IEC 62552:2015 impacts on manufactures from EU perspective

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Asia-Pacific Economic Cooperation

1. EU historical development of refrigerators
2. Refrigerating appliances standardization overview
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4. Energy consumption test in detail
5. Impact of global standard on product design
6. Concluding remarks

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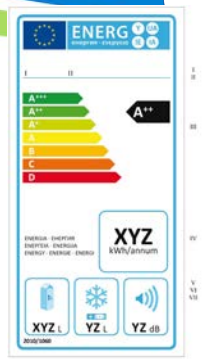
Domestic Refrigerator - EU



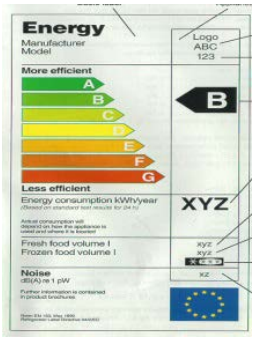
Label update

A^{+++}

First product in the EU with energy label

Energy labelling

Waste Material directives



MEPS

Label update

A^{+}, A^{++}

EuP

New MEPS

New label

New limits

No B

No A

CECED voluntary agreement

MEPS + efficiency target

1995 1999 2002 2003 2009 2010 2012 2014 2017/

MEPS= Minimum Efficiency Performance Standard

CECED = European Committee of Domestic Equipment Manufacturers

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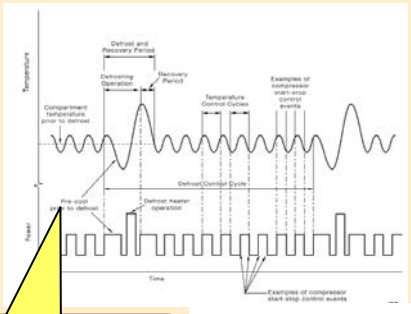
Refrigerating appliances standardization overview

ISO	IEC	Europe (CENELEC)
ISO5155:1995 ISO7371:1995 ISO8187:1991 ISO8561:1995		EN153:…..
ISO15502:2005	Copy IEC62552 ed1:2007 IEC62552 ed1:C1:2008	EN153:2006
ISO15502/C1:2007 Small corrections		
	New Global Standard IEC62552-1: 2015 ed1 IEC62552-2: 2015 ed1, IEC62552-3: 2015 ed1 Developed by: IEC SC59M/MT2 Publ.Feb 2015	Publ.March 2013 EN62552:2013 Wine cooler Small adjustments
		EN62552-1, -2, -3: 2016 ?

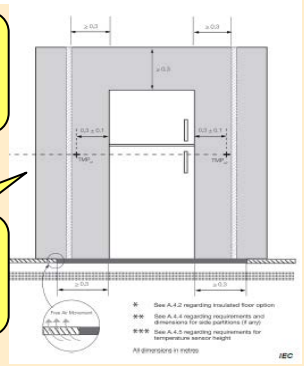
New global standard: main improvements

IEC62552-1:2015 General Requirements	IEC62552-2:2015 Performance Testing	IEC62552-3:2015 Energy consumption and volume

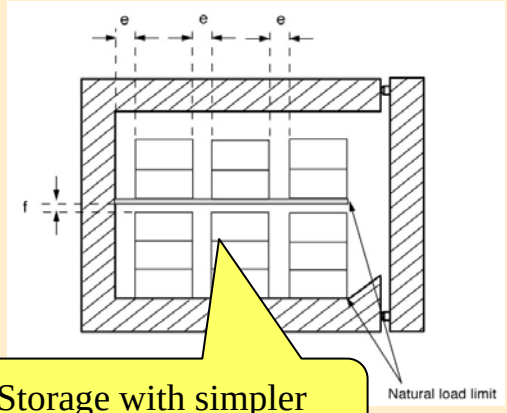
• Definitions
• Installation of product
• Test room
• Measurement accuracy
• Location of sensors
	• Storage
	• Cooling capacity
	• Freezing capacity
	• Automatic ice making
	• Pull down
	• Wine storage
	• Temperature rise
	• Water vapor
		• Energy consumption
		  • Steady state
		  • Defrosts
		  • Auxiliaries
		  • Load processing
		• Volume



