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Environmental Stewardship: How Semiconductor Suppliers Help to Meet Energy-Efficiency Regulations and Voluntary Specifications in China

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Abstract

Recognizing the role that semiconductor suppliers can play in meeting energy-efficiency regulations and voluntary specifications, this paper provides an overview of Chinese policies and implementing bodies; a discussion of current programs, their goals, and effectiveness; and possible steps that can be taken to meet these energy-efficiency requirements while also meeting products' high performance and cost goals.

1 Introduction

China is the second largest energy consumer in the world, behind the United States, and accounts for about 10.8% of the world's total annual energy consumption.[1] By 2025, projections indicate that China will be responsible for approximately 14.2% of world energy consumption.[2] China is largely dependent on coal to fulfill its energy needs, and stands as the world's largest consumer and producer of coal. Of the 45.5 quadrillion Btu of energy consumed in China in 2003, 65% was coal, 25% was oil, 6% was renewable energy including hydropower, 3% was natural gas, and 0.9% was nuclear energy.[3] This energy consumption is projected to increase due to the country's economic expansion and rapidly growing industrial sector, which accounts for most of this energy use. In 2003 alone, the industrial grew by 11.6%[4], contributing significantly to the rise in China's GDP. China's leadership is working to quadruple the size of the country's economy by 2020 over 2000, which would result in a projected increase in oil consumption alone by 50 percent or more by 2020.[5]

2 Overview of Appliance Market

China has experienced tremendous growth in the household appliances and consumer electronic sectors over the past 25 years, becoming one of the world's largest manufacturers and markets for a wide range of products. In 1981, shortly after China's economic reforms began, ownership of appliances was extremely limited, and even televisions were an uncommon commodity. In contrast, by 2005, each of China's nearly 190 million urban households had on average 1.3 color televisions, and nearly all owned a clothes washer, refrigerator, and air conditioner. In just seven years, personal computer ownership rates jumped from zero to over 40% (see **Fig. 1**). Ownership rates in rural households lag urban areas by 15 to 20 years, although ownership rates for color televisions is just five years behind the urban trend (see **Fig. 2**).

[1] Carbon Sequestrian Leadership Forum, http://www.cslforum.org/china.htm

[2] Energy Information Administration, China: Environmental Issues, http://www.eia.doe.gov/emeu/cabs/chinaenv.html

[3] Energy Information Administration, *International Energy Outlook 2006* Table D13. Delivered Energy Consumption in China by End-Use Sector and Fuel, 2003-2030, www.eia.doe.gov

[4] Lawrence Berkeley National Laboratory *Comments on Recent Energy Statistics from China* (October 2003)

[5] Science at Berkeley Lab, *Taking the Measure of China's Energy Strategies*, http://www.lbl.gov/Science-Articles/Archive/sabl/2005/September/03-China-report.html

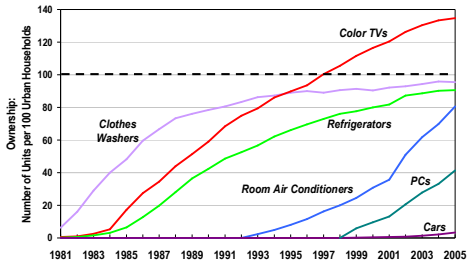


Fig. 1 Urban Ownership of Major Appliances

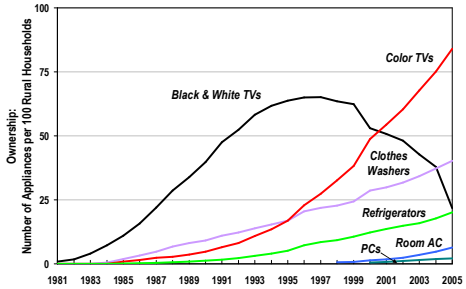


Fig. 2 Rural Ownership of Major Appliances

Economic policies encouraging "domestication" of production, extensive investment by foreign companies, combined with a rapid increase in household wealth and demand for energy services, have underpinned the growth of China's appliance industry. Although in the early years of the industry, production was aimed primarily at the domestic market, China's rapid absorption of more advanced technologies and quality production skills shifted the focus to the international market. Ten years ago, over three-fourths of production was sold domestically; today, over three-fourths of televisions produced in China are exported (see **Table 1**).

