Best available technology of plug-in refrigerated cabinets, beverage coolers and ice cream freezers and the challenges of measuring and comparing energy efficiency

Eva Geilinger, Martien Janssen, Per Henrik Pedersen, Paul Huggins, Eric Bush

Topten International Services, Re/genT BV, Danish Technological Institute, The Carbon Trust, Topten International Services

Abstract

Energy efficiency potentials for plug-in refrigerated cabinets, beverage coolers and ice cream freezers are shown by comparing typical and best models available on the market. A research project demonstrates efficiency potential when applying commercially available measures, and it investigates technologies for future improvements. This paper identifies the lack of a unified test methodology and energy efficiency rating system as challenges for energy saving initiatives in Europe. National and regional programmes for efficient refrigeration are portrayed. Their experiences can help the design of planned EU regulations. The programmes make implementing minimum requirements and energy labels faster and easier; for years they have raised awareness and supported manufacturers / importers to market high-efficiency products. One lesson to be learned from them is that market surveillance and verification tests are needed to ensure good data quality and fair product comparisons.

Efficiency potentials today

Comparing the energy efficiency of commercial and professional refrigerators and freezers is not easy because little data is available. To date there is no product information requirement on energy consumption for manufacturers. Topten International researched energy consumption data for four common plug-in product types: beverage coolers, ice cream freezers, storage refrigerators and storage freezers [1]. The first two types are display cabinets; the latter two are also known as refrigerated service cabinets or refrigerated storage cabinets (chilled and frozen).

Best-efficiency models available are identified and presented online under www.topten.eu > Professional Refrigerators [2]. Their energy consumption data is provided according to one of the following protocols: EN ISO 23953-2:2005, EN 441-1995 or CECED Italia Test protocol for professional refrigerators and freezers[1]. One valuable data source is the Energy Technology List (ETL) by the Department of Energy & Climate Change (DECC) in the United Kingdom [3].

Energy saving potentials are estimated by comparing best-efficiency models to typical models with comparable net volume. Display cabinets are also compared to open models since they are commonly used for selling beverages and ice cream. Again, the energy consumption data conforms to the above protocols.[2] A domestic model was also included in the comparison. Note that household appliances are subject to less demanding conditions and are designed and tested accordingly (static

[1] The data is normalized based on the method described by Tait Consulting limited [7]

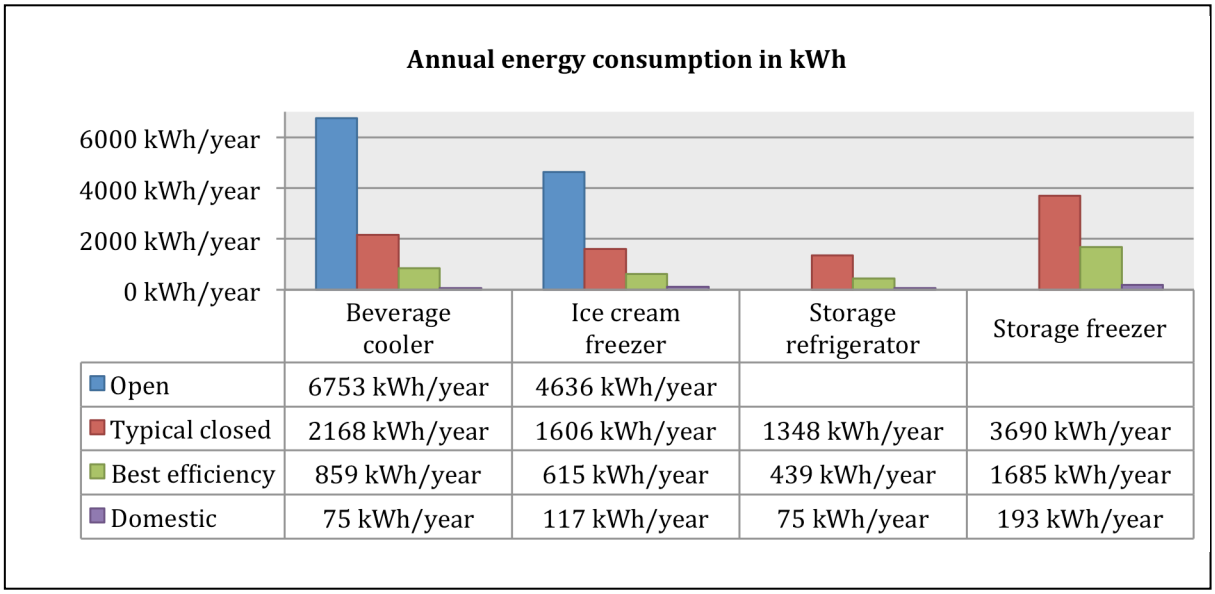
[2] In the case of the refrigerated service cabinets the base case from the preparatory study Lot 1 was used as the typical model [5]. In the case of the display cabinets newer product data from ETL was used as the typical model since the preparatory study Lot 12 for display cabinets [6] is over 5 years old. For the open models the energy consumption data is from the manufacturer's technical documentation. Although the test standard is unknown we consider the values valid for comparison since no door openings are necessary for testing open models.

cooling system, no door openings, no load, lower ambient temperature); these factors can halve the energy consumption determined.

The comparison is summarized in Figure 1. It shows that:

- Typical commercial and professional refrigerators / freezers use 2 – 3 times more energy than best-efficiency models available.
- Open display cabinets use 8 times more energy than best-efficiency models available.
- Domestic models use 5 – 10 times less energy than best-efficiency models available.

