Preface

Energy-efficiency standards and labels have been one of the major approaches for energy-saving actively used in the world. Implementation of standards and labels can improve energy efficiency and stimulate the development of energy-saving technologies. In addition, reducing energy use will decrease pollutant emissions and help protect the environment. In the "Tenth Five-Year Plan for Energy Conservation and Resources Comprehensive Utilization" issued by the relevant authorities, priority is given to development and improvement of energy-efficiency standards for primary energy-using products, including industrial equipment (such as boilers, electro-motors, fans, pumps, transformers, etc), household appliances, lighting apparatuses, automobiles and so forth; establishment and implementation of energy-efficiency information labeling; carrying on energy conservation product certification system; and further market disciplining energy-using products.

In order to facilitate the Government to develop a plan on energy efficiency, the China National Institute of Standardization (CNIS) brought forward the Project of Energy Conservation Potential Analyses of Primary Energy-Using Goods in China. The Project is intended to analyze and estimate the energy conservation potential and associated social/economic benefits by 2020 from implementation of new energy-efficiency standards and labels for main energy-consuming products, so as to provide policy-makers convincing information and scientific data for the government to set standard and label priorities. In addition, this project presents recommendations for other further policy actions.

Under the financial support from the China Sustainable Energy Program of the Energy Foundation (Grant number: G-0202-06173), CNIS began the analysis in February of 2002. The American Council for an Energy-Efficient Economy provided technical support for the analysis process.

Assignment of the workgroup members is as follows:

Li Aixian, responsible for overall organization and coordination of the Project, examining and integrating the final report;

Cheng Jianhong, responsible for the analysis of household appliances, central air-conditioning and industrial boilers;

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Liang Xiuying, responsible for the establishment of models, energy potential analysis, compiling, integrating and translating of the final reports including both Chinese and English versions;

Fan Yuhua, responsible for the translation of some parts of the English version.

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Thanks are also given to the leaders of the former State Economic and Trade Commission and the Standardization Administration of China for their support and direction all along that guaranteed the successful completion of the Project.

Contents

Executive Summary

Energy-efficiency standards and labels have been one of the major energy-saving policies actively used by nations in recent years. Energy-efficiency standards prohibit the production, sale and import of inefficient products, and finally remove them from the marketplace. Energy-efficiency labels can empower consumers to choose energy-efficient products, and then shift the efficiency distribution of these products upward. Thus, standards and labels can not only improve energy efficiency and save energy, but also stimulate the development of energy-saving technologies and strengthen competitive international trade. In addition, the reduction in energy demand can reduce future investment in power infrastructure, mitigate the pressure of energy supply, reduce the peak load of the power network, and improve electric system reliability. Meanwhile, it can reduce pollutants, mitigate climate change, improve environmental quality, and bring economic benefits to consumers.

There are many successful examples from other countries to show the tangible results of energy conservation and environmental protection by implementing energy efficiency standards and labeling. The EU, the US, Australia, New Zealand, Korea, Japan, Philippine, Thailand, etc. have all successfully developed energy-efficiency standards and obtained enormous energy savings and great economic and environmental benefits from their implementation. Energy-efficiency labels have been widely applied to household appliances, office equipment, commercial and industrial equipment, and affected consumers' purchases, not only in the developed countries of Europe and America, but also in some Asia-Pacific countries. Taking America as an example, up to now, energy-efficiency standards have been applied to refrigerators, freezers, room air conditioners, central air conditioners and heat pumps, furnaces and boilers, water heaters, direct-fired space heaters, clothes washers, clothes dryers, dishwashers, ranges and ovens, pool heaters, fluorescent lamp ballasts, TVs, fluorescent lamps, incandescent lamps, electric motors, HID lamps and so on. The energy savings produced from standards will be about 8% of total projected electricity use, 4% of total primary energy and nearly10% of peak demand in 2020. In addition, the U.S. "Energy Star" program has been an internationalized energy-efficiency labeling program.

But in China, the energy saving effect through standards and labeling is very limited. There are two main reasons to explain it. One is small coverage of standards and labeling. Currently, products covered by existing energy standards focus on

domestic appliances (such as refrigerators, room air conditioners and washing machines), several types lighting equipment, and a few types of industrial equipment. China has yet to set mandatory standards on many of its common residential appliances and industrial equipment. China has implemented endorsement labels, but the products and manufacturers covered by certification are also limited. Information labels are still under consideration and unimplemented.

The other reason for low savings from standards in China is the low level of energy efficiency criteria including the energy efficiency limiting value (the mandatory standard) and the energy conservation evaluating value (a recommended but not mandatory level). In China, existing standards are implemented after about half a year from the date the standard is issued. The relatively short time makes it hard for manufacturers to improve their products to meet higher energy efficiency criteria and thus standards are set low enough that many existing products can meet them. The standards with low level are not effective to promote and induce the improvement of energy efficiency.

China is a developing country with one of the world's fastest growing economies. China's energy supply is always enduring huge pressure to support economic sustainable development and to improve the quality of human life. This in turn puts more expectation on China's energy conservation work. Therefore it is very important to learn experience from other countries to attain energy saving potential through standards and labels.

This project analyzed and estimated the overall savings potential from establishing minimum efficiency standards and information labeling programs for common domestic appliance and major energy-using industrial equipments in China. Products included are color TV sets, room air conditioners, refrigerators, rice cookers, freezers, washing machines; consumer electronics and office equipment (standby power); fluorescent lamps, fluorescent lamp ballasts, HID lamps, traffic lights, exit signs, central air conditioners, motors, pumps, fans, air-compressors, transformers and industrial boilers. Most of these products are used widely in China and not covered by existing mandatory energy standards. The improvement in their energy efficiency will make important contributions to energy conservation at the end-use level. In developing this analysis, we examined current energy efficiency levels, manufacturer's capacity for adopting new technology and producing new products with high energy performance, international advanced energy efficiency level and the trend of technology development. Based on this research, we propose energy efficiency criteria for new standards for each of the products, and then estimate the

energy saving potential per product by comparing with baseline energy consumption. Table 1 and table 3 summarize the potential for energy and economic savings from adopting national minimum-efficiency standards and information labels for the above products, respectively. Table 2 and table 4 show the potential peak load and emission reductions from adopting these standards and information labels, respectively.

Table 1 Estimated Energy Savings and Economics of Proposed New Standards

Products	Effective Year	Energy savings				Net Benefits (NPV benefits - costs)	Benefit-Cost Ratio
		2010		2020			
		TWh	MMTce	TWh	MMTce	RMB Million	
Residential							
TV	2004	3.07	1.19	4.79	1.73	8946	5.8
Room AC	2004	13.39	5.21	20.04	7.25	30925	3.0
Refrigerator	2003	12.65	4.92	21.78	7.88	45729	9.1
Rice cooker	2005	4.69	1.82	8.41	3.04	12362	4.3
Freezer	2003	3.92	1.53	7.38	2.67	14017	6.8
Washing machine							
Impeller	2004	0.39	0.15	0.56	0.20	5148	2.4
Drum	2004	1.11	0.43	2.91	1.05	1893	1.4
Standby Power							
Color TV	2004	3.26	1.27	5.10	1.84	9173	5.0
Microwave oven	2006	0.46	0.18	1.46	0.53	1298	2.3
Laser printer (<10ppm)	2004	0.14	0.05	0.24	0.09	761	6.1
Facsimile machine (<10ppm)	2006	0.12	0.05	0.25	0.09	291	1.6
Copier (<20cpm)	2006	0.39	0.15	1.32	0.48	3145	7.2
Computer monitor	2004	1.05	0.41	2.04	0.74	4632	2.8
Lighting							
Double-capped fluorescent lamp	2003	9.57	3.72	12.86	4.65	43826	5.3

Products	Effective Year	Energy savings				Net Benefits (NPV benefits - costs)	Benefit-Cost Ratio
		2010		2020			
		TWh	MMTce	TWh	MMTce	RMB Million	
Fluorescent ballast	2005	17.80	6.92	46.18	16.71	5214	1.1
HID lamp	2005	2.51	0.98	0.79	0.29	4604	3.4
Traffic light	2005	9.09	3.53	7.63	2.76	25067	9.0
Exit sign	2004	3.26	1.27	4.41	1.60	14455	3.8
Commercial/industrial							
Central AC							
Recp type chilling unit	2005	2.56	1.00	4.55	1.65	16437	16.1
Water-cooled screw type water chilling unit	2005	2.95	1.15	7.07	2.56	22968	15.3
Water-cooled centrifugal water chilling unit	2005	1.10	0.43	3.65	1.32	10603	13.7
Unitary	2005	0.45	0.18	1.39	0.50	3825	9.2
Motor	2004	11.29	4.39	16.46	5.96	37301	5.0
Fan	2004	7.87	3.06	12.27	4.44	31320	17.3
Pump	2004	16.64	6.47	29.49	10.67	70558	24.8
Air compressor							
Mini type	2004	0.76	0.29	1.23	0.45	2740	7.2
Large Scale	2004	4.41	1.71	7.88	2.85	17245	8.1
Transformer	2004	8.29	3.22	22.08	7.99	30182	4.9
Industrial							
Building	2005	-	2.07	-	4.83	4751	79.3
Producing	2005	-	9.43	-	30.82	26588	27.3
Total		**143**	**67.2**	**254**	**127.7**	**506003**	**3.7**

Table 2 Estimated Summer Peak Load and Pollutant Reductions from New Standards

Products	Summer Peak Load Reductions		Emissions Reductions in 2020			
	2010 GW	2020 GW	Carbon MMT	NOx 1000T	SO_2 1000T	PM10 1000T
Residential						
TV	0.25	0.39	1.38	21.08	275.05	128.46
Room AC	5.91	8.84	5.79	88.19	1150.62	537.39
Refrigerator	1.88	3.25	6.29	95.85	1250.48	584.03
Rice cooker	0.80	1.43	2.43	36.98	482.51	225.35
Freezer	0.58	1.10	2.13	32.46	423.45	197.77
Washing machine						
Impeller	-	-	0.16	2.47	32.21	15.04
Drum	-	-	0.84	12.81	167.17	78.07
Standby Power						
Color TV	0.26	0.41	1.47	22.43	292.58	136.65
Microwave oven	0.07	0.21	0.42	6.44	84.03	39.24
Laser printer (<10ppm)	0.04	0.06	0.07	1.08	14.03	6.55
Facsimile machine (<10ppm)	-	-	0.07	1.10	14.29	6.68
Copier (<20cpm)	0.10	0.34	0.38	5.79	75.60	35.31
Computer monitor	0.32	0.62	0.59	8.97	117.09	54.69
Lighting						
Double-capped fluorescent lamp	1.87	2.52	3.72	56.57	738.08	344.72
Fluorescent ballast	3.49	9.04	13.34	203.19	2650.95	1238.11
HID lamp	0.23	0.07	0.23	3.50	45.61	21.30
Traffic light	1.29	1.08	2.20	33.58	438.06	204.59
Exit sign	0.46	0.63	1.28	19.42	253.40	118.35

Products	Summer Peak Load Reductions		Emissions Reductions in 2020			
	2010 GW	2020 GW	Carbon MMT	NOx 1000T	SO_2 1000T	PM10 1000T
Commercial/industrial						
Central AC						
Recp type chilling unit	0.89	1.58	1.31	20.01	261.01	121.90
Water-cooled screw type water chilling unit	1.03	2.46	2.04	31.09	405.62	189.44
Water-cooled centrifugal water chilling unit	0.38	1.27	1.05	16.06	209.48	97.84
Unitary	0.27	0.81	0.40	6.13	80.03	37.38
Motor	2.28	3.32	4.76	72.42	944.79	441.26
Fan	1.59	2.48	3.54	53.97	704.08	328.84
Pump	3.36	5.96	8.52	129.75	1692.85	790.63
Air compressor						
Mini type	0.19	0.32	0.36	5.42	70.77	33.05
Large Scale	0.89	1.59	2.28	34.65	452.07	211.14
Transformer	1.57	4.18	6.38	97.16	1267.59	592.02
Industrial						
Building	-	-	3.28	49.90	650.99	304.04
Producing	-	-	20.91	318.39	4153.91	1940.06
Total	**30.0**	**54.0**	**97.6**	**1486.8**	**19398.4**	**9059.9**

Table 3 Estimated Energy Savings and Economics of Information Labels

Products	Effective Year	Energy savings				Net Benefits (NPV benefits - costs) RMB Million	Benefit-Cost Ratio
		2010		2020			
		TWh	MMTce	TWh	MMTce		
TV	2004	0.86	0.33	1.34	0.49	2560	6.6
Room AC	2004	4.82	1.87	7.22	2.61	6358	1.6
Refrigerator	2003	0.25	0.10	0.44	0.16	352	1.5
Rice cooker	2005	0.68	0.26	1.21	0.44	2055	8.9
Freezer	2003	0.78	0.31	1.48	0.53	2900	8.5
Washing machine							
Impeller	2004	0.07	0.03	0.10	0.04	1007	1.7
Drum	2004	0.36	0.14	0.95	0.34	56	1.0
Double-capped fluorescent lamp	2003	6.12	2.38	8.23	2.98	16654	1.9
Unitary AC	2005	0.21	0.08	0.64	0.23	1608	5.4
Total		**14.2**	**5.5**	**21.6**	**7.8**	**33550**	**2.0**

Table 4 Estimated Summer Peak Load and Pollutant Reductions from Information Labels

Products	Summer Peak Load Reductions		Emissions Reductions in 2020			
	2010 GW	2020 GW	Carbon MMT	NOx 1000T	SO_2 1000T	PM10 1000T
TV	0.07	0.11	0.39	5.90	77.01	35.97
Room AC	2.13	3.18	2.08	31.75	414.22	193.46
Refrigerator	0.04	0.06	0.13	1.92	25.01	11.68
Rice cooker	0.11	0.21	0.35	5.33	69.48	32.45
Freezer	0.12	0.22	0.43	6.49	84.69	39.55
Washing machine						
Impeller	-	-	0.03	0.45	5.93	2.77
Drum	-	-	0.27	4.16	54.33	25.37
Double-capped fluorescent lamp	1.20	1.61	2.38	36.21	472.37	220.62
Unitary AC	0.12	0.37	0.19	2.28	36.81	17.19
Total	**3.8**	**5.8**	**6.2**	**95.0**	**1239.9**	**579.1**

The analysis shows, the total amount of energy that can be saved from standards in China. We estimate that savings can total 143TWh of electricity and 67.2MMTce of primary energy in 2010; 254TWh of electricity and 127.7MMTce of primary energy in 2020. Adding the energy savings from information labels, the electricity savings amount to 56% of projected residential electricity use in 2020. That is to say, during the next 17 years, projected growth in residential electricity use could be reduced by nearly 85% though energy-efficiency standards and information labels.

The new standards would also save about 34TWh of electricity and 14MMTce of primary energy in 2005. The tenth five-year plan's goal for energy conservation is to save 340MMTce of primary energy from 2001 to 2005, so the new standards alone could realize 4.1% of that.

Over the 2003-2020 period, the electricity and coal bill savings are 764 billion RMB Yuan (discounted to year 2000). After deducting the 225 billion RMB Yuan incremental cost, the net benefits is 539 billion RMB Yuan. The average benefit-cost ratio of standards and labels is 3.7 and 2.0, respectively. Energy standards in particular are incredibly cost-effective perspective. Labeling is less cost-effective because we assumed that labels would promote the most-efficient (and most expensive) products. To the extent labels promote less efficient products, the benefit-cost ratio will improve, but energy savings decline.

Electricity savings will have a great impact on reducing summer peak load and balancing peak demand and supply. We estimate that the standards and information labels would save a total of about 59.7 GW of power in the year 2020. This is roughly equal to the generating capacity of 200 average power plants (300 MW each). The peak load reduction would reduce the need for new power plant construction and improve electric system reliability.

Emission reductions from the reduced energy consumption would also be significant. In the year 2020, 103.9, 1.58, 20.6, 9.64 million tons of carbon, NOx, SO_2 and PM_{10} could be reduced respectively, which would mitigate deterioration of environmental problems, such as green house effect, photochemical smog, and acid rain. The carbon savings for example are equivalent to the annual carbon emissions from over 4.5 million average passenger cars.

These numbers reveal clearly the energy conservation potential for China major energy using products through standards and information labels. It is important to develop carefully targeted standards and labels to realize these savings. We

recommend to the Chinese government that:

- Energy-efficiency standards and labels should be supported by relevant polices and funded as one of the most important energy saving instruments;

- Product coverage of standards should be expanded, especially the development of standards for industrial boilers, ballasts, pumps, transformers, refrigerators, room air conditioners, central air conditioners, motors, double-capped fluorescent lamps, and fans;

- Research on reach standards (more stringent standards which are set several years before they take effect) should be emphasized to help improve energy efficiency effectively;

- Information labeling programs should be developed as soon as possible, the first round product coverage should include room air conditioners, refrigerators, freezers, TVs, rice cookers, washing machines, double-capped fluorescent tubes, and traffic lights.

Chapter 1 Background

1. Overview of Energy Conservation in China

Energy, is the foundation of our national economy and an organic part of the overall national strength. It is also a critical factor that restricts China's sustainable economic and social development. Therefore, energy conservation and energy efficiency promotion is an inevitable approach for ensuring our national energy security and continuing economic development, converting the mode of economic growth and sharpening competitive edge of enterprises, so as to support the country's environmental protection and sustainable development strategy.

China is not only a country with the fastest economic growth rate in the world, but also the second largest energy consumer, next to the U.S. only. Its energy consumption has been growing by 5% yearly since 1985, of which the consumption of electrical energy grows even faster. The ever-growing energy consumption and excess dependence on fossil fuels result in rapid increase of greenhouse gas emissions. It is the world's second largest greenhouse gas discharger now. The associated environmental and health problems become increasingly remarkable. The imbalance of energy supply and demand is getting worse because of the increasing demand for primary energy with the fast growing industrialization, urbanization and advancement of living standard.

1.1 Major achievements in energy conservation

Chinese government always touches great importance to energy conservation. It set the policy of "Promoting both energy exploitation and saving, with the latter as the prior" in early 1980s. Remarkable achievements have been achieved since then in energy conservation. 900 megatons of coal equivalent (MTce) have been saved since 1990; the emission reduction was equivalent to reduction of 18 megatons of sulfur dioxide and 390 megatons of carbon dioxide. The energy consumption per 10,000 Yuan of GDP dropped from 1995' 3.97 Tce to 2000' 2.77 Tce, which is about a third of 1980's 7.89Tce. During the period of Ninth Five-Year Plan, the cumulative total energy conservation was 410 MTce, the emission reduction was equivalent to 8 megatons of sulfur dioxide and 180 megatons of carbon dioxide. And the unit energy consumption of major primary energy-using products dropped in different degree. The direct energy saving in this period was worth 66 billions Yuan. Exploitation of new energy and renewable energy reached 30 MTce, the emission reduction is equivalent

to 22 megatons of GHG and over 1.5 megatons of sulfur dioxide/dust, that has made great contributions to improvement of the global environment and is instrumental to China's environmental diplomacy. In the past 20 years, China's primary energy consumption has been growing by 4% to 5% yearly, which maintains the average rate of 8% to 9% for the national economic growth, fulfilling the general objective of fostering economic development with both energy exploitation and economization. Not only has it supported the economic development and eased the energy shortage, but also played an important role in improving the environment and pursuing sustainable development.

Furthermore, the legal construction of energy conservation has also made important progress. A set of regulations, such as *Rules on energy saving management by key energy consumers, Rules on management of energy consuming product certification and Rules on electricity saving management* have been promulgated since *Energy Conservation Law of the P.R.C* was enacted in January 1st, 1998. Meanwhile local or sector-specific rules for enforcement of the Law have also been developed by 14 provinces/municipalities and two ministries; drafts of such rules is under examination in 8 provinces/municipalities; formulation of the rules has been put on legislating agenda in 5 provinces/municipalities. The detailed regulations have reinforced the legislation of energy conservation. Management of energy saving has been promoted, the relevant technologies advanced; the legal responsibilities confirmed and public awareness awakened through broad dissemination.

China is a contractor both to the UNFCCC and Montreal Protocol on Ozone Depletion. China has made great efforts and remarkable achievements in climate change mitigation, of which energy conservation and new energy exploitation have an important share that has been announced by Chinese government in various events and received attention and recognition from the international community.

1.2 Challenge and opportunity faced by our work in energy conservation

While great progress in energy conservation has been made, we should be aware of the gap between China and advanced countries. Our energy efficiency is only about 30% for the time being, 10% lower than that of developed countries. As one of the largest energy consumers in the world, our energy consumption per capita is only half of the world average, while the energy consumption per unit output is 2.3 times the world average, ranking high in the world in terms of energy consumption of unit output. Our unit energy consumption of primary industrial products is 40% higher than the weighted average of world advanced level. For example, coal consumption

for power generation is 28% higher, energy consumption per ton of steel production in our large and medium scale steelworks 25% higher; and energy consumption for synthetic ammonia production in large scale plant 40% higher. The figures indicate that we still have lot to do in energy conservation, and huge energy conservation potentials are there for us to exploit. It is important for us to make persistent and even greater efforts to further promote energy conservation.

The first decade of the century is a critical period for China to readjust its economic structure strategically. The basic situation of China, namely the big population, insufficient energy resources per capita and fragile ecological environment, determines that we have to vigorously push energy conservation in our modernization drive. First, energy conservation is the only choice for guaranteeing our national economy security. Being in an industrialization stage with high-speed economic development, China is facing the problems of insufficient energy sources, high energy consumption, and big waste and low efficiency. To reach the level of a medium developed country, we should solve the problems with a double-track approach, i.e. through both exploitation and economization of energy sources. Secondly, energy conservation is the most effective way of protecting the environment by means of reducing pollution and saving resources. Thirdly, energy conservation and consumption reduction is an important measure to increase economic benefits and enhance competitiveness of enterprises. Along with the booming of foreign trade after China's entry into WTO, energy conservation has been playing a more and more important role in importation and exportation. Energy-efficiency standards and labeling has become a green pass in international trade. As a major exporter of electromechanical products, China should be conscious of the market change, and take timely action to deal with the situation. To direct and push energy conservation, the State Economic & Trade Commission promulgated *The Tenth Five-Year Plan for Energy Conservation and Integrated Resource Utilization*. The targets set out in the document of energy conservation by 2005 are as follows:

The energy consumption per 10,000 Yuan of GDP should be reduced to 2.2Tce (fixed price in 1990); the accumulative total energy saving shall reach 340MTce; the average annual energy conservation rate 4.5%; 16 megatons of fuel oil and 5 megatons of refined oil should be saved or substituted.

1.3 Key working items in the 10th five-year plan period

To reach the target mentioned above, the relevant authorities in charge of energy conservation will focus on the following work:

1.3.1 Reinforcement of the relevant legislation

Currently, the State Economic & Trade Commission has developed two regulations, i.e. *Rules on Petroleum Conservation Management* and *Rules on Energy Efficiency Labeling Management*, and solicited comments broadly.

1.3.2 Further development of energy efficiency standards

Standards planned include those for industrial boilers, electrical motors, fans, water pumps, transformers, household appliances, lighting apparatus, automobiles, energy-using products in building industries, etc.

1.3.3 To establish and implement energy efficiency labeling system throughout the country, carry on certification for energy efficient products and further discipline the market.

1.3.4 To readjust energy consumption structure and increase the proportion of coal in electric power generation and the use of electric power in end energy consumption.

1.3.5 To develop clean coal technologies; increase the use of natural gas; promote the utilization of new and renewable energies (including wind generated electricity, solar heat and photovoltaic –electricity); expedite domestic engineering of large and medium methane projects; enlarge the proportion of new energies in energy consumption structure and promote the utilization of high efficiency and clean technologies.

1.3.6 To develop and disseminate new technologies, new processes, new products and new equipment for energy conservation;, eliminate technologies and equipment with high energy consumption, low efficiency and heavy pollution, and boost the progress of energy conservation technologies; aggressively boost development of primary energy conservation technologies, e.g. those for clean coal, and the relevant demonstrations; further strengthen the technical innovation for energy conservation and consumption reduction in high energy consuming industries, such as power generation, metallurgy, non-ferrous metal, chemicals, construction materials, etc.; orient and strengthen the work for oil substitution and oil-saving in heavy oil consumption industries and the railway and traffic sectors.

1.3.7 To strengthen supervision and management of primary energy-using

organizations according to the relevant legal requirements and build up energy consumption reporting mechanism and information system of primary energy-using units, strengthen fundamental work on energy conservation, accelerate the construction of energy conservation management and supervision system, develop energy conservation intermediary organs and service system, and supervise and push energy conservation work of enterprises.

1.3.8 To study and borrow foreign advanced managerial experiences and technologies, establish energy conservation management system and new operation mechanisms in ways that meet China's national situation and the needs for market economy, including energy conservation information dissemination mechanism, relevant government procurement mechanisms, contracted energy management and voluntary energy conservation agreements with enterprises based on the market.

1.3.9 Reconstruction for energy conservation of the SETC Building, in the mode of "Contracted energy management and benefits sharing from energy saving" (i.e. shared savings); push governmental agencies to set examples in energy conservation and cost reduction.

1.3.10 To promote information dissemination and training on energy conservation

2. The Current Situation of China's Energy-Efficiency Standard and Labeling

With fast economic development and escalating of people's living standard, the annual and social possession of energy consumption equipment has been increasing. For the moment the average energy utilization efficiency of energy-using equipment and products is only 60% and there is a big room for further energy saving. To promote energy efficiency of household electrical appliances, office equipment, industrial equipment and buildings is very meaningful for energy conservation and climate change mitigation. It is stated in the *Tenth Five-Year Plan on Energy Conservation and Integrated Resource Utilization* that the focus of governmental management and supervision on energy conservation shall shift from industrial process to end energy-using products, popularize the advanced and eliminate the backward by restricting market access and uplifting energy efficient products right at the upstream, and take controlling end energy-using products and enhancing their energy efficiency as a focus for the country's future energy conservation work.

Energy-efficiency standards and labeling have been adopted in many countries as important tools in promoting product energy efficiency, while Energy-efficiency standards curb production, distribution and import of high energy-using products, and washes them out from the market ultimately; energy-efficiency labeling encourages consumers to buy low energy-using and energy efficient products, so as to enlarge the latter's market share, and results in elevation of product energy efficiency, energy saving, technical advancement and products' market competitive power. Furthermore, the reduction of energy needs may save capital investment on electric generation, release pressures on energy supply, lower the peak load of electric network and upgrade the stability of electric system. Meanwhile it reduces emission of pollutants, mitigate climate change, and improve environmental quality. In summery, energy conservation brings dual benefits to us both economically and environmentally. Energy-efficiency standards and the labeling system have been successfully implemented in the US, EU countries, Canada, Australia, New Zealand, Korea, Japan, Philippines, Thailand, etc., and big energy saving has been brought from large amount of terminal energy-using electric appliances and equipment, and notable economic and environmental benefits gained. Let's take the US for an example, its energy-efficiency standards cover refrigerators, household air conditioners, central air conditioners, heat pumps, furnaces, boilers, water heaters, direct-burning warmers, washing machines, dryers, dishwashers, cooking ranges, baking ovens, swimming pool heaters, fluorescent lamp ballasts, TV sets, fluorescent lamps, filament lamps, electric machines, transformers, HID lights, etc., the estimated energy saving generated from implementation of established energy-efficiency standards is about 8% of the overall power consumption in 2020, 4% of the primary energy, and peak demands are reduced by 10%. Its energy labeling is applied in household appliances, office apparatus and commercial/industrial equipment. Its implementation has profoundly influenced consumer purchase and use behavior. Particularly, the "Energy Star" has become an internationalized energy-efficiency labeling project.

2.1 Basic conception of energy efficiency standards and labeling

2.1.1 Energy efficiency standards

Energy efficiency standards set out specific requirements for energy performance of energy using products, based on the premise of not compromising other product performances/characteristics such as function, quality, safety and price.

Energy efficiency standards are categorized into four groups according to their content:

- Instructive standards

Require producers to add a specific performance feature or include/exclude a certain component to/from all new products.

- Minimum energy performance standards (MEPS)

Set out the threshold values for minimum product energy efficiency or maximum product energy consumption that shall be achieved by producers from a fixed date. Products that do not reach the value are prohibited from the market. This kind of standards is frequently used. For instance, the most energy efficiency standards for household appliances in the US and EU are in this category.

- Average energy efficiency standards

Set out average product energy efficiency in a certain period, that allow a producer to select an appropriate level of energy efficiency to each product and have the average energy efficiency of its products achieve the required value. American standards for automobiles and some Japanese standards are in this category.

-Energy efficiency grading standards

Set out several product energy efficiency grades, including energy efficiency limits, target values or classifying values for energy efficiency. Korean energy efficiency standard are in this category, and Chinese ones also include such values.

Energy efficiency standards can also be divided into the following two groups according to the period prior to implementation and their required efficiency levels.

- Current status standards

Take 6 months to 1 year from publication to implementation. The limits set forth in such standards are usually lower than the average level of the products in the marketplace at the time standards are set. The currently used Chinese standards are of this kind.

- Reach standards (not such defined internationally)

Generally need longer preparatory period, usually as long as 3 to 5 years. The values set forth in such standards are normally higher than the market average and

sometimes even higher than the currently highest one. Most energy efficiency standards in the US, EU and Japan are of the group.

2.1.2 Energy efficiency labeling

An energy efficiency label is attached to a product to provide information on its energy characteristics (usually in forms of power consumption, energy efficiency and/or energy cost) for consumers (including companies, governmental agencies and individuals) to make informed purchase decision, so as to assist and encourage them to choose energy-efficient products.

Energy labeling can be implemented on either voluntary or mandatory basis. The latter is adopted in most countries with their energy conservation authorities in charge of labeling details.

After more than 20 years development, the labeling system has been getting more and more mature. The following two types of labeling are implemented currently:

- Endorsement labeling

The labeling is also called certification labeling. It provides exactly same universal labels to a number of products that meet some specific standard requirements. The label does not give any detailed information.

- Informative labeling

The label provides information on product energy consumption, operation costs, energy efficiency or other important product information to consumers with a sequence of discontinuous performance grades or a series of continuous scales. The information should be readily understandable by consumers in order to enable them to consider product energy efficiency together with price, reliability, convenience and other product characteristics in their purchase decision making. Such labels also allow consumers to make comparisons between products with similar features on their energy performance.

According to the indication manner, information labels can be divided into two types, i.e. the energy efficiency grading label and the continuous comparative label.

A grading label assigns products to specific grades (e.g. the 1-5 scale used in

Thailand or the A-G scale used in Europe) making it easy for consumers to identify efficient products. Continuous labels provide information on each product using a continuous scale. A single information labeling does not enable consumers to make selection based on comparison, because it only gives technical performances of a product excluding energy efficiency information.

2.2 History and current situation of energy efficiency standardization in China

Since China took the policy of reform and opening up to the world in late 1970s, its economy has been growing quickly. With the people's living standard escalating, possession of household appliances and power consumption keep increasing. In this context, the first batch of 9 energy efficiency standards for household appliances, including GB12021.1, *General Rules for Compilation of Restriction Value and Testing Method of Power Consumption Efficiency of Household Electric Appliances and Like Products* and other 8 product-specific standards for domestic refrigerators, room air conditioners, household washing machines, color and monochrome TV receivers, automatic rice cookers, radio-recorders, household fans, and electric irons (see Table 1-1), were drafted, by the National Energy Foundation and Management Standardization Committee, in the mid- and late-1980's. These standards were promulgated by the former State Bureau of Technical supervision and took effect on December 1, 1990.

The products covered by the first batch of standards are household appliances. Their provisions include limits for the products' power consumption or efficiency, and their test methods. These standards were of the type of current status ones, intended to restrict or eliminate high energy consuming products on the market then. Implementation of these standards promoted energy efficiency of our domestic products. But limited by the technical conditions at the time, technical and economic analysis for the standards was not very adequate, values set in the standards not very scientifically sound, social awareness of the standards' importance not enough, that the implementation did not achieve the effect as expected.

The current development of international standardization for energy efficiency, advancement of analyzing methods for the standards and good examples of successful implementation have provided good condition for us to learn and borrow in our national standardization. Meanwhile, the level of research and production of household appliances in China has improved considerably, which has provided technical conditions for promotion of energy efficiency. With enactment and

enforcement of the *Energy Conservation Law of P.R.C* since the mid- 1990s, governmental management of energy conservation has been strengthened, which provided an opportunity for further development of energy efficiency standardization. Since 1995, China National Institute of Standardization (CNIS) and the National Energy Foundation and Management Standardization Committee started to revise the first batch of energy-efficiency standards and develop additional ones, under the leadership of relevant authorities and in cooperation and sponsorship of American Environmental Protection Agency, America Energy Foundation, International Institute for Energy Conservation, and American Lawrence Berkeley National Laboratory. These standards are then approved by the General Administration of Quality Supervision and Inspection and Quarantine of the PRC (AQSIQ). Thereafter, the study on energy-efficiency standards in China opened a new chapter of steady development, and the coverage of products addressed by the standards has been extended to light equipment and commercial and industrial equipment.

Table 1-1 The first batch of national energy efficiency standards published

Serial number	Name of standard
GB12021.2-1989	The limited value and testing method of energy consumption for household refrigerators
GB12021.3-1989	Limited value and testing method of energy consumption for room air conditioners
GB12021.4-1989	Limited value and testing method of energy consumption for household electric washing machines
GB12021.5-1989	Limited value and testing method of energy consumption for electric irons
GB12021.6-1989	Limited value and testing method of efficiency and warming energy consumption for automatic rice cookers
GB12021.7-1989	Limited value and testing method of electrical energy consumption for broadcasting receiver of color and monochrome televisions
GB12021.8-1989	Limited value of efficiency and testing method of on radio receivers and recorders
GB12021.9-1989	Limited value and testing method of energy consumption for electric fans

At the moment, 2 Chinese standards are being revised (for household refrigerators (second revision) and room air conditioners) and 6 new standards were recently developed and approved for tube fluorescent lamp ballasts, medium/small tri-

phase asynchronous motors, air pumps, double-capped fluorescent lamps, self-ballasted fluorescent lamps, and single-capped fluorescent lamps (see Table 1-2). Revision or development of 7 standards is underway, of which the products involved are those either for household or commercial/industrial use, such as electric washing machines, color TV (first revision), high-pressure sodium lamps and ballasts, central air conditioners, fans, and water pumps.

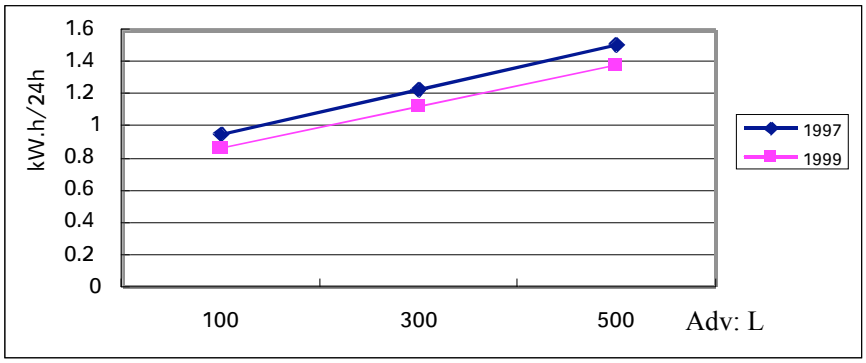
There are four other standards which have to be finished and submitted to SAC for approval. These are: Limited values of energy efficiency and evaluating values of energy conservation for air compressors, Limited values of energy efficiency and rating criteria of double-capped fluorescent lamps for general lighting service, Limited values of energy efficiency and rating criteria of self-ballast fluorescent lamps and Limited values of energy efficiency and evaluating values of energy conservation for single-capped fluorescent lamps, which have be finished and submitted to SAC for approval.

Table 1-2 National energy efficiency standards revised or newly published

Serial number	Name of standard
GB12021.2-2003	Limited values of energy efficiency and evaluating values of energy conservation for household refrigerators
GB12021.3-2000	Limited values of energy efficiency and evaluating values of energy conservation of room air conditioners
GB17896 - 1999	Limited values of energy efficiency and evaluating values of energy conservation of ballasts for tube fluorescent lamps
GB18613-2002	Limited values of energy efficiency and evaluating values of energy conservation for medium three-phase asynchronous motors
GB19153-2003	Limited values of energy efficiency and evaluating values of energy conservation for air compressors
GB19043-2003	Limited values of energy efficiency and evaluating values of energy conservation for double-capped fluorescent lamps
GB19044-2003	Limited values of energy efficiency and evaluating values of energy conservation for self-ballast fluorescent lamps
	Limited values of energy efficiency and evaluating values of energy conservation for single-end fluorescent lamps*

Note: standards with * mean their drafts for approval have been finished.

The new standards set out stricter threshold limits for energy efficiency (power consumption), and provide energy saving evaluation values. For the purpose of future implementation of energy efficiency labeling, values for energy efficiency grading are given in some of the standards. The power consumption (energy efficiency) limits is compulsory, and intended to eliminate low-efficiency products from the market; energy saving evaluation values are recommended, applicable for producers in setting energy efficiency targets. The values also provide a technical basis for the upcoming implementation of informative energy efficiency labeling. The standards also clarify the relevant product categorization; establish energy efficiency (consumption) indexes, test methods and rules for the indexes. The indexes have been set through a series of internationally advanced engineering/economic analysis methods, such as quantitative cost/benefit analysis, consumer influence analysis, prediction of the energy saving by the standard implementation, prediction of environmental effects (reduction of emission) by the standard implementation. The preliminary study has guaranteed rationality of the values set forth in the standards. Implementation of the new standards has greatly promoted energy efficiency of household appliances. A survey of refrigerators in 1999 indicated the energy efficiency of refrigerators decreased by 9% relative to 1997 (see Figure 1-1).



Source: Li Aixian, 2001

Figure 1-1 Comparison on energy efficiency of refrigerators between 1997 and 1999

2.3 Current situation of energy efficient product certification in China

China kicked off implementation of energy efficient product certification, i.e. the scheme of endorsement labeling, in October 1998. Then China Certification Organization for Energy Conservation Products was established under the authorization of the AQSIQ and the leadership of the former SETC. The Organization consists of two parts, the Management Committee for China's Energy Conservation

Product Certification and China Certification Center for Energy Conservation Product (CECP). The former was accredited by the National Accreditation Board in August 1999 and became qualified to conduct certification for energy efficient products in a universally recognized manner.

The certification leads to grant of a certificate and a label to an applicant by the CECP, to endorse the energy efficiency of a product, provided the product is confirmed qualified against relevant standard and technical requirements. It is an endorsement label, used on voluntary basis, similar to the Energy Star in the US. The certification takes the internationally adopted mode of “plant condition inspection; product test; follow-up test and inspection after certification", belonging to the category of product quality certification. The product certified in the first batch was household refrigerators. The certification was conducted by the CECP in April 1999. The next were room air conditioners, initiated on June 1st, 2000. Up to now, 17 categories of products are covered by the certification program categorized as household appliances, lighting apparatus, , electric power and water conservation. Specific Products include household refrigerators, room air conditioners, tube fluorescent lamp ballasts, electric power trap coils, medium- and small- sized electric motors, water-saving toilets, and so on. 347 types of products from 35 manufactures have passed the certification and received the label.