3 National Energy-Efficiency Policies

The rapid uptake of appliances and electronics into Chinese households drove a sustained increase in residential electricity use, averaging 14% per year between 1980 and 2004. The impact of this growth spurred the government to initiate China's first program on equipment standards, which was established in 1990. This first round of equipment standards in general was fairly lax and incompatible with the testing procedures and standards methodologies used internationally.

The following national policies have provided the infrastructure for development of mandatory and voluntary energy-efficiency programs: Energy Conservation Law of The People's Republic of China (1998)，Regulation on Energy Conservation Production Certification (1998)，China Medium and Long Term Energy Conservation Plan (2004), Regulation on Energy-Efficiency Labeling Administration (2004), Notice on the Carrying Out of Resource Conservation Activities Nationwide (2004), and Procurement Policy for Energy-Efficient Products (2004).

3.1 Standards and Labeling System

China's standards system—including energy efficiency, safety, classification, and other areas—is currently under the authority of AQSIQ (State Administration of Quality, Supervision, Inspection, and Quarantine), formerly known as the State Bureau of Technical Supervision (SBTS). Although directly under the State Council—China's top government body, headed by the Premier—AQSIQ holds a vice-ministerial rank, lower than other ministries such as the Ministry of Information Industry (MII) (see **Fig. 3**).

	Computers			Refrigerators			Room Air Conditioners			Televisions		
	Production	*Exports*	*E/P*	*Production*	*Exports*	*E/P*	*Production*	*Exports*	*E/P*	*Production*	*Exports*	*E/P*
1995	0.8	0.5	63%	9.2	1.0	11%	6.8	0.3	5%	20.6	5.7	28%
1996	1.4	1.3	96%	9.8	1.0	10%	7.9	0.3	3%	25.4	5.3	21%
1997	2.1	1.9	93%	10.4	1.2	12%	9.7	0.7	7%	27.1	4.1	15%
1998	2.9	2.1	71%	10.6	1.5	14%	11.6	1.1	9%	35.0	4.3	12%
1999	4.1	3.7	91%	12.1	2.1	18%	13.4	1.8	13%	42.6	5.7	13%
2000	6.7	5.0	74%	12.8	3.5	28%	18.3	3.2	18%	39.4	10.3	26%
2001	8.8	5.8	66%	13.5	4.5	33%	23.3	5.6	24%	40.9	11.6	28%
2002	14.6	9.4	64%	16.0	6.1	38%	31.4	9.2	29%	51.6	18.8	37%
2003	32.2	28.0	87%	22.4	8.8	39%	48.2	18.9	39%	65.4	31.3	48%
2004	59.7	39.0	65%	30.1	12.9	43%	63.9	26.7	42%	74.3	44.1	59%
2005	80.8	59.7	74%	29.9	13.8	46%	67.6	28.3	42%	82.8	64.1	77%

Source: NBS; China Customs. E/P: ratio of exports to production

Table 1 Production and Export of Selected Appliances (million units)