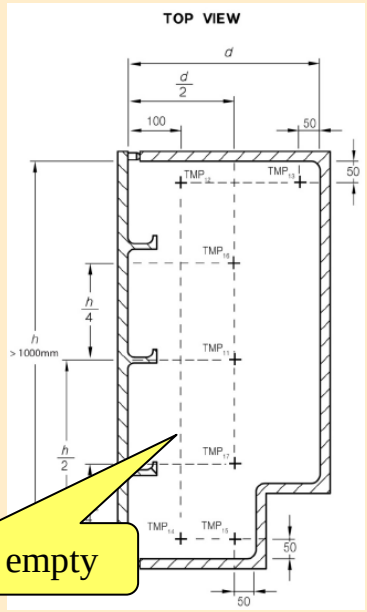
Precise definitions



More flexible



Storage with simpler load schemes



Frozen food empty

New global standard: main improvements

1. Energy consumption tests:
   - Reduced uncertainty (no load packages)
   - Two ambient temperatures reduces circumvention options
   - Separate measurement of defrost energy and “steady state” part
     - Reduces test time
     - Variable defrost finally included
   - Flexible test time algorithm (no fixed 24 hours) with guaranteed stability
   - Reduced or equal test time despite two ambient temperatures
2. Volume measurement less sensitive to interpretation
3. Storage temperature tests still with load, but much faster
4. New compartment types (e.g. pantry, wine storages)
5. Freezing capacity determination much faster
6. Cooling capacity test for refrigerators

Energy consumption test in detail

Main changes compared to actual IEC62552:2007 (or ISO15502):

Item	IEC62552:2007	New Global Standard IEC62552-1,-2,-3:2015
Ambient Temperature [° C]	25	16 and 32 ° C. Annual energy consumption: $E_{total} = f\{E_{daily\text{-}16^\circ C}, E_{daily\text{-}32^\circ C}\}$ where f is a function to be regionally defined. Suggested: $E_{total} = F*365* E_{daily\text{-}16^\circ C} + (1\text{-}F)*365* E_{daily\text{-}32^\circ C}$
Fresh Food Target Temperature [° C]	5	4
Frozen Food Target Temperature (3 and 4 star compartments) [° C]	-18 warmest package	-18 average temperature of 5 or more distributed temperature sensors (no packages)

Impact is a function of F

Energy consumption increase

Energy consumption decrease

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Energy consumption test in detail

Energy consumption procedure

1. Run tests at two or more thermostat positions
2. Find steady state part in each test (P_{SS1} or P_{SS2})
3. Correct steady state part for ambient temperature
4. Evaluate defrost periods
5. Average defrosts (can be at different test points but must be at the same ambient)
6. Daily energy: $$E_{daily} = P \times 24 + \frac{\Delta E_{df} \times 24}{t_{df}}$$
7. Adjust compartment temperatures with an average temperature increment during defrosts
8. Interpolate between tests to target temperatures (e.g. fresh food 4 ° C)
9. Add all together to get annual energy consumption (note that actual formula is regional dependent)

$$E_{total} = f\{E_{daily16°C}, E_{daily32°C}\} + E_{aux} + \Delta E_{processing\text{-}annual}$$