The certification has greatly promoted the energy efficiency level of products. Before its implementation, only very few models of refrigerators reached Class A of EU energy-efficiency labeling. By the end of 1999, 26 models reached the level, i.e. 16.3% of the certified products. An analysis made at the time of the products from 13 refrigerator manufacturers indicated that the average energy saving of certified refrigerators was 18 % against the common ones and the highest saving reached 40%. These savings were achieved through system optimization and design.

2.4 Progress of research on energy efficiency labeling

The SETC has initiated research on informative energy efficiency labeling (hereafter referred to as labeling) and preparatory technical work for its implementation since 2001. By the end of 2002, the Tentative Rules on Energy Efficiency Labeling Management, jointly developed by the SETC, the AQSIQ and the Certification and Accreditation Administration of the PRC (CNCA) passed comment solicitation and was to be published, when the SETC decided to conduct pilot projects of the labeling in household appliances.

In this context, The CNIS, under the support of the STEC and sponsorship of the China Sustainable Energy Program, the UN Project of Standards for Labels and Instruments and the NEPA/UNDP/GEF Project of Obstacle Removal in Broad Commercialization of Energy Saving Substitution for CFC in Refrigerators in China, organized comprehensive investigations and studies, and, on this basis, published *Pronspectus on Energy Efficiency Labeling* jointly with Energy Conservation and Integrated Resource Utilization Dept. of the SETC; carried out feasibility study on the labeling implementation in China; developed a draft of the detailed rules on the implementation for comment solicitation; selected a design company to design the label patterns according to international common practice; and hired a survey company to conduct a market survey of the label patterns. These preparations will ensure smoothness of the upcoming implementation.

3. Opportunities for the Development of China's Energy-efficiency Standards and Labeling

Although some effects have been achieved in energy conservation through implementation of the standards and labeling, problems and gaps between China and advanced countries still exist. Firstly, the product coverage of the standard and labeling is narrow with many household appliances and commercial equipment excluded; products involved in the certification is limited; the informative labeling is still at an early stage and the implementation has not begun in a real sense. Secondly, the values set forth in our standards are much lower than the international level. And for the time being, the preparatory period between standard publication and implementation for is only 6 months. The time for producers to get ready is limited. The energy efficiency limits are generally lower than the market average, aiming to bar 5-10% low efficiency products. These standards are of the type of current status ones. There are applicable to curb high energy consuming products' production and sale in recent period. The energy efficiency evaluation values set forth for certification are not high enough to activate producers' efforts for their product energy efficiency. Thirdly, there is not a planned schedule to make timely revision of energy efficiency standards. Therefore the values can not reflect technical progress and push product innovation.

It is a crucial transitional period now that China's economy is facing the challenge of strategic structural renovation and the entry into WTO. It also presents new opportunities for further development of the energy standardization and labeling.

3.1 Prioritization by the government

Recognizing the role of energy efficiency standardization and labeling in energy conservation and export promotion, the Energy Conservation and Integrated Resource Utilization Dept. of the SETC, the pertinent governmental authority, touches great importance to the work and has been pushing it vigorously. The Dept. has labeled the work of "development and revision of the energy efficiency standards for major energy using products, establishment and implementation of energy efficiency labeling and promotion of energy efficient product certification" as a priority in the *Tenth Five-Year Plan for Energy Conservation and Integrated Utilization of Resources*. By now, a draft of *Rules on Energy Efficiency Labeling Management* have been put on the Web for comments; design and market survey concluded for refrigerator label patterns; a plan for the standardization drafted; a strategy defined of prioritizing energy efficiency standardization in international cooperation and developing reach standards to set targets for producers, motivate product/equipment innovation and orient producers to enhance their technical ability. The drive from government will be most instrumental for the development of energy efficiency standardization and labeling to meet the needs of energy conservation.

3.2 Good conditions of international cooperation

China's energy efficiency standardization and labeling have benefited greatly from international organizations and experts. Many organizations, namely the Project of China Sustainable Energy of America Packard Foundation and Energy Foundation, International Energy Agency (IEA), American Environmental Protection Agency (EPA), International Institute for Energy Conservation (IIEC), American Lawrence· Berkeley National Laboratory (LBNL), Global Environmental Facility (GEF), American Council for an Energy Efficient Economy and the CLASP, have made great contributions for China's energy efficiency promotion and established cooperative relationship with relevant Chinese research institutions. In the process, the guidance and assistance from foreign experts were indispensable for us to borrow advanced foreign experience avoid twists and turns, build competency, upgrade the standards' level and promote implementation of the standards and labeling.

3.3 Progress of energy saving technologies

Prioritized in technical development and renovation, energy conservation has been given more shares in enterprises' technical reformation and product innovation. A number of breakthroughs of energy saving technologies were made in the Ninth Five-Year Plan period and have been put to use in the relevant industries. Particularly, remarkable progress has been made in energy saving technologies for household

appliances as China becomes a world power for these products. Advancement of the technologies enables higher standards to be set for more products, and to wash out low efficiency products and develop high efficiency ones in an economical, rational and technically viable manner.

3.4 Demand of consumers and market

There is a big difference between the product energy efficiencies of different brands in the recent marketplace. For example, the difference can reach 50% for refrigerators; 30% for air conditioners and 50% for TV sets. In this case it is difficult for consumers to make choice in terms of energy efficiency. In addition, many products are self-declared to be energy efficient, such as “energy saving lamp”, “super energy saving refrigerator” and so on and so on. Exaggeration or unauthorized labeling is not rare in the marketplace. Both high efficiency products and low efficiency ones are coexisting in the marketplace. Energy efficiency standards and labels are instrumental for disciplining market competition, establishing a sound and fair market environment and providing reliable and readily understandable information for comparison, so as to help consumers make choice in a energy efficient, economical and high quality manner among the products of various types, prices and technical levels. In addition, implementation of the standards and labeling also provide comprehensive and convincing energy efficiency information for governmental agencies and decision makers to overlook the situation of the end products’ energy consumption, as the basis for relevant policy making.

The opportunity has come for us to release the great energy conservation potential in the end-use products through extending product coverage of energy efficiency standards and labeling, upgrading the standardized energy efficiency level and promoting implementation of the standards and labeling. We should take advantage of the opportunity to promote our product energy efficiency, so as to respond to the challenge of the WTO entry.

Chapter 2 Objectives and Scope of Energy Conservation Potential Analysis of Primary Energy Using Products

1. Objectives

While energy efficiency standards and labeling are applicable to most energy using products, the potential is different from product to product and so is the influence of the standardization on them. To answer the questions of which products should be covered firstly, how large is the potential for the products/equipment and how significant is the indirect economic and environmental benefits associated, analysis and prediction shall be made on energy conservation potential of primary energy using products on scientifically sound basis. For this purpose, the Project of *Energy Conservation Potential Analysis of Primary Energy Using Products* has been carried out with the following objectives:

1.1 Quantification of energy conservation potential of the standards and labeling

The energy conservation potential from implementation is to be quantified through selection of primary energy-using products, analysis and study for the energy conservation potential of the coming 15 years brought out by the relevant standardization and labeling, calculation of the associated environmental and economic benefits and establishment of the database of energy conservation potential of primary energy using products. The work can also serve for promoting the relevant policy maker's consciousness of energy efficiency and providing convincing information to further their support of the standardization and labeling.

1.2 Assistance in governmental energy efficiency plan making

A product priority order for the standardization and labeling is to be formulated through energy conservation analysis to provide scientifically reliable reference for the relevant authorities to make plan for the work; product coverage of the standards shall be extended, enforcement of them be strengthened and the labeling be expedited with the governmental work deepening.

1.3 Contributions for policy making

We will contribute suggestions and advisements to the relevant authorities for the

policy making regarding the energy saving technologies, supporting measures and popularization plans that back up implementation of the standards and labeling.

2. Scope

The energy conservation potential analyses of Primary energy using products is intended to predict, on the nationwide basis, the benefits from energy saving and environmental improvement in the next 10 years (up to 2010) and 20 years (up to 2020) achieved by the standardization and labeling. The analysis is focused on the results of mandatory standards for threshold energy efficiency limits and energy efficiency informative labeling, with the exception of the contribution from endorsement labeling. The scope covers the analysis of energy saving, economic benefits, pollutant reduction and peak demand reduction.

Theoretically speaking, all energy using products, including indirect ones, e.g. doors and windows in buildings are candidates for standardization. But the room for energy saving changes from product to product, so does such potential that can be released on a technically feasible and economically reasonable basis. While the standardization, including the processes of preliminary research, standards development and implementation, requires considerable financial resources and human resources, the products to be standardized shall be widely used or energy intensive, influential and mostly concerned by consumers, mature in terms of their producers and markets, and urgent to be renovated, in order to realize distinct benefits with less input. Through adequate consultations with relevant authorities, institutions and experts, four categories of products have been selected, i.e. household appliances, consumer electronics/office equipment (standby power), lighting fixtures, and industrial/commercial equipment, specifically:

Household appliances: refrigerators, freezers, room air conditioners, washing machines, TV sets, electric water heaters, gas water heaters, electric rice cookers, microwave ovens, household fans and ceiling fans;

Consumer electronics/office equipments (standby power): TV sets, microwave ovens, laser printers, copiers, facsimile machines, and computer monitors;

Lighting fixtures: double-capped fluorescent lamps, single-capped fluorescent lamps, self-ballasting fluorescent lamps, fluorescent lamp ballasts, exit lights, traffic lights and HID lamps and ballasts;

Industrial/commercial equipment: commercial refrigerators / show cases, automatic vending machines, central air conditioners, electric motors, fans, water

pumps, transformers, air compressors and boilers.

Compared with energy efficiency standards, implementation of the labeling can bring more obvious effect. Generally, products to be labeled shall meet the following conditions:

- The products have big energy consumption;
- The products are used by most households or face fast growth of users;
- High tech for the product energy saving is available but has not been widely adopted;
- The energy costs is to be born by purchasers;
- The purchase is to be made from retailer;
- Significant difference in energy efficiency exist or may exists between different products;

This labeling part of this project applies only to household appliances.

Chapter 3 Outline of Analytical Methodologies

The technical line of this Project is shown in Figure 3-1. The first step is to establish a screening model to figure out the maximum energy saving from the standardization and labeling; the second step is to select products with higher energy saving potential among candidate products for further analysis; the third step is to establish an analyzing model and figure out the annual energy saving and the associated pollutant reduction, economic benefits and peak demand reduction, year by year, for each selected product.

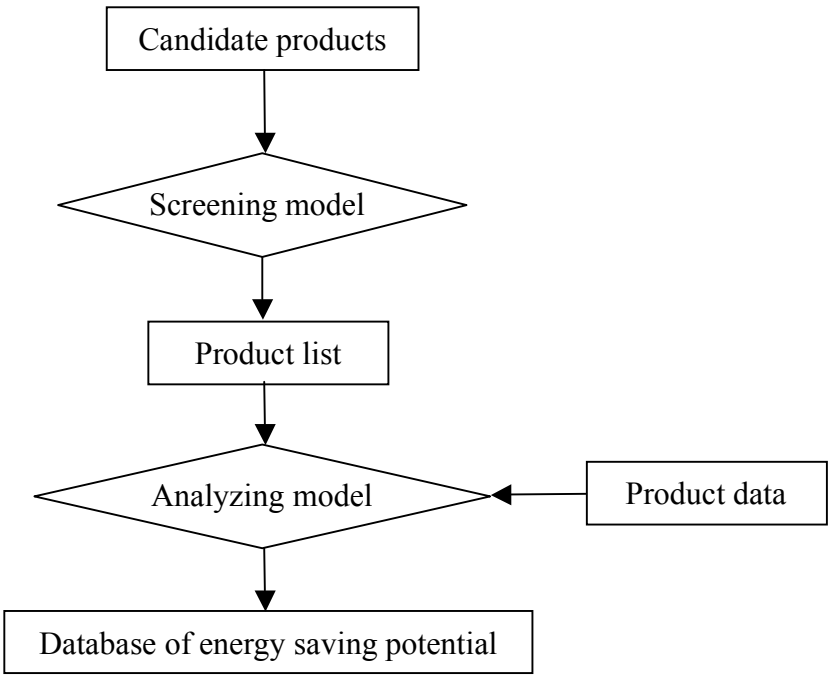


Figure 3-1 Technical line chart of energy conservation potential analysis

Product screening is a rough process of calculation, aiming to establish a screening model, define a product list for energy saving potential analysis, and sort out the products with higher potential for further analysis. The preliminary screening can save a lot of unnecessary work by focusing the analysis on a few deserved products. The procedure at the third step mentioned above includes the processes of collection of the relevant product data; calculation of the annual energy saving of a unit product according to the predicted percentage of energy saving from standardization; and calculation of the total energy saved for a product by multiplying

the unit product energy saving by the total number of the products sold annually and the average life of the product. In this way, preliminary savings estimates were made for each product, and the products with the largest savings selected for further analysis.

The products finally selected through the screening include TVs, room air conditioners, refrigerators, electric rice cookers, freezers, consumer goods/office equipment (in idle condition), double-capped fluorescent lamps, fluorescent lamp ballasts, HID lights, traffic lights, exit lights, central air-conditioners, electric motors, fans, water pumps, air compressors, transformers and boilers (Refer to Table C-2 in Annex C for the details of screening). The calculation of screening analysis is as follows:

Energy savings = inventory _ annual energy use per unit _ savings potential factor (%) _ percent affected in 2020

Energy conservation potential analyses include energy source analysis, environmental analysis, economic analysis and peak demand analyses, conducted in relation to either minimum energy-efficiency standards or energy-efficiency information labeling. It is critical to have the analyses be conducted on an authentic baseline. Definition of the baseline is made through adequate collection and analysis of product data. For this purpose, we collected product energy efficiency data from manufacturers, trade associations, research institutions, laboratories, governmental agencies and information services, and their publications. Based on the data, the baseline, the reachable largest energy saving potential and threshold energy efficiency limits were worked out for each product, in consideration of current advanced international energy efficiency level, development and application of energy saving technologies, product development trend and domestic economic/technical conditions (See Table C-1 in Appendix C). Based on the benchmarks, energy efficiency promotion by standardization can be quantified and the annual energy saving per product figured out. The total energy saving of certain product can be obtained by multiplying the number of the product on market by the per product saving. Effect of energy efficiency standards on the present net value can be figured out by deducting the original cost from the present value of total energy saving based on the energy analysis.

The effects of new standards on pollutant reduction can be got through environmental analysis. The emission reduction for each pollutant, such as carbon dioxide, sulfur dioxide, nitrogen oxide, particulate and so on, is figured out by

applying a specific emission factor (e.g. grams of pollutant per kWh produced) to its energy saving. For the product/equipment that may effect peak load, the power saving can be calculated. Peak demand reduction can be obtained through applying a peak factor (ratio of peak energy use to annual energy use) to the energy saving from the standard. Reduction of peak demand enhances reliability of power network operation and eases the urgency for capacity expansion of power supply. The relevant calculations are:

Emission reductions = end-use electricity savings ÷ T&D loss factor _ emission factors

Peak demand reductions = end-use electricity savings ÷ T&D loss factor _ reserve factor _ peak factor

The minimum energy-efficiency standard will bar out the products where energy efficiency is below the required level. The energy efficiency informative labeling influences all products on the market by encouraging consumers to choose energy efficient products and thus orienting manufacturers to seek innovation, so as to attract customer interest. Owing to the difficulty of separating a certain energy efficiency change from the developing market trend, it is much more difficult to define the energy saving by the labeling than the standards. According to the investigation by other countries, the effect of the labeling is some 20% of the products sold are of highest energy efficiency level. So we can suppose that the annual energy saving per product brought along by the labeling is 20% of the difference between the maximum energy saving potential and standard energy saving potential. Then, the total saving, pollutant reduction, economic benefits and peak load decrease can be worked out the same way of estimation in the case of energy standards. Refer to Appendix A for detailed calculations.

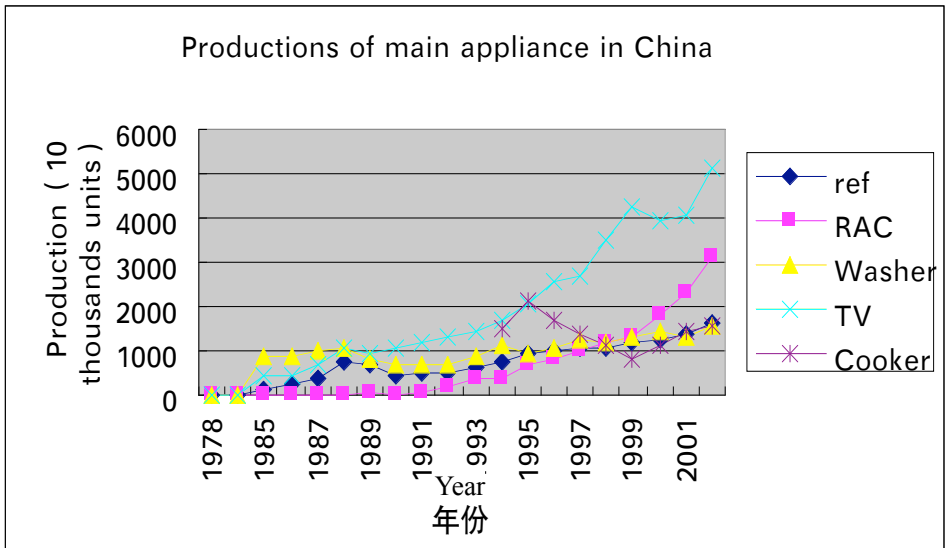
Chapter 4 energy conservation potential analysis of primary energy-using products in China

1. Analysis of energy conservation potential of energy efficiency standard

1.1 Household Appliances

Along with economic development, China has become a household appliances production power. The gross output value of household appliance industries grew by 32.1% yearly from 1986 to 1996, and the output of primary household appliances is first in the world. The objective of the household appliances industry is to transform China from a large producer to a powerful producer in near future. FIG 4-1 shows the output of household appliances in China over the years.

FIG 4-1 Yearly output of primary household appliances in China



In the 1980's, household appliances and electronic products in China experienced a fast development. The market growth rate began to slow down in 1990's, but the market demand remained firm in urban districts due to the renewal demand and add-on purchase demand. At the same time, the possession rate in rural regions is low, which is 2.5% for refrigerators and 20% for washing machines, and the purchase demand is in steady rise, which accumulates huge market consumption potential (see FIG 4-2).

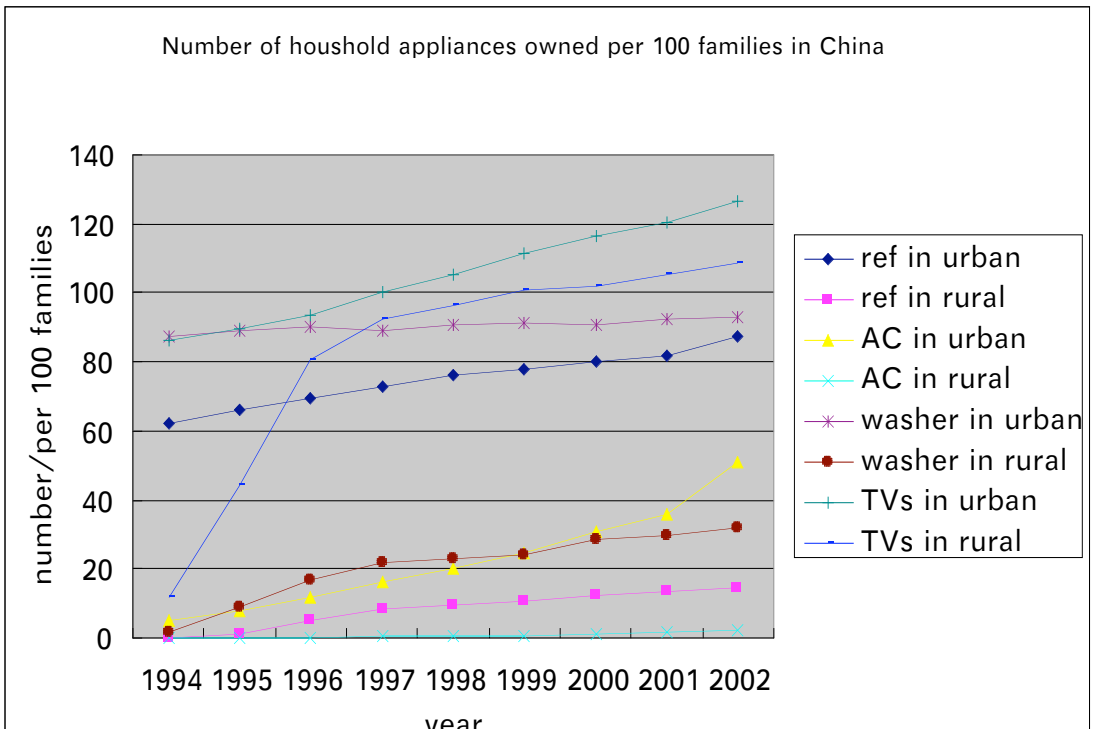


FIG 4-2 the possession rate of primary household appliances per hundred households from 1996 to 1999

In accordance with the service life of consumer durables, China has entered a regeneration period of household appliances since 1980's, and the amount of renewal is considerable each year. Table 4-1 shows the amount of renewal of household appliances in 1999. Therefore, in a future period, the quantity of household appliances purchase and renewal will rise, and the market demand will be high. The consequent result is that the household electricity consumption grows fast, and takes a bigger proportion of total use, and the growth rate is much higher than that of the total electric power consumption in the same period (see table 4-2). According to the power consumption of household appliances in 1997, the power consumption of refrigerators ranked the first 38.6TW; TV sets ranked the second, 20.6TWh; then washing machines and air conditioners, 7.9TWh and 7.5TWh respectively. Along with the increase of output and purchase of household appliances, the power consumption shall keep on increasing, for instance, microwave ovens, electric heaters, electric water heaters and computers will rise rapidly in the next few years, the yearly output of air conditioners will reach 10 million, and its power consumption will exceed that of washing machines and TV sets.

Table 4-1 the amount of possession and renewal of household appliances in China in 1999 (million)

	Refrigerators	Washing machines	TV sets
Society possession	110	150	320
Current renewal quantity/year	4	5	5

Table 4-2 comparison of the growth rates of gross energy consumption and household power consumption

	1995	1997	1998
The gross power generation」hundred million kWh」	10070	11356	11670
Growth rate of the national gross electric power consumption (%)	8.50	5.02	2.77
Growth rate of the gross household power consumption (%)	15.88	11.45	8.43

On the whole, the energy efficiency of household appliances in China is far behind that of like products in Japan, Europe and America, and bigger energy conservation potential shall be obtained through adopting more strict minimum energy efficiency standard. Now let's make detailed analysis of household appliances according to the amount of energy savings after implementation of energy efficiency standard.

1.1.1 Domestic refrigerators

1.1.1.1 Overview

Along with advances in science and technology and promotion of people's living standard, refrigerators have become daily necessities. Refrigerators have been developed in the last 15 years in China, it has been developing quickly although it started late and the development gives priority to introduction of foreign product lines and technologies. Until 1985, 42 product lines had been introduced, and the output built up to 13.49 million in 2001 from 4.7 million in 1991 with an annual growth rate of 11.1% (Fang Yan, 2002). China is becoming a power of refrigerators production, and the yearly output is 20% of the total output of refrigerators in the world. FIG 4-3 shows the production increase of refrigerators over the years in China.

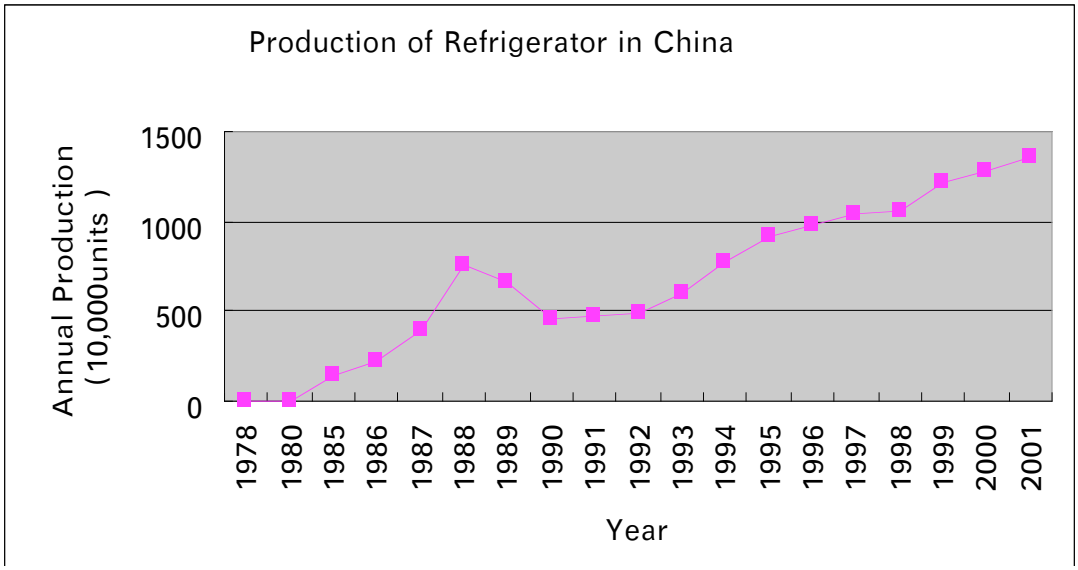


FIG 4-3 the yearly output of refrigerators in China

The social possession of refrigerators in China was 110 million according to statistics in 2000. Table 4-3 shows the market penetration of refrigerators for urban areas in China, wherein it is 89.6% in east coastal areas, 80.7% in midland and 83.8% in west area (Fang Yan, 2002). Refrigerators of urban households have entered a renewal period with stable market demand, while the possession rate in rural regions is quite low and the market demand for refrigerators is still huge.

Table 4-3 the possession of refrigerators per hundred households in urban and rural areas

Year	1985	1990	1995	1999	2000	2001
Urban areas	6.58	42.33	66.22	77.74	80.13	82.13
Rural areas	0.06	1.22	5.15	10.64	12.31	13.50

Households in America, Japan and European Countries tend to use large-volume refrigerators, low-volume refrigerators also enjoy sizable market, but the market of medium-volume refrigerators is shrinking. Things are different in China, medium-volume refrigerators are still the mainstream of market demand. The growth of sales of Refrigerators from 161 liters to 230 liters drives the growth of the overall market of refrigerators, in particular, refrigerators from 161 liters to 180 liters are mostly favored by consumers, while the market for refrigerators below 160 liters and above

250 liters is still quite limited. This condition is being changed along with the adoption of large-volume products by urban households (Fang Yan, 2002).

Refrigerators consume more energy as compared with other household appliances, which is 32% of the gross power consumption of household appliances, according to statistics of 1985. The power consumption of traditional refrigerators of about 200 liters in China is 1.2- 1.4kWh/24h. The implementation of revised energy efficiency standard for refrigerators in 1999 promotes an increase in energy efficiency of refrigerators. It is shown from survey in 2002 that the energy consumption of primary refrigerators in China dropped by 10% as compared with that in 1999 (FIG 4-4). Along with technical advancement and energy conservation consciousness promotion of enterprises in recent years, the time for further renewal of energy efficiency standard, and carrying out more strict minimum energy efficiency standards is mature. In revised standard, limited values of energy consumption (E_{max}) and evaluating values of energy conservation (E') were calculated using the following equations:

E_{max} = (M _ V_{adj} + N) ÷ 365

E'= E_{max} _ 75%

where,

V_{adj}=adjusted volume

M, N= relative parameters

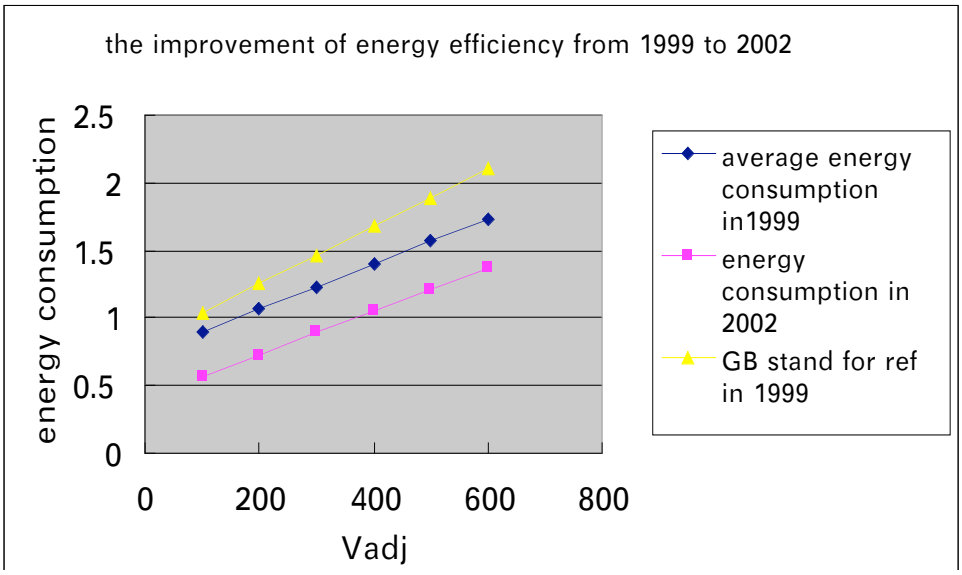


FIG 4-4 Comparison of energy efficiency levels of domestic refrigerators in China in 1999 and 2002

1.1.1.2 Analysis of energy conservation technologies

The energy conservation technologies adopted by our country mainly start with the following aspects to enhance the overall efficiency of products in accordance with present market research and related research reports.

- Reduce cold losses of refrigerators

During steady operation of refrigerators, the power is mainly consumed to overcome the temperature rise in refrigerators due to higher ambient temperature around refrigerators, in order to maintain the required low temperature inside. The less quantity of heat enters refrigerators from outside, the less power consumed by refrigerators. Therefore, the following measures are adopted:

a) Thicken the insulation. Increase the wall thickness of refrigerators to reduce heat leakage in unit area. The thicker, the better heat-proof effects. The increase of thermal-protective coating thickness will conserve more power, but the size of refrigerators will be enlarged and more space shall be taken up. Furthermore, more materials, means indirect energy consumption, to produce these materials. Therefore, there exists a reasonable thickness of insulation.

b) Improve on insulation material and technology. For the moment, heat insulating material used in refrigerators is generally polyurethane (PU)rigid

foam that are die pressed and expanded on site, and better incubation effects could be achieved through adoption of new aerogel thermal insulating material as well as micropore expanding technology developed abroad.

c) Adopt advanced mode of heat insulation. Vacuum thermal baffle technology changes the mode of incubation realized through thickening "expanding layer". Independent vacuum layer is added to the frothing, thus the expanding layer could block air like vacuum glass, which guarantees the consistent cooling effects of refrigerators, takes no space of refrigerators, and is the best combination of body volume and service volume. For the moment, the application of vacuum thermal baffles is not generalized due to its high cost.

d) Improve on door seal structure. The function of door seal to the power conservation of refrigerators is quite important, and reducing the gap between the body and door of refrigerators could reduce the discharge of cold air in refrigerators. Therefore, the design and selection of door seal are quite important for power conservation of refrigerators.

- Use high-performance compressors

The compressor is the heart of a refrigerator, and is the main component that consumes energy. In order to reduce the power consumption of refrigerators, the most simple and effective way is to enhance the efficiency of compressors. It is generally recognized that the COP value of high-performance compressors is 1.2 times more than the index value of reciprocating compressors of the same volume, or 1.15 times more than the index value of rotary compressors of the same volume. For the moment, the COP value of advanced compressors in the world is around 1.6, including 1.5 - 1.6 for compressors made by AMERICOLD.COP is more than or equal to 1.35 for compressors made by Beijing Embraco Snowflake Compressor Company Ltd. The COP value of high-performance domestic compressors (including R600a compressors) is between 1.2 and 1.4, and the COP value of over 80% of products is equal to or less than 1.2 (Zhang Huajun, 2001).

For the moment, competition on the market for refrigerator compressors is becoming more and more fierce. Foreign compressor manufacturers enter China's market through joint venture, individual proprietorship and even smuggling, and in addition, the supply is greater than the demand, which results in fierce competition on the domestic market. The competition focuses on: enhanced quality of compressors, mainly to scramble for market share of primary refrigerators manufacturers through

promotion of COP value; reduction of noise and presentation of good service; developing and extending the range of products; producing full series of compressors (R12, R134a, R600a) to meet demand of different refrigerator manufacturers; strengthen research and design force to adapt to special requirements of users for different electric voltage and frequencies; expand market, coverage and sales volume; and reduce cost and retail price to contend for markets.

The replacement of CFC in compressor industry should be accelerated. For the moment, the mainstream replacement working medium is R134a and R600a, and the replacement technology has become mature. The application of R134a is mainly to reduce the residual moisture content of compressors, to enhance cleaning technology and to pass low temperature capillary test (capillary flow drop is not less than 5% under -45_ for 500 hours, and the impurity content in capillaries is not more than 10mg). We think that it is proper to adopt R134a in small compressors.

- Reasonable system design

Factors directly related to energy consumption of refrigerators include structural design of the body, optimized matching of refrigeration system and perfection of control measures, wherein the first two items are predominant (see FIG 4-5). It is found through comparison that the most convenient and effective way is to adopt high-performance compressors in refrigeration systems.

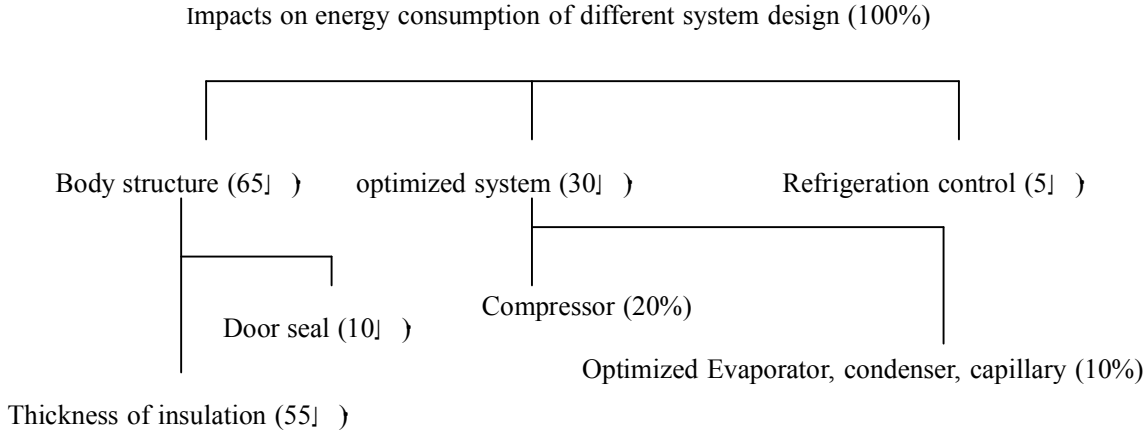


FIG 4-5 factors that affect energy consumption of refrigerators

The working status of compressors is decided by the system design of refrigerators in a certain extent. No power shall be conserved even with excellent compressors if the system design is not reasonable. Therefore reasonable system design guarantees the refrigerating capacity of compressors and power conservation

effects, and has direct influence on the power conservation level of refrigerators.

In recent years, more and more refrigerator enterprises began to develop advanced cooling distribution systems with electronic temperature control along with the development of electronic controllers of household appliances and the quality promotion of electromagnetic valves, including two-way cycle, multi-path cycle, bi-refrigerating cycle, Lawrence cycle, Stirling cycle, and magnetic refrigerating cycle. The two-way cycle system (or bi-temperature double-control system) is the most popular of the new cycles, whose market share is 10% and has become the development trend of domestic refrigerators.

- Adopt variable frequency control (VFC)

Adoption of fuzzy logic control is becoming the development trend of VF refrigerators. Measure the difference between each chamber temperature and the design temperature with temperature sensor in refrigerators to get corresponding temperature fluctuation rate, decide the temperature of foods in refrigerators with fuzzy reasoning, and then control the rotation rate of VF compressors, operation of fans and status of air doors accordingly. Thus the refrigerators run in a optimum efficiency status and the optimal refreshing could be achieved. Through consistent study and memorization of regulation demands of users, ambient temperatures, times of opening and closing the door and foods being put in and taken out, the neural network shall preset the information in control procedures, and select optimal control plan by dint of expert system automatically. For instance, defrost automatically when the door is opened or closed in accordance with the practical running status of refrigerators, which reduces the influence of temperature recovery on food in the defrost course of refrigerators; refrigerate and cool food forcefully and deodorize it before the period in a day when the frequency of door opening and closing is the highest; when large amount of foods are put in, ice is being made or during the period with highest closing and opening frequency, switch status automatically, lest the temperature of food in refrigerators rises; lower the rotation rate of fan electromotor, enter the power conservation running status, and reduce running status accordingly during the period with lowest door closing and opening frequency; and when less food is put in. Neural network fuzzy controller could distribute cold to each chamber in reason in accordance with concrete conditions of users, for instance, when users put fresh food in the refrigerating chamber, and other chambers do not need cold quantity to be added, the control system shall centralize the cold to the refrigerating chamber, thus the food can be frozen quickly.

- Application of new working medium for power conservation

With different working mediums of refrigerators, the power consumption required for getting same refrigerating output are different in theory. Therefore, adoption of new power conservation working medium shall reduce energy consumption of refrigerators, and shall bring about certain power conservation effects. Currently, domestic enterprises have began to replace CFC - 12 with HFC - 134a and HC - 600a, and diversified mixed working mediums are in service also, which affects the power conservation works to a certain extent. It is shown through related scientific research reports that:

a) The insulating property of products with cyclopentane as foaming agent is poor, which is 15 - 20% behind R11, and 10 - 15% behind R141b, and micropore blowing technology and thickened foaming layer need to be adopted to improve the heat-insulating property;

b) The boiling point of R600a is much higher than that of R12, thus working parameters of compressors and heat exchangers should be changed greatly, and their structure and size require to be greatly adjusted, namely the whole system needs to be redesigned. Its advantage is environmentally friendly and could save certain power.

