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APPLiA and Eurovent considerations on SD and FDD air conditioners

In a nutshell:

In this position we would like to provide data and information supporting the impact assessment under preparation by the Commission, related to the revision of the Lot 10 products. We have collected information that should help in assessing the base case and the minimum energy efficiency and labelling requirements for Single Duct (SD) and Fixed Double Duct (FDD) air conditioners.

In particular, this PP aims to clarify:

- that there is no market competition between FDD and split air conditioners;
- that there is no market competition between SD and split air conditioners;
- the possible future technological improvement for FDD and SD.

1. Preamble

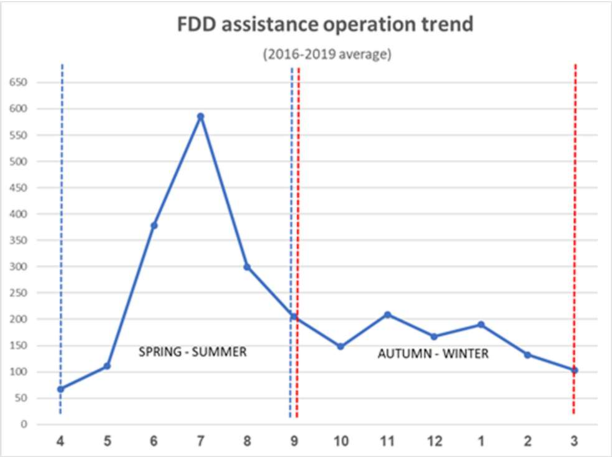
This paper was initiated to answer a request by the Commission for data to further analyse some of the products covered by the Lot 10 preparatory study. One of the reasons for this request is that the ecodesign preparatory study did not assess any base case for Fixed Double Duct air conditioners.
The contents of this document apply to Portable Single Duct air conditioners and Fixed Double Duct air conditioners. The same conclusions apply also to Fixed Single Duct air conditioners as well as to Portable Double Duct air conditioners.

2. No competition between FDD/SD and split air conditioners

3.1 Fixed Double Duct air conditioners

3.1.1 Real life usage/customer behavior

FDD air conditioners work for a limited number of days during the summer and/or winter season. This can be deducted by analysing the below graph. It assesses the trend in the number of assistance operations (average number of calls for failures in the period 2016-2019) performed on FDD per month by the after sales service of one of the major EU manufacturers. Since the assistance operations are linked with the usage pattern (the higher is the use the higher is the probability of the need of assistance), we can consider the trend as a good proxy of the usage of these appliances. During the spring-summer season the calls for maintenance were 2.5 times higher than during the autumn-winter season.



Furthermore, according with an end user survey performed in Italy (October 2019)[1], 86,1% of the respondent declares to use the FDD unit (with the heat pump) only in the April-September period. Among those (13,9%) that declare to use the FDD also in heating mode, only 24% has no other primary heating system. This means that only about 3,0% of the FDD owners interviewed are using the product as primary source of heating.

The evidence is that FDD air conditioners are mainly dedicated to cooling purposes (specifically only during the summer peaks) even when equipped with a HP.

This is also reflected in the standard EN14825, indicating that: *"It applies to factory made units defined in the EN 14511, **except single duct, double duct**, control cabinet and close control units."*

[1] *Source data are available upon request*

3.2 Single Duct air conditioners

3.2.1 Real life usage/customers' behavior

In December 2019 the digital market research and technology company Toluna (an itwp company) has performed an extensive market research study (interview sample: 3167 people) on the Italian, German and French markets. Specifically, this study aimed to analyse and assess the customers' use pattern and the reason for purchasing a single duct air conditioner.

The major findings of this study are:

SD air conditioners are mainly dedicated to cooling purposes during a limited period of the summer season. 44% of the customers use the single duct air conditioners only few hours or few days in the summer season and the 31% only few weeks in the summer season.