Energy saving potentials of best available technology (BAT) are between 54 – 67% in all cases. Replacing open cabinets with BAT display cabinets brings energy savings of 87% for both beverage coolers and ice cream freezers.



	Beverage cooler	Ice cream freezer	Storage refrigerator	Storage freezer
Open	6753 kWh/year	4636 kWh/year		
Typical closed	2168 kWh/year	1606 kWh/year	1348 kWh/year	3690 kWh/year
Best efficiency	859 kWh/year	615 kWh/year	439 kWh/year	1685 kWh/year
Domestic	75 kWh/year	117 kWh/year	75 kWh/year	193 kWh/year

Figure 1: Comparison of the annual energy consumption for an open cabinet (if applicable), a typical closed cabinet, a best-efficiency model and a domestic model with approximately the same net volume

The following three tables show the products used in the comparison.

Table 1: Comparison of 3 plug-in beverage coolers and a household refrigerator

	Open cooler	**Typical glass door cooler**	**High-efficiency glass door cooler**	**Household refrigerator A+++**
Net volume	324 liters	350 liters	346 liters	346 liters
Energy use	6753 kWh/year	2168 kWh/year	859 kWh/year	75 kWh/year
Electricity costs in 8 years (0.15 €/kWh)	8104 €	2602 €	1031 €	90 €
Refrigerant	R404A (high-GWP)	R134a (high-GWP)	R600a (low-GWP)	R600a (low-GWP)
				

Table 2: Comparison of 3 plug-in ice cream freezers and a household freezer chest

	Open ice cream freezer	**Typical glass top ice cream freezer**	**High-efficiency insulated top ice cream freezer**	**Household chest freezer A+++**
Net volume	151 liters	183 liters	224 liters	200 liters
Energy use	4636 kWh/year	1606 kWh/year	615 kWh/year	117 kWh/year
Electricity costs in 8 years (0.15 €/kWh)	5563 €	1927 €	738 €	140 €
Refrigerant	R404A (high-GWP)	R290 (low-GWP)	R290 (low-GWP)	R600a (low-GWP)
				

Table 3: Comparison of 2 plug-in refrigerated service cabinets and a domestic model (each for chilled and frozen)

	Typical storage refrigerator	**Best-efficiency storage refrigerator**	**Household refrigerator A+++**
Net volume	450 liters	449 liters	346 liters
Energy use	1348 kWh/year	439 kWh/year	75 kWh/year
Electricity costs in 8 years (0.15 €/kWh)	1618 €	527 €	90 €
Refrigerant	R134a (high-GWP)	R290 (low-GWP)	R600a (low-GWP)
			
	Typical storage freezer	**Best-efficiency storage freezer**	**Household upright freezer A+++**
Net volume	450 liters	449 liters	406 liters
Energy use	3690 kWh/year	1685 kWh/year	193 kWh/year
Electricity costs in 8 years (0.15 €/kWh)	4428 €	2022 €	232 €
Refrigerant	R404A (high-GWP)	R290 (low-GWP)	R600a (low-GWP)
			

Household refrigerators and freezers use 66% less energy than 20 years ago

Energy efficiency of household refrigerators and freezers has been a focus of European Union (EU) policies for almost 20 years. Today the lowest performing products allowed on the market are A+ compared to the initial lowest energy class G; this means a 66% decrease in energy consumption. More and more A+++ models are appearing on the market. They consume half the energy of typical A+ models sold today. Energy efficiency is still improving.

The household refrigerators and freezers success story raises hopes that similar energy savings can be realized for commercial and professional products.

There are 275 million household refrigerators and freezers in the EU; that is 23 times more than the professional plug-in products in this discussion (12 million units, see Table 4). Nonetheless, household refrigerators and freezers use only 4.5 times more energy.

Table 4: Stock and energy consumption in the EU

	Beverage coolers	Ice cream freezers	Refrigerated service cabinets	Household refrigerators	Household freezers
Stock in EU-27	6 million units	3 million units	3 million units	191 million units	84 million units
Energy consumption	16 TWh/year	4 TWh/year	7 TWh/year	82 TWh/year	40 TWh/year

Source: JRC Energy Efficiency Status Report [4]. Estimates are for the years 2007 (beverage coolers, ice cream freezers), 2008 (refrigerated service cabinets) and 2005 (household refrigerators/ freezers).

Summary of EU policies regarding energy efficiency of household refrigerators and freezers

As early as 1995 an energy label for household refrigerating appliances was introduced; it was redesigned in 2010 to reflect the changes in how appliances are rated regarding energy usage and efficiency and narrowing the measurement tolerance. Since 1999 household refrigerators and freezers must comply with minimum energy efficiency requirements in order to be placed on the market. These minimum energy efficiency requirements were revised and sharpened per July 2010. Since then, only class A or more efficient refrigerators and freezers are permitted on the EU market. Requirements were again tightened in 2012, and will be further tightened in 2014, introducing A+ as the minimum requirement in two steps (2012: Energy Efficiency Index (EEI) < 44, 2014: EEI < 42).