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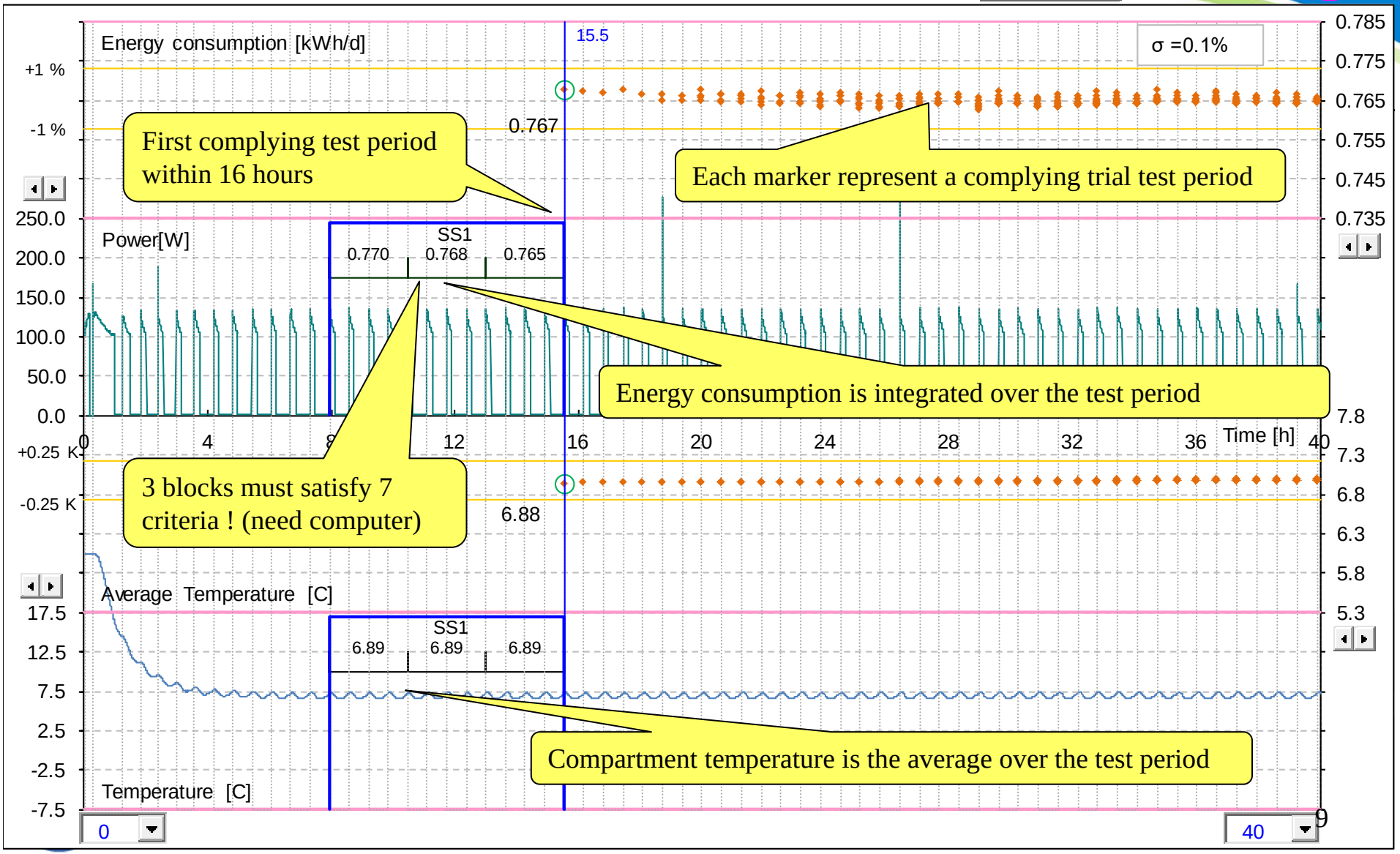
