The market of electric motors, pumps & fans in the European Union and Switzerland

Rita Werle, Conrad U. Brunner, Rolf Tieben, Petar Klingel, Impact Energy Inc.

Richard Phillips, Swiss Federal Office of Energy

Abstract

The Swiss Federal Office of Energy (SFOE) is the public regulator establishing Minimum Energy Performance Standards and conducting market surveillance in Switzerland. In order to better understand and steer the market transformation, SFOE has started an annual monitoring of the motor market in 2017. A first report was published in 2018 giving an overview of the efficiency, number and size of motors sold in Switzerland in 2016. In 2019 the second report is published, giving an overview on motors, pumps and fans not only on the market in Switzerland, but also the European Union (EU).

The results show:

- From the total 180'000 electric motors sold in Switzerland in 2017, approximately 70'000 were subject to the Swiss Minimum Energy Performance Standards (MEPS). From the motors in scope of the MEPS, 64% were of the IE4 and IE3 energy efficiency classes[1], 35% of the IE2 class and less than 1% of the IE1 class. The price of an IE3 electric motor compared to IE2 was 14% higher. An IE4 motor costs 17% more than an IE3 motor.
- From the total 190'000 circulator pumps sold in Switzerland in 2017, 97% had an energy efficiency index (EEI) below or equal to 0.23, thus compliant with the respective MEPS. In the European Union, 82% of the total 8.3 million circulators sold had an EEI below or equal to 0.23.
- From the total 50'000 water pumps sold in Switzerland in 2017, 91% were below 10 kW. 40% of all water pumps sold in Switzerland were multistage submersible pumps. The respective figures for the European Union are: from the total 2.7 million water pumps, 85% were below 10 kW. The share of multistage submersible pumps in the EU was 45%.
- From the total 170'000 fans sold in Switzerland in 2017, 51% were forward curved and radial bladed fans and only 21% (the more efficient) backward curved fans. From the total 24.1 million fans sol in the EU, 56% were forward curved and radial bladed fans and 19% backward curved fans.

This market analysis is being done in the framework of the Swiss Topmotors program (www.topmotors.ch/en) by the independent consulting company Impact Energy, as mandated by the SFOE, in collaboration with the global market research company IHS Markit. The analysis is based on direct surveys of relevant manufacturers. This paper focuses on the main findings of the 2018 survey and analysis.

Background

Motor systems represent a large share of global and Swiss electricity consumption (around 50%). More than half of this is for industrial applications and building technology in the service sector including infrastructure facilities, commercial applications, etc.

[1] IE code, based on IEC 60034-30-1, 2007

The Swiss Topmotors programme, managed by Impact Energy, has been promoting efficient motor systems, pumps, fans, compressors, transport and process machines since 2007 with the support of the Swiss Federal Office of Energy (SFOE).

Goal

The SFOE is the public regulator for establishing and implementing minimum energy performance standards (MEPS) for energy using products and for their market surveillance. The SFOE closely monitors market developments for all energy-using products. In the case of motor systems, it is especially focused on motors, circulator pumps, water pumps and fans which are subject to MEPS. It is important to monitor the market transformation towards energy-efficient equipment and especially the effect of MEPS, to verify the success and effectiveness of policy instruments, sharpen their scope and advance the requirements if necessary.

The Topmotors Market Report was first launched in 2017 to research the sales, the efficiency (MEPS compliance), the availability and the price of electric motors and the price of VFDs in Switzerland. The goal was to cover at least 50% of the market with available data. The Topmotors Market Report is published annually to inform the SFOE and all interested stakeholders on the status of the market development. This paper summarizes the findings of the second Topmotors Market Report 2018. [10]

Scope

The Topmotors Market Report 2018 covers sales data from 2017 of electric motors and price data from 2018 for motors and VFDs. In addition, it also covers market data on the sale of circulators, water pumps and fans in Switzerland and in the European Union from 2017.

In Switzerland, MEPS are in effect in line with the Efficiency ordinance (EnEV) for motors, circulators and water pumps and are fully synchronized with the respective European Ecodesign Directive (see Table 1).

Product	European Union: Ecodesign directive, regulation no./year	Switzerland: Efficiency ordinance (EnEV), Annex no.
Motor	640/2009	2.7
Circulator	641/2009	2.8
Water pump	547/2012	2.9
Fan	327/2011	2.6

Table 1 MEPS in the European Union and Switzerland

From 1 January 2017, the following criteria apply to electric motors within the scope of MEPS in Switzerland, as laid out in Annex 2.7 of the Swiss Energy Efficiency Ordinance:

- Scope:
  - Motors with nominal output power of minimum 0.75 kW up to maximum 375 kW;
  - 2-, 4-, 6- poles.
- Minimum requirement (energy efficiency class as defined in IEC 60034-30-1):
  - Efficiency class IE3;
  - Or IE2 sold in combination with a VFD.

As before, the energy efficiency of electric motors has been defined and is measured since 2014 by IEC 60034-30-1 from 0.12 kW to 1000 kW for 2-, 4-, 6- and 8-pole motors under 1000 V.

Methodology

In order to ensure impartial, scientific and anonymous market research, the SFOE mandated Impact Energy to conduct the market research. Impact Energy commissioned IHS Markit, a global market research agency with know-how, expertise and experience for industrial products. IHS Markit's primary task was interacting with the industrial companies which manufacture, import or sell the products to large end-users, original equipment manufacturers (OEMs) and wholesalers. It is not possible to ascertain how many of these products were purchased as standalones or eventually integrated into machines and exported abroad from Switzerland.

The survey was sent out with a questionnaire in spring 2018 to a total of 59 companies involved in motors, pumps, fans and VFDs in Switzerland. Useful answers for the research could be derived from 18 leading companies (including all large international manufacturers), three of which are manufacturing in Switzerland. The direct findings of the survey cover around 60% of the market volume. The full market data is an estimate based on the survey and calculated data from Switzerland and other European countries. The sales data were collected by IHS Markit and anonymized. Companies surveyed were informed about of the purpose of the research, clearly stating that the data gathered would be kept confidential and used in an anonymous manner. The subsequent data evaluation work by Impact Energy was based on anonymous files.

The reliability of the data gathered is satisfactory, as it covers more than the planned 50% of the market. At the same time, it must be evaluated critically, as the research findings are based on self-declared data by manufacturers complemented by IHS Markit estimates for the entire Swiss market based on larger samples in Europe.

