ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT

Energy&Appliances 2015 project

A new approach for testing appliances with respect to end-users behaviour

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ENEA UTTEI-SISP | Insubria University*

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Context

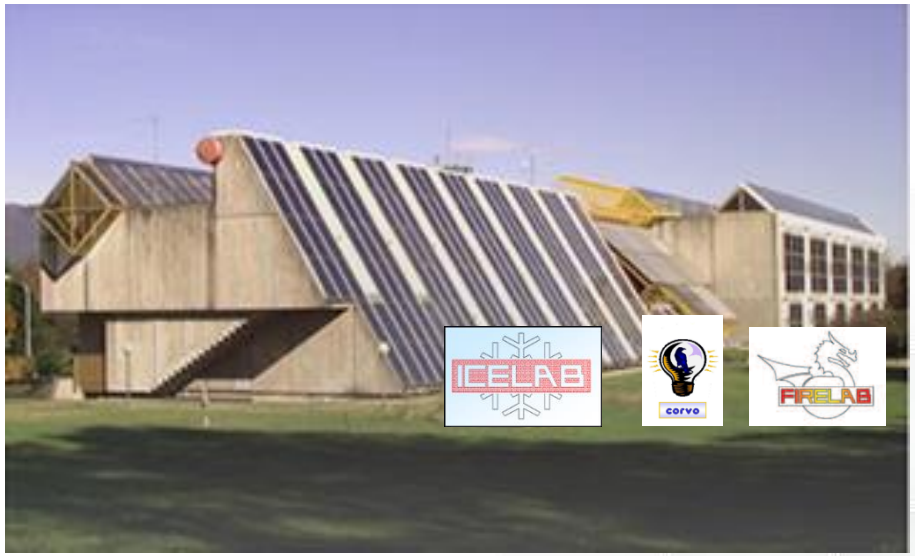
- ✓ ENEA
- ✓ The Energy&Appliances Project
- ✓ The legislative framework: Labelling scheme and standard
- ✓ Characterization of the market of household appliances and the user profiles
- ✓ Defining common user profiles for energy assessment
- ✓ Conclusion

ENEA and the Research Laboratory in Ispra

Pursuant to art. 37 of Law no. 99 of July 23rd, 2009, the Agency's activities are targeted to research, innovation technology and advanced services in the fields of energy.
ENEA performs **RESEARCH ACTIVITIES** and provides **AGENCY SERVICES** in support to public administrations, public and private enterprises, and citizens.

- **Nine ENEA Research Centres** and **five Research Laboratories**
- A network of **TERRITORIAL OFFICES**
- An **ENEA-EU LIAISON OFFICE IN BRUX**
- **ENEA headquarters** located in Rome.

Ispra Laboratories
provide highly qualified technological support in testing and certifying energy efficiency and environ-mental impact of cold appliances, electric ovens and lighting systems



www.enea.it

The Project "Energy & Appliances 2015"

The Framework:

"Industry 2015 Energy Efficiency" Program, by the Ministry of Economic Development

The Object:

Development of a range of appliances within three years, characterized by a considerable reduction in consumption of energy and water, through the implementation of specific evidence.

- **By** the involvement of large enterprises, SMEs, research institutes, ensuring access to skills necessary to consolidate the new solutions through research, validation, regulatory law and technological transfer.
- **For** the investigation in:
  - ✓ Innovative materials for improving energy efficiency and reducing environmental impact.
  - ✓ Innovative technologies for **cleaning clothes and dishes**.
  - ✓ Innovative technologies for the **preparation and storage of food**.
  - ✓ Innovative Electronic Technologies (sensors, control logic, user interfaces).
  - ✓ New methods for the qualification and certification of the products.

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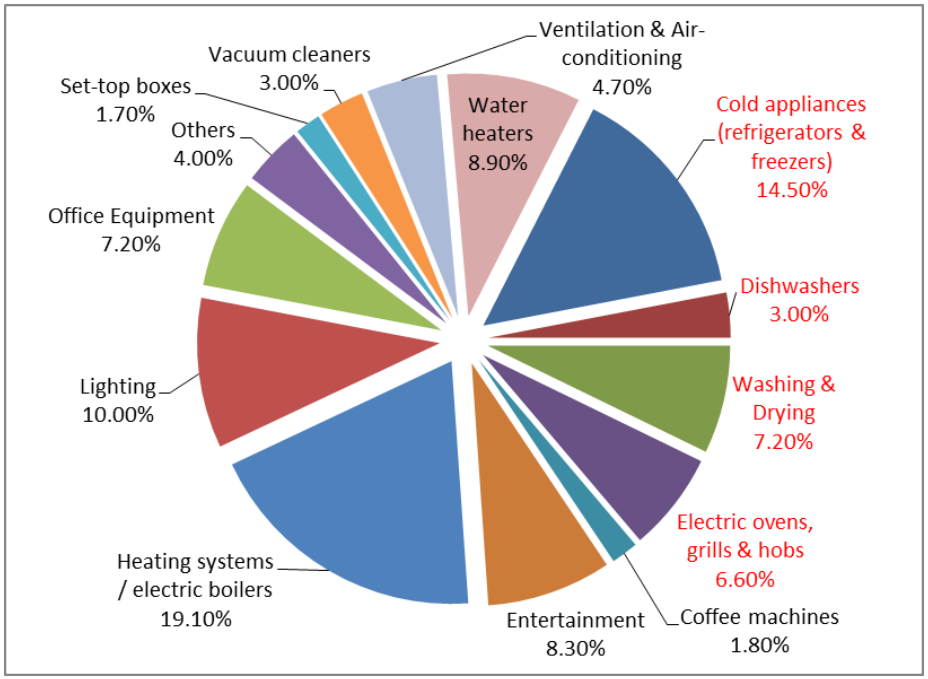
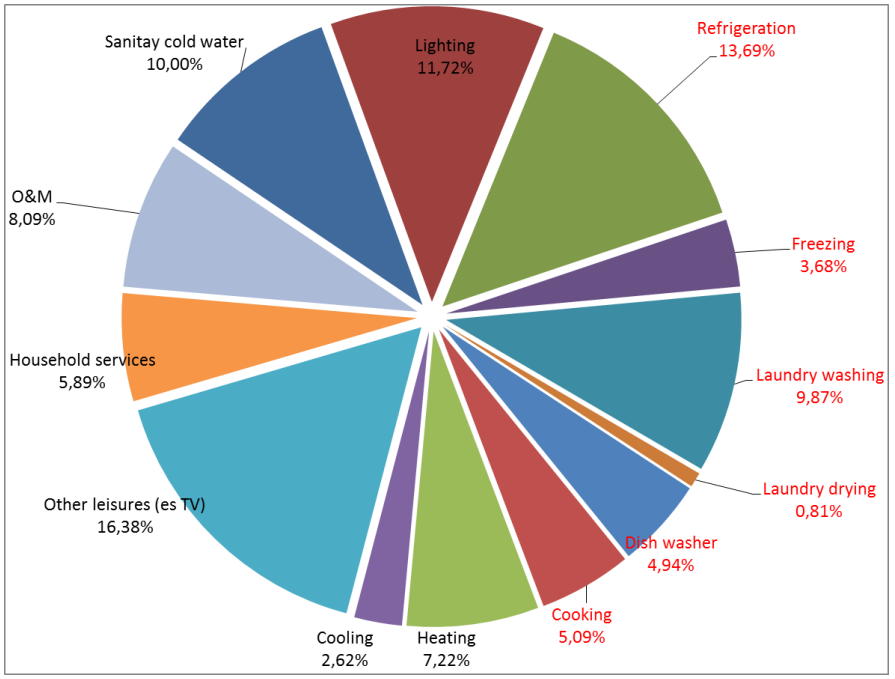
Residential electricity consumption