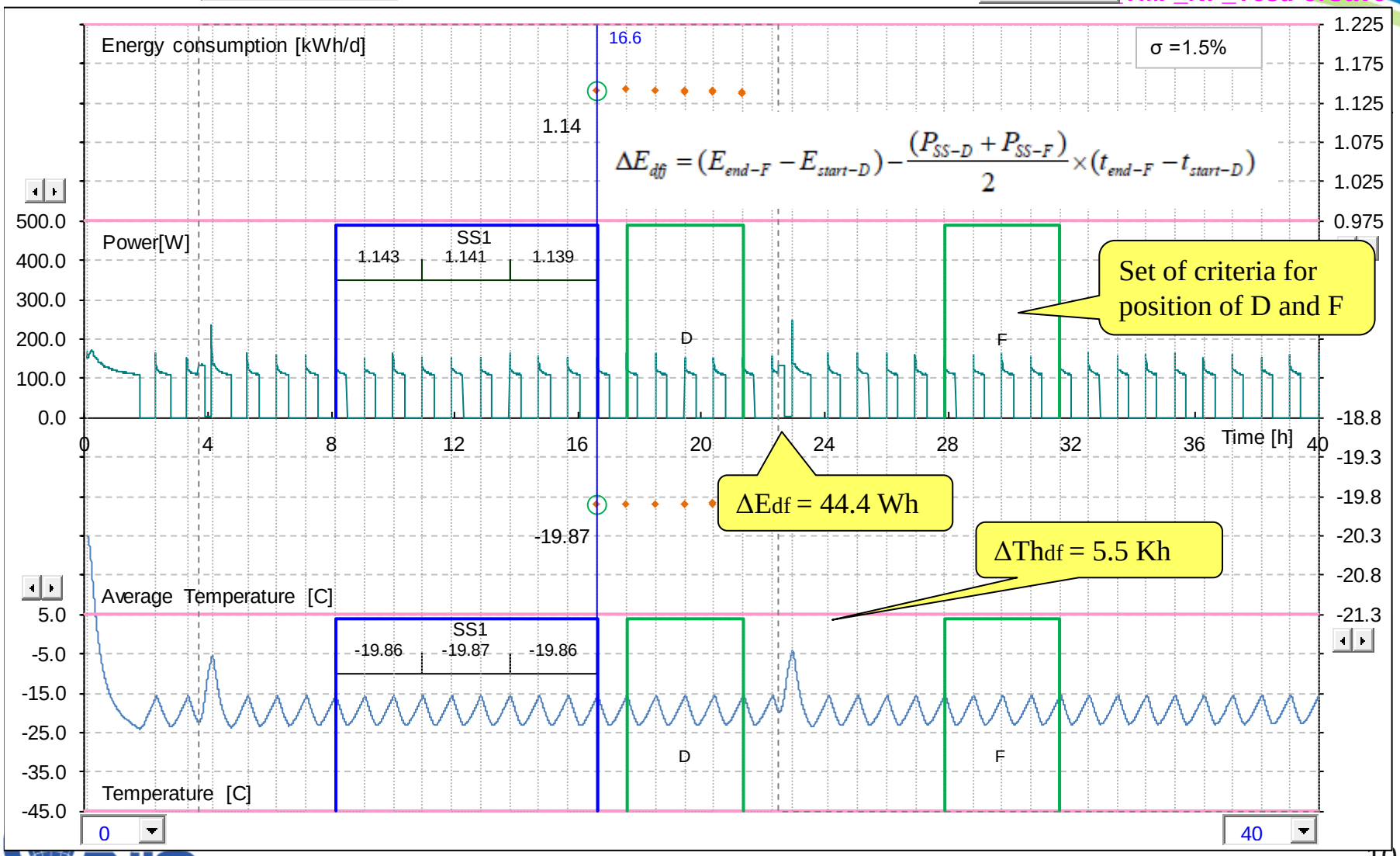
Energy consumption test in detail- Steady state (SS1 method)