The findings for motors and VFDs, which were surveyed for the second time in 2018, show consistent data. For pumps and fans, which were surveyed for the first time in 2018, data consistency can only be verified in coming years. The goal for the coming years is to increase the quality and reliability of the raw data and their evaluation, which can also be achieved by having more companies participate in the survey.

The motors' electric energy consumption was estimated:

- Average configuration of 4'500 operating hours per year;
- Annual average load factor of 0.7;
- The respective efficiency of each class.

As the available data on the size of pumps and fans is scarce, it is not possible to calculate their energy consumption.

Motors in Switzerland

The total number of electric motors sold in Switzerland in 2017 was 177'786 (see Table 2).

Motors sold in Switzerland 2017	Quantity		Motor output (mech.)		Electricity consumption	
Nominal output power (kW)	Number	Share	MW_{mech}	Share	GWh/a	Share
0.12 - 0.75 kW	105'641	59.4%	40	4.0%	175	5.1%
> 0.75 - 375 kW	**71'931**	**40.5%**	**829**	**82.9%**	**2'827**	**82.4%**
> 375 – 1'000 kW	214	0.1%	131	13.1%	430	12.5%
Total	177'786	100.0%	1'000	100.0%	3'432	100.0%

Table 2 Quantities for 2017, motor output and electricity consumption by size (all numbers of poles)

It is interesting to see how the number and electricity consumption of all motors sold in 2017 in Switzerland compare (see Figure 1 and Figure 2). While 59.4% of the motors sold were below 0.75 kW, these only account for 5.1% of the total electricity consumption of motors in Switzerland. At the same time, 40.5% of motors sold were between 0.75 and 375 kW and accounted for 82.4% of the total electricity consumption of motors in Switzerland, being clearly the most significant size group in terms of electricity consumption.

