ENERGY AND CO_2-IMPACT OF ECO-DESIGN REGULATION FOR FANS ON THE EUROPEAN MARKET

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SUMMARY

Fans are components in many different products and are regulated since 2011 in Eco-design regulation. A fan is typically not a final product but is used as a component in different application, systems, and products. This study shows that is targeting and helpful to regulate a component (possibly additionally) like a fan and not only a final product (whatever this might be) and that Eco-design regulation for fans is an important driver for energy efficiency and has a significant impact. Regulating fans as a component stimulates the availability of efficient fans at reasonable prices and drive efficiency also in cases where fans are implemented in other products where the fan efficiency is not dominating its performance. Since its first implementation 2013 the following savings in electrical energy have been achieved: 12 GW electrical power, 150 TWh electrical energy and 12 MT CO_2. This is significant and a good example for regulation.

INTRODUCTION

Fans are omnipresent in different products and application. Since 2011 Eco-design regulates minimum energy performance of fans above 125 W [2]. A fan in that meaning typically is not a final product but used as a component in different other products, systems, and applications. From the very beginning, questions have been raised, whether it is helpful to regulate a component and not a final product only (Figure 1). But so called “cascading” is a well-established element in regulation. It ensures the availability of cost effective and efficient components for the downstream products, which are also again components for the next step (motor → fan → ventilation unit, heat pump or chiller → technical building system → building). The main important aspect in this principle is, that the requirements for each product in the chain, are guiding in the right direction for all following chain links. This study analysed the European market transformation for fans from the beginning of the regulation 2012 until 2020 and estimates the energy savings achieved influenced by the regulation. Additionally, an estimation of the share of fans placed on the European market in other Eco-design regulated products (ventilation units, air heating/cooling devices, chillers, RAC, refrigeration) has been made.

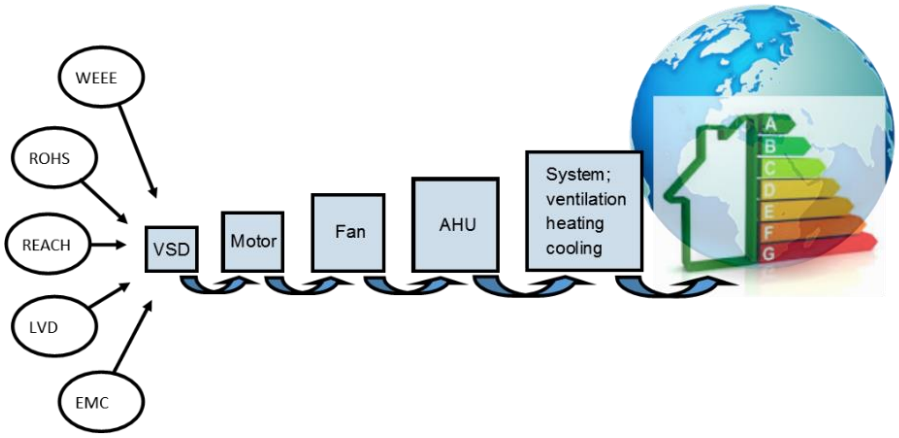

Figure 1: Multiple Regulation - Cascading

In 2018, we produced a questionnaire to determine the energy savings aspects of the Eco-design Regulation EU 327/2011 in relation to the estimated market size and this have been published [1][2][2] and presented to the relevant stakeholders in the European Commission and industry partners. The documents have also been used in several publications issued by political institutions. In 2019, EVIA's Fans Working Group agreed to update the questionnaire to reflect the most recent data and provide estimates for 2020 and 2025. One of the reasons for this restart was, that the revision of the fan regulation with important clarifications and an update of minimum requirements was presented in 2017, but was not finalised until now, although the industry and the market expected this. Possibly significant energy savings CO_2-reductions lost for many years. The basis for the energy savings estimations considered the possibly upcoming revision of regulation EU 327/2011.

