TECHNICAL GUIDE

ErP DIRECTIVE
LOT 11
FANS AND MOTORS

Climate and energy policy, what is the ErP Directive, motor and fan efficiencies

VES
Better air for the built environment

CLIMATE AND ENERGY POLICY, WHAT IS THE ErP DIRECTIVE, MOTOR AND FAN EFFICIENCIES

To combat electricity usage and reduce carbon output in Europe the following measures have been put in place to help with significant reductions to energy consumption.

Climate and Energy Policy

In March 2007, the EU's leaders endorsed an integrated approach to climate and energy policy. They committed Europe to transforming itself into a highly energy-efficient, low carbon economy.

To kick start the process, the EU Heads of State and Government set a series of demanding climate and energy targets to be met by 2020:

- 20% reduction in greenhouse emissions
- 20% increase in renewable energy resources
- 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

ErP Directive

The Energy related Products Directive (ErP) was enforced, with the aim to reduce energy across the supply chain of energy related products, introducing efficiency standards for the installation of electric motors and fans.

European Directives applicable to electric motor and fan efficiency:

Ecodesign Directive	(2005/32/EC) energy using products (EuP) *- Commission Regulation (EC) No 640/2009 - Ecodesign requirements for **electric motors.***
Ecodesign Directive	(2009/125/EC) extension to energy related products (ErP) *- Commission Regulation (EU) No 327/2011 - Ecodesign requirements for **fans** driven by motors with an electric output between 125 W and 500 kW.*

Legislative requirements for HVAC systems

Components, such as fans and motors, used in the air handling industry are included in the Ecodesign Directive. They will need to meet or exceed the requirements set out by the EC.

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Electric Motor Efficiencies

Ecodesign Directive	(2005/32/EC) energy using products (EuP) *- Commission Regulation (EC) No 640/2009 - Ecodesign requirements for **electric motors.***

From 1st January 2015, motors with a rated output of 7.5 to 375 kW shall not be less efficient than the IE3 efficiency level, or shall meet the IE2 efficiency level, whilst used with a variable speed drive.

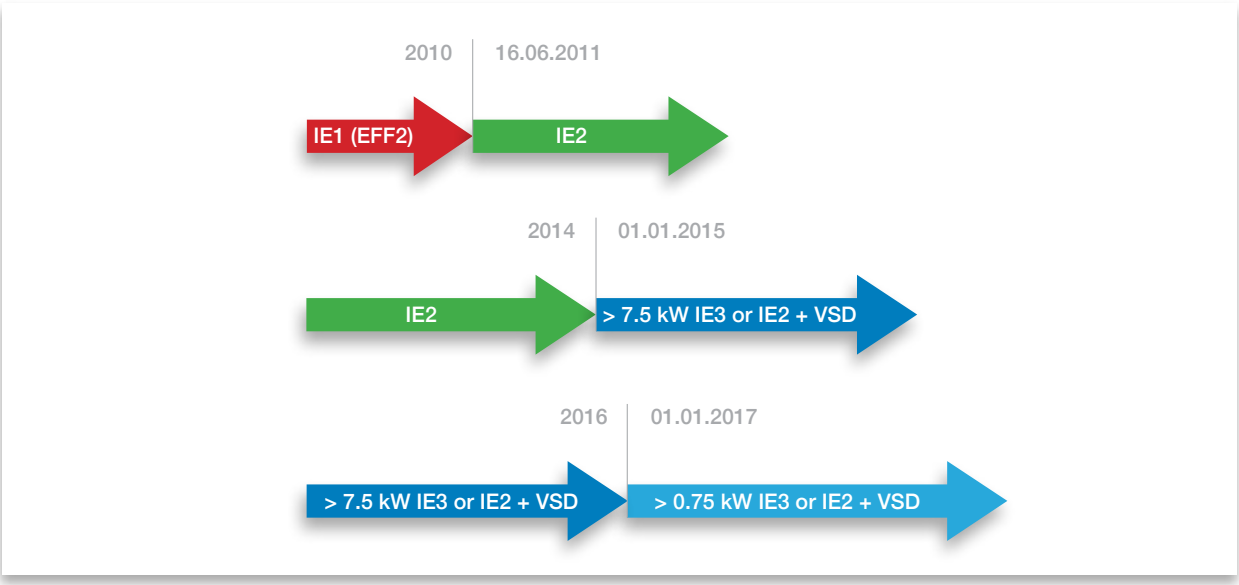
Variable Speed Drive (VSD):