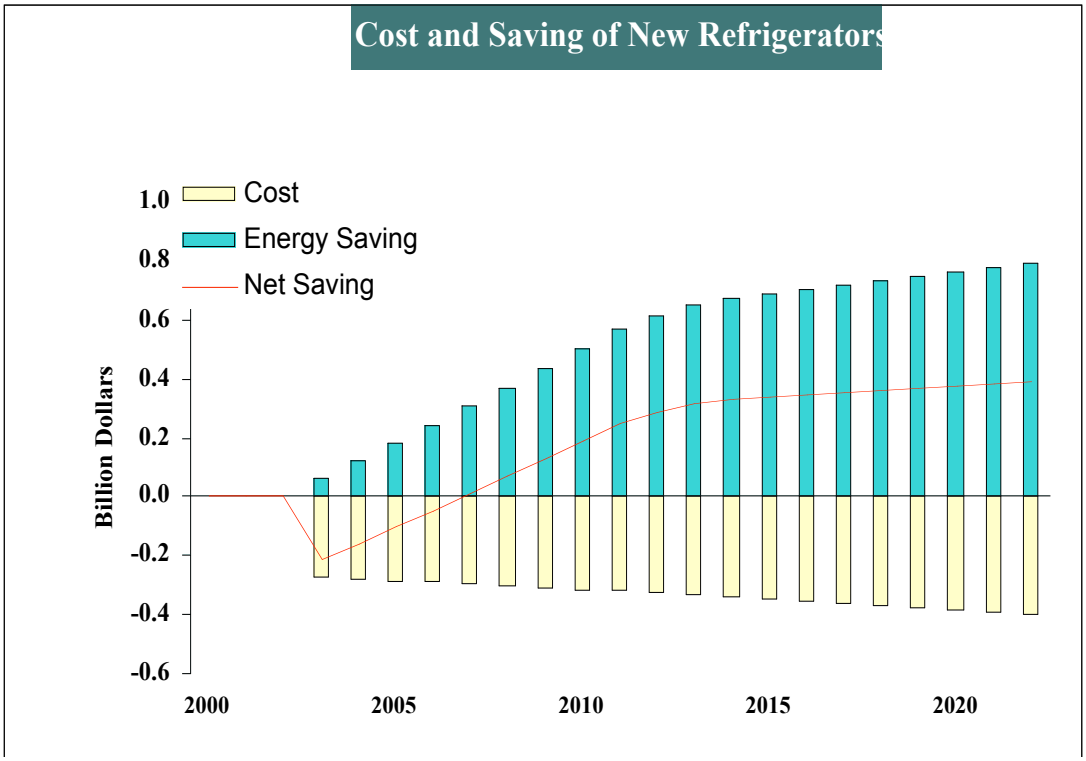
1.1.1.3 Energy conservation potential of new energy efficiency standards

Through comparison with the development of energy conservation technologies of refrigerators in foreign countries, it is clear that the development of power conservation refrigerators shall bring no burden to refrigerator manufacturers in China, which even have some advantages in the thickness of thermal-protective coating, utilization of working medium and improvement of low-efficiency compressors. However, the existing energy efficiency standard of refrigerators can’t embody this progress fully, and can't boost enterprises to enhance energy efficiency further.

For household refrigerators, in accordance with life cycle cost analyses, it seems to us that the restriction value of power consumption in the new standard could be set to 0.7kWh/24h. Suppose the new standards shall be carried out in 2003, then the power conservation in 2010 shall be 12.65TWh, amounting to 4.92MMTce.In primary energy; the power conservation in 2020 will be 21.78TWh, amounting to 7.88MMTce. Per unit incremental cost of energy efficient refrigerator is about RMB 50. Suppose the electric charge is 0.4615 Yuan/kWh, then the net benefits of users for using power

conservation refrigerators is RMB 45.7 billions, the benefit cost ratio is 9.1; discharge reduction of pollutants brought along by power conservation will be 6.29MMT of carbon, 0.096MMT of nitrogen oxide, 1.25MMT of sulfur dioxide and 0.58MMT of PM_{10} in 2020. At the same time, the peak demand shall be reduced by 3.25GW. FIG 4-6 shows the relation between power conservation quantity and cost of refrigerators.

For freezers, we suppose the restriction value of power consumption in the new standard could be set to 1.20kWh/24h. Suppose the new standards shall be carried out in 2003, then the power conservation in 2010 shall be 3.92TWh, amounting to 1.53MMTce.In primary energy; the power conservation in 2020 will be 7.38TWh, amounting to 2.67MMTce. Per unit incremental cost of energy efficient refrigerator is about RMB 50. Suppose the electric charge is 0.4615 Yuan/kWh, then the net benefits of users for using power conservation refrigerators is RMB 14 billions, the benefit cost ratio is 6.8; discharge reduction of pollutants brought along by power conservation will be 2.13MMT of carbon, 0.032MMT of nitrogen oxide, 0.423MMT of sulfur dioxide and 0.198MMT of PM_{10} in 2020. At the same time, the peak demand



will be reduced by 1.10GW.

FIG 4-6 Refrigerator: Energy savings and Cost

1.1.2. Room air conditioners

1.1.2.1 Overview

Initially, the air conditioning industry in China developed slowly. It began to develop fast in the early 1990's with the introduction of technologies and product lines from other countries. At this time, and the air conditioner market became an emerging market with a steady increase of output and demand. Now China has become the third biggest air conditioner market next to America and Japan only, and its market share in the world is 12%. FIG 4-7 shows annual production of air conditioners in China from 1985-2002.

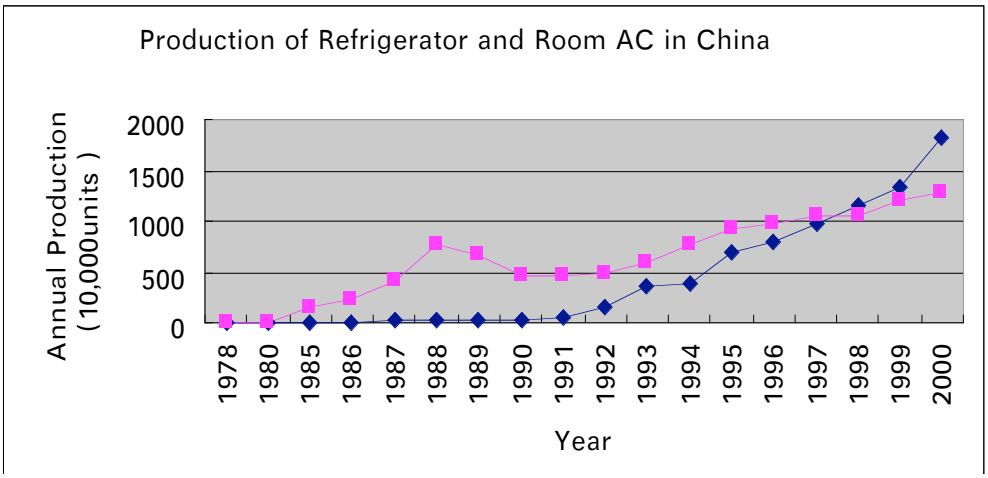


FIG 4-7 the production of air conditioners in China from 1985-2002

The development of scientific research offers a foundation for power conservation progress of air conditioners in China. Among primary air conditioners, 30% have reached the world level in 1990's, wherein some products and technologies are leading in the world, 60% are in the world level of 1980's, and 5%-10% need to be updated or eliminated. Presently, market competition is fierce, and enterprises are attaching more importance to adoption of new technologies and materials and development of new products, which promotes the speed of new product development.

At the same time enterprises are paying attention to quality management: 80% of large enterprises have passed ISO9000 system certification and some plan to pass ISO10012 certification, EU CE safety certification, American UL safety certification, and UALEO1000 system evaluation of Veleo Corporation, which create conditions for products to advance into world market and to participate in international competitions.

On the whole, the overall situation of the air-conditioning industry in China could be summarized as follows:

- Early shift from planned economy to market economy;
- Fast introduction of foreign technologies and funds;
- Fast annual growth rate in recent 10 years and big market development force;
- Comparatively integrated system of development, production, marketing and technical service;
- Product system with all sizes and classes of equipment and promoted output and technical level;
- Some products sold in the international market.

Still, air conditioner manufacturers in China are behind as compared with that in foreign countries;

. There are quite a few problems with technologies and quality as compared with advanced level in the world, such as product reliability, auto control level, supporting capacity, product development ability, experimental investigation means, product technology content, technical means, testing means and fundamental research.

- Most products have not reached a scale economy, and there are still units produced in small workshops. Some enterprises has been provided with hardware conditions for large-scale production, but mass production can't be conducted due to poor quality level and low technical level;
- The quality of employees is low, which can't adapt to the needs for technical development;

- Normative market atmosphere is not formed, and disordered competition is fierce, such as blind price reduction, and false and unscientific propaganda;

- Product structure and business organization are far behind, for instance, no large enterprise groups are formed that take big market share, represent vocational level, and have competitiveness in international market; supporting factories with featured products and scale economy are still needed; production enterprises are over dispersed; the production level of small businesses is low, their development capacity is weak with few products, and market fluctuations shall affect their survival.

1.1.2.2 Analysis of energy conservation technologies

Ways for promoting the energy efficiency of room air conditioners are various, and refer to Table 4-4.

Table 4-4 primary ways of power conservation of room air conditioners

Ways	Plan
Increase heat exchange surface	Increase front face area of coils Increase length of coils Increase density of fins Add super-cooling condenser
Enhance coefficient of thermal transmission	Improve on design of fins Improve on the design of coils Add throw ring unit
Enhance efficiency of compressors	Adopt high performance rotary compressors Adopt scroll compressors Adopt variable frequency compressors
Enhance efficiency of fans and fan electromotors	Adopt high performance electromotors Adopt DC motors

Control system	Fuzzy logic control technology
Flow control unit	Adopt electronic expansion regulation valve
Refrigerant	Change refrigerant

Now possible power conservation plans shall be discussed and analyzed in view of their advantages and disadvantages.

- Promote efficiency of heat exchanger

a) Enlarging the front face area of coils is the most common way to increase the heat exchange surface. The front face area of air conditioners on the market is still the maximum allowable area and its increase will result in expansion of the size of air conditioners with high expenses. In addition, increasing of heat exchanger area will promote the dehumidification, and will result in a rise of evaporator temperature, which will reduce the capacity of latent air heat absorption by evaporators. Another way of increasing heat exchanger area is to increase the number of coils, which is restricted by the size of air conditioners, their weight, and amount of refrigerant, and relates to product appearance and weight bearing capacity of walls.

b) Another way of increasing heat exchanger area is to increase the density of fins. This will increase the energy consumption of fans, reduce the drainability, generate dusts, and affect the performance of fins.

c) Improve on design of fins. This will enhance the heat exchange coefficient and promote the heat exchange ability. Types of fins include: plain fin, corrugated fin, caulking fin and shutter fin. This way is economic and feasible.

- Enhance the efficiency of fans and fan electromotors

Generally air conditioner manufacturers purchase fans from fan manufacturers directly. Manufacturers may improve on current fans by adopting high-efficiency electromotors, for instance, the motor efficiency of PSC could reach 50%」70%, and the efficiency of high power motors is higher.

- Improve on air circulation system

This includes promotion of fan electromotor efficiency, improvement on the

shape of fan blades and the angle of air door, increase of upcast area, and optimization of air cycle path.

- Promote efficiency of compressors

Ways of enhancing efficiency of compressors, one is to select redesigned compressors, such as rotary, scroll and VFC compressors, and the other is to enhance the efficiency COP of compressors. Most compressor manufacturers produce rotary compressors, whose energy efficiency is 2.5- 3.1W/W for the moment. Manufacturers plan to enhance its efficiency to 3.34W/W, but this relates to improvement on the design of compressors, increase of volumetric efficiency and electrical efficiency, adoption of sound insulation materials, performance enhancement and introduction of new technologies and equipment. Scroll compressors are under mass production, which are used for heavy duty air conditioners. The performance factor (COP, W/W) of new-style swirl compressors may reach 3.08 - 3.22. VFC compressors could enhance the energy efficiency of air conditioners greatly, and their quarterly power conservation rate could be promoted by 25-40%.

- Electronic expansion valve

For the moment, most air conditioners adopt capillaries as relief fitting, which is the optimum matching energy efficiency designed on certain state point, and capillaries could compensate load transformation automatically with accurate calculation, which is acceptable in larger range of variation. Electron expansion valve is similar to TXVS, but its adjustability of control procedures can't be matched by TXVS. Electron expansion valve uses overheat control to control refrigerant flow, and could be used to control discharge temperature of compressors. Tests show that the promotion of SEER upon adoption of VFC compressors and electron expansion valves is greater than TXVS, but electron expansion valves are only effective in promoting SEER, and can't be measured out in steady test conditions.

- Integrated system optimization

Adopt CAD to optimize the system, proceed fuzzy logic control with high and new technology, thus the complete machine is well matched, and people's demand for comfort could be met at the same time when energy efficiency is promoted and energy consumption is reduced.

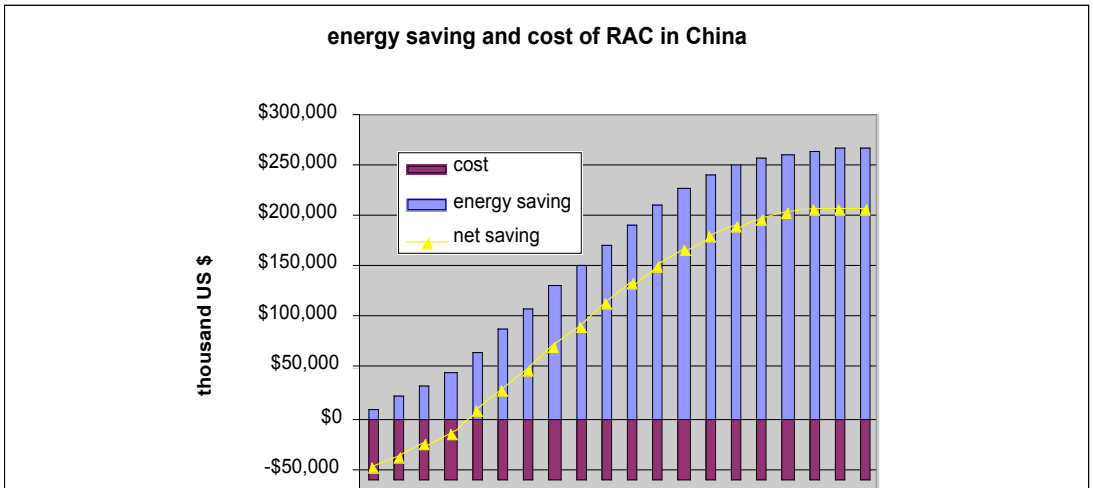
1.1.2.3 Energy conservation potential of new energy efficiency standard

The energy efficiency standard for room air conditioners (GB12021.3-2000) mainly regulates allowable minimum limited value of energy efficiency and evaluating value of energy conservation under rated condition of air conditioners.(Refer to Table 4-5 for details)

Table 4-5 energy efficiency restriction value and energy-saving design value for room air conditioners

Type	Rated refrigerating output (CC] ৳ W	Energy efficiency restriction value (EER) W/W		Power conservation evaluation of estimate (EER) W/W	
		Cold blast	Heat pump	Cold blast	Heat pump
Wall - hanging	CC ≤2500	2.50	2.40	2.85	2.75
	2500<CC≤4500	2.45	2.35	2.70	2.60
	4500<CC≤7100	2.40	2.30	2.55	2.45
	CC >7100	2.30	2.25	2.55	2.45

Along with development of energy conservation technologies and advancement of production technologies, the establishment and implementation of stricter energy efficiency standard for air conditioners could further boost the promotion of energy efficiency of room air conditioners in China. Through integrated analysis, the EER is set to 2.8w/w in the new standard, which becomes effective in 2004. Suppose the new standard is carried out in 2004, then the power conservation in 2010 shall be 13.39TWh, amount to 5.21MMTce in primary energy; the power conservation in 2020 shall be 20.04TWh, amount to 7.25MMTce; per unit increment cost of energy efficient air conditioners is about RMB54, suppose the electric charge is 0.4615 Yuan/kWh, then the net income of users for using high performance air conditioners is RMB 30.9 billions, the benefit cost ratio is 3.0; discharge reduction of pollutants



brought along by power conservation will be 5.79MMT of carbon, 0.088MMT of nitrogen oxide, 1.15MMT of sulfur dioxide and 0.54MMT of PM_{10} in 2010;at the same time, the peak demand shall be reduced by 5.91GW. FIG 4-8 shows the relations of air conditioner power conservation and cost (USD).

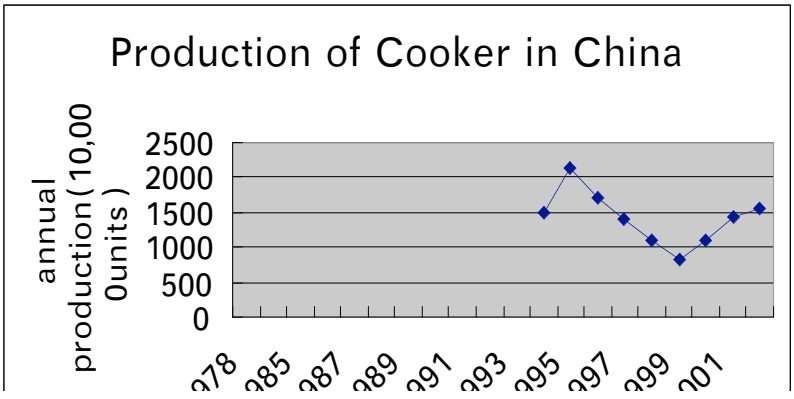
Fig 4-8 the prediction of power conservation of air conditioners in China after implementation of the new energy efficiency standard

1.1.3 Rice cookers

1.1.3.1 Overview

Rice cookers consume electric energy for automatic rice cooking rice and heat preservation, and they can be used for other types of cooking of other foods. The types of heating include: electrical resistance, infrared, and induction type, and the electrical resistance type breaks into direct electrical heating and indirect electrical heating, which are widely used; the infrared type adopts radiation heating, which saves time, has strong penetrating power, and saves energy by 20-50% as compared with convection and conduction; in the electromagnetic induction mode, eddy flows are used to heat the cooker, whose body is directly connected with objects to be heated, thus the heat losses during transfer is reduced, and the thermal efficiency is 75% or higher with high firepower, even heating and sound cooking quality. New-style rice cookers mainly adopt new types of heating, such as far-infrared heating and electromagnetic induction heating, which promote the thermal efficiency greatly. All major companies inland are devoting themselves to the renewal of products to embody the advancement of modern technologies.

For the moment, the market demand of rice cookers is stable, and quite a few consumers tend to purchase computer-controlled rice cookers. According to data of the National Bureau of Statistics of China and Light Industrial Machinery, the possession of rice cookers in China is ever-increasing, and the yearly output shall reach 45 millions in 2010. FIG 4-9 shows the yearly production and development



trend of automatic rice cookers in China.

FIG 4-9 the yearly production of rice cookers in China

1.1.3.2 Analysis of energy conservation technologies

Products adopting resistance wire consume 3% more power than products adopt electric hot tray, and the adoption of advanced fuzzy control technology could promote the average efficiency by another 3%. The proportion of products adopting resistance wire without fuzzy control is 30% of the overall market, and products with eddy-current heating and fuzzy control shall become mainstream products along with technical development and cost reduction, and the products adopting resistance wire without fuzzy control shall be washed out gradually.

FIG 4-10 shows the correlation between rated capacity and thermal efficiency of rice cookers derived from market statistics, and the average thermal efficiency of each rated power segment is shown in Table 4-6.

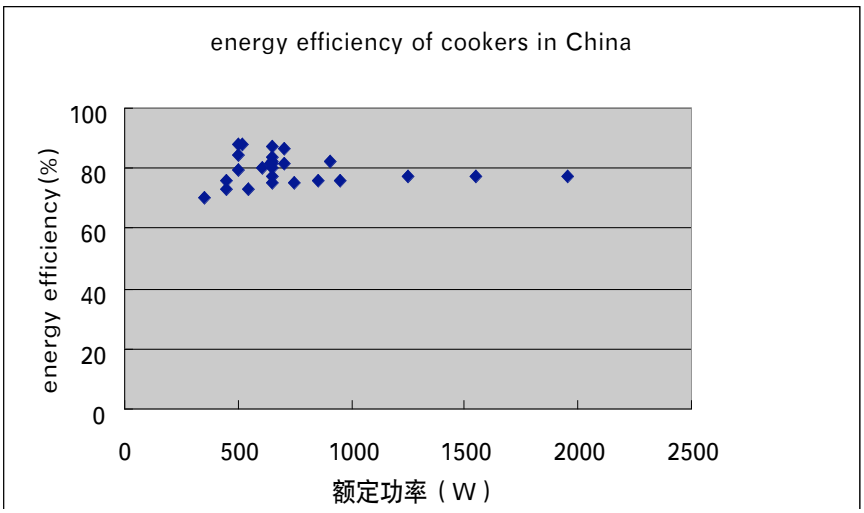


FIG 4-10 thermal efficiency distribution of rice cookers

Table 4-6 rated power and average thermal efficiency of rice cookers

Rated power P」 W」 ｳ	**Average thermal efficiency」 %」 ｳ**
P≤600	78
600_P≤1000	81
1000_P≤2000	79

Following measures are taken by rice cookers to preserve temperature:

- Increase insulating layer thickness, which is in general use;
- Adopt new materials to increase heat reflectivity」 ㄐ
- Lower the coefficient of heat conductivity of outer materials.

FIG 4-11 shows the correlation between rated power and power consumption in heat preservation state of rice cookers, which is derived from statistical data.

Primary ways of energy conservation reconstruction are as follows in accordance with the technical features of rice cookers:

- Enhance the contact thermal conductance rate;
- Enhance surface heat reflectivity;
- Increase heat insulating materials;
- Improve on type of heating;
- Improve on control technique」 f(uzzy control」 ㄗ for instance, control time of cooking, test boiling, and keep on heating with microcomputer, and to show the whole course digitally, the mainstream products are induction heating rice cookers;
- Enhance heating evenness.

It is possible to enhance the thermal efficiency of rice cookers control system from above analysis, but which related to adoption of new materials and increase of control system, and shall result in high cost.

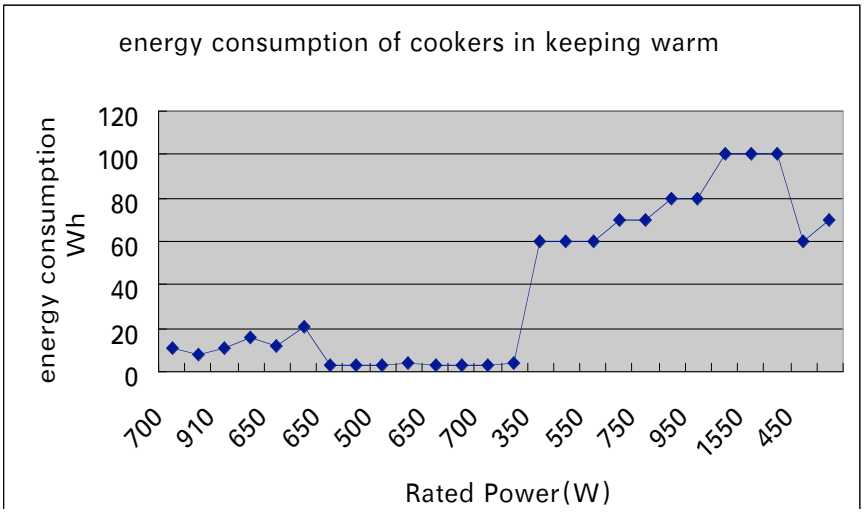


FIG 4-11 shows the correlation between rated power and energy consumption in heat preservation mode of rice cookers

1.1.3.3 Energy conservation potential of new energy efficiency standard

The active energy efficiency standard for rice cookers was established in 1989 and its indices can't reflect the development of new-style heating techniques and advanced power conservation technologies. In view of the general development trend of the rice cooker industry, products with resistance wire heating without fuzzy control should be eliminated in revising the active standard, and the production of products with resistance wire and with low energy efficiency are suggested to be stopped presently, and the energy conservation goal is to promote the average thermal efficiency from 76% to 86%, and to promote the share of high-performance products on the market. Suppose the new standards shall be carried out in 2005, then the power conservation in 2010 shall be 4.69TWh, amount to 1.82MMTce in primary energy; the power conservation in 2020 shall be 8.41TWh, amount to 3.04MMTce; per unit increment cost of energy efficient rice cookers is about RMB20, suppose the electric charge is 0.4615 Yuan/kWh, then the net income of users for using energy-saving rice cookers is RMB 12.4 billion, the benefit cost ratio is 4.3; discharge reduction of pollutants brought along by power conservation will be 2.43MMT of carbon, 0.037MMT of nitrogen oxide, 0.483MMT of sulfur dioxide and 0.225MMT of PM_{10} in 2020;at the same time, the peak demand shall be reduced by 1.43GW.

1.1.4 Washing machines

1.1.4.1 Overview

Now the possession of domestic washing machines is about 80 millions in the whole nation and the yearly output is about 10 millions. It is shown from related data that the possession of washing machines in the whole nation is 80 millions, semi-automatic double-cylinder washing machines take 60% of the total, impeller full-automatic ones take 30%, while tumbling-box ones take about 10%. The market condition of washing machines keeps stable. The increase mainly comes from export. The demand for washing machines in domestic market in 2000 was almost the same as that in 1999. Table 4-7 shows the yearly production of washing machines in China according to the data from State Bureau of Statistics.

With the development of market and the improvement of technology, there are mainly three types of washing machines: impeller, drum and milling.

Presently most washing machines in China are impeller washing machines. Among impeller washing machines, the production of washing machines with single cylinder is shrinking year after years, and the output was only 0.2% of the gross production; the output of washing machines of double cylinders reached a peak in 1994, which began to fall due to the rise of full-automatic impeller washing machines in the last two years. Full-automatic impeller washing machines have been developing fast in recent year. Famous manufacturers of impeller washing machines include Little Swan, Royalstar, National, Haier and Weili.

Drum full-automatic washing machines do not damage clothes due to tender washing and are favored by more and more consumers, but the sales volume is much lower than that of washing machines with sleeve barrels for being difficult to move, long wash time and high price. Famous manufactures of tumbling-box washing machines include Xiaoya, Little Swan, Haier, Siemens, Meiling, Whirlpool and Wegoma.

Milling washing machines have just taken the first step in China, wherein Little Swan and Haier have began to develop and produce such washing machines.

Table 4-7 Production of washing machines in China over the years (million)

Year	Production (million)	Urban Household Penetration ｣ ‰｣ ｳ	Rural Household Penetration ｣ ‰｣ ｳ
1990	6.63	78.41	9.12

1991	6.87	80.58	10.99
1992	7.08	83.41	12.23
1993	8.96	86.36	13.82
1994	10.94	87.29	15.3
1995	9.48	88.97	16.81
1996	10.75	90.06	20.54
1997	12.55	89.12	21.87
1998	12.07	90.57	22.81
1999	13.422	91.44	24.32
2000	14.43	90.5	25.58

There are some trends in the future market development of washing machines:

- Sales of fully-automatic washing machines increase

In view of product composition, the demand for fully-automatic washing machines is rising, which now account for half of the gross production of washing machines. According to the statistics of the Household Appliances Association, the output of impeller fully-automatic washing machines in 2000 was 48% more than that in 1999, that of the tumbling-box washing machines increased by 33%. Now the demand in urban area gives priority to fully-automatic washing machines for the time being.

- Energy conservation and water saving washing machines receive more attention

Along with the rise of water rates due to water shortages, people are paying attention to the water consumption indicator of washing machines and the position of impeller washing machines is being shaken. 38.52% of interviewees in Beijing, Shanghai, Guangzhou and Shenyang select tumbling-box washing machines, which outclasses the people that select impeller washing machines. Tumbling-box washing machines are entering more households, which is in line with the trend in international market.

- Impeller and drum washing machines take the best part of the market

Impeller and drum washing machines have advantages and disadvantages, and consumers have specific emphasis upon purchase. 38.52% of the interviewees say that they shall select tumbling-box washing machines, 29.51% say that they shall select washing machines that integrate impeller and tumbling-box functions, 16.39% select impeller ones and 8.20% select common double-cylinder washing machines. In addition, a few consumers select rotating cylinder and milling ones, 4.10% and 3.28% respectively.

- Mini washing machines develop too

Recently, washing machine manufactures at home and abroad have put forward mini washing machines. Some weigh only 5kg with capacity of 1 kg. The water consumption of these machines is 20 kg for washing a load of 5 shirts and underwear. The major advantages are 1) small size, portable and usable in camp sites; 2) few clothes are washed, which saves water, power and is more economic. 3) clothes could be classified in washing, thus colored clothing could be prevented from dying each other, which also meets demand for sanitation. Miniaturization of domestic washing machines may become a development trend according to analysis of experts.

1.1.4.2 Analysis of energy conservation technologies

An important trend in future is to develop and produce energy-saving and water-saving washing machines; primary energy-saving technologies are shown as follows:

- Shorten working hours and change mode of operation

Generally, the wash performance shall be promoted with prolonged wash time, but it is shown from tests that the wash performance becomes unchanged after the wash time reaches certain value. It is obvious that overlong wash time shall damage clothes and increase power consumption. Washing machines of different structures are also provided with different best wash time. For impeller washing machines, the first 5 minutes is the best period for stain removal, then the period of 5-10 minutes. After 10 minutes, the wash performance is stable and after 12 minutes, the wash performance sees no distinct enhancement. For dehydration, the water capacity of clothes is almost unchanged after 3 minutes of dehydration. Working procedures, time and operation mode of wash and dehydration that conform to structural requirement and meet washing off properties (including one-way wash time and stand-by time) shall be designed to achieve the purpose of power consumption.

- Adopt appropriate transmission structure

Fully-automatic impeller washing machines are driven by clutch, and different clutches are provided with different transmission efficiency. The eccentric shaft clutch used at the beginning has a low transmission efficiency, and the planetary reducer applied now has a higher transmission efficiency. It is shown from tests that the power consumption of planetary reduction gear is greatly reduced and the efficiency is promoted by more than 30%.

Tumbling-box washing machines could adopt frequency control electromotor to drive the axle of washing machines directly, thus the clutch is removed and the transmission efficiency is further promoted.

- Adopt high performance electromotor

Adopting high-performance electromotor shall reduce input power directly and reduce power consumption. It is feasible in theory, but the production of high performance electromotor needs extra copper or iron materials, while this consumption shall be equalized only by increasing the times of operation of washing machines. Otherwise this mode of power consumption is not worth the extra materials..

Presently, the standard for special-purpose motor of washing machines is JB/T3758-1996 "General Technical Specifications for Electric Motors of Washing Machines". Table 4-8 shows the requirement of motor efficiency regulated by JB/T3758-1996.

Table 4-8 efficiency of motors required by JB/T3758-1996

Item	**Power (W)**									
	25	(30)	40	(45)	60	90	120	(135)	180	250
Efficiency %	22	25	30	33	41	49	52 *53	*45	56 *50	59
Power factor	0.92					0.95				
Note: figures with * are values of electric motors used by water extractors										

It is clear from the above table that corresponding efficiency could be obtained only by adopting electro motors that suit the load, and the under load or overload is

not proper.

- Application of converter technique

Presently the way of controlling washing machines has developed to variable frequency control, which adopts advanced converter technique to apply power to motors (such as brushless DC motor and switch reluctance motor) through AC-DC-AC, or AC-DC inversion. The rotation rate of electric motors could be regulated through regulating the waveform of voltage conveniently. Therefore, frequency conversion washing machines could select washing water stream, wash time and dehydration rotation rate and dewatering time according to the type and texture of washings, and they could save power under the precondition of guaranteeing best wash performance.

The efficiency of common AC electric motors could reach 45%-50%, and the utilization efficiency of electric energy could reach 90% if DC electric motors are adopted and the life of motors could be prolonged by 200%, which saves cost to consumers;

- Fuzzy-logic control washing machines

In the late 1980's, the sensor technology was developed at a fast speed, and the development of sensors for water level, quantity and grime degree and the application of nerve (sensitive) and fuzzy control technology enable washing machines to work in their best modes, and they are greatly promoted in wash performance and operation.

The principle of fuzzy control: the washing machines are provided with texture sensor, level sensor, temperature sensor, and dirt sensor, wherein the weight of clothing could be detected automatically through the gravitation sensor, and the surrounding temperature could be detected through temperature sensor to regulate the wash time automatically. The computer could judge the weight, texture, dirtiness and the temperature of washing water automatically, and could select water level, wash and dewatering time and the intensity of water effect, which improve the scrubbing effect and reduce power consumption by detecting quality and ambient temperature of clothes and by selecting optimized washing procedures.

- Electric power waveform control technique

Before 2001, corporations of the National Group began to apply a new energy-

saving technology on household appliances, which is "ultra-electric wave transducer technology" developed by Panasonic for power consumption reduction of electric motors of household appliances. Power consumption could be reduced by 5%-10% if this technology is applied on electric motors, and it could be used on air conditioners, refrigerators and washing machines.

It is reported that the new technology optimizes the frequency and amplitude of transmission power just like former transducer technologies, at the same time, accuracy control technology for electric power waveform is adopted in the trade for the first time, which further lowers the power consumption. This technology could result in accurate control by combining 30-100 waveforms to generate "ultra-waveform" in accordance with characteristics of different kinds of electric motors, while former transducers use waveforms determined by square wave or sine wave.

- Selection of drainage pattern

Presently, the drainage patterns of washing machines mainly include upward drainage and downward drainage and one way of energy conservation is to adopt high performance water pumps.

- Reduce the tolerance of the inner cylinder and enhance the manufacturing accuracy

The space of cylinders inside and outside could be reduced through this design proposal, which shall reduce tolerance, reduce water consumption, and reduce rotation energy consumption and heating energy consumption without affecting washing capacity.

- Enhance the heat-insulating property

If tumbling-box washing machines need to heat the washing water, the energy consumption could be reduced if the heat-insulating property of external cylinder is promoted or the coefficient of thermal transmission of the cylinder is lowered.

1.1.4.3 Foreign energy efficiency standard for washing machine

- Energy efficiency standard of washing machines in USA is shown in Table 4-9:

Table 4-9 energy standard for washing machine in USA

Type	Efficiency(energy factor)
Top open type, <45.71	25.7 liters/kWh
Top open type >45.71	33.7 liters/kWh

- Energy efficiency standard of washing machines in Switzerland is as follows (Table 4-10):

Table 4-10 Energy efficiency standard of washing machines in Switzerland

	Power consumption restriction value
Washing machine	0.23kwh/kg

- Energy efficiency standard of washing machines in Hong Kong is as follows (Table 4-11):

Table 4-11 Energy efficiency standard of washing machines in Hong Kong

Type	Power consumption
Automatic / semiautomatic tumbling-box washing machines	0.26 kwh/kg
Automatic/ semiautomatic impeller or milling washing machines	0.0264 kwh/kg

- Energy efficiency standard of washing machines (drum washing machines) in EU is regulated as follows (Table 4-12, 4-13, 4-14):

Table 4-12 Energy consumption of Washing Machine

	kWh/Kg				kWh/Kg
A			C	=<	0.19
B	0.19	<	C	=<	0.23
C	0.23	<	C	=<	0.27
D	0.27	<	C	=<	0.31
E	0.31	<	C	=<	0.35
F	0.35	<	C	=<	0.39
G	0.39	<	C		

Table 4-13 indicator of wash performance

A			P	>	1.03
B	1.03	≥	P	>	1.00
C	1.00	≥	P	>	0.97
D	0.97	≥	P	>	0.94
E	0.94	≥	P	>	0.91
F	0.91	≥	P	>	0.88
G	0.88	≥	P		

Table 4-14 indicators of spin dry performance

A			D	=<	45%
B	45%	<	D	=<	54%
C	54%	<	D	=<	63%
D	63%	<	D	=<	72%
E	72%	<	D	=<	81%
F	81%	<	D	=<	90%
G	90%	<	D		

1.1.4.4 Energy conservation potential of new energy efficiency standard

It is observed that the implementation of washing machine energy efficiency standard could increase the energy efficiency level by 15%. As compared with the existing standard issued in 1989, the proposed new standard will cover drum washing machines and add the limited value of water consumption and assessment methods.

Suppose the new standards shall be carried out in 2004, then the power conservation in 2010 shall be 1.50TWh, amount to 0.58MMTce in primary energy; the power conservation in 2020 shall be 3.47TWh, amount to 1.25MMTce; per unit increment cost of energy efficient rice cookers is about RMB80, suppose the electric charge is 0.4615 Yuan/kWh and water price is 3.00 Yuan/m^3, then the net income of users for using energy-saving rice cookers is RMB 7.04 billions, the benefit cost ratio is 1.9; discharge reduction of pollutants brought along by power conservation will be 1.00MMT of carbon, 0.015MMT of nitrogen oxide, 0.199MMT of sulfur dioxide and 0.093MMT of PM_{10} in 2020.

1.2 Standby power consumption

Along with generalization of household electrical appliances and audio visual products, extensive application of automated office equipment and progressive development of networking, more and more products are provided with the standby function (remote switch, network wake-up, time switch, and intelligent switch). It facilitates our life, but results in power consumption, namely standby power consumption.

It is shown from recent research that the standby power consumption is 3% to 13% of the total civil power consumption of OECD (note: China-IEA "Energy Efficiency Standard and Labeling" Forum in Nov. 2001, Benoit Lebot, IEA, measures for reduction of standby power consumption). The increase of standby power consumption and subsequent environmental problems are a source of growing worldwide concern, with some people calling it a “vampire”.

The IEA is an active initiator and impellor of standby power consumption reduction, and has held three international forums since 1999 for discussion of technical ways and supporting policies to reduce standby power consumption. In 2000, it also presented “1W Plan” that aimed to reduce the standby power consumption of all products to be under 1W by 2010. Developed countries, such as European countries, America, Japan and Australia respond actively to this plan, and have strengthened the study of power consumption reduction technologies and the establishment of related standards. For instance, a special group was established by IEC in October, 1999 for inspection of the test procedures of standby power consumption of electric appliances. The EU began to make related investigations since 1990's, and in 1995 it began to carry out a voluntary agreement on TV sets and video recorders. A voluntary agreement on related audio visual products has also been formulated. In America, the “Energy Star” is mainly in charge of standby power consumption reduction activities, which cover TV sets, video recorders, 2 in 1 TV set/video recorder, computer displays, copiers, computers, printers and facsimile printers. American government is paying close attention to the standby power consumption and energy consumption of office equipment in federal government, and President Clinton once issued two orders in his tenancy, demanding federal government and local governments to purchase equipment with “Energy Star” label. In July, 2001, President Bush issued an order again, demanding the federal government to purchase products whose standby power consumption was less than 1W. Strongly supported by American Government, the “Energy Star” label and standby power consumption indices have been recognized in many countries. All

these activities and measures forcefully boost the development of standby power consumption reduction technologies.

