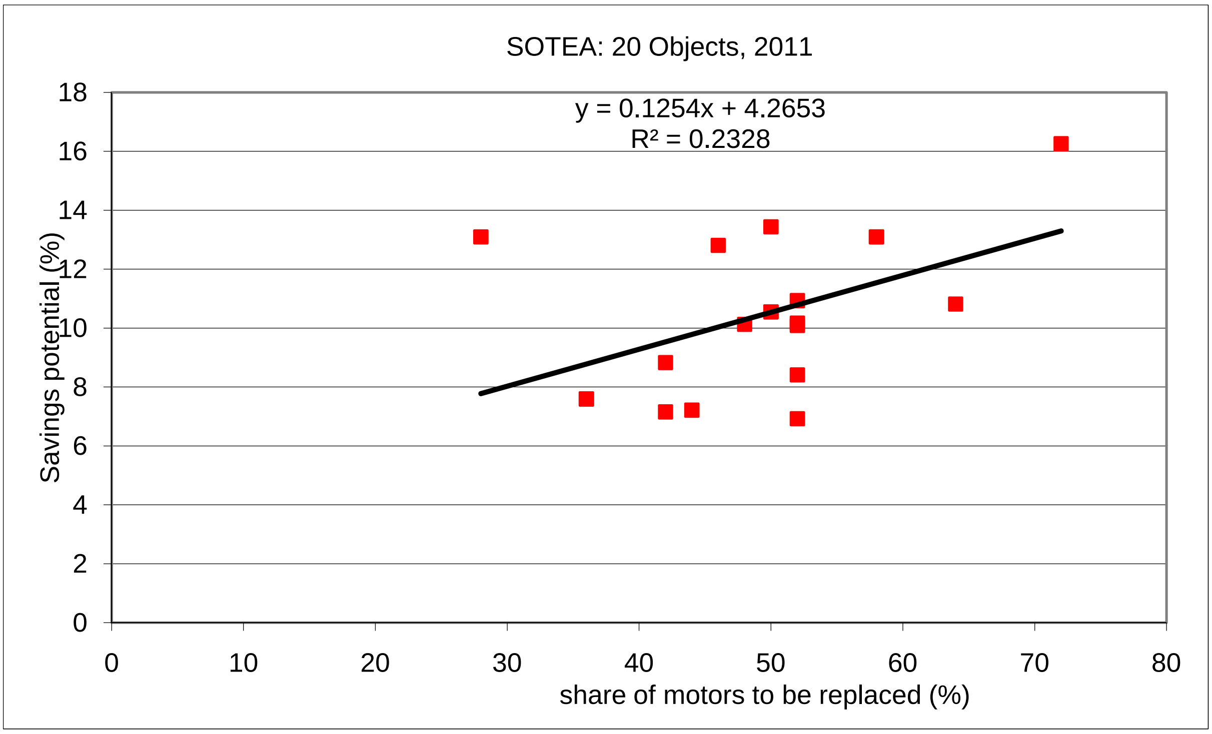
1. annual electricity consumption (preferably for the last year completed)
2. peak load (in the same year)
3. average age of motor systems.

This last data is very difficult to determine. It is somewhere between the year of construction of the plant and the year of the last big renovation.

Further inputs for SOTEA are: total number of workplaces and from this the share of office workplaces, industry type, cost of annual electricity consumption, average electricity price, etc. Number and size of motors are not needed as input.

Motor efficiency has been improved over time: an Eff3 motor built in 1990 has considerably higher losses than a 2011 IE3 motor. Smaller size motors (1 - 10 kW) typically have a larger percentage increase in efficiency than larger size motors (100 - 500 kW). SOTEA includes an assumed distribution of motor sizes for different industries based on stock analyses in pilot projects [10]. SOTEA uses assumptions for motor life cycle and motor load factors as a function of nominal power. It includes estimates for efficiency based on motor age (correlated with sales statistics from European motor efficiency classes Eff3, Eff2 and Eff1 from 1998 to 2009 [11]), also taking into account partial load. The average age of motor systems within the object is matched to the distribution of motors and used to calculate the number of motors to be replaced within the following ten years. The software is regularly improved and calibrated with the number of projects going through detail analyses.

