FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

New performance requirements on conventional climatisation systems

…or: Know your enemy!

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Solar Energy Systems ISE

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Milano, March 26th - 27th, 2012

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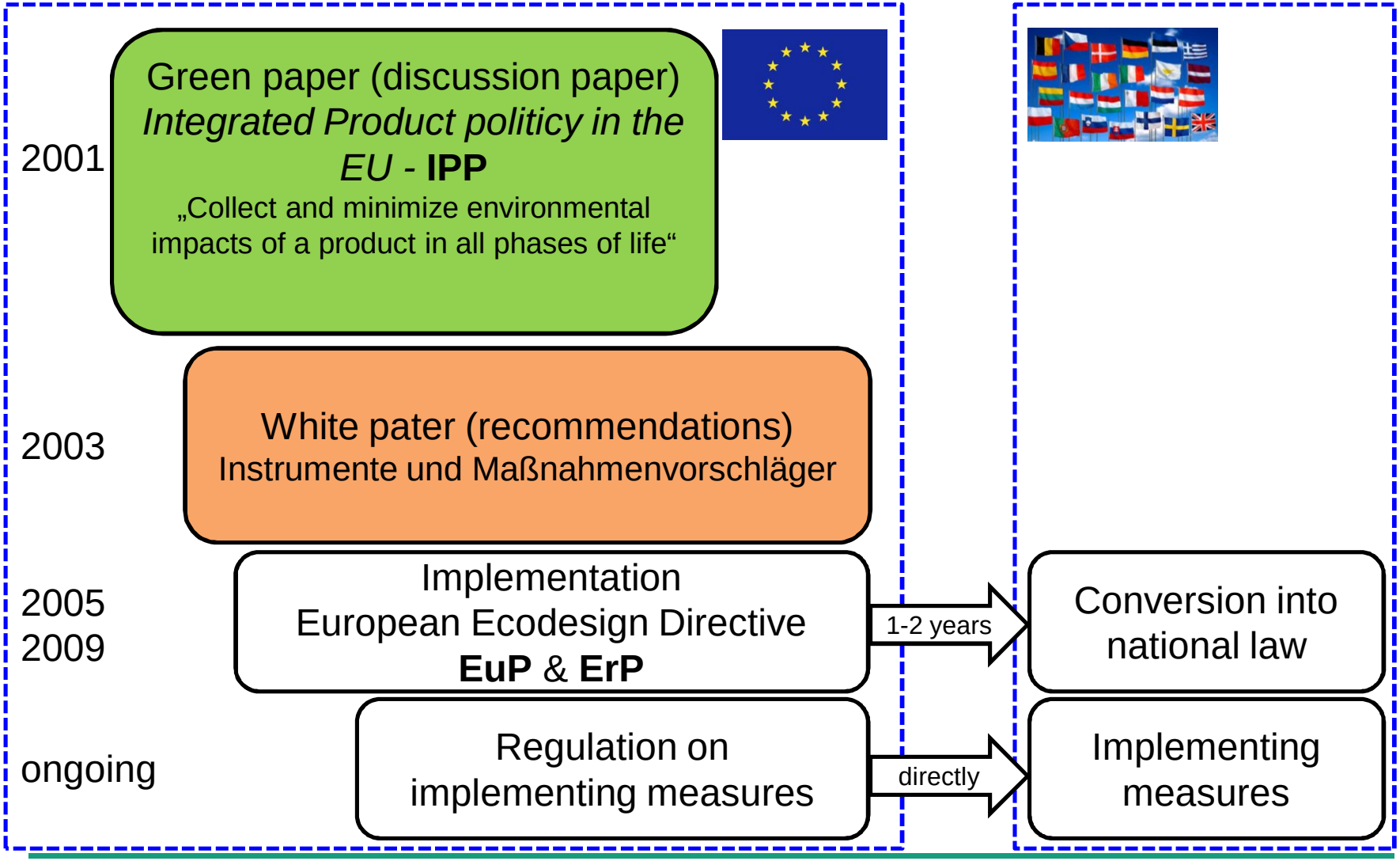
Agenda