METHOLOGY OF DATA COLLECTION AND ANALYSIS

Current general available data on sales of fans did not consider the energy performance of the fans nor a detailed sizing when placing on the market. So, we developed a special questionnaire as a basis for the following market impact estimations which is simple enough to allow manufacturer to answer the questions with an acceptable effort but also allowing to determine the answers we needed. The framework of the analysis. The data are given for EU-28 (including UK) market when placing on the market the fan and we collected the data of fan manufacturers representing approx. 33 % of estimated market size in EU-28 in piece for different fan sizes (el. fan power). These results have been extrapolated to the estimated market size taken from EU LOT 11 studies [4]. The typical power savings, defined for each fan size groups for each year, lead to energy savings by considering 4,000 operating hours per year for each fan, which was estimated as a good average of all fan applications, but clearly has significant uncertainty. The CO_2-factor for electricity of 460 g $CO_2/kWh_{Electricity}$ was used for CO_2 savings calculation. The saving estimations made are based on Best Efficiency Point BEP (optimistic) but not including variable speed drive (conservative). The study does not include very big fans >> 22 kW (lack of information and only few data available), no jet fans (no suitable performance data in the regulation) and no fans below 125 W_{el} (outside the scope). It does also not include special industrial fans like dust conveying fans, high pressure low flow fans (HPLV) and other special application.

We had weak information about fans placed in the market integrated in other products, which are manufactured completely outside EU. This is valid for our questionnaire but as well for the data about the market we used as a basis ([4][5]).

The energy performance for the fans has been divided for the questionnaire in 4 groups:

1. Fans not complying with 2013 limit of EU 327/2014 [5].
2. Fans complying with 2013 limit, but not with 2015 limit.
3. Fans complying with 2015 limit or better (until 2017) and not complying with the expected limit of the revision (called 202x) of EU 327/2011 (from 2018 on)
4. Fans complying with the expected limit for revision 202x (Table 1).

Data have been collected and divided into the following design groups and sizes:

- Design (some manufacturer could only provide data as a mix of axial, radial and other fans – split was done according to an average share of all)
  - Axial fans
  - Radial fans (including others)
- Sizes (some manufacturer could only deliver a mix of different sizes – split was done according to an average share of all)
  - 125 W $\leq$ x < 375 W $P_{el,av}$ = 250 W
  - 375 W $\leq$ x < 750 W $P_{el,av}$ = 560 W
  - 0.75 kW $\leq$ x < 3 kW $P_{el,av}$ = 1.88 kW
  - 3 kW $\leq$ x < 11 kW $P_{el,av}$ = 7.0 kW
  - x $\geq$ 11 kW $P_{el,av}$ = 18 kW

Table 1: Expected Minimum Requirements for Fans EU 327/2011 Revised

Fan type	**Measurement category[1]**	**Pressure**	**Efficiency grade[2] N**
Axial	A, C	static	0.50 (0.48)
	B, D	total	0.64 (0.60)
Forward curved and radial < 5 kW	A, C	static	0.52
	B, D	total	0.57
Forward curved and radial ≥ 5 kW, Backward curved	A, C	static	0.64
	B, D	total	0.67
Mixed flow	A, C	static	$0.57+0.07\cdot(\alpha-45)/25$
	B, D	total	0.67
Cross flow	B, D	total	0.21
Jet Fans	E	-	0.50
[1] ISO 5801 [2] Factor according EU 327/2011 revised			

RESULTS FROM MARKET QUESTIONNAIRE

Fans placed on the market

In 2012 approx. 8.8 Mio fans within the EU 327/2011 scope have been placed on the market. We see a steady growth up to 12.5 Mio in 2019. In 2020 sales decreased slightly possibly caused by Covid-19 lockdowns (Figure 2). In 2012 nearly 50 % of the fans did not comply with the 2015 limits, which changed until 2015, where only a few fans did not comply. Considering exports outside EU for downstream products and spare parts, there is always a stock of non-complying fans. Revision of the fan regulation EU 327/2011 was expected to come into force around 2018, so we see a drastic change to 202x compliant products in 2018. The correct shape could not be determined, because until 2017, data could not be split into 2015 and 202x limit (dotted line). It is

remarkable, that we see no further replacement of 2015 limit fans from 2018 on. This is different from the situation we had 2012 to 2015. We assume a push back situation because the market expects the revised regulation, and it was not published (and it is not until now). We even see a slightly decrease of 202x compliant fans.