Figure 5 Comparison of SOTEA results for 20 objects



Note: The figure includes results of 9 objects from Easy and 11 further objects from the Topmotors pilot projects.

In essence, the age of the motors is the key criteria for determining their efficiency and drawing conclusions on the share of motors to be replaced. The higher this share, the more savings are to be expected (see Figure 5).

SOTEA uses a top-down approach. It subtracts from the total electricity consumption within the object all elements of considerable electricity consumption which are not related to that of motor systems:

- office space
- electric water heating
- process heat
- electric steam generation
- server room
- canteen

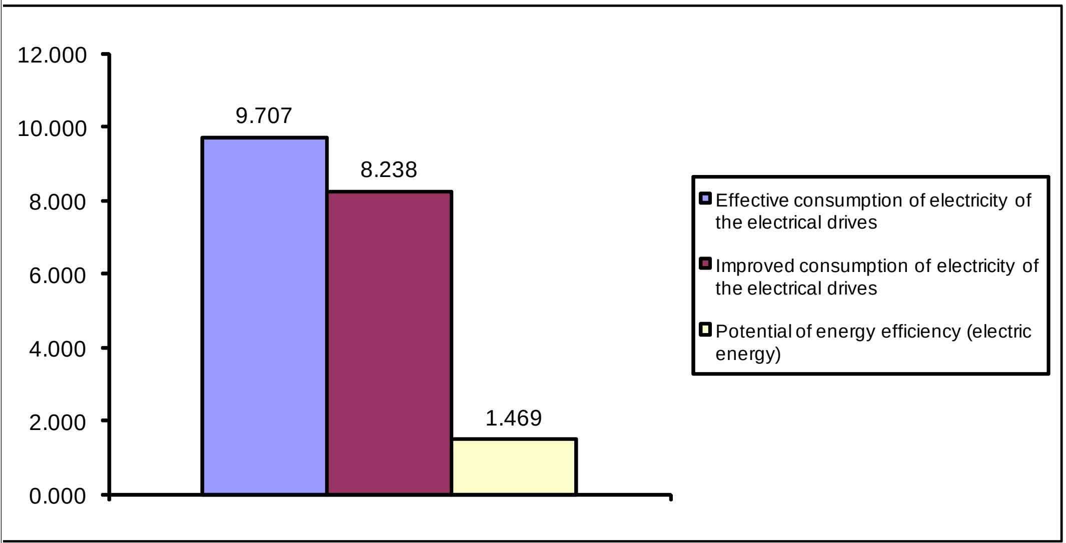
In order to calculate the consumption of the above uses, SOTEA includes assumptions (in the range of 5 – 30 % from the total electricity consumption). During the first meeting with the program participant it is discussed whether any of the above uses are relevant for that participant and if so, the participant can give a better estimate on the extent of this consumption which is immediately transferred into SOTEA.

In the end, all results relate strictly to the electricity consumption of motor systems only. Experience from Easy and Topmotors (based on 20 objects) shows that the electricity consumption of motor systems within one object is 83% of the total electricity consumption on average.

Figure 6 Snapshot of SOTEA results

Calculations

Effective consumption of electricity of the electrical drives	9.707	[GWh/a]
Fraction of effective consumption of electricity of electrical	69.3	[%]
Percentage of motors to be replaced	64.0	[%]
Numbers of motors with VFD	40.0	[%]
Improved consumption of electricity of the electrical drives	8.238	[GWh/a]
Potential of energy efficiency (electric energy)	1.469	[GWh/a]
Potential of energy efficiency (in currency)	0.157	[Mio CHF/a]
Potential of energy efficiency (in percentage)	15.1	[%]
Additional investments for realisation of the potential of energy efficiency	0.205	[Mio CHF]
Payback-time for realisation of efficiency potential	1.3	[a]