Expected future efficiencies based on on-going research and development

Design of plug-in commercial equipment has been mainly focused on costs throughout last decades and less on energy efficiency. As during recent years more attention has been paid by especially large end-users of such systems, such as beverage companies and beer brewers, more energy efficient products are entering the market. There are effectively a large number of energy saving measures feasible for such kind of products, several of these have been developed and implemented in domestic refrigerator products. A non-complete list of energy saving measures comprises:

a) More energy efficient compressors. Where a COP level of 1.8[3] is quite typical for a reasonably sized domestic refrigerator compressor today, this has been far above typical values for commercial refrigerator compressors, this despite the larger sizes these typically have. Based on customer requests, compressor manufacturers have developed more efficient compressors getting close to the efficiency of domestic refrigerator compressors. In addition variable speed compressors are entering the market which offer an additional energy saving potential.

[3] At ASHRAE rating condition of 54.4/-23.3 °C and vapour/liquid temperatures of 32.2 °C

b) More efficient fans have been introduced with electronically commutated motors which may reduce the fan consumption with as much as a factor 3. As the power used by the evaporator fan is effectively transferred to heat inside of the cabinet, which subsequently has to be removed by the refrigeration system, the power reduction on the total system is about double of what has been gained by the fan itself.

c) Better insulating glass doors and thicker insulated walls.

d) Increased heat exchangers performances by increased sizing and improved designs.

e) Lighting systems are often used (especially in glass door coolers) which are being replaced with LED lighting. Also here a multiplying effect is present as the lighting power consumption is turned into heat in the product.

f) Energy Management Systems controllers which ensure that the compartment temperatures are higher during the stand-by mode periods (i.e. a time frame where the cooler is switched on but no products are taken / sold).

Substantial energy saving by combinations of the measures quoted above are quite feasible. As an example, Re/genT is involved with a EU 7th framework research project called iCool, which already has demonstrated a reduction of a typical glass door cooler with a consumption of 3.9 kWh/day to a level of 0.9 kWh/day by commercially available measures; this means 77% energy savings. Further improvements are investigated in the iCool project such as the use of phase change materials to cover the peak heat loads of an appliance when it is loaded with warm products (see http://www.icool.fp7.co/ for more details).

Challenges of measuring and comparing energy efficiency

Comparing product data on energy consumption is quite complex today because no product information requirement exists. The values in catalogues and on manufacturer websites cannot be compared between brands. Manufacturers generally test energy consumption according to their own criteria. Details about the test methodologies are often unknown. In some cases the methodology might resemble EN 153 for testing household refrigerators (e.g. no door openings, no control of inside temperatures, lower ambient temperature). This leads to significantly lower energy consumption values. Figure 2 shows the big difference in energy consumption values found in the catalogue and tested according to the standard EN 441-1995 for the same model.

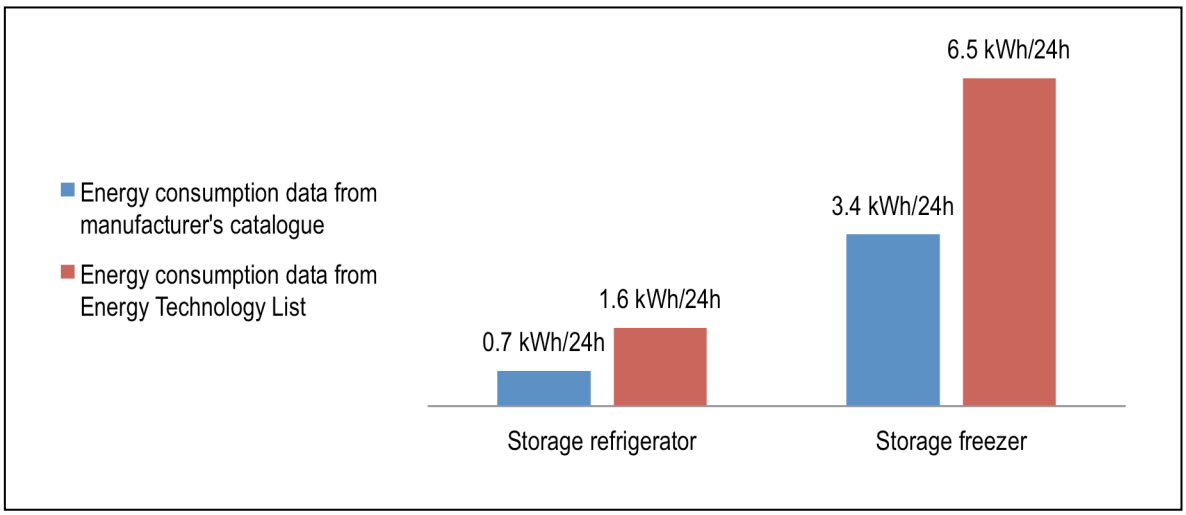


Figure 2: Energy consumption values for the same models found in the manufacturer's catalogue and tested according to EN 441-1995.

International test standards do exist, but these are, at a European level, almost exclusively used to determine compliance with national and regional programmes. Display cabinets, including beverage coolers and ice cream freezers, are covered by EN ISO 23953-2005, of which an amended version was published in May 2012 (EN ISO 23953-2005/A1:2012). A new test standard for refrigerated service cabinets is currently being developed by a CEN TC44 working group; the final version is targeted for the end of 2013. There are two other test protocols used for service cabinets: EN 441-1995, which preceded EN ISO 23953-2005[4], and the CECED Italia test protocol for professional refrigerators and freezers.

The acceptable temperature range for the load (so called M-packages) is described as temperature class in the test. The programmes portrayed below require products to conform to temperature class M1 for chilled goods (-1°C to +5°C) and L1 for frozen goods (-18°C to -15°C). Another commonly required temperature class is M2 (-1°C to +7°C); the test standards give a choice of 7 pre-set temperature classes.