- EuP and ErP
- Implementing directive
- Affected devices
- Requirements for the devices
    - Key figures
    - Calculation
    - Limits and time schedule
    - Reference Values 2012
- Conclusion

EuP and ErP



EuP and ErP

EuP

- Directive 2005/32/EG „Energy using products“
- establishes a framework to set mandatory ecological requirements for energy using products

ErP

- Directive 2009/125/EG „Energy related products“, replaces EuP
- Not only energy using products, but more general energy related products (affects also e.g. windows, insulation materials, ...)
- Relevant: Resources for construction, operation and disposal

EuP and ErP

Conversion into national law

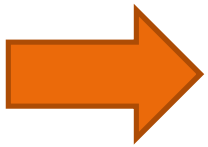
- Directives must be transposed into national law
  - EuP 2005: Until August 2007
  - ErP 2009: Until November 2010

- Germany
  - EuP implemented on time: *Energiebetriebene-Produkte-Gesetz (EBPG)*
  - ErP implemented with one year delay

Implementing directive

According to the ErP, implementig measures are necessary for the eco-friendly design of products which fall in the following categories

- Relevant energy consumption
- Significant sales and trading volumes
- Significant environmental impact
- Significant potential to improve the environmental impact without entailing excessive costs



Division into product categories by the EU Commission

Implementing directive

- Lot 1: Heizkessel und Kombiheizkessel[4] (abgeschlossen, Entwurf der Durchführungsmaßnahme für 2. Hälfte 2011 geplant)
- Lot 2: Warmwasserbereiter[5] (abgeschlossen, Entwurf der Durchführungsmaßnahme für 2. Hälfte 2011 geplant)
- Lot 3: PCs und Monitore[6] (abgeschlossen, kein Handlungsbedarf festgestellt, vorerst keine weitere Aktivität)
- Lot 4: Drucker, Kopierer und Multifunktionsgeräte[7] (abgeschlossen, kein Handlungsbedarf festgestellt, vorerst keine weitere Aktivität)
- Lot 5: Fernseher[8] (abgeschlossen, Durchführungsmaßnahme seit 22. Juni 2009 in Kraft[9])
- Lot 6: Standbyverluste[10] (abgeschlossen, Durchführungsmaßnahme seit 6. April 2009 in Kraft[11])
- Lot 7: Batterieladegeräte und externe Stromversorgungen[12] (abgeschlossen, Durchführungsmaßnahme seit 7. Januar 2009 in Kraft[13])
- Lot 8: Bürobeleuchtung[14] (abgeschlossen, Durchführungsmaßnahme seit 18. März 2009 in Kraft[15])
- Lot 9: Straßenbeleuchtung[16] (abgeschlossen, finaler Bericht auf der Webseite, siehe Link)
- Lot 10: Raumklima-Anlagen[17] (abgeschlossen, Durchführungsmaßnahme in Arbeit)
- Lot 11: Elektrische Motoren (1-150 kW)[18], Umwälzpumpen[19] und Ventilatoren[20] (abgeschlossen, drei getrennte Durchführungsmaßnahmen, zwei seit 22. Juni 2009 in Kraft)
- Lot 12: Gewerbliche Kühl- und Gefrieranlagen[21]
- Lot 13: Private Kühl- und Gefrierschränke[22] (abgeschlossen, Durchfü
- Lot 14: Private Geschirrspül[24]- und Waschmaschinen[25][26] (abgesc 2010 in Kraft)
- Lot 15: Kleine Heizgeräte für Festbrennstoff[27]
- Lot 16: Wäschetrockner (abgeschlossen, Entwurf der Durchführungsn
- Lot 17: Staubsauger[28] (abgeschlossen)
- Lot 18: Settopboxen mit komplexer Funktion[29] (abgeschlossen, kein Handlungsbedarf festgestellt, vorerst keine weitere Aktivität)
- Lot 19: Haushaltsbeleuchtung[30] (abgeschlossen, Durchführungsmaßnahme für Teilbereich in Kraft[31], weitere Schritte in 2011 vorgesehen)
- Lot 20: Einzelraumheizgeräte[32]
- Lot 21: Warmluftzentralheizung (ohne CHP – Zentrale Heizungssysteme)[33]
- Lot 22: Haushalts- und Gewerbeöfen für Speisen inkl. Mikrowellengeräte[34]
- Lot 23: Haushalts- und Gewerbeherde und -grills[35]
- Lot 24: gewerbliche Geschirrspüler, Waschmaschinen und Trockner[36]
- Lot 25: nicht-gewerbliche Kaffeemaschinen[37]
- Lot 26: Verbrauch im vernetzten Bereitschaftsbetrieb (networked stand-by)[38]
- Lot 27: Haushalts-Notstromversorgung (domestic UPS)
- Lot 28: Pumpen für Schmutzwasser und Flüssigkeiten mit hohem Feststoffanteil
- Lot 29: Pumpen für private und öffentliche Schwimmbäder, Teiche, Springbrunnen, Aquarien und Pumpen für sauberes Wasser
- Lot 30: Produkte in Motor-Systemen (alle Produkte die nicht von 640/2009 erfasst werden)
- Lot 31: Produkte in Motor-Systemen die nicht von Lot 30 erfasst werden.