- Paraphrasing, this is defined in the regulations as a controller which is able to continuously adapt the power to the motor, but not by means of only varying the voltage applied to the motor
- In simple terms, a VSD is an inverter, which uses variable frequency and voltage to control motor power and speed
- The regulations allow VSDs to be used as a means of effectively increasing the efficiency of fans
- This means that for some fans, they will only be ErP compliant if used in conjunction with a VSD

IE ratings

The requirements laid out by Ecodesign for all IEC electric motors are:

- From 16th June 2011, motors can be no less efficient than IE2 level
- From 1st January 2015, motors rated output of 7.5 to 375 kW shall be no less efficient than IE3 level, or meet IE2 level using a variable speed drive (VSD)
- From 1st January 2017, motors with a rated output of 0.75 to 375 kW shall be no less efficient than IE3, or meet IE2 level using a VSD



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Minimum FMEG efficiency requirements:

Nominal minimum % efficiencies for IE2 efficiency level (50 Hz)

Rated output power (kW)	Number of poles		
	2	4	6
0.75	77.4	79.6	75.9
1.1	79.6	81.4	78.1
1.5	81.3	82.8	79.8
2.2	83.2	84.3	81.8
3	84.6	85.5	83.3
4	85.8	86.6	84.6
5.5	87.0	87.7	86.0
7.5	88.1	88.7	87.2
11	89.4	89.8	88.7
15	90.3	90.6	89.7
18.5	90.9	91.2	90.4

Rated output power (kW)	Number of poles		
	2	4	6
22	91.3	91.6	90.9
30	92.0	92.3	91.7
37	92.5	92.7	92.2
45	92.9	93.1	92.7
55	93.2	93.5	93.1
75	93.8	94.0	93.7
90	94.1	94.2	94.0
110	94.3	94.5	94.3
132	94.6	94.7	94.6
160	-	-	-
200-375	94.8	94.9	94.8

Nominal minimum % efficiencies for IE3 efficiency level (50 Hz)

Rated output power (kW)	Number of poles		
	2	4	6
0.75	80.7	82.5	78.9
1.1	82.7	84.1	81.0
1.5	84.2	85.3	82.5
2.2	85.9	86.7	84.3
3	87.1	87.7	85.6
4	88.1	88.6	86.8
5.5	89.2	89.6	88.0
7.5	90.1	90.4	89.1
11	91.2	91.4	90.3
15	91.9	92.1	91.2
18.5	92.4	92.6	91.7

Rated output power (kW)	Number of poles		
	2	4	6
22	92.7	93.0	92.2
30	93.3	93.6	92.9
37	93.7	93.9	93.3
45	94.0	94.2	93.7
55	94.3	94.6	94.1
75	94.7	95.0	94.6
90	95.0	95.2	94.9
110	95.2	95.4	95.1
132	95.4	95.6	95.4
160	95.6	95.8	95.6
200-375	95.8	96.0	95.8

Exemptions from the regulation

There are certain exceptions from these requirements:

- Brake motors
- Motors designed to operate wholly immersed in a liquid
- Motors complete integrated into a product (for example, gear, pump, fan or compressor), where the motor performance cannot be tested independently
- Motors specifically designed to operate:
  - at altitudes exceeding 1,000 metres above sea level
  - where ambient air temperatures exceed 40 °C
  - with a maximum operating temperatures above 400 °C
  - where ambient air temperatures are less than –15 °C for any motor, or less than 0 for a motor with air cooling
  - where the water coolant temperature at the inlet to a product is less than 5 °C or exceeds 25 °C
  - in potentially explosive atmospheres, as defined in Directive 94/9/EC

CLIMATE AND ENERGY POLICY, WHAT IS THE ErP DIRECTIVE, MOTOR AND FAN EFFICIENCIES

Fan and motor assemblies – ErP Compliance and FMEG

Ecodesign Directive	(2009/125/EC) extension to energy related products (ErP) *- Commission Regulation (EU) No 327/2011 - Ecodesign requirements for **fans** driven by motors with an electric output between 125 W and 500 kW.*

Fan Motor Efficiency Grade (FMEG) is a system whereby fans of all types are graded. The basis of the FMEG is the optimum or maximum efficiency of the fan, calculated as:

Fan Efficiency (%) = Air flow (m^3/s) x Pressure (Pa)/Motor input power (Watts)

The pressure can be either static or total (depending on the fan test method used).