The test standards also give a choice of 8 climate classes. They indicate the tolerable range for ambient temperature and relative humidity in the testing chamber. All the national and regional programmes require climate class 3 (ambient temperature 25°C, 60% humidity) for display cabinets and 4 (ambient temperature 30°C, 55% humidity) for service cabinets. Manufacturers might select a different climate class for use in their own product testing activities.

There are differences in the test protocols for cabinet door opening frequency in each of the standards. In general display cabinets are prescribed to be opened more often than service cabinets, and chilled cabinets are prescribed to be opened more often than frozen cabinets. Test protocols also differ regarding door opening time. Taken together these factors affect energy consumption measurements. Results due to EN 441-1995 are, in general, slightly higher than those measured according to EN ISO 23953-2005 and CECED Italia[5]. Doors are kept open for longer periods, allowing more infiltration of warm air and humidity.

Table 5: Single door opening behaviour: differences in test protocols

Test protocol	Test duration with door openings (hours)	Duration initial door opening (minutes)	Duration further door openings (seconds)	Door is opened every ... minutes	Total duration of door kept open (seconds per 24 hours)
CECED Italia - chilled cabinets + counter freezers	12	2	6	10	552
CECED Italia - vertical freezers	2 x 4[6]	2 x 1	6	10	408
EN 441-1995	12	3	12	10	1044
EN ISO 23953-2:2005[7]	12	3	6	10	612
EN ISO 23953-2:2005 /A1:2012 - chilled cabinets	12	3	15	13	1260
EN ISO 23953-2:2005 /A1:2012 - frozen cabinets	12	3	6	10	612

[4] The scope of EN ISO 23953-2005 is refrigerated display cabinets; that is why it was not well accepted for testing service cabinets and manufacturers as well as energy saving programmes continue to use EN 441-1995, even if it was officially replaced.

[5] In their newest working document on ecodesign requirements for refrigerated service cabinets the European Commission suggests a test protocol that corresponds to CECED Italia.

[6] With a 4 hour break in between

[7] Same single door opening behaviour as in the Australian standard AS 1731.5-2003

Strategies for market transformation

The European Commission plans to regulate ecodesign and energy labelling for several professional and commercial refrigeration product groups. Draft regulations exist for 5 product groups affiliated in DG ENTR Lot 1: refrigerated service cabinets, blast cabinets, walk-in cold rooms up to 400m3, refrigeration process chillers and remote condensing units. It is expected that these regulations will be adopted by the end of 2013. An energy label and minimum energy efficiency requirements are proposed for refrigerated service cabinets. Initially they were targeted to be applied from July 2014. In the most recent drafts the date of application has been delayed by one year to July 2015.

The European Commission with assistance from the Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS), is currently updating the 2007 preparatory study for ENER Lot 12 commercial refrigerators and freezers: refrigerated display cabinets (remote and plug-in) including ice cream freezers and vending machines.

National and regional programmes for promoting energy efficiency in commercial and professional refrigeration products have been going on in the UK, Denmark, Switzerland and Italy for many years. These programmes lead the way in delivering energy savings on a European level and support the EU regulatory process. They will be portrayed in the following chapters. Table 6 gives an overview.

Table 6: Programme overview: products covered, eligible energy consumption data

Programme	Energy Technology List (UK)	Energy Technology List (UK)	The Danish Energy Saving Trust/ Go' Energi	topten.ch (Switzerland) and topten.eu (Europe)	topten.ch (Switzerland) and topten.eu (Europe)	CECED Italia
Product list name	Commercial Service Cabinets	Refrigerated Display Cabinets	Commercial fridges / Commercial freezers	Glass door refrigerators / Ice cream freezers / Supermarket freezers	Storage refrigerators / Storage freezers	(no publicly available product list)
Active since	2003	2003	2005	2012	2012	2012
Products covered						
Type	plug-in only	remote + plug-in	plug-in only	plug-in only	plug-in only	plug-in only
Door / lid	insulated	glass	insulated	glass / insulated	insulated	insulated
Open cabinets	no	yes	no	no	no	no
Refrigerant	no requirement	no requirement	no requirement	only GWP < 5 (R290, R600a)[8]	only GWP < 5 (R290, R600a)	no requirement
Extent	236[9] models of 13 brands	970[9] models of 39 brands	46 models of 5 brands	7 models of 2 brands	CH: 48 models of 3 brands; Europe: 73 mod. of 3 brands	793 models of 5 brands
Eligible energy consumption data						
Primary test standard	EN 441-1995	EN ISO 23953-2005	EN 441-1995	EN ISO 23953-2005(/A1:2012)[10]	CECED Italia Test protocol for professional refrigerators and freezers	CECED Italia Test protocol for professional refrigerators and freezers[11]

[8] Other low-GWP refrigerants like CO2 (R744) would be eligible, but no such products have been registered at Topten so far.

[9] Since the scheme's inception over 1550 refrigerated display cabinets (RDC) have been assessed for inclusion. Approximately 20% of proposed RDC products did not meet the criteria. Products are removed from the ETL when the underlying technology category performance criteria are made more stringent. Similarly, some 25% of commercial service cabinets failed to make the grade and the remaining 75% - some 273 products - were verified to be eligible

[10] As of today no product data according to the 2012 version has been registered at Topten.