Residential electricity consumption breakdown in the EU-27 (source JRC), 2009



Residential electricity consumption in Italy (source RSE), 2010

% Appliances object of the E&A Project

31.30% in EU-27 38.08% in Italy

% Cold Appliances

14.50% in EU-27 17.40% in Italy

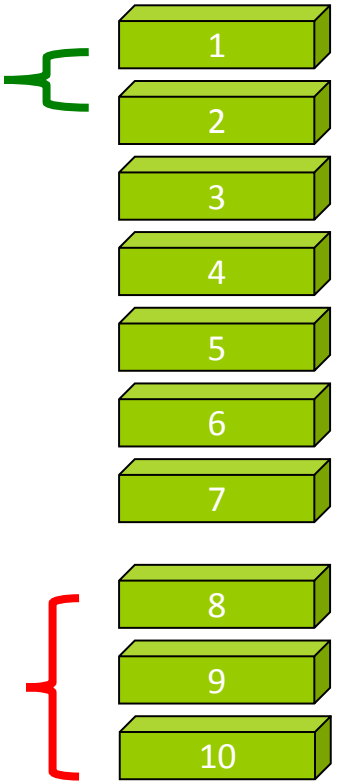
Effects of the EU legislation for energy efficiency

Eco-label

voluntary, «mark of excellence»

Ecodesign Directive

mandatory, minimum requirements for entering the Community market



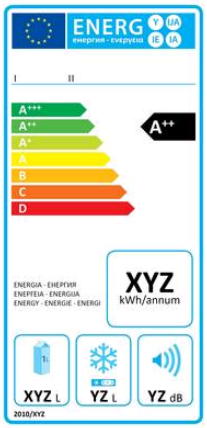
Product classes

A+++
A++
A+
A
B
C
D
E
F
G

Incentives

EU GPP

voluntary, stimulate market for better products while ensuring adequate competition



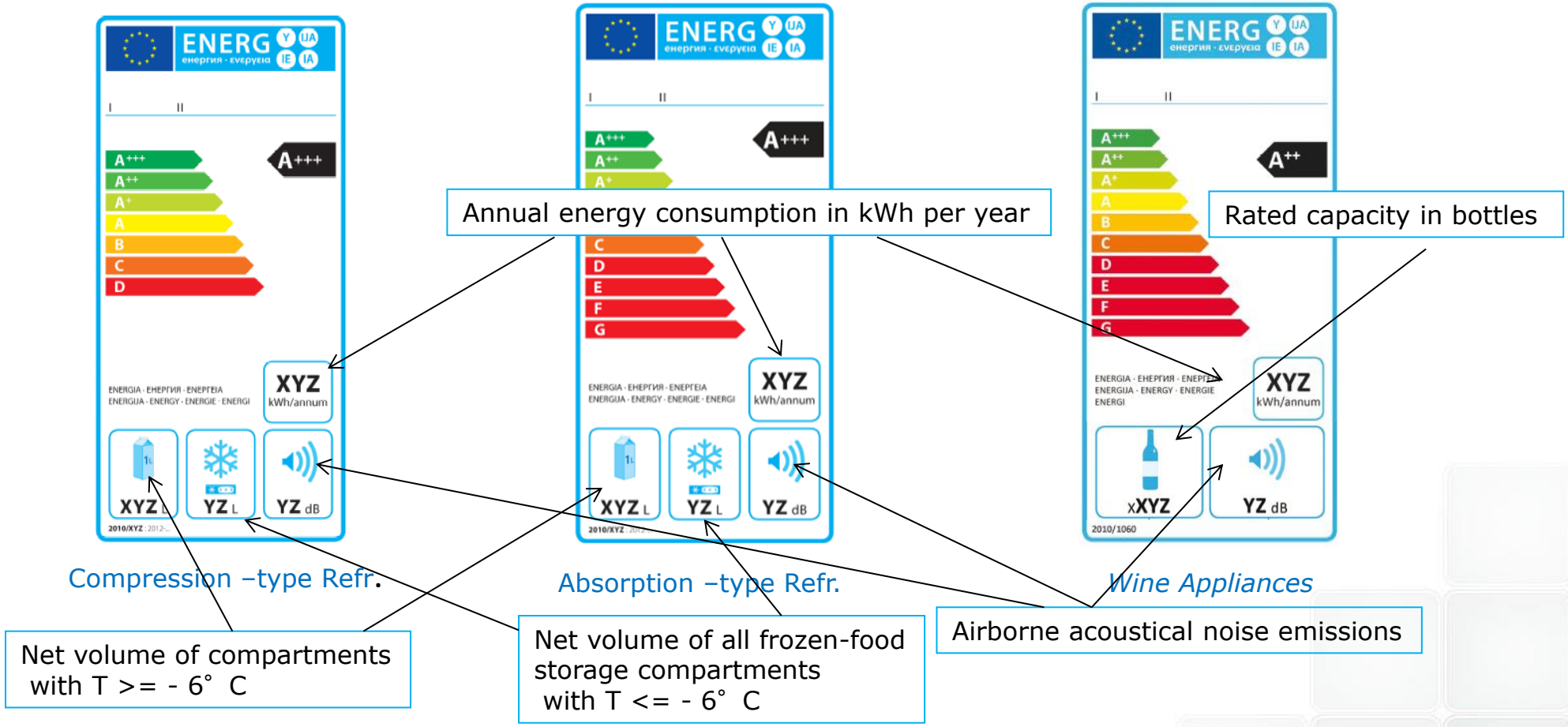
Energy Labelling Directive

mandatory, ranking of products according to energy efficiency and functional performance

The labelling scheme / Standard EN ISO

Label Delegated Regulation N. 1060/2010 - Directive 2010/30/UE (recast of 92/75/CEE)

Ecodesign Delegated Regulation N. 643/2009 - Directive 2009/125/CE (recast of 2005/32/CE)

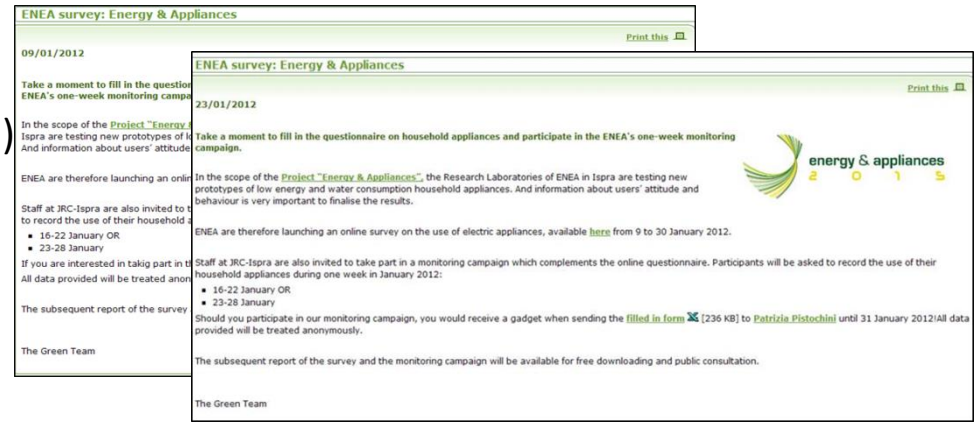


Standard EN ISO 15502 2005: Household refrigerating appliances: characteristics and test methods

