Appliances Guide

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Energy efficient Air-conditioners

Country

China

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Index

1 Subtypes and markets 3

2 Efficiency range and user savings 8

3 Performance and information requirements 10

4 Test procedures and standards 14

5 References 17

1 Subtypes and markets

Refrigerators are one of the most common household appliances in China today. China produced the first domestic refrigerator in the 1950s. Today, 96.7 million refrigerators are produced in China annually (output of 2011). China is the largest producer and user of refrigerators in the world. The domestic sale of refrigerators in 2011 was about 69.6 million. The China National Institute of Standardization (CNIS) estimates there to be around 400 million refrigerators in use in China in 2011[1].

The penetration rate of refrigerator in urban households was estimated to be about 98.5% in 2012. National policy geared at bringing home appliances to the Chinese countryside lead the penetration rate of refrigerators to increase to 67% in 2012, up from 30.2% in 2008[2]. Due to diverse sales-stimulating policies such as subsidies for energy efficient products and home appliance sales in the countryside, leading to saturation in the urban markets with a penetration rate approaching 100%, sales are estimated to decrease in future.

Main types of technologies

Refrigerators can be divided into different types according to their function, construction and cooling method.

(1) In terms of **functionality**, refrigerators can be divided into 5 categories:

(1.1) BC: Refrigerator only for storing fresh food, no frozen food compartment;
(1.2) BD: Freezer only for storing frozen food;
(1.3) BC/BD: fridge/ freezer where the compartment can be switched to act as either a fridge or freezer but not both at the same time;
(1.4) BCD: Fridge freezers featuring two or more compartments, in which there is at least one fridge and one freezer compartment;
(1.5) BCDW: same as above if frost free;

Top10 collected market data about 1511 refrigerator models on the Chinese market in November 2013 and provides an analysis. The following figure shows that 94% of the refrigerators on the market are BCD/BCDWs, 3% are BCs, 2% are BC/BDs and 1% are BDs, respectively.