Product: Compartment shown: Control cycle: SS method: V2.4 www.re-gent.nl

Load Data | Fresh Food [C] | Power | SS1 | Update All | Combi_TMF



Energy consumption test in detail- Defrost analysis

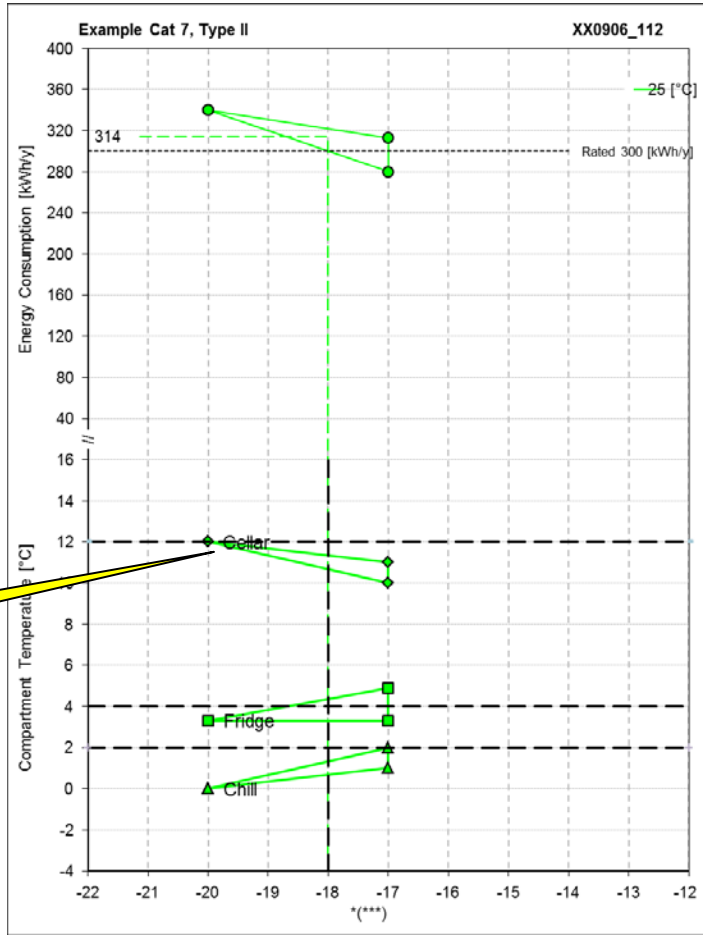


Energy consumption test in detail- Aggregation

Energy consumption test						Triangular Interp.
		25 [°C]				Inside Triangle
Climate room humidity	[%rh]	50	50	50	50	
Thermostat setting fresh food	[-]	4	5	5	4	**4.7**
Thermostat setting frozen food	[-]	-19	-18	-19	-19	**-18.6**
Running time	[%]	20.0	30.0	25.0	24.0	**25.5**
Cycle time	[s]	50	60	60	55	**56.7**
Energy consumption	[kWh/y]	340.0	313.0	280.0	310.0	**314.4**
Fridge	[°C]	3.3	4.9	3.3	4.0	**4.0**
*(***)	[°C]	-20.0	-17.0	-17.0	-18.5	**-18.0**
Chill	[°C]	0.0	2.0	1.0	2.5	**1.1**
Cellar	[°C]	12.0	11.0	10.0	10.5	**11.1**

Collecting different tests

Interpolation, two point or triangulation



Energy consumption test in detail- Energy Labels / MEPS

Appliance_Survey - Triangular.xltm

	A	B	C	D	E	F	G
1	**Cabinet model**		**Example Cat 7, Type II**				
2	*RCP*		XX0906_112			Version 3.2	
3	*Reference standard*		EN153:2006				
4	*Appliance category*		7				
5	*Appliance placement*		Free standing				
7	***Main results***		*Rated*	*Measured*	*Deviation from rated*	*Expanded Uncert. (k=2)*	*Measu Toleran*
8	*Test series used for calculation*			25 [°C]			
9	*Calculations according regulation (EC) 643/2009 (EuP) and delegated regulation (EU) 1060/2010 (Lab*						
10	*Energy consumption*	*[kWh/y]*	300	**314.4**	4.8%	3.4%	
11	*Adjusted volume*	*[dm3]*	497.3	497.6	0.1%		5
12	*Energy efficiency index*	*[%]*	40.6	42.5	4.8%		
13	*Efficiency class (as of 20/12/2010)*	*[-]*	**A+**	**A+**			
14	*Efficiency class (as of 1/7/2014)*	*[-]*	**A+**	**A**			
15	*EEI limit 44 of 1/7/2012*	*[-]*	Pass				F
16	*EEI limit 42 of 1/7/2014*	*[-]*	Pass				
17	*Climate class*						
18	*Minimum level*		SN	SN	Pass		
19	*Maximum level*		ST	ST	Pass		

Energy Efficiency Class calculation
Example is for Europe
Will be available for many countries

Check against MEPS

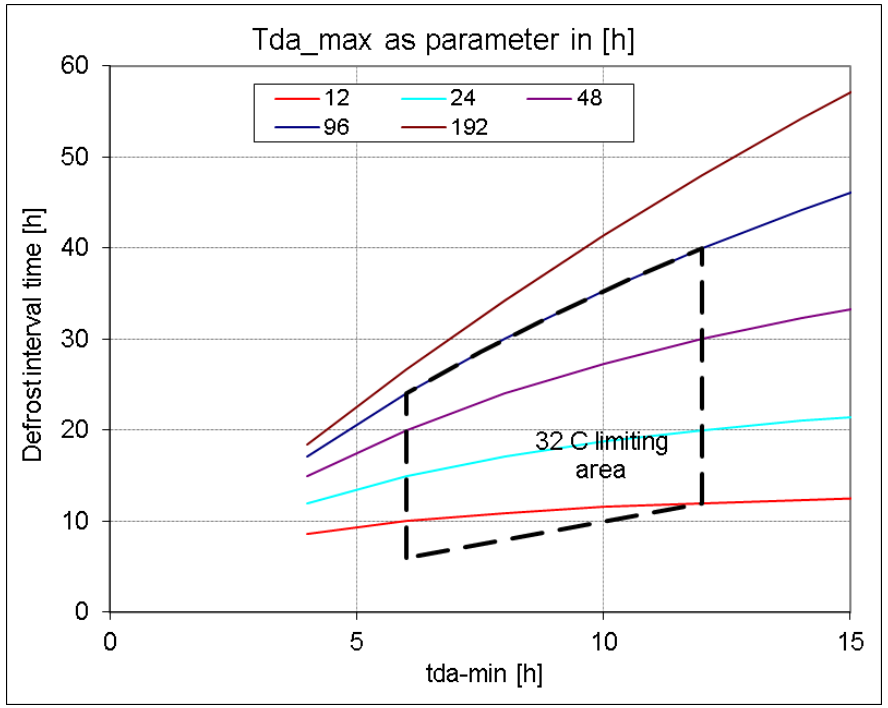
Energy consumption test in detail- Defrost interval