Customers buy SD air conditioners only when they have constraints or needs that do not allow the use of split systems or when they need an auxiliary unit to support the main AC system. In fact, the more frequent answers to the question "Why did you buy a portable air conditioner instead of a fixed air conditioner system" are (note: multiple answers were possible):

- Because I already have a fixed air conditioning system and I needed an additional system (33%)
- Because I live in a rented apartment and therefore I cannot install a fixed system (32%)
- Because I was looking for an immediate solution without the need for installation (25%)
- Because I was looking for a temporary solution (21%)
- Because I live in a building with architectural constraints that does not allow me to install an outdoor unit (15%)

3.3 Preserving the cultural heritage while ensuring the human comfort

In order to protect and preserve the cultural heritage, the legislation of many EU Member States (at the national as well as regional/local level) defines strict rules for the installation of air conditioners/heat pumps (especially for the outdoor units) in the historical buildings.
Just as an example, the legislative status of Italy and France is presented below.

3.3.1 The Italian case

Italian legislation strictly addresses the rules applicable for the installation of air conditioners/heat pumps. **Specifically, in the case of historical buildings with and without a permanent use, only SD and FDD air conditioners are de facto allowed to be installed**; this rules are specifically addressed within the Italian D.Lgs. n.42/04 and the D.P.R. n. 31/2017.

3.3.2 The French case

In November 2016, the Cannes municipality had launched the "plan façade" aimed to improve the appearance of the main street façade all over the territory under its competence. Among several intervention's planned, the removal of split's outdoor was included. The plan has been completed in 2018.

According to this plan façade SD and FDD air conditioners only can be installed and used for ensuring the human comfort.

3. Market share

4.1 EU 28 in 2018

The table below shows the ACs sales data in the EU 28 in 2018:

Product	Italy (number of units)	Other EU28 Countries (number of units)	Total	TOTAL	MKT share
DD units (without inverter)[1]	6.360	13.529	19.889	30.158	0,82%
DD units (with inverter)[2]	6.140	4.129	10.269		
SD duct units (without inverter)[3]	116.064	440.396	557.000	557.000	15,08%
SD duct units (with inverter)[4]	-	-	-		
Pair and Multi Split air to air (from 0 to > 6kW)[5]	1.350.618	1.755.185	3.105.803	3.105.803	84,1%

- [1-2-3-4-5] Italy: Assoclima 2018 data collection
- [1-2] Other EU28: Assoclima 2018 data collection
- [3-4] Review of Regulation 206/2012 and 626/2011: Task 5 report – Italy: Assoclima survey 2018
- [5] Other EU28: EHPA yearly report

The evidence is that the market of SD and FDD represents a very minor part of the whole ACs market in the EU with less than 16% of the total.

4.2 Italy 2006-2017

The below table shows data assessed by the Italian HVAC Manufacturer Association Assoclima. It covers the years 2006-2017 for different air conditioning product categories.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Italy: Product sold/installed, (000) units												
DD	26	25	16	39	15	13	11	10	1	11	13	13
SD	105	115	68	28	126	55	71	62	25	62	73	80
ACs<7kW	935	1133	946	652	775	715	694	650	534	628	1010	926
ACs>7kW	56	48	37	29	31	32	26	25	24	28	34	33
Multisplit	259	364	268	213	249	237	208	228	183	197	314	273
%(SD+DD)/ALL	10%	8%	6%	7%	12%	6%	8%	7%	3%	8%	6%	7%

The evidence is that the market share of SD and FDD has remained almost stable in Italy. The data show that FDD and SD air conditioners are not in competition with the other ACs products.

4.3 Product and Installation costs

4.3.1 Double Duct air conditioners

The costs (including the installation costs) of the most sold products of the 3 major split units manufacturers (representing about 60% of EU market share), have been compared with the ones of FDD units sold in the EU market by the 5 major manufacturers (representing 95% of the EU market share).
The table below summarises the findings of this assessment[2].

A+/A

Product	ITA	FRA	GER	SPA
Pair Split - 2,5 Kw	275	435	396	363
Pair Split - 3,5 kW	374	558	443	515
FDD - 2,5 kW	1.036	961	1.130	1.398

Installation	ITA	FRA	GER	SPA
Pair Split - 2,5 kW	250	350	450	200
Pair Split - 3,5 kW	250	350	450	200
FDD - 2,5 kW	400	500	600	350

End User Price	ITA	FRA	GER	SPA
Pair Split - 2,5 kW	525	785	846	563
Pair Split - 3,5 kW	624	908	893	715
FDD - 2,5 kW	1.436	1.461	1.730	1.748