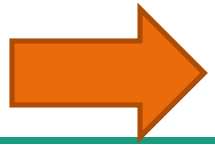
Lot 10: Room air conditioning

Quelle: Wikipedia.org 2012

Implementing directive

Room air conditioners

- Relevant energy consumption
  - Annual electricity consumption in 2005: 30 TWh → 2050: 74 TWh
- Significant sales and trading volumes
- Significant environmental impact
  - No explicit number available, but probably high
- Significant potential to improve the environmental impact without entailing excessive costs
- Significant environmental impact
  - Direct and indirect greenhouse gas emissions
- Significant potential to improve the environmental impact without entailing excessive costs
  - 11 TWh annual savings by 2020 possible

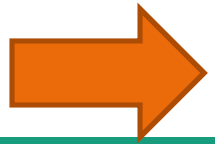


DirectiveNr. 206/2012 from **6.3.2012**

Implementing directive

Room air conditioners

- Relevant energy consumption
  - Annual electricity consumption in 2005: 30 TWh → 2050: 74 TWh
- Significant sales and trading volumes
  - No explicit number available, but probably high
- Significant environmental impact
  - Direct and indirect greenhouse gas emissions
- Significant potential to improve the environmental impact without entailing excessive costs
  - 11 TWh annual savings by 2020 possible