[11] The CECED Italia test protocol is based on EN ISO 23953-2:2005, but door openings have been altered: the duration of the initial door opening is only 2 minutes and for vertical freezers door openings are performed during only 8 hours.

Other accepted test standards	none	none	EN ISO 23953-2005 (correction factor 1.1)	EN 441-1995 (correction factor 0.91)	EN 441-1995 or EN ISO 23953-2005 (correction factors 0.8-1[12])	none
Test condition: climate class of testing chamber	4 (ambient temperature 30°C, 55% humidity)	3 (ambient temperature 25°C, 60% humidity)	4 (ambient temperature 30°C, 55% humidity)	3 (ambient temperature 25°C, 60% humidity)	4 (ambient temperature 30°C, 55% humidity)	4 (ambient temperature 30°C, 55% humidity)

The programmes are coordinated to some extent, and therefore it is possible for the manufacturer / importer to use the same test reports for identical models supported under different programmes.

The Danish and the Topten programmes accept data according to more than one test standard. As described above, the energy consumption measurements vary between test standards and must therefore be adjusted.

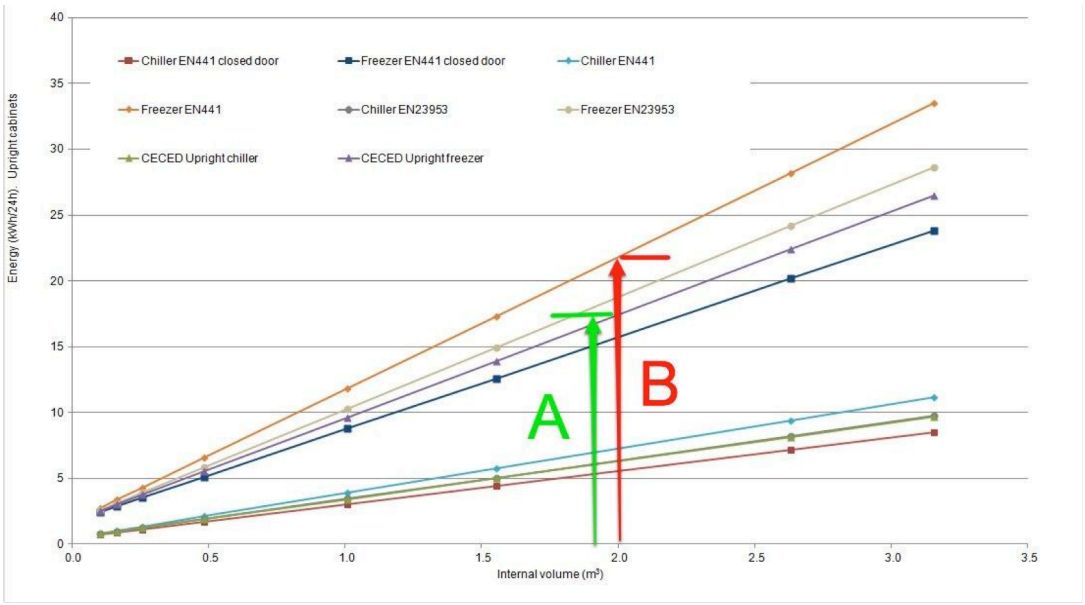
Correction factors to adjust energy consumption between test standards

The Danish Technological Institute (DTI) tested 2 refrigerated service cabinets (1 refrigerator, 1 freezer) according to EN 441-1995 and EN ISO 23953-2005. The energy consumption was 9.7% lower for the refrigerator and 7.1% lower for the freezer when measured according to EN ISO 23953-2005. With this result a correction factor of 1.1 for energy consumption tested according to EN ISO 23953-2005 was set for the Danish programme.

The Carbon Trust tested 7 commercial service cabinets with volumes between 0.37 m3 and 0.57m3 (3 L1 and 4 M1 class) and 6 refrigerated display cabinets with total display area (TDA) between 0.21 m2 to 1.33 m2 (4 L1 and 2 M2 class) according to EN 441-1995 and EN ISO 23953-2005. For refrigerated display cabinets the energy consumption measured was between 4% more and 12% less under EN ISO 23953-2005 (although an outlier of 18% more was observed), and for commercial service cabinets it was between 0% and 43% less. Based only in part on these test results, the use of EN ISO 23953-2005 was not adopted for ETL compliance of commercial service cabinets.

A document by Tait Consulting for the ecodesign regulation impact assessment study in May 2012 [7] describes how to proportion energy consumption between EN 441-1995, EN ISO 23953-2005 and the CECED Italia test protocol. The proportions were derived from a data set of over 3000 products. Figure 3 shows a graph and description of the methodology. The Topten programme derived correction factors based on this methodology.

[12] see http://www.topten.eu/english/criteria/professional-storage-refrigerators.html



As an example calculation step: in Figure 8 the energy consumed by a 2 m^3 upright freezer cabinet tested according to EN441 is around 22 kWh (dimension B) per 24 hours; and for the same cabinet under CECED Italia 17.5 kWh (dimension A). So a test result under EN441 should be adjusted by the ratio:

Test result as if under CECED Italia = [Test result under EN441] x (A / B)

Figure 3: Graph demonstrating how to adjust energy consumption between different test standards

Source: Performance Data Normalisation Methodology for Professional Storage Cabinets, Tait Consulting [7].

Tests to verify product data

In the UK, the Carbon Trust has tested a number of cabinets listed on the Energy Technology List. On three separate occasions groups of refrigerated display cabinets and commercial service cabinets have been tested. Approximately 10% of commercial service cabinets and 5% of refrigerated display cabinets have been independently tested to confirm compliance to ETL performance criteria. The very significant majority passed ETL compliance testing.