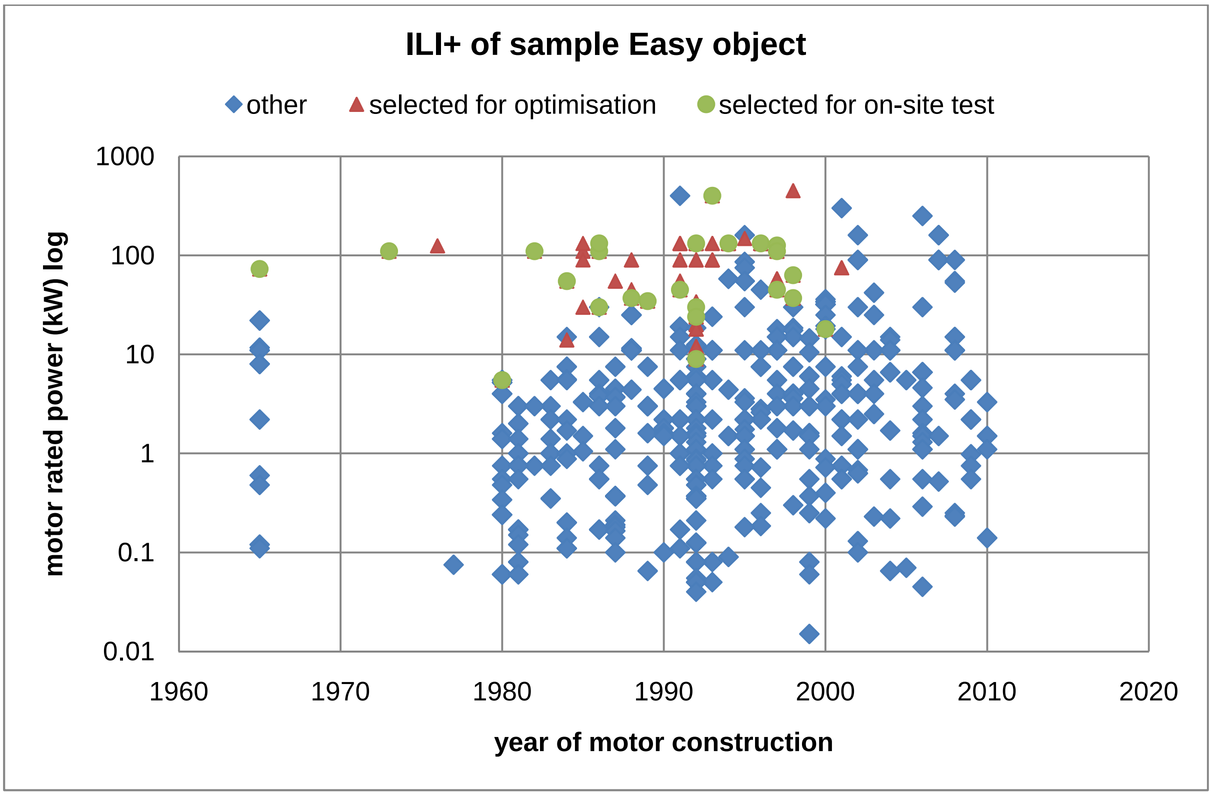


SOTEA also calculates a payback period for the additional investments needed for better efficiency. Additional investments represent the cost difference between replacing the motor system at the end of its average technical lifetime with equally (in-) efficient components as base line plus upgrading to more efficient components (e.g. installing an IE3 motor instead of an IE1 or IE2 motor).

Step 2: motor list

The purpose of Step 2 is to have a list of motors covering 70% of the electricity consumption of all drives in the object. The goal is to identify from all motors listed the sub-group on which efficiency measures are foreseen to be made. After grouping the motors chosen for implementation according to their application, a list of motors to be tested on site can be identified (see Figure 7).