The gross output value of China's household appliances industries grew by 32.1% yearly from 1986 to 1996, and the output of primary household appliances is on the top list in the world. It is predicted that its gross sales shall reach RMB 250 Billion in 2010. Under this condition, research institutions and government institutions in China have also began to pay close attention to the issue of standby power consumption. In February, 2000, China joined the forum on "Integrated Solution for Standby Power Consumption Reduction" held in Tokyo by IEA, and completed Sample Surveys of household electric appliances in 168 households in Beijing and Guangzhou by CECP in April, 2001 under the backing of American Lawrence Berkeley National Laboratory. Findings show that the average standby power consumption is about 10% of the total energy consumed in a household, equivalent to a light of 15-30W lamps burning continuously in each household. In Nov. 2001, the State Economic and Trade Commission and IEA held "Energy Efficiency Standard and Labeling International Forum" in Beijing, on which the "standby power consumption of household electrical appliances and office equipment" was widely concerned by the government and delegates as one of the key topics. In July, 2002, under the support of American Laurence Berkeley National Laboratory, CECP completed the analysis of standby power consumption and prediction of energy conservation potential of Color TV sets. In February, 2002, it initiated the energy conservation product certification of color TV sets. In July 2002, it completed tests of the standby power consumption level of some office equipment in Beijing and Guangzhou again, and plans to advance the certification works at the speed of two products each year. In August 2002, the press conference on the topic "Reduce Standby Power Consumption and Advance Environmental Protection" sponsored by the CECP was held in Beijing, and nearly 70 media made special reports on it, including Xinhua News Agency, CCTV, Phoenix TV, Beijing TV, which played an important role in enhancing the knowledge of the public on standby power consumption, promoting the social energy-saving and environmental considerations, and generalizing high-performance and low-power products.

The standby power consumption is being given importance by related power conservation departments in China. During the Energy Conservation Propaganda Week in 2001, the State Economic & Trade Commission, Ministry of Finance and State Machinery Affairs Administration jointly sponsored an initiative to save power and suggested to purchase high-performance and low energy consumption products, including products of low standby power consumption. The State Economic & Trade

Commission is also organizing related units and experts to investigate and analyze the energy conservation potential of the government and energy-using equipment and products related as of a bulk purchase initiative of the government in order to establish corresponding policies and measures.

Along with promotion of living standard and scientific level, the standby function of products shall be used more, and the standby power consumption reduction is becoming more important. The standby power consumption products concerned here include household electrical appliances (color TV sets and microwave ovens) and office equipment (laser printers, facsimile printers, copiers and computer displays), which will be described now.

1.2.1 Color TV sets

1.2.1.1 Overview

Since 1980's, the people's living standard has been rising continuously along with the reform and opening up and the concept and demand of consumption has undergone significant changes. Consumer durables represented by color TV sets began to enter households in large scale and become hotspot consumption concern of the whole society. The possession of color TV sets per hundred households in urban areas is 117 in 2000 according to statistics (China Statistical Information Net, Primary Consumer Durables Possession per Hundred Household in Urban Areas). At the same time, consumption ideas in rural areas also undergo huge changes, powerful consumer markets are formed in coastal rural areas, and color TV sets are increasingly popularized. Table 4-15 shows the sales of color TVs in China from 1985 to 2001.

Table 4-15 Sales volume of color TV sets over the years in China (10,000)

Year	TV's produced	Export volume	Domestic Sales volume
1985	435	-	435
1986	554	-	554
1987	673	-	673
1988	1,038	-	1,038
1989	940	-	940
1990	1,033	-	1,033
1991	1,205	-	1,205

1992	1,333	-	1,333
1993	1,436		1,436
1994	1,689		1,689
1995	2,058		2,058
1996	2,538		2,538
1997	2,711	906	1,805
1998	3,497	1,298	2,199
1999	4,262	1,021	3,241
2000	3,936	1,944	1,992
2001	3,967	1,944	2,023

Now the service life of color TV sets, refrigerators and washing machines bought by citizens in urban areas in 1980's have expired in succession. A survey on "Economic Information News" shows that 50% of color TV sets in urban households were purchased in mid 1980's, and 50%- 80% of them shall be renewed in coming years if their service life is 10 years, and the sales quantity and possession of TV sets in China shall rise sharply (China Statistical Information Network).

The color TV sets possession was 297 millions in 2000 in accordance with China Statistical Yearbook and Population Census (Table 4-16).

According to the report issued by Ministry of Information Industry, the total market capacity should be 525 millions (compared with mid level of developed country, per household has 1.5 color TVs and total households are 350 millions). But the current inventory is 340 millions. So the report indicates that the domestic demand of color TVs per year during the future 10 years will reach 30 millions.

Table 4-16 Possession of color TV sets in China

Year	1985	1990	1995	1998	1999	2000
Urban areas						
Average population per household	3.89	3.5	3.23	3.16	3.14	3
TV sets possession per hundred households	17.21	59.04	89.79	105.43	111.57	114.4
Overall Population	25094	30191	35174	37942	38892	45844
Overall households	6450.9	8626	10889.78	12006.96	12385.99	15281.33
Color TV sets possession (10,000)	1110.2	5092.79	9777.936	12658.94	13819.05	17481.85
Rural areas						
Average population per household	5.12	4.8	4.48	4.3	4.25	4.13

Color TV sets possession per hundred					38.24	62.4
Color W/B TV sets possession per hundred					62.35	
Overall Population	80757	84142	85947	86868	87017	80739
Overall households (10,000)	15772.85	17529.58	19184.6	20201.86	20474.59	19549.39
Color TV sets possession (10,000)	0	0	0	0	7829.483	12198.82
Whole nation						
Overall households					32860.58	34837
Color TV sets possession (10,000)					21648.53	29680.67

1.2.1.2 Current standards

Refer to Table 4-17 for the minimum requirements for standby power consumption of TV sets by different energy conservation marks abroad.

Table 4-17 Minimum requirements for standby power consumption of TV sets by different energy conservation marks abroad.

Swiss energy 2000 (Switzerland)	Energy Star America	Group for Efficient Appliances (GEA) (Europe)	Blue Angel (Germany)	Nordic Swan (Scandinavia)
≤3W	≤3W	≤1W	≤4W	≤1W

The Top - runner objective of Japan is to reduce the standby power consumption of color TV sets to be less than 1W in 2003. EU launched the voluntary compliance agreement activity for TV sets and video recorders in 1995, and the top 16 companies on EU market signed an agreement to reduce standby power consumption in 1996, the objective of which was that the average standby power consumption of weighted product of these companies should be less than 6W in 2000, and less than 3W in 2009, and the weighted average standby power consumption is not allowed to be higher than 10W from January 1st, 2000.

Energy Star in America has been successful in this field due to support of the government, and it has become a global voluntary standard, which has been adopted or is ready to be adopted by New Zealand, Australia, Japan, as well as EU countries, Canada, Brazil and Mexico. The active standard on color TV sets of Energy Star is that the standby power consumption is no bigger than 3W, which will be revised on July 1st, 2002, that is it is no bigger than 1W for analog color TV sets and 3W for DTV from July 1st, 2002 to June 30, 2005, and the standby power consumption index of less than 1W shall be carried out on both analog TV and DTV after July 1st, 2005.

At the Tokyo Conference, IEA initiated to reduce the standby power consumption of all color TV sets to less than 1W by 2010.

The GB12021.7 "Power Consumption Restriction Value of Color and W/B TV Receivers and Its Testing Method" was established in China in 1989, which went into force in 1990. The restriction values of input power of color TV sets ranging from 37cm to 56cm and W/B TV receivers ranging from 31cm to 47cm are contained in the standard, wherein the restriction value of input power of color TV sets is 55-75 W, but the standby power consumption is not regulated. In 2002, the CECP initiated energy conservation product certification of color TV sets, and the current technical index of energy conservation evaluating value is 3W.

In accordance with Sample Surveys conducted in Beijing and Guangzhou in April 2001, the average standby power consumption of color TVs in China is 8.1W, wherein 13.4% of the sample has a standby power consumption less than 3W, 1.7% has standby power consumption less than 1W, and 54.3% had standby power consumption above 7W. The average energy consumption while working is 79.5W. The average work hour of the sampled households is 5.13 hours, the average stand-by time is 2 hours and the average closedown time (unplugged) is 16.87 hours.

1.2.1.3 Energy conservation potential of new energy efficiency standard

It is shown from above analysis that the average standby power consumption of domestic color TV sets is 8.1W, far above the world average. On the other hand, the average stand-by time of domestic color TV sets is shorter than in most countries due to different living habits and operating mode. However, as living habits in China continue to change due to a desire for increased conform and convenience, consumers may be less likely to unplug sets when they are not in use, and as a result the standby function of color TV sets will likely be applied more, which shall result in more energy consumption. Therefore, it is necessary to regulate the restriction value of standby power consumption as an important index. Technologies used to reduce standby power consumption of color TV sets are relatively simple and mature, so we suggest reducing it from 8.1W to less than 3W, and the cost is RMB 7-8 Yuan for each color TV set according to information provided by Changhong, TCL, Konka, Skyworth, KAWA and Konrowa. Estimating that the market price is 25% higher than the manufacturing cost, thus it is estimated that consumers will pay RMB 10 Yuan more on average after adoption of the 3W standard.

Suppose the new standard is carried out in 2004, then the power conservation in

2010 shall be 3.26TWh, amounting to 1.27MMTce in primary energy. The power conservation in 2020 shall be 5.10TWh, amounting to 1.84MMTce. Suppose the electric charge is 0.4615 Yuan/kWh, then the net income of users for using energy-saving color TV sets is RMB 9.173 billions and the benefit-cost ratio is 5.0. The discharge reduction of pollutants brought along by power conservation will be 1.47MMT of carbon, 0.022MMT of nitrogen oxide, 0.293MMT of sulfur dioxide and 0.137MMT of PM_{10} in 2020. At the same time, the peak demand shall be reduced by 0.41GW.

In addition, the energy savings of color TVs in active mode are also estimated. Suppose the new standard also regulates the maximum energy consumption of TVs in active mode, and the energy efficiency is increased by 13%, then the power conservation in 2010 shall be 3.07TWh, amounting to 1.19MMTce in primary energy. The power conservation in 2020 shall be 4.79TWh, amounting to 1.73MMTce. Suppose the electric charge is 0.4615 Yuan/kWh, then the net income of users for using energy-saving color TV sets is RMB 8.946 billions and the benefit-cost ratio is 5.8. The discharge reduction of pollutants brought along by power conservation will be 1.38MMT of carbon, 0.021MMT of nitrogen oxide, 0.275MMT of sulfur dioxide and 0.128MMT of PM_{10} in 2020. At the same time, the peak demand shall be reduced by 0.39GW.

1.2.2 Computer monitors

1.2.2.1 Overview

With the reform and opening up, China has become a global computer production base, and the yearly output of displays is in the first position in the world. The display industry in China is export-oriented, and the output and export volume of foreign-funded enterprises takes 92% and 95% of the total respectively. Display manufactures are highly concentrated around Taiwan, Korea and Japan. The display industry in China is mainly influenced by the global macro economic environment, and industrial restructuring and industrial layout of transnational enterprises under the policy of reform and opening up.

30% of displays made in China are exported to the American market. 50% of the displays made in China are exported to the European Market. EU has a more developed market protection mechanism as compared with other economic regions in the world; the trade among EU countries takes 60% of their total, and their economic growth mainly depends on driving domestic demand. European Market is

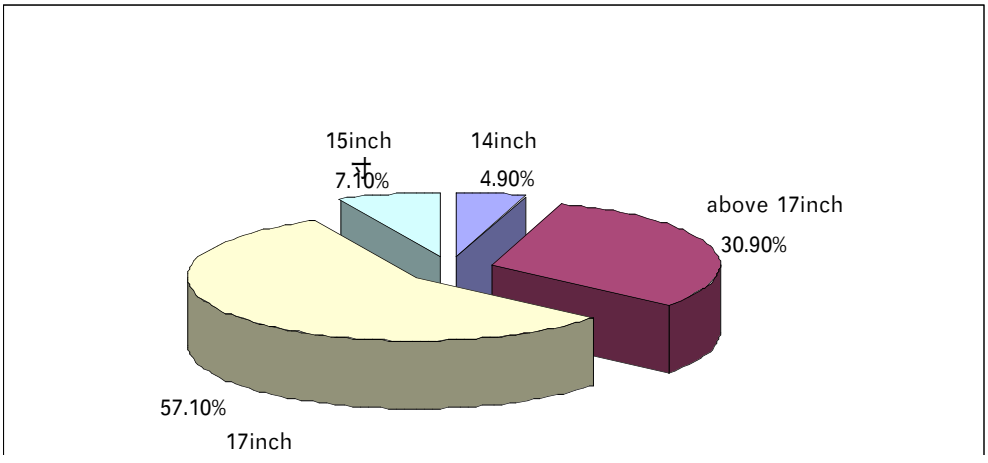
comparatively stable as compared with American Market.

15% of the displays made in China are exported to Asian countries and 5% to other regions.

During the 2001 global recession, the market structure regulation of displays was quickened, and downstream TFT (thin film technology)- LCD (liquid crystal display) product lines in Taiwan were transferred to the mainland from the second half year of 2001 in order to reduce the cost of LCD displays and enhance competitiveness in international markets. Taiwan enterprises began to produce TFT- LCD displays in mass production on mainland from 2001, and invest in Changjiang (Yangtze) Delta for constructing a notebook computer production base. The output of Taiwan notebook computers on mainland will be promoted to 37% of Chinese market from 5.2% in 2001 and that of TFT -LCD displays will build up to 69% from 29%. Korea enterprises also plan to invest more on TFT-LCD displays, and the increase of TFT-LCD output in future has come to stay.

According to data of Computer Association, the output of personal computers in the world dropped for the first time in 16 years due to influence of weak economy in America and Europe and over-investment in IT network industry, and the growth rate dropped from 15.9% in 2000 to - 5.1% in 2001, which has direct influence on the display industry that gives priority to export. In 2001, the overall output of displays on mainland was 43.26 million, a drop of 5.7%, and 2.64 million less than that in 2000, which was 43% of the overall output in the world that was 10,080 million units. Wherein the output of CRT displays in 2001 was 41.61 million (96.2% of total production), and that of TFT - LCD displays was 1.65 million (3.8%).

In 2001, the product structure of displays was greatly adjusted, 17" displays became mainstream products, and the market of LCD displays was expanded. Of the 41.61 million CRT displays sold in 2001, 4.9% were of 14", which was 2.04 million, 2.53 million less than that in 2000; 30.9% were of 15", which was 12.86 million, and



6.29 million less than that in 2000; 57.1% were of 17", which was 23.76 million, and 4.61 million more; and 7.1% were of a size more than 17", which was 2.95 million. The 1.65 million of TFT - LCD displays include 1.54 million of 15" displays, 93.4% of output, and displays of other sizes only take 6.6% of the total (See FIG 4-12).

FIG 4-12 product type structure of CRT in 2001

The sales volume of displays on domestic market was approximately 9.97 million (1.17 million imported from customs not included) in 2001 by taking the sales of CRT (cathode ray tube) in domestic market, and the distributed amount of CRT by the Ministry of Foreign Trade and Economic Cooperation as the basis and by combining the home sales data of Display System Committee, 1.29 million more than that in 2000 with a growth rate of 14.9%. Wherein the sales of CRT displays were 9.43 million, 94.6% of the domestic sales volume; the sales of TFT-LCD displays were 540 thousand, 5.4% of the total domestic sales.

Although the growth rate of output and sales volume of displays in China had been great from 1995 to 2000, it tends to be stable along with the cooling of the world economy. In accordance with the five-year plan of the Ministry of Information Industry, the market demand of displays in China is expected to be 20 million in 2005, the annual growth rate between 2006 and 2010 is estimated to be 10% and it is 6% from 2011 to 2020.

1.2.2.2 Current standards and energy conservation potentials of new energy efficiency standards

America Energy Star and European GEA have formulated restriction values of standby power consumption of displays. The minimum standby power consumption on OFF status is 2W according to regulations of American Energy Star.

The normal standby power consumption of CRT displays in China is 5.43W according to office product investigation and test conducted by CEPREI (China Electronic Product Reliability and Environmental Testing Research Institute) in 2002. The service time of the sampled displays is 7.72 hours in average daily, the average stand-by time is 4.6 hours, and the activation rate of energy conservation function is 70%.

The power supply of CRT displays is similar to that of color TV sets with relatively simple and mature technologies. Consumers may pay extra 10 Yuan for

each display after the 2W standard is adopted, but the subsequent economic benefits are distinct. Suppose the restriction value of standby power consumption in new energy efficiency standard is 2 W, and the standard is effective in 2004, then the power conservation in 2010 will be 1.05TWh, amounting to 410 kilotons of standard coal in primary energy. The power conservation in 2020 will be 2.04TWh, amounting to 740 kilotons of standard coal. Suppose the electric charge is 0.84 Yuan per kWh, then the net income of users for using displays whose standby power consumption is 2W is RMB 4.63 billion and the benefit-cost ratio is 2.8. The discharge reduction of pollutants brought along by power conservation will be 590 kilotons of carbon, 8.97 kilotons of nitrogen oxide, 117.09 kilotons of sulfur dioxide and 54.69 kilotons of PM10 in 2020. At the same time, the peak demand will be reduced by 0.62GW.

1.2.3 Microwave ovens

1.2.3.1 Overview

The microwave oven industry in China has been developing gradually. It has now entered a swift growth period after ten years' development, and its production and distribution has kept a high growth rate annually. Presently, microwave ovens are not popular in China due to restrictions of economic conditions and food culture, and its possession per hundred households in urban areas is less than 20, which is the lowest among primary household appliances.

The brands and origins of microwave ovens are highly concentrated in China; more than 30 manufacturers have been washed out from the market under the pressure of price reduction launched by Galanz, and the places of production are mainly concentrated in Guangdong, Tianjin, Shandong, Shanghai and Anhui. Galanz, LG and Midea (it entered this market only at the close of 1999) take 90% of the overall market shares, wherein the market share of Galanz is 75%. For the moment, Galanz has become the biggest microwave oven production base in the world, whose annual production capacity is 15 million, whose domestic market share is more than 50%, and whose international market share is 30%. Such market dominance is rare in the home appliance market at home and abroad. The demand for fast, high performance, convenient and clean microwave ovens is on the increase along with improvements to people's living conditions, and quickened life rhythm, therefore, the microwave oven market shall see a fast growth rate in the next few years.

In 2000, the output, domestic sales and export volume of microwave ovens in

China was 13.6 million, 6 million and 8.37 million respectively, a great increase relative to comparable figures for 1999. In accordance with the sales monitoring of 206 retail shops in 35 cities by SINO-MR, the retail quantity of microwave ovens rose by 27.7% in 2001(until the end of August) over the previous year, and the domestic sales volume in 2001 is predicted to reach 8 million. The output, sales volume and export volume of domestic microwave ovens from 1995 to 2000 are shown in Table 4-18 and FIG 4-13.

Table 4-18 output, sales volume and export volume of microwave ovens from 1995 to 2000 (10,000)

Year	1995	1996	1997	1998	1999	2000
Output	200	300	430	600	920	1360
Sales volume	120	170	230	280	340	600
Export volume	114	150	207	324	582	837

Data source: SINO-MR

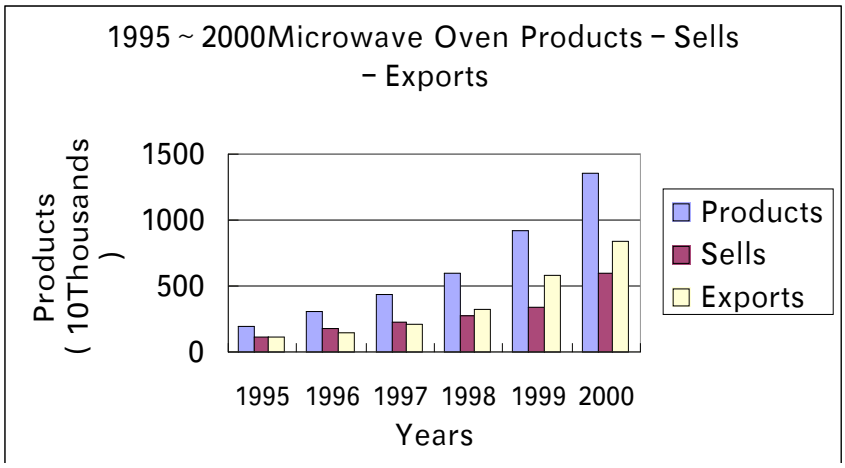


Table 4-13 output, sales volume and export volume of microwave ovens from 1995 to 2000

In view of types, the mechanical grilling type, mechanical non-grilling type and computer grilling type are primary types on the market, whose market share is over 99% of the gross market share, while the market share of computer-controlled non-grilling microwave ovens is only 0.7% of the whole market. Only computer-controlled microwave ovens are provided with the standby function (unlike in the U.S. where most microwaves have standby consumption to power clock), whose home sales volume was 2 millions in 2000 if their market share is regarded to be one third

of the whole market. In view of the output and sales volume from 1995 to 2000, the microwave oven industry has entered a fast growing period with an average annual growth rate of 40%, wherein the low-price mechanical microwave ovens grow faster. We estimate that this growth rate cannot be sustained for the next 20 years, and therefore estimate that the annual growth rate will be 20% before 2006, 10% from 2007 to 2012 and 6% from 2013 to 2020.

1.2.3.2 Current standards and energy conservation potentials of new energy efficiency standards

Sample Surveys conducted in China and Britain show that the rate of standby function utilization is different in view of different products (i.e. TVs, VCRs, microwave ovens) with microwave ovens in the top place, nearly 100%. In addition, the stand-by time of microwave ovens is much longer as compared with the time of its service; thus it is quite important to formulate an energy efficiency standard to reduce the standby power consumption of microwave ovens.

According to sample surveys conducted in Beijing and Guangzhou in April, 2001, the average standby power consumption of computer-controlled microwave ovens is 2.7 W. The average operating hours of microwaves in the investigated households is 0.5 hour, and the average stand-by time is 23.5 hours. The standby power consumption standard is set to be 1W based on the “1W” initiative offered by IEA. Suppose the new standard is carried out in 2006, then the power conservation in 2010 shall be 0.46TWh, amounting to 180 kilotons of coal equivalent in primary energy. The power conservation in 2020 shall be 1.46TWh, amounting to 530 kilotons of standard coal. Suppose the electric charge is 0.4615 Yuan per kWh, then the net income of users for using microwave ovens whose standby power consumption is only 1W is RMB 1.298 billions and the benefit-cost ratio for this standard is 2.3. The discharge reduction of pollutants brought along by power conservation will be 420 kilotons of carbon, 6.44 kilotons of nitrogen oxide, 84.03 kilotons of sulfur dioxide and 39.24 kilotons of PM10 in 2020. At the same time, the peak demand shall be reduced by 0.21GW.

1.2.4 Copiers

1.2.4.1 Overview

Along with China's entry into WTO, foreign funds flow into China’s market in succession, in particular, into the manufacturing industry. The duplicating machine

industry grows fast driven by foreign investment. Currently 60% of duplicating machines in the world are produced in China, and all primary duplicating machines manufacturers have invested in China, mainly in Changjiang (Yangtze River) Delta, and Zhujiang (Pearl River) Delta, such as Shanghai Ricoh, Shanghai Xerox, Shanghai HP, Guangdong Minolta (No. 1 in output), Shenzhen Ricoh, Toshiba, Copyer (a subsidiary of Ricoh), and Zhuhai Canon. Companies in Shanghai and Suzhou give priority to sales in domestic market, while duplicating machines made in Shenzhen and peripheral locations are mainly for export. In the past two years, Japan's economy has been on the low side, and many Japanese corporations have cast their sights to China. Duplicating machines and typewriters made in Guangdong Shilong Minolta Plant are 40% of its total, and Shilong has become the most important production base of Minolta. In 2002, Sharp also is reported to expand its business on copiers in China to meet rising market demand. It is announced that its sales volume shall be doubled and the output shall be increased by 40%. At the beginning of 2001, Canon initiated "China Plan", its Asian Headquarters were moved to Beijing, and it invested USD 90 millions in building the biggest production base of Canon in the world----- Suzhou Production Base. Canon plans to transfer the production of medium speed and basic models of copiers to this new base, and mass production was initiated in July 2001. After the base is established, the output of copiers will be approximately 30% of its total. In 2001, Toshiba invested tens of millions in Shenzhen Fuyong building a new plant for producing Toshiba copiers, which is the biggest production base for Toshiba copiers with an annual production capacity of 400 thousand--twice than before. Spokesman of Japan Ricoh also declared that Ricoh will increase the output of data copiers in Shenzhen Plant, and will promote the output of facsimile printers in Shanghai Plant. It is seen from above that China has become the biggest duplicating machine producer in the world.

The yearly output of copiers was 217.5 thousands in 1995, while it was 2.1029 million in 1999 according to the Statistical Yearbook, and the output in 2001 reached 1.441 million despite the economic distress in the whole world. Table 4-19 shows the output of copiers in China from 1998 to 2001.

Table 4-19 Output of copiers from 1998 to 2001 (10,000)

Year	1998	1999	2000	2001
Output	117.93	210.29	156.60	144.10

Data from Japan Sharp: the market size in China in 2001 is 210 thousand, and predicted to be 300 thousand in 2004. The growth rate is predicted to be 14% until

2010 and 7% until 2020.

1.2.4.2 Current standards and energy conservation potentials of new energy efficiency standards

America Energy Star and European GEA have formulated restriction values of standby power consumption of copiers. The minimum standby power consumption of copiers is 5-20W when they are shifted to “OFF” state automatically according to model and speed of different copiers. The minimum standby power consumption of copiers less than 20cpm is 5W.

The average standby power consumption of copiers is 12W according to office product investigation and test conducted by CEPREI laboratory in 2002. The average work hour of the investigated copiers is 2.75 hours, and the average stand-by time is 6 hours.

Suppose the restriction value of standby power consumption in new energy efficiency standard is 5W, and the standard is effective in 2006, then the power conservation in 2010 will be 0.39TWh, amounting to 150 kilotons of standard coal in primary energy. The power conservation in 2020 will be 1.32TWh, amounting to 480 kilotons of standard coal. Suppose the electric charge is 0.84 Yuan per kWh, then the net income of users for using duplicating machines whose standby power consumption is 5W is RMB 3.145 billions and the benefit-cost ration is 7.2. The discharge reduction of pollutants brought along by power conservation will be 380 kilotons of carbon, 5.79 kilotons of nitrogen oxide, 75.60 kilotons of sulfur dioxide and 35.31 kilotons of PM10 in 2020. At the same time, the peak demand shall be reduced by 0.34GW.

1.2.5 Laser printers

1.2.5.1 Overview

Printers are important text and image output equipment and are products that are the most popular, active and competitive on the market of computer peripheral equipment. In recent years, printers are widely applied in “SOHO” (small offices and household offices), and their market is steadily increasing due to the technical integration, networking, and promotion of printing speed and quality.

As a whole, foreign printers still predominate on the Chinese printer market. The

most influential printer manufacturers include EPSON, STAR, OKI, FUJITSU (Nanjing), NEC, OLIVETTI (Nantian), Start, Kong Yue, Xiang Computer, and so on; four manufactures divide the market of ink jet printers in China, namely EPSON, Canon, HP, and Lexmark, Great Wall and Legend have also put forward ink jet printers, and Xerox has also put forward integrated machine based on ink jet printer. Both China and foreign enterprises have made sound achievements in distribution of laser printers, wherein the HP, EPSON, Canon, Founder, OKI and Panasonic are the most influential. In addition, Start has recently entered the high-end network laser printer market, and Lexmark and Xerox also have huge potentials. The integrated lab (fax, xerox, print and scan) of Legend caters for the SOHO (small office, home office) market, and Weihai Beiyang Group have also developed small heat sensitive/heat transfer inkers and heat sublimation inkers.

The average annual growth rate between 1996 and 2000 was 31.2% on China's overall printer market, while it was 78.5% and 55.7% respectively on the ink jet printer market and laser printer market. During the same period, the annual growth rate of 24-pin universal printers and flat push printers was only -1.1% and 20.3%, which was lower than the market average. Table 4-20 shows the home sales volume of printers from 1996 to 2001

Table 4-20 Home sales volume of printers from 1996 to 2001

Year	1996	1997	1998	1999	2000	2001
Home sales volume (10,000)	104.7	146.7	183.0	234.2	292.7	345.6

Data sources: China Computer Association

The growth rate of laser printer market is only next to that of the ink jet printer market, and its market share has grown up to 20% in 2000 from 10.2% in 1996. Along with the networking development in China, the advantages of laser printers are becoming obvious; in particular, the network computers have become another focus of competition.

Traditionally, printers are regarded as accessory equipment of computers, while they are regarded as important nodes in the network now, and low-cost, high-speed and top-quality high end printing sharing could be realized through networks. In view of user demand, network printing develops from low-end shared network printing to high-end network printing, and professional user applications develop to medium and small businesses. At the same time, integrated solutions have become the main form

of user demand (not only network computers, but also network print servers and network print software are contained).

Network computers are winning more attention on the laser printer market, but still more middle and low end laser printers are sold.

The demand for printers in 2005 is 8 million according to the five-year plan of the Ministry of Information Industry. Laser printer sales are fast increasing according to data compiled by the China Computer Association, and the market size of laser printers from 1996 to 2000 is shown in table 4-21.

Table 4-21 the market size of laser printers in China from 1996 to 2000

Year	1996	1997	1998	1999	2000
Sales volume (10,000)	10.7	21.1	33.3	44.9	58.5
Growth rate」 %」 ㄅ	67.2	97.1	52.4	34.8	30.3
Market share」 %」 ㄅ	10.2	14.4	18.2	19.2	20.0

Source of the data: China Computer Association

1.2.5.2 Energy conservation potentials of current standards and new energy efficiency standards

American Energy Star and European GEA formulate restriction values for the standby power consumption of printers, and printers shall enter the state with low power consumption automatically after they stop working for a period according to their model and printing speed. The minimum standby power regulated for laser printers less than 10ppm is 10W.

The standby power consumption of China's low - speed printers (those less than 10ppm) is 20W according to test results in offices. The average working time of the investigated printers is 3.15 hour, and the average stand-by time is 7.5 hours.

Suppose the standby power consumption in new energy efficiency standard is 10W, and is effective in 2004, then the power conservation in 2010 shall be 0.14TWh, amounting to 50 kilotons of standard coal in primary energy. The power conservation in 2020 shall be 0.24TWh, amounting to 90 kilotons of standard coal. Suppose the typical commercial electric rate is 0.84 Yuan per kWh, then the net income of users for using laser printers whose standby power consumption is 10W is

RMB 761 millions and the benefit-cost ratio is 6.1. The discharge reduction of pollutants brought along such power conservation will be 70 kilotons of carbon, 1.08 kilotons of nitrogen oxide, 14.03 kilotons of sulfur dioxide and 6.55 kilotons of PM10 in 2020. At the same time, the peak demand shall be reduced by 0.06GW.

1.2.6 Facsimile machines

1.2.6.1 Overview

Facsimile printers are important office equipment, the market demand of which has grown by 51% annually in recent years. The growth rate of facsimile printers is number one in the world, and it has become the number 4 means of communication next to telephones, mobile communication and wireless paging.

It is shown in the Statistical Yearbook that the output of facsimile printers in China form 1998 to 2000 has been growing by 22% on average and the growth rate was 62% in 2001. The output of facsimile printers from 1998 to 2001 is shown in Table 4-22.

Table 4-22 Output of facsimile printers from 1998 to 2001

Year	1998	1999	2000	2001
Output (10,000)	128.69	159.99	196.30	318.20

The average standby power consumption of facsimile printers is 6.8W according to office product investigation and test conducted by CEPREI in 2002. The average work hour of the investigated facsimile printers is 1.2 hour, and the average stand-by time is 22.71 hours.

1.2.6.2 Energy conservation potentials of current standards and new energy efficiency standards

American Energy Star and European GEA formulates restriction values of standby power consumption of facsimile printers, which are put together with technical index of printers, and different technical requirements are offered for independent facsimile printers and the “2 in 1” machines that integrate printers with facsimile printers. Facsimile printers shall enter the low power consumption state after

having stopped working for a period according to their model and speed. The minimum standby power consumption of independent facsimile printers (less than 10ppm) is 3W.

Suppose the standby power consumption of facsimile printers is 3W according to new energy efficiency standard that is effective in 2006, then the power conservation in 2010 shall be 0.12TWh, amounting to 50 kilotons of standard coal in primary energy. The power conservation in 2020 shall be 0.25TWh, amounting to 90 kilotons of standard coal. Suppose the electric charge is 0.84 Yuan per kWh, then the net income of users for using facsimile printers whose standby power consumption is 3W is RMB 291 millions and the benefit-cost ration is 1.6. The discharge reduction of pollutants brought along such power conservation will be 70 kilotons of carbon, 1.10 kilotons of nitrogen oxide, 14.29 kilotons of sulfur dioxide and 6.68 kilotons of PM10 in 2020.

1.3 Lighting fixtures

1.3.1 Fluorescent lamp ballasts

1.3.1.1 Overview

Fluorescent lamps are energy converters for converting electrical energy to luminous energy. Ballasts play an important role in this process by guaranteeing the normal ignition of fluorescent lamps. Fluorescent lamp ballasts fall into three major categories -- magnetic ballasts, mixed ballasts and electronic ballasts in accordance with principle of operation.

Magnetic ballast is composed of an iron core inductive coil, end cover, T-shape high silicon iron, V-shape high silicon iron, binding post, and soleplate. The principle is that when electric current in the coil changes, magnetic flux is changed also to generate induced electromotive force, which is of a reverse direction and obstructs electric current transformation. The magnetic ballast can light lamps through cooperation with the starter (see FIG 4-14). This combination is simple in structure, reliable in operation, low in price and high in market share. But there exists certain electric resistance on the coil, and there is induced current inside the conductor, namely eddy flows, which generate heat to accelerate the aging of ballast and lead to losses of electrical energy.

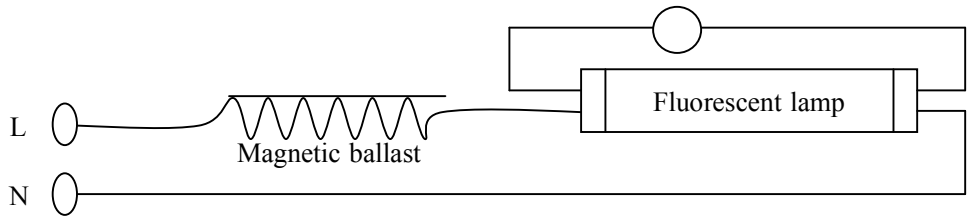
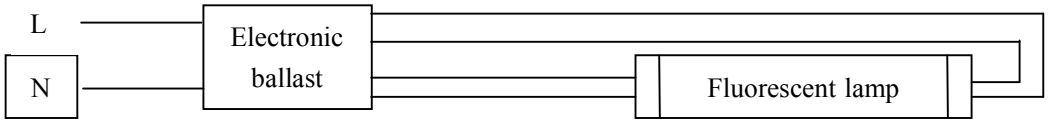


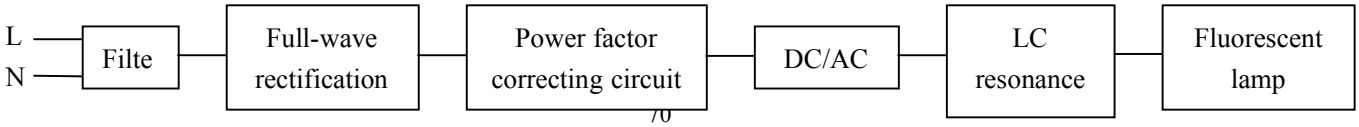
FIG 4-14 the operation principle of magnetic ballast

World energy crisis occurred in 1970's, and many companies began to devote themselves to the study of energy-saving luminous sources and electronic ballasts. The fast development of semiconductor technology and constant release of high-counterpressure switches offered conditions for the development of electronic ballasts. At the end of 1970s, foreign manufacturers took the lead in putting forward the electronic ballast of the first generation, which was a great innovation in the history of illumination. I t has large energy-savings. It was regarded as an ideal product to replace magnetic ballast, and some noted enterprises input human and material resources on additional higher R&D on the product. The progress in microelectronic technology advanced electronic ballasts to be more efficient and reliable, and quite a few semiconductor companies put forward products with dedicated power switches and integrated control circuits. In 1984, Siemens developed active power-factor correction IC for electric appliances, for instance TPA4812, and the power factor reached 0.99. Later other companies launched integrated electronic ballasts in succession, Finland Herwali Company put forward adjustable light monolithic integrated circuit electronic ballast in 1989, and electronic ballasts are widely applied in developed countries for the moment.

Electronic ballasts are converters that convert power frequency AC supply to high frequency AC supply, and its operation principle is shown in FIG 4-15:

FIG 4-15 the operation principle of electronic ballast





Power frequency power supply is converted to DC power supply after RFI filter, biphase rectification and passive (or active) power-factor corrector (PPFC or APFC). 20K-100KHZ high frequency AC power is output through DC/AC converter to LC series resonant circuit of lamps in order to heat the filaments of lamps, at the same time, resonance high voltage is generated on capacitor, which is added to both ends of lamps, thus the status of lamps is converted from discharge to conduction, then to luminescent state. At this time, high frequency inductance could restrict the increase of electric current to guarantee the normal working of lamps. Different protective circuits are added to increase the reliability, such as abnormal voltage protection, surge voltage, current protection and temperature protection.

The comparison between magnetic ballast and electronic ballast is shown in Table 4-23.

Table 4-23 Comparison between magnetic ballast and electronic ballast.

		Magnetic ballast	**Electronic ballast**
1	Quality of lighting	With stroboflash and noise	Without stroboflash and noise
2	Structure	Simple structure, low cost and long service life	Complicated structure and high cost
3	Power factor	Low power factor	High power factor
4	Working Voltage	Be unable to start or work under 180V	Be able to start and work under 140V with lowered luminous flux
5	Working temperature	High work temperature up to 120 C, more heat production, and hard start-up in low temperature	Normal working from +50 C to – 10 C, and conformity with fire control requirements with low temperature rise
6	Energy consumption	40W(fluorescent lamp power)+10W(ballast heat power)= 50W(light fitting input power)	40W(fluorescent lamp power)+2.5W(ballast heat power)= 42.5W(light fitting input power)

7	Efficiency of lamps	No promotion of lamp efficiency	The efficiency of lamps is promoted by 20% due to adoption of high frequency electronic ballast.
8	Maintenance	It can't be started at one time with low electric voltage or low temperature, and start-up for many times is easy to damage cathode and starter of the lamp, the starter needs to be replaced often with high maintenance cost.	Start at one time without starter and the maintenance cost is low.

The advantages of electronic ballast are:

- Energy conservation. The power consumption of electronic ballast is only 40% of that of magnetic ballast, the lighting efficiency is enhanced by 20%, the working current is only 40% of the current used by magnetic ballast under high frequency of about 30KHZ, and it could start up and work in low temperature and low voltage.

- Without stroboflash. When lamps work with 30KHZ, it shines stably without stroboflash, which is in favor of vision protection.

- Without noise. It creates a quite environment for work and study.