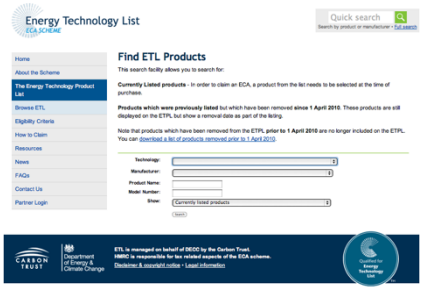
The Danish Technological Institute has also conducted a number of accredited tests to verify product data. The Danish Energy Saving Trust / Go' Energi picked the models for testing and asked manufacturers / importers to give the serial numbers for three appliances from their storage. The Trust / Go' Energi then decided which one of the three to test. From 2005 to 2011 a total of 12 models were tested. 4 models failed; the test result showed that they do not comply with the criteria and the models were removed from the lists.

The CECED Italia committee selects representative samples that are tested by an independent laboratory before manufacturers are allowed to label the products. The approximate cost of 6000 Euro (excl. VAT of 21%) per product tested is covered by the manufacturer. It is foreseen that participating manufacturers will test one model annually at an independent laboratory; this will cost about 3000 Euro (excl. VAT of 21%).

Topten Switzerland intends to test 2-3 models every year to be able to check manufacturers' declarations.

UK: Energy Technology List

The Energy Technology List (ETL) is part of the Enhanced Capital Allowance Scheme for Energy-Saving Technologies (ECA Scheme) and operates in the UK. It is a tax break scheme that enables businesses to claim a 100% first year capital allowance on investments in ETL products against the taxable profits from that period of investment. The ETL covers 58 technologies and over 16'600 qualifying products.



The ECA scheme began in 2003 and, after 10 years, continues to remain impactful in the UK cabinet market. The ETL is managed by the Carbon Trust on behalf of the Government (Department of Energy & Climate Change (DECC)).

Dissemination

Website: An ETL Website has existed since 2001 and is a key source of information on energy saving products. Each month over 10'000 users visit the site to check product information or learn more about energy saving technologies. In any one year the site has over 120'000 visitors who view over a million webpages. A range of publications focused upon a customer purchasing ETL products are available on the website; manufacturers and suppliers use them in pre-sales activities.

Label: Manufacturers or their suppliers can differentiate their products with the ETL logo. It is widely used in websites, data sheets, sales brochures, etc.

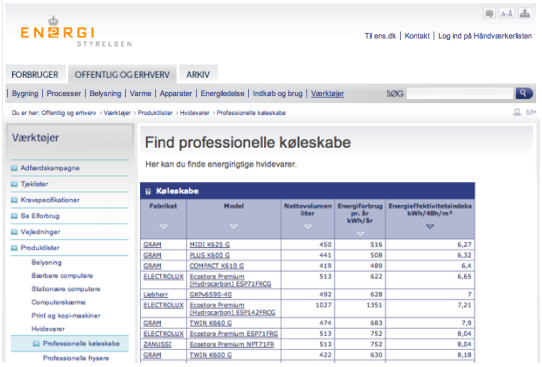
Stakeholder events: The Carbon Trust holds several events each year to ensure manufacturers or suppliers remain engaged in communicating the benefits of ETL technologies to their customers. Discussions include estimated impacts for the trading year (April to March), products added or removed, and coming changes.

Rationale behind criteria

The criteria for commercial service cabinets (CSC) and refrigerated display cabinets (RDC) are designed to support the top 25% of the market[13]. They were tightened in 2004 and 2008 for CSC, and in 2004, 2008 and 2013 for RDC, to adapt to product improvements. Minor changes were made in other years to clarify ambiguities; in total CSC and RDC criteria have each been updated 6 times.

Denmark: The Danish Energy Saving Trust and Go'Energi

The lists had been operated from the beginning in 2005 by the Danish Electricity Saving Trust and later on Go'Energi, which both were governmental institutions. A label "Recommended by Go'Energi" helped manufacturers and importers to market their products.



The list stopped in Spring 2013 due to lack of resources and decisions by the Danish Energy Agency to upgrade the work supporting EU Ecodesign and energy labeling systems. The label cannot be used since April 1st.

[13] In general, the ECA scheme criteria are set to meet the top 25% of the market. More rigorous criteria (top 10%) are used in some markets to encourage innovation.

The list remained available until May 31st under
http://www.ens.dk/offentlig-og-erhverv/vaerktoejer/produktlister/hvidevarelister

The scheme is coordinated with the corresponding UK scheme and therefore it was possible for the manufacturer/importer to use the test reports that were also used in the UK scheme if the cabinets are identical.

Dissemination

Label to use for manufacturers/importers: The appliances have been marketed and sold with help of recommendations from Danish Electricity Saving Trust and Go'Energi. It has been possible to place a label on the appliances: "Recommended by Go'Energi". This has been very efficient, and the products are believed to have had a marked share of at least 80 %. The remaining part of the marked consists of cheaper less efficient appliances.

