

# Study of Chinese New EES for Variable-Speed Air-conditioners, Washing Machines and Panel-TVs

## Abstract:

In 2012, China's National Development and Reform Commission (NDRC) and Standardization Administration of China (SAC) jointly launched the "One hundred Energy Efficiency Standards Program" to develop or revise 100 energy efficiency standards (EES) and Quota (energy consumption per unit output) standards in 2 years. For household appliances, the EES of variable-speed (VS) air-conditioners, washing machines and panel-TVs have been revised in 2013. Compared with the old standards, the new standards improved the requirements for each energy efficiency grades and defined new energy efficiency parameters and test methods. Following the EES revision, some mandatory energy labels were also revised.

In this paper, the new Chinese EES for VS air-conditioners, panel-TVs and washing machines are introduced in details. An investigation based on China's retail market data and government data has been done, and it analyzes the market changes of each energy efficiency grades for every kind of appliances after one year implementation of the new standards. This paper also provides suggestions improving current EES of household appliances.

## 1. Washing machines

### 1.1 Product background

China started producing washing machines from 1970s, now has become the biggest washing machine producer and user in the world. With the wide deployment of washing machines in 1990s and 2000s, the productivity and sales of washing machines in China began to reduce in recent years. It is reported China produced about 35.7 million washing machines in 2011, reduced about 42.5% compared with 2010. The domestic sale of washing machines is 34.4 million in 2012, reduced about 3.8% compared with 2011<sup>[1]</sup>. The Chinese ownership of washing machine was about 350 millions in 2012, China is still one of the biggest producer and consumer of washing machines in the world<sup>[2]</sup>.

There are two main kinds of washing machines: drum washing machines and impeller washing machines. Double cylinder washing machines were popular in 1980s and 1990s, but have very small market share now. According to the market research of Top10 China in 2014, 49% washing machines in Chinese market are drum washing machines, 48% products are impeller washing machines and the double cylinder washing machines only have 3% market share<sup>[3]</sup>.

### 1.2 EES changes of washing machines

The first EES of washing machines was released in China in 2004 named <GB 12021.4-2004 The maximum allowable values of the energy consumption and energy efficiency grade for household electric washing machines>, then the China energy label of washing machine was implemented in 2007, which was based on GB12021-2004<sup>[4]</sup>. From October 2013, the new MEPS for washing machines <GB12021.4-2013 Maximum allowable values of energy, water consumption and grades for household electric washing machines> began to be implemented. Compared with GB12021.4-2004, GB12021.4-2013 improves the energy efficiency

requirements significantly, defines the water efficiency grades and redefines the methods to calculate the energy and water consumption<sup>[5]</sup>.

(1) Energy efficiency requirements improved

There are 5 energy efficiency grades classified in washing machine EES, and covered 3 different kinds of washing machines: drum washing machines, impeller washing machines and double cylinder washing machines. Impeller washing machines and double cylinder washing machines share the same requirements. The following table 1 and 2 show the energy efficiency requirements change between GB12021-2004 and GB12021-2013.

For impeller washing machines, the new EES eliminates grade 4 and grade 5 products from the market. The former grade 3 requirements become the minimum energy performance indicator in the new EES.

**Table 1 Energy efficiency requirements changes of impeller washing machines and double cylinder washing machines**

Grade	Energy consumption (kWh)/(cycle.kg)		Water consumption L/(cycle.kg)		Rate of washing ability	
	GB12021-2004	GB12021-2013	GB12021-2004	GB12021-2013	GB12021-2004	GB12021-2013
1	≤0.012	≤0.011	≤20	≤14	≥0.90	≥0.90
2	≤0.017	≤0.012	≤24	≤16	≥0.80	≥0.80
3	≤0.022	≤0.015	≤28	≤20	≥0.80	≥0.80
4	≤0.027	≤0.017	≤32	≤24	≥0.70	≥0.80
5	≤0.032	≤0.022	≤36	≤28	≥0.70	≥0.80

For drum washing machines, grade 2,3,4 and 5 products are all kicked out from the market. The old grade 1 requirements become the minimum energy performance indicator in the new EES.