- Long service life of lamps. One-time start-up that is free from starter, reduced impacts and flickers, and reduced work load of maintenance and replacement of the starter and lamps

- High power factor, which reduces reactive losses, enhances the availability of the capacity of power supply equipment, and reduces losses along the line.

Magnetic ballasts have advantages in structure and price and many manufacturers are making improvements on it and develop energy-saving products. For instance, Philips put forward low-loss magnetic ballast for 36W fluorescent lamps, and American ballast manufactures began to produce only energy-saving magnetic ballasts from 1990.

In accordance with the market demand, the requirements for ballasts are being

changed on the lighting fitting market. Along with the implementation of Green Lighting Project and the guidance of national policies, more users are interested in high-performance lighting products. At the same time, the sustainable development of national economy leads to new demands for lighting fixtures, which expands the fluorescent lamp ballast market. The conventional magnetic ballasts shall be eliminated gradually due to large power consumption and low energy efficiency, and new-style energy-saving ballast shall replace them. Presently electronic ballasts and energy-saving magnetic ballasts are predominant. The R&D of electronic ballasts in China started late with low technical level, and we failed to realize the difficulty and complexity of this product at the beginning. The development of semiconductor devices was behind, the products were of a poor quality, and the market was not standardized, thus consumers sustain losses and the image of electronic ballasts is injured. While in comparison, the development and utilization of energy-saving magnetic ballast is more mature with low price and high reliability, and it is an energy-saving product that conforms to the market, meets national energy-saving and environmental requirements and possesses great growth potential. Along with the implementation of Green Lighting Project and the promotion of production level, the circuit design and supporting electronic devices of lighting fixtures have entered a new stage, and high-quality products began to enter construction projects, which paves the way for the generalization of electronic ballasts and energy-saving magnetic ballasts.

The sales volume of ballasts in China is about 160 million in recent years, of which 80% are magnetic ballasts. In 2001, the production of ballasts (including fluorescent and HID ballasts) was on the rise, the total output of ballasts reached 179 millions with an annual growth rate of 11.3%, which was higher than the GDP growth rate. Wherein, the output of fluorescent lamp ballasts was 169 million with an annual growth rate of 10.9%. It is predicted that the yearly output of magnetic ballasts will be 118 million and that of electronic ballasts will be 66 million in 2004.

1.3.1.2 Current standard and the energy conservation potential of new energy efficiency standard

For the moment, the energy efficiency standard for fluorescent lamp ballasts was released on 1999. Quite a few indices in the standard are lower than that in other countries, and can't meet the demand of energy-saving technology development and green lighting for the time being, which need to be revised soon.

Replacement of conventional magnetic ballasts with electronic ballasts shall

generate considerable energy conservation effects. But starting from the situation of our country, we suggest to replace traditional magnetic ballasts with energy-saving magnetic ballasts in current stage and to encourage development of electronic ballasts, which is feasible technically and economically. Suppose the conventional magnetic ballasts are replaced by energy-saving magnetic ballasts in the transition period according to the new energy efficiency standard, and magnetic ballasts are replaced by electronic ballasts from 2005, then the power conservation in 2010 shall be 17.80TWh, amounting to 6920 kilotons of standard coal in primary energy. The power conservation in 2020 shall be 46.18TWh, amounting to 16.71 megatons of standard coal. Suppose the electric charge is 0.64 Yuan per kWh, then the net income of users for electronic ballasts is RMB 5.214 billions and the benefit-cost ratio is 1.1. The discharge reduction of pollutants brought along by power conservation will be 13.34 megatons of carbon, 203.19 kilotons of nitrogen oxide, 2.651 megatons of sulfur dioxide and 1.238 megatons of PM10 in 2020. At the same time, the peak demand shall be reduced by 9.04GW.

1.3.2 Double-capped fluorescent lamps

1.3.2.1 Overview

Since it was born in 1938, double-capped fluorescent lamps (direct-tube) have been under reforms and improvements, wherein the emergence of T8 (_26mm) fluorescent lamp in 1978 was the most important event, which means the beginning of a variety of more efficient fluorescent lamps along with application of rare earth phosphor powder of a new generation. Along with technical improvements and production practice, compact fluorescent lamps appeared in 1980's, and high-performance T5 direct-tube fluorescent lamps were put forward at the later stage of 1990's with enhanced power and reduced tube diameter.

Fluorescent lamps have been the main choice of schools, offices, stores, and halls after they are invented. Now direct-tube T8 and T5 fluorescent lamps are widely applied in different places, and compact fluorescent lamps are used to replace medium and small power incandescent lamps for local illumination due to its limits in shape and ornament. Fluorescent lamp with electronic ballasts can be applied conveniently outdoors for they can adapt to the temperature fluctuation of working environment. Direct-tube fluorescent lamps with electronic ballasts have been successfully applied in high-rise buildings or urban overpasses, viaducts as well as large bridges for contour lighting.

For the moment, main direct-tube, double-capped, fluorescent lamps produced in China include:

- T12-power from 20W to 125W;
- T10-power from 18W to 65W;
- T9-power from 19W to 36W;
- T8-power from 15W to 58W;
- T5-tricolor, power from 8W to 42W.

Wherein the power range of common double-capped fluorescent lamps is from 18 to 40W. The output of double - fluorescent lamps in China and their distribution are shown in Table 4-24.

Table 4-24 Output of double - end fluorescent lamps from 1997 to 2001

Double-capped	1997	1998	1999	2000	2001
Output	40000	42000	45000	46000	55000
T8	5000	8000	10000	13000	19000
T5	3000	3200	3500	3900	4170

Note: T5 fluorescent lamps break into two types with same caliber. One is the traditional low-duty lamps with halogen power, whose power is usually 4 -8 W. The other is the so-called T5 fluorescent with tricolor powder whose power range is from 14 to 28W.

T8 fluorescent lamps, compact fluorescent lamps and T5 fluorescent lamps are derived from conventional fluorescent lamps, and have large long-term potential.

T8 fluorescent lamps represent the trend of development, and they can replace T9, T10 and T12 fluorescent lamps for they have same length and base pins and the key is price. For the moment fully-automatic production line for T8 fluorescent lamps has been introduced with 14 operators along the whole line. The yearly output is 8.4-9 millions if the operation line runs around the clock for 300 days yearly and the percent of products that pass quality inspections is 95%. If the manufacturing cost of

T8 lamps is below 2 Yuan each and the ex-factory price is 3 Yuan each, T8 fluorescent lamps shall take more market from T9, T10 and T12, whose minimum ex-factory price is 2.6 Yuan each now. T8 is smaller diameter and uses less materials. If the ex-factory price of T8 fluorescent lamps drops to 2.8 Yuan each, T8 fluorescent lamp shall ultimately take all markets of T9, T10, and T12. Esp. the T12 lamps shall be firstly washed out from the market gradually within 10 years due to its low lighting efficiency.

Just like that T8 fluorescent lamps shall replace T12 and T9 ultimately; the appearance of T5 fluorescent lamps shall impact the T8 fluorescent lamps soon. While the extinction of a product depends on whether its performance, characteristics or advantages could be replaced by other products and whether its cost price loses marketability. It is inevitable for the product to withdraw from the market if it loses all advantages. It is clear that T8 lamps shall finally replace T9, T10 and T12 fluorescent lamps for it has advantages in all aspects, but we have the opposite conclusion in view of the relation between T8 and T5. T5 is low in cost, high in efficiency and small in size, which shall be favored for public lighting in new buildings. Different from T5, the geometric parameters and interface design of T8 are fully compatible with original T9, T10 and T12 lamps, and at the same time, rare earth tricolor T8 fluorescent lamps are put forward in the world. Experiences tell us that lighting fixtures that have laid a solid market basis shall not withdraw from market due to appearance of new products, and the common case is their shares shall be reduced gradually. Fluorescent lamps have a history of 60 years, while they are extended instead of being replaced completely, but their market share is gradually shrinking. There are more chances for T8 to replace T9-T12 and there are still more commercial chances for T8 even with the appearance of T5. In addition, T5 has more requirements on work environment and is not fit for exterior lighting or illumination in cold areas, which offers living space for T8.

T5 shall be favored in interior illumination and shall take a dominant position in some newly-built public buildings. (It needs to indicate that T5 can be very bright which produces glare on computer screens which means they can’t be used in all offices.) They will convince the whole architectural lighting circle with original types and supporting new-style light fittings. Its market demand shall be in a rapid rise although it is provided with a much higher price than T8. China will become the biggest T5 market with its high-speed economic development and large-scale urban renewal.

So we draw a conclusion that T8 and T5 shall exist together for a long term. T8

shall expand its market share in conventional fluorescent lamp market and wash out T9, T10 and T12, while T5 shall focus on interior illumination in newly-built buildings and get more market share gradually.

1.3.2.2 The energy conservation potential in current standard and new energy efficiency standard

- America

Regulations on lighting energy conservation in America are quite complicated, which relate to the Department of Energy and state governments. The lighting energy efficiency standard is issued in form of law, which must be executed (see Table -25).

Table 4-25 Primary coverage of the energy efficiency standard for fluorescent lamps in America

Type of fluorescent lamp	RATED POWER (W)	MIN. LIGHTING EFFICIENCY (LM/W)	MIN. COLOR-RENDERING INDEX (CRI)
48" fluorescent lamps with dual-pins lamp holder 」F40」FM28」F2T8」ヴ	>35	75	69
	□35	75	45
24"U-shape fluorescent lamps 」F40/U」F32T8/U」ヴ	>35	68	69
	□35	64	45
96" slim fluorescent lamps 」F96T12」F96T8」ヴ	>65	80	69
	□65	80	45
96" high output fluorescent lamps	>100	80	69
	□100	80	45

- New Zealand

New Zealand released the Minimum Energy Efficiency Standard for tube double-capped fluorescent lamps for general lighting- NZHB 4782.2:2001,which regulates the minimum lighting efficiency of different double-capped fluorescent lamps and the lighting efficiency after 70% of the nominal service life is over. In this standard, energy efficiency is graded just like that in China's standard, and the difference is that we graded the energy efficiency as 1, 2 and 3, and New Zealand grades it as P, Q, R, S. See Table 4-26 for details.

It is regulated in this standard that all double-capped fluorescent lamps should meet Q or R. Products that fail to meet Q or R shall be listed as S, which are prohibited in production or distribution.

Table 4-26 Energy efficiency grades of double-capped fluorescence lamps in New Zealand

Category	**Length (mm)**	550-600	850-900	1150-1200	1450-1500
	Power (W)	16-20	20-40	20-80	35-65
P	**Initial lighting effect F100**	Undetermined			
	Holding lighting effect FM				
Q	**Initial lighting efficiency F_{100}**	$F_{100}\geq 70.0$	$F_{100}\geq 74.0$	$F_{100}\geq 85.0$	$F_{100}\geq 85.0$
R	**Initial lighting efficiency F_{100}**	$F_{100}<70.0$	$F_{100}<74.0$	$F_{100}<85.0$	$F_{100}<85.0$
	Holding lighting efficiency F_M	$F_M\geq 57.5$	$F_M\geq 61.0$	$F_M\geq 70.0$	$F_M\geq 70.0$
S	**Initial lighting efficiency F_{100}**	$F_{100}<70.0$	$F_{100}<74.0$	$F_{100}<85.0$	$F_{100}<85.0$

	Holding lighting efficiency F_M	F_M<57.5	F_M<61.5	F_M<70.0	F_M<70.0

Note: F100 is the initial lighting effect of double-capped fluorescent lamps after having operated for 100 hours; and FM is the lighting effect when 70% of the nominal service life is over.

- Japan

Japan began to develop fluorescent lamps from 1940, and fluorescent lamps became popularized in lighting field after having produced direct-tube 40W fluorescent lamp FL40 in 1949.

Similar with America, the energy efficiency standard for energy-using products is also set in form of law and required to be implemented forcefully.

The "Law on Intelligent Use of Energy" ("Energy Conservation Law" for short), was released in 1979, and the energy efficiency standards for domestic refrigerators and cold air conditioners were regulated. In 1994, the energy efficiency standards for 3 kinds of fluorescent lamps were contained in the revised "Energy Conservation Law" (see Table 4-27), which were required to be reached by 2000. At the same time, the production specification, energy consumption, energy efficiency index and other information were required to be made clear in the catalogue and packing. For the moment, the energy efficiency standards for fluorescent lamps have been adjusted again (see Table 4-28), and the new standards shall be effective in 2005.

Table 4-27 Energy efficiency standard for Fluorescent Lamps in Japan that was effective in 2000

Use of fluorescent lamp	Energy efficiency objective (lm/w)	Standard effective date
For commerce or public use	75	January 1st, 2000
Domestic lighting	65	January 1st, 2000

Table 4-28 Target values of energy efficiency adjustment in Japan in 2005

Category		Min. energy efficiency (lm/W)
Direct-tube	100W, fast starter	79

	40W, high frequency	86.5
	40W, fast starter	71
	40W, starter	60.5
	20W, starter (electronic ballast)	77
	20W, starter (magnetic ballast)	49

- Korea

The minimum energy efficiency indices of fluorescent lamps in Korea are shown in Table 4-29.

Table 4-29 The minimum energy efficiency values of fluorescent lamps in Korea

Category		**Power W**	**Min. energy efficiency (lm/W)**	**Target energy efficiency (lm/W)**
Direct-tube	T10	20	55.0	76.0
		40	66.0	98.0
	T8	32	73.0	95.0

- Thailand

Of the power consumption in Thailand, the power consumption of lighting is 24% of the commercial power consumption, 8% of civil power consumption and 10% of industrial power consumption. The power consumption of fluorescent lamps is 70% to 80% of the total power consumption for lighting.

The yearly output of fluorescent lamps in Thailand is about 70 million, including 50 million for domestic market and 20 million for export. It is estimated that T8 fluorescent lamps take 95% of the total sales of 1200mm/600mm fluorescent lamps.

The minimum lumen index of fluorescent lamps is regulated in TISI236 - 2533 of Thailand, referring to Table 4-30.

Table 4 - 30 The minimum lumen index value of fluorescent lamps in the standard of Thailand

Color		Min. lumen	Min. lumen maintaining rate (%)		Lighting efficiency (lm/W)	
			2000h	70% service life		
600mm	Daylight color	880	80	70	18W	48.9
	Cold white	1020	80	70		56.7
	Warm white	1060	80	70		58.9
1200mm	Daylight color	2300	80	70	36W	63.9
	Cold white	2700	80	70		75.0
	Warm white	2800	80	70		77.8

- Hong Kong

The Minimum energy efficiency values of different light sources are regulated in the "Energy Efficiency Regulations of Lighting Fixtures" in Hong Kong (Table 4-31), which is exercised voluntarily.

Table 4-31 Minimum energy efficiency values of fluorescent lamps regulated in related regulations in Hong Kong.

Type of lamp	Nominal power L_w	Minimum allowable value of lighting efficiency lm/W
Tube fluorescent lamps	$L_w<18$	40
	$18\leq L_w<40$	50
	$L_w\geq40$	60

- China

For the moment, most double-capped fluorescent lamps on China's market adopt halogen powder, whose lighting efficiency is far behind fluorescent lamps with tricolor powder. The energy efficiency restriction values for 14- 21W, 22- 35W, and 36-65W double-capped fluorescent lamps in China's energy efficiency standards are shown in Table 4-32:

Table 4-32 Energy efficiency restriction values of double-capped fluorescent lamps

Nominal power scope W	Energy efficiency restriction value lm/W		
	Hue: RR, RZ	Hue: RL, RB	Hue: RN, RD
14~21	44	51	53
22~35	53	62	64
36~65	55	60	63

While the lighting efficiency level of tricolor double-capped fluorescence lamps of the same kind is: 14-21W, 68lm/W; 22 - 35W, 75lm//w; 36- 65W, 83lm//w.

It is clear from compare that the energy efficiency restriction values in China are on the low side, far behind other countries in view of the energy efficiency level of double-capped fluorescent lamps, and the development potential is huge.

It is observed from above paragraphs that the output of direct - tube fluorescent lamps grew by 6% yearly in average from 1995 to 2000. It is predicted that the lamp quality and lighting efficiency shall be promoted after implementation of energy efficiency standards, and proportions of lamps with different calibers shall be changed greatly, while the total output growth rate shall drop to about 3%.

The average yearly lighting time of double-capped fluorescent lamps is 3,361 hours in accordance with the yearly lighting time of double-capped fluorescent lamps in 4 lighting fields (table 4-33) and their distribution proportion.

Table 4-33 Yearly lighting time of different lighting places

Location	Daily lighting time	Yearly lighting days	Yearly lighting time
	Hour/day	Day/year	hour
Residents	6	360	2160
Industry	12	250	3000
Commerce	12	360	4320
Public	10	250	2500

Source: Green Lights

In the national standard "Requirements for the Performance of Double-capped Fluorescent Lamps", the nominal life of products is regulated to be 7000 and 8000 hours, which shall be converted to average service life with years as the unit in accordance with average annual lighting time. Refer to Table 4-34 for details.

Table 4-34 Average life of all classes of double-capped fluorescent lamps

Power（W）	**14-21 halogen powder**	**22-35 halogen powder**	**36-65 halogen powder**	**14-21 tricolor**	**22-35 tricolor**	**36-65 tricolor**
Yearly lighting time (hour)	3361	3361	3361	3361	3361	3361
nominal life（hour）	7000	8000	8000	8000	10000	1000
nominal life（year）	2.08	2.38	2.38	2.38	2.98	2.98

Source: Green Lights

Based on above data, suppose it is regulated in the new energy efficiency standard that T8 shall replace T12, and the standard shall be effective in 2003, then the power conservation in 2010 will be 9.57TWh, amounting to 3720 kilotons of standard coal in primary energy. The power conservation in 2020 will be 12.86TWh, amounting to 4.65 megatons of standard coal. Suppose the electric charge is 0.64 Yuan per kWh, then the net income of users for replacing T12 with T8 is RMB 43.826 billions in the service life and the benefit-cost ratio is 5.3. The discharge reduction of pollutants brought along by power conservation will be 3.72 megatons of carbon, 56.57 kilotons of nitrogen oxide, 738.08 kilotons of sulfur dioxide and 344.72 kilotons of PM10 in 2020. At the same time, the peak demand will be reduced by 2.52GW.

1.3.3 Traffic lights

1.3.3.1 Overview

Traffic lights refers to colored signal lights on roads for directing vehicles and pedestrian flows, which are mainly used on highways, toll gates, industrial and mining establishments, railways, and ferryboats. Traffic lights can be classified in various ways, φ400mm,φ300mm,φ250mm and φ200mm in view of the size of light transmission surface; metal materials (iron or aluminum) or nonmetal materials

(engineering plastics or fiberglass reinforced plastics) in view of the sheathing material; type of luminous source including incandescent lamps (<110W, 220V), low-tension tungsten halide lamps (<60W, 220V), and LED (<25W, 220V); and type of lamp (motor vehicle signal lamps, non motor vehicle signal lamps, crosswalk signal lamps, driveway signal lamps, direction signal lamps, flaring warning lights and count-down digital displays) in view of function.

The development trend of traffic lights is to replace incandescent lamps with LED. In recent years, traffic lights with LED as luminous source have been developed greatly along with implementation of "Smooth Traffic Project", and LED possession is 30% of the total installed signal lights, and LED lights are given priority in newly-installed signal lights. Table 4-35 shows the comparison of power consumption and selling price of traffic lights adopting LED and incandescent lamps respectively. Fig 4-16 shows the yearly production estimation of traffic lights.

Table 4-35 Comparison of traffic lights adopting LED and incandescent lamps respectively

Type	Red light	Green light	Yellow lamp	Red arrowhead	Green arrowhead	Pedestrian		Bicycle	
						R	G	R。Ÿ	G
Specification (W)	8W	12 W	8 W	8 W	12 W	8 W	12 W	9 W	13 W
Power consumption of incandescent lamps (W/unit)	100	100	100	100	100	100	100	100	100
Power consumption of LED lights (w/unit)	7.8	11.8	7.8	7.8	11.8	7.8	11.8	8.2	12.4
Daily average work hours	14.4	8.4	1.2	14.4	8.4	14.4	8.4	R:14.4	8.4

(h)								Y:1.2	
Selling price of incandescent lamps (Yuan/unit)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Selling price of LED lights (Yuan/unit)	100.00	600.00	140.00	50.00	250.00	50.00	250.00	55.00	260.00

Source of the data: China Illumination Association

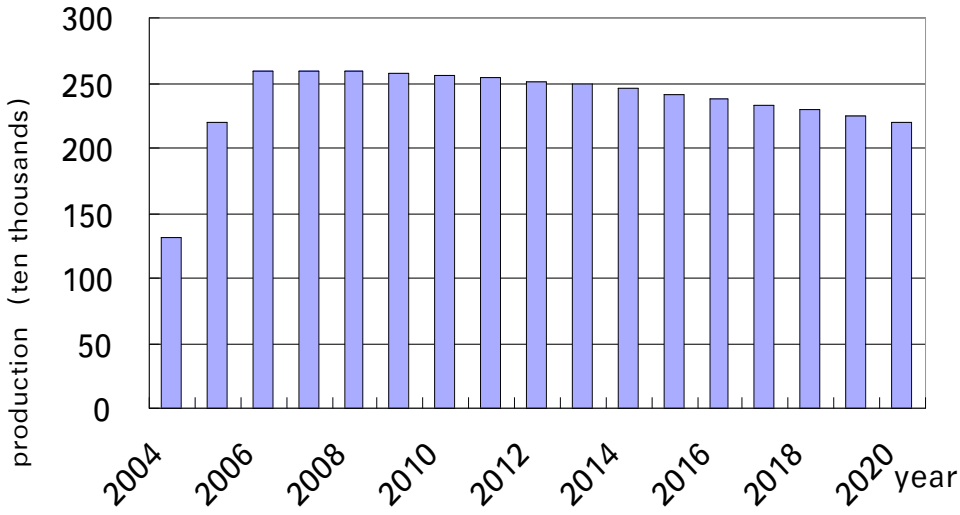


Fig 4-16 the yearly production estimation of traffic lights

In recent years, domestic LED light-emitting diode has been developed quickly. First, the technology is becoming mature gradually. Second, more LED manufacturers appear, and even some chip manufacturers appear. Third, the LED luminous intensity is enhanced greatly, Red (R) and Yellow (Y) could reach 2000-4000mcd, and green

(G) could reach 3000-4500mcd, and the service life of LED traffic life is lengthened while the power consumption is reduced.

1.3.3.2 The energy conservation potential in current standard and new energy efficiency standard

Suppose the LED lights shall replace incandescent lamps in traffic lights in the new standard, and the new standard shall be effective in 2005, then the power conservation in 2010 will be 9.09TWh, amounting to 3530 kilotons of standard coal in primary energy. The power conservation in 2020 will be 7.63TWh, amounting to 2760 kilotons of standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for replacing incandescent lamps with LED in traffic lights is RMB 25.067 billion and the benefit-cost ratio is 9.0. The discharge reduction of pollutants brought along by power conservation will be 2.2 megatons of carbon, 33.58 kilotons of nitrogen oxide, 438.06 kilotons of sulfur dioxide and 204.59 kilotons of PM10 in 2020. At the same time, the peak demand shall be reduced by 1.08GW.

1.3.4 Exit signs

1.3.4.1 Overview

Exit signs are also called safety lights, which are installed in passages, corridors, staircase doors, outlet portals and fire doors of buildings as symbols for fleeing for one's life upon fires or special disasters. It is regulated in Article 26 of "High-Rise Fire Control Rules Issued by Ministry of Public Security of P.R.C" that the passages, staircases and exits of buildings should be kept unbarred and nothing is allowed to be piled up there, and the dispersion marks and indicators lights should be kept integrated and operable". Also it is regulated in Article 10 of the "Fire Control Management Regulations in Public Recreation Places" issued by the Ministry of Public Security of PRC that standard lights should be set near fire escapes, exit passageways and staircase portals to serve as signs of dispersion. Instructive marks should be set on walls less than one meter to the ground on top of doors, at exit passageways and nooks, and the spacing between marks on walkways should be less than 20 meters". The utilization of exit signs relates to personal safety, and they are necessary for buildings.

There is a DC-AC conversion unit and an electrical storage device in each exit sign. Under normal power supply, exit signs are powered by power supply of

buildings and the storage battery shall be charged. When the power supply system is cut, the power supply of exit signs is switched automatically to storage battery, thus exit signs could be used for instructing escaping direction upon emergency power shutoff.

The demand and output of exit sings are directly related to the development of building industry. FIG 4-17 forecasts the yearly output of exit signs from 2004 to 2020.

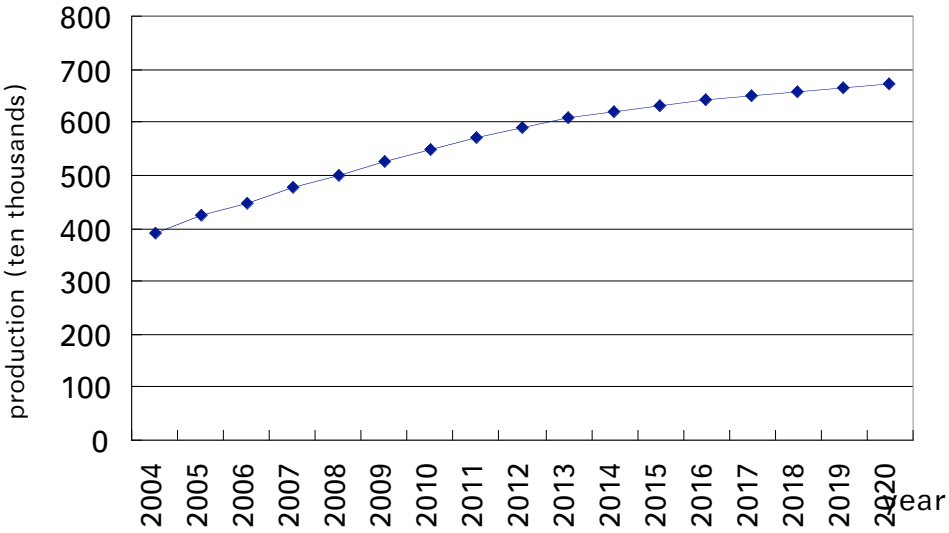


FIG 4-17 Yearly production forecast of exit signs in China

1.3.4.2 Current standard and the energy conservation potential of new energy efficiency standard

For the moment, there is no energy efficiency standard for exit signs, and most exit signs produced in China adopt fluorescent lamps. In order to promote the application of LED in exit signs, to enhance the visual range of exit signs in smog, and to reach the world energy efficiency level, China should put forward corresponding energy efficiency standard for exit signs.

The rated power of exit signs that use incandescent lamps should be around 40W, and the rated power of exit signs that use fluorescent lamps should be around 13W. But the same effects could be achieved with 3W LED lights. Suppose the LED lights shall replace incandescent lamps or fluorescent lamps in exit signs in the new standard, and the new standard shall be effective in 2004, then the power conservation in 2010 will be 3.26TWh, amounting to 1270 kilotons of standard coal in primary energy. The power conservation in 2020 will be 4.41TWh, amounting to 1600 kilotons of standard coal. Suppose the electric charge is 0.84 Yuan per kWh, then the net income of users for LED exit signs is RMB 14.456 billions and the benefit-cost ratio is 3.8. The discharge reduction of pollutants brought along by power conservation will be 1.28 megatons of carbon, 19.42 kilotons of nitrogen oxide, 253.40 kilotons of sulfur dioxide and 118.35 kilotons of PM10 in 2020. At the same time, the peak demand will be reduced by 0.63 GW.

1.3.5 HID

1.3.5.1 Overview

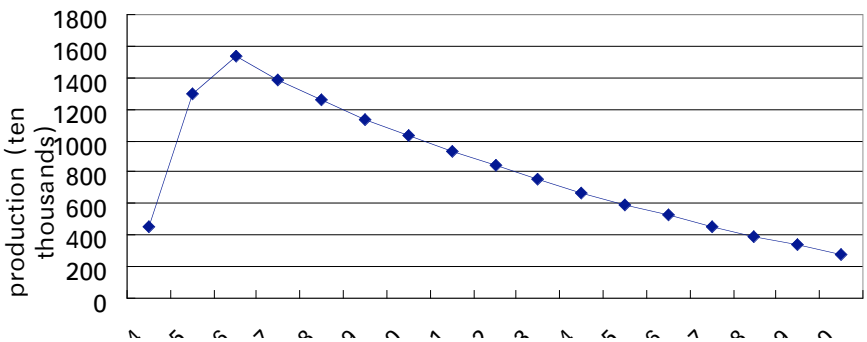
In recent years, artificial light sources with low lighting efficiency and high environmental pollution are being washed out in order to conserve power and protect environment, and they are replaced by high-efficiency and low-pollution green lighting sources. Advanced HID lights provide not only high lighting efficiency, but also color rendering, color temperature and approximate point light source discharge. Thus it renders high lighting quality, flexible lighting fitting designs and higher economic benefits with long life of service. Therefore, the invention of HID lights becomes the third illumination revolution after incandescent lamps and fluorescent lamps. HID shall be increasingly popularized in future lighting market with above-mentioned merits.

HID breaks into three types: MHL (Metal Halide Lamp), HPSL (High pressure

sodium lamp) and HPMVL (High pressure mercury vapor lamp), which adopt arc discharge for lighting that is more complicated as compared with other luminous sources, such as fluorescent lamps, incandescent lamps and halide lamps.

In HID, MHL is provided with high color rendering, high efficiency, long life and low light attenuation, wherein the high efficiency refers to the proportion of visible light in the radiant energy output as compared with that in other luminous sources. In addition, it has a wide power selection range (18W-10KW); thus it can be extensively applied in outdoor and indoor locations, such as playgrounds, roads, bridges, construction sites, shopping centers, meeting places, and show windows; in industrial applications (image processing, printing and plate making); as well as technical product applications (optical fiber engine, HDTV, LCD projectors and auto bulbs). MHL can come in many shapes. Conventional high and medium power MHL (above 100W) are applicable to outdoor lighting only due to big lighting lumen number, and the development of low-power MHL become a trend in recent years along with advances in luminous source development. In addition, low power MHL (under 70W) are being applied in household and indoor recreational facilities widely due to development of electronic ballast technology. HPSL is of a high lighting efficiency, low power consumption, and long service life. It has golden white photochromic rays, which can pass through fog and which are applicable to roads, airports, wharfs, railway stations, and industrial and mining establishments. As compared with MHL and HPSL, the lighting efficiency of HPMVL is relatively low, esp. self-ballasted HPMVL, whose lighting efficiency is approximate to that of common incandescent lamps. Generally, the lighting efficiency of HPMVL is 50lm/W, its color rendering index is 45Ra, its color temperature is 3300 to 4300k, and its average life is 6000h; while the lighting efficiency of HPSL is 100-120 lm/W with an average service life of 24000h. Therefore, HPMVL should be washed out gradually in view of the development trend of electric light sources and long-term economic benefits.

Along with the urban development in China, the road lighting conditions are being improved and the demand for HID in recent years is rising. The self-ballasted HPMVL could run without ballasts with low cost of initial installation, so self-



ballasted mercury lamps are still popular in rural and mountainous regions in China, and their yearly output is between 10 million to 20 million in recent years. As the luminous source of a new generation, the output of MHL and HPSL is being increased gradually, and the proportion of HPMVL is reduced naturally on the market. The possession of newly-added products of HPMVL from 2004 to 2020 is predicted in FIG 4-18. In this figure, products produced before 2004 are not included and the service life of HPSL is about 2 years, thus there is a rise on the left side of the graph.

FIG 4-18 Prediction of possession of newly-added products

1.3.5.2 The energy conservation potential in current standard and new energy efficiency standard

Table 4-36 shows the luminous flux and converted lighting efficiency of HPMVL quality products and top-grade products according to industry standard QB/T2051-1994. It is observed from the table that the minimum efficiency of HPMVL is between 25.4lm/W and 42.5lm/w.

Table 4-36 HPMVL luminous flux and lighting efficiency

Rated power	**Luminous flux**		**Lighting efficiency**	
W	Lm	Lm	lm/W	lm/W
	Min.	Average	Min.	Average
50	1270	1650	25.4	33
80	2380	3200	29.75	40
125	4040	5500	32.32	44
175	5950	8000	34	45.71
250	8920	12000	35.68	48
400	17000	22000	42.5	55
1000	42500	56000	42.5	56

Replacement of HPMVL with MHL and HPSL shall generate considerable energy conservation effects. Suppose the new energy efficiency standard shall be effective in 2005, then the power conservation in 2010 will be 2.51TWh, amounting

to 980 kilotons of standard coal in primary energy. The power conservation in 2020 will be 0.79TWh, amounting to 290 kilotons of standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for replacing HPMVL with MHL and HPSL is RMB 4.604 billions and the benefit-cost ratio is 3.4. The discharge reduction of pollutants brought along by power conservation will be 230 kilotons of carbon, 3.5 kilotons of nitrogen oxide, 45.61 kilotons of sulfur dioxide and 21.30 kilotons of PM10 in 2020. At the same time, the peak demand will be reduced by 0.07 GW.

1.4 Industrial and Commercial Equipment

1.4.1 Industrial boilers

1.4.1.1 Overview

China is the biggest coal producer and consumer in the world and coal is widely used in power generation, construction, heating and apartments. At the end of 1998, gross installation of industrial boilers in the whole country was 501 thousand units with a capacity of 1.257 million tons of steam. The yearly output of industrial boilers is 30 -40 thousand in recent years, with a capacity to product 80-100 thousand tons of steam.

For the time being, coal-burning industrial boilers are given priority, since these account for 90% of the gross installed capacity--1.13 million tons of steam. The rough coal consumed each year is about 400 MT with 7.2 MT S02 and 4 MT dusts being discharged yearly. Efficiency promotion of industrial boilers, esp. coal-burning boilers, is of special importance for improving environmental conditions in China and the world, and for energy consumption reduction.

- Industrial boiler manufacturing in China

In China, industrial boilers refer to boilers whose volume is less than 65 tons of steam. Boiler manufacturers are numerous and dispersed in China with low technical level. For the moment, boiler manufactures are rated as A, B, C, D and E according to boiler pressure. There are 706 manufactures that have manufacturing license above level E, wherein 9 have class A license, 18 have class B license, 40 have class C license and 149 have class D license, which are issued by the former Ministry of Machinery and Ministry of Labor jointly; and 490 manufactures have Level E1 and E2 manufacturing license issued by each province, municipality and autonomous region. In addition, there are thousands of normal pressure boiler manufactures without manufacturing license, and the yearly output capacity of the whole industry is 150-180 thousand tons of steam. FIG 4-19 shows the production of different capacity industrial boilers in China in 1999.

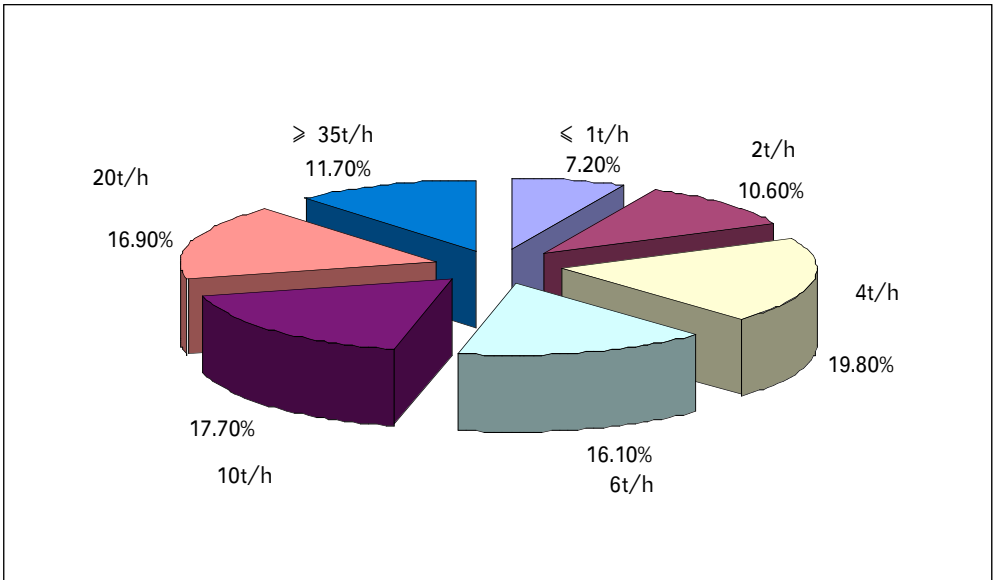


FIG 4-19 the production of different capacity industrial boilers in 1999

Statistical data shows that the average output of industrial boiler manufacturers was only 330 tons of steam in 1999. There are 15 enterprises whose yearly output was over 1,000 tons of steam, of which the output of 2 manufactures reached 2,000 tons of steam, and the output of 28 manufactures was between 500 and 1,000 tons of steam. According to statistics of the first half year of 2000, the output of industrial boilers above level D was 23 thousand units, with a capacity of 72 thousand tons of steam. For the moment, most industrial boilers produced in China are coal-burning boilers, and of all industrial boilers distributed in 1999, 79% were coal-burning boilers, 16% were fuel oil-burning boilers and 5% consumed other fuels.

After a few decades of development, industrial boiler manufacturing in China

has formed a comparatively integrated production system, and has established unique industrial boiler series. Around 50 manufactures are capable of new product development, but most products are largely identical with minor differences and low technical level, and other enterprises mostly copy drawings of others through purchase. The only industrial boiler institute in China is not capable of undertaking researches on basic theories and applied technologies, and developing new products.

- Operation of in-use boilers in China

Of all in-use industrial boilers in 1998, 240 thousand were for production, with a total capacity of 700 thousand tons of steam (account for 56% of the total installed capacity). The average unit capacity is 2.9 tons of steam. 260 thousand units were for apartments, with an average unit capacity of 2.1 tons of steam (account for 44% of the total installation capacity).

The combustion equipment of coal-burning industrial boilers is mainly grate firing chain furnace, which accounts for 63-65% of the total number of installed boilers; those that adopt reciprocating grate furnaces make 20% of the total; those that adopt fixed grate furnaces make 10%, those that adopt circulating fluid bed make 3-5%; and those that adopt other types of furnaces, coal-throwing furnaces for example, make 1%. During operation of in-use industrial boilers, the pressured components are reliable and are not likely to result in accidents, but combustion equipment, such as fire grate, transmission device, air distribution and side seal components, have quite a few problems, which need to be improved soon. Auxiliary machines are of a low level, and such problems as valve leakage, insensitive control, and inefficient dust collector, appear often, which influence boiler efficiency and environmental protection.

The unit capacity of in-use industrial boilers is only 2.4 steam ton on average. Among the in-use industrial boilers, about 33-47% are spare boilers, whose working pressure is 50% lower than the design pressure, and whose service load is only 60-80% of the design load. The practical operating efficiency of in-use industrial boilers is only 60-70%, 10-15% lower than the design efficiency, and that of some boilers is only 30%. Seeing that the operating efficiency of coal-burning boilers in developed countries is 80-85% on average, the operating efficiency of operators needs to be further enhanced in China.