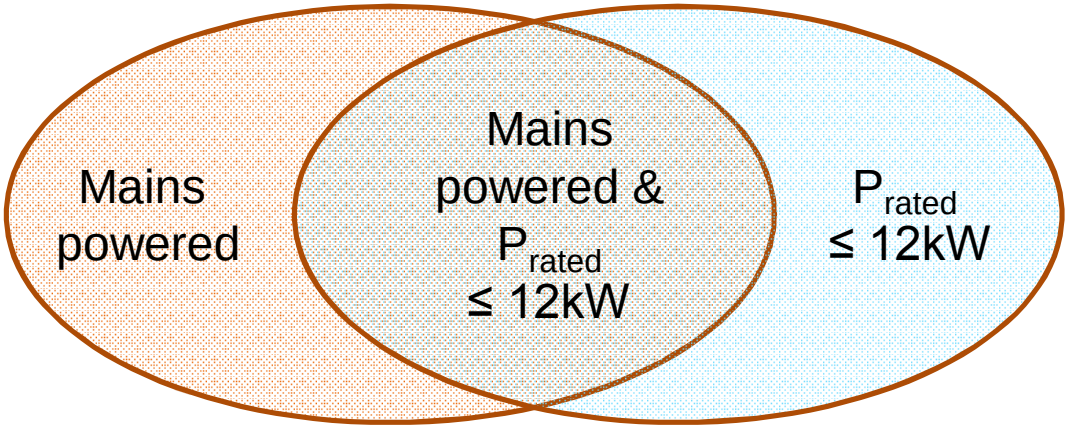


DirectiveNr. 206/2012 from **6.3.2012**

Affected devices

Affected devices

Mains powered air conditioners with $P_{rated} \leq 12kW$

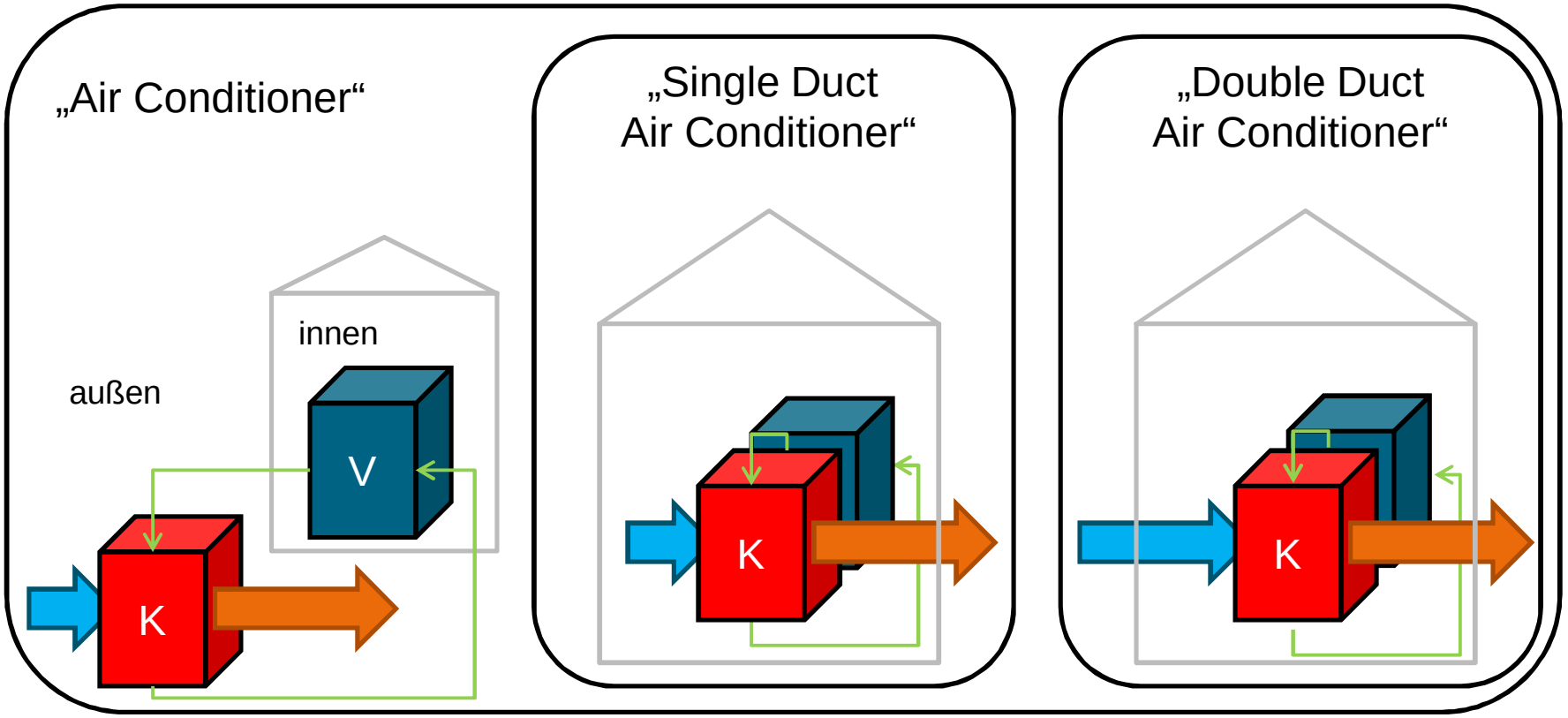


Explicitly excluded

- Devices with non-electrical energy sources
- Devices that do not use air as a heat carrier