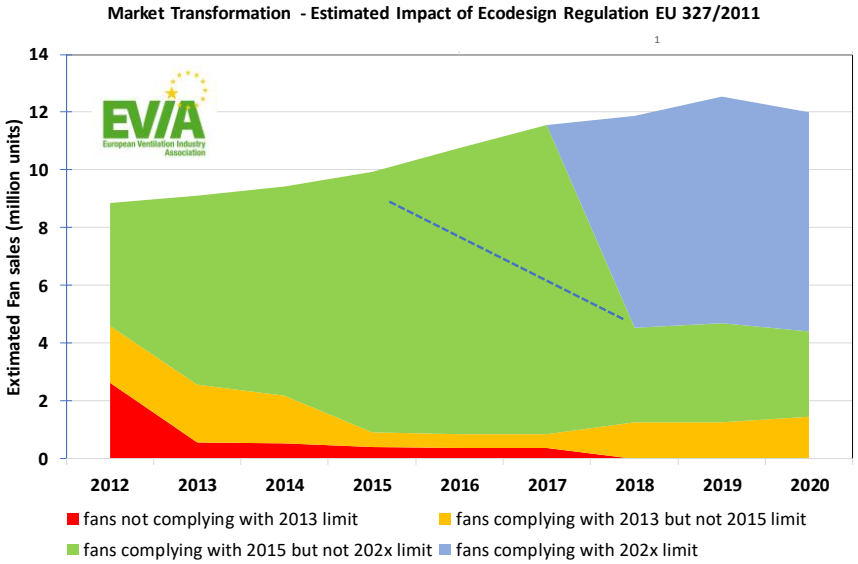

Figure 2: Estimated fans placed on the EU market 2012 - 2020 and their efficiency class

Size and design of fans

More than 50 % of the fans placed on the market are between 125 and 375 W_{el} but this does not reflect the energy impact of this size (Figure 3). Figure 4 shows the relative energy impact based on pieces multiplied with the average power of each group. From an energy consumption perspective, the size from 3 to 11 kW is the domination group (approx. 15 % in pieces but 60 % in energy impact). Still reasonable is also the smaller product group caused by its high number of pieces. Form a political perspective (regulate the energy dominating product group) the fan size from 0.75 to 11 kW is key and smaller fans caused by the absolute quantity. We did not question smaller sizes of fans below 125 W, so we cannot give any information, whether it would be reasonable to implement these fans in the regulation.