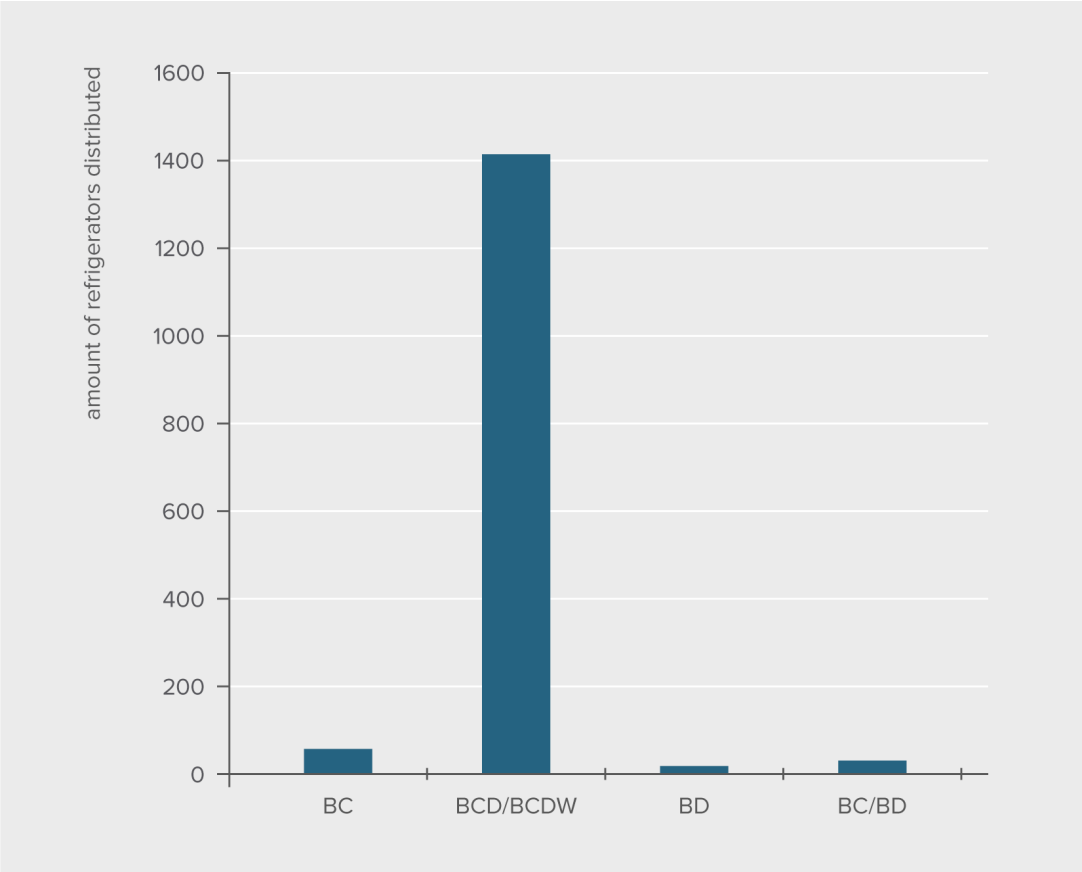

Figure 1: The distribution of different refrigerators based on functions

(2) Refrigerators are built to operate in different **climatic zones**.

Therefore, refrigerators are classified into subtropical (ST), tropical (T), sub-temperate (SN) and temperate (N) types. The temperature parameters for the different BC types are shown in table 1. SN is the most common classification in China.

Table 1: Environment temperature requirement for different refrigerators

Refrigerator types	Environment temperature (°C)
SN	10-32
N	16-32
ST	18-38
T	18-43

(3) There are four star levels (0,1,2,3) to describe the **storing temperature** of the storage compartments.

Table 2: Requirements for the frozen storage compartment

Star	Temperature of the frozen storage compartment (°C)
0	T> -6°C
1	-6 °C > T > -12°C
2	-12 °C > T > -18°C
3	T < - 18° C

(4) Normally, BCs and BDs are one-door refrigerators with volumes of below 100 litres. BCDs are particularly popular with families. Most BCs and BDs are used for commercial applications such as in food stores and supermarkets. BCDs have two-doors, three-doors or side-by-side doors and the volume is usually above 200 litres. Generally, Chinese families prefer three-door, two-door or side-by-side-door refrigerators due to the greater wealth character and the according overall improvement of life quality. As a consequence, food purchase and energy consumption are relatively higher. It is moreover reported that more residents purchase new refrigerators because of growing demand for bigger cooling volume rather than because of functional shortcomings of their older fridges [4].

Refrigerators with a volume below 100 litres are defined as mini refrigerators, 100-200 litres as small refrigerators, 200-300 litres as medium refrigerators, and fridges with a volume above 300 litres as large. Figure 2 shows the market distribution of refrigerators in China sorted by the size of appliance. A majority of refrigerators in use have a volume between 100 and 300 litres.