Characterizing the market of household appliances and the user profiles

1st Enquiry

- 2010
- Presence and the main energy efficiency and technical characteristics of the domestic appliances installed in the Italian households.
- By the society ODC Services
- Owning a PC and able to use Internet, living in I.
- 3 000 families answered (0,125% tot. population)



2nd Enquiry

- 2012
- Adaptation of the previous survey in English and Italian
- Focusing only on domestic appliances object of E&A project adapted to the new EU legislation
- By ENEA Ispra in collaboration with JRC IET and Green Team and with the technical support of ENEA
- Staff of JRC – Ispra (Italy) involved by a intranet broadcast of Green Team
- A total of 2% of the JRC staff responded, coming from different EU Countries

Object of the survey 2012 – Cold Appliances

PRIVATE DATA

- Sex
- Age
- Nationality
- Profession
- Educational qualification
- Composition of the family unit
- Years of residence in Italy
- Type of housing situation
- Population of the town of residence
- Types and quantity of household appliances own
- Types and quantity of household appliances networking
- Weekly use of the kitchen nook
- % of energy cons. different appliances in the electric bill
- Most energy consumers appliances
- Relevance of the habits for energy savings
- Behaviour of the family to save energy
- Respect of the environment

ADDITIONAL QUESTIONS

- Purchase through Governmental incentives
- Noise level
- Energy Efficiency Class
- Knowledge of energy labelling
- Use of Operating Manual
- Usefulness of the Operating manual
- Interpretability of commands
- Criteria adopted for choosing a new appliance
- Criteria adopted for the disposal of the old appliance
- Comments on information provided by TV, internet, advertising materials

COLD APPLIANCES

Volume (estimated and real)
Age of the appliances (estimated or real)

- Type of installation
- Type of cooling system
- Use
- Automatic defrost system and frequency of use
- Refrigerator:
  - Presence and quantity of low temperature comp.
  - Quantity of stars at the low temperature comp.
- Freezer:
  - Type of loading door
  - Type of cooling system
  - Freezing of fresh food
- Refrigerator-freezer:
  - Number of opening doors
- Wine storage appliances:
  - Number of compartments at different temperatures
  - Range of available variable temperatures
  - Type of wine storage appliances

Sharp look at **Ownership** and Remarks

49.8 % in Italy

17.4 % in Italy

	Survey 2010 ODC SERVICES	Survey 2012 European Commission
Subject	Italian families	JRC community in Ispra
N. of questionnaire	3000 families out of 60,6 Mio of citizens	25 families out of 1600 researchers
Most owned appliances	Fridge-freezer or Fridge+freezer → 100% Washing machine → 95.3% Oven → 94.4% Cooker → 86.6% Dishwasher → 60%	Fridge-freezer or Fridge+freezer → 100% Oven → 84% Washing machine → 84 Dishwasher → 60%
Household appliances networking	Washing machine → 20.6% Oven → 18.2% Fridge-Freezer → 15.3% Dishwasher → 12.7% Cooker → 13.6%	Oven → 18% Fridge-Freezer → 17% Dishwasher → 13% Washing machine → 13 Cooker → 9%
Use of cooker	More time each days → 66.3% One time a day → 27.7%	One time a day → 59% More time each days →
Incidence of appliances consumption on own energy bills	More than 75% → 7.3% Between 50% and 75% → 37.9% Between 20% and 50% → 46.2% Less than 20% → 8.7%	More than 75% → 14% Between 50% and 75% 41% Between 20% and 50% 27% Less than 20% → 18%
Most energy consumer appliances	Washing machine Electric Oven Dryer Dishwasher Fridge-freezer	Electric Oven Washing machine Dryer Fridge-freezer Dishwasher
Relevance of habits for saving energy	Yes → 60.1% Enough → 39.6% Other → 0.3%	Yes → 60% Enough → 32% Other → 8%

	Survey 2010 ODC SERVICES	Survey 2012 European Commission
Behaviour of the family	Adoption of common rules → 72.5% Individual behaviour → 25.1%	Adoption of common rules → 72% Individual behaviour → 28%
Respect of environment	Enough → 60.5% Always → 32.6% Sometimes → 6% Low → 0.9%	Enough → 59% Always → 41%
Knowledge of the energy labelling	Yes → 35.7% No → 34.5% I have heard → 29.8%	Yes → 97% No → 3%
Purchase incentivised by tax allowance	Refrigerators – No → 33% Fridge-Freezer – No → 62.3% Freezer – No → 34%	Refrigerators – No → 63% Fridge-Freezer – No → 61% Freezer – No → 89%
Higher level of noise	Washing machine Fridge-Freezer Refrigerators Freezer	Freezer Wash-dryer Washing machine Dishwasher
Consultation of Operating Instructions	Often → 51.9% Always → 33.1% Sometimes → 13.3% Almost never → 1.7%	Always → 32% Often → 32% Sometimes → 20% Almost never → 16%
Remarks to Operating instructions	Useful → 55.1% Complex → 27.1% Incomplete → 21.6% Easy → 9.4% Exhaustive → 5.6% Useless → 1.8%	Useful → 52% Incomplete → 28% Exhaustive → 9% Complex → 8% Easy → 3% Useless → 0%
Criteria for purchasing a new appliance	Consumption Cost Brand	Consumption Brand Cost
Disposal of the replaced appliance	Retailer Garbage dump Leave it to other person	Retailer Garbage dump Leave it to other person
Judgment on information by media	Useful → 39% Tendentious → 34% Incomplete → 11.3% Often false → 8.4%	Incomplete → 42% Tendentious → 39% Useful → 11% Often false → 8%

Largest impact on selection: consumption

Sharp look at Ownership and **Remarks**

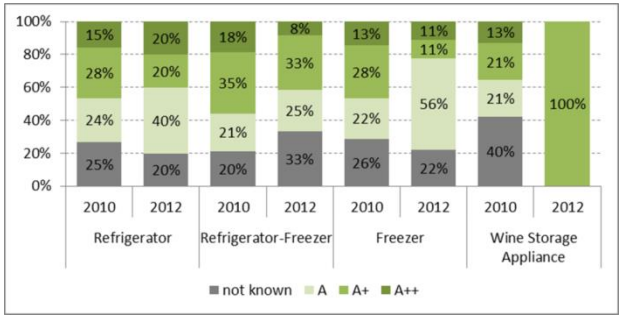
- **Energetic and environmental issues play a key role for almost all respondents**.
  - Nominal energy consumption is the most important criteria for purchasing.

- **Manuals** are consulted after purchase or upon necessity.
  But information is:
  - useful ± 53%
  - incomplete ± 25% and complex 27% (2010) and 8% (2012).

- **Information by media is often judged:**
  - tendentious ± 36%
  - false 8%
  - incomplete 11% (2010) and 42% (2012).