The coal used by in-use industrial boilers is mainly raw coal with unstable quality and granularity, the content of small coal whose diameter is less than 3mm takes 45-65% in the raw coal, while lump coal whose diameter is bigger than 10mm is

only 15-30%. Coal consumption for power generation is only 20 MT each year, 6-8% of the total coal consumption of industrial boilers. The proportion of cleaned coal is quite low for various reasons. 75.5% of the coal used by industrial boilers is bituminous coal, 9.7% is anthracite, 9.1% is low grade coal and 5.6% is lignite.

1.4.1.2 Analysis of energy-saving technology

- Primary energy conservation barriers

For the moment, the barriers to efficiency improvements in industrial boilers in China include:

a) Raw coal is widely used in industrial boilers, wherein small coals whose diameter is less than 3mm take a large proportion, which is 40-65%. Fire grates have a poor quality, thus heat losses due to incomplete combustion is 10-27% generally, 8-12% higher than the recommended value in Chinese Industrial Standards. The design value in Britain is only 3-5%, and thus heat loss due to incomplete combustion is 5-10% higher than that in foreign countries.

b) The technical study and development of new products or new technologies are insufficient in China. On the one hand, most enterprises purchase drawings of designs, and on the other hand, large international corporations in developed countries are only interested in large utility boilers. For the moment, corporations abroad that are engaged in production of coal-burning industrial boilers are small, which have insufficient design and development force, and are reluctant to assume profit risks by entering China's market.

c) Now environmental protection is highly emphasized, and the country has revised the "Boiler Air Pollutant Emission Standard", which presents higher demands for industrial boilers, but the law enforcement and funds for complying boiler purchases are not adequate.

d) There are too many boiler manufacturers with surplus production capacity. The yearly output capacity is about 150 thousand tons of steam, while the market demand is only 80 thousand tons of steam, which results in fierce competitions in the market and it is difficult for good products to expand their market share. The production scale is small, and the industrial concentration and intensity are still in the primary stage. Poor economic performance leads to

inability to develop new products, and newly-developed products continue to follow former models with low efficiency.

e) The operation and management of boilers is of a low level, and the stokers are unqualified in safety, cleanness, and energy conservation. In addition, most coal-burning industrial boilers users do not have supporting automatic control systems.

- Energy-saving technologies

Energy-saving technologies for boilers have progressed in recent years, and the main energy-saving technologies are as follows according to existing manufacturing process and product features:

a) Test items of boiler efficiency. When measuring heat losses with boiler thermal efficiency, following items should be measured, such as dry & wet-bulb temperature (onsite temperature), air temperature, fuel preheating temperature, water temperature, discharge temperature, exhaust oxygen content, CO and CO2 content, furnace surface temperature, and wind speed in stokehold.

b) Factors that affect boiler efficiency and energy-saving methods, reduction of excess air for instance (e.g., see Table 4-37 which shows the relation between excessive air and boiler efficiency); lower (fume) discharge temperature; letdown boiler pressure; adjust fuel oil temperature; adjust fuel oil atomization pressure; decrease boiler discharge; decrease vapor leakage; reduce burner deposition; control feed temperature; and reduce heat loss.

Table 4-37 The relation between excess air and boiler efficiency

%CO_2	**% excess air**	**% efficiency**	**Practical efficiency decrease**
14.0	10	84.8	
7.5	100	78.5	7.5%
6.0	140	75	11.6%

Source: GEF

1.4.1.3 Current standard and the energy conservation potential of new energy

efficiency standard

For the moment, China has not formulated a national-level mandatory energy efficiency standard for boilers, and the average efficiency of coal-burning boilers in China is 12-15% lower than that in foreign countries. If the operating efficiency of coal-burning industrial boilers is promoted from 65% to 75% in the new standard, effective in 2005, then 11.5 MT standard coal will be saved in 2010, and 35.65 MT standard coal will be saved in 2020. Suppose the average coal price is RMB 247 Yuan per ton, then the net income is RMB 31.339 billions and the benefit-cost ratio is about 30. The pollutant discharge reduction will be 24.19 megatons of carbon, 368.3 kilotons of nitrogen oxide, 4804.9 kilotons of sulfur dioxide and 2244.1 kilotons of subparticles in 2020, which is in favor of energy conservation and environmental protection.

1.4.2 Water pumps

1.4.2.1 Overview

Pumps play an important role in China's national economy, which are widely used in all walks of life and consume 20% of the gross power generation each year. There are about 5 thousand pump manufacturers in the whole country, whose annual output is 2.23 million pumps, and the capacity of supporting motors is 20 GW, wherein clean water centrifugal pumps are 58.52% of the total output (source of data: output of pumps is from Statistical Yearbook, and the proportion of clean water centrifugal pumps is from IIEC).

Since 1980's, China has begun to eliminate low-efficiency and high-energy consumption pumps. In 1996, the "1996 Recommended Energy-Saving Blower Fans and Water Pumps" was compiled in order to further generalize energy-saving pumps.

For the moment, common industrial pumps are overstocked, while the demand for high-level and top-grade pumps exceeds supply, which are imported from abroad. Domestic products can reach the world level at the end of 1980's or the beginning of 1990's, which can't meet market demand and users' demand with unreasonable industrial structure and product structure. Therefore, products are overstocked on one hand, and products in urgent need are behind times and can't break traditional product structure on the other hand.

It is observed from Fig 4-20 that the output of pumps in China is rising, and the average annual growth rate is about 5%. The output of pumps in China is predicted to maintain a sustainable growth rate in the next period if we strengthen management of product quality, replace imported pumps with domestic pumps, develop the comparative advantage of domestic pumps on international market, and increase export volume.

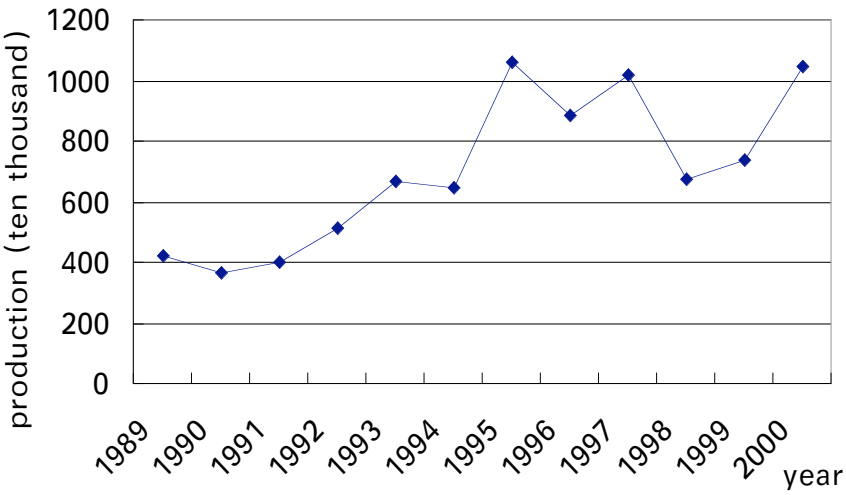


FIG 4-20 The yearly output of pumps up to 2000

1.4.2.2 Current standards and energy conservation potential of new energy efficiency standard

For the moment, the country vigorously advocates development of energy-saving products, and the energy-saving pumps and blower fans have been listed as main demonstration projects by the State Council. It is presented in the Tenth Five-Year Plan for Energy Conservation and Integrated Resource Utilization that energy efficiency standard for energy-using products, water pumps for instance, should be formulated and perfected, which shall offer technical basis for eliminating high energy consumption products and developing energy-saving product certification and energy efficiency labeling system. Therefore, energy efficiency standard is in urgent demand to support implementation of related energy policies and to quicken the development of electromechanical products to be energy-saving products.

The efficiency of pumps in China is far from that in foreign countries although it has been greatly promoted; for example, the efficiency of clean water pumps has reached 70-80%. Suppose the efficiency in the new standard is promoted to 76.8%

from weighted average 75.5% (a modest improvement), the yearly power consumption of each water pump is reduced by 1110kWh, and the new standard is effective in 2004, then the power conservation in 2010 will be 16.64TWh, amounting to 6.47 MT standard coal in primary energy. The power conservation in 2020 will be 29.49TWh, amounting to 10.67 MT standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for using energy-saving water pumps is RMB 70.558 billions and the benefit-cost ratio is 24.8. The discharge reduction of pollutants due to power conservation will be 8.52 MT carbon, 129.75 kilotons of nitrogen oxide, 1.693 MT sulfur dioxide and 790.6 kilotons of subparticles in 2020. At the same time, the peak value demand will be reduced by 5.96GW.

1.4.3 Distribution Transformers

1.4.3.1 Overview

Power transformers (include transmitting transformers and distribution transformers) are widely used in all branches of the national economy. Transformers have huge energy conservation potential for they are extensively applied with long operation time, esp. 10kV and 35kV medium/small transformers (namely distribution transformers). At the same time, the reliability of transformers is of crucial importance to the power supply of electric networks.

Along with fast development of industrial construction and urban construction in China, more and more transformers are being applied. The annual growth rate is 5% on average since 1990. FIG 4-21 shows product of transformers from 1978-2000. Among in-use transformers, quite a few should be eliminated. The gross capacity of high energy-consuming distribution transformers of ‘64’ and ‘73’ series that have served for over 20 years is 22.04 GW. Transformers are aging in large enterprises, and high energy-consuming transformers are about 29% of the total. High-performance transformers are in great demand and have huge market potential.

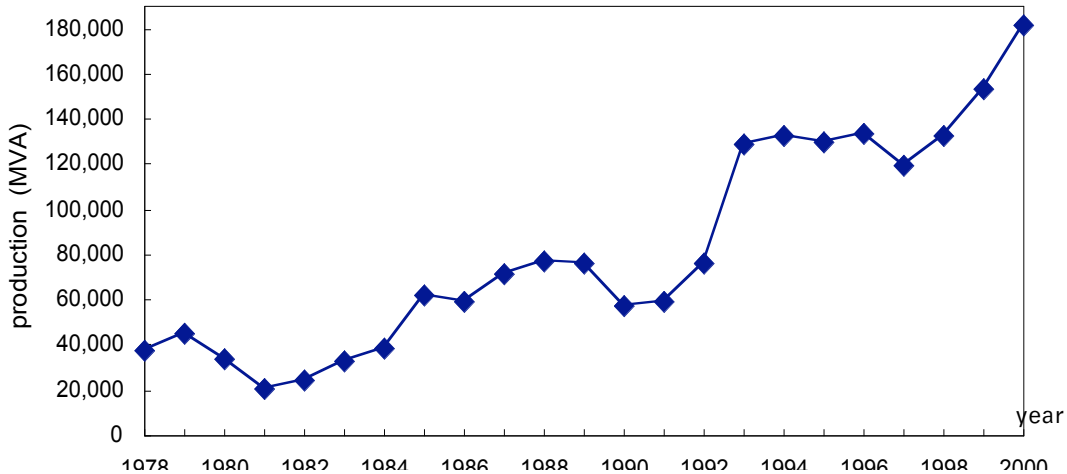


FIG 4-21 production of transformers from 1978-2000

The output of medium/small transformers in China will likely keep on increasing in the next 10 years, and Table 4-38 show the predicted possession of newly-added medium/small transformers (2004-2020).

Table 4-38 The possession of newly-added medium/small transformers in China

Year	Production (million KVA)	Year	Production (million KVA)	Year	Production (million KVA)
2004	93	2010	1255	2016	2489
2005	283	2011	1456	2017	2701
2006	472	2012	1659	2018	2914
2007	664	2013	1864	2019	3128
2008	859	2014	2071	2020	3344
2009	1056	2015	2279		

1.4.3.2 Current standards and energy conservation potential of new energy efficiency standard

Distribution transformers are provided with three product standards in EU: international standards (ISO and IEC), European standards and regulations (EN and HD) and national standards (for instance BSI, NF, DIN, NEN, UNE, and OTEL). Among international standards, two primary European agreements regulate energy

efficiency level:

HD428 tri-phase oil immersed distribution transformers, 50Hz, 50- 2500kVA, and the maximum voltage is no more than 36kV; and HD538 tri-phase dry-type distribution transformers, 50Hz, 50- 2500kVA, and the maximum voltage is no more than 36kV.

American NEMA approved "Guide Rules for Determining Energy Efficiency of Distribution Transformers" (NEMA Standard Publication TP 1-1996) in 1996, whose purpose is to promote the application of high-performance transformers and assist buyers in selecting high-performance transformers.

Most 10kW and 35kW transformers are designed according to voluntary ministry standards in China, which have gone through revisions time after time, and products have developed from former high energy consumption SJ1, SJ2, SJ3, SJ4, SJL and SJL1 series and D1, S2, S5, SL, SL1 and SL3 series to current low energy consumption S9 series. The efficiency levels of transformers in China are diversified now along with transformation from planned economy to market economy, and demand for power conservation and environmental protection by the society. In addition, in view of the production technology level of China's enterprises, many of them have possessed the capacity of producing high-performance transformers, therefore, energy efficiency standard should be adopted to standardize transformer market under current market economy system, and to boost the development of high-performance transformers. CECP has listed the energy conservation certification of transformers in its plan, which shall promote the development of energy-saving product certification in China. Table 4-39 show the loss of four series of transformers.

Table 4-39 Losses of Four Series of Oil-Filled Transformers of different sizes

KVA	Europe C Series (W)		China S11 (W)		China S9 (W)		China S7 (W)	
	Load losses	No-load losses	Load losses	No-load losses	Load losses	No-load losses	Load losses	No-load losses
50	875	125	870	130	870	170	1150	190
100	1475	210	1500	205	1500	290	2000	320
160	2000	300	2150	284	2200	400	2850	460
250	2750	425	3050	409	3050	560	4000	640
400	3850	610	4300	570	4300	800	5800	920
630	5400	860	6200	851	6200	1200	8100	1300
1000	9500	1100	10300	1200	10300	1700	11600	1800
1600	14000	1700	14500	1706	14500	2400	16500	2650

Suppose S9 series replace S7 series in the new standard, each transformer could

save power 2086kWh yearly, and the new standards is effective in 2004, then the power conservation of high performance transformers in 2010 will be 8.29TWh, amounting to 3.22 MT standard coal in primary energy. The power conservation in 2020 will be 22.08TWh, amounting to 7.99 MT standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for using high-performance transformers is RMB 30.182 billion and the benefit cost ratio is 4.9. The discharge reduction of pollutants due to power conservation is 6.38 MT carbon, 97.16 kilotons of nitrogen oxide, 1.268 MT sulfur dioxide and 592.0 kilotons of subparticles in 2020. At the same time, the peak value demand will be reduced by 4.18GW.

1.4.4 Central air conditioners

1.4.4.1 Overview

In the last few years, China's economy is developing in the way that favors the central air conditioning industry. On the basis of macroeconomic policies, the state’s primary investment projects include realty, and technology-intensive industries (such as electrommunication, medicine, and chemical industry) and central air conditioners are widely applied in these industries.

In 2001, the growth rate of central air conditioner sales was 7-8%, the same as the annual growth rate of China's economy. China is the biggest distribution market of water chilling units, whose sales volume was 34,000 units in 2001, and the annual growth rate is more than 8.5%. At the same time, the distribution mode is being changed greatly, and heat pumps and small water chilling units are becoming more popular. Frequently, users install several small water chilling units instead of installing a big plant unit in order to make the operation of each part more efficient. As a result, the sales volume of screw and scroll water chilling units is increasing, and they are welcomed by more and more design institutes. Conversely the demand for absorbing type water chilling units is decreasing gradually, but there are still many manufacturers.

In 2000, the gross market sale of principal air conditioners (chillers) in China was 36,585 units. Table 4-40 shows sales volume and market share of different types of chiller units. The output of piston water chilling units somewhat dropped over the previous year, and the output of other types of air conditioners was distinctively increased over the previous year. The growth rate of different types of machines are as follows: piston-type water chilling units - 7.3%; screw water chilling unit 29.3%; centrifugal water chilling units 37.22%; lithium bromide absorbing water chilling

units 20.45%; air-cooled heat pumps 75.85%; and packaged unitary air conditioning units 16.13%.

Table 4-40 Sales volume and market share of all classes of air conditioners

Classification	1998		1999		2000	
	Sales Volume	Market Share (%)	Sales Volume	Market share (%)	Sales Volume	Market Share (%)
Piston-type	4360	18.4	4315	15.8	4000	10.9
Screw-type	2287	9.7	2706	9.9	3500	9.6
Centrifugal-type	543	2.3	583	2.1	800	2.2
Absorbing-type	2800	11.8	2613	9.6	3285	8.9
Air-cooled hot pump	5750	24.3	8530	31.2	15000	41
Unitary-type	7921	33.5	8611	31.5	10000	27.3
total	23661	100	27358	100	36585	100

Source: China Association of refrigerating and air conditioners

The output of central air conditioners in China ranks the third in the world after the U.S. and Japan. Through technology import, joint ventures, and Sino-foreign collaboration since 1990's, the product performance, energy efficiency level and production technologies and equipment are greatly improved, and the production and management level of some key enterprises has reached or approached the advanced level in the world.

Between 1996 and 2000, the market size and production of central air conditioners fluctuated, and the average annual growth rate was about 10%. Now traditional domestic products, products of joint ventures and famous international brands coexist on the market due to restriction of market capacity and the state's macro policies, and they are competing in technology, quality, service, fund, management, and marketing. American Carrier and York, Japanese Daikin and Sanyo, and Korean LG are all carrying out their marketing strategy in China, thus the central air conditioner market in China is following the development trend in the world.

1.4.4.2 Analysis of energy-saving technologies

For the moment, the following ways are used to enhance energy efficiency in large water-chilling units:

- Compressor is a primary part for energy efficiency promotion, but its energy efficiency is unlikely to increase by than 3% by 2007 after fast development for over 20 years.

- Energy efficiency could be promoted through improving blower fan motors and air flow. The electrical efficiency of PSC motors is only 60%, while that of ECM motors could reach 85%, but now high-performance air conditioners have adopted ECM, whose electrical efficiency is often not promoted heavily. Improvement of air flow will reduce the power consumption of indoor and outdoor fan motors, which depend on improved fan design, case body structure and forms.

- Friction losses are hard to be reduced without enlarging caliber of pipes. If caliber is enlarged, the scavenge oil of the refrigeration system is more difficult and heat interchange effects will be reduced, therefore friction losses in pipelines are difficult to reduce any more.

- Energy efficiency could be promoted through lowering condensing temperature, enhancing vaporization temperature as well as lowering power consumption of fans. But the technologies related to circular pipes and slab ribs are quite mature now and hard to be improved any further. Adoption of other heat exchangers, micro-channel heat exchanger for example, will promote EER a little over 16 EER (Btu/W), the maximum level for the moment.

- Variable speed control of motors

Products of 15 SEER or more on the market often use variable speed technology, and products of 14 SEER sometimes adopt variable speed technology on fans of indoor machines. Variable speed technology enhances the energy efficiency of air conditioners, enhances the comfort of consumers and reduces energy consumption.

For the moment, AC converters or DC controllers are adopted in speed transmission system in accordance with types of electric motors. Indoor fan electromotors of high-SEER systems often use permanent-magnet DC motors. The development of power supply technology and digital control technology will make

variable speed technology more reliable and cheaper.

- High-performance compressors

Compressor manufacturers have been pursuing high-performance design in order to enhance EER and SEER. Most of their technologies are proprietary, but the Compliant Scroll compressors of Copeland Corporation and bi-constant speed compressors of Bristol enable air conditioner manufacturers to assemble bi-volume air conditioners easily. The performance of variable speed compressor is better than constant speed compressor in the case of low refrigerating output, but they are inferior to constant speed compressors in performance in the case of high refrigerating output.

- Micro-channel heat exchangers

Some manufacturers have developed a micro-channel heat exchanger that is used in air conditioners on automobiles and that is different from conventional circular pipe and slab rib heat exchangers, the cross section of its heat exchange tube is a rectangle with quite a few micro-channels, through which refrigerant passes through. There are aluminum fins welded between heat exchange tubes. This heat exchanger is efficient in heat exchange with little air resistance, which could enhance system efficiency as condenser of home air conditioners.

Micro-channel heat exchangers have been applied in auto industry for years, but have not entered the building air conditioner market. The reason is that building air conditioners do not have such strict restrictions on size and weight as auto air conditioners on one hand, and there are many uncertainties for air conditioners to adopt such heat exchangers on the other hand. For the moment, quite a few primary OEMs are testing the performance of air conditioners that adopt micro-channel heat exchangers.

1.4.4.3 Current standard and the energy conservation potential of new energy efficiency standard

GB/T 18430.1-2001 "Vapor Compression Cycle Water Chilling Unit (heat pump), and Water Chilling Units (heat pump) for Industry, Commerce or Similar Usages" was released on August 30th, 2001, and was implemented on April 1st, 2002. It regulates the models, basic parameters, technical requirements, test methods, test rules, marks, packing and storage of water chilling units (heat pumps) for industry, commerce and other like uses that adopt vapor compression refrigeration cycle and are driven by

electric motors. They are applicable to central air conditioners above 50kW or water chilling units for processing, and applicable to plant units that adopt chemical agent in water as cold (heat) loader in order to prevent freezing due to external air temperature. Plant units driven by engines (diesel engines, gas-engines), or turbines (vapor turbines, gas turbines) could consult this standard. This standard is similar to ARI Standard 550/590 - 1998, which is concise and clear. The refrigeration performance factors regulated in this standard should not be lower than the numerical values presented in Table 4-41.

Table 4-41 Refrigeration performance factors (COP, EER and W/W) under nominal operating conditions)

Type of compressor	Reciprocating piston-type		Scroll-type		Screw-type			Centrifugal type	
Refrigerating capacity, kW	>50~116	>116	>50~116	>116	≤116	116~230	>230	≤1163	>1163
Water cooled	3.5	3.6	3.55	3.65	3.65	3.75	3.85	4.5	4.7
Air-cooled & evaporating type	2.48	2.57	2.48	2.57	2.46	2.55	2.64	—	—

Note: This standard is recommended.

Source: CNIS

GB/T 18430.2-2001 "Vapor Compression Cycle Water Chilling Units (heat pump), and Water Chilling Units for Home Use or Other Uses" was released on August 30, 2001, and was implemented on April 1st, 2002. It regulates the models, basic parameters, technical requirements, test methods, test rules, marks, transport and storage of water chilling units (heat pump) for industry, commerce and other like uses that adopt vapor compression refrigeration cycle and are driven by electric motors. It is applicable to central air conditioners whose refrigerating output is less than 50kW and other sister machines could take this standard as reference. The refrigeration performance factors regulated in this standard should not be lower than the numerical values summarized in Table 4-42.

Table 4-42 Refrigeration performance factors (COP, EER and W/W) under nominal operating conditions)

Nominal refrigerating capacity (kW)	Refrigerating performance factors		
	Air-cooled	Water-cooled	Evaporating-cooled
<8	2.30		2.60
≥8-16	2.35		2.70
≥16-31.5	2.40	3.30	2.80
≥31.5-50	2.45	3.40	2.90

GB/T 17758-1999 "Cellular Air Conditioners" was released on May 25th, 1999, and was carried out on December 1st, 1999. It regulates the definition, model, basic parameters, technical requirements, tests, test rules of cellular air conditioners, and air conditioners for automobiles, trains ands boats. In the standard, various types of cellular air conditioners are presented, and the EER value for each type is offered according to different refrigerating output.

In general, the formulation of Chinese Standards consults relevant standards in America and Japan, and the test requirements are described in detail just like that in the United States. The difference is that no computing formula is presented for EER of partial load, and the reason is that we are not quite familiar with climatic conditions of different regions, while the computing formula of America is not applicable to China's situation.

For central air conditioner users, the cold water refrigerating units take a considerable part of the gross capacity, whose performance affects users' economic benefits directly. Refrigerating air conditioners consume more energy, making energy savings vital. Suppose the minimum energy efficiency restriction value shall be increased by 9% over the current level, and the new standard is effective in 2005, then the power conservation resulting from high-performance central air conditioners in 2010 will be 7.07TWh, amounting to 2.75 MT standard coal of primary energy. The power conservation in 2020 will be 16.66TWh, amounting to 6.03 MT standard coal. Suppose the electric charge is 0.84 Yuan per kWh, then the net income of users from using high performance air conditioners is RMB 53.834 billions; the benefit-cost ratio is 14.5. The discharge reduction of pollutants due to power conservation will be 4.81 MT carbon, 73.29 kilotons of nitrogen oxide, 0.956 MT sulfur dioxide and 446.56 kilotons of subparticles in 2020. At the same time, peak electrical demand will be

reduced by 6.13GW.

1.4.5 Electric Motors

1.4.5.1 Overview

Electric motors are primary motive power machines in people's life and production, which are widely applied and are closely related to people's life. The yearly power consumption of electric motors in China takes more than 60% of the total industrial load, while the output of medium/small electric motors takes 70% of the total output of electric motor, therefore, promotion of power utilization efficiency of medium/small electric motors is important for energy conservation, environmental protection and sustainable economic growth in China.

For the moment, there are more than 300 series of medium/small electric motors with almost 1500 models produced in China. Products with a rated power between 0.55kW and 315kW, 2, 4 or 6 poles (and sometimes 8), and with frame numbers between 80 and 355mm are widely applied in industry, agriculture, national defense, general services and household electrical appliances. The export volume of electric motors is 7 GW yearly, 20% of the total output of AC electric motors, and they are the most important electromechanical products for export in China.

Most of in-use motors in China are tri-phase asynchronous motors with a rated power between 0.55kW and 100kW, among which Y series account for 70% and Y2 series account for 10%. Y series were designed in a unified way at the beginning of 1980’s, whose energy efficiency level is similar to world average level at the end of 1970’s. The annual production of Y series is about 20 million kW with a grow rate of 5%. The energy efficiency level of Y2 series is similar to world average level at the end of 1980’s. The annual production of Y2 series can reach 4 million kW.

It is forecasted that the yearly output of medium/small asynchronous motors will reach 39 GW by 2010, and 47 GW by 2020. FIG 4-22 shows the yearly output of medium/small asynchronous machines

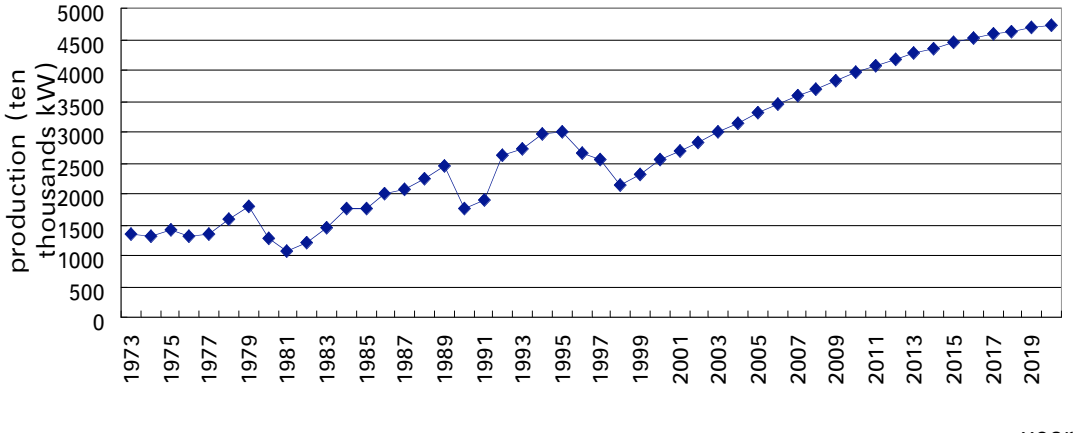


FIG 4-22 Prediction of production increase of electric motors in China

1.4.5.2 Current standards and energy conservation potential of new energy efficiency standard

EU CEMEP standard regulates high and low efficiency indices of electric motor of each specification. Products whose efficiency value is lower than the low index are called eff3 electric motors, products whose efficiency value is between high index and low index are called eff2 motors and products whose efficiency value is higher than the high index are called eff1 motors. The efficiency of high-performance motors is 1-5% higher than that of common electric motors, and their energy consumption drops by 1-6% correspondingly. Table 4-43 lists the efficiency indices of CEMEP - EU.

American Congress passed "Energy Policy Act" in 1992, namely EPACT. In the Act, the minimum efficiency of electric motors was regulated, which was effective in 60 months. Under EPACT motors that fail to meet the energy index in ACT are not allowed to be produced in America or imported into America after October, 1997. EPACT efficiency index was based on approximately the average efficiency value of high-efficiency motors produced by primary electric motor manufacturers in America. For the moment, electric motor manufacturers in America have followed this Act in motor production, and have completed the transition from production of common motors to high-efficiency motors. To further promote the energy conservation of motors, DOE, Environmental Protection Administration as well as CEE in America are encouraging the production and application of Premium-Efficiency Motors, whose efficiency is approximately 2% higher than that of general high-efficiency motors. The EPACT efficiency index of electric motors in America is regulated according to NEMA12-10 formulated by NEMA in 1990. Table 4-44 shows the American NEMA12-10 Standard efficiency values. EPACT refers to the “Rated” values and not

the “Min” values.

Table 4-43 EU CEMEP bipole electrical efficiency rating

KW	eff3 _ (%)	eff2 _ (%)	eff1 _ (%)
1.1	<76.2	≥76.2	≥82.8
1.5	<78.5	≥78.5	≥84.1
2.2	<81.0	≥81.0	≥85.6
3	<82.6	≥82.6	≥86.7
4	<84.2	≥84.2	≥87.6
5.5	<85.7	≥85.7	≥88.6
7.5	<87.0	≥87.0	≥89.5
11	<88.4	≥88.4	≥90.5
15	<89.4	≥89.4	≥91.3
18.5	<90.0	≥90.0	≥91.8
22	<90.5	≥90.5	≥92.2
30	<91.4	≥91.4	≥92.9
37	<92.0	≥92.0	≥93.3
45	<92.5	≥92.5	≥93.7
55	<93.0	≥93.0	≥94.0
75	<93.6	≥93.6	≥94.6
90	<93.9	≥93.9	≥95.0

Table 4-44 American NEMA12-10 Standard Efficiency Values.

	2P		4P		6P		8P	
Horse power	Rated	Min	Rated	Min	Rated	Min	Rated	Min
1.0	75.5	74.0	82.5	81.5	80.0	78.5	74.0	72.0
1.5	82.5	81.5	84.0	82.5	85.5	84.0	77.0	75.5
2.0	84.0	82.5	84.0	82.5	86.5	85.5	82.5	81.5
3.0	85.5	84.0	87.5	86.5	87.5	86.5	84.0	82.5
5.0	87.5	86.5	87.5	86.5	87.5	86.5	85.5	84.0
7.5	88.5	87.5	89.5	88.5	89.5	88.5	88.5	84.0
10.0	89.5	88.5	89.5	88.5	89.5	88.5	88.5	87.5
15.0	90.2	89.5	91.0	90.2	90.2	89.5	88.5	87.5
20.0	90.2	89.5	91.0	90.2	90.2	89.5	89.5	88.5
25.0	91.0	90.2	92.4	91.7	91.7	91.0	89.5	88.5
30.0	91.0	90.2	92.4	91.7	91.7	91.0	91.0	90.2
40.0	91.7	91.0	93.0	92.4	93.0	92.4	91.0	90.2
50.0	92.4	91.7	93.0	92.4	93.0	92.4	91.7	91.0
60.0	93.0	92.4	93.6	93.0	93.6	93.0	91.7	91.0
75.0	93.0	92.4	94.1	93.6	93.6	93.0	93.0	92.4
100.0	93.6	93.0	94.5	94.1	94.1	93.6	93.0	92.4
125.0	94.5	94.1	94.5	94.1	94.1	93.6	93.6	93.0
150.0	94.5	94.1	95.0	94.5	95.0	94.5	93.6	93.0
200.0	95.0	94.5	95.0	94.5	95.0	94.5	94.1	93.6

Source: IIEC

Note1: U.S. standard based on IEEE B standard, which is a more stringent test standard than the IEC test standard generally used in China. Efficiencies are generally 1-2 efficiency points lower with IEEE B than with IEC when the same exact motor is tested.

Note2: output data over the years is from the Statistical Yearbook.

For the moment, the motor energy efficiency restriction value in China is equal to the minimum limit of eff2 of EU, and the efficiency value is close to former Y2 series, so current motor energy efficiency standard in China can't promote the

integrated level of motors in China greatly, and it should be improved in the next few years.

Suppose the average efficiency of electric motors is promoted to 86.5% from 85.3% in the new standard (i.e., for going to EU Eff-1 level, but short of U.S. standard), the power savings of each electric motor is 289kWh on average, and the new standard is effective in 2004, then the power conservation of high performance electric motors in 2010 will be 11.29TWh, amounting to 4.39 MT standard coal in primary energy. The power conservation in 2020 will be 16.46TWh, amounting to 5.96 MT standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for using high-performance electric motors is RMB 37.3 billion and the benefit-cost ratio is 5.0. The discharge reduction of pollutants due to power conservation is 4.76 MT carbon, 72.42 kilotons of nitrogen oxide, 0.945 MT sulfur dioxide and 441.26 kilotons of subparticles in 2020. At the same time, the peak value demand shall be reduced by 3.32GW.

1.4.6 Blower fans

1.4.6.1 Overview

Blower fans are important power consumption equipment that are widely applied in different branches of the Chinese economy. The annual power consumption of blower fans is 81,000 GW, about 10% of the gross power output. Blower fans are universal machines for gas compression and transport, which are widely used in cement, metallurgy, mining, light textile and construction projects. Now there are 7 categories, 200 series and 2000 models of blower fans on the Chinese domestic market. Ventilation blower fans are primary products, which are 65% of the total output of blower fans. There are about 2,000 blower fan manufacturers and the yearly output is 669 thousand blower fans.

Compared with blower fan products abroad, there are few mainstream products in China, and the energy efficiency is 2-10% lower. Efficiencies are lower because the domestic blower fan industry is of a low manufacturing level, has poor system reliability and low operating efficiency; the product quality of some small enterprises is poor, which results in lower overall efficiency; and the efficiency consciousness of users is poor. The output of blower fans in the past 10 years has fluctuated a lot, and the growth rate is predicted to be 4.9-20% in the next 10 years. The possession of newly-added ventilation blower fans is estimated to be 3.3 million until 2010, and 5.1 million until 2020. The export volume of blower fans is not huge, and many of them

are exported as auxiliary parts of power stations. Some medium and minor enterprises have entered the international market, but the export products give priority to fittings and ventilation blower fans with little technical content, and products are mainly exported to South-East Asia and Pakistan.

1.4.6.2 Current standards and energy conservation potential of new energy efficiency standard

In the Tenth Five-Year Plan for Energy Conservation and Integrated Resource Utilization, it is presented that China shall formulate and carry out energy efficiency standard and certification labeling system of blower fans in order to promote the energy efficiency level of blower fans, and to standardize market of energy-saving blower fans.

Suppose the new standard is effective in 2004, the minimum energy efficiency restriction value in the new standard shall promote the average efficiency of blower fans from 67.5% to 69.0% (a modest improvement), and the yearly power consumption of each blower fan is reduced on average by 3432kWh, then the power conservation due to application of high-efficiency blower fans in 2010 will be 7.87TWh, amounting to 3.06 MT standard coal in primary energy. The power conservation in 2020 will be 12.27TWh, amounting to 4.44 MT standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for using energy-saving blower fans is RMB 31.32 billion and the benefit cost ratio is 17.3. Discharge reduction of pollutants due to power conservation will be 3.54 MT carbon, 53.97 kilotons of nitrogen oxide, 704.1 kilotons of sulfur dioxide and 328.8 kilotons of subparticles in 2020. At the same time, the peak value demand will be reduced by 2.48GW.

1.4.7 Air Compressors

1.4.7.1 Overview

The yearly demand of air compressors is rising along with social development and sustainable economic development. At the beginning of 1990's, the yearly output of air compressors in China was about 500 thousand. These came from state-owned enterprises. Such enterprises continue to produce equipment, but in addition, individual enterprises also produce equipment, with production now reaching 300 thousand per year. Thus it is obvious that the development of air compressors is rapid. The West Development, West-East Pipeline Project, South-North Water Transfer and

policies on strengthening infrastructure construction and enlarging domestic demand all relate to application of air compressors.

According to statistics of related departments, the energy consumption of air compressors is about 10% of the gross power generation in the whole country. As early as 1987, the total installed power of compressed air stations in mechanical industry reached 9_10^5 kW, the power consumption was 3.5_10^5 kW per hour, and the yearly power consumption reached 1.3_10^9 kW per hour. The air compressor is a vital part in auto production, and the development of the Chinese auto industry will likely be accelerated after China's entry into WTO. Take the Second Automobile Factory as an example: the power consumption of air compressors shall reach 2.83_10^8 kWh if 500 thousand automobiles are produced annually. Energy balance data of mechanical industry enterprises shows that the power consumption of compressed air stations is 5-20% of the gross power consumption of enterprises (10% on average), and even 30% in some enterprises. According to statistics of 35 large and medium non-ferrous metal underground mining areas in 1986, the power consumption of compressed air stations was about 30% of the gross power consumption. It is obvious that energy consumption reduction and energy efficiency promotion of air compressors are of great significance for energy conservation and environmental protection.

Air compressors can be classified according to working principle, discharge pressure, compression level, volumetric flow and architectural features. Current air compressor standards are compiled according to architectural features of air compressors, such as GB/T13928 "Mini type Reciprocating Piston Compressors ", JB/T8933-1999 "No-Oil Lubrication Reciprocating Piston Air Compressors", GB/T13279 "General Fixed Reciprocating Piston Air Compressors", JB/T6430 " General Oil Injection Screw Air Compressors", JB/T4253 "General Oil Injection Sliding Blade Air Compressors", and JB/T8934 "Direct Connection Portable Reciprocating Piston Air Compressors ". Air compressors are classified as large, medium or small according to volume flow, as shown in Table 4-45:

Table 4-45 classification of air compressors by volume flow

Category	Volumetric flow (m^3/min)
Mini type air compressors	< 1
Small air compressors	1-10
Medium air compressors	>10-<100
Large air compressors	≥100

According to article 3.17 of chapter three "Classification of Compressors" in JB/T9107-1999 "Reciprocating Compressors-Terminology", the mini type compressors are defined as "air compressors whose power is no bigger than 15kW, and whose rated pressure is no bigger than 1.4MPa."

Large and medium air compressors are mainly used in chemical industry, fertilizer plants, oil production and refinery, large internal combustion engines start-up, automobile production, enterprise air force stations, war industry and nuclear power stations, and mini type air compressors are mainly used for mineral extraction, road construction, textile and light industry, medical service and medicine, instrument control, construction and decoration, all classes of air-operated instruments. In addition, mini type compressors are used for vehicle braking charge.