Figure 7 Selecting motors for testing and implementation: ILI$^+$ at one Easy object (sample)



S.A.F.E. puts great emphasis on conveying the message that the largest savings lay in the optimization of the complete motor system, not the replacement of the electric motor only. Nevertheless, this optimization needs to have a starting point. Since the core of the complete system is the motor, the motor itself is the starting point of the analysis – according to the Topmotors methodology developed by S.A.F.E. Once the parameters of the motor in operation are captured (load variations, load factor), the optimization can be extended to the complete system and include all relevant mechanical and electrical components as well as an analysis of the necessary load to avoid inefficiently small and leaky ducts and pipes with unnecessary high resistance due to high flow speed.

ILI$^+$: intelligent list

ILI$^+$, developed under Topmotors, is an Excel based tool. It is literally a list of motors, allowing the analysis of the existing motor park in an object in detail. It uses a bottom-up approach: motors need to be added to the list until their total annual electricity consumption reaches 70% of the annual electricity consumption of all drives within the object (this latter data is derived from SOTEA). In order to achieve this as fast as possible and get to the core of the largest efficiency potentials, at first motors with the highest rated capacity, age and annual operating hours are put on the list. These are the ones most prone to be selected for optimization (see Figure 7).

For each motor the three key input parameters for ILI$^+$ are combined with the following criteria:

1. Nominal power > 10 kW
2. Motor age > 15 years
3. Annual operating hours > 3 000 h/a

The nominal power of the motor can be easily taken from the information on the rating plate. Motor age may differ from the year of construction (on rating plate), if motors were put into operation later. The annual operating hours can only be estimated by technical personnel who know which motors are used for what purpose and how long they usually run.

Other input parameters for each motor are application type (pump, ventilator, compressor, mechanical conveyor; other), availability of a frequency converter, number of poles and in the extended optimization phase transmission type.

ILI^{+} assigns for each motor an estimated load and efficiency, based on motor size and age. After this, it calculates the actual electricity consumption and the potential savings. For the savings calculation, it simply assumes a motor replacement (old inefficient motor to new IE3 motor). These calculations are all based on the international standard IEC 60034-30 (from 2008) for 2-, 4-, 6- and 8-pole motors starting from 0.75 kW.

Once all input data is in the list, the optimization can be started. As ILI^{+} usually lists hundreds of motors (depending on the size of the object), the Decision Maker tool is helping in assessing these motors according to different criteria.

Figure 8 ILI^{+} Decision Maker

Potential of reduction according to criteria

Criteria		Default values	My values	Number of motors		Potential of reduction of energy		Potential of reduction of costs	
				absolute	in %	[kWh/a]	[kWh/LC]	[CHF/a]	[CHF/LC]
(1) Rate of realisation of the maximal saving potential in %		50	50	37	7%	371'245	7'376'542	55'687	1'106'481
(2) Age, older than x years		15	15	337	62%	623'104	9'934'263	93'466	1'490'139
(3) Operating hours per year > x Stunden		3000	3000	358	66%	770'215	12'524'360	115'532	1'878'654
(4) Dimension of motors > x kW		10	10	180	33%	705'862	12'571'654	105'879	1'885'748
(5) Motors without FC (frequency		yes	yes	504	93%	846'861	13'707'339	127'029	2'056'101
(6) Application	Pump	yes	yes	115	21%	41'133	428'643	6'170	64'296
	Ventilator	yes	yes	177	33%	205'304	2'249'990	30'796	337'499
	Compressor air compr.	yes	yes	3	1%	16'725	334'506	2'509	50'176
	Compressor cold	yes	yes	14	3%	135'509	2'684'199	20'326	402'630
	Mechanical conveyor	yes	yes	0	0%	0	0	0	0
	Others	yes	yes	231	43%	503'753	8'896'278	75'563	1'334'442

The tool selects motors from the list according to the following default values:

- Realizing 50% of the maximum savings potential
- Motors older than 15 years
- Motors running longer than 3 000 hours per year
- Motors with a rated capacity of more than 10 kW
- Motors with no frequency converter
- Motors with different applications: pumps, fans, compressors (for air, for cooling), mechanical conveyors and other applications.