Affected devices

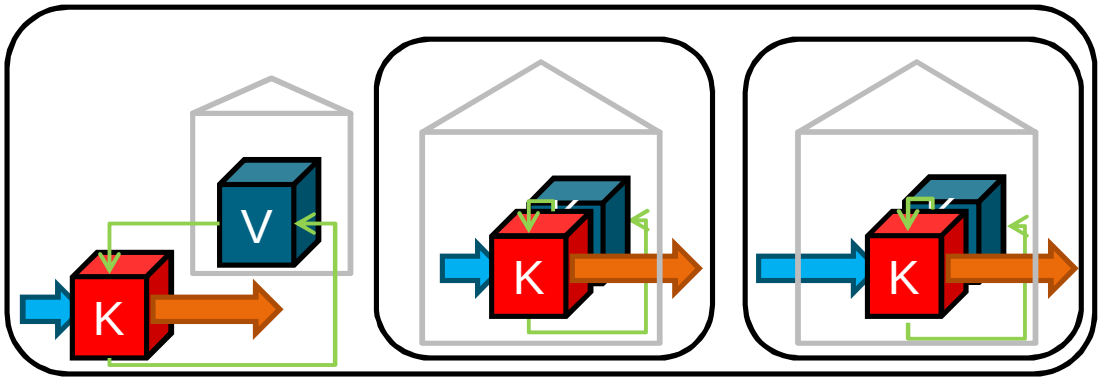
Distinctions



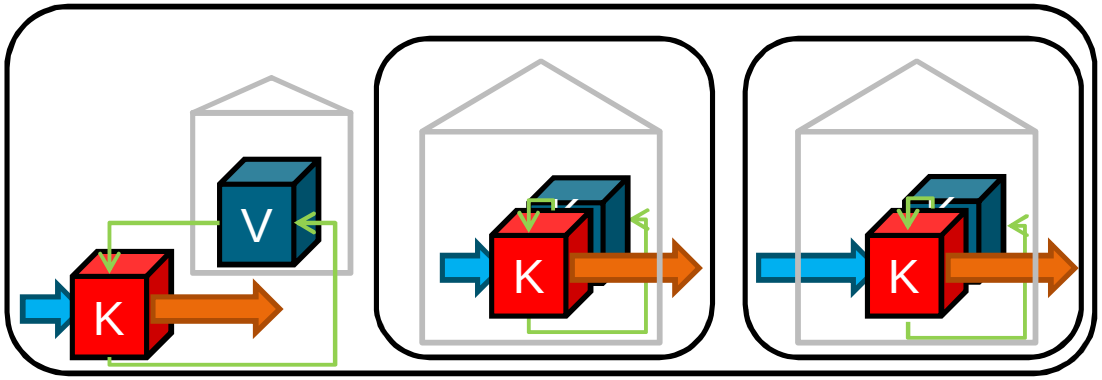
Affected devices

Distinctions

GWP of refrigerant > 150



GWP of refrigerant ≤ 150



Affected devices

Distinctions

GWP of refrigerant > 150

Name	i.e.	GWP
R 717	NH3	0
R744	CO2	1
R 290	Propane	3

GWP of refrigerant ≤ 150

R 134 a	1300
R 404 a	3780
R 507 a	3850
R 410 a	1980

Requirements for the devices

Key figures

Air conditioners		SD-air conditioners		DD-air conditioners	
Seasonal EER / COP		Rated EER / COP			
cooling	heating	cooling	heating	cooling	heating
SEER	SCOP(A)	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
power consumption „off“ P_{off}					
power consumption „standby“ P_{sb}					
power consumption „standby+info“ P_{Info}					
sound power level					

Requirements for the devices

Key figures

Seasonal performance figures for heating and cooling

$$\text{SEER or SCOP} = \frac{\text{Reference annual thermal energy demand}}{\text{annual electricity consumption}}$$