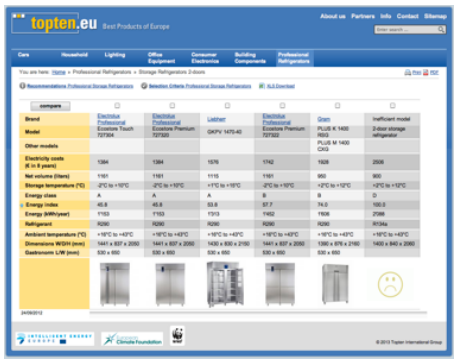
Website: The product lists are presented with photos and technical data. Also selection criteria, user advice and purchase tips can be found there. The website has been very important for dissemination – especially because the manufacturers and the big suppliers used it as a part of their marketing campaigns.

TV and internet commercials: To support the communication of manufacturers/importers and raise awareness for the label, the Danish Electricity Saving Trust and Go'Energi advertised the label in TV and internet commercials.

Rationale behind criteria

The criteria were negotiated between the Danish Energy Saving Trust and the Danish Association of Contract Kitchen Equipment Suppliers. They are similar to the UK criteria.

Switzerland: Topten and regional rebate programmes



Topten originated in Switzerland and is now a global initiative coordinated by the Topten International Group (www.topten.info, [8]). It is a voluntary, non-profit project aiming to stimulate demand for the most energy efficient products in national markets. Topten is active in 17 European countries (funded by Intelligent Energy Europe (IEE) and coordinated by ADEME), China and USA.

Since 2010 Topten Switzerland together with eight cities and electricity utilities has been working on a project to promote efficient professional refrigeration products. Starting September 2013 five of the partner cities and electricity utilities plan to implement 3-year rebate programmes.

Dissemination

Financial incentives: Rebates of 160 to 1450 Euro[14] will be paid when buying a refrigerator or freezer from the Topten lists. Approximately 4500 cabinets will profit from this programme. Rebates will multiply communication as partner cities and utilities advertise in their region. Swiss suppliers will inform customers about rebates in sales conversations and marketing.

Website: From the Topten homepage, buyers can find all product lists with one simple click. High-efficiency products are represented with photos, technical data, an "inefficient" product for

[14] The rebate depends on the product type (catalogue prices range from 900 to 5000 Euro) and is limited to a maximum of 25% of the paid price as stated on the receipt.

comparison, selection criteria, user advice and purchase tips, downloads and links to publications, standards and labels. Swiss market lists are available in German, French and Italian. www.topten.ch is well received and used (statistics: 1 mio. visits with 47 mio. hits in 2012).

Product lists are also available in English at www.topten.eu: Professional Refrigerators[15].

Media: Topten advises on best products and usage by offering expertise for professional articles, radio and TV shows. In 2012 Topten Switzerland had over 40 mio. media contacts.

Rationale behind criteria

As technologies improve, Topten criteria become stricter; lists stay limited to the 10 or so best products in each class.

Italy: CECED Italia

CECED Italia is the Italian Association of Home and Professional Appliances Manufacturers. Members of CECED Italia anticipated the forthcoming EU energy labeling regulations by voluntarily setting up a system for the energy efficiency classification of professional cabinets and counters.

Companies participating in the project have started to label their professional cabinets and counters to allow an objective evaluation of the products' efficiency for their customers.

CECED Italia in cooperation with the test laboratory IMQ has set up a voluntary evaluation and testing protocol based on EN ISO 23953-2, with adaptations on volume calculation and testing conditions (e.g. door opening frequency, loading patterns).

Dissemination

Label to use for manufacturers/importers: Participating manufacturers use the E.C.E. label to market their products.

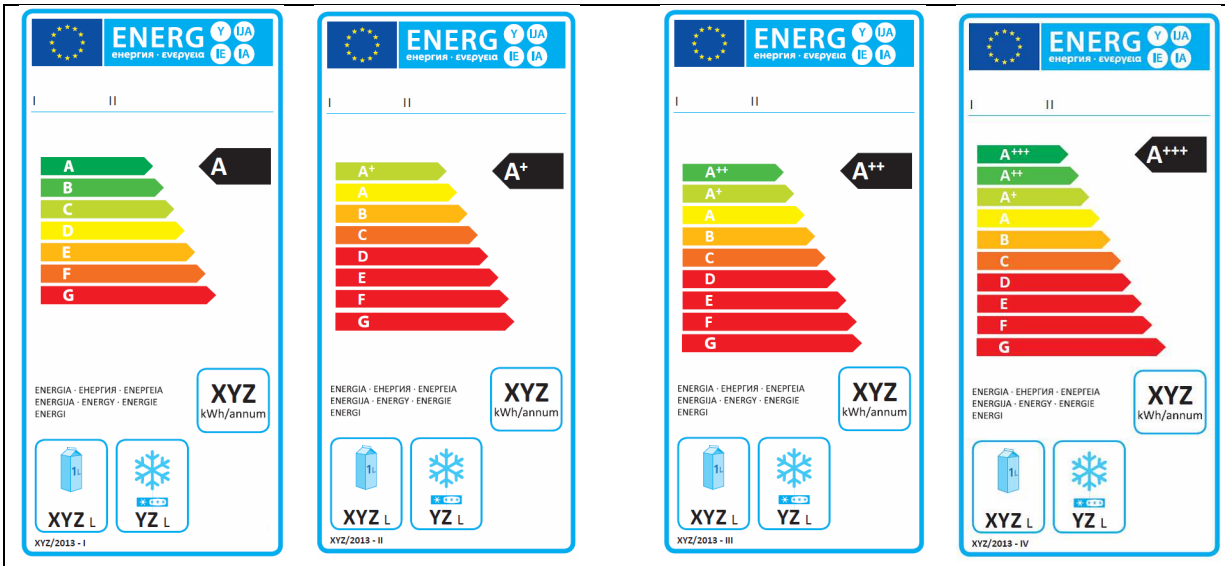
Rationale behind energy efficiency classification

The label classifies energy efficiency on a scale from 7 (best) to 1 (worst). It is similar to the classical A to G scale of the EU energy label. One step up means an improvement of efficiency by 10 to 20%. The energy efficiency index (EEI) 100 stands for the typical model; it is the class threshold between 4 and 3. The thresholds were based upon a data set with several hundred models from four manufacturers.