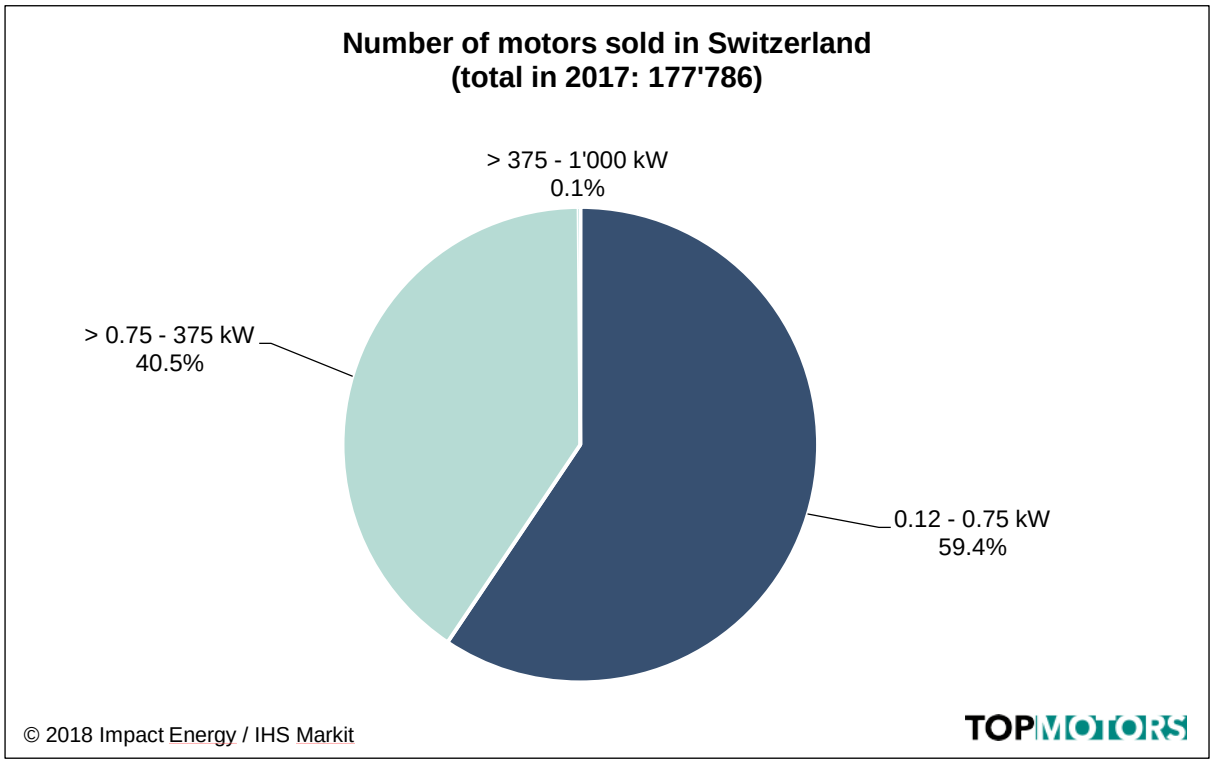

Figure 1 **Number of motors sold in Switzerland in 2017 by size**

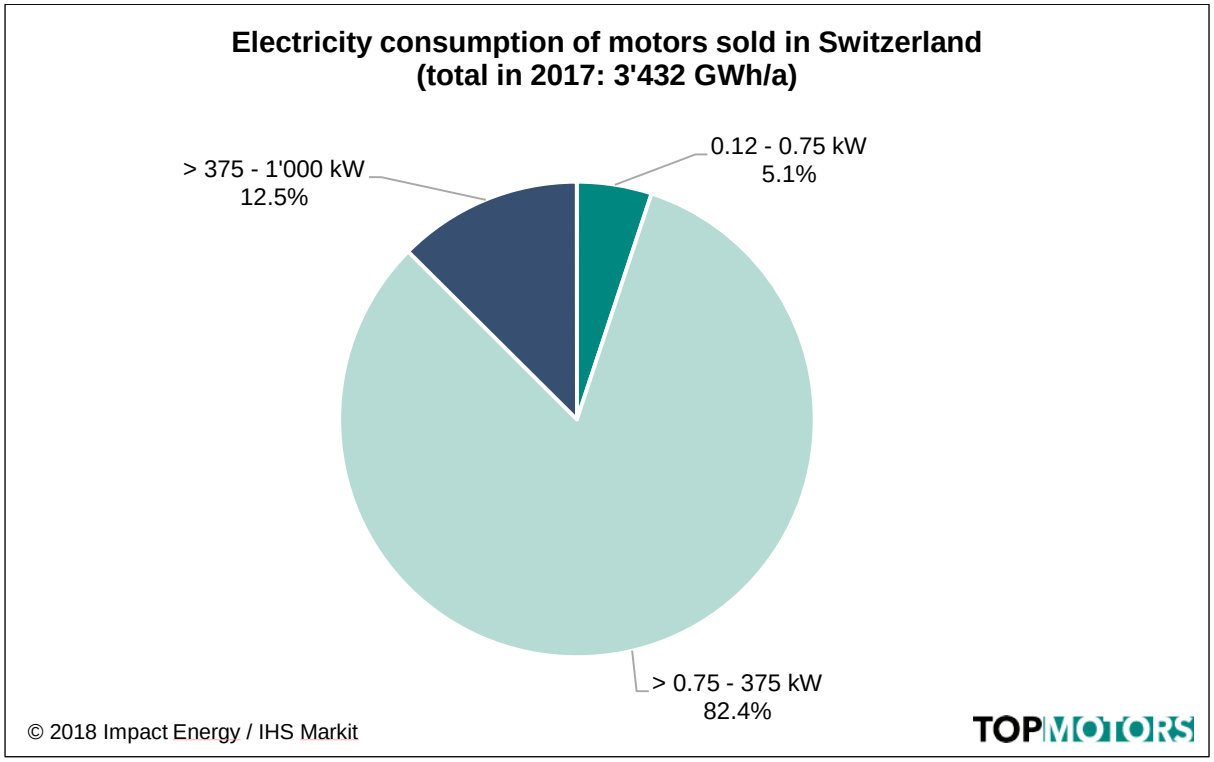

Figure 2 **Motors sold in Switzerland in 2017: electricity consumption by size**

Figure 3 shows the distribution of motors sold by efficiency class. For the smaller motors falling outside the scope of the MEPS (e.g. below 0.75 kW), the units sold were on average of lower efficiency (e.g. higher share of IE2 and IE1 motors).

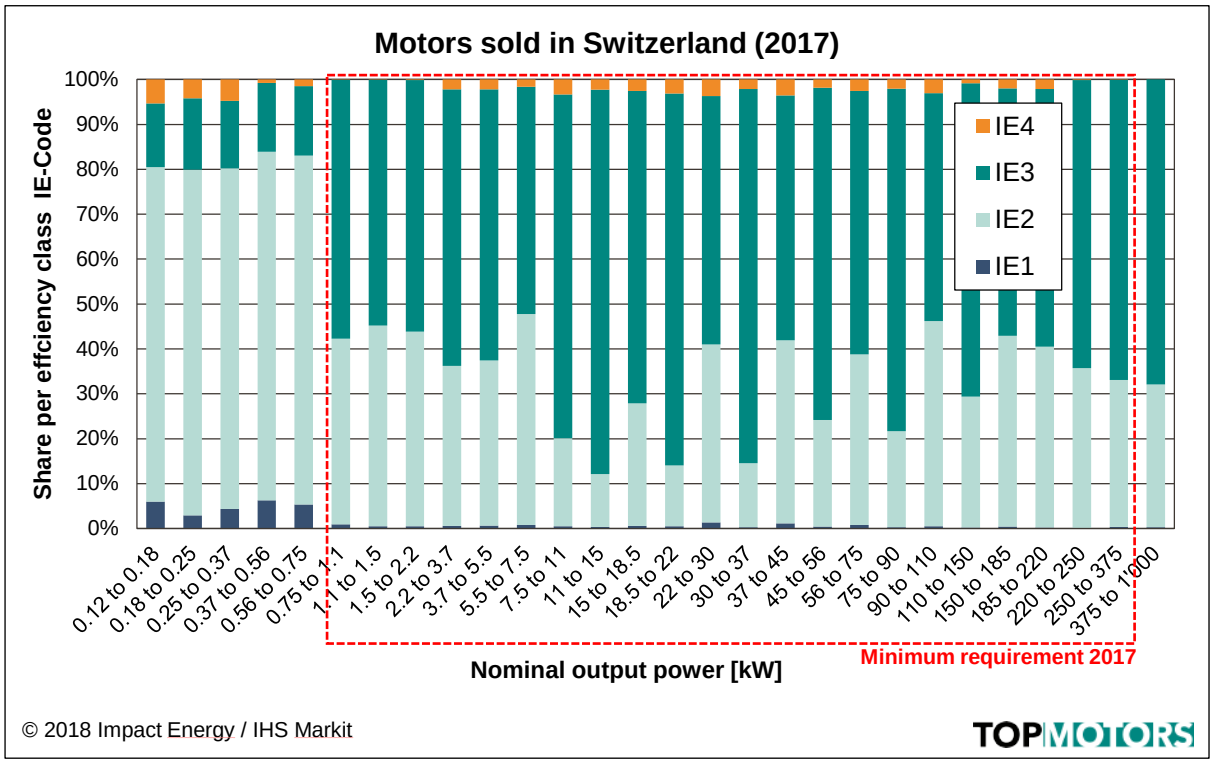

Figure 3 Efficiency class by size of motors sold in Switzerland in 2017

From the total 177'786 motors sold in 2017, 70'143 (39.5%) were within the scope of MEPS (0.75 - 375 kW nominal output power and 2-, 4-, 6-poles). The motors in scope account for 81.0% of electricity consumption of all motors sold. Out of the motors in scope, it is assumed that 57'292 or 81.7% met the 2017 MEPS.

The detailed findings are as follows (see Figure 4):

1. It should be emphasized that some of the motors sold in 2017 did not have to comply with the MEPS as they were outside the scope (e.g. not capable of continuous operation, brake motors, designed to operate in potentially explosive atmospheres, etc.) as defined in the Ecodesign Regulation No. 640/2009.

2. 0.6% of the motors sold were IE1; those under the scope of MEPS did not comply with the MEPS.

3. 64.0% of the motors sold were IE3 and IE4 and complied with the MEPS.

4. 35.4% of the motors sold were IE2. It cannot be accurately determined to what percentage they met the MEPS, while it is assumed that they did so to a large extent, taking into account the following assumptions and considerations:

    a. It is assumed that 50% of the IE2 motors were sold together with a VFD (according to the regulation in effect, IE2 in combination with a VFD is acceptable as a substitute for IE3) and hence complied to the MEPS.

    b. Some of the motors are not under the scope of MEPS as mentioned in point 1 above.