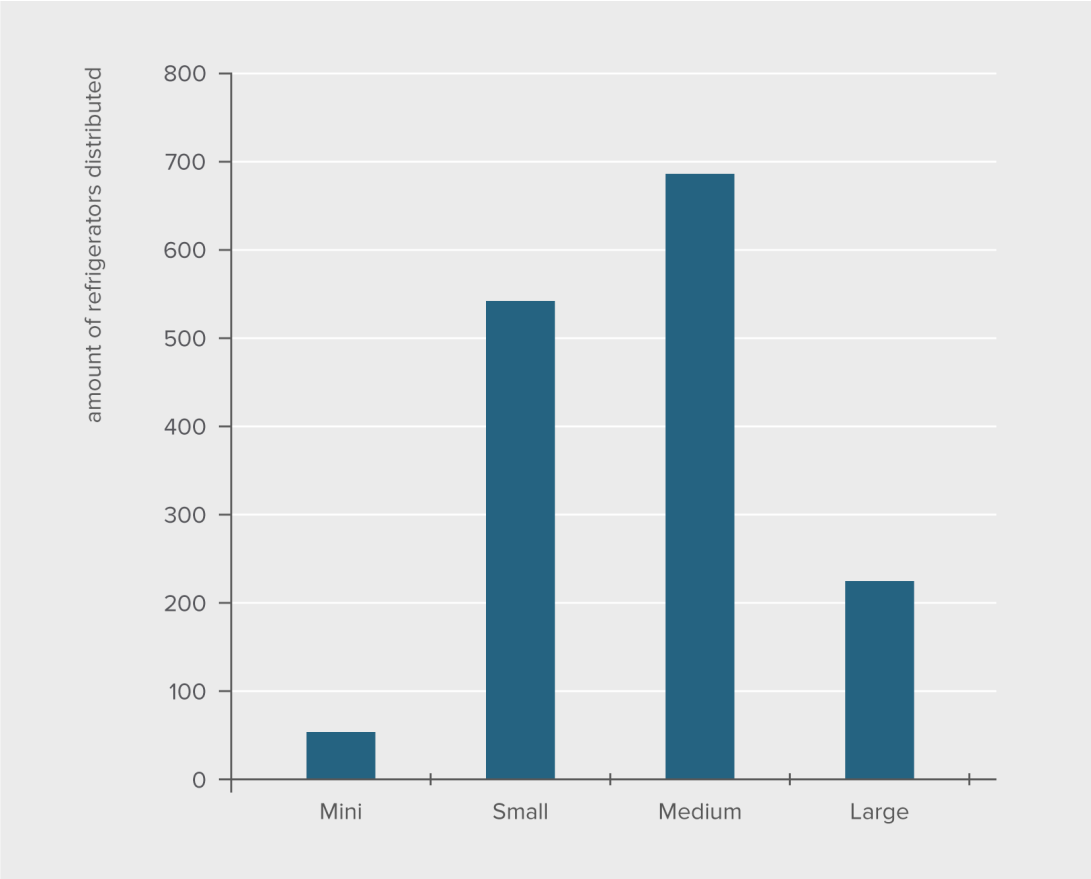

Figure 2: Market distributions of refrigerators according to size

(5) Fridges can further be classified by the **technology** used to achieve the **cooling effect**:

(5.1) Air-cooling refrigerators: fans are used to distribute the cold air inside the refrigerators, ice-free, consume more energy than direct cooling refrigerators.
(5.2) Direct-cooling refrigerators: the inside temperature of refrigerator is lowered by the natural convection on the evaporator surface. They require manual removal of ice.

Compared with the direct-cooling refrigerators, the air-cooling refrigerators are ice-free but consume 10% more energy. The noise of air-cooling refrigerators is 2-3 decibel higher than direct-cooling refrigerators. However, the market share of the ice-free air-cooling refrigerators has increased faster. Market research suggests that the sale of air-cooling refrigerators with three-doors increased by 133.3% in 2011 compared to 2010. About 43.3% of the direct-cooling refrigerators feature three doors. It is estimated that the market share of air-cooling refrigerators with three doors will keep rising in the future [4].

About 95% of refrigerators on the Chinese market are compression-type refrigerators. This type uses motors to provide the mechanical energy and uses compressor for the refrigerant. New technologies have emerged which may help to reduce the energy consumption of refrigerators. Manufacturers are trying to improve the insulation and the efficiency of the compressor [5].

The China Household Electrical Appliances Association (CHEAA) released a roadmap for the technical development of refrigerators in 2011. Energy efficiency, environmental friendliness, quality and smart

features were considered. Energy consumption of refrigerators was to be reduced by 20% in 2015 compared with the energy consumption of comparable models in 2009. The usage of variable speed compressor was to be increased to more than 10%. And the insulation performance will be improved by 5%. It is also estimated that the energy consumption used for the production of the refrigerators will be reduced by 15% in 2015 [6].

There is no data on the energy consumption of refrigerators by sector (residential, commercial and industry).

2 Efficiency range and user savings

The following table gives a comparison between a typical inefficient appliance and the best available technology.