**Table 2 Energy efficiency requirement changes of drum washing machine**

Grade	Energy consumption (kWh)/(cycle.kg)		Water consumption L/(cycle.kg)		Rate of washing ability	
	GB12021-2004	GB12021-2013	GB12021-2004	GB12021-2013	GB12021-2004	GB12021-2013
1	≤0.190	≤0.110	≤12	≤7	≥1.03	≥1.03
2	≤0.230	≤0.130	≤14	≤8	≥0.94	≥1.03
3	≤0.270	≤0.150	≤16	≤9	≥0.94	≥1.03
4	≤0.310	≤0.170	≤18	≤10	≥0.70	≥1.03
5	≤0.350	≤0.190	≤20	≤12	≥0.70	≥1.03

(2) Water efficiency grades defined

Besides the huge upgrade of energy efficiency requirements, GB12021-2013 also defines water efficiency grades on the base of EES. It means the product can be classified on the water consumption efficiency requirements only when it can meet the MEPS. Following table 3 and table 4 show the water consumption efficiency requirements defined in GB12021-2013.

**Table 3 Water consumption efficiency requirements of impeller washing machines and double cylinder washing machines**

Grade	Water consumption L/(cycle.kg)
1	≤10
2	≤14

3	≤18
4	≤22
5	≤28

**Table4 Water consumption efficiency requirements of drum washing machine**

Grade	Water consumption L/(cycle.kg)
1	≤6
2	≤7
3	≤8
4	≤10
5	≤12

Although the EES for washing machines has already defined the water efficiency grades, the China energy label for washing machines didn't include such information yet. Normally drum washing machines consume more energy than impeller washing machines, but consume less water than impeller washing machines in China. For consumers, it is very helpful to know both the energy efficiency grades and water efficiency grades of the washing machine to make a wiser decision.

(3) Methods to calculate the energy and water consumption redefined.

According to the household appliances using habit investigation finished by CLASP in 2014, in China washing machines seldom work with rated washing load, mostly with half or 2/3 load<sup>[6]</sup>. GB12021-2013 redefines the method to test and calculate the energy and water consumption, considering rated load and half load both, which is closer to the real washing situation.

The formula to calculate energy consumption:

$$E_e = I_e \cdot (E_1 + 2E_2) / (2m)$$

$E_e$ : energy consumption per kilogram. (kW•h)/(cycle•kg)

$I_e$ : energy efficiency compensation coefficient, for impeller washing machine it is 0.75, for drum washing machine it is 0.85.

$E_1$ : energy consumption of washing cycle with the rated washing capacity. kW•h

$E_2$ : energy consumption of washing cycle with half-rated washing capacity. kW•h

$m$ : rated washing capacity. kg

The formula to calculate the water consumption:

$$W_e = I_w \cdot (W_1 + 2W_2) / (2m)$$

$W_e$ : water consumption per kilogram. L/(cycle•kg)

$I_w$ : water consumption efficiency compensation coefficient. 0.75

$W_1$ : water consumption of washing cycle with the rated washing capacity. L

$W_2$ : water consumption of washing cycle with half-rated washing capacity. L

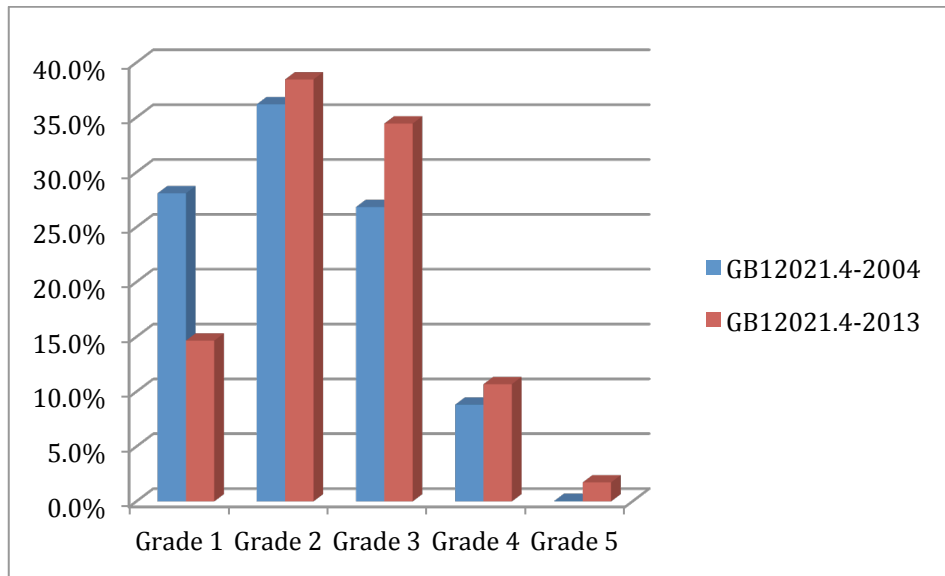
$m$ : rated washing capacity.kg

As showed in the first formula, the energy efficiency compensation coefficient is different for impeller washing machines and drum washing machines, the result of energy consumption for drum washing machines will be bigger than impeller washing machines even though the test results are the same.