Air compressors are extensively applied in different industries and fields with different service times. Large and medium air compressors do not stop when being applied in chemical industry and fertilizer industries, and reserve machines are used upon breakdowns. When they are used in enterprises' air force stations, they could work for 8 to 10 hours during working days; and when they are used for start-up of planes, they work 1 to 2 hours daily. For mini type air compressors, they never shut down when being applied in textile and light industries; they work intermittently when being used for construction and decoration; and they typically work 10 to 12 hours daily when being used for mineral extraction and road construction.

Direct-connection portable reciprocating piston air compressors (hereinafter referred to as direct-connection portable compressors) mainly depended on import before the beginning of 1990's, whose selling price was around RMB 3,000. In the mid and late stages of 1990's, the domestic direct-connection portable compressors enjoyed a fast development, and the selling price has dropped from RMB 2,000 to RMB 300-500 now. Now few such air compressors are imported, while the export volume is huge instead.

The price of large and medium compressors made in China is only 2/3 of that of

imported ones, and more and more homemade compressors are replacing imported products, but the export volume of large and medium compressors is still relatively small.

1.4.7.2 Current standards and energy conservation potential of new energy efficiency standard

Air compressors consume large amount of energy and generate a lot of noise. Compressed air, electrical system, air tank, and after cooler are somewhat dangerous. A series of relevant standards have been formulated both here and aboard, such as international standards formulated by ISO/TC118 (the Technical Committee for Compressors, Pneumatic Tools and Pneumatic Machinery of ISO): ISO1217 “Positive-Displacement Compressor Acceptance Test”, ISO3857 “Compressors, Pneumatic Tools and Machinery-Terminology", ISO5390 “Classification of Compressors”; PTC9 “Performance Test Standard for Positive-Displacement Compressors, Vacuum Pumps and Air Blowers” formulated by ASME; and BS1517 “Positive-Displacement Compressor and Air Exhauster Test Specifications”.

China has formulated or adopted equivalent international standards, and has issued a series of basic standards, product standards, test acceptance standards, operating standards, safety standards, and quality rating standards, such as:

GB/T4975-1995 “Positive-Displacement Compressors Terminology- General Provisions”

GB/T13279 - 2002 “General Fixed Reciprocating Piston Compressors”

GB/T13928 - 1992 “Mini type Reciprocating Piston Air Compressors”

The energy efficiency index of air compressors regulated in current state or industry standards is specific power, which refers to the power consumed by unit air capacity under regulated operating conditions. There is no unified international standard for energy efficiency restriction value and rating of air compressors. Large air compressor manufacturers abroad generally formulate energy efficiency index by themselves. The energy efficiency index of piston-type air compressors in China is almost the same as that in foreign companies, and some models even perform better. But standard and index related to screw or sliding blade whirling air compressors formulated in China is far behind that in large companies abroad. Table 4-46 shows the specific power distribution of common reciprocating piston-type air compressors measured by the State Compressor Quality Supervision and Inspection Center since 1995, and it reflects the energy efficiency condition of piston-type compressors for the

moment.

Table 4-46 Specific power distribution of common piston air compressors since 1995

Model	The proportion of reaching (A+B)/2
W-0.9/7	45.0
V-0.67/7	14.8
W-0.48/7	25.0
V-0.36/7	7.7
V-0.17/7	30.0
10 bar compressors	29.4
VF-3/7	28.6
Oil-free piston compressors	37.5
Total	***29.4***
Max. and min. items removed	***24.7***

Note: (A+B) /2 refers to the average value of premium products and first-quality products in view of specific power.

The current energy efficiency evaluation system of air compressors has played an important part in promoting energy efficiency and production level of air compressors, but it does not regulate the energy efficiency of complete air compressors, so even the specific power of host machines of air compressors is up to the requirement, the energy efficiency of the complete machine is still low, and energy conservation can't be achieved fundamentally due to resistance losses of pipes, intake mufflers, one-way valves and coolers. Users of air compressors not only pay attention to the advance in host machines, but also lay emphasis on energy efficiency, safety, reliability and running cost of complete machines. However the energy efficiency of complete machines, which is of concern to users, is not regulated in current energy efficiency evaluation system of air compressors.

In order to reflect practical situation of air compressors, to guide energy-saving technology advancement of manufacturers, to promote the energy efficiency of air compressors, and to save energy and protect the environment in a real sense, requirements that reflect energy efficiency of air compressor systems must be formulated, including testing methods.

According to test data of the State's Compressor Quality Supervision & Inspection Center, since 1985, product standard and rating standard of air compressors,

and suggestions of key enterprises, universities and research units, we suppose the new standard is effective in 2004, and the average energy consumption level of small compressors shall be reduced from 14.30kW/ ($m^5 \cdot min^{-1}$) to 12.58 kW($m^5 \cdot min^{-1}$), and that of large and medium air compressors will be reduced from 6.30kW/($m^3 \cdot min^{-1}$) to 5.60 kW/($m^3 \cdot min^{-1}$). In this situation, the power conservation of high performance air compressors in 2010 will be 5.16TWh, amounting to 2.01 MT standard coal in primary energy. The power conservation in 2020 will be 9.11TWh, amounting to 3.30 MT standard coal. Suppose the electric charge is 0.53 Yuan per kWh, then the net income of users for using high-performance air compressors is RMB 19.985 billion and the benefit-cost ratio is 8.0. The discharge reduction of pollutants due to power conservation is 2.63 MT carbon, 40.1 kilotons of nitrogen oxide, 522.5 kilotons of sulfur dioxide and 244.2 kilotons of subparticles in 2020. At the same time, the peak value demand shall be reduced by 1.91GW.

2. Analysis of energy conservation potential of energy efficiency labeling

The objective of energy efficiency labeling is to encourage consumers to purchase electric appliances with the least energy consumption. For consumers, energy efficiency of home appliances is visible through the labeling system, thus they could consider both energy utilization and running cost when making buying decisions, and they may tend to buy products with high energy efficiency. From the angle of production and distribution, manufacturers should improve the energy efficiency of existing products when they realize that the labeling shall affect consumers or shall potentially affect consumers. At the same time, distributors and retailers shall adjust stock and product display according to energy efficiency labeling of products. The result is that the average energy efficiency of all products on the market is promoted.

Labeling evaluation projects done in EU countries, America, and Thailand show that energy efficiency labeling aiming at household electrical appliances, lighting fixtures and equipment can promote the overall energy efficiency level of products distinctively. Our analysis here is concentrated on household electrical appliances, including double-end fluorescent lamps and unitary central air conditioners.

Table 4-47, 4-48 shows the energy conservation potential of energy efficiency information labeling based on the methodology described in Appendix A.

Table 4-47 Estimated Energy Savings and Economics of Information Labels

Products	Effective Year	Energy savings				Net Benefits (NPV benefits - costs)	Benefit-Cost Ratio
		2010		2020			
		TWh	MMTce	TWh	MMTce	RMB Million	
TV	2004	0.86	0.33	1.34	0.49	2560	6.6
Room AC	2004	4.82	1.87	7.22	2.61	6358	1.6
Refrigerator	2003	0.25	0.10	0.44	0.16	352	1.5
Rice cooker	2005	0.68	0.26	1.21	0.44	2055	8.9
Freezer	2003	0.78	0.31	1.48	0.53	2900	8.5
Washing machine							
Impeller	2004	0.07	0.03	0.10	0.04	1007	1.7
Drum	2004	0.36	0.14	0.95	0.34	56	1.0
Double-capped fluorescent lamp	2003	6.12	2.38	8.23	2.98	16654	1.9
Unitary AC	2005	0.21	0.08	0.64	0.23	1608	5.4
Total		**14.2**	**5.5**	**21.6**	**7.8**	**33550**	**2.0**

Table 4-48 Estimated Summer Peak Load and Pollutant Reductions from Information Labels

Products	Summer Peak Load Reductions		Emissions Reductions in 2020			
	2010	2020	Carbon	NOx	SO_2	PM10
	GW	GW	MMT	1000T	1000T	1000T
TV	0.07	0.11	0.39	5.90	77.01	35.97
Room AC	2.13	3.18	2.08	31.75	414.22	193.46
Refrigerator	0.04	0.06	0.13	1.92	25.01	11.68
Rice cooker	0.11	0.21	0.35	5.33	69.48	32.45
Freezer	0.12	0.22	0.43	6.49	84.69	39.55
Washing machine						
Impeller	-	-	0.03	0.45	5.93	2.77
Drum	-	-	0.27	4.16	54.33	25.37
Double-capped fluorescent lamp	1.20	1.61	2.38	36.21	472.37	220.62
Unitary AC	0.12	0.37	0.19	2.28	36.81	17.19
Total	**3.8**	**5.8**	**6.2**	**95.0**	**1239.9**	**579.1**

Chapter 5 Macro influence of energy efficiency standard and labeling

The implementation of energy efficiency standard and labeling shall promote the energy efficiency of products and reduce unnecessary power and fuel consumption of products. The saved energy shall boost the deepening of energy-saving works in China, relieve the contradictions between supply and demand, and guarantee the energy security and sustainable economic development.

1. Reduce investment on energy supply infrastructure

In industrialized countries, the energy consumption of household electrical appliances, equipment and lighting fixtures take a considerable share of the total energy consumed. Generally, the energy consumption per capita is stable, and the overall energy consumption of buildings is in proportion to the population growth. In contrary, in developing countries, the energy consumption of buildings is much lower than that in industrialized countries, but it is also rising due to increasing saturation of household electrical appliances and increase of energy consumption per capita. For example, the GDP per capita of Sweden was USD 17,500 in 1996, energy consumption per capita was 170MJ, and the annual growth rate was 0.8% for 10 consecutive years. In the same year, the GDP per capita in China was only USD 2,700, the energy consumption per capita was 22MJ, and the annual growth rate in the same 10 years was 8.7% (IEA 1999). Countries whose energy demands are growing fast have to expand investment on energy supply infrastructure in order to meet ever-increasing energy consumption.

Energy efficiency standards and labels can reduce energy consumption through improving the energy efficiency level of energy-using goods. It is observed from analysis (see Table 5-1) that the power conservation is estimated to be 157.3TWh until 2010 and 275.8TWh until 2020 after implementation of minimum energy efficiency standards and labeling. According to the initial forecast of power departments, the growth rate of power demand in China in the next 10-15 years will be 6%, and the predicted energy demands will be reduced by 9% if energy efficiency standard and labeling is adopted in the next 15 years.

Power reduction leads to reduction of fuel for power generation, namely 72.66 million tons of coal equivalent is saved until 2010, and 135.5 MT standard coal is saved until 2020 after conversion. The application of energy efficiency standards and

labeling reduces demand for fuels, thus investments on acquisition, exchange and utilization of fuels in future will also be reduced, and expenses of energy departments could be used to support production and service of other products. Therefore a high-performance energy department shall generate higher economic benefits.

Table 5-1 Energy conservation of efficiency standard and labeling

	2010			2020		
	Electricity TWh	**Primary energy MMtce**	**Peak demand GW**	**Electricity TWh**	**Primary energy MMtce**	**Peak demand GW**
Energy efficiency standard	143	67.2	30.0	254	127.7	54.0
Information labeling	14.2	5.5	3.8	21.6	7.8	5.8
Total	157.3	72.7	33.8	275.8	135.5	59.7

The power conservation due to adoption of new standard is 33.9TWh until 2005, equivalent to 14.57 MT standard coal. The power conservation resulting from information labeling is 6.9TWh over the same period, equivalent to 2.77 MT of standard coal. The total power conservation is 40.8TWh, equal to 17.34 MT of standard coal in primary energy. The goal of energy conservation in the Tenth Five-Year Plan is to save 340 MT standard coal until 2005, and 5.1% of the objective could be achieved through applying the recommended new standard and information labeling program.

During the Ninth Five-Year Plan, a comprehensive and lasting power shortage developed into a power imbalance in different regions, and an increased difference between the peak and trough in the demand curve. The peak power shortage is becoming more and more serious. Along with the increase of air conditioners in commercial buildings and households, the top load of the year during the Ninth Five-Year Plan is shifted from winter to summer, and air temperature is having a bigger impact on power load. If a power-using product operates during peak of power demand, then energy efficiency reduction of the product due to power efficiency promotion shall reduce peak demand of electric networks, enhance the adjusting ability of the electric system, enhance the reliability and stability of the electric system, and reduce the amount of needed investment for new power plants. It is observed from Table 5-1 that the implementation of energy efficiency standard and

labeling will reduce peak value demand by 59.7GW until 2020, which corresponds to reduction of establishment of 200 new power plants (i.e. 300MW each), and the saved money that can be used in other important fields.

2. Increase welfare of consumers

The energy efficiency standard and labeling could promote the energy efficiency level of energy-using goods, lower power consumption of these products, and reduce running cost of consumers. Although promotion of energy efficiency shall increase purchase cost, but it is much smaller as compared with the reduction of running cost. Table 5-2 shows the economic benefits realized through implementation of energy efficiency standards and labeling, and it is clear that the average benefit cost ratio of implementation of energy efficiency standard and labeling is 3.4, and the gross net income in 2020 will reach RMB 539.5 billion. Take the refrigerator as an example, Fig 5-1 shows the economic savings for refrigerators from new standard, RMB 45.7 billion of net income could be realized by 2020, and the benefit cost ratio is 9.1.

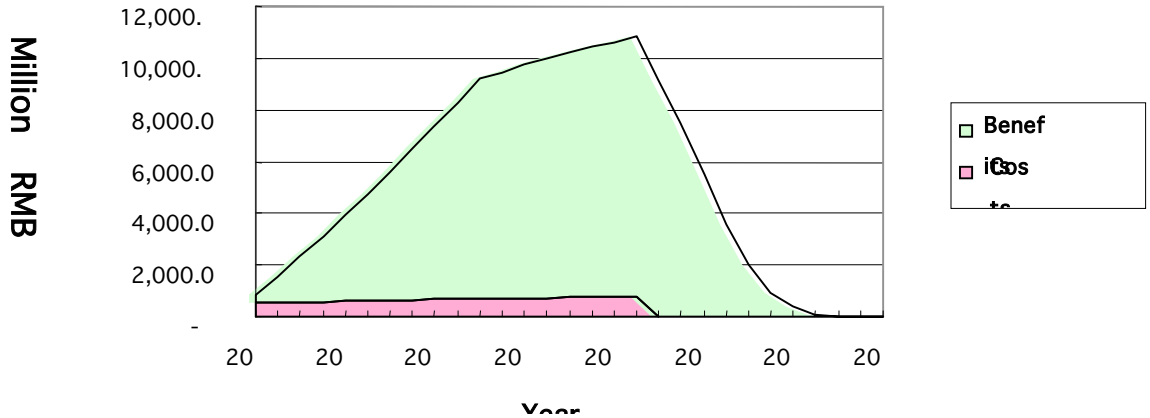


Fig 5-1 The benefits and cost curve of efficiency standard of refrigerators

Table 5-2 Economic benefits of energy efficiency standard and labeling

2020	NPV benefit	NPV cost	Net Benefit	Benefit-cost ratio
Standards	696098	190096	506003	3.7
Information labels	68248	34698	33550	2.0
Total	764346	224794	539552	3.4

3. Favor pollution abatement and environmental improvement

The reduction of energy consumption shall result in reduction of discharges of carbon, sulfur dioxide, nitrogen oxide, particles, toxic gases and other suspended particles in power plants. Until 2020, the carbon discharge will be reduced by 104 MT through adoption of energy efficiency standards and labeling, corresponding to the carbon discharge of 4.50 million medium passenger vehicles; the discharge reduction of nitrogen oxide will reach 1.58 MT; the discharge reduction of sulfur dioxide is 20.64 MT, and the discharge reduction of particulates is 9.64 MT. The discharge reduction of air pollutants shall help relieve greenhouse effect, photochemical smog and acid rain, and shall be important for improving environmental quality and promoting the quality of people's life. Table 5-3 shows the environmental benefits from standards and information labels.

Table 5-3 Environmental benefits from standards and information labels (MMT)

	Emissions Reductions in 2020			
	Carbon	**NOx**	**SO_2**	**PM10**
Standards	97.64	1.49	19.40	9.06
Information Labels	6.24	0.09	1.24	0.58
Total	103.88	1.58	20.64	9.64

Chapter 6 Policy Advice on Promoting Energy Standards and Labeling

1. Vital function of standardization under new situation

1.1 Role in international trade

Standardization is a technical link that can lead to foreign trade and international technological cooperation, and the degree of standardization directly influences the formation and elimination of technical barriers in trade.

Relevant investigations organized by the state show that technical barriers have become the principal restriction to the foreign trade export after China's entry into WTO. In 1970's, among non-tariff barriers that influence foreign trade, only 10%-30% are technical barriers, while this proportion has been rising since the 1990's. For the time being, at least two thirds of import and export enterprises are influenced by foreign technical barriers, and some products lose their market, which results in huge economic loss directly or indirectly. According to analysis of experts, four reasons deserve recognition: the macroeconomy level in China is low, composition of export commodity is backward, and product level is low; the technical level and management level of some enterprises is low; some developed countries intend to restrict the export of China's products with technical trade measures; China has not got sound measures to counter foreign technical barriers.

Along with China's entry into WTO, the markets at home and abroad are being merged, which requires that China's standards be connected with international standards as soon as possible. Uniform market requires uniform technical standards in technical, economic and trade exchanges, and any standard that is independent of and distinguished from international standards shall bring troubles to the market. In China, firstly we should get to know the standard level and technical level of current products in the world through international standards, and to enhance the competitive power of China's products by transferring advanced technologies of developed countries. Secondly, we may remove trade and technical barriers, develop international market, expand export and enhance economic benefits through adopting international standards. Thirdly, we may advance brand strategy, realize economies of scale and make China's brands become world brands by adopting international standards. Therefore, adopting international standards is an important method for Chinese brand products to keep competitive advantages; it is the golden key to an open market, and

the bridge for China's market to enter the world market, which is of far reaching importance.

We should have a dialectical view on the adoption of international standards. Adopting international standards could simplify the procedures of home products' entry into international market, and avoid technical barriers resulting from trade protectionism. Yet international standards are not easy to meet, which forms a barrier also. In addition, we must be fully prepared for meeting more competitors before entering international market. These competitors have got not only competitive products, but also competitive ways of standardization, such as standard formulation, inspection and product certification. Countries, esp. developing countries, which did not participate in formulation of international standards, should not underrate these negative factors. We ought to fully realize the "duality" effect of standardization, and establish corresponding standardization policies.

Different modes are adopted for different kinds of standards:

--Direct adoption, experimental verification and supplementation and modification;

--Earnest research, aggressive adoption and discrimination.

1.2 Standard harmonization--the development trend of standardization in the world in the 21st century

Along with commercial internationalization, standards are also internationalized. Establishment of national standards on the basis of international standards has become a requirement for members of WTO, and the status and role of international standards are becoming more and more important.

EU standardization strategy stresses the further expansion of European standardization system (25 countries shall be included by 2010 on the basis of 19 presently), which shall table standardization proposals in international standardization organizations in a unified manner, consolidate European status in international standardization activities and strengthen the competitive power of European industry on world market.

America and Japan also give priority to market adaptability of standards, international standardization strategy, and coordination and implementation of standardization policy and R&D policy. Actually the core of their standardization

strategy is still the international standardization strategy.

It is shown from analysis that the primary differences between Chinese standards and International/European standards and standards in developed countries are mainly shown in standard nature and content, standard system composition and timely updates. Most international/European standards and standards in developed countries are voluntary, and standards referred by WTO/TBT are also voluntary. While according to the Standardization Law of China, it is clearly regulated that standards may contain mandatory requirements, and the mandatory clauses mainly concern: (1) requirements for environment protection, life, health and property security; (2) requirements for guaranteeing technical compatibility, information compatibility as well as product exchangeability; (3) requirements for unified check, test and labeling of products; (4) other requirements regulated by federal laws.

The only way of China's standardization is to transfer from compulsory standard system to voluntary standard system, to connect with international conventions and to be consistent with international/European standard system.

Due to the differences on product structure, market demand, economic base, and product consciousness, the product standards in China sometimes/often do not have a one to one correspondence with international standards and advanced standards abroad. Advanced standards abroad are different from those in China in concept and meaning, in addition, foreign standards are mainly technical documents of enterprises, which are not provided to outside, thus most enterprises in China establish their product standards or technical documents through analyzing and copying foreign samples, and model machines or combining foreign samples, instructions and agreements with domestic R & D. According to international conventions, these products are not produced with formal international standards or advanced standards abroad, thus they do not belong to the scope of adopting international standards or advanced standards abroad. Some products are produced by adopting only corresponding international standards or advanced standards abroad, thus they are not belong to the scope of adopting international standards or advanced standards abroad. Some products are produced by adopting only corresponding international standards or a part of or all advanced standards abroad, and some products are produced with international standards or advanced standards abroad without establishing corresponding standard system in China. These cases do not belong to adoption of international standards or advanced standards abroad according to the requirements of WTO/TBT.

1.3 The role in protecting domestic industry

Now the trade barriers of customs duty are weakened, while technical barriers concerning technical regulations, standards, qualification evaluation and certification have become the most secret and ticklish non-tariff barriers, and have become a hard nut to crack in foreign trade. The three trade groups (countries), namely EU, NAFTA and Japan, which take the best part of world trade, are actively using standardization to develop and protect their industries and have obtained distinct results.

Restricting import with technical standard barriers is only a stopgap, which may restrict yourself and may come in for complaints and countermeasures. In the long view, we encourage enterprises to introduce into and assimilate advanced standards abroad in order to enhance their self-development. Market competition is quality competition actually, while quality competition is standard competition first. National industry shall be protected naturally with the promotion of market share. Development is active protection, while restriction is a passive behavior.

With the "TBT Convention", the establishment and implementation of standards should not be required to be in line with certain international standards due to climate, geographic factors or basic technical problems; preferential treatment should be given to developing countries in their development and demand for capital and trade. They should be allowed to protect local technologies without being in line with international standards, and their obligations should be partly or wholly avoided.

China’s market shall be gradually opened to the outside world according to the equity principle of GATT, which shall affect China's economy greatly. Especially some infant industries are more likely to be affected due to lack of price and quality advantages with backward production technology and equipment, small production scale, high cost and low quality of products although they have huge development potential. The utilization of “Escape Clauses” consciously by any country in order to protect their self-interests does not violate any law even though they constitute technical barriers. In this situation, it is more necessary to make full use of such “Escape Clauses” in accordance with the China’s characteristics in nationality, culture, resource, climate, geography, basic technology and status as a developing country, to protect national industry with principles of the “TBT Convention”, and to be justified, powerful and temperate.

Standards are divided as national standards and international standards, and the so-called national standards are established by referring to current international

standards and by combining the situation of China. For instance, China introduced quite a few product lines for household electrical appliances from Europe in 1980's, and we have established our own national standards by referring to ISO/IEC standards and on the production basis of such introduced equipment through substantive coordination.

When national standards are not accepted or identified by world communities, they have to be abandoned and international standards have to be introduced instead. We have began to realize that standards could guide the trend of technology, technology needs market support, market could cultivate industry, while large industry may be involved in international politics. Presently, the input into standard research in our country and in enterprises is behind the development of technology and product. Few standards on the world stage are suggested by China's enterprises or by Chinese, at the same time, the standard release and implementation are also behind the times in industry administration sections inland, which shall have a strong impact on the development of an independent economy and industry.

2. Basic roles of energy standard and labeling

The active role of energy efficiency and energy efficiency labeling is shown in following aspects:

2.1 Reduce the energy supply and demand imbalance and guarantee the sustainable development of the national economy

China became an energy net importer in 1993, and the scale of energy import is growing year after year. Energy security and energy conservation are fundamental conditions for completing the mid- and long-term economic goals of China. The practice of compulsory energy efficiency standards and energy efficiency information labeling plays an important role for reducing energy demand in China through energy efficiency enhancement in a planned way according to China's situation. In view of the economy, it reduces the pressure for power generation capacity and related capital construction, and saves abundant capital investment; and on the other hand, it also generates huge economic benefits.

Just as analyzed in this project: the establishment and implementation of new energy efficiency standards will increase product energy efficiency levels. By 2010, 143TWh electric power can be conserved, amounting to 67 megatons of standard coal; by 2020, 254TWh electric power can be conserved, amounting to 128 megatons

of standard coal. At the same time, 21.6TWh electric power can be saved by 2020 through implementing energy efficiency labeling, amounting to 8 megatons of standard coal. The total power savings of both is equivalent to 56% of the predicated power consumption of urban households in China in 2020. In other words, the savings are equivalent to reducing the power consumption growth of urban households by 85% in the next 20 years. The cost increase due to implementation of energy efficiency standards and labeling is much smaller as compared with the huge economic benefits, and the average cost benefit ratio is about 3.4.

2.2 Offer new measures for the government to regulate and control the market

Along with the progressive improvement of China's market economy, the way of supervising economy by the government is being changed. The state department dealing with energy conservation, namely the former State Economic and Trade Commission, brought up the idea of transferring from direct management (regulate industrial production directly) to indirect management to support impartial market competition and to protect consumers, namely transferring from process management to product management and giving priority to management of energy-using goods at the end-use consumption level. The implementation of energy efficiency standards and labeling could guide the market, encourage advanced products and eliminate the backward, and strengthen the management of end-use energy using goods, which is a new way for market regulation in the new age.

2.3 Be in favor of establishing impartial market competition mechanism and promoting energy-saving technology advancement of enterprises

The implementation of energy efficiency standards shall further strengthen market control and eliminate backward high energy using goods on the one hand, and formulate advanced goals of energy conservation for enterprises, guide enterprises to establish rational development program, strengthen management, adopt advanced energy-saving technologies, promote energy efficiency, enhance the competitive power of China's energy using goods at home and abroad, and connect with world level as soon as possible on the other hand. In a similar manner, the implementation of energy efficiency labeling can further promote the energy efficiency level of products, boost consumers to purchase low energy-using and high energy efficiency products, increase the share of high-performance products on the market, establish fair and healthy consumer markets, boost the energy efficiency of products and promote the advancement of energy-saving technology.

2.4 Meet the demand of foreign trade

For energy conservation and environmental protection, many countries have set up "Green Trade Barriers" in trade, and posed requirements for the energy efficiency index of products to be exported or imported. Now that China has entered WTO, China's economy is transitioning to an export-oriented economy, and the import and export trade volume will greatly expand. Establishment of energy efficiency standards and information labeling can gradually promote the connection of China's enterprises with international standards, and promote the international competitiveness of China's products, help establish reciprocal entry conditions between countries, and help reduce trade barriers.

In addition, the global market economy is an open economy, and the expansion of social division of labor and market expansion extend the economic communication between different countries and regions. Social division of labor and the domestic market are not restricted by national borders any longer. To guarantee the normal and orderly development of international economy and trade, a series of universal international business and trade treaties, regulations and conventions have been formed or are being formed in the world. In accordance with WTO/TBT regulations, the range of government intervention only covers security, health, environmental protection, national security and fraud prevention. Compulsory energy efficiency standards are part of technical regulations and should be observed in foreign trade.

2.5 Reduce discharge of pollutants and enhance environmental quality

The implementation of energy efficiency standards and labeling shall distinctively promote the service efficiency of energy, thus reduce the pollution generated in the course of energy production and utilization. 30% of CO_2 in the atmosphere is generated in the course of electric power generation, which is one of the main causes of the greenhouse effect. The reduction of power consumption shall control the discharge of air pollutants in the course of electric power generation and utilization, and protect the environment accordingly.

As shown in this project: until 2020, the carbon discharge can be reduced by 104 megatons, amounting to the carbon discharge of 4.5 million medium passenger service vehicles in a year; the discharge reduction of nitrogen oxide can reach 1.58 megatons; the discharge reduction of sulfur dioxide can reach 20.64 megatons; and the discharge reduction of atmospheric particles can be 9.64 megatons, due to the implementation of energy efficiency standards and labeling. The reduction of air

pollutant discharges will greatly relieve the greenhouse effect, photochemical smog and acid rain, and play an important role for improving environmental quality and promoting the quality of people's life.

The reduction of power consumption shall reduce peak load demand and reduce the difference between peak power demand and available supply, in the summer especially. It is estimated in this project that new standards can reduce on-peak power demand in 2020 by 59.7GW, amounting to the generating capacity of 200 average power plants (i.e. 300MW each). These savings reduce the demand for new generating station establishments and electric network capacity expansion, improve the power supply capability of electric network and enhance the reliability and electric quality.

2.6 Promote product structural adjustment and industrial development

Along with global economic integration, China's entry into WTO and the promotion of a higher standard of living, market competition is becoming more and more fierce. Each manufacturing enterprise has realized that it must strengthen its technological development ability and possess key technology itself in order to guarantee competitive power. But presently China gives priority for export to low end products, the added value of which is comparatively low; while high end and low end products on the domestic market are intermingled. The implementation of energy efficiency standards and labeling shall effectively promote the adjustment of enterprises and improve on product structure, make enterprises pay attention to competition of other enterprises instead of only production capacity, and promote the healthy and orderly development of related industries accordingly.

3. Main barriers of energy efficiency standards and labeling

3.1 The revision cycle of energy efficiency standards is long

In China, 7 years were spent from the completion of the first batch of energy efficiency standards to the revision of some standards, and some standards are not ready to be revised even now. The revision cycle of energy efficiency standards is prolonged due to the lack of scientific planning, insufficient academic ability and capital, and slow reaction to the changing market.

3.2 The management system of energy efficiency standards and labeling is not perfect

The energy conservation management system in China at the current time is difficult to influence. It is hard to maneuver all social forces to participate in and support energy efficiency standardization.

In addition, due to institutional reform and adjustment, the energy efficiency information labeling system has not been put forward in China formally, the implementation and supervision mechanism of energy efficiency labeling have not been established, and the efficient implementation and further expansion of the system need to be studied earnestly.

3.3 The implementation of energy efficiency standards is not fully enforced

China has released 10 energy efficiency standards, but their implementation is not fully enforced. The state has not made it an imperative to have a system that removes high energy using goods and corresponding supervision measures for energy efficiency standards. Thus energy-using goods that use more than standard efficiency requirements could go on circulation and exchange in the market, which affects the successful implementation of standards and achievement of energy savings.

3.4 The standards development capacity is inadequate, and energy efficiency standardization lacks funds

For a number of years, the expenditure for formulation and revision of national standards has mainly come from state appropriations, and the secretariats of quite a few standardization technical commissions nationwide which are set in scientific research academies or institutes. After such academic institutes are merged into enterprise groups or become enterprises, the standards work that gives priority to social benefits are not provided with adequate funds any more, and a great many units are reluctant to go on assuming this work.

In the meantime, as the market economy develops, more standards are needed, but the funds appropriated for standardization are unchanged. Participation in international standardization activities and adoption of international standards and more advanced standards from abroad are also affected due to insufficient investment.

3.5 The development work of energy efficiency standards and labeling is still weak

This is embodied in two aspects: one is the data collection is somewhat difficult; the other is the research and analytical procedure is relatively backward. Due to the partitioned government management in China, a unified and integrated way of data collection, storage, statistics, inquiry and analysis is not formed. At present, statistical methods are generally used in China, which is somewhat behind the cost effectiveness analysis method adopted by advanced countries in the world. In addition, scientific energy efficiency research development and standard formulation can't be combined organically. The fundamental scientific research of energy efficient standards is itself backward, which affects the application of standard effectiveness to a certain degree.

3.6 Awareness of energy efficiency standards is comparatively weak

Energy efficiency standards are not well recognized and understood due to insufficient public education, training of sales force and consumers. Standards are not well accepted by the market. The problem in minor enterprises is more serious, which do not perceive standards as a way to compete in the market, have not established an enterprise standard system, and often produce without any standards.

3.7 The range of products covered by energy efficiency standards is limited

The currently released and implemented energy efficiency standards are restricted to some household electrical appliances, lighting fixtures, as well as some industrial equipment. An integrated energy efficiency standard system has not been established, which partly influences the application of an integrated result in energy efficiency standards. Energy efficiency standards for commercial equipment, office equipment and industrial equipment should be gradually developed and researched on an ongoing basis.

3.8 Related encouragement policies and support regulations are few

Production of energy-saving products relates to enterprise production of high technology appliances and equipment. Enterprise development and energy-saving product production need certain inputs. Therefore, the retail price of energy-saving products shall be higher as compared with that of common, low end products. At present, preferential policies and fiscal subsidy measures are not released, the production enthusiasm of enterprises is not fully engaged, and the market propulsion is not strong.

3.9 Enterprises are not active in participating in international collaborations

Presently China's manufacturing enterprises lack enthusiasm for participating in the formulation and revision of standards and standardization activities both at home and aboard, not to mention capital input and cultivation of high-level standardization personnel. They do not understand international standards and conventions and are not willing to participate in international competitions. They either can't make full use of preferential policies of WTO/TBT Conventions or are punished due to violations of state policies and regulations.

3.10 Enterprises are usually resistant to standard establishment and implementation instead of the main force of standard establishment

In China, it is government that organizes the establishment of standards, and enterprises are not active in establishing standards, or adding capital input in this aspect. In addition, most enterprises only passively participate in standard research. Due to the coerciveness of energy efficiency standards and high demand, they strive to lower standard indices, prolong standard progress as best as they can, and have become an important resistance to the establishment and implementation of energy efficiency standards.

4. Summary of foreign experience

4.1 Summary of general standards work abroad

4.1.1 Unification of technical development and standards

When researching and establishing standards development strategy, many nations emphasize the unification and coordination of technical development and standards policy. This is regulated in the USA: NIST (National Institute of Standards and Testing) takes part in the council of ANSI (American National Standards Institute), and offers financial support to international standardization activities conducted by ANSI. Participation in domestic and international standardization activities by experts in metering and field testing, and participation in standardization activities and establishment of standards by research and development personnel are scored as an index for their performance evaluations. 300 metering and testing experts of NIST have taken part in the formulation of more than 1200 standards. In 1999, 2832 persons from American federal government agencies participated in standardization activities and made use of 2669 standards.

The “National Industry Technological Strategy” established by Japan in April,

2000 (general strategy) suggested that to popularize and apply technical development achievements the farthest, take standardization as an instrument leading to new technologies and markets, and understand the significance of R&D with the objective of standardization. Japan also defines the level of participation in standardization activities by research and development personnel in their performance evaluations. Presently, experts from Japan's AIST (National Institute of Advanced Industrial Science and Technology) and product assessment technique agencies have participated in standardization activities organized by special committees of the Standard Branch of Japan's Industrial Standard Investigation Association.

4.1.2 Establish uniform information bank

A standards management system must be provided with the function of information collection. Information becomes a resource to be shared only after being collected. The information collection here means collection by level or by category instead of gathering information to the central level. No matter on which level information is gathered, information sources must be connected through standard information feedback systems to guarantee the acquisition of adequate, true and reliable information to be timely processed and transferred in order to support the standard system. But the establishment of an information feedback system with above-mentioned functions is not an easy job and many problems are to be solved. It costs more if a physical system is established, so it is more realistic to establish a virtual system that connects all related facilities and organs, but it still relates to a lot of problems.

4.1.3 Grasp the initiative of establishing international standards

Some countries and regions should base themselves upon national standards first, then turn to widely accepted international standards, to bring domestic technical regulations under the system of international standards. They devote themselves to ISO and IEC activities, esp. establishment and revision of international standards, to guarantee that international standards fully embody their domestic interests, and bring their domestic standards under international standards in order to protect and develop their own products.

4.2 Summary of successful experience of energy efficiency standards

- The small scale promotion of energy efficiency standards shall result in huge energy conservation effects;

- Quite a few countries are finding ways to improve the procedures of energy efficiency standard establishment, for instance shortening the update cycle and implementation interval of standards;

- Collaboration and information exchanges internationally are beneficial;

- It is quite necessary to collaborate with related interests, for instance, manufactures and consumers may take part in establishment of standards. Energy efficiency standards are beneficial for large multinational companies as well as the quantity of small companies that may be reduced gradually with economic globalization;

- For some countries, the construction of energy performance testing facilities is the key factor in implementing energy efficiency standards. The unification and confirmation of energy efficiency test procedures in Asia can create conditions for the establishment and implementation of energy efficiency standards, and promote the construction of testing capability. The demand of government for testing shall create demand and a market for testing organs;

- Energy efficiency standards could be unified by country, and the market product range, average price, market mechanism and market competitions should be taken into consideration. Therefore, each country should determine specific standard levels according to its different situation.

4.3 Summary of successful experience in energy efficiency labeling

- Internationally, energy efficiency labeling is a successful policy instrument, which saves substantial energy with low input;

- Energy efficiency labeling could enhance the transparency of equipment energy utilization efficiency, provide consumers with direct product energy efficiency information, and serve a variety of energy and market objectives;

- It is shown from research that the alternatives for energy efficiency labeling plans are diversified, for instance, labeling may be compulsory or voluntary, it may be a comparison or endorsement, and comparisons also break into grade or continuous labeling;

- The energy efficiency labeling could be modified according to reactions of

consumers. The recognition of labeling by consumers should be taken into full consideration before adoption or modification, and the technical requirements could be modified through collaboration in the trade;

- An important point in designing energy efficiency labeling is to consider fully the social, cultural, and linguistic factors in the design process. Some existing labels could be referenced in design, and adoption of national or international labeling should take the reaction of local consumers into consideration;

- A comprehensive survey of consumers should be conducted, which is a necessary step for guaranteeing the effect of energy efficiency labeling;

- Theoretically, energy efficiency standard and energy efficiency labeling should complement each other and boost the market conversion together.

4.4 Summary of supervision, evaluation and implementation experience of energy standards and labeling

- Evaluation and supervision clauses should be added to the design of energy efficiency standards and labeling activities. The budget for evaluation and supervision should be guaranteed, and the evaluation should be designed to be conducted in the initial stage of project implementation;

- Establish a timely data collection and tracking system. It is necessary to establish product sales and energy efficiency level databases for products in the market;

- Strengthen capacity development of actuating units. The development of executive capacity of private and public organizations is quite important;

- Evaluation needs different data resources. Evaluation is a technology, and the successful degree of developing standards and labels is described through evaluating several related indices;

- The evaluation should be directly connected with activity design. The most serious problem is that evaluation is usually conducted after completion of activities instead of being conducted in the course of the activity. Evaluation and supervision should take activity designer and executive staff

as their clients;

- Establish a definite frame and guidelines for supervision and implementation. Appoint supervision implementation procedures and notify all related units of the activity operation;

- Avoid bottleneck problems in testing. It is quite important to possess adequate performance testing ability in order to track market data accurately, which could be done in domestic labs or internationally authorized labs.