Level	Typical Inefficient appliance. If MEPS is implemented: Appliance just complying to minimum requirement (MEPS)	Typical appliance purchased (BAU – Business As Usual)	Best Available Technology (BAT)	Typical appliance in the stock (over all appliances in use)	Expected future BAT (Best not yet Available Technology)
Typical Capacity / Size	*107L*	*215L*	*186L*	*206L*	*178L*
Category	**Double-door**	**Three-door**	**Double-door**	**Double-door**	**Double-door**
Type	BCD	BCD	BCD	BCD	BCD
Lifetime (years)	12-16	12-16	12-16	12-16	12-16
Qualitative classification of the provided service (e.g.: washing performance /etc.)	☐ Poor ☐ Low ☐ Average ☐ Good ☐ Excellent ☑No information	☐ Poor ☐ Low ☐ Average ☑ Good ☐ Excellent ☐ No information	☐ Poor ☐ Low ☐ Average ☐ Good ☐ Excellent ☑ No information	☐ Poor ☐ Low ☐ Average ☐ Good ☐ Excellent ☑No information	☐ Poor ☐ Low ☐ Average ☐ Good ☐ Excellent ☑ No information
Yearly energy consump-	186 kWh	153 kWh	95 kWh	212kWh	77 kWh

tion ***Please precise the energy considered (electricity, gas,...):*** _____					
Yearly energy cost (RMB)	93	77	48	106	39
If applicable: yearly energy consumption for further energy carriers (which one?)	N.A.	N.A.	N.A.	N.A.	N.A.
If applicable: yearly water consumption	N.A	N.A.	N.A.	N.A.	N.A.
Purchase cost in (currency)	899RMB	2098 RMB	1699 RMB	1599 RMB	Not available on the market
Operation & Maintenance cost	45	105	85	80	
Labelling class (for the aforementioned labels)	2	1	1	2	1

3 Performance and information requirements

Mandatory requirements

The Chinese government released the first refrigerator energy efficiency standard (EES) in 1989, <GB12021.2 The maximum allowable values of the energy consumption and energy efficiency grade for household refrigerators>. The standard was revised in 1999, 2003 and 2008, and it is reported that a new version is being worked on. Table 4 shows the changes in EEI requirements in 2003 and 2008.

Table 4: EEI requirements changes in 2003 and 2008

EET	Energy Efficiency Index (EEI)		
	GB 12021.2-2003	GB 12021.2-2008	
	All types	Fridge Freezer	All other types
1	EEI ≤55%	EEI ≤40%	EEI ≤50%
2	55%< EEI ≤65%	40%< EEI ≤50%	50%< EEI ≤60%
3	65%< EEI ≤80%	50%< EEI ≤60%	60%< EEI ≤70%
4	80%< EEI ≤90%	60%< EEI ≤70%	70%< EEI ≤80%
5	90%< EEI ≤100%	70%< EEI ≤80%	80%< EEI ≤90%

Energy efficiency test and product standard in China are based on ISO 7371: 1995 and therefore similar to those of the EU.

Minimum Energy Performance Standards (MEPS)

Beyond the EEI requirement outlined in GB12021.2-2008, it also defines the maximum allowable values of energy consumption (E_{max}) which is the maximum allowable values of 24 hours' energy consumption when the refrigerator run under stable situation. The tested 24 hours' energy consumption and rated 24 hours' energy consumption should not exceed the maximum (E_{max}) as defined by <GB12021.2-2008> and 2012. The changes are shown in Table 5.

Table 5: E_{max} requirements in <GB12021.2-2008>

Types	E_{max} requirements from 2008	E_{max} requirements from 2012
BCs with no star	0.9*(0.221*Vadj+233+CH)*Sr/365	0.8*(0.221*Vadj+233+CH)*Sr/365
BCs with 1 star	0.9*(0.661*Vadj+181+CH)*Sr/365	0.8*(0.661*Vadj+181+CH)*Sr/365
BCs with 2 stars	0.9*(0.428*Vadj+233+CH)*Sr/365	0.8*(0.428*Vadj+233+CH)*Sr/365
BCs with 3 stars	0.9*(0.624*Vadj+233+CH)*Sr/365	0.8*(0.624*Vadj+233+CH)*Sr/365
BCDs	0.8*(0.697*Vadj+272+CH)*Sr/365	0.7*(0.697*Vadj+272+CH)*Sr/365
BC/BDs	0.9*(0.530*Vadj+190+CH)*Sr/365	0.9*(0.530*Vadj+190+CH)*Sr/365
BDs	0.9*(0.567*Vadj+205+CH)*Sr/365	0.9*(0.567*Vadj+205+CH)*Sr/365

Energy efficiency tier distribution

According to market data, 95% of the refrigerators on the market are tier 1 and about 5% of the products are tier 2. Tier 3, 4 and 5 refrigerators have disappeared from the market. As a result, the technology in refrigerators sold on the market has improved and most models are able to meet the tier 1 requirement. Furthermore, the energy efficiency standard is outdated and may need to be revised shortly.