These default values can be changed ("My values"). The Decision Maker shows how many motors match the given criteria and how much savings can be generated by selecting these motors for optimization (both in kWh and CHF per year and per life cycle). Cost calculations are based on a database with costs for motors, frequency converters and different belts (V-belts, flat belts, tooth belts).

The savings calculated with the Decision Maker are not necessarily cumulative: each line shows the results of one criterion only. Thus, there may be 337 motors older than 15 years and some of them may run for more than 3 000 h/a but the extent of this interrelation is not given. Nevertheless, the criterion for maximum savings potential incorporates all three key criteria: motor size, age and annual operating hours. Therefore, it is a good indicator for possible savings. First it takes the motor with the highest savings potential, followed by the motor with the next highest savings potential and so on, until the inserted (or default) realization rate of the maximum savings potential is reached. If this is 50%, it means that the first 37 motors with the highest savings potential are selected which reach 50% of the possible savings (see Figure 8). After the assessment with the Decision Maker, motors chosen for implementation will be marked in ILI^{+} and imported into a separate list for optimization. Here, the optimization considers the following: new motor smaller in size, use of frequency converter, more efficient transmission (preferably none). Savings potentials are adjusted at this phase in accordance with these additional pieces of information.

Finally, once the optimization has been completed for each selected motor (system), a detailed report with the results is generated.

Step 3: on-site test

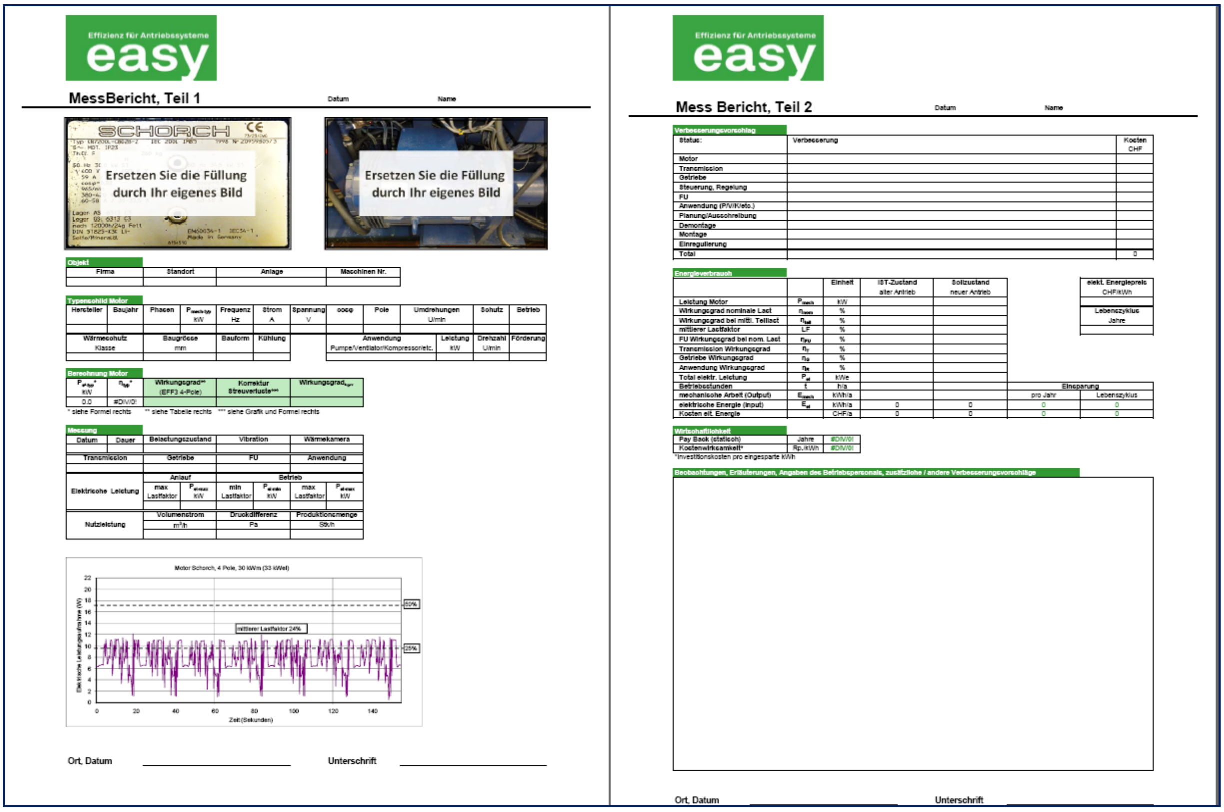
Savings potentials calculated with ILI+ are verified by on-site tests. Based on the list of motors chosen for optimization, groups of motors with similar applications are created. For each group, one motor – being a representative model of that group – is chosen for testing.