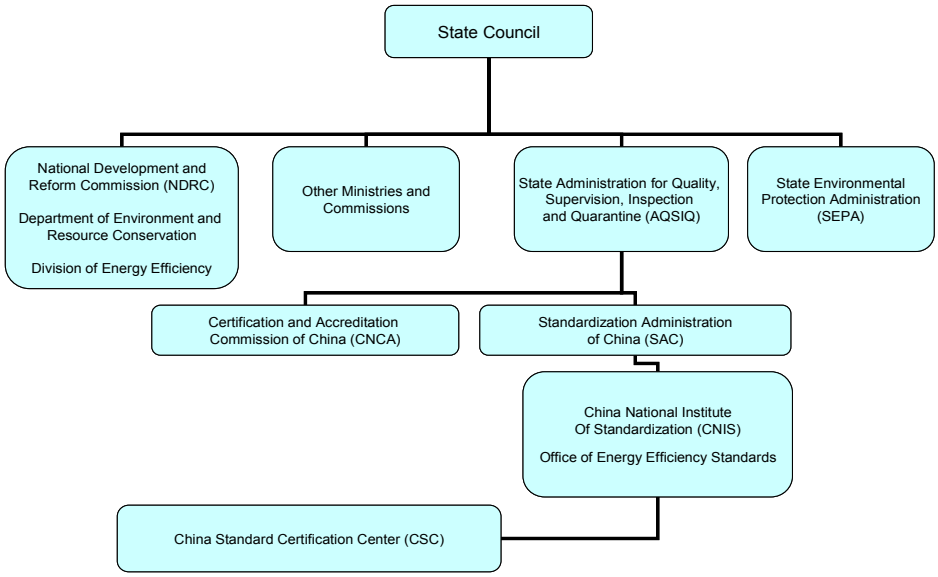


Fig. 3 Basic Structure of China's Standards and Labeling Organizations

The administrative functions of AQSIQ relative to standardization are exercised by the Standardization Administration of China (SAC), which is responsible for review and approval of new energy standards. Technical development work on energy standards has been delegated to the China National Institute of Standardization (CNIS), Office of Energy Efficiency Standards. In 1998, China established the China Certification Center for Energy Conservation Products (CECP, now the China Standard Certification Center or CSC) to implement a voluntary energy efficiency labeling program.

Overall energy efficiency policy, however, is developed and managed by the powerful National Development and Reform Commission (NDRC), based on the framework of energy conservation laid out in the National Energy Conservation Law of 1998. Though administratively separate, CNIS and CSC both provide technical support to NDRC and are responsive to new policy directions developed by NDRC.

3.2 Four Key Programs

Currently, China has four major programs related to standards and labeling. Each is described briefly below. The first two are mandatory and implemented by CNIS; the third is a voluntary endorsement labeling program managed by CSC; and the fourth is a government procurement program implemented by NDRC and the Ministry of Finance.

3.2.1 Mandatory Minimum Efficiency Standards

Developed by CNIS, mandatory energy efficiency standards now cover most residential and commercial appliances, lighting and heating and cooling equipment. Beginning in 1999, CNIS developed a series of new standards based upon international practice, and in 2003 began development of "reach" standards, or two-period, two-tiered standards. Though the standards are mandatory, conformity varies widely. In the near term, CNIS will be revising some current standards, for rice cookers for example, and developing new standards for products in the industrial and commercial sector.

3.2.2 Mandatory Energy Information Labeling

In 2005, China launched a categorical mandatory energy information label, adapted from the EU categorical energy label (see **Fig. 4**). Including five categories of efficiency, from 100% (meeting the minimum standard, or category 5) to 55% of the minimum standard (category 1), the label is applied now only to refrigerators and room air conditioners, although it is expected to be expanded to other product categories. As of October 2005, application materials for 6,223 models from 146 manufacturers (including 2,100 models from 78 refrigerator manufacturers and 4,123 models from 68 air conditioner manufacturers)

had been submitted. CNIS is responsible for managing this program.

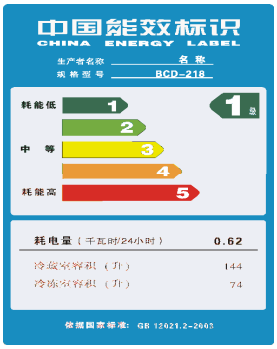


Fig. 4 Energy Label for Refrigerators and Room Air Conditioners

3.2.3 Voluntary Energy-Efficiency Labeling

The voluntary energy efficiency endorsement labeling program, analogous to the US ENERGY STAR program with which it cooperates closely, has been administered by CSC since 1998. Currently, the program labels 50 product categories from over 300 participating manufacturers, including home appliances, consumer electronics, office equipment, lighting and selected industrial equipment. Each product that qualifies for the certificate can display the Energy Conservation Certification label (see **Fig. 5**). In the near term, CSC plans to certify additional consumer electronic and office products, such as scanners, and add a new category of products from the commercial and industrial sector.

Fig. 5 Energy Conservation Certification Label

3.2.4 Government Energy-Efficiency Procurement

As part of a drive to increase the efficiency of the government sector, NDRC and the Ministry of Finance implemented a new program of government energy efficiency procurement in 2005. The program established a list of nine products, including air conditioners, refrigerators, fluorescent lamps (linear and CFLs), TVs, computers, printers, faucets, and toilets, for which China's centralized procurement system must "preferentially procure" only those models that have achieved certification under the CSC energy efficiency labeling program. By 2007, the program will be expanded nationwide.