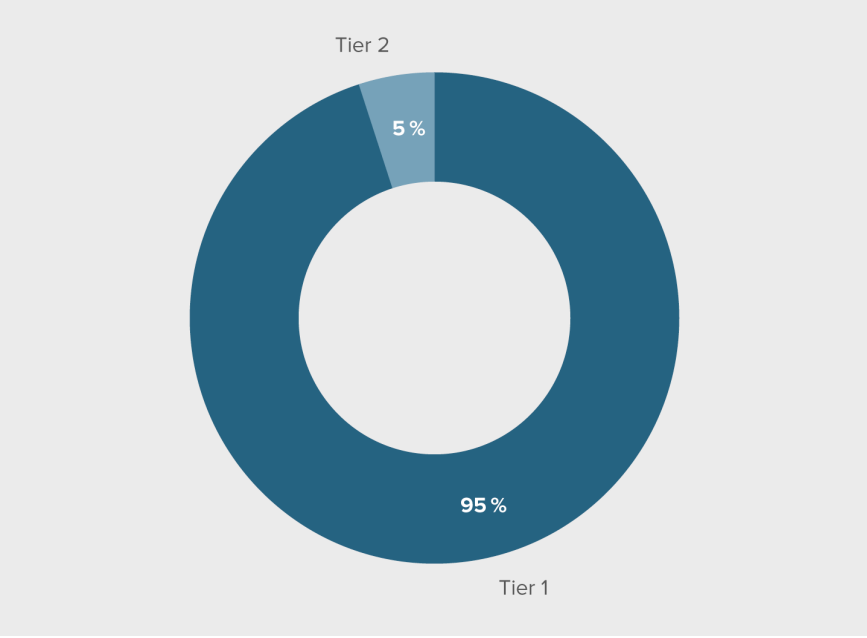

Figure 3: Energy efficiency tiers distribution of refrigerators

Mandatory labelling

In 2004, China's National Development and Reform Commission (NDRC) and the Administration of Quality Supervision, Inspection and Quarantine of China (AQSIQ) released the "Measures management of the energy label", which initiated the introduction of a mandatory energy-labelling programme in China.

The refrigerator energy-labelling programme was implemented in 2005 based on GB12021.2-2003. The current refrigerator energy label is based on GB12021.2-2008. Government requires refrigerators to bare energy labels. The manufacturers or importers will self declare the energy label and put the label on record. The government will supervise the manufacturer. Figure 4 shows a sample of an energy label, which can be found on refrigerators. It contains information about the energy efficiency tier, the product model, the manufacturer, 24 hours of energy consumption, compartment volumes and the EES. The energy label programme plays an important role in promoting energy efficiency and energy saving technology, helping in pushing the transformation of the market towards more energy efficient products.

Figure4: Energy label sample of refrigerator

Voluntary requirements

Beside the mandatory MEPS requirement, GB 12021.2-2008 also defines the voluntary requirement for energy conservation products. Refrigerators above tier 2 can get an energy conservation saving label after an application to the China Qualification Centre (CQC). Figure 5 shows the energy conservation label sample.

Figure 5: Energy conservation label sample

Subsidy programme

China government announced the energy efficient appliances subsidy programme in June 2012, which ended in 2013. Refrigerators eligible for subsidies as listed in Table 6 will receive different subsidy rates depending on the type and total volume of the refrigerator. The subsidy criteria and subsidy rate are presented in Table 6[9]. For BDs, BC/BDs and BCDs with a TSV above 300 litres the subsidy standard is equal to the requirement of tier 1 while for other types it has to be above the tier 1 requirement.