1. t_{df} =Elapsed time (not generally used)
2. t_{df} depends on compressor run time (widely used)
   - Requires measurement of time interval
3. Variable (= adaptive defrost = more and more used)
   - t_{df} is based on a calculation only and requires manufacturer input

$$E_{daily} = P \times 24 + \frac{\Delta E_{df} \times 24}{t_{df}}$$

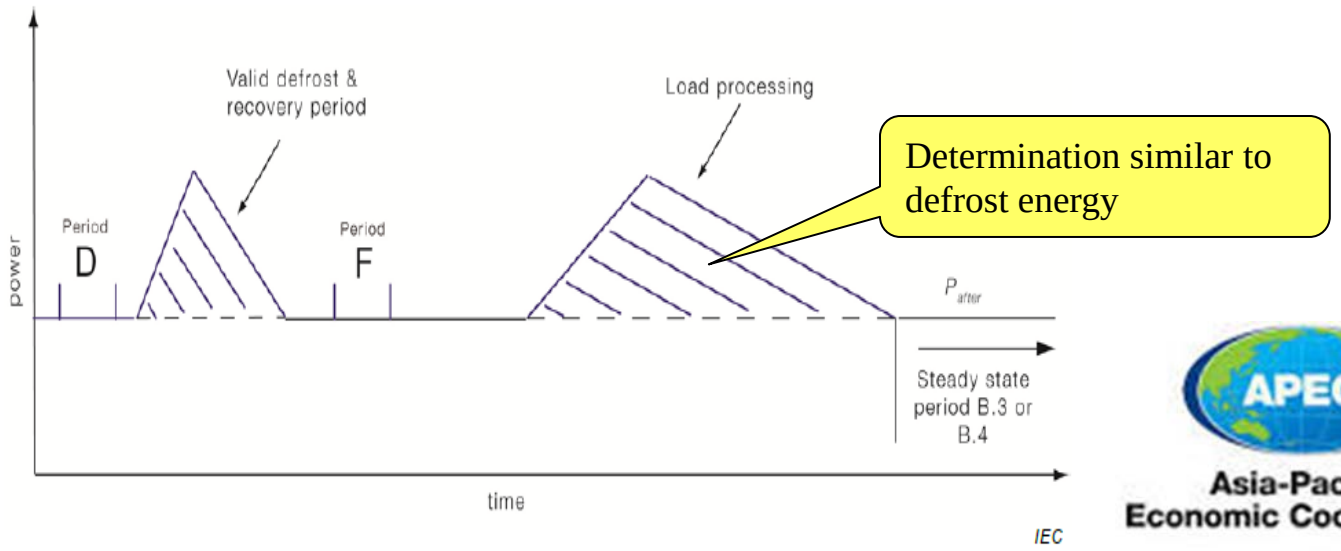
$$\Delta t_{df32} = \frac{\Delta t_{d-max} \times \Delta t_{d-min}}{[0{,}2 \times (\Delta t_{d-max} - \Delta t_{d-min}) + \Delta t_{d-min}]}$$