Sharp look at Cold appliances

- The most common **energy class** of used cold appliances is **A+**.
  - Class B and C are no longer represented



Questions		Refrigerator		Refrigerator-freezer		Freezer		Wine storage appliance	
		2010	2012	2010	2012	2010	2012	2010	2012
Energy efficiency class	A++	15%	20%	18%	8%	13%	11%	13%	0%
	A+	28%	20%	35%	33%	28%	11%	21%	100%
	A	24%	40%	21%	25%	22%	56%	21%	0%
	don't know	25%	20%	20%	33%	26%	22%	40%	0%
Installation	freestanding	51%	33%	62%	38%	82%	64%		
	built-in	47%	67%	38%	62%	17%	36%	n.a.	n.a.
	other	2%	0%	0%	0%	1%	0%		
Cooling system	static	30%	9%	20%	15%	36%	20%		
	air-circulation	21%	9%	21%	15%	13%	0%	n.a.	n.a.
	no-frost	27%	18%	38%	31%	20%	10%		
	don't know	22%	64%	21%	38%	31%	70%		
Low temperature compartments	4-stars	0%	0%	100%		100%			
	3-stars	41%	14%	0%		0%			
	2-stars	11%	14%	0%	n.a	0%	n.a.	n.a.	n.a.
	1-star	4%	15%	0%		0%			
	0-star	8%	0%	0%		0%			
	don't know	37%	57%	0%		0%			
Number of doors and configuration	combi	n.a	n.a	49%	42%	n.a	n.a.	n.a.	n.a.
	2 doors			45%	58%				
	side-by-side			4%	0%				
	>2 doors			1%	0%				
Purchases with state incentives?	No	89%	62%	88%	48%	91%	45%	n.a.	n.a.
	Yes	11%	38%	12%	52%	10%	55%		
Noise	No	78%	75%	80%	62%	70%	91%	n.a.	n.a.
	Yes	18%	25%	16%	23%	12%	9%		
	don't know	2%	0%	3%	0%	1%	0%		
	installed in another room	2%	0%	2%	15%	18%	0%		
Average age	Years	6.8	5.5	6.0	5.3	6.5	4.5	5.3	
Average volume	Lt.	128.2	n.a.	159.2	201.7	129.1	89.4	n.a.	n.a.

- Purchases with **state incentives** in 2012 result **higher by 35%** than in 2010.
- Noise is not an important performance / problem.
- **Energy class, type of cooling system, quantity of stars of the refrigerator units** are **often not known.**
- The **average age** of cold appliances **was reduced** from 6-7 to 4.5-5.5 years

Personal habits in the use of Cold Appliances

Question		2012
freezing of fresh food	always	6%
	often	50%
	sometimes	31%
	never	13%
use of freezer for fresh food	lower of the temperature of thermostat	0%
	use of fast freezer / super cool switch	27%
	neither of them	73%
automatic defrost	yes	43%
	no	57%
defrost frequency	once a month	0%
	once every 3 months	15%
	once every 6 months	23%
	once a year	54%
	never	8%

The monitoring campaign

- Model and brank
- Type of installation and location
- Class of energy efficiency
- Date of purchase (real or estimated)
- Dimension and volume
- Equipment of devices (
  - inner LED, humidity control, inner shelves, door pockets, fruit and vegetable drawers, tempered glass shelves, chill compartments)
- Cooling system
- Controls (display and selector of program)

THE LOGBOOK

ENEA - Monitoring campaign on the use of the domestic appliances beyond the JRC staff

energy & appliances 2015

Refrigerating Appliances

General info about the apliances							
	Model						
	Brand						
	Type		Bottom Freezer		Top Freezer		Side by side
			Compact Refr.		Built-in		Refr. only
	Energy Rating		A+++, A++, A+, A, B, C, D, E, F, G		I do not know		
	Estimated or real year of purchase						
	Total Capacity Lt.		Lt.		I do not know		
	Freezer Capacity Lt.		Lt.		I do not know		
	Refr. Capacity Lt.		Lt.		I do not know		
	Dimensions mm (H x W x D)						
	Where is it installed?		Kitchen		.....		
	Fresh Food Features						
	LED Interior Lighting		Yes		No		I do not know
	Humidity Control		Yes		No		I do not know
	Door Pockets		Yes		No		I do not know
	Shelves n.						
	Fruit and Vegetable Drawers		Yes		No		I do not know
	Tempered Glass Shelves		Yes		No		I do not know
	Chill Compartment		Yes		No		I do not know
	Exterior Features						
	LED Display		Yes		No		I do not know
	Cooling Features						
	Frost free		Yes		No		I do not know
	Static		Yes		No		I do not know
	Controls						
	Display		Electronic display		Big LED display	Other	
	Programme selector		Electronic		Manual		Touch control

ENEA - Monitoring campaign on the use of the domestic appliances beyond the JRC staff

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Refrigerating appliances

Monitoring Week from ..... to ..... January 2012

Day of the week		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Time								
Maintenance	clean of the back of the appliance							
	clean of the inside compartments /drawers (refr.)							
	clean of the inside compartments /drawers (freezer)							
	clean of gaske							
	other.....							
Follow the instruction for	pre-freezer							
	change thermostat							
	other.....							
"Storage" of hot foods								
Freeze of fresh food								
Use of closed containers								
Foods are stored according to the								
No. opening of the appliance								
Other								

- Maintenance: cleaning of back of the appliance, of inner compartments and drawers for freezer and refrigerator respectively, cleaning of gasket.
- Daily actions: storage of cold food, freezer of fresh food, use of closed containers, storage of food according to different level of chill, number of opening.

WEEKLY DIARY

Monitoring activities by logbook 2012

- All participants have reported the **brand** of their appliances; only more than half of them reported the **mode**l.

- All but one model was **built-in**, the other were self -standing, with freezer on the bottom. **Most of them are in class A+** (45%), one in class A++. Refrigerating appliances were bought in 2005 - 2011 with an **average age of 4 years**, all are in the kitchens.

- Often the users do not know some features, over all inner LED (56%) and the humidity control device (25%).