A++/A+

Product	ITA
Pair Split - 2,5 Kw	383
Pair Split - 3,5 kW	413

Product	ITA
Pair Split - 2,5 Kw	250
Pair Split - 3,5 kW	250

Product	ITA
Pair Split - 2,5 Kw	633
Pair Split - 3,5 kW	663

A+++/A++

Product	ITA
Pair Split - 2,5 Kw	883
Pair Split - 3,5 kW	943

Product	ITA
Pair Split - 2,5 Kw	250
Pair Split - 3,5 kW	250

Product	ITA
Pair Split - 2,5 Kw	1.133
Pair Split - 3,5 kW	1.193

BAT SEER 10,5

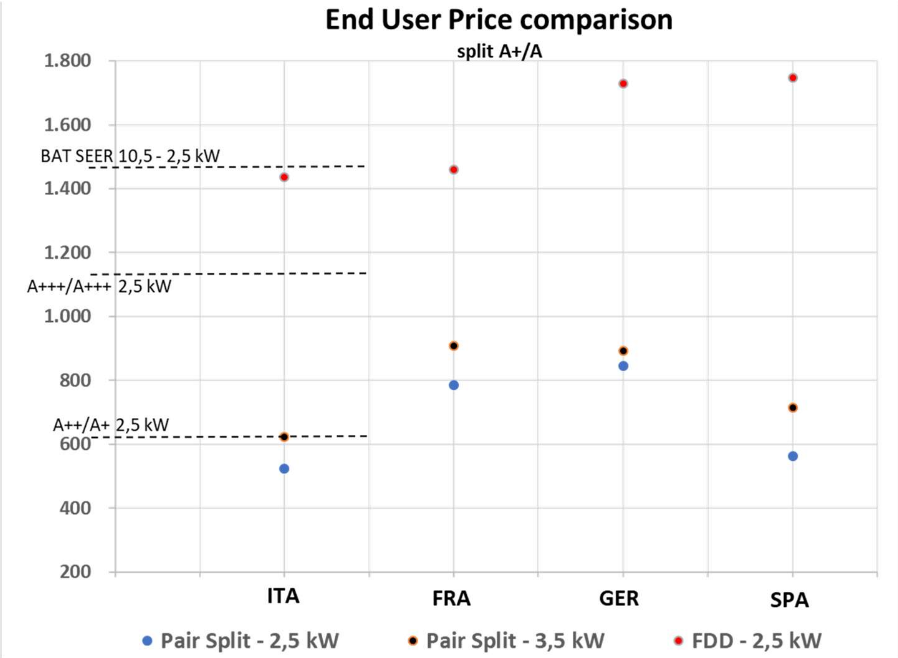
Product	ITA
Pair Split - 2,5 Kw	1.218
Pair Split - 3,5 kW	1.317

Product	ITA
Pair Split - 2,5 Kw	250
Pair Split - 3,5 kW	250

Product	ITA
Pair Split - 2,5 Kw	1.468
Pair Split - 3,5 kW	1.567

The same findings are also reported in the below chart, showing the evidence that FDD are not competing with the core part of the market (A+ and A++ class that accounts for 75% of the market) or the A+++ segment, that is still 15% cheaper than the FDD.

[2] Source data are available upon request



The above chart clearly shows that FDD are not competing with the core part of the Splits market (A+ and A++ class that accounts for 75% of the market) or the A+++ segment, that is still 15% cheaper than the FDD.

4. Conclusion on pattern of use of FDD/SD and market competition with split air conditioners

Considering all the presented data and information it is possible to conclude that **both FDD and SD air conditioners are not in competition with split air conditioners,** are mainly dedicated to cooling purposes, are prevalently used for a limited number of days/year and when consumers have constraints or needs that do not allow the use of split systems or as auxiliary units to support the main AC system.