$$\Delta t_{df16} = 2\Delta t_{df32}$$



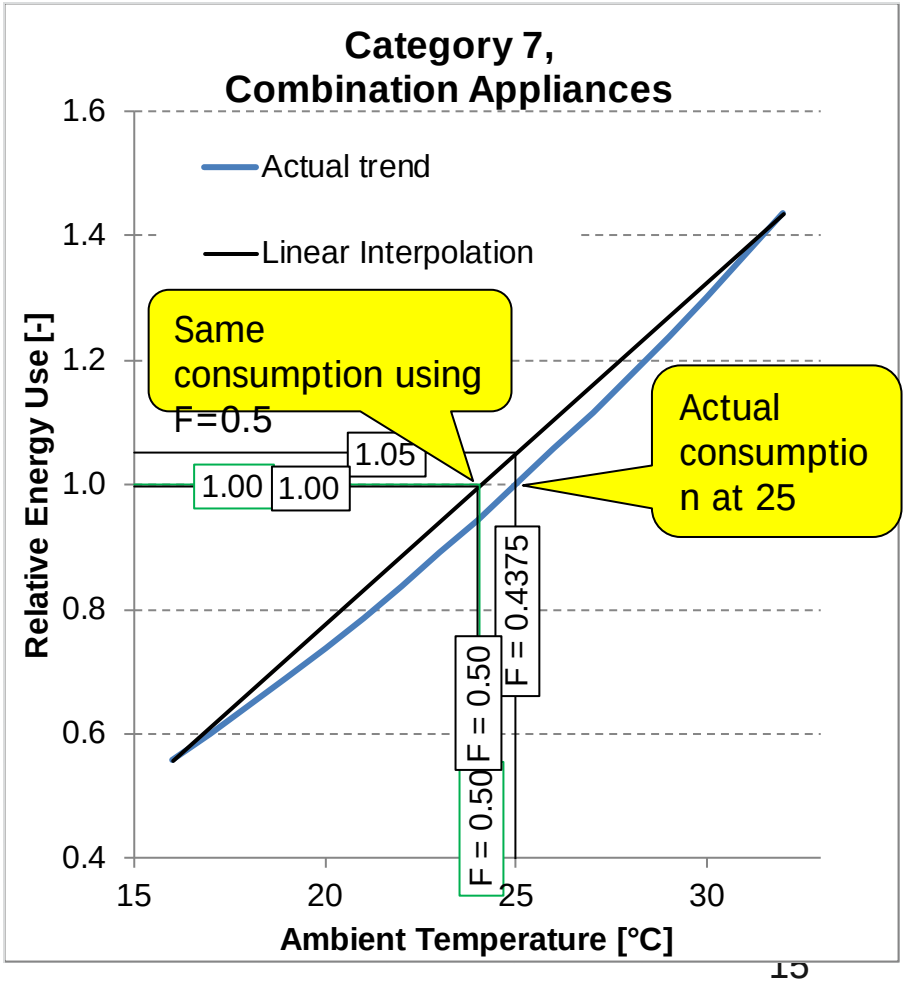
Energy consumption test in detail-
Summary energy consumption

1. More complex to define stability then before. Software needed.
2. No load packages = Significantly shorter test times (can range from less then 10 hours to a few days)
3. Defrosts are measured separately from steady state -> allows shorter test periods
4. Energy use which can be added (not in all regions):
   - Auxiliaries (e.g. heaters and automatic ice makers)
   - Load processing efficiency (extra test in Annex G)



Energy consumption test in detail-
Interpolation factor *F* options

1. Linear interpolation equivalent to 25 ° C -> *F* = 0.4375
2. Linear interpolation equivalent to 24 ° C -> *F*=0.5
   - Gives similar energy consumption as a real test at 25 ° C, as shown by trend study and experimental analysis
   - Trend between 16 and 32 ° C is non-linear (increasing slope at higher ambient temperatures)



Impact of global standard on product design

Experimental investigation by manufacturers in CECED

Formula: $E_{total} = 0.5 * E_{16^\circ C} + 0.5 * E_{32^\circ C}$ (no load processing)

73 products split over different categories:

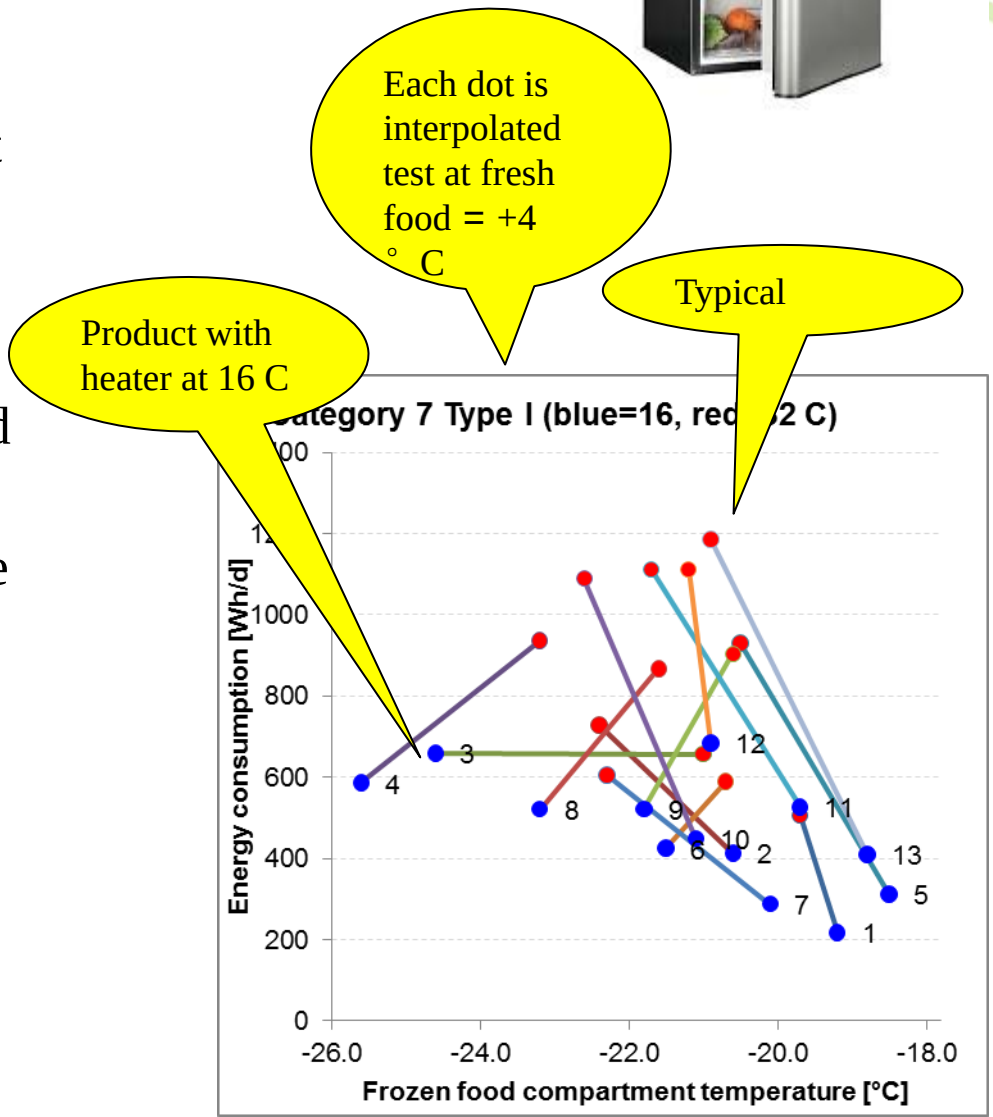
Categories are under revision

Category	Main characteristic	Average change (%)	Spread (%)
Category 1, 2 and 3	Fridges with or without chill compartments	+12	+5 .. +16
Category 7, single control (Type I)	Combination appliances such as top and bottom mounted freezers	+13	+5 .. +75
Category 7, double control (Type II) + Category 10, static type	Combination appliances	+2	-7 .. +10
Category 7, double control (Type II) + Category 10, No-Frost	Combination appliances	+4	-6 .. +14
Category 8, static	Upright Freezers	-5	-15 .+6
Category 8, No-Frost	Upright Freezers	-2	-8 ..+8
Category 9	Chest Freezers	-6	-5 ..-6

Impact of global standard on product design

Category 7, type I

- Single control, can not control both compartments optimally at all ambient temperatures
- 25 appliances, large spread in impact: +5 to +75 % (average +23 %)
- None of the appliances were optimised for the new standard --->
- 18 appliances excluded as these can be improved: **positive effect new standard (!)**
- Average increase of 7 products remaining: +13 %



Impact of global standard on product design

Combi single control, What to do?

- Characteristics:
  - Typical low cost appliance
  - Often on the MEPS boundary
  - Ambient range now often large (e.g. T).
  - Controlling over ambient range by heaters, light activation etc.
- Need careful redesign at 16 and 32 ° C
  - Reduce heater capacity
  - Drop climate class T, ST or SN if not needed
  - User “clever” evaporator design to play with charge
- If nothing works, upgrade to double control

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Europe Energy Labelling/Ecodesign

- Review of generic label directive in 2015/2016
- Study started for cold appliances, expected completion 2016
- Implementing measures 2017..2018 (both label and MEPS)
- Target is to synchronize with IEC62552-1,2,3:2015
- New standard does not define interpolation between 16 and 32 ° C, proposal
  - To obtain the same consumption as a test at 25 ° C use:
  - $E_{total} = 182.5 * E_{daily\text{-}16\,^{\circ}C} + 182.5 * E_{daily\text{-}32\,^{\circ}C}$ *[kWh/y] (F=0.5)*
  - Load processing not included as effect on product ranking very small
- Adjusted volume formula needs replacement for consistency (see IEC SC59M proposal on adjusted volume)

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Concluding remarks

- New global standard is released and is being integrated in energy regulations (CN, AU/NZ, EU)
- Many advantages of new standard, for manufacturers, test houses but also for consumers
- Procedures are quite different than before
- All products will require optimization to the new standard
- Single control combi most seriously affected (on purpose)

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