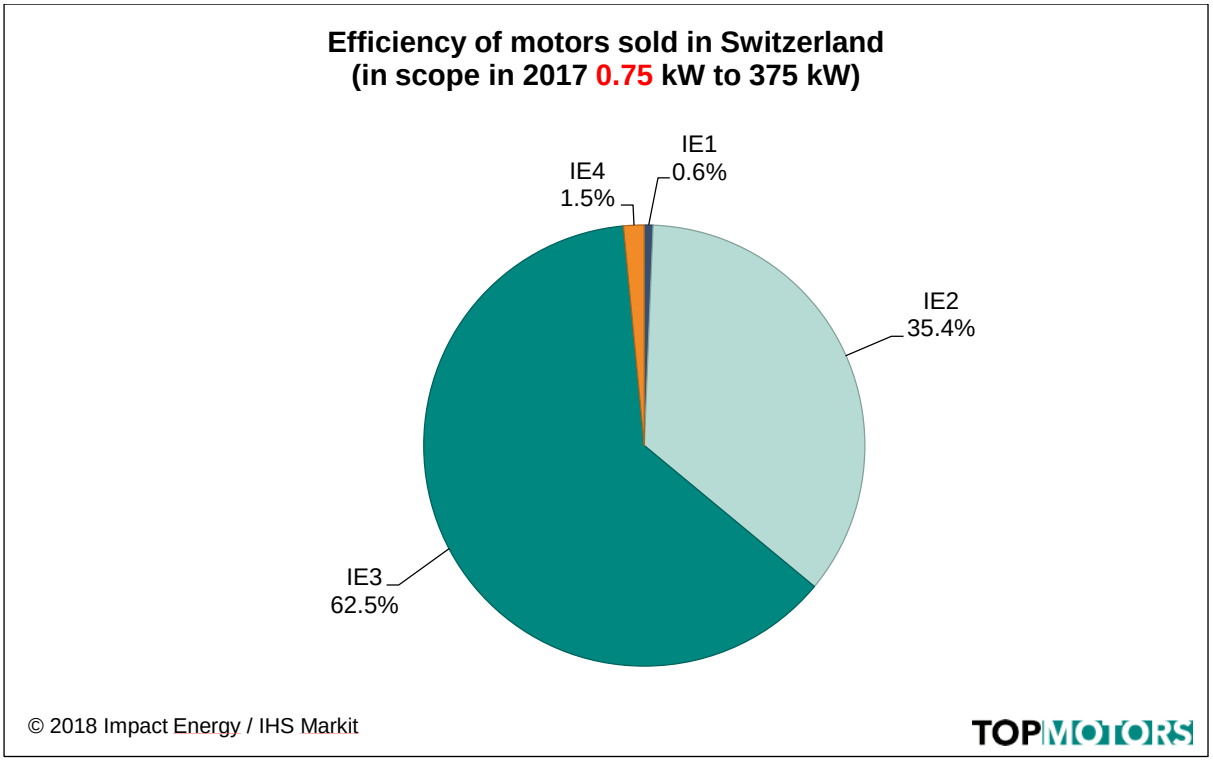

Figure 4 **Motors sold by efficiency class within the scope of MEPS in Switzerland in 2017 (0.75 - 375 kW, 2-, 4-, 6-poles)**

Motor and VFD prices in Switzerland

The Topmotors Market Report 2018 gives the motor and VFD prices for the year 2018.

Specific price 2018 (USD/kW)		
IE2	**IE3**	**IE4**
180	**204**	**237**

Table 3 **Average specific motor prices USD/kW by efficiency class for 2018 (linear average value for 28 size classes)**

The price premium for more efficient motors (IE3 and IE4) as compared with standard motors (IE2) was surveyed by motor size. Motor prices were subdivided into 28 size categories. The three curves compared are shown in Figure 5:

- IE3 as compared with IE2
- IE4 as compared with IE3
- IE4 as compared with IE2

The cost differential varies significantly depending on nominal output power. The highest price premiums are for 1.5 - 5 kW and for 90 - 150 kW.