[15] The criteria for energy consumption are less strict for the European market and therefore more models are listed.

Proposed EU energy label

Starting 1st July 2015 an energy label and a product fiche shall be provided for professional storage cabinets. One year later A+ shall be added as top class. A++ shall be added in 2018 and A+++ in 2019. The energy label will indicate the annual energy consumption and the storage volumes. It will not show if the refrigerant used in the cabinet has high or low global warming potential (GWP).



Newest draft regulation from June 2013:			
1st July 2015	1st July 2016	1st July 2018	1st July 2019
Last draft regulation from June 2012:			
July 2014	January 2015	January 2016	January 2018

Table 7: Timetable for the energy label

The energy efficiency classes are defined as shown in Table 8.

Table 8: Proposed energy label classes

Class	Energy Efficiency Index (EEI)
A+++	< 15
A++	15-20
A+	20-30
A	30-40
B	40-55
C	55-75
D	75-90
E	90-100
F	100-110
G	110-125

Draft ecodesign regulation

The draft ecodesign regulation distinguishes between heavy- and light-duty cabinets. Light-duty cabinets by definition are capable of maintaining their operating temperature in an ambient temperature of 25°C and 60% relative humidity (climate class 3) but not in 30°C and 55% relative humidity (climate class 4). Heavy-duty cabinets perform well in ambient conditions that correspond to climate class 4 (typical for restaurant kitchens).

In the draft regulation annex III the measurement method for energy consumption is described including door openings (corresponding to the CECED Italia test protocol), ambient conditions

(climate class 3 for light-duty cabinets, climate class 4 for heavy-duty cabinets), required temperatures of test packages and more. The calculation of the net volume is also described in detail.

For heavy-duty cabinets one single stage of energy efficiency requirements is proposed from 1st July 2015. Models worse than energy efficiency class G would then be phased out. For light-duty cabinets three stages of energy efficiency requirements are proposed:

- From 1 July 2015: EEI < 125 (phase out worse than G)
- From 1 July 2016: EEI < 110 (phase out G)
- From 1 July 2018: EEI < 100 (phase out F)

Product information requirements proposed for 1st July 2015 onward include all information needed to evaluate energy efficiency as well as the global warming potential of the refrigerant.

Summary

54% to 87% energy saving potential today and room for improvement

The product comparison by Topten International shows that 54 – 67% of energy consumption could be saved if best-efficiency models were used instead of the current typical models. Choosing best-efficiency display cabinets over open cabinets brings energy savings of 87%.

The research project iCool found that commercially available measures can reduce a typical glass door cooler's energy consumption by 77%. Phase change materials could further increase energy savings in the future.

Household refrigerators and freezers decreased their energy consumption by 66% since energy labelling and ecodesign measures have been applied. Beyond this significant improvement, new best-efficiency models offer a further 50% energy saving potential.

These combined findings raise hopes that plug-in commercial and professional refrigerators / freezers will halve their energy consumption once EU policies have been adopted.

Existing programmes will ease market integration of the EU energy label

There are already widely known programmes in European countries that steer towards energy efficient products. Manufacturers act as multipliers for dissemination as these programmes support their marketing. Financial incentives offered by governments, cities and utilities encourage buyers, dealers and manufacturers to push for more energy efficient products. Planned EU energy labels and minimum requirements will be more quickly integrated by manufacturers and suppliers.

The European Commission can unify procedures and ensure quality product information

This paper identifies the lack of unified test methodology and energy efficiency rating system as challenges for energy saving initiatives in Europe. The European Commission and the standardisation organisation CEN are working towards unifying the procedures.

There will be a period when product data from different test protocols will have to be adjusted for comparison. The European Commission could issue a guideline document similar to the data analysis in *Performance Data Normalisation Methodology for Professional Storage Cabinets* by Tait Consulting [7].

One lesson to be learned from national and regional programmes is that verification tests are needed to ensure good data quality and fair product comparisons. Market surveillance should be a substantial part of EU policies.

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[2] Topten product lists 'Professional Refrigerators' on topten.eu by Topten International: http://www.topten.eu/english/criteria/professional-display-refrigerators-crit.html&fromid= http://www.topten.eu/english/criteria/professional-storage-refrigerators.html&fromid=

[3] Energy Technology List 'Refrigerated Display Cabinets' and 'Commercial Service Cabinets' by the Department of Energy & Climate Change (DECC) in the United Kingdom: http://etl.decc.gov.uk/etl

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(Products in scope: Service cabinets, blast cabinets, walk-in cold rooms, industrial process chillers, water dispensers, ice-makers, dessert and beverage machines, minibars, wine storage appliances and packaged condensing units)

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(Products in scope: Refrigerated display cabinet (remote and plug-in) and vending machines)

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http://www.topten.eu/uploads/File/Storage%20Cabinets%20-%20Normalisation%20Method%20V0_5.pdf

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