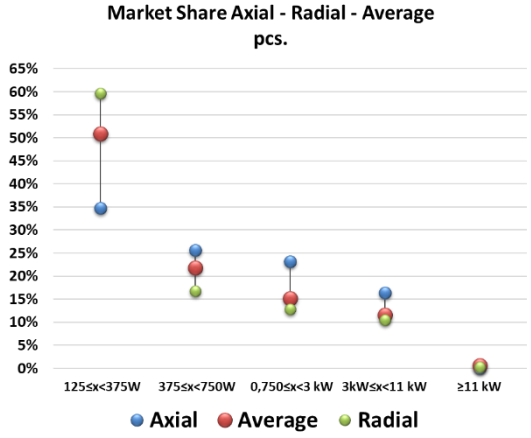

Figure 3: Market share radial axial and sizes based on pieces

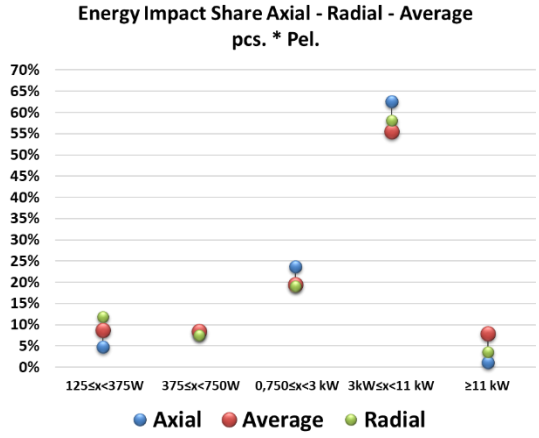

Figure 4: Market share radial - axial and sizes based on pieces multiplied by power

Savings per fan

The electrical power savings per fan have been determined as follows: From 2012 to 2017 each participating company estimates example efficiency improvements in each size group for its product portfolio. The weighted average over all fans and companies is used for the energy savings calculation. From 2018 on, the savings per fan have been calculated to the reference of 2013. This means the fan efficiency was calculated for axial and radial fans in each size group with 2013 limits as the basis. Improvement for each group is the efficiency difference of 2015 or 202x limits to 2013 limits weighted by overall fans and companies. Example for axial fans see Table 2.

Table 2: Power savings per fan based on Eco-design limits (example axial fan Cat A,C)

Axial Fan	2013	2015	202x	Power Savings [kW]	
	η (eta)			2013 → 2015	2015 → 202x
$P_{el.av}$	N = 36	N = 40	N = 48		
0.25	0.259	0.299	0.312	0.03	0.01
0.55	0.280	0.320	0.348	0.07	0.04
1.875	0.314	0.354	0.404	0.21	0.23
7.0	0.350	0.390	0.464	0.72	1.11
18.0	0.364	0.404	0.491	1.78	3.20

Summarizing and weighting for all fans, sizes and companies Figure 5 shows the average saving for each fan placed on the market in each single year (orange line). The blue line beyond is showing the average savings summarised from 2012 on saying for all fans placed on the market since 2012. Based on an outlook to 2025 given by some companies, the scenario was extended up to 2025. Significant savings will be still possible.

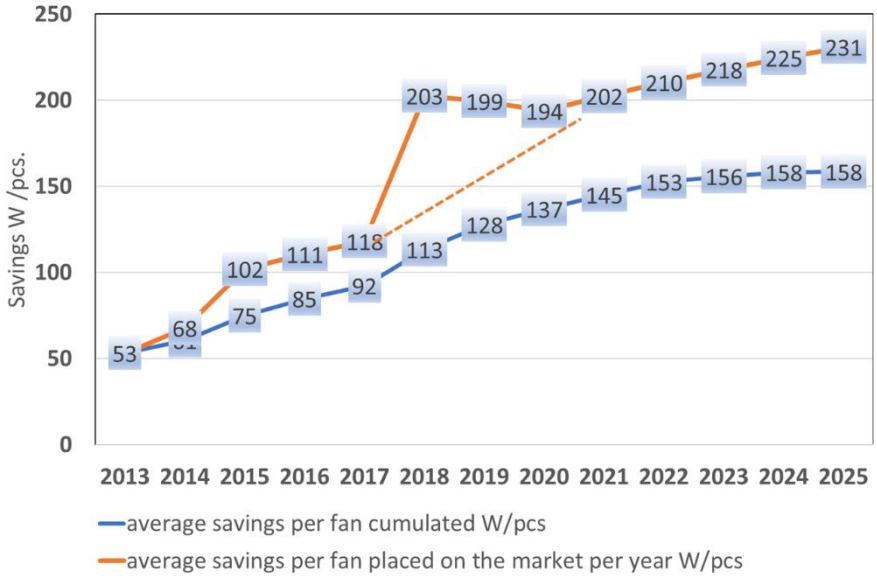

Figure 5: Average savings per fan placed on the market

Energetic success of the Eco-design Regulation since coming into force 2013

Since the beginning of Eco-design regulation the need to regulate a “component” like fan was challenged, because it is mainly not a final product placed on the market to be used as such. Most of the fans are integrated somehow in other products or systems, which are partly covered by other regulation. Also, the average power saved per fan (over all sizes in the scope of the regulation) does not seem to be very high. But we have to consider the huge number of fans (12,5 Mio in 2019) and