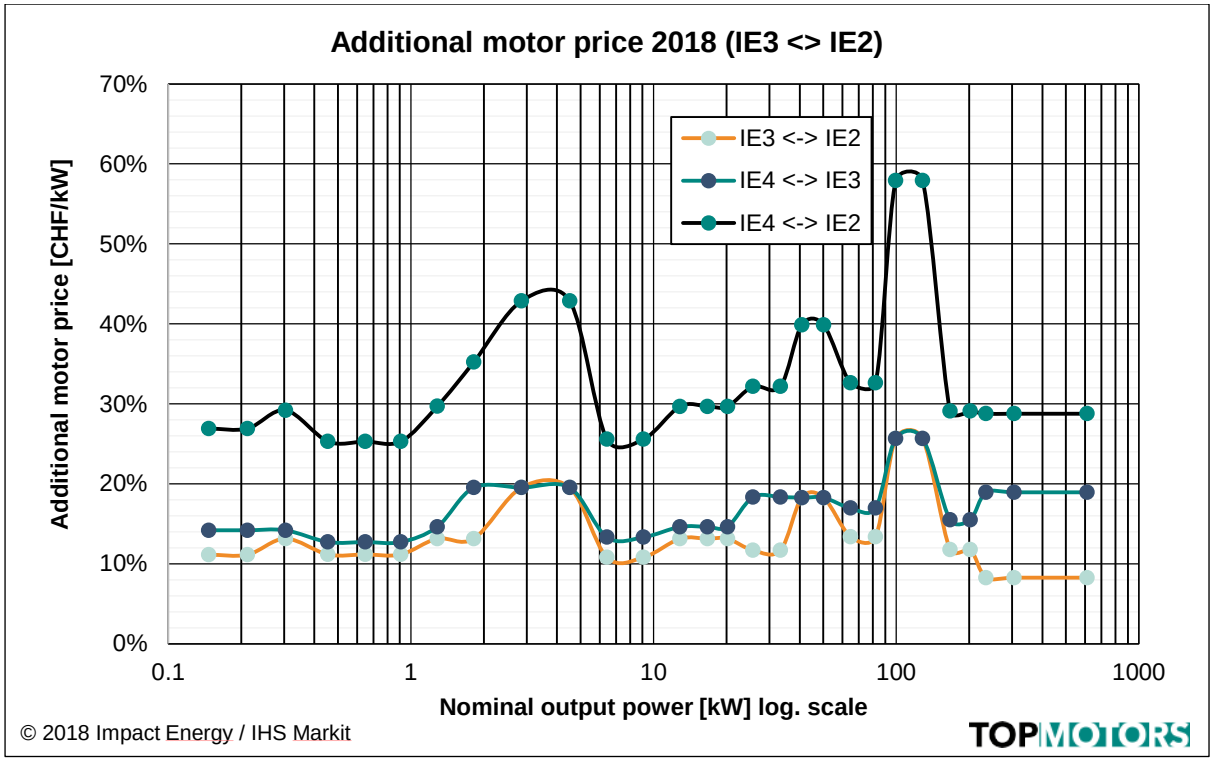

Figure 5 **Additional motor price by size category**

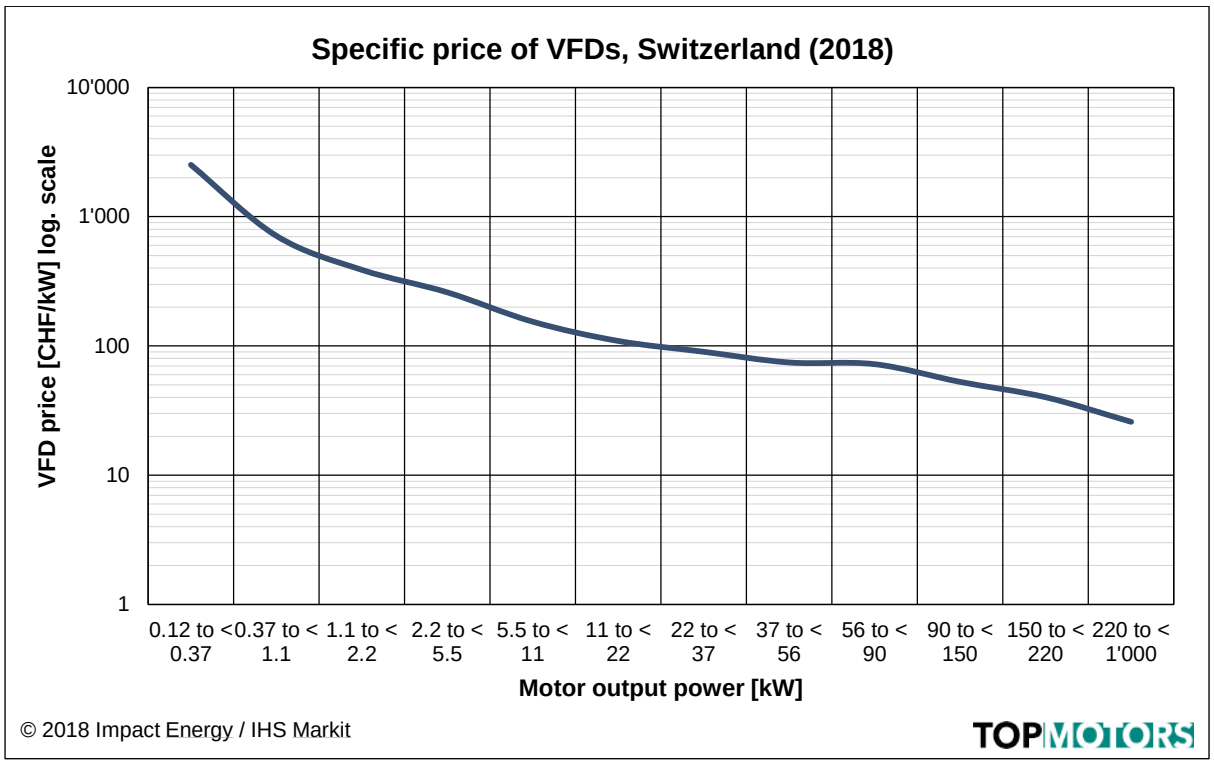

Figure 6 **Specific price of VFDs in Switzerland in 2018**

The average specific prices of VFDs rose by 5% in 2018 compared to 2017 (see Table 4).

Price of Variable Frequency Drives (USD/kW) average	
2017	356.6
2018	374.3
Additional price 2018/2017	**+5.0%**

Table 4 Average specific VFD prices in 2018 and 2017 (linear average value for 12 size classes)

Circulators in Switzerland and the EU

Glandless circulators are used to circulate water in a closed circuit, primarily in heating systems but also in cooling systems and other types of systems (they are not used for drinking water or waste water). In accordance with the EU's 2009 Ecodesign Regulation No. 641, a glandless circulator is a circulator where the shaft of the motor is directly coupled to the impeller and the motor is immersed in the pumped medium.

The Ecodesign Regulation for glandless circulators with hydraulic power of between 1 and 2'500 W has been in force in Europe since 2013. The Regulation was tightened in 2015. The implementation of this Regulation in Europe, and subsequently in Switzerland, prompted a major development in the market, which had a significant impact on energy considerations. The original technology was launched in Switzerland in 1993 by Jürg Nipkow[2]. The minimum requirements can only be met by using an integrated, high-efficiency pump, consisting of a variable frequency drive (VFD), permanent magnet motor and an efficient impeller.

In 2017, 187'004 circulators were sold in Switzerland. Of these, 96.8% had an energy efficiency index (EEI) of ≤ 0.23, i.e. they satisfied the minimum requirements of Annex 2.8 of the Swiss Energy Efficiency Ordinance (EnEV) for circulators with less than 2'500 W_{hydr}. The share of circulator sales in Switzerland is equivalent to 2.2% of the units sold in the European circulator market.

In 2017, 8'334'522 circulators were sold in the European Union. Of these, 82.4% had an EEI of ≤ 0.23, i.e. they satisfied the prevailing minimum requirements of EU Ecodesign Regulation 641/2009. Most of the circulators (85.4%) were smaller than 10 kW, and frequently even smaller than 2 kW.