5. Technological improvement for FDD and SD air conditioners: Ecodesign minimum requirements and energy labelling

6.1 Preamble

The new draft Regulations proposes to apply the Seasonal Energy Efficiency Ratio and Seasonal Space Cooling Energy Efficiency to all air conditioners/heat pumps in its scope and define minimum Ecodesign and energy labelling requirements.
According to all the above considerations, Eurovent and its Members hold that the proposed requirements:

- are not based on the right metrics
- are not representative of the real products' features
- are not representative of the consumers' needs
- do not represent the real-life usage of the products

6.2 Ecodesign minimum efficiency requirements

The proposed Ecodesign draft Regulation defines requirements in terms of Seasonal Energy Efficiency Ratio and Seasonal Space Cooling Energy Efficiency. The resulting impact on the industry and consumers will be the phase out of single/double duct products.
According to our internal evaluation, the proposed seasonal metrics and minimum ecodesign requirements would have an extremely severe impact on both industry and consumers, since **about 99% of FDD and SD air conditioners (both portable and fixed) will be phased out from the EU market in 2022. This will have an obvious impact on industry but an even more dramatic impact on consumers facing the unavailability of an air conditioning system**

6.3 Alternative proposal for new Ecodesign minimum requirements

In accordance with the current Regulations' approach and the below-assessed technological improvements, Eurovent has analysed the current BAT of SD (EER=3,6 – COP=2,9) and FDD air conditioners (EER=3,1 – COP=3,1) present into the EU market and has also assessed the future BNAT.
According to our internal analyses we propose alternative new Ecodesign minimum requirements as in the below table,

Product	EER_{rated}	COP_{rated}
Double duct air conditioner	2,6	2,6
Single duct air conditioner	2,7	2,2

Propane in SD: the current Ecodesign Regulation considers a 10% reduction of the minimum efficiency requirements when a refrigerant with GWP < 150 is employed (leading to a minimum EER = 2,34). Despite refrigerants with GWP<150 are mandatory for these products due to the F-gas legislation, we propose a minimum efficiency level increase to EER =2,7 resulting in a significant energy saving.

6.4 Energy labelling

6.4.1 Single Duct air conditioners

The BAT of SD air conditioners has an EER of 3,6 which meets the lower limit of the current A++ energy efficiency class (3,60 ≤ EER < 4,10). The A+ class (3,10 ≤ EER < 3,60) is populated by a very limited number of products.
The table below compares the distribution of the models in the current energy labelling classes with the alternative one we propose in the following of this PP.

CURRENT SCALE	ENERGY LABELLING POPULATION 2006-2009	2009-2013	2015-2019	APPLIA – EUROVENT PROPOSED SCALE AND TESTING METHOD
A+++	/	/	/	A
A++	/	/	up to 2-3%	B
A+	/	/	up to 13%	C
A	from 20% to 40%	from 40% to 80%	up to 80%	D

The table below compares the EER of the A+ energy efficiency class with the one of the BAT and BNAT.

		BAT			BNAT		
Current Class Label	**A+**	**A++**	**Delta abs**	**Delta %**	**A++**	**Delta abs**	**Delta %**
Proposed Class Label	**D**	**B**			**B**		
Cooling Capacity [W]	2500	2500			2500		
Power Input [W]	807	695	-112	-14%	630	-65	-9%
EER	3,10	3,60	0,50	16%	3,97	0,37	10%

The results of the analysis of the technical differences between the products in the current BAT (A++) and those in the current A+ class are:

A++ (BAT) Vs A+

The technical difference between A++ and A+ products are:

- DC motors both at evaporator and condenser side
- Air flow optimized for both air paths and fan
- Optimized compressor (on – off):
- equivalent / higher efficiency provided compared to DC compressor
- smaller displacement compared to A+ compressor, this implies an oversizing effect of the heat exchangers

This set of technical elements leads to an improvement of 16% in the energy efficiency.

BNAT Vs A++ (BAT)

The table below summarises the possible technical improvements of a SD air conditioners to reach the BNAT level starting from the BAT level.

Improvement Potential	EER	EER increase	EER increase
		abs	%
BAT A++	3,60		
Heat Exchanger increase	3,67	0,07	2%
Thermodynamic cycle optimisation	3,71	0,04	1%
Aeraulic system opt	3,78	0,07	2%
DC motor efficiency	3,86	0,08	2%
Compressor efficiency increase	3,97	0,12	3%
BNAT	3,97		

Heat exchanger increase

Portability is one of the major peculiarities of SD air conditioners and will be limited by the increase of the dimension of the SD's heat exchangers. In order to not jeopardise the portability, the dimensions of the product must remain within well-defined values. As consequence, due to the optimization of the interaction between air flow and heat exchanger it is expected an efficiency improvement of around **2%.**

Thermodynamic cycle optimisation

By optimizing the working temperature, it is expected to get an improvement of about **1%.**

Refrigerant

The BAT products already use R290 as refrigerant, in line with the F-Gas ban entered into force on 1 January 2020 (GWP <150). R290 is already a very efficient and any further refrigerant change is considered to not contributing to any further energy efficiency improvement.