### 1.3 Grades distribution

Based on washing machines information collected from China market and government data, the distribution of energy efficiency grades was analyzed. Before the revision of GB12021.4-2004, grade 1 washing machines took 28% market share, which reduced to about 14.5% after the revision. Grade 2 washing machines' market share increase from 36.2% to 38.5%,

which means more than half washing machines in the market can be certified as energy saving products (EES sets grade 2 requirements as the minimum requirements for energy-saving products certification).



**Figure 1 Grades distribution change of washing machine**

## 2 VS air-conditioners

### 2.1 Product background

VS air conditioners were introduced into Chinese market in the 1990s. Sales remained low until 2009. In 2010 and 2011, sales doubled on an annual basis, with the VS air conditioner market share growing from 16% in 2009 to 35% in 2011. From 2012, the productivity and sales of VS air-conditioners both reduced. It is reported the domestic sales of VS air-conditioners was 24 million in 2012 and the ownership was above 40 million in 2012<sup>[7]</sup>.

### 2.2 EES changes of VS air-conditioners

The first EES for VS air-conditioners was published in 2008 named <GB 21455-2008 Minimum allowable values of the energy efficiency and energy efficiency grades for variable speed room air conditioners>, the energy labeling of VS air-conditioners started in 2009 based on GB 21455-2008<sup>[8]</sup>.

The new version of GB21455-2008 has been released in 2013 and been implemented since October 1<sup>st</sup> 2013. Compared with GB21455-2008, GB21455-2013 defines the annual performance factor (APF), enhances the energy efficiency requirements and reduces the energy efficiency grades<sup>[9]</sup>.

(1) APF defined

APF is the ratio of heat insufflated in and taken from the room to the electricity consumed by the VS air conditioner for one year, which is the parameter to measure the energy efficiency of the VS air-conditioners with heating pump, while seasonal energy efficiency ratio (SEER) is the parameter to measure the energy efficiency performance of VS air-conditioners without heating function. GB21455-2013 regulates the testing annual heating time is 433 hours and cooling time is 1136 hours. Following table 5 shows the APF requirements in GB21455-2013 classified on the cooling capacity.

**Table 5 APF requirements for heat pump VS air-conditioners**

Rated cooling capacity	APF Wh/Wh

	Grade 1	Grade 2	Grade 3
<=4500W	4.5	4.0	3.5
4500W-7100W	4.0	3.5	3.3
7100W-14000W	3.7	3.3	3.1

(2) Energy efficiency requirements improved

GB21455-2013 eliminated former grade 4 and grade 5 VS air-conditioners out from the market and improved the SEER requirements of grade 1,2 and 3, as showed in table 6.

**Table 6 SEER requirements changes**

Rated cooling capacity	SEER Wh/Wh							
	Energy efficiency grade							
	1		2		3		4	5
	GB 21455-2008	GB 21455-2013	GB 21455-2008	GB 21455-2013	GB 21455-2008	GB 21455-2013	GB 21455-2008	GB 21455-2008
<=4500W	5.2	5.4	4.5	5.0	3.9	4.3	3.4	3.0
4500W-7100W	4.7	5.1	4.1	4.4	3.6	3.9	3.2	2.9
7100W-14000W	4.2	4.7	3.7	4.0	3.3	3.5	3.0	2.8

Following the changes of EES, energy label of VS air-conditioner was also revised. Besides the rated cooling capacity and cooling season energy consumption, the new label adds APF, rated heating capacity and heating season energy consumption information on the label.

Figure 2 is the new label sample of VS air-conditioner.



**Figure 2 New energy label of VS air-conditioner based on GB21455-2013**

### 2.3 Grades distributions

After one-year implementation of the new EES, grade 1 market share of VS air-conditioners decreased from 19% to 10%, grade 2 market share decreased from 46% to 44.5%, while grade 3 market share increased from 29.6% to 49.6%.