Rated performance figures for heating and cooling

$$\text{EER}_{\text{rated}} \text{ or } \text{COP}_{\text{rated}} \frac{\text{Rated thermal capacity}}{\text{Rated electric consumption}}$$

Requirements for the devices

calculation

$$SEER = \frac{\text{Reference annual cooling energy demand}}{\text{annual electricity consumption}} = \frac{Q_C}{Q_{CE}}$$

$$Q_C = \text{design load for cooling} \times \text{equivalent active mode hours for cooling} = P_{designC} \times H_{CE}$$

- $P_{designC}$ = Rated capacity at 35 ° C / 27 ° C (ambient/indoor)
- HCE = 350 hours

$$Q_{CE} = \frac{\text{reference annual cooling demand}}{\text{active mode seasonal energy efficiency ratio}} + Q_{E,etc} = \frac{Q_C}{SEER_{on}} + Q_{E,etc}$$

- $Q_{E,etc}$ = Sum of annual electricity demands for OFF,SB,SB+Info
- $SEER_{on}$ = Average effiency ratio

$$SEER_{on} = \frac{\sum_{j=1}^{n} hj \times P_c(Tj)}{\sum_{j=1}^{n} hj \times \left(\frac{P_c(Tj)}{EERd(Tj)} \right)}$$

Requirements for the devices

calculation

$$SEER = \frac{\text{Reference annual cooling energy demand}}{\text{annual electricity consumption}} = \frac{Q_C}{Q_{CE}}$$

$$Q_{CE} = \frac{\text{reference annual cooling demand}}{\text{active mode seasonal energy efficiency ratio}} + Q_{E,etc} = \frac{Q_C}{SEER_{on}} + Q_{E,etc}$$

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Requirements for the devices

calculation

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$$SEER_{on} = \frac{\sum_{j=1}^{n} hj \times P_c(Tj)}{\sum_{j=1}^{n} hj \times \left(\frac{P_c(Tj)}{EERd(Tj)} \right)}$$

$$P_c(Tj) = \text{part load} = \text{design load} \times \text{part load ratio} = P_{designC} \times \frac{Tj - 16}{T_{designC} - 16}$$

j	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Tj	°C	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
hj	h	205	227	225	225	216	215	218	197	178	158	137	109	88	63	39	31	24	17	13	9	4	3	1	0

degradation coefficient if Pc(Tj)<$P_{designC}$ = 0.25

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Requirements for the devices

calculation

Efficiency ratios in the heating and cooling mode: SEER and SCOP

- SCOP calculation analogue to SEER
- But three different heating periods
  - Warmer (W)
  - Average (A)
  - Colder (C)
- Obligation to mention only the SCOP (A)

Requirements for the devices

1.1. 2013	Air conditioners		SD-Air conditioners		DD-Air conditioners	
	SEER	SCOP(A)	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
GWP > 150						
GWP ≤ 150						
P_{off}						
$P_{standby}$						
P_{Info}						
Noise						

Requirements for the devices

Limits and time schedule

1.1. 2013	Air conditioners		SD-Air conditioners		DD-Air conditioners	
	SEER	SCOP(A)	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
GWP > 150	3,60	3,40	2,40	1,80	2,40	2,36
GWP ≤ 150	3,24	3,06	2,16	1,62	2,16	2,12
P_{off}	NA		1 W			
$P_{standby}$			1 W			
P_{Info}			2 W			
Noise	60 – 70 dB(A)		65 dB(A)			

Requirements for the devices

Limits and time schedule

1.1. 2014		Air conditioners		SD-Air conditioners		DD-Air conditioners	
		SEER	$SCOP_{(A)}$	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
< 6kW	GWP > 150						
	GWP ≤ 150						
> 6kW	GWP > 150						
	GWP ≤ 150						
P_{off}							
$P_{standby}$							
P_{Info}							
Noise							