Testing is done by qualified third parties, chosen in competition for the testing assignment in mutual agreement by the Easy participant and the program management.

The testing serves to better understand the operating conditions of the motor, in particular the starting and running phases.

After the assigned professionals complete the testing, they deliver the test results in form of a two-page summary on each motor to the Easy program management. The summary includes observations of the motor systems' actual performance and specific recommendations for optimization, including cost estimations. The summary is based on a template designed by the Easy program management for this purpose (see Figure 9).

Figure 9 Template of the testing summary document



Step 4: implementation

Once the results of the testing are available, energy savings and investment costs of each planned efficiency measure can be further refined. The cost-effectiveness of each measure is determined together with any other capital budgeting assessment method (e.g. payback period, net present value) required by the Easy participant. As already mentioned before (see Timeline), the Easy program management subsidizes only the most cost-effective measures.

Subsidies are paid for any new equipment installed to improve system efficiency, such as motor, variable frequency drive, pump, fan, compressor, better controls with factory automation, etc. If the existing (running) motor is already amortised (generally speaking when motor age is over 20 years) or it already failed, the subsidy is paid after only 60% of the investment cost of the newly installed motor – since the motor needed to be replaced anyway.

Based on the thorough investment profitability assessment, the investment plan is compiled. The plan may actually include more measures than subsidized by Easy, or certain measures may be extended, should the Easy participant decide so (e.g. investing into more expensive equipment for better product quality).

Based on the investment plan, an implementation plan is prepared, dividing the actual implementation period into several stages. Subsidies are paid after the realisation of the first stage which has to cover at least one fourth of the total investment.