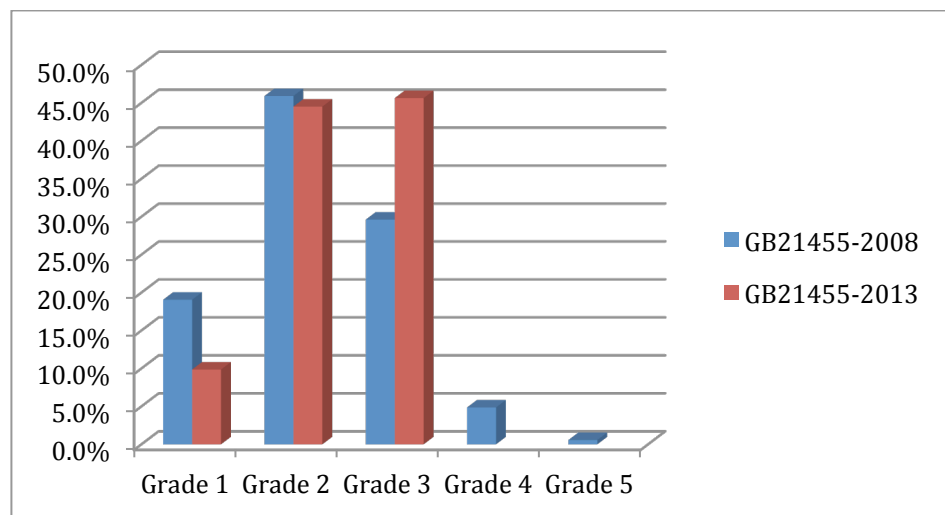


Figure 3 Grades distribution of VS air-conditioners

## 3 Panel-TVs

### 3.1 Product background

After 60 years development when the TV was firstly produced in China, it has become one of the household appliances with the highest market penetration. The 'per hundred households' penetration rate of panel-TVs in rural areas was about 116.9 units in 2012, while in urban areas the rate was 118.3 in 2012. Since 2012, the demand from rural areas is bigger than the demand from urban areas, with a rate of about 51:49. It is estimated that rural areas will become even more important markets for TV sales in the next few years in China.

There are two types of flat panel technologies: PDP (plasma display panels) and LCD (liquid crystal displays). Although PDP TVs can still be found on the market, they take only a very small market share of 2%. LCD TVs have become the absolute mainstream technology. LCD TVs are illuminated either by LEDs (light emitting diodes) or CCFL (cold cathode fluorescent lamps), depending on the different backlight technologies. EES of panel-TV defined the energy efficiency requirements separately for LCD TVs and PDP TVs.

### 3.2 EES changes and label of TV

Chinese government released the first EES for flat panel TVs (GB24850-2010) in 2010. GB 24850-2010 not only regulated the energy efficiency requirements, but also the test method. Energy efficiency index (EEI) is defined to measure the energy efficiency performance of TVs, which is the ratio of the energy efficiency of the tested TVs to reference energy efficiency value provided by EES<sup>[10]</sup>.

GB24850-2010 was revised in 2013 and has been implemented since October 1<sup>st</sup> 2013. Compared with GB24850-2010, GB24850-2013 improves the energy efficiency requirement significantly, defines the on mode static power, on mode dynamic power and the fluctuation values of power, revises the value of the signal processing power<sup>[11]</sup>.

(1) Energy efficiency requirements improved significantly

Panel-TVs are classified into 3 grades based on the value of EEI. For LCD panel-TVs, the minimum energy performance indicator of GB 24850-2013 is even higher than grade 2 requirements of GB 24850-2010. For PDP panel-TVs the grade 1 requirements of GB24850-2010 become the minimum energy performance indicator of GB 24850-2013, which means the grade 3 LCD panel-TVs, grade 2 and grade 3 PDP panel-TVs would be eliminated from the market. Table 7 gives out the details of EEI requirements changes.

**Table 7 EEI changes of GB24850-2013**

Grade	Energy efficiency ratio of LCD panel-TVs		Energy efficiency ratio of PDP panel-TVs	
	GB24850-2010	GB24850-2013	GB24850-2010	GB24850-2013
1	1.4	2.7	1.2	2.0
2	1.0	2.0	1.0	1.6
3	0.6	1.3	0.6	1.2

(2) Method to define on mode power changed

The on mode power of panel-TV is determined by on mode static power and on mode dynamic power in the new standard. So the TVs need to be tested by both static signals and dynamic signal. In the old standard, only the power using dynamic signals needs to be tested.