	CH – compliance: 96.8%		EU – compliance: 82.4%	
	Switzerland		**European Union**	
Circulator	**Number**	**Share**	**Number**	**Share**
EEI > 0.23	5'984	3.2%	1'466'876	17.6%
EEI ≤ 0.23	181'020	96.8%	6'867'646	82.4%
Total	**187'004**	**100.0%**	**8'334'522**	**100.0%**
CH as share of EU	2.2%			

Table 5 Pump sales in Switzerland and the EU in 2017: circulators

The market transformation towards new, high-efficiency circulators can be described as exemplary. The development of the new technology of efficient circulators was followed by a rapid transformation of the market, first supported by a voluntary labelling programme. The circulator market was completely changed by a new, efficient technology within 20 years.

[2] Jürg Nipkow, Klein-Umwälzpumpe mit hohem Wirkungsgrad, Swiss Federal Office of Energy, 1994

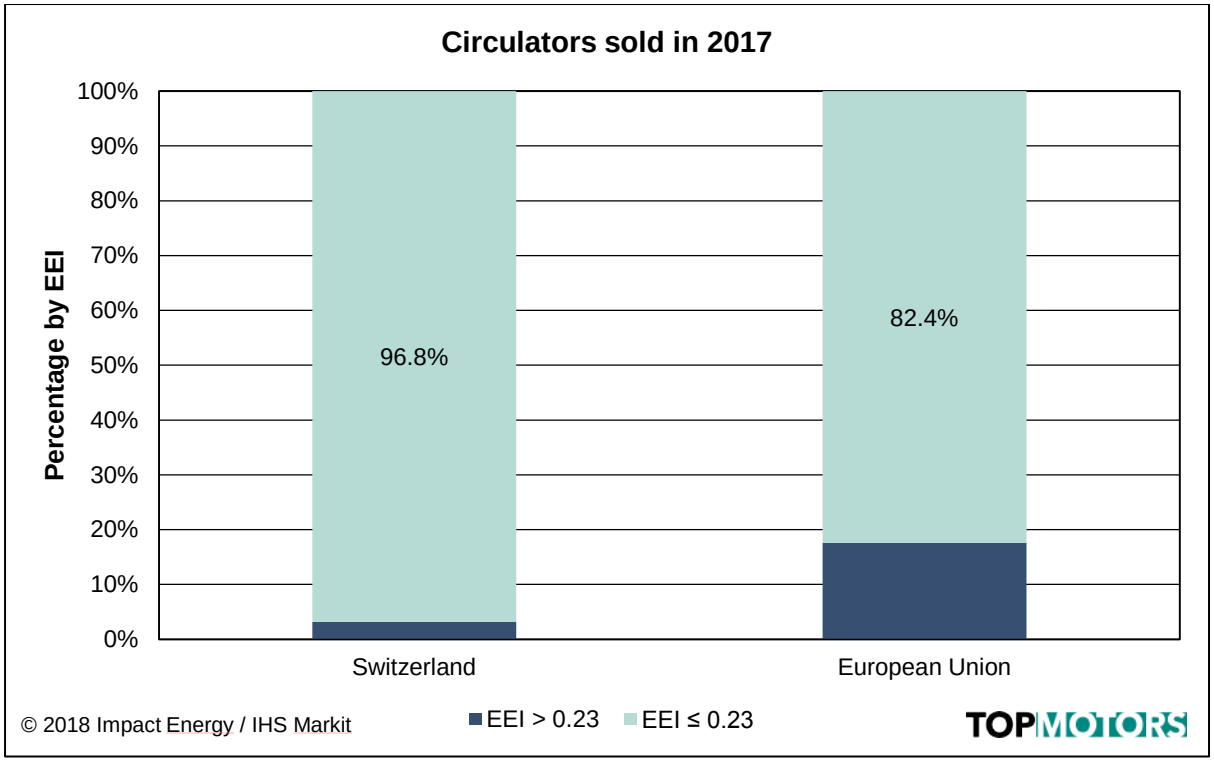

Figure 7 Share of sales of circulators according to EEI (≤ 0.23 is the minimum requirement for Switzerland and the EU)

Water pumps in Switzerland and the EU

Glanded water pumps are used in many different ways to transport liquids. Clean water is paramount (i.e. not waste water nor drinking water), axial, multistage and submersible pumps are used. The terminology of the five types of water pumps with a capacity of less than 150 kW, as specified by EU Ecodesign Regulation No. 547/2012 and also referred to in Annex 2.9 of the EnEV, are not yet very common among pump manufacturers and retailers (although this Regulation was adopted in 2012 and has been in force since 2013). According to IHS Markit, therefore, the relevant findings must be treated with some caution.

A distinction is made between the following five types of water pumps in the Regulation:

- ESOB: end suction own bearing
- ESCC: end suction close coupled
- ESCCi: end suction close coupled inline
- MS-V: vertical multistage
- MSS: submersible multistage

In 2017, 51’577 water pumps were sold in Switzerland. The vast majority of them met the minimum requirement of a minimum efficiency index (MEI) of ≥ 0.4 as set out in Annex 2.9 of the EnEV. Some pumps were even available with the higher MEI value of 0.7. Most of the pumps (91.0%) were smaller than 10 kW, and frequently were smaller than 2 kW. The share of water pump sales in Switzerland is equivalent to 1.9% of the units sold in the European water pump market.

A surprisingly high proportion (39.8%) of water pumps sold in Switzerland are submersible multistage pumps (MSS); in the EU, the figure is as high as 45%. These permanently installed or mobile pumps are used for a wide range of purposes, such as supplying water, irrigation (e.g. in agriculture), construction, swimming pools and aquariums. They are also used by fire services and disaster management personnel. This is clearly an important market segment. However, no ISO standards

currently exist for submersible pumps, nor are there any IEC standards for electric motors in submersed applications.

In 2017, 2,736,388 water pumps were sold in the EU. Of these, 85.4% were smaller than 10 kW. There are no figures for the share of pumps that meet the minimum requirement of a MEI of ≥ 0.4 as specified by EU Ecodesign Directive No. 547/2012.