their typical long operation time. Just a simple example for 2019: 12,5 Mio fans placed on the market with 200 W average savings is 2 500 MW electrical power savings in this year in EU-28. Cumulating the achieved savings from 2012 on (first tier of Eco-design 3027/2011) it is 12 GW or 12 big power stations or 150 TWh electricity saved (Figure 6). CO_2-emission reduction of approx. 12 MT have been achieved since 2012 until 2020 (Figure 7).

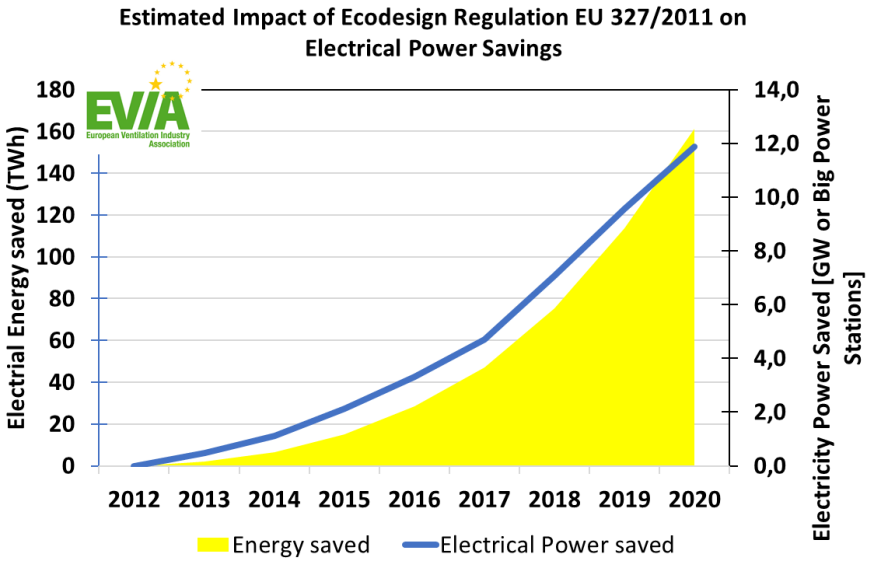

Figure 6: Electrical power savings of fans cumulated from 2012

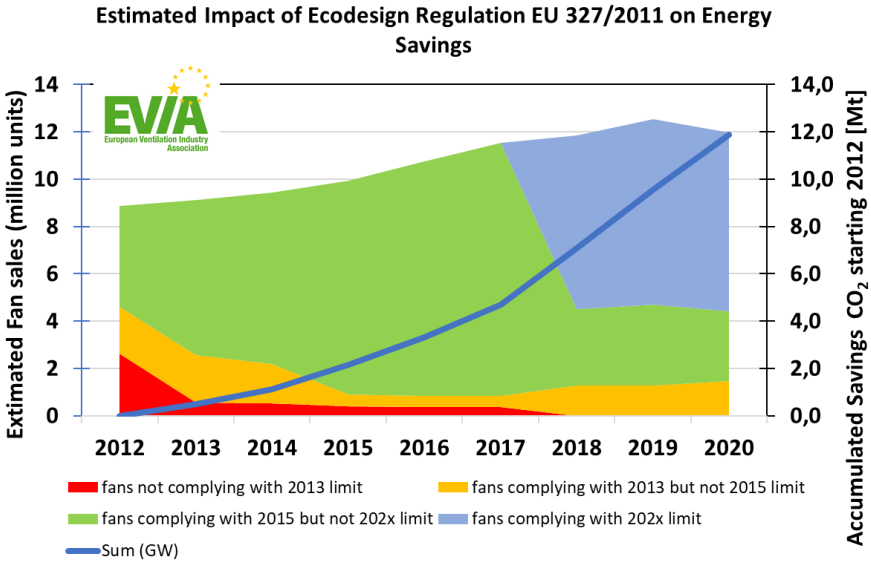

Figure 7: Fan sales per year and cumulated CO_2 savings from 2012

FANS IMPLEMENTED IN OTHER PRODUCTS

We asked manufacturer 2017 and 2020 on a qualitative way, how much of their fan sales are estimated to be used or implemented in other Eco-design regulated products and how much are placed on the market to be implemented or use in not regulated applications and products. This questionnaire has high uncertainty, because same fan might be used in regulated or non-regulated products downstream. So, this is just a qualitative impression of the manufacturers weighted by their estimated market share. Figure 8 shows the result of the questionnaire having an average of

28 % of fans integrated in other products. Different for each fan manufacturer depending in their product range and customers from 5 to 35 %. The top-down approach by analysing the sales of ErP products with a significant number of fans implemented (ventilation units, air heating and chillers, heat pumps, room air conditioner and professional refrigeration) leads to 32 % of the fans, implemented in ErP regulated products. The questionnaire 28 % and the top-down-analysis 32 % is in the same range, so this seem reasonable.