(3) Signal processing power value changes

The Formula to calculate energy efficiency of panel-TVs:

$$Eff=(L*S)/(P_k-P_s)$$

Eff: energy efficiency of panel-TV

L: brightness of the TV

S: screen size

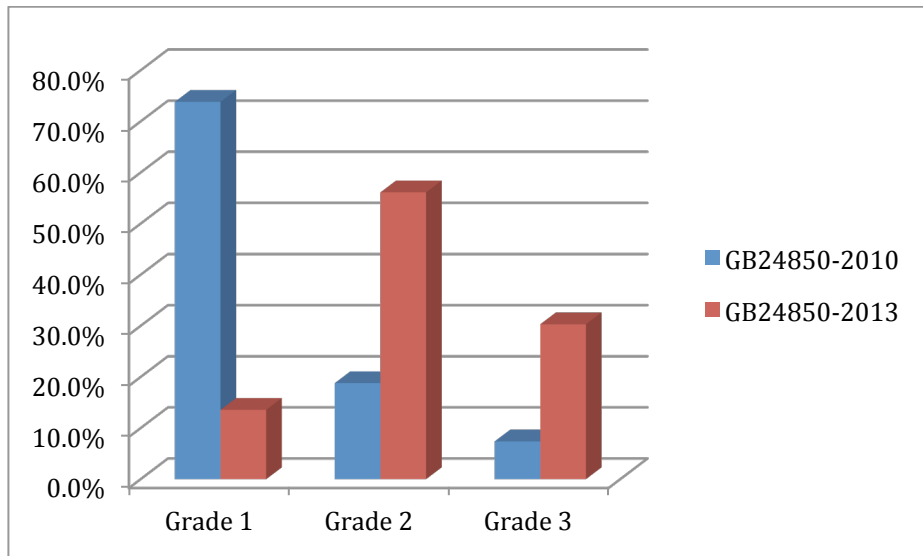
P<sub>k</sub>: on mode power

P<sub>s</sub>: signal processing power

The P<sub>s</sub> has been decreased 6-7 W in the new standard, which can result in the increase of Eff compared with the old standard, also can increase the value of EEI.

### 3.3 Grade distributions

Because of the implementation of new EES, the percentage of grade 1 panel-TVs reduced from 73.8% to 13.6%. The percentage of grade 2 increased from 18.8% to 56.1%. Grade 3 percentage increased from 7.4% to 30.3%.



**Figure 4 Grades distribution changes of panel-TVs**

#### **4 Conclusions and Recommendations**

EES and energy label play very important role in improving the energy efficiency of household appliances, eliminating inefficient products, promoting the technology development and guiding the consumption. But with the rapid development of technology, the EES and energy label implementing rules are easily to be out of date which may confuse the market or block the technology development. As mentioned above, washing machine's EES was revised after 9 years, which is too old to promote the development, the technology changed, the using habit changed and the market changed. There should be a timeline of the EES revision set by government. The market monitor mechanism is also need to be established. Grade 1 panel-TV's percentage was already more than 70% just after 3 years of the first panel-TV EES published, which means the requirement of grade 1 is too low, most products can meet the requirement and there should be a further revision. The market monitor mechanism can help reflect the real market change in time and provide evidences for the standard revision.

As mentioned in Market Analysis of China Energy Efficient Products (MACEEP): the standard revision should keep the principle of technology neutrality, which include the different base value for LCD panel-TVs and PDP panel-TVs when calculating the energy efficiency index, and the difference value of energy efficiency compensation coefficient for impeller washing machine and drum washing machine.

Following the changes of EES, the energy label should also be revised to provide the important and necessary information to consumers: the water efficiency grades are important information for consumers when purchasing which should be added to the energy label of washing machines. The power of panel-TV is the direct information of energy consumption which also should be added to the energy label of panel-TVs.

Reference or reasons need to be provided to explain some given values in EES, such as: the energy efficiency compensation coefficient and water compensation coefficient of washing machines. The energy efficiency compensation coefficient of impeller washing machines is 0.75, which is 0.85 for drum washing machines. The water compensation coefficient is 0.75. It was recommended that more transparency or explanatory documents are needed in such circumstances.



## Reference

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