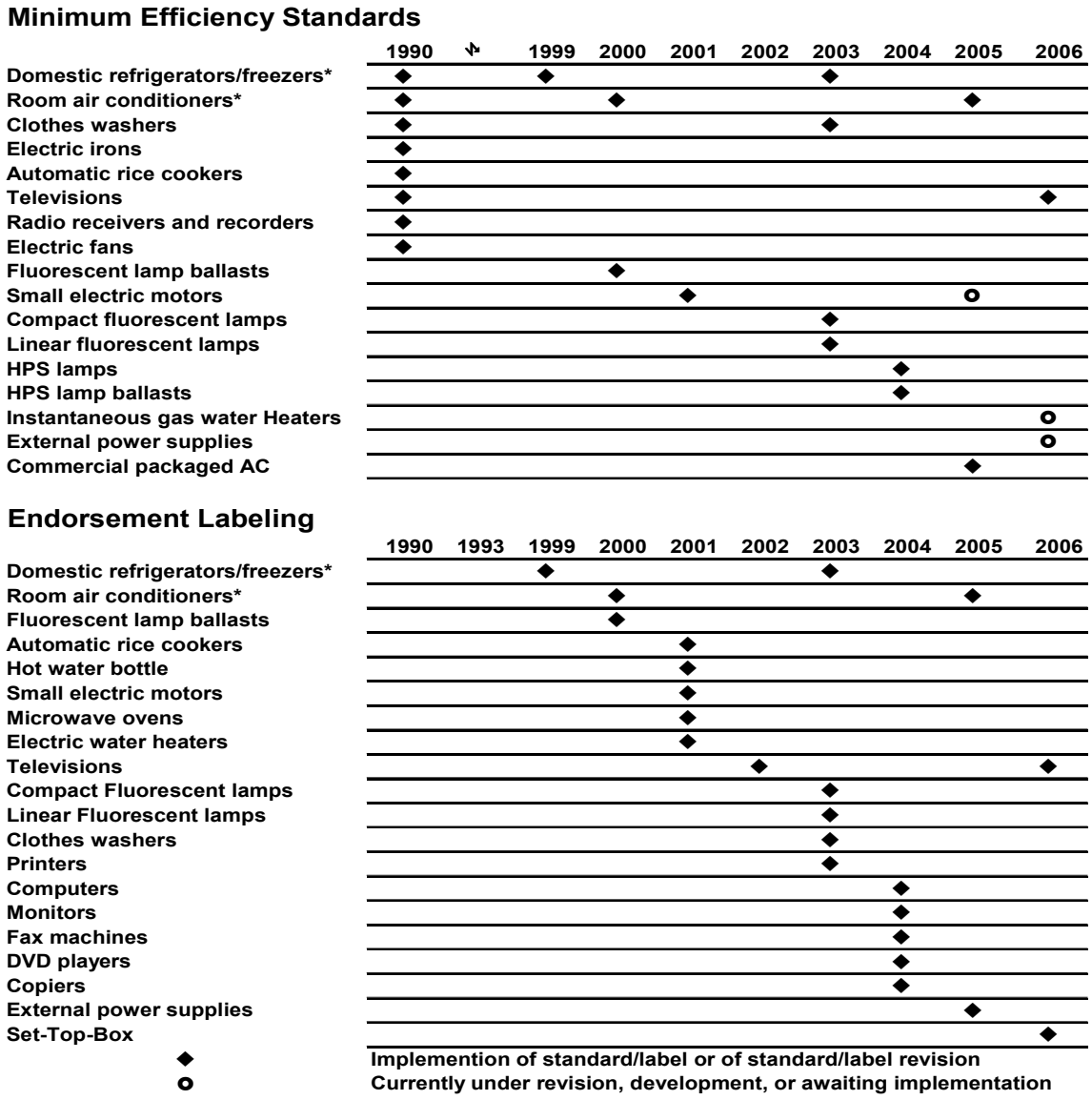
3.3 Products Covered and Timeline

Significant overlap exists between the list of products subject to minimum energy efficiency standards and those certified for energy efficiency labeling (see **Fig. 6**). For products subject to the minimum efficiency standard, such as refrigerators and air conditioners, energy efficiency criteria are developed simultaneously with the same timeframe of implementation and revision. Other products, such as printers, computers, DVD players, and other consumer electronics, are generally not subject to minimum efficiency standards and are covered only by the efficiency labeling program. In these cases, the timeline for revisions is subject to market and technical developments.