Aeraulic system optimization

The reduction of the air flow losses due to the products' design optimization are accounted to contribute for an efficiency improvement of about **2%.**

DC motor efficiency

A++ models (BAT case) are already equipped with DC motor and with an optimized air flow path to reduce air flow losses. We are not aware of any technology that in the next future (within the time horizon of the new Regulations) will be able to provide a further remarkable reduction in fan power input. It can be estimated that the natural evolution of this technology would contribute to an efficiency increase of about **2%.**

Inverted compressor

The preparatory study considers the inverter technology as the way-out for increasing the SD efficiency. We are not aware of any compressor able to provide such a large efficiency improvement as the ones reported in the study.

According to table 2 of the preparatory study, for getting the BNAT level, the compressors should contribute to an efficiency increase of about 10% (65W reduction on 695W of input power).

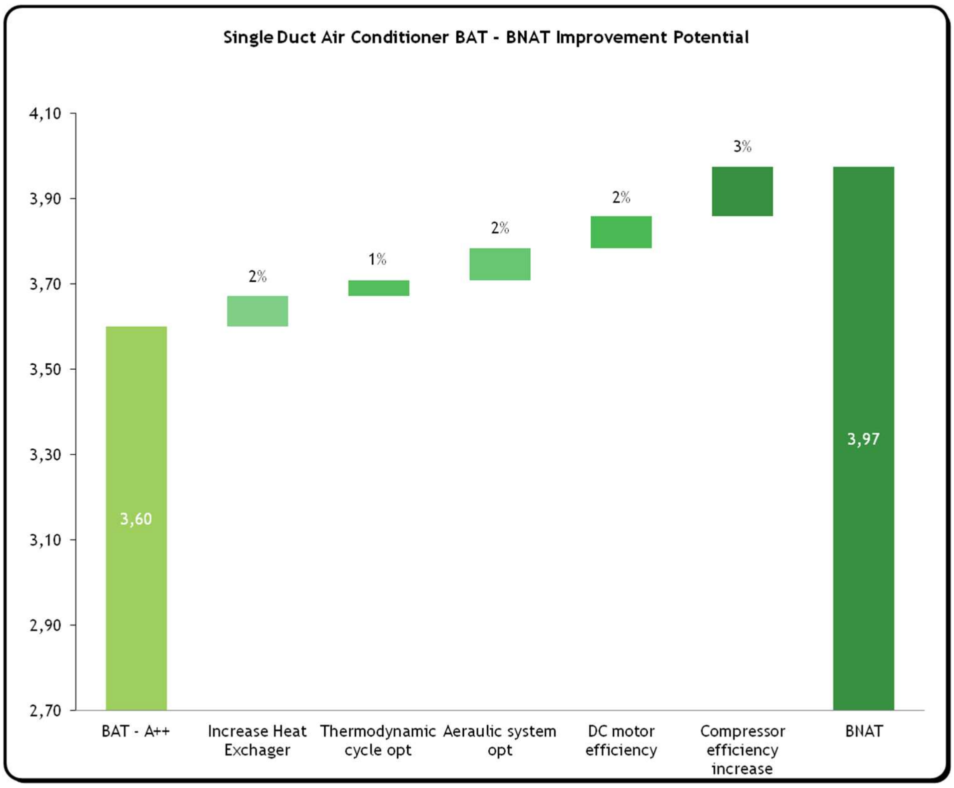
The BNAT, as reported in Task 6 of the study, would imply an EER at 35/24°C of 4,83. This is by far too high compared with the current EER 3,6 of the BAT (34,2% increase).

The current A++ products are equipped with optimized compressor providing higher or equivalent efficiency of inverter compressor suitable for this specific application, therefore the proposed level for the BNAT will not be possible in the next future. Nevertheless, it can be estimated that the natural evolution of compressor technology would contribute to an efficiency increase of around **3%.**

Overall efficiency improvement BNAT

The below charts summarise all possible efficiency improvements analysed above. The BNAT would result in an EER of 3,97 which corresponds to an A++ product (according to the current regulation) having an efficiency closer to the upper limit of the B class (as proposed in the following of this PP).