	Switzerland		European Union	
Water pump	**Number**	**Share**	**Number**	**Share**
< 10 kW	46'934	91.0%	2'335'671	85.4%
> 10 kW	4'643	9.0%	400'717	14.6%
Total	**51'577**	**100.0%**	**2'736'388**	**100.0%**
CH share EU	1.9%			

Table 6 **Pump sales in Switzerland and the EU in 2017: water pumps**

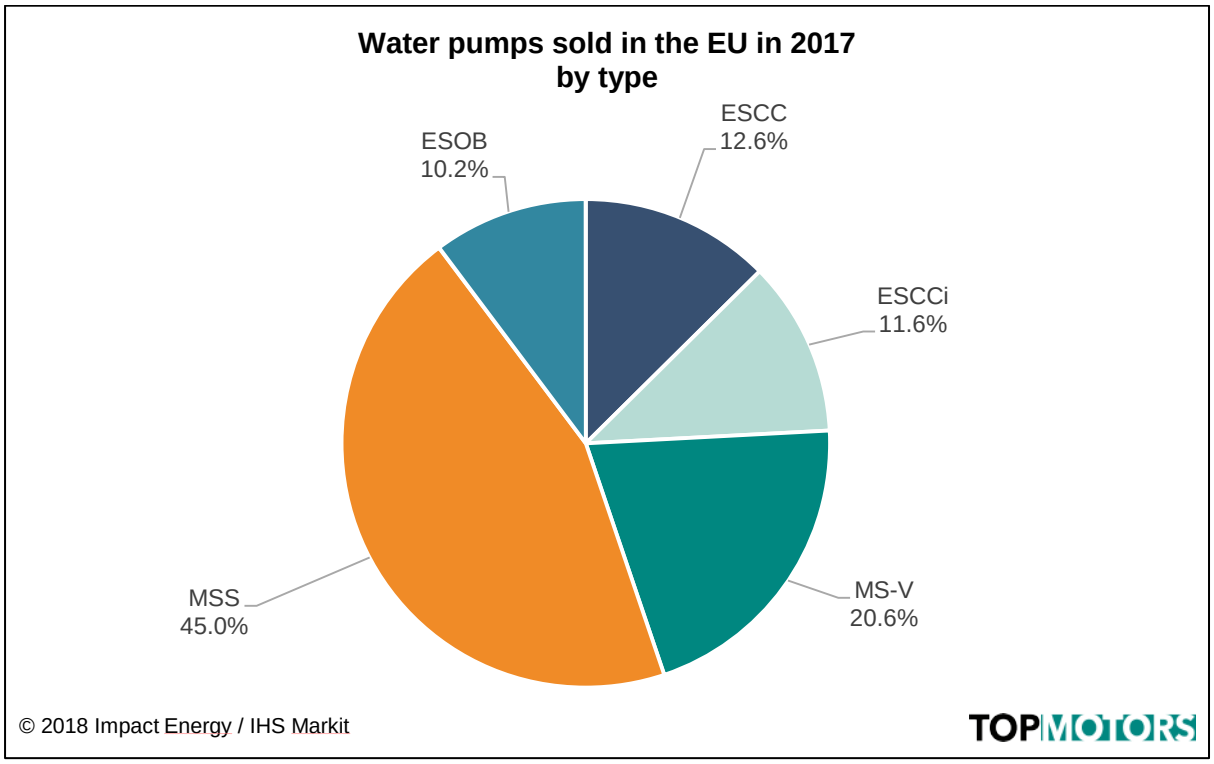

Figure 8 **Water pumps sold in the EU in 2017 by type**

Fans in Switzerland and the EU

A distinction is made between the following six fan types in the EU Ecodesign Regulation No. 327/2011:

- axial fans
- centrifugal forward-curved fans and centrifugal radial bladed fans
- centrifugal backward-curved fans without housing
- centrifugal backward-curved fans with housing

- mixed flow fans
- cross flow fans

In 2017, 170’259 fans were sold in Switzerland. Of these, 98.8% were smaller than 10 kW. Approximately 94% of the fans were used in homes, 5% were used in the service sector and 1% was used in industry. However, the fans used in homes are smaller and hence cheaper. The services and industry sectors account for around 45% of the sales volume of fans. Over 95% of the fans used in homes meet the minimum requirements specified in Annex 2.6 of the EnEV. The fans sold in Switzerland account for 0.7% of all fans sold in Europe.

In 2017, 24’096’950 fans were sold in the EU. Of these, 98.9% were smaller than 10 kW. Approximately 95% of the fans were used in households, 4.5% were used in the service sector and 0.5% were used in industry. The share of fans that meet the minimum requirements set out by EU Ecodesign Regulation No. 327/2011 is not known.

	Switzerland		European Union	
Fan	**Number**	**Share**	**Number**	**Share**
< 10 kW	168'250	98.8%	23'832'354	98.9%
> 10 kW	2'009	1.2%	264'596	1.1%
Total	**170'259**	**100%**	**24'096'950**	**100%**
CH share EU	0.7%			

Table 7 Total fan sales in Switzerland and the EU in 2017

In both Switzerland and the EU, the less efficient forward-curved fans and the centrifugal fans account for the largest share of sales by far: 51% of the Swiss market and 55% of the EU market respectively. The more efficient backward-curved fans, on the other hand, account for a share of only 21% in Switzerland and 19% in the EU.

This phenomenon is related to the structure of EU Ecodesign Regulation no. 327/2011, which evaluates each fan technology individually and does not promote only the best technologies in a “technology-neutral” way by allocating a generally valid efficiency value. Figure 9 shows the fan efficiency of the four different basic fan types.