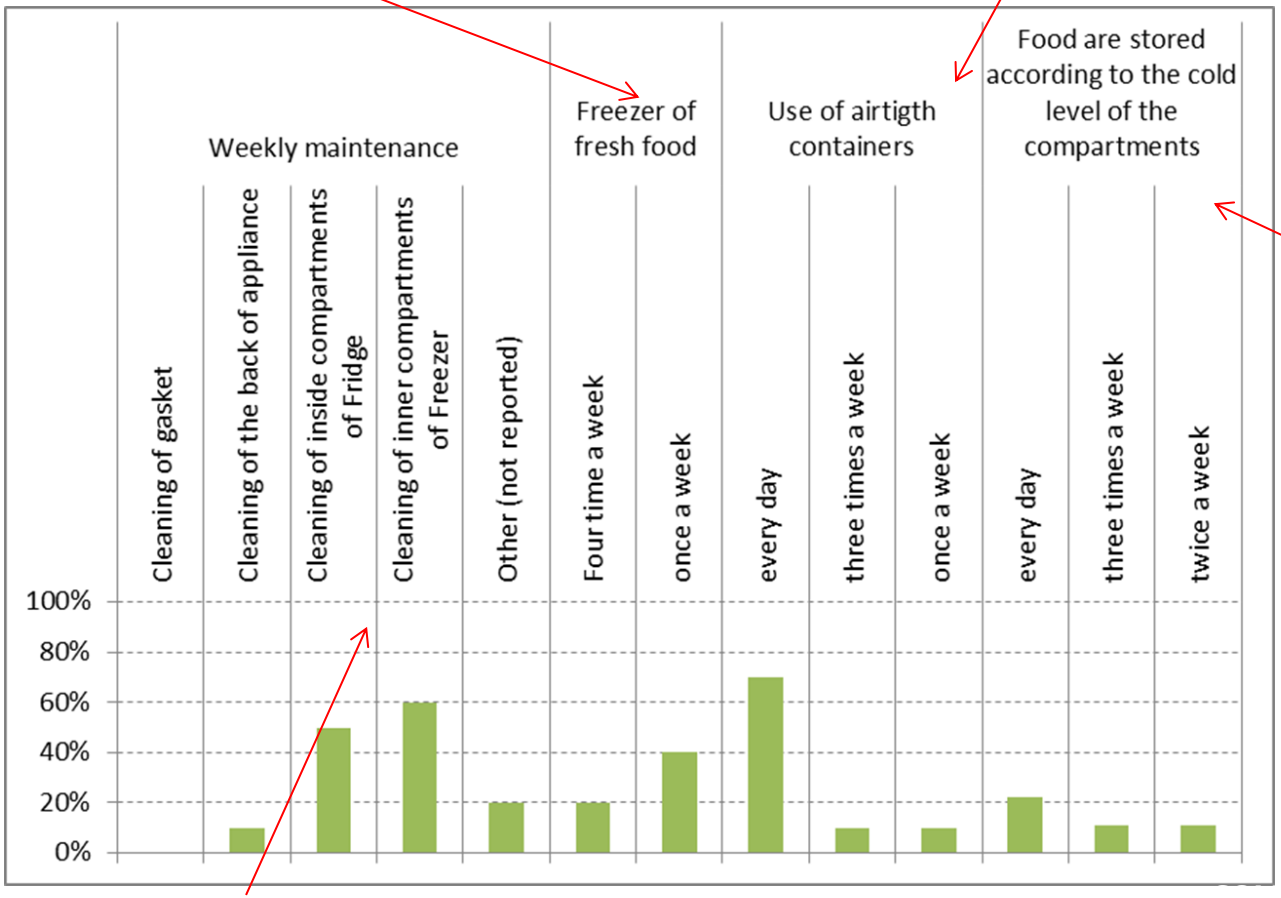
	Inner LED	Humidity control	Door pockets	Fruit and vegetable drawers	Tempered glass shelves	Fresh compartments
Yes	22%	38%	75%	89%	67%	50%
No	56%	38%	13%	11%	22%	38%
Not known	22%	25%	13%	0%	11%	13%

- Programs are selected by **manual switch** by 75% of users, the remaining 25% by touch control. 71% of the appliances do not have a display, while 29% has a LED display.

Personal habits in the use of the cold appliance

40% of users do not freeze fresh food and / or don't ever freeze

All users use airtight containers to store food, 78% of them on a daily base.



Half of the users does not place food into specific cold level of compartments

Inside compartment are cleaned by 60% of users of freezer and By 50% of users of fridge.

10% of the users store hot food in the fridge for up to 4 times a week.

Cold appliances have been opened 8 times daily

Main features:

- Standard procedures: accepted common procedures to allow reproducibility of measurements
- For refrigerating appliances, standard procedures related as "static":
  - energy consumption: simplified situations to allow reproducible conditions
  - users behaviours is excluded

Standards are periodically reviewed, to take into account:

- technological changes;
- **common users' habits -> to better reproduce domestic appliances real working conditions**

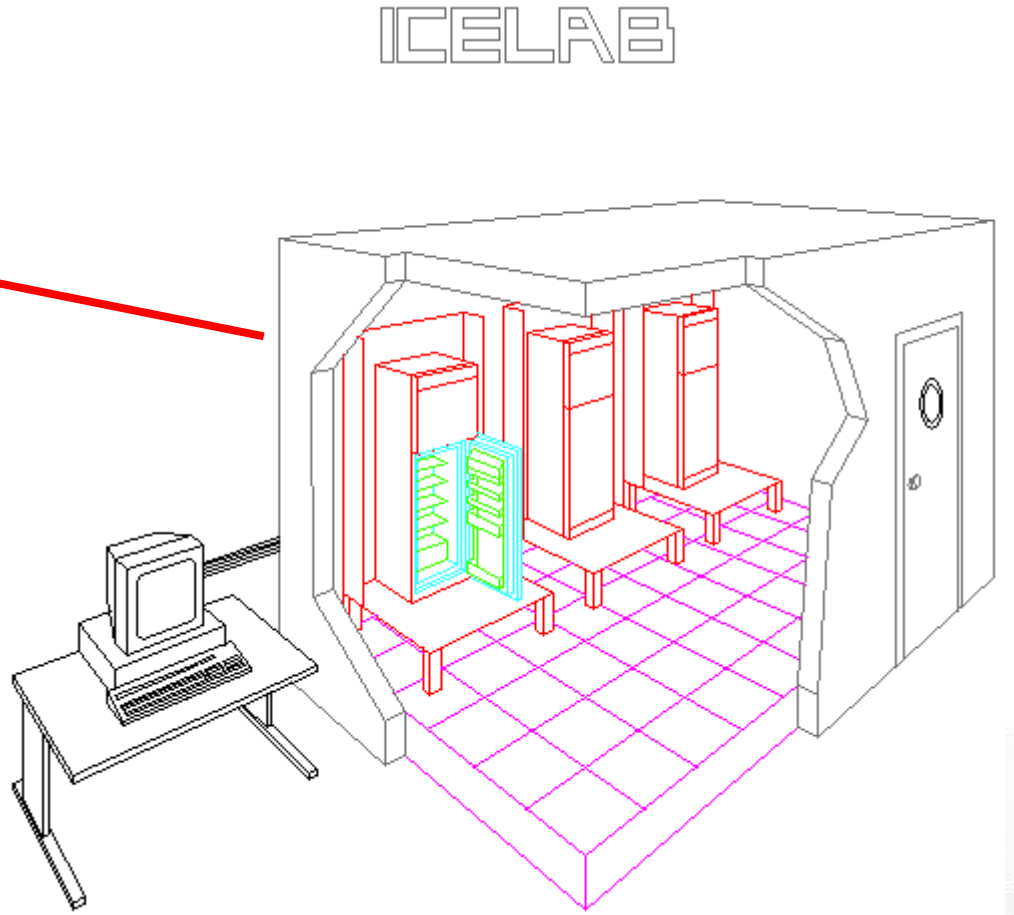
Methodology for New Tests –Refrigerating Appliances

- Standard tests (EN ISO 15502:2005 and EN 153:2006):
  - Storage temperatures
  - Energy consumption
  - Volume