There are three important exemptions to ErP compliance:

- Motors with less than 125 watts
- Fans used to move air or gases at temperatures exceeding 100 °C
- Placed on the market before 1st January 2015 as a replacement for identical fans integrated in products which were placed on the market before 1st January 2013

It is the responsibility of the manufacturer to ensure that the finalised fan motor assembly complies with legislation and meets the required efficiency level. The two main components that have a large effect are:

- The motor
- The transmission

The formula to calculate the FMEG grade for a forward curved fan in a housing is:

$$N = 2.74 \times \ln(P) - 6.33 - \eta e$$

And to calculate the FMEG grade for a backwards curved fan with no housing is:

$$N = 4.56 \times \ln(P) - 10.5 - \eta e$$

Where:

N is the FMEG grade

P is the input power in kW

ηe is the optimum or maximum efficiency percentage

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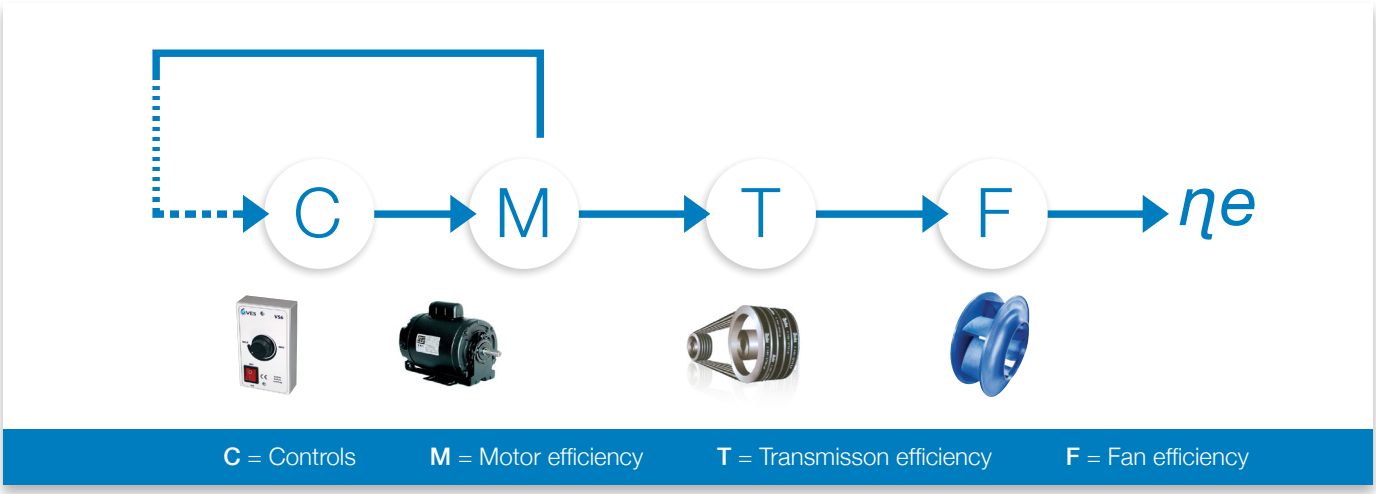
The overall efficiency (ηe) is the product of all the components efficiencies included in the fan assembly. The formula for calculating this is shown below:

$$\eta e = \eta r \times \eta m \times \eta t \times C_m \times C_c$$



Where:

N is the optimum efficiency of the bare shaft fan

P is the motor efficiency

ηe is the transmission

ηe is a compensation factor defined by ISO 12759 to account for the sub optimal matching of components

This factor is 0.9

C_c is the part load compensation factor.