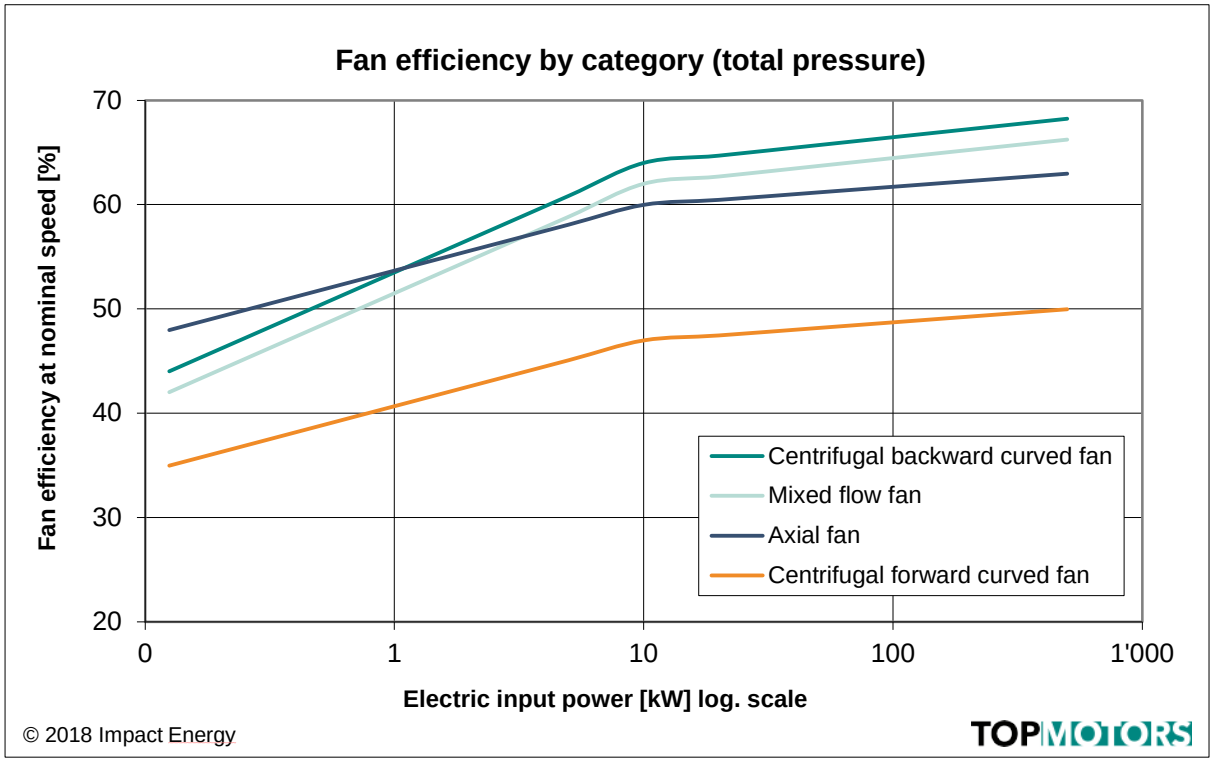

Figure 9 **Fan efficiency by type and size at maximum speed in accordance with EU Ecodesign Regulation No. 327/2011**

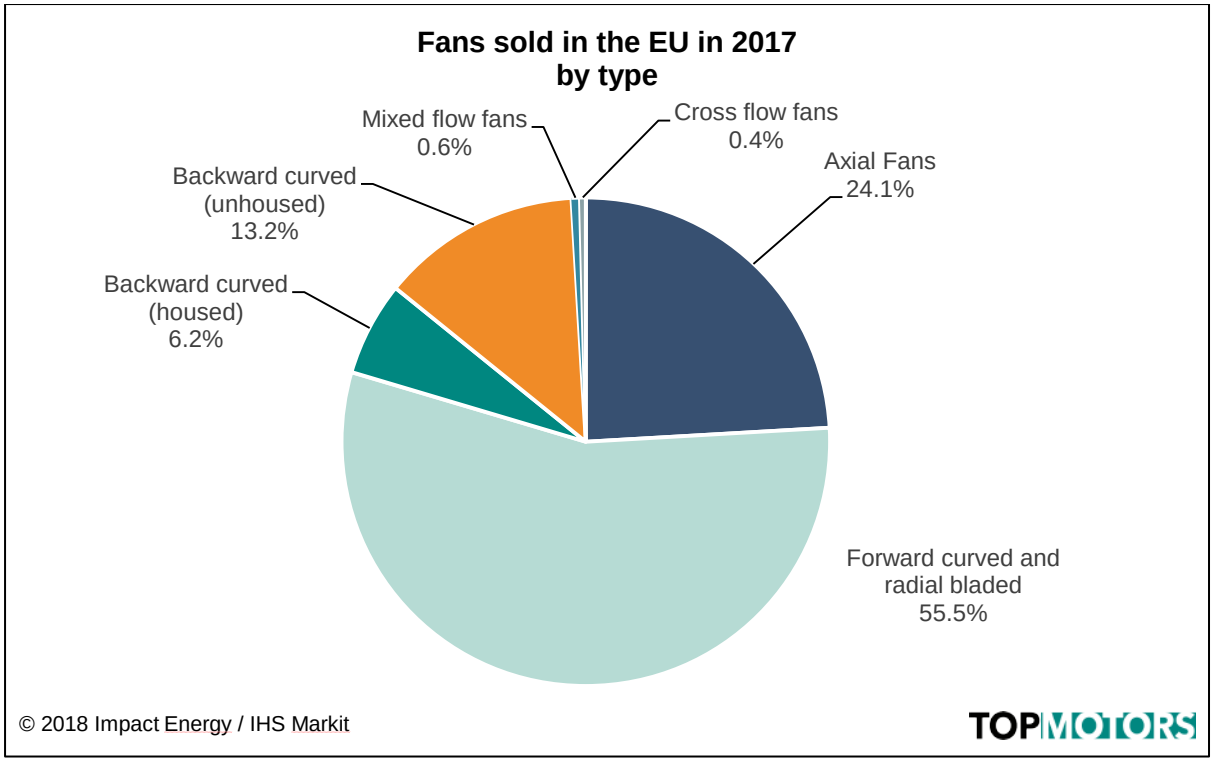

Figure 10 **Fans sold in the EU in 2017 by type**

Observations and recommendations

This study is the second of its kind to be conducted in Switzerland. The motor section in the Topmotors Market Report 2017 was enhanced and refined. The section on pumps and fans is new, as is the comparison with EU data.

The findings for the development of elements subject to minimum requirements in Switzerland are promising and must be monitored annually. The high share of IE3 and IE4 motors as well as the very high level of circulators is a positive confirmation of the ongoing market transformation. The available data for water pumps and fans are less clear to judge the state of the market transformation.

For motors, the expected entry into force of a revised Regulation no. 640 of the Ecodesign Directive means changes from 2021 (and in a second tier from 2023), establishing minimum requirements also for smaller (from 0.12 kW) and larger (up to 1,000 kW) motors as well as for VFDs.

For pumps and fans, this data, which has been collected for the first time, and the development of market shares, should be pursued in the coming years. In the case of fans in particular, market stimulation is needed for promoting the use of backward-curved fans with increased efficiency.

Outlook

The third Topmotors Market Report 2019 is currently under preparation and will be published in 2020, including data on motors and VFDs in Switzerland and the European Union as well as the analysis on pumps and fans in both Switzerland and the European Union.

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