Table 6: Subsidy rate for different types of refrigerators

Refrigerator type	Total Storage Volume (TSV)1	Subsidy Appli-cable (RMB/Unit)	Energy Efficiency Requirement (EEI)
Freezer, Fridge/Freezer (BD, BC/BD)	(TSV) ≤ 120L	70	EEI ≤ 50%
	120L< TSV ≤ 300L	130	
	TSV > 300L	180	
Fridge Freezer, frost-free fridge freezer (BCD, BCDW)	TSV ≤ 240L	260	EEI ≤ 32%
	240L < TSV ≤ 300L	330	
	TSV > 300L	400	EEI ≤ 40%

[1] The “Storage Volume” is tested according to the Chinese National Standard GB/T 8059.

4 Test procedures and standards

In China, <GB/T 8059.1-1995> specifies the measurement method of "Household refrigerating appliances". It is based on ISO7371:1995. <GB12021.2-2008 The maximum allowed energy consumption and energy efficiency grade for household refrigerators> regulates the maximum allowable energy consumption as well as the energy efficiency of this product group, setting MEPS and defining the EE grade, both according to the Energy Efficiency Index.

Energy efficiency index (EEI) was adopted as the main energy efficiency indicator. It is the ratio between the tested energy consumption in 24 hours and the base (reference) value of energy consumption. The formula of EEI calculation is shown below:

$$EEI=E_{test}/[(M*V_{adj}+N+CH)*S_r/365]*100\%$$

EEI: The energy efficiency index.

E_{test}: The tested 24 hours' energy consumption of the refrigerator.

M, N: parameters have been given out according the types of refrigerators, see table 7.

Table 7: M and N values in EEI formula

Type	Description	M value	N value
Type 1	Refrigerator without star compartment	0.233	245
Type 2	Refrigerator with 1-star compartment	0.643	191
Type 3	Refrigerator with 2-star compartment	0.450	245
Type 4	Refrigerator with 3-star compartment	0.657	235
Type 5	Refrigerator-freezer	0.777	303
Type 6	Frozen-food storage appliances	0.558	200

Type 7	Chest freezer	0.597	216
Type 8	Upright frozen food holding cabinet	0.624	223
Type 9	Upright freezer	0.519	315

CH: Variable temperature correction factor is set at 50 kWh if the refrigerators have a variable temperature compartment of less than 15 liters, otherwise 0.

S_r: an adjustment factor. S_r will be 1.1 if the volume of the refrigerator is 100L, or smaller than 100L, or bigger than 400L and has through the door ice-making capacity. Otherwise 1.0.

V_{adj}: The adjusted volume, the formula is as follow:

$$V_{adj} = \sum_{c=1}^{n} V_c \times F_c \times W_c \times CC$$

n: number of different types of compartments

Vc: measured storage volume of a specific type of compartment (Liters)

Fc: Constant, equal to 1.4 for forced air cooling or 1.0 for non-forced air.

CC: Climate type correction coefficient, (= 1 for N or SN, =1.1 for ST and = 1.2 for climate type T)

Wc $= \left(\frac{25-T_c}{20}\right)$ where Tc is the compartment temperature.

<GB12021.1-2008> defines five energy efficiency tiers based on the value of EEI. Tier 1 products are the most energy efficiency products and tier 5 is the minimum energy performance standard (MEPS). Refrigerators below tier 5 are not allowed on the market.

Table 8: EEI requirements for different tiers in GB12021.2-2008

Tiers	**Energy efficiency index (EEI)**	
	BCD type	Other types
1	EEI≤40%	EEI≤50%
2	40%≤EEI≤50%	50%≤EEI≤60%
3	50%≤EEI≤60%	60%≤EEI≤70%

4	60%≤EEI≤70%	70%≤EEI≤80%
5	70%≤EEI≤80%	80%≤EEI≤90%

BCDs with EEI≤50% are classified as energy efficient refrigerators (tier 2 and tier 1). EEI≤60% is the energy conservation threshold for other types of refrigerators. Tier 1 refrigerators are the most energy efficient products, which meet international requirements, tier 2 are classed as energy efficient products, tier 3 corresponds to averagely efficient products on the market and tier 5 is the minimum performance level for market access [8].

5 References

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