Requirements for the devices

Limits and time schedule

1.1. 2014		Air conditioners		SD-Air conditioners		DD-Air conditioners	
		SEER	SCOP(A)	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
< 6kW	GWP > 150	4,60	3,80	2,60	2,04	2,60	2,60
< 6kW	GWP ≤ 150	4,14	3,42	2,34	1,84	2,34	2,34
> 6kW	GWP > 150	4,30	3,80	idem			
> 6kW	GWP ≤ 150	3,87	3,42				
P_{off}		NA		0,5 W			
P_{off}							
P_{sb}				0,5 W			
P_{sb}							
P_{Info}				1 W			
P_{Info}							
Noise		60 – 70 dB(A)		65 dB(A)			
Noise							

Requirements for the devices

Limits and time schedule

2013 2014		Air conditioners		SD-Air conditioners		DD-Air conditioners	
		SEER	$SCOP_{(A)}$	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
< 6kW	GWP > 150	+28%	+12%	+8%	+13%	+8%	+10%
	GWP ≤ 150				+14%		
> 6kW	GWP > 150	+19%		idem			
	GWP ≤ 150						
P_{off}		Keine Angabe		-50%			
P_{sb}				-50%			
P_{Info}				-50%			
Noise		± 0%		± 0%			

Requirements for the devices

Product informations

Air conditioners

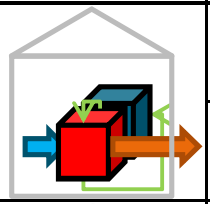
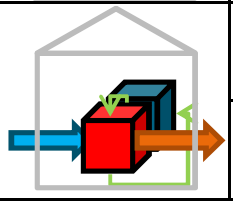
- design capacity
- **SEER and SCOP**
- **Cooling capacity and EER at Tj = 20, 25, 30, 35 ° C**
- **Heating capacity and COP for Tj = (-15), -7, 2, 7, 12 ° C**
- Bivalence and operating temperature limit
- Heating capacity and COP for bivalence and operating temperature limit
- Capacity and EER / COP in cyclic operation + interval reduction factor
- Capacity and annual electricity consumption in OFF/SB/SB+Info
- Information for power control, noise level, GWP

Requirements for the devices

Product informations

Local air conditioners (SD and DD)

- Rated capacity & Rated energy consumption
- **EER and COP at standard test conditions**

Device	Function	Room air temperature	Ambient air temperature
SD 	Cooling	35 (24)	
	Heating	20 (12)	
DD 	Cooling	27 (19)	35 (24)
	Heating	20 (<15)	7 (6)

- Hourly or annual energy consumption (?)
- Power consumption in OFF/SB/SB+Info, noise level, GWP

Requirements for the devices

Product informations

EuP

- Directive 2005/32/EG „Energy using products“
- establishes a framework to set mandatory ecological requirements for energy using products

ErP

- Directive 2009/125/EG „Energy related products“, replaces EuP
- Not only energy using products, but more general energy related products (affects also e.g. windows, insulation materials, ...)
- Relevant: Resources for construction, operation and disposal ???

Requirements for the devices

Product informations

(12) Products subject to this Regulation should be made more energy efficient by applying existing non-proprietary cost-effective technologies that can reduce the combined costs of purchasing and operating these products.

(13) The ecodesign requirements should not affect functionality from the end-user's perspective and should not negatively affect health, safety or the environment. In particular, the benefits of reducing electricity consumption during the use phase should more than offset any possible additional environmental impact during the production phase.

No Life Cycle Analysis

(14) The ecodesign requirements should be introduced gradually in order to provide a sufficient timeframe for manufacturers to re-design products subject to this Regulation. The timing should be such as to avoid negative impacts on the functionalities of equipment on the

(19) The measures provided f
accordance with the opin
lished by Article 19(1) of

HAS ADOPTED THIS REGULATION

Articl

Subject matte

1. This Regulation establishes
the placing on the market o
conditioners with a rated capaci
heating if the product has no c
fans with an electric fan power i

2. This Regulation shall not a

(a) appliances that use non-elect

- Relevant: Resources for construction, operation and disposal ???