The questionnaire of 2020 in Figure 9 gives similar results for 2017 and a shift to ~50 % of fans integrated in other ErP regulated products. One of the reasons for that shift is, that other regulation like EU 2281/2016 on air heating and cooling devices, EU 1188/2015 on warm air heaters and EU 1253/2014 on ventilation units came into force. But still 50 % of fans are integrated in non-regulated products.

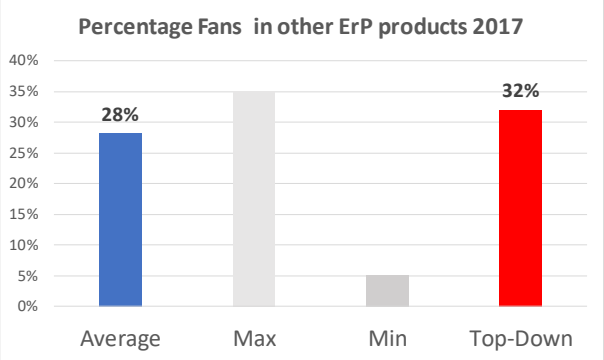

Figure 8: Fans implemented in other Eco-design regulated products 2017
Questionnaire and top-down statistical analysis

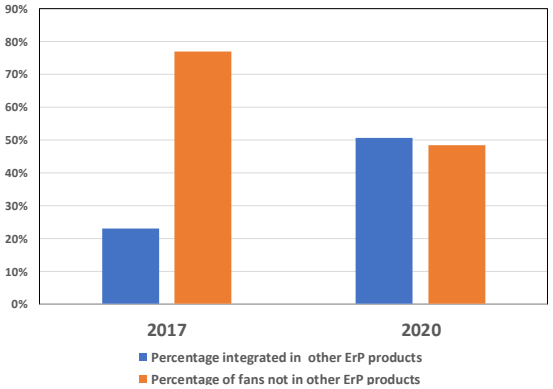

Figure 9: Fans implemented in other Eco-design regulated products 2017 and 2020

CONCLUSION

This study shows, that the Eco-design regulation on fans is an important driver to higher efficient products and components. The transformation of the market to more efficient products is quite quick, but it clearly follows the upgrade of the regulation. We saw that a stop or interruption of the progress of the revision immediately stops the transformation progress to more efficient fans. This happens in 2018 when the planned revision of EU 327/2011 was interrupted for nearly 4 years up to now.

It is important to regulate components like fans even though they might be implemented in other energy related products. Reasons are: Availability of efficient products at reasonable prices, less options to bypass the regulation by implementing the fans outside EU-market into other products. Significant savings would be lost.

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