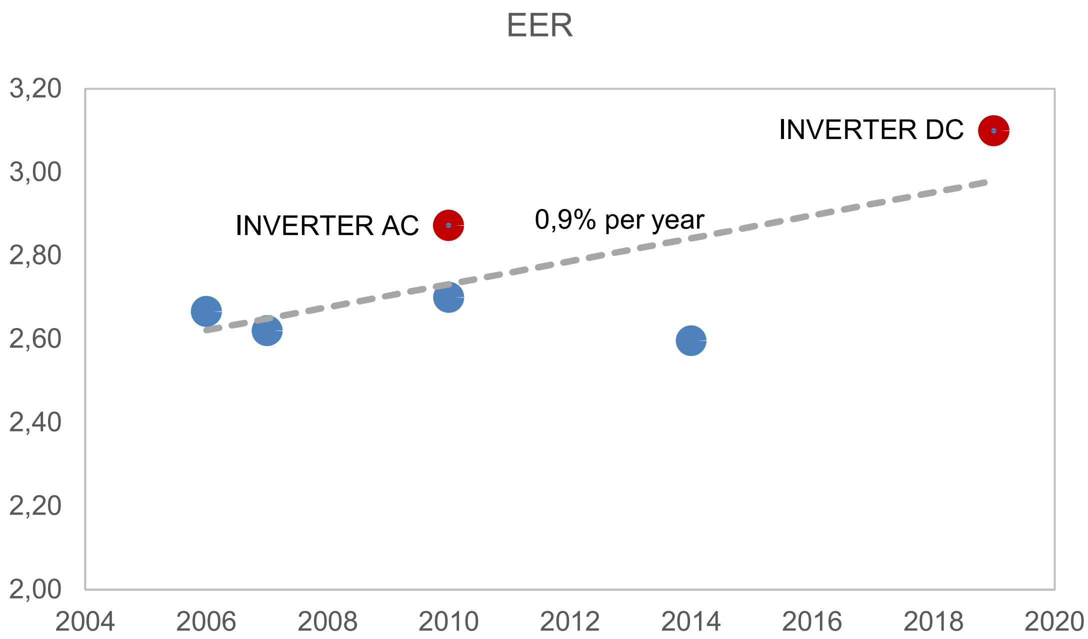
According to the alternative energy labelling scale we propose in the following, both BAT and BNAT SD air conditioners would occupy the B class and leave the A class completely empty for the mid-term time (nearly 5 years).



6.4.2 Fixed Double Duct air conditioners

Analysis of the efficiency improvements

The chart below shows the past industry's effort in addressing the demand for continuous efficiency improvements. The trend line shows an average yearly improvement of 0,9% through the last 15 years. The most recent introduction of the inverter DC compressor and fan motor technology resulted in a significant improvement.



Best available Technology (BAT) of Double Duct air conditioners

The Best Available Technology of FDD air conditioners is represented by:

- R410A "full DC" unit,
- inverter driven DC motors: compressor, indoor and outdoor fans (ECM the last).
- Indoor fan: Crossflow indoor fan
- Outdoor fan: Double inlet centrifugal fan with forward curved blades.
- Coils: 7mm enhanced copper tube in lanced aluminum fins. The condensate from the indoor coil in cooling mode is sprayed, by an internal pump, on the outdoor coil to increase efficiency.

The BAT product's specification is reported below:

N.	FDD fixed air conditioners	
1	Mounting	Wall (2 holes)
2	Refrigerant	R410A
3	Cooling power – P Rated	2,2 kW
4	Heating power – P Rated	2,4 kW
5	EER	3,10
6	Current energy efficiency class	A+
7	Eurovent / Applia Proposed Class	C
8	COP	3,20
9	Current energy efficiency class	A
10	Eurovent / Applia Proposed Class	C

Physical dimensions constrain

FDD air conditioners are the preferred choice for consumers not allowed to install outdoor units. They may live in historical buildings or in areas where the City Regulations do not allow to spoil the building facades, or because the Condominium Regulation does not allow to install outdoor units. The size of the unit that can be installed is often constrained by the interior configuration, often the units are located below windows; window receptacle width, height and depth constrain the unit's physical size.