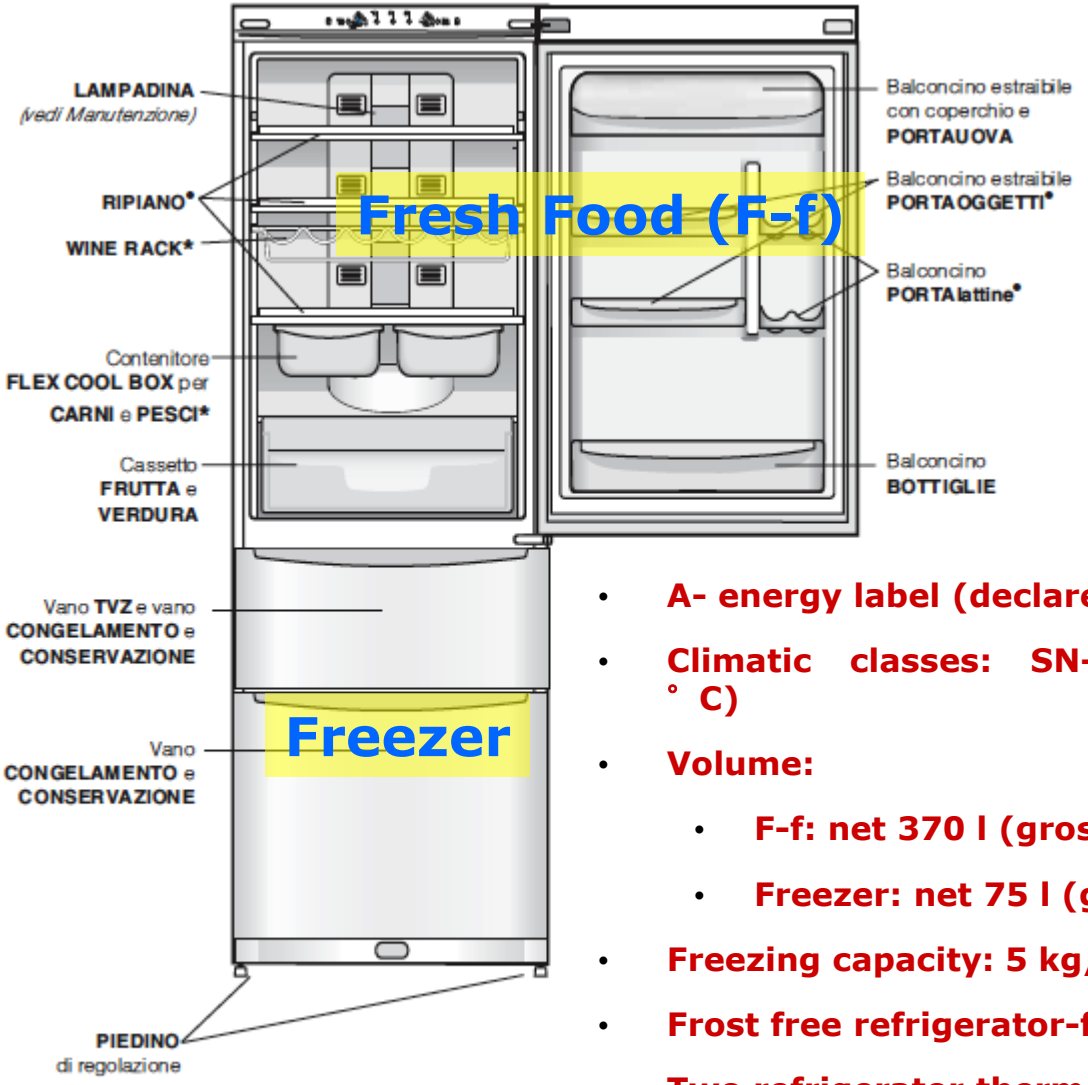
- Investigation of end-users' habits & behaviour

- New tests based on users behaviours, focusing on:
  - "Energy consumption"
  - "Storage temperatures" & "Freezing"

Test settings (1/2) Climatic Chambers: Icelab



Test settings (2/2) Refrigerator-Freezer: Main Features



*Variabili per numero e/o per posizione.
*Presente solo in alcuni modelli.

- **A- energy label (declared)**
- **Climatic classes: SN-N-ST (10—38 ° C)**
- **Volume:**
  - **F-f: net 370 l (gross 419 l)**
  - **Freezer: net 75 l (gross 123 l)**
- **Freezing capacity: 5 kg/24h**
- **Frost free refrigerator-freezer**
- **Two refrigerator thermostats (F-f and freezer compartments)**
- **Single compressor fridge-freezer**

Standard procedure: EN ISO 15502:2005 and EN 153:2006

Results:

Storage temperatures: satisfied

Energy consumption: 442 kWh/year (+13% declared value)

Volume as declared

Notes on energy consumption test:

- **Climatic chamber with stable ambient variables**
- **Freezer**: load as in storage plan
- **F-f compartment**: No load
- **No 'human interaction'**

Energy Consumption in Refrigerating Appliances

Factors influencing energy consumption in refrigerating appliances:

- Internal T within appliance (setting of thermostat)
- T_{amb} (environment)
- Doors opening (frequency & duration)
- Load (food & drinks) insertion
- Proximity of heat sources
- Ambient air ventilation
- Seals deterioration

Factors NOT in EN ISO 15502:2005 and EN 153:2006:

- T_{amb} → 19 ° C
- Doors opening → 8 opening (person/day)
- Load (food) insertion/extraction/rotation → 2 kg (person/day)

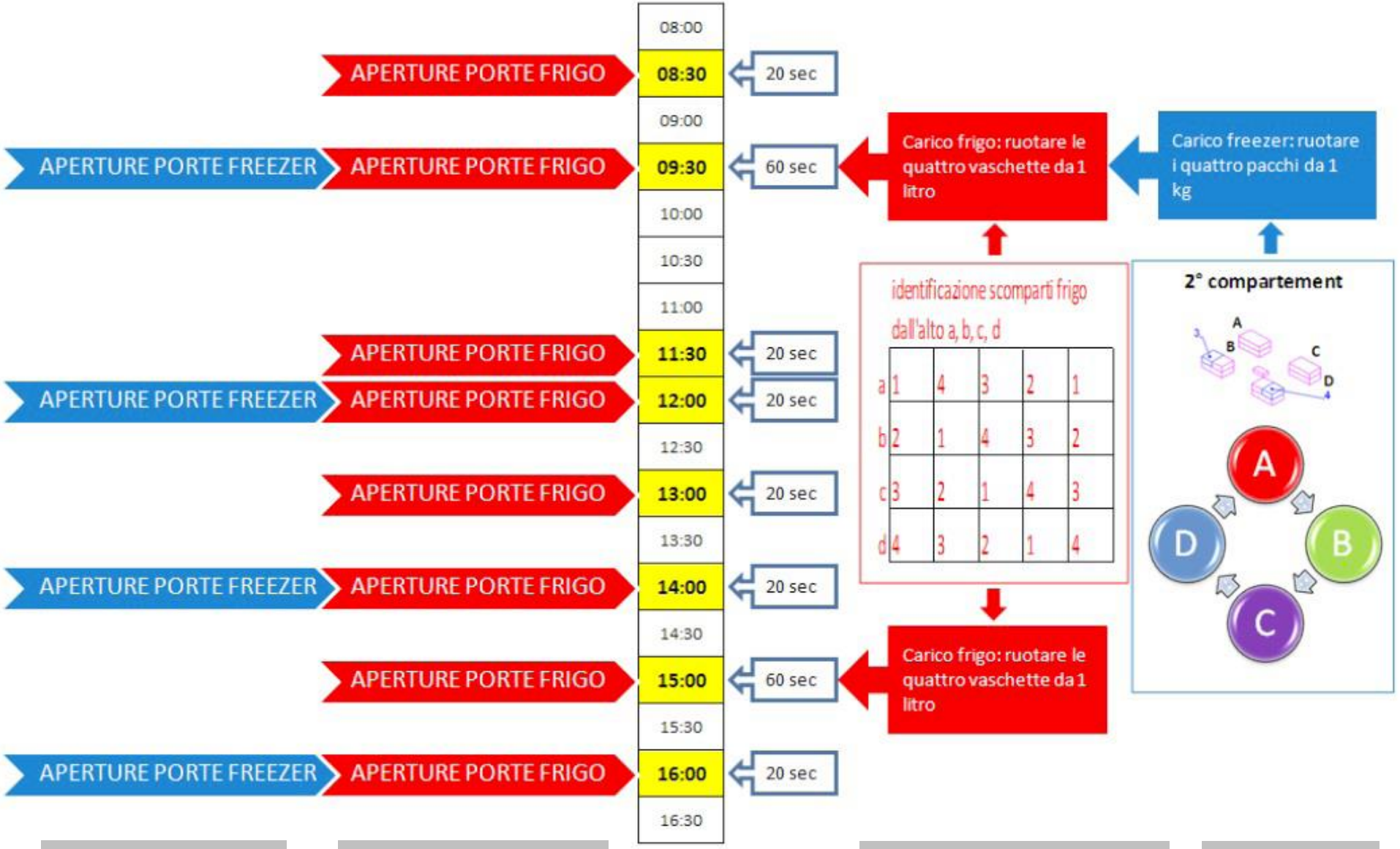
From Preparatory Studies for Eco-design Requirements, in: http://www.atlete.eu