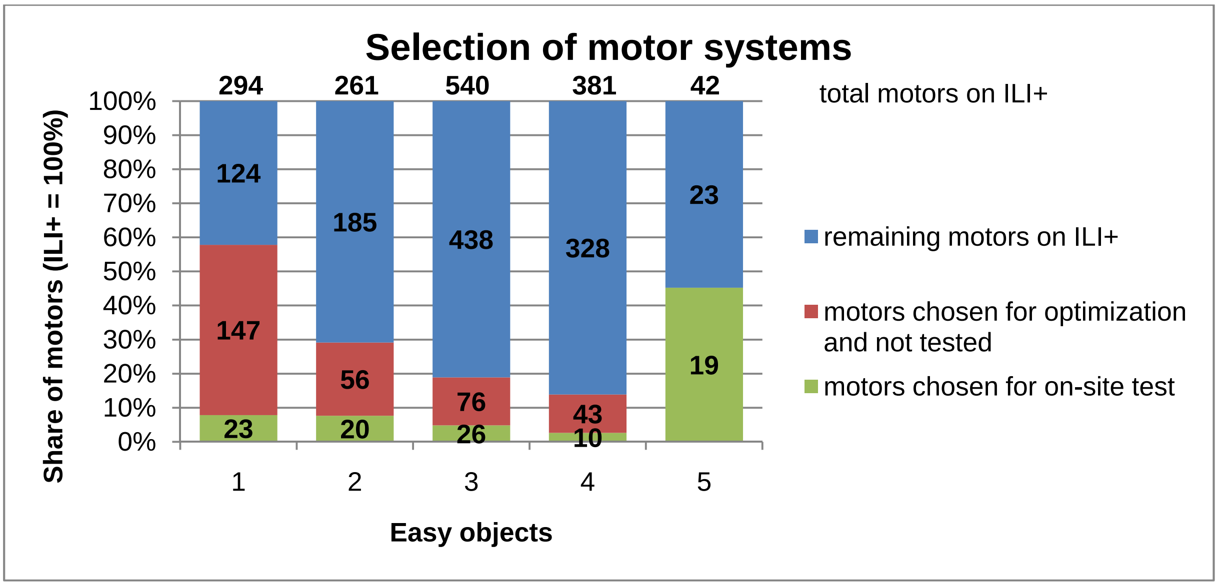
Program participants and first results

When designing Easy, the program management set the goal to implement efficiency measures at 5 objects, each with an electricity consumption of 10 - 40 GWh/a. Up to now, 9 efficiency potential assessments and 5 motor lists have been completed. Currently there are five program participants between Steps 2 and 3 in the sequence.

In all 5 objects together, 1518 motors were listed on the motor lists. With the total number of motors within the objects unknown, only the most energy consuming motors of each object had to be listed for an efficient analysis. Each motor list covers in fact between 68% and 95% of the electricity consumption of the motor systems in the respective object.

The number of motors put on the motor list varies from 42 to 540 per Easy object (see Figure 10). For example, in object 3 there are 540 motors on the motor list, from these 102 have been chosen for optimization and 26 of those are tested on site. In the case of object 5, in total 42 motors were put on the motor list. From these, 19 have been chosen for optimization and all 19 will be tested on site.

Figure 10 Selection of motors from ILI+ for optimization and on-site test



The first results of the program show that from the 1518 motors listed in the five motor lists a selection of 420 motors has a fair chance to be improved with a low payback time (see Table 5).

Table 5 Results so far

Program participant			Motors chosen for optimization					
No.	Core business	Total electricity consumption		Electricity consumption	Savings on motor replacement	average age	average operating hours	average nominal power
		GWh/a	no.	GWh/a	GWh/a	a	h/a	kW
1	Dairy production	40.2	170	15.5	0.5	20	5 693	29
2	Waste incineration	38.2	76	31.4	1.1	22	5 450	116
3	Chocolate production	35.4	102	19.0	0.6	21	5 037	80
4	Production of industrial adhesives	12.4	53	3.8	0.1	17	6 482	23
5	Meat processing	5.9	19	3.6	0.1	12	4 269	65
	Total	***132.1***	***420***	***73.4***	***2.5***	***18***	***5 386***	***63***

The total electricity consumption of the five Easy objects is 132.1 GWh/a, of which 89% (higher than the average 70% estimated) are electric motor systems. The average age of motors chosen for optimization in the five objects is between 12 and 22 years. The average operating hours range between 4 269 h/a and 6 482 h/a, average nominal power ranges from 23 kW to 116 kW.

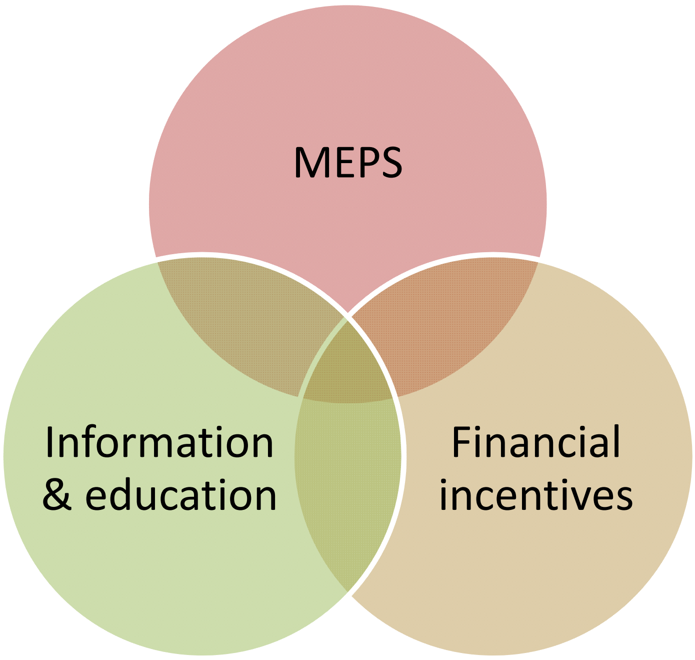
The 1518 motors listed consume 97.7 GWh/a, while the 420 selected motors consume 73.4 GWh/a. The analysis of the motor list shows that only 28% of the total motor number (420 motors) already captures 75% of the motor electricity consumption (97.7 GWh/a). This result shows the importance of a systematic selection process.