Efficiency improvements over 5 years

For these reasons the energy efficiency cannot be improved by increasing its dimension, but only working on the basic technologies:

- Compression
- Inverter Drive
- Refrigerant
- Heat Exchanger
- Air Management System (AMS) and Fan Motors

FDD air conditioners are often manufactured by SMEs that do not control/lead the improvement of these technologies.

Compressors

The improvement of the compressor efficiency is fundamental for the development of more efficient FDD air conditioners.

The compressor efficiency improvement in the next five years could be estimated in the range of 5% increase of the EER.

Inverter drive

Inverter efficiency improvements could be achieved by the refinement of the wave shape supplying the compressor as well as reducing losses in the inverter/motor coupling by better algorithms, materials, circuiting, etc. This is not an available technology.

Current drive used in the BAT product has a peak efficiency of about 92 – 93%, and about 90 – 91% at the rated compressor frequency. The possible improvement is therefore very limited. With the current BAT of drives, the optimisation of the coupling of compressor and drive could be possible. It is reasonable to assume a corresponding 1% increase of the EER.

Refrigerant

Refrigerant has a great influence on the refrigeration cycle efficiency. Refrigerants must be selected trading off the efficiency, the GWP and the safety. Current BAT products use R410A, for the future the use of R32 (as it is happening for Split Air Conditioners) could be foreseen. The expected efficiency increase going from R410A to R32 is assumed to be 2%.

Heat Exchanger

Further improvements of the heat exchanger performance can be expected by reducing the diameter of the pipes from 7 mm to 5mm or even 4mm. The reduced diameter improves the heat transfer coefficient while it reduces the air side pressure losses (allowing higher air flow at same noise and unit size further improving heat transfer). This also results in a significant reduction of the heat transfer at the refrigerant side which limits the overall heat transfer improvement or require adding one row of tubes increasing cost and size.

Microchannel heat exchangers represent another promising technology. Unfortunately, they cannot be used in FDD air conditioners, since FDD air conditioners use the condensate from the evaporator in cooling mode to improve the condenser heat exchange by spraying it onto the outdoor coil. The Microchannel heat exchange technology still needs significant further development to efficiently and stably operating as evaporator and to be used in FDD air conditioners and should not be considered for FDD air conditioners.

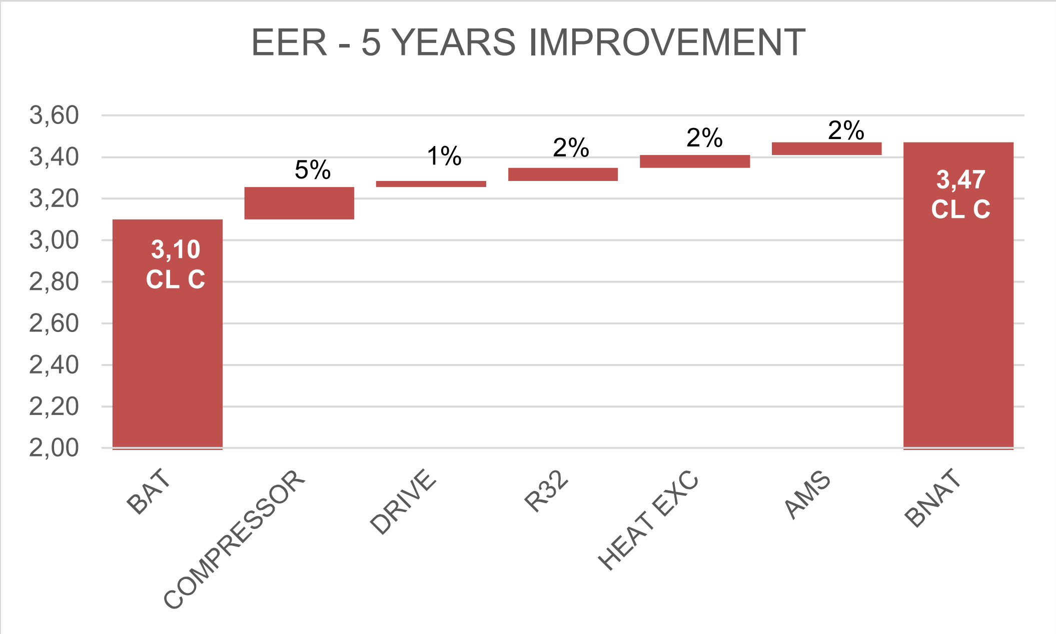
The use of 5 / 4 mm internally enhanced cooper tube, without increasing the unit size is estimated to bring a 2% increase of EER.