5. Proposals on how to promote the development of standards and labeling

5.1 Basic Principles for establishing energy efficiency standards

- Start from the interests of the whole, and carry out state policies on energy conservation, environmental protection and technical economy;

- Promote technological advances;

- Further define the market and reflect the market demand quickly;

- Further organize and focus enterprises, and gradually develop the principal function of enterprises in the standardization;

- It is imperative that standards are released as technical regulations, and enterprises are not allowed to produce, distribute and import products that are not in line with these regulatory standards;

- Further speed the connection with international conventions, and strengthen participation in international standardization activities and adoption of international standards;

- The objective of standard formulation is to obtain the best social and economic order and to promote the best social benefits;

5.2 Contents of the energy efficiency standard

A part or all of following contents may be discussed in formulating energy efficiency standards according to energy-using product features, industrial development trends, and relating energy-saving policies and environmental protection

policies in accordance with the demand of different energy-saving measures:

- Energy efficiency restriction value (minimum efficiency or maximum consumption);
- Energy conservation evaluation value (recommended efficiency or consumption);
- Energy efficiency grade (e.g. A, B, C…);
- Leading energy efficiency indicators (e.g. reach standard);

5.3 Improvement on plans for standards formulation, implementation and supervision

5.3.1 Strengthen the transparency of standard formulation and labeling development:

- establish national energy efficiency formulations and subsequent revisions and timely annual plans, and publicize them to the society;
- absorb market players, esp. enterprises, into research work;
- expand the range and channels of soliciting suggestions from the society, such as soliciting suggestions from government sectors and the public through journalism, bulletin and Internet;
- Report the national standards and revisions to International communities for Standardization, WTO and domestic organizations.

5.3.2 Enhance the time efficiency, and shorten the cycle of standard formulation, revision, and R & D

Establish energy efficiency standards and labeling work schedule to realize institutionalization, serialization and normalization of energy efficiency standards and labeling procedures. Energy efficiency standards and labeling projects are managed by stages, and fast standard establishment and revision procedures that are popular in the rest of the developed world can be adopted for some standards and labels to shorten the cycle of energy efficiency standard research and energy efficiency labeling development.

5.3.3 Strengthen participation by more interests

Energy efficiency standards and labeling should represent the interests of all stakeholders. Medium and small enterprises, users, workers, non-governmental organizations and governmental organizations should be encouraged to participate in standards formulation for they share the interests of standards establishment and they are encouraged to provide necessary funds.

5.3.4 Increase the capital input into standards and labeling projects

The research of energy efficiency standards and labeling is a complicated engineering system, which requires extensive survey, data collection, substantive testing and verification, adequate model analysis and calculation, and countless coordination, discussion and suggestions in each stage of R & D. These works require substantive manpower and material and financial resources, which demand adequate funding support of the government to guarantee that standard and labeling projects be advanced, scientific, reasonable, and operable. For instance, the USA government spends about USD 11 million on establishment and implementation of standards yearly, and the financial savings from these standards is more than 1000 times the government input (Nadel 2003).

5.3.5 Strengthen standard education, training and implementation

The government should put forward corresponding policies to encourage research and implementation of energy efficiency standards and labeling projects, including timely education and training on standards and labeling, supervising and guiding manufacturing enterprises to carry out standards and labeling strictly, measures to identify the views of various interested parties, and adopting encouraging and preferential policies.

5.3.6 Expand the product coverage of energy efficiency standards and labeling

The future energy efficiency standards should lay emphasis on the following fields in accordance with the energy strategy adjustment and energy structure changes in China:

a) Industry /commerce field

With improvement of People's life, many appliances and equipment used

in homes, factories and commercial buildings are in ever-increasing numbers. They all consume a large number of energy. Especially, industrial energy consumption takes 70% of the total energy consumed in China. The development of energy standards will reduce the energy consumption of all of these products and equipment without diminishing the services they provide to consumers.

We estimated energy savings from new standards by conducting an analysis of energy conservation potential. Table 6-1 shows the energy efficiency rankings of products to be covered by standards according to energy savings in 2020. Among those products, primary industrial equipment including industrial boilers, pumps, transformers, central air conditioners, electrical motors, blower fans, air compressors have the highest impact on energy conservation. So they should be chosen to establish energy standards first and system economic operation standards. Among household appliances and lighting fixture, fluorescent lamp ballasts, refrigerators, room air conditioners and double-capped fluorescent lamps should be given priorities in energy standards scheme. In addition, although energy savings from standby power standards are lower than others, this part of energy savings is easier to realize due to advanced energy-saving technology. We propose selecting TVs, computer monitors, microwave ovens, copiers, facsimile machines and laser printers as second-tier candidates for energy standards.

Table 6-1 Product Rank of Energy Savings in 2020

Rank	Product Name	Energy savings in 2020	
		TWh	MTce
1	Industrial Boilers		35.65
2	Fluorescent Ballasts	46.18	16.71
3	Pumps	29.49	10.67
4	Transformers	22.08	7.99
5	Refrigerators /Freezers	21.78	7.88
6	Room Air-Conditioners	20.04	7.25
7	Central Air Conditioners	16.66	6.03
8	Electric Motors	16.46	5.96
9	Double-capped Fluorescent Lamps	12.86	4.65
10	Fans	12.27	4.44
11	Air Compressors	9.11	3.30
12	Rice cooker	8.41	3.04
13	Traffic lights	7.63	2.76
14	Freezers	7.38	2.67
15	TVs(standby power)	5.10	1.84
16	TVs(active mode)	4.79	1.73
17	Exit Signs	4.41	1.60
18	Washing Machines	3.47	1.26
19	Computer monitors(standby power)	2.04	0.74
20	Microwave ovens(standby power)	1.46	0.53
21	Copiers(<20cpm)(standby power)	1.32	0.48
22	HID (High Intensity Discharge) Lamps and Ballasts	0.79	0.29
23	Facsimile machines(<10ppm)(standby power)	0.25	0.09
24	Laser printers(<10ppm)(standby power)	0.24	0.09

b) Oil-burning equipment

The consumption of oil and oil products is taking an ever bigger part in the energy consumption structure in China. Import volume has been ascending since 1993. Energy conservation is extremely urgent and the emphasis of energy efficiency standards research should be focused on key energy consumption products, such as motorcars and diesel engines.

c) Water-using equipment

The water resource problem is very serious in China, and it is hardly too much to say that the water resource problem shall concern the growth and prosperity of the Chinese nation in the 21st century, so we must emphasize this issue. The basic way to solve the water problem in the 21st century is to tap new

resources, economize on expenditure, and strengthen management, wherein the promotion of water use efficiency is a primary measure and the formulation of efficiency standards for water consumption products is imperative. Products related include taps and toilet bowls.

d) Gas-using products

Along with the development of the "East West Gas Transfer" project and the improvement in urban infrastructure, gas consumption shall be greatly increased, and the possession of gas appliances shall be increased. At the beginning of popularization of these products, formulation of energy efficiency standards and identification of gas appliances is an economical way to avoid waste. Products that should be mainly researched include gas water heaters, gas ovens and gas-burning boilers.

5.3.7 Further exploit ways of implementing energy efficiency standards

1) Implement the information energy efficiency labeling system as soon as possible.

It is verified by experience of other countries that the energy efficiency grade identification could change market product structure, promote the market share of high-performance products, provide uniform energy conservation measurement reference for the market and consumers, standardize market behaviors, further enhance the energy conservation consciousness of consumers and create and expand the energy conservation product market.

Energy efficiency information labeling mainly presents the efficiency grade of energy-using products, and the division of energy efficiency level shall be made clear in energy efficiency standards. Thus we may say that a way of implementing energy efficiency standards is to widely adopt the energy efficiency labeling program. Developed countries in the world adopt both regulatory and voluntary means to standardize the energy efficiency labeling in order to further advance energy conservation and environmental protection policies. Therefore, we should make pilot projects, conduct research, and standardize energy efficiency labeling in China gradually by borrowing successful experience abroad.

2) Carry on and perfect energy-saving product certification;

China has made great achievements in energy-saving product certification since 1999, and has developed certification works on household electrical appliances, such as domestic refrigerators and color TV sets, office equipment, lighting products and some industrial equipment. But the effect is not yet ideal, which is mainly due to the fact that the state has not put forward corresponding energy-saving product stimulation policies, and the propaganda of energy-saving products is behind the times. National market stimulation and consumer preferential policies should be drafted as soon as possible, and the system related to energy-saving product certification should be perfected gradually.

3) Generalize knock-out system of high energy using goods as soon as possible

The knock-out system of high energy using goods is clearly regulated in the "Energy Conservation Law of P.R.C". The standard referred to is the energy efficiency restriction values in energy efficiency standards. The state should now establish a system to remove high energy using goods from the market, to strengthen implementation of energy efficiency standards.

4) Develop voluntary objective agreement activities gradually.

A voluntary objective agreement is an energy conservation objective agreement concluded between manufacturing enterprises in accordance with energy efficiency standards and is a voluntary commitment. The objective is to save energy, protect the environment, establish the goodwill of an enterprise, minimize the energy conservation cost of enterprises, standardize the market, and establish goodwill among enterprises in a mature industry.

5.3.8 Rely on the state, strengthen inter-industrial alliance, and establish the international status of China’s energy efficiency standards

In view of the broad market in China, foreign manufacturers and intellectual property rights owners are sure to balance their interests between market and intellectual property rights. Domestic enterprises should rely on the strength of the state and alliances and strengthen industrial alliances after entry into WTO, especially the alliance between suppliers and operators to win more development and manufacturing space for enterprises.

In recent years, manufacturing enterprises are taking a positive attitude towards independent intellectual property rights, but they are still far behind enterprises in

developed countries. For the time being, no domestic enterprise is studying forward-looking technologies that could lead the industry in the next 10-20 years. Thus this project could move forward only by forming an energy efficiency standard research and application system initiated, supported, authorized and supervised by the government, instead of only adopting means of depreciation and public relations.

5.4 Capability development

Emphasis on energy efficiency standards and labeling research should come from the government. At the same time, feasibility research should be done in the course of project implementation through different kinds of means, such as manufacturing enterprises. In addition, standards need to be renewed and revised along with technical developments just like products, thus direct information between products and markets is necessary. Of course, this needs huge economic power to support.

In order to advance international standard activities, developed countries place stress on cultivation of personnel who are familiar with rules of ISO/IEC international standard deliberation and are provided with specialized knowledge. In order to better participate in international standardization activities, Japan is ready to cultivate international standardization talents that give priority to private enterprises.

Personnel working on international standards must have high quality skills, such as a high level of English, profound scientific knowledge, and expertise in technology and standardization in the field,. They should fully grasp international technical and economic development trends, the competitiveness and status of their enterprises or industries at home and aboard, as well as developments in foreign enterprises and industries related to this technology. They should know the development strategy of enterprises and industries in this field and policies of related countries and governments; they should have strong language competence, and should explain the benefits of adopting China's standard to experts from related countries and enterprises.

Therefore, China should place stress on cultivation and training of an energy efficiency standards and labeling force, strengthen development of personnel and units, and cultivate a group of experts for international energy efficiency standard and labeling research.

5.5 On international cooperation

In recent years the scope and depth of energy efficiency standards and labeling activities in China have been greatly developed. The international energy efficiency standards have become an important factor for increase in quantity of export through the trade agreements. China must participate in the establishment of international standards and labeling and related activities in order to win competitive advantage on the global market, which includes:

5.5.1 Track dynamic changes abroad and adjust consistently

China should grasp and adapt related energy efficiency standards, technical regulations and energy development trends in foreign countries and regions, assimilate advanced technologies and experience of other countries, and adjust energy efficiency indices and systems in related industries for export, and develop and protect national industry by adopting technologies of others and adopting restricting measures.

5.5.2 Promote the reciprocal admission of energy efficiency labels

Quite a few countries, such as USA, EU and Switzerland, have considered a reciprocal admission agreement on energy efficiency labeling in order to eliminate potential trade barriers. The global adoption of energy efficiency labeling is also an important condition for smooth foreign trade and a major factor for China's products to enter the international market fully. Considering global economic integration and the increase of household appliances in many nations, the import and export volume of China, a major base for household appliance manufacturing, will substantially increase., Establishing and implementing an energy efficiency identification system for appliances can directly affect import and export services in China, which promote the competitive power of export of domestic products on one hand, and bring up new demands for products entering China's market on the other hand.

5.6 On energy conservation mechanism and policies

Energy efficiency standards and identification labels show the energy consumption indices of products to consumers, thus energy-consuming products can be compared with each other in the market, which promotes their competitive power and helps guide users to select energy-saving products. This could standardize the energy-saving market effectively, build a favorable environment of competition for manufacturing enterprises, and create an atmosphere of concern for the environment, energy use and stress on sustainable development in the global society.

The following efforts are suggested in order to make the implementation of energy efficiency standards and labeling work smoothly:

5.6.1 improve on market promotion mechanisms

Energy-saving products build on high technologies. And enterprises need more input to develop and produce energy-saving product. Therefore, the retail price of energy-saving products can be somewhat higher as compared with that of common products. The purchase capability of China's consumers is greatly different across the nation,, and the product price affects the sales volume for the most part. Therefore, formulating corresponding encouragement policies and subsidy measures shall quicken the popularization of energy-saving products and stimulate the production of energy saving products in manufacturing enterprises. Presently, the income per capita in China is low, the purchase power of consumers varies greatly,, and the product price directly affects sales volume. Therefore market stimulus mechanisms should be adopted and corresponding preferential policies should be established and implemented to stimulate the enthusiasm of enterprises and to lower the energy conservation cost. At the same time, consumers should also be guided to purchase energy-saving products, to promote energy-saving consciousness, the ability to distinguish product energy efficiency, and expand demand for energy-saving products.

5.6.2 Active advancement by the government

It is seen from the experience abroad that the effective implementation of energy efficiency standards and labeling systems is mainly based on governmental support. In both developed countries and developing countries, the implementation of resource and environmental protection policies depends on governmental support. Techniques such as offering stimulation, revenue reduction, subsidies, low-interest loans, accelerated depreciation, and assistance in market exploitation, can be the initial power for promoting the efficiency of energy utilization. China has a huge total energy consumption and low usage ratio. This requires more stimulation and support from government at all levels to improve the energy efficiency standard system and policies. Along with establishment of the highest energy efficiency standard, preferential policies and support should be given to high energy efficiency products and projects in order to encourage and promote the development of energy efficiency products and industries in China.

Along with the further deepening of reform and opening up in China, the government procurement market shall be further opened, which provides a huge

market for high-efficiency products. In the meantime, the extensive development of energy efficiency standards and labeling also provide government procurement with definite point of reference and a market for products.

5.7 Develop reach standards research gradually

Most energy efficiency standards are implemented immediately after being formulated in China. The duration from accepting a new standard to formal effect of the standard is about 6 months, which is quite short as compared with the cycle of new product development in enterprises. Such lead times are acceptable when many existing products already meet the standards. However, if few existing products meet the standard, in view of the coerciveness of energy efficiency standard, it is easy to affect the production plan and development strategy of enterprises and to result in extra economic losses.

Thus, in order to set strong standards that aim to push efficiency to higher levels than current products, extra time needs to be provided before standards take effect. Formulating reach standards aims to determine the energy efficiency target value in the next 3-5 years, and spare some time to enterprises to adjust their product design and production and arrange their technical reconstruction progress within reason. Thus production and development units can afford to develop energy-saving high performance products in a planned way to boost the energy efficiency of products consistently and comprehensively. At the same time, the market guidance of standards could be promoted to avoid unnecessary energy use.

In fact, short-term and long-term standards can often be combined in a single standard-setting process. For example, in the U.S., the most recent standards for clothes washers include two tiers – a modest standard that takes effect in 2004 and a more aggressive standard that takes effect in 2007.

Other foreign countries, Japan,, Korea and Thailand for instance, have implemented reach standards, and they determine the future energy conservation levels by adopting cost effectiveness analysis and model calculations in accordance with technical developments and prediction of energy conservation technologies. They serve the enterprises producing household appliances, lighting, and industry, commerce and office products better, and have won the sound results of energy conservation and environmental protection that guarantee the stable development of the market.

For example, presently reach standards for double-end fluorescent lamps and refrigerators in China are discussed and drafted combining SEPA (the State Environmental Protection Administration)/UNDP/GEF refrigerator project and former SETC (the State Economic and Trade Commission)/UNDP/GEF green lighting promotion project under the help from the American Energy Foundation and LBNL Lab. These attempts will be helpful to improve energy efficiency greatly in China.

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Appendix A. Methodology

The objective of energy saving potential analysis is to calculate energy savings resulting from energy efficiency improvements by implementing new minimum energy performance standards and information labels.

To quantify the increase in energy efficiency before and after new energy standards and labels have been implemented, it is critical to establish a baseline first. Baseline means an energy efficiency level of products in the case of no new energy standards and labels. For products that already have standards, a baseline model with energy use approximately equal to the minimum efficiency requirement is usually chosen. For products without an existing standard, a baseline model can be set according to current average energy efficiency levels estimated or determined from discussions with manufacturers, guilds, institutes, testing laboratories, government agencies and information organizations. The higher energy efficiency levels and the effective dates of new standards are proposed after consulting with some known experts. As important factors, the present international advanced energy efficiency levels, the development trend of new energy conservation technologies and the capability of domestic manufacturers to produce high efficiency products are also considered. Table C-1 (see Appendix C) summarizes relative data.

The analysis matrix includes energy savings, economic benefits, emissions reductions, and peak demand reductions. The major two energy saving measures are energy standards and information labels. Product coverage lies on the result screening analysis. The detail calculation approach is as follows.

(1) Screening candidate products

The product screening is a rough calculation, whose purpose is to filter those products with bigger energy conservation potential from candidate products then decide the list of products which will enter detail analysis matrix. Basic equation for screening is as follows:

Energy savings = inventory _ annual energy use per unit _ savings potential factor (%) _ percent affected in 2020

Savings potential factor means increase percent in energy efficiency by new standard compared with baseline.

All new energy efficiency standards are assumed to take effect in 2005, and the prediction is for savings in 2020. For products whose life is longer than 15 years, some of them sold before the effective date of new standard will not be retired by 2020 and their energy efficiency level may not perfectly meet the limited value of minimum energy efficiency regulated in the new standard. Thus, the total energy savings should be multiplied by percent affected by standard in 2020.

(2) Calculating energy savings

The following equation is used to calculate end-use electricity savings in set year for each product:

End-use electricity savings = annual electricity savings per unit _ inventory of new efficient products

These products in operation will save energy during their lifetime due to the increase in efficiency. Because the proposed standards are mandatory, all related products sold will, in theory, meet the new standard(s). In the case where the new standards are not implemented, we assume that efficiency levels remain at present levels. Once the new standards are set, efficiency levels are expected to rise to the level required by new standards and remain at this level. In actuality, product energy efficiency is gradually increasing, even in the absence of new standards. At the same time, some products will be sold with higher energy efficiency than required by the new standards. We implicitly assume these factors counterbalance each other.

Here inventory of new efficient products means quantity of all equipment meeting new standards and not yet retired by the year in the forecast (e.g. 2010, 2020). It should be indicated that the savings from units installed during the forecast year will be equivalent to only half-year sales time annual savings per unit account for sales throughout the purchase year.

The equation for primary energy savings is as follows:

Primary energy savings = end-use electricity savings ÷ T&D loss factor _ heat rate

(3) Calculating emissions reductions

Emissions reductions of carbon, nitrogen oxides, sulfur dioxide, and particulate materials from the reduced energy consumption are calculated using the following

equation:

Emission reductions = end-use electricity savings ÷ T&D loss factor _ emission factors

(4) Calculating economic benefits

High efficiency products will reduce operation costs for consumers. The financial savings can be determined by multiplying energy rates by energy savings. Economic benefits will be reduced by subtracting financial costs (the product of per-unit incremental purchase cost for each product multiplied by the number of units sold) from financial savings. Present value (PV) calculations are discounted to 2000 using a 7.6% discount rate. Net present value (NPV) of investment aggregates the present value of annual investments from the effective date of each standard through 2020. The NPV of savings aggregates the present value of annual utility bill savings from the effective date of the standard through the year in which products installed through 2020 die out. That means the NPV of savings also includes savings after 2020 for products sold prior to 2020. NPV is calculated as:

NPV of investment = □{PV (annual sales volume _ Per unit incremental cost)}

NPV of savings = □{PV (end-use energy savings _ energy price)}

For washing machines, we also calculate savings from water savings.

(5) Calculating peak demand reductions

The utilization of some appliances put great impact on summer peak load, for example air conditioners. To set standards for them will produce significant benefits from peak demand reductions. Peak demand reduction is calculated as:

Peak demand reductions = end-use electricity savings ÷ T&D loss factor _ reserve factor _ peak factor

Peak factor for each appliance is the average coincident power demand of the appliance during peak periods divided by the annual electricity consumption of the appliance.

For energy information labels, the calculation of savings is based on the investigation and research conducted by other countries. We suppose that the annual

energy saving per product brought along by the labeling is 20% of the difference between the maximum energy saving potential and standard energy saving potential. The total saving, pollutant reduction, economic benefits and peak load decrease from labels can be calculated as the same way in the case of standards.

Appendix B. General Parameters

The following lists general parameters across all products:

T&D loss factor:	0.925（7.5% loss）
Reserve factor:	1.1（10% reserve margin）
Residential electricity rate:	0.46 ¥/kWh
Commercial electricity rate:	0.84 ¥/kWh
Industrial electricity rate:	0.53 ¥/kWh
Industrial coal rate:	251.7 ¥/ton
Residential water price:	3.00 ¥/m^3
Discount rate:	7.6%
Heat rate (2010):	359.6 Gce/kWh
Heat rate (2020):	334.8 Gce/kWh
Carbon emission factor:	0.267 kg/kWh
NOx emission factor:	0.004 kg/kWh
SO_2 emission factor:	0.053 kg/kWh
PM10 emission factor:	0.025 kg/kWh

Appendix C. Data

TableC-1 Baseline and Proposed new standards

Product	2000 National Sales (million)	annual increase rate %	unit savings potential %	savings potential by standard %	savings potential by label %	Baseline	New Standard	Units	Basis for New Standard	Average Product Life (years)	Effective Date (Year)
TVs (active mode)	19.92	3.5	30	13	4	80	70	W	According on Japan "Top Runner"	7.5	2004
Room air conditioner	17.3	5.0	30	11	4	2.5	2.8	EER(W/W)	Minimum LCC on previous analysis	7.5	2004
Refrigerator/freezer	9.26	3.2	40	36	1	1.10	0.7	kWh/24h	Minimum LCC on previous analysis	11.25	2003
Rice cooker	12.978	6.0	20	12	2	76	86	Heat efficiency (%)	。。	5.0	2005
Freezer	3.84	3.5	40	20	4	1.50	1.20	kWh/24h	Minimum LCC on previous analysis	11.25	2003
Washing machine									。。		
Impeller	9.79	1.0	30	12	4	0.03	0.03	kWh/kg/cycle	GB12021.4	10	2004
Drum	1.32	2.0	30	11	4	0.35	0.31	kWh/kg/cycle	GB12021.4	10	2004
TVs (standby mode)	19.92	3.5	98	63	7	8.1	3	W	Energy Star	7.5	2004
Microwave oven	2.00		81	63	4	2.7	1	W	IEA"1W"	8	2006
Laser printer	0.59	15.0	67	50	3	20	10	W	Energy Star	5	2004

Product	2000 National Sales	annual increase rate	unit savings potential	savings potential by standard	savings potential by label	Baseline	New Standard	Units	Basis for New Standard	Average Product Life	Effective Date
(<10ppm)											
Facsimile machine (<10ppm)	1.96	15.0	85	56	6	6.8	3	W	IEA“1W”	3	2006
Copier (<20cpm)	1.56	14.0	78	58	4	12.0	5	W	Energy Star	8	2006
Computer monitor	8.68	13.0	74	63	2	5.43	2	W	Energy Star	5	2004
Double-capped fluorescent lamp	360.00	3.0	42	10	6	55	67	Lumin/W	T12 replaced by T8	2.38	2003
Fluorescent ballast	112.00	10.0	15	15		2.03	2.40	BEF	Green lights	5	2005
High Intensity Discharge Lamp	17.46	8.0	60	33		150	100	W	Blended & HPMV replaced by MH or HPS	5	2005
Traffic light	3.40	1.8	95	92		100	7.80	W	Incandescent replaced by LED	5	2005
Exit sign	2.73	4.4	88	88		40	5.00	W	Incandescent & fluorescent replaced by LED	6	2004
Central air conditioner									。。		
Recp type chilling unit	0.0038	3.6	39	9		3.50	3.85	EER(W/W)	。。	8	2005
Water-cooled screw type water chilling unit	0.002	3.5	42	9		3.65	4.02	EER(W/W)	。。	11	2005
Water-cooled centrifugal water chilling unit	0.00026	3.7	41	9		4.50	4.95	EER(W/W)	。。	25	2005

Product	2000 National Sales	annual increase rate	unit savings potential	savings potential by standard	savings potential by label	Baseline	New Standard	Units	Basis for New Standard	Average Product Life	Effective Date
Unitary	0.0054	5.5	30	9	4	2.65	2.92	EER(W/W)	。。	15	2005
Motor	4.2	2.8	6	1		85.3	86.5	Efficiency (%)	Based on EU eff-1 Chinese voluntary standard	10	2004
Fan	0.4377	2.5	3	2		67.5	69.0	Efficiency (%)	。。	10	2004
Pump	6.27	2.5	5	1		75.5	76.8	Efficiency (%)	。。	10	2004
Air compressor									。。		
Mini type	0.8	5.0	17	12		14.30	12.58	$kW/(m^3.min^{-1})$	。。	4	2004
Large scale	0.1	10.0	15	11		6.30	5.60	$kW/(m^3.min^{-1})$	。。	8	2004
Transformer	0.55		25					Loss	S7 replaced by S9	20	2004
Industrial boiler									。。		
Building	0.01	3.8	15	14		0.60	0.70	Heat efficiency (%)	GEF boiler project	10	2005
Producing	0.025	3.8	12	10		0.72	0.80	Heat efficiency (%)	GEF boiler project	15	2005

Table C-2 Analysis Results of Screening

Product	Data source	unit savings potential	savings potential by standard	Inventory	Per unit power use	Annual load factor	Per unit energy use	Total energy use	Total primary use	Product life	Percent affected in 2020	Energy savings in 2020	
		%	%	million	W	%	kWh (electr.) m^3 (gas)	10^8 kWh	10000 Tce	years	% Blank 100	10^8 kWh	1000 Tce
Residential													
TV	CECP	30	15	21648	80	21	149.80	324.28	1085.68	7.5		48.64	162.85
Room AC	LBL	30	15	8000	1500	5	600.00	480.00	1607.04	7.5		72.00	241.06
Refrigerator	LBL	40	20	8000	62	100	536.55	429.24	1437.10	11.25		85.85	287.42
Rice cooker	Thailand, Korea	20	10	9600	600	8	438.00	420.48	1407.77	5		42.05	140.78
Freezer	LBL	40	20	3000	62	100	547.50	164.25	549.91	11.25		32.85	109.98
Washing machine	LBL	30	15	8124			46.80	38.02	149.04	12		5.70	19.09
Water heater (electr.)		15	8	1500			685.00	102.75	402.78	12		8.22	27.52
Water heater (gas)		15	8	3500			109.50	38.33	150.23	8		3.07	10.26
Household fan		10	5	12000	60	6	30.00	36.00	141.12	16		1.80	6.03
Ceiling fan		10	5	5000	60	7	36.00	18.00	70.56	16		0.90	3.01
Standby power													
Color TV	CECP	98	63	21648	8	8	5.91	12.80	42.86	10		8.00	26.78
Microwave oven	CECP		50	586	4	96	33.58	1.97	6.59	11		0.98	3.29
Laser printer (<10ppm)	CECP	67	41	500	18	22	35.02	1.75	5.86	5	21	0.15	0.50
Facsimile machine	CECP	85	26	356	7	42	24.82	0.88	2.96			2.30	77.00
Copier	CECP	78	39	367	28	29	71.54	2.62	8.79			1.02	3.43
Computer	CECP	63	31	2270	5	30	14.12	3.20	10.73	5		0.99	3.33

Product	Data source	unit savings potential %	savings potential by standard %	Inventory million	Per unit power use W	Annual load factor %	Per unit energy use kWh (electr.) m^3 (gas)	Total energy use 10^8 kWh	Total primary use 10000 Tce	Product life years	Percent affected in 2020 % Blank」 ㄟ 100	Energy savings in 2020 10^8 kWh	 1000 Tce
monitor													
Lighting													
Double-capped fluorescent lamp	BELSRI Green Lights	42	17	36000	36	38	121.00	435.59	1458.34	8000hs		74.05	247.92
Self-ballast fluorescent lamp	Green Lights	31	16	30066	11	27	26.40	79.37	265.74	5000hs		12.70	42.52
Single-end fluorescent lamp	Green Lights	31	16	15033	11	27	26.40	39.69	132.87	5000hs		6.35	21.26
Fluorescent ballast	CNIS	78	35	54518	9	34	27.00	147.20	492.82	6	70	36.06	120.74
HID lamp	Green Lights CALI	60	33	1746	150	23	300.00	52.38	175.37	5000hs	50	8.73	29.23
Traffic light	Green Lights	95	92	220	135	100	1182.60	26.02	87.11	1000hs	55	13.16	44.08
Exit sign		88	88	300	40	83	292.00	8.76	29.33	1000hs		7.71	25.81
Commercial/industrial equipment													
Recp type chilling unit	Tianjin University	39	13	2.51	231000	46	924000	231.86	776.27	8		30.14	100.91
Water-cooled screw type water chilling unit	Tianjin University	42	13	1.30	516000	46	2064000	267.82	896.68	11		34.82	116.57
Water-cooled centrifugal water chilling unit	Tianjin University	41	13	0.31	1440000	46	5760000	180.00	602.64	25	60	14.04	47.01
Unitary	Tianjin University	30	9	4.241		46	18113	7.68	25.70	15		0.66	2.21
Motor	BECon	。。	2	。。	。。	46	。。	3091.00	10347.89	10	95	58.72	196.61
Fan	IIEC/MIECC	3	3	269	3643.12	68	21701.35	583.77	1954.45	10		17.51	58.63
Pump	IIEC/MIECC	5	5	3000	2666.67	68	15884.80	4765.44	15954.69	10		238.27	797.73

Product	Data source	unit savings potential	savings potential by standard	Inventory	Per unit power use	Annual load factor	Per unit energy use	Total energy use	Total primary use	Product life	Percent affected in 2020	Energy savings in 2020	
		%	%	million	W	%	kWh (electr.) m^3 (gas)	10^8 kWh	10000 Tce	years	% Blank」 ﾇ 100	10^8 kWh	1000 Tce
Mini type air compressor	NTCRE	17	11	220	1500	9	1200.00	2.64	0.883872	2.5		2.90	9.72
Lager scale air compressor	NTCRE	15	10	32	15000	11	15000.00	48.00	160.70	4		4.80	16.07
transformer	ICA	10.2kWh/y -1kvA	20	。。		63	。。	10^9 kVA	。。	20	72	100.80	337.48
Industrial boiler for building	Xi'an JiaoTong Univ.	15	8	27		41	。。	1800.00	6026.40	10	90	129.60	433.90
Industrial boiler for producing	Xi'an JiaoTong Univ.	12	5	25		61	。。	4000.00	13392.00	15	90	180.00	602.64

Table C-3 Estimate Savings from New Standards for Appliances

Product	Energy Savings				Net Benefits (NPV benefits-costs)	Benefit-cost Ratio	Summer Peak Load Reductions		Emission Reductions in 2020			
	2010		2020				2010	2020	Carbon	NOx	SO_2	PM10
	TWh	MMTce	TWh	MMTce	¥ Million		GW	GW	MMT	1000MT	1000MT	1000MT
TV	3.07	1.19	4.79	1.73	8946	5.8	0.25	0.39	1.38	21.08	275.05	128.46
Room AC	13.39	5.21	20.04	7.25	30925	3.0	5.91	8.84	5.79	88.19	1150.62	537.39
Refrigerator	12.65	4.92	21.78	7.88	45729	9.1	1.88	3.25	6.29	95.85	1250.48	584.03
Rice cooker	4.69	1.82	8.41	3.04	12362	4.3	0.80	1.43	2.43	36.98	482.51	225.35
Freezer	3.92	1.53	7.38	2.67	14017	6.8	0.58	1.10	2.13	32.46	423.45	197.77
Washing machine												
Impeller	0.39	0.15	0.56	0.20	5148	2.4	-	-	0.16	2.47	32.21	15.04
Drum	1.11	0.43	2.91	1.05	1893	1.4	-	-	0.84	12.81	167.17	78.07
Total	**39.22**	**15.25**	**65.87**	**23.82**	**119020**	**4.2**	**9.42**	**15.01**	**19.02**	**289.84**	**3781.49**	**1766.11**

Table C-4 Estimate Savings from New Standards for Standby Power

Product	Energy Savings				Net Benefits (NPV benefits-costs)	Benefit-cost Ratio	Summer Peak Load Reductions		Emission Reductions in 2020			
	2010		2020				2010	2020	Carbon	NOx	SO_2	PM10
	TWh	MMTce	TWh	MMTce	¥ Million		GW	GW	MMT	1000MT	1000MT	1000MT
Color TV	3.26	1.27	5.10	1.84	9173	5.0	0.26	0.41	1.47	22.43	292.58	136.65
Microwave oven	0.46	0.18	1.46	0.53	1298	2.3	0.07	0.21	0.42	6.44	84.03	39.24
Laser printer (<10ppm)	0.14	0.05	0.24	0.09	761	6.1	0.04	0.06	0.07	1.08	14.03	6.55
Facsimile machine (<10ppm)	0.12	0.05	0.25	0.09	291	1.6	-	-	0.07	1.10	14.29	6.68
Copier (<20cpm)	0.39	0.15	1.32	0.48	3145	7.2	0.10	0.34	0.38	5.79	75.60	35.31
Computer monitor	1.05	0.41	2.04	0.74	4632	2.8	0.32	0.62	0.59	8.97	117.09	54.69
Total	**5.42**	**2.11**	**10.41**	**3.77**	**19300**	**3.7**	**0.79**	**1.64**	**3**	**45.81**	**597.62**	**279.12**

Table C-5 Estimate Savings from New Standards for Lighting

Product	Energy Savings				Net Benefits (NPV benefits-costs)	Benefit-cost Ratio	Summer Peak Load Reductions		Emission Reductions in 2020			
	2010		2020				2010	2020	Carbon	NOx	SO_2	PM10
	TWh	MMTce	TWh	MMTce	¥ Million		GW	GW	MMT	1000MT	1000MT	1000MT
Double-capped fluorescent lamp	9.57	3.72	12.86	4.65	43826	5.3	1.87	2.52	3.72	56.57	738.08	344.72
Fluorescent ballast	17.80	6.92	46.18	16.71	5214	1.1	3.49	9.04	13.34	203.19	2650.95	1238.11
HID lamp	2.51	0.98	0.79	0.29	4604	3.4	0.23	0.07	0.23	3.50	45.61	21.30
Traffic light	9.09	3.53	7.63	2.76	25067	9.0	1.29	1.08	2.20	33.58	438.06	204.59
Exit sign	3.26	1.27	4.41	1.60	14455	3.8	0.46	0.63	1.28	19.42	253.40	118.35
Total	**42.23**	**16.42**	**71.87**	**26.01**	**93166**	**1.8**	**7.34**	**13.34**	**20.77**	**316.26**	**4126.1**	**1927.07**

Table C-6 Estimate Savings from New Standards for Commercial/industrial Equipment

Product	Energy Savings				Net Benefits (NPV benefits-costs)	Benefit-cost Ratio	Summer Peak Load Reductions		Emission Reductions in 2020			
	2010		2020				2010	2020	Carbon	NOx	SO_2	PM10
	TWh	MMTce	TWh	MMTce	¥ Million		GW	GW	MMT	1000MT	1000MT	1000MT
Central AC												
Recp type chilling unit	2.56	1.00	4.55	1.65	16437	16.1	0.89	1.58	1.31	20.01	261.01	121.90
Water-cooled screw type water chilling unit	2.95	1.15	7.07	2.56	22968	15.3	1.03	2.46	2.04	31.09	405.62	189.44
Water-cooled centrifugal water chilling unit	1.10	0.43	3.65	1.32	10603	13.7	0.38	1.27	1.05	16.06	209.48	97.84
Unitary	0.45	0.18	1.39	0.50	3825	9.2	0.27	0.81	0.40	6.13	80.03	37.38
Motor	11.29	4.39	16.46	5.96	37301	5.0	2.28	3.32	4.76	72.42	944.79	441.26
Fan	7.87	3.06	12.27	4.44	31320	17.3	1.59	2.48	3.54	53.97	704.08	328.84
Pump	16.64	6.47	29.49	10.67	70558	24.8	3.36	5.96	8.52	129.75	1692.85	790.63
Air compressor												
Mini type	0.76	0.29	1.23	0.45	2740	7.2	0.19	0.32	0.36	5.42	70.77	33.05
Large Scale	4.41	1.71	7.88	2.85	17245	8.1	0.89	1.59	2.28	34.65	452.07	211.14
Transformer	8.29	3.22	22.08	7.99	30182	4.9	1.57	4.18	6.38	97.16	1267.59	592.02
Industrial												
Building	-	2.07	-	4.83	4751	79.3	-	-	3.28	49.90	650.99	304.04
Producing	-	9.43	-	30.82	26588	27.3	-	-	20.91	318.39	4153.91	1940.06
Total	**56.32**	**33.4**	**106.07**	**74.04**	**274518**	**10.2**	**12.45**	**23.97**	**54.83**	**834.95**	**10893.19**	**5087.6**

Table C-7 Estimate Savings from Information Labels

Product	Energy Savings				Net Benefits (NPV benefits-costs)	Benefit-cost Ratio	Summer Peak Load Reductions		Emission Reductions in 2020			
	2010		2020				2010	2020	Carbon	NOx	SO_2	PM10
	TWh	MMTce	TWh	MMTce	¥ Million		GW	GW	MMT	1000MT	1000MT	1000MT
TVs	0.86	0.33	1.34	0.49	2560	6.6	0.07	0.11	0.39	5.90	77.01	35.97
Room AC	4.82	1.87	7.22	2.61	6358	1.6	2.13	3.18	2.08	31.75	414.22	193.46
Refrigerator	0.25	0.10	0.44	0.16	352	1.5	0.04	0.06	0.13	1.92	25.01	11.68
Rice cooker	0.68	0.26	1.21	0.44	2055	8.9	0.11	0.21	0.35	5.33	69.48	32.45
Freezer	0.78	0.31	1.48	0.53	2900	8.5	0.12	0.22	0.43	6.49	84.69	39.55
Washing machine												
Impeller	0.07	0.03	0.10	0.04	1007	1.7	-	-	0.03	0.45	5.93	2.77
Drum	0.36	0.14	0.95	0.34	56	1.0	-	-	0.27	4.16	54.33	25.37
Double-capped fluorescent lamp	6.12	2.38	8.23	2.98	16654	1.9	1.20	1.61	2.38	36.21	472.37	220.62
Unitary AC	0.21	0.08	0.64	0.23	1608	5.4	0.12	0.37	0.19	2.82	36.81	17.19
Total	**14.2**	**5.5**	**21.6**	**7.8**	**33550**	**2.0**	**3.8**	**5.8**	**6.2**	**95.0**	**1239.9**	**579.1**