The potential savings for motor replacement only are estimated at 2.5 GWh/a, which typically is between 20 and 30% of the expected system efficiency improvement. Data on investment and payback will be made available as soon as possible.

Lessons learned

Based on many years of experience with different market transformation programs, S.A.F.E. identifies the three key elements of market transformation as mandatory Minimum Energy Performance Standards (MEPS), information and education programs and financial incentives.

Figure 11 Three basic elements of market transformation



In the case of electric motors, MEPS are already in place and following the European MEPS. Topmotors is the program for information and education and Easy covers the third element, financial incentives (even if only for a limited number of companies).

Lessons learned from the interaction with (potential) program participants so far:

- *The involvement of a committed person from management level is key* for the success of the project. In one case this meant smooth and fast acting, in other cases due to internal personnel changes the project was stopped or significantly delayed.
- *Qualified technical personnel are a short-cut resource*. In two cases there was practically no or very limited time available for technical personnel to be involved in the project.
- *Smooth production comes first*. In one case, the company was reluctant to allow measures affecting motor systems involved in the core production processes and backed out from the project after Step 1. S.A.F.E. suspects that this was partly because motors were integrated into machines and demounting them could have led to warranty problems with the OEMs. In another case, problems in production caused the contact for Easy to be fully occupied with this issue, causing a delay in the project.
- *Program transaction costs are higher for participants with smaller energy consumption*. If the energy consumption is low, the possible savings are also low in absolute terms. For example, if the savings potential is equally 10% for the objects consuming 10 GWh/a and 40 GWh/a, clearly, the savings are higher in the latter case (1 GWh/a vs. 4 GWh/a). In the case of one participant with relatively lower total energy consumption Step 2 was not conclusive, thus program management needed to invest extra time and efforts to assist the participant to the next step.
- *Industrial companies operate in a changing business environment*. One participant was not able to pull through the project, since the plant was shut down after Step 1. This object also used very stringent payback criteria which in any case may have led to a decision not to participate in Easy after Step 1.
- *Information on efficient motor systems is not widespread*. At most of the discussions technical personnel and management seemed to have heard about the already existing Minimum Energy Performance Standards for motors for the first time. Also, on ways to exploit efficiency potentials and a systematic approach to do so.
- *Due to language barriers communication was delayed* between the Easy contact person and the Easy program management (Switzerland has four official languages).

The above list confirms the existence of most barriers described previously (see “Why to introduce a motor systems efficiency program?”).

As for the barrier of the preliminary assessments, since up to now all participants who decided to stop the project did this immediately after Step 1, and those who made Step 2 did not decide to stop but went on, S.A.F.E. believes its hypothesis is being confirmed to be correct.

Conclusions

Finally, the ultimate question is: how effective is Easy in transforming the market? The answer is: time will tell. Easy is a pilot program for the Swiss market, gaining experience on barriers to overcome, real costs of the program and the possibilities to raise awareness on motor systems efficiency and train participants to systematically exploit savings potentials in the years after the program as well, on their own.

To raise this issue to a global level, the Easy program management actively participates in the global motor systems efficiency project EMSA [3] which also benefits from the Swiss experience gained through Easy.

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