Air management system (AMS)

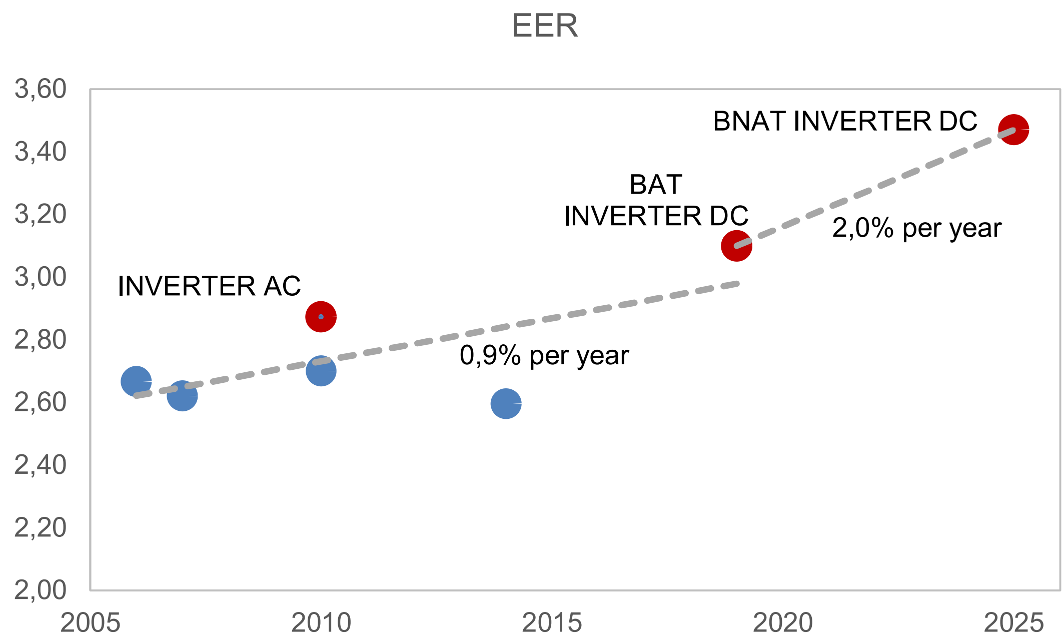
BAT products already use inverter driven DC motors for both indoor and outdoor fans (ECM the last). The contribution of indoor fan motor power drawn is very marginal (10 – 15W), any improvement on motor efficiency will give no advantage EER. On the other hand, the improvement of the outdoor fan motor efficiency may give some positive contribution. A better Air Management System allows for a higher air flow at same noise level and it improves the cycle efficiency (higher evaporating temperature and lower condensing temperatures). The Outdoor fan motor and Air Management System improvement is assumed to give a 2% EER improvement

Overall efficiency improvement BNAT

The below chart summarises all the possible efficiency improvements analysed above. All together they will increase the current BAT EER from 3,10 to 3,47 (+12%), the BNAT will then be close to the lower limit of the B class, but not enough to move to B.



It is also to be noted that as result the EER improvement trend throughout the next 5 years sharply increases from the past 0,9%/year up to 2,0%/year, more than doubling.



6.5 Alternative proposal for a dedicated Energy Labelling scale

In accordance with the current Regulations' approach and with the above-assessed technological improvements, Eurovent proposes to define a new energy labelling scale as presented below and to keep the current measurement method according to EN14511 for SD and FDD air conditioners.

6.5.1 Single duct

Revised Energy Label				
	EER		COP	
	≥	<	≥	<
A	4,1		3,6	
B	3,6	4,1	3,2	3,6
C	3,2	3,6	2,8	3,2
D	2,9	3,2	2,5	2,8
E	2,6	2,9	2,3	2,5
F	2,3	2,6	2,1	2,3
G		2,3		2,1

6.5.2 Double duct

Revised Energy Label				
	EER		COP	
	≥	<	≥	<
A	4,1		4,6	
B	3,6	4,1	3,8	4,6
C	3,1	3,6	3,2	3,8
D	2,7	3,1	2,8	3,2
E	2,4	2,7	2,5	2,8
F				
G				

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