Definition of New Test Procedures: Main Features

Weekly user schedule for a family of 3 people, defined as follows:

- Three T_{amb} (19 ° C, 25 ° C, 32 ° C)
- Door openings (up to 8 openings daily/ 20 s -- 60 s)
- Load also in the fresh food compartment (test packages and liquids)
- Halved load in the freezer compartment
- Load rotation in both F-f and freezer compartments
- Inserting of 5 kg load (declared freezing capacity) at T_{amb} in the freezer once a week (Shopping on Wednesdays)

Scheme of Test Procedure (Example not on Wednesdays)



Door openings freezer

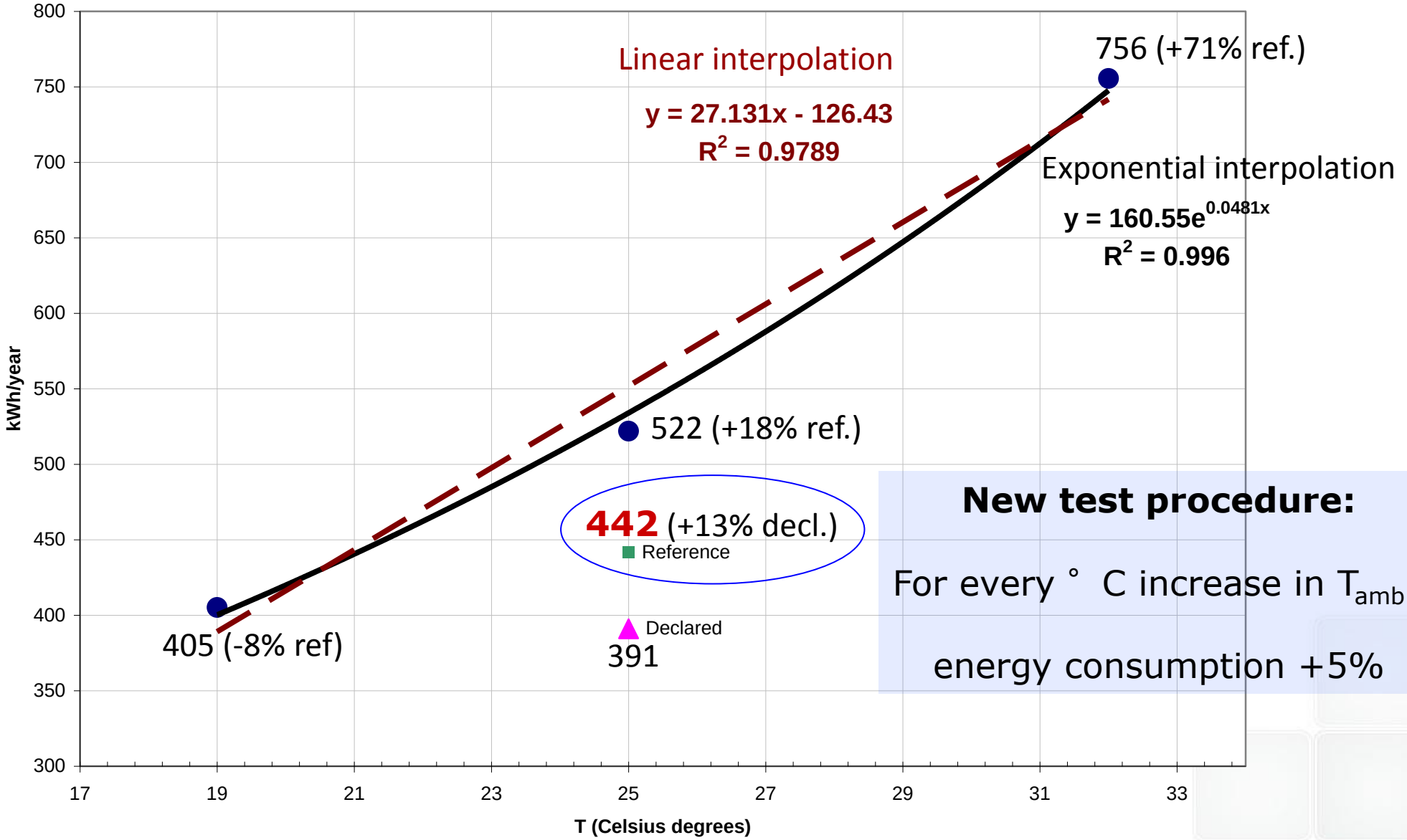
Door openings F-f compartment

T length

Rotations F-f compartment

Rotations freezer

Main Results (1/2): Energy consumption test



New test procedure:

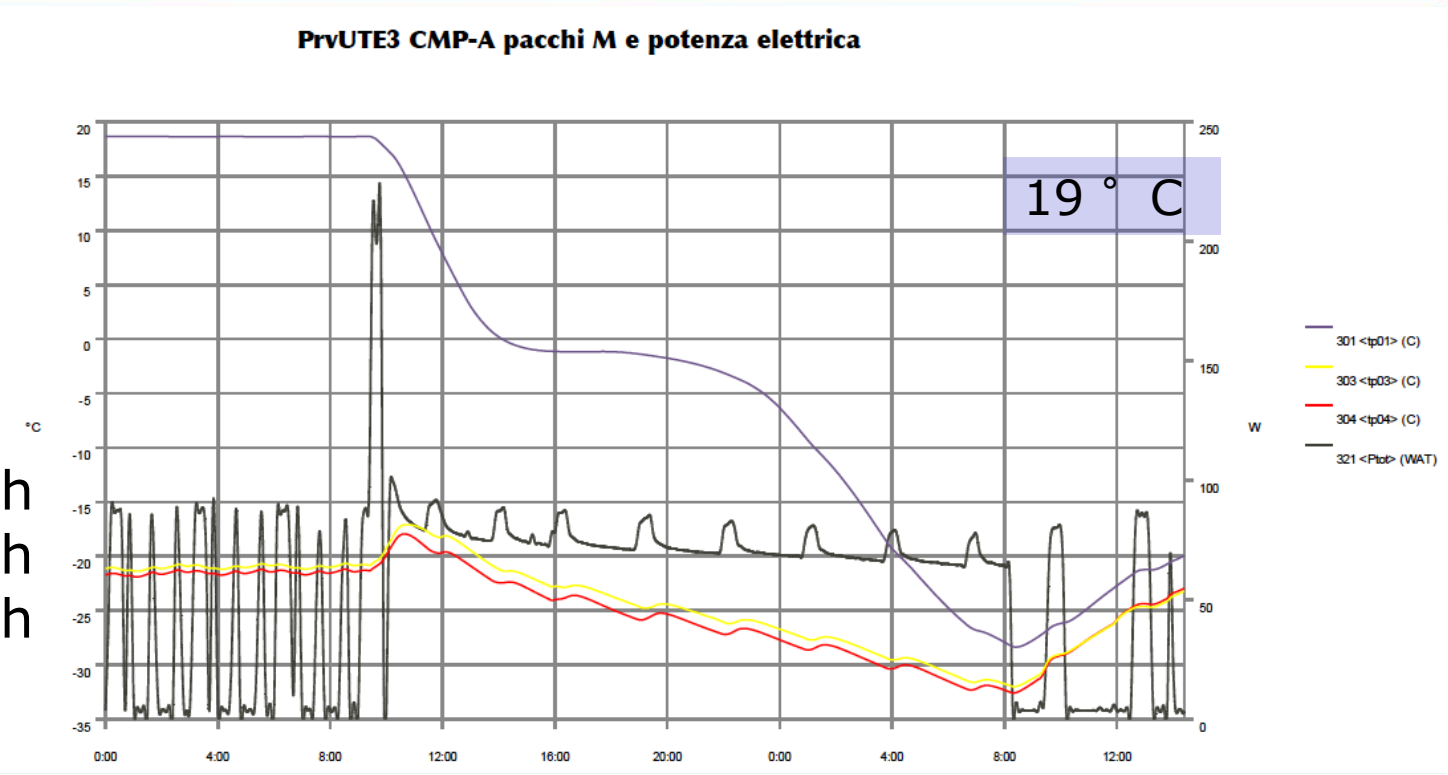
For every ° C increase in T_{amb}

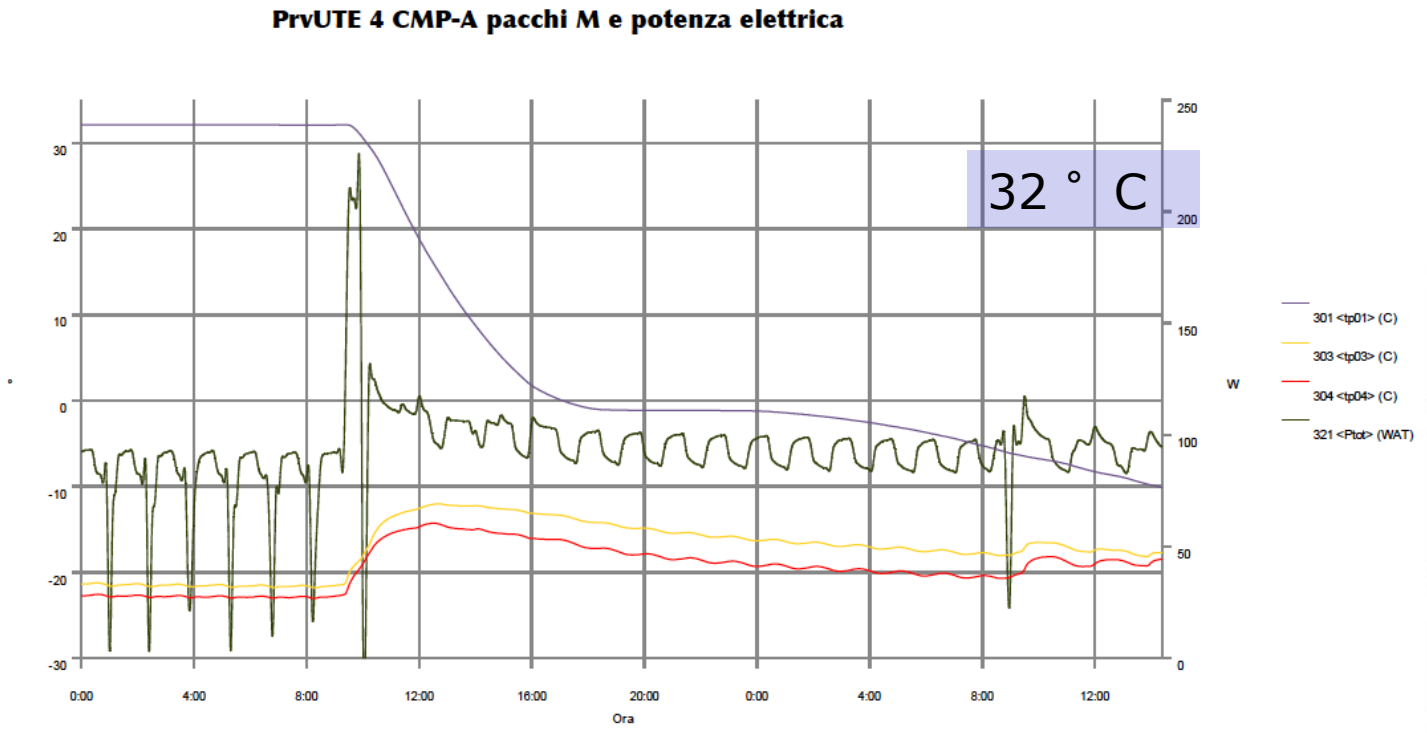
energy consumption +5%

Main Results (2/2)

"Freezing test"

19 ° C: -18 ° C in ~16h
25 ° C: -18 ° C in ~24h
32 ° C: -18 ° C in >32h





Conclusions

Achieved results:

1. The Italian market of household appliances has been characterized and user profiles defined.
2. Deviation between the real and the standard conditions now applied for energy certification have been evaluated.

Some general recommendations:

1. Implementation of the contents of the manuals by:
    1. Quick reference book;
    2. All technical specifications of the appliance;
    3. Practical tips to reduce energy consumption and to adopt a more efficient use.
2. A deeper control of information transmitted by the media is needed:
    1. Because judged often false and misleading, as to Framework Directive 2010/30/EC.
    2. To perform more targeted and widespread information campaigns at sale's points by trade associations and independent third parties.

Measurement procedure:

- Standard measurement procedure with T_{amb} (25 ° C) related to energy consumption values, consistent with a new test procedure at lower ambient temperature (19° C).
- Factors related to users' habits (door opening, l Load insertions, freezing operation, …) may influence energy consumption up to + 18%.
- Ambient temperature influence:
    - Energy consumption up to + 5% for every ° C increase .
    - Time required for freezing increases significantly.

Thank you for your attention!

For any further information please apply to:

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