Requirements for the devices

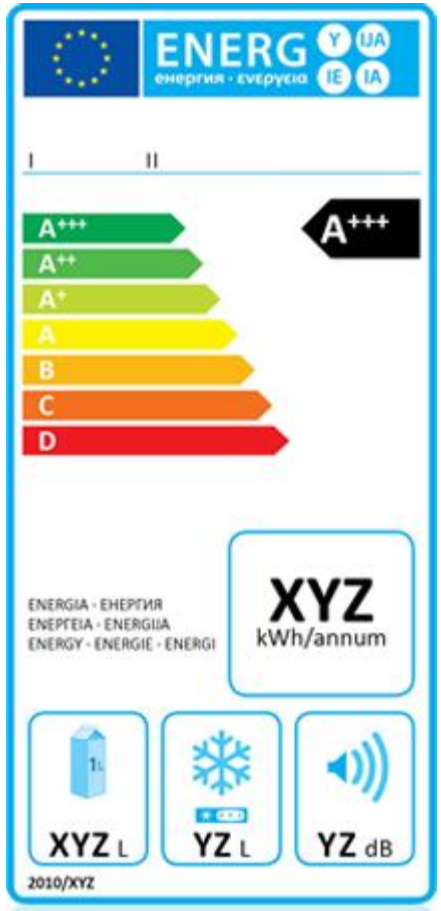
Reference values 2012

Best market available technology

Air conditioners		SD air conditioners		DD air conditioners	
SEER	SCOP(A)	EER_{rated}	COP_{rated}	EER_{rated}	COP_{rated}
8,50	5,10	3,15	2,60	3,00	3,15

Conclusion

- Distinction between „air conditioners“, „single duct“ and „double duct air conditioners“
- For air conditioners annual efficiency ratios are the key figures. For local device: rated efficiency ratios
- Two steps in the time schedule: 1.1.2013 and 1.1.2014
- Split units must have higher effiency
- Devices with better GWP of the refrigerant may have worse performance
- Air conditioners with higher capacity need to be more efficient than smaller devices
- Consequences:
- Compliance procedures for access to the EU market (CE approval)
- Energy label will be introduced



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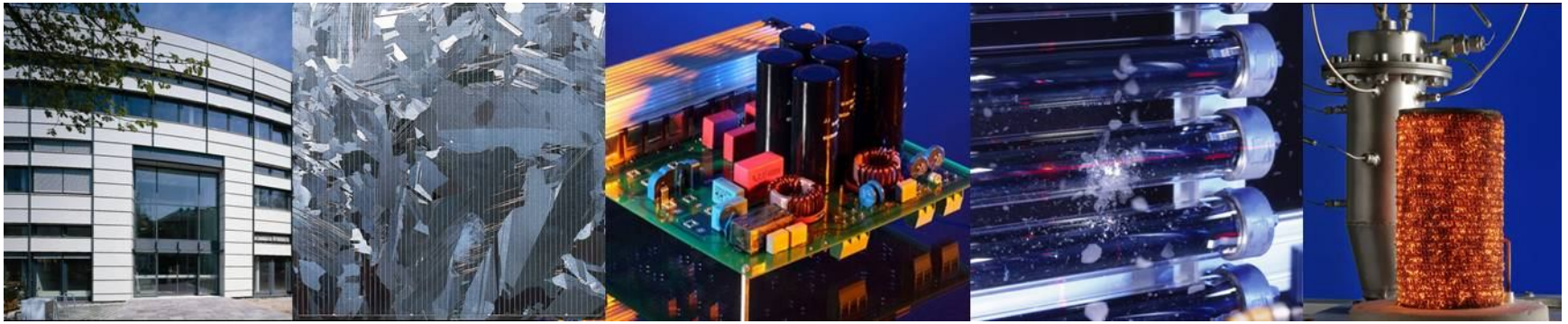
Thank You Very Much for Your Attention!



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