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Consider power range 0.125 to 10 kW range, non-discharge ducted axial fan (categories A&C as referenced below)

Target efficiency (η_{target}) = 2.74 x ln(P.) - 6.33 + N

Natural of electrical input power

Efficiency grade

Let input power = 2.5 kW

Category 'A' (non-ducted) so for 2015, N=40

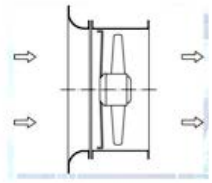
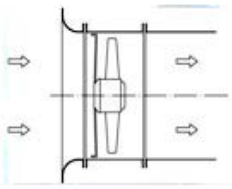
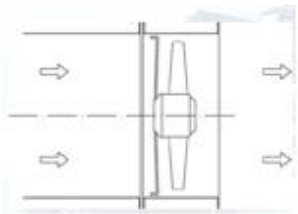
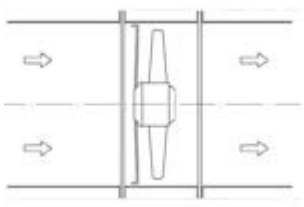
Target efficiency (η_{target}) = 2.74 x ln (2.5) - 6.33 + 40

= 2.74 x 0.9163 - 6.33 + 40

= 36.2%

FMEG - Installation Categories

Fan installations are divided in to four categories of position with regards to inlet and outlet and whether they are ducted or non-ducted. The table below show the four categories:

Category A	Category B
	
Free (non-ducted) inlet Free (non-ducted) outlet	Free (non-ducted) inlet Ducted outlet
Category C	**Category D**
	
Ducted inlet Free (non-ducted) outlet	Ducted inlet Ducted outlet

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The table below shows the minimum energy efficiency requirements for fans from 1st January 2015

Fan Type	Measurement Category (A-D)	Efficiency category (static or total)	Efficiency Grade (N) 2013 (%)	Efficiency Grade (N) 2015 (%)	Target Efficiency	Target Efficiency	Product
Axial Fans	A, C	static	36	40	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6.33 + N$	
					$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1.88 + N$	
	B, D	total	50	58	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6.33 + N$	
					$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1.88 + N$	
Centrifugal forward curved fan and centrifugal radial bladed fan	A, C	static	37	44	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6.33 + N$	
					$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1.88 + N$	
	B, D	total	42	49	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6.33 + N$	
					$10 < P \leq 500$	$\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$	
Centrifugal backward curved fan without housing	A, C	static	58	62	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10.5 + N$	
					$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2.6 + N$	
Centrifugal backward curved fan with housing	A, C	static	58	61	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10.5 + N$	
					$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2.6 + N$	
	B, D	total	61	64	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10.5 + N$	
					$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2.6 + N$	
Mixed flow fan	A, C	static	47	50	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10.5 + N$	
					$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2.6 + N$	
	B, D	total	58	62	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10.5 + N$	
					$10 < P \leq 500$	$\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$	
Crossflow fan	B, D	total	13	21	$0{,}125 \leq P \leq 10$	$\eta_{target} = 1{,}14 \cdot \ln(P) - 2.6 + N$	
					$10 < P \leq 500$	$\eta_{target} = N$	

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To comply with the ErP the fan must be equal to or greater than the FMEG levels defined in the Directive. Each fan type has its own FMEG level. The method used to test the fan also alters the FMEG target levels.

The Directive's initial FMEG levels came into force on 1st January 2013 (ErP2013). Following this, a second enhanced FMEG level has come into force on 1st January 2015 (ErP2015).

Exemptions from the regulation

All standard fans are subject to ErP regulations. However there are several fan applications that are exempt from ErP Regulations. These are listed below:

- Fans in vehicle applications for the transportation of people or goods
- Fans with an optimum efficiency at speeds of 8,000rpm or higher
- In applications in which the 'specific ratio' is over 1.11
- Fans used in the conveyance of non-gaseous substances in industrial applications
- 'Smoke-extract' type fans

The introduced legislation applies to all fan manufacturers and ventilation manufacturers that assemble fan assemblies.

VES can provide all units with ErP 2015 compliant fans with some products using 2017 compliant fans.

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