4 Product Design Improvements

The semiconductor market in China is growing rapidly. In 2005, China took the lead as the number one consumer of semiconductors in the world. According to Price Waterhouse Coopers' *China's Impact on the Semiconductor Industry: 2005 Update*, Chinese consumption of semiconductors now accounts for more than 20 percent of worldwide consumption. Energy-efficiency organizations in China and other major economies believe that innovative, leading semiconductor suppliers will garner new business opportunities from selling efficient components to product manufacturers and assemblers, who can then offer high efficiency end products that will save consumers energy and money while also providing environmental benefits.

In consumer appliances such as air conditioners, washing machines and refrigerators, the industry is witnessing the transition from single-phase DC motor to inverter based motors. With this inverter based motor, up to 60% of the energy can be saved. Semiconductor suppliers play an integral role in designing intelligent modules that can drive these inverter based systems, which not only results in a more efficient solution, but also lowers the cost of manufacturing due to the integration within the module itself. In AC/DC applications, the use of integrated power switches



* Note: Denotes products that also are subject to the mandatory energy information label.

Fig. 6 Timeline of Standards and Labeling in China (Selected Products)

can lower standby losses to under 1 Watt or less to both meet the Global 1 Watt Initiative and reduce energy and part count in end applications. In TVs, there continues to be the need for more efficient AC/DC, DC/DC power modules for the power supply and to reduce standby power, which can be solved by efficient power switches. In plasma displays, servers, PC power supplies and low power supplies, the use of Power Factor Correction (PFC) controllers helps to regulate current to conform to input voltage, which improves power factor. Through the use of topologies such as SEPIC and quasi-resonant and full-resonant topologies, energy-efficient solutions can further be achieved to help to meet some of the stringent energy regulations and standards.

5 Conclusions

China is responsible for about 14% of the world's greenhouse gas emissions[6] and, as the industrial sector continues to grow, experts predict that within this decade China could overtake the United States in producing the most greenhouse gas emissions in the world. The impact of climate change is expected to be considerable, and as a

[6] Carbon Sequestrian Leadership Forum, http://www.cslforum.org/china.htm

developing country, China is not required to limit its emissions under the internationally agreed Kyoto Protocol. As such, the use of energy-efficient products and implementation of energy efficiency policies will play a significant role in China's approach to addressing its energy concerns, including climate change.

As the world's largest manufacturer of electronic systems and major consumer of electronic devices, China holds a very influential position in terms of global energy consumption. In China alone, 60% of household energy consumption is electricity-based and the growth of consumer electronics and white goods will only continue in the next decade. Further, as a major exporter, the efficiency of Chinese-manufactured products affects many other nations that import significant volumes of electronics and other energy-consuming devices.

Recognizing this, CSC, CNIS, and other Chinese organizations have developed strong relationships with their international energy efficiency counterparts, including the US EPA's ENERGY STAR program, the Australian Greenhouse Office, the European Union's Code of Conduct, and the International Energy Agency. These organizations are collaborating based on the principle that all stakeholders are best served through the implementation of one global test procedure and one global data set for evaluating and setting efficiency levels, which may vary by country to reflect local interests and concerns. CSC, for example, positively promotes international harmonization on energy-efficiency requirements and test procedures with its international colleagues, and is participating in developing harmonized testing specifications and energy performance levels for External Power Supplies, CFLs, Set-top Boxes, and potentially other products. Looking ahead, CSC plans to follow international technical trends on energy efficiency, and will update China's energy-efficiency requirements accordingly.

An important part of China's approach is to not only require or encourage energy-efficient designs, but also to provide valuable energy use information to consumers either through an endorsement label or an information label. When purchasing an appliance, it is important that consumers not only consider the cost of the actual appliance, but also the potential savings that one might achieve by using an application whose very design itself is energy-efficient.

As energy concerns grow in China and across the globe, semiconductor suppliers have increasing opportunities to help their customers meet more stringent regulations and voluntary specifications. Governments and energy efficiency organizations are looking for ways to save energy across a wide array of consumer products and by optimizing all modes of operation from active to off or standby. For 2007, two key products (globally manufactured and traded) of interest are televisions and set-top boxes. Given that power semiconductors offer significant energy savings potential, semiconductor suppliers are encouraged to participate in the design and revision of energy-efficiency specifications and standards. By rising to the energy challenge and working collaboratively, China, its international partners, semiconductor suppliers, and other stakeholders can grow the market for high efficiency components and end products, save energy, and contribute to a cleaner global environment.

6 Literature

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