Energy Saving Potential of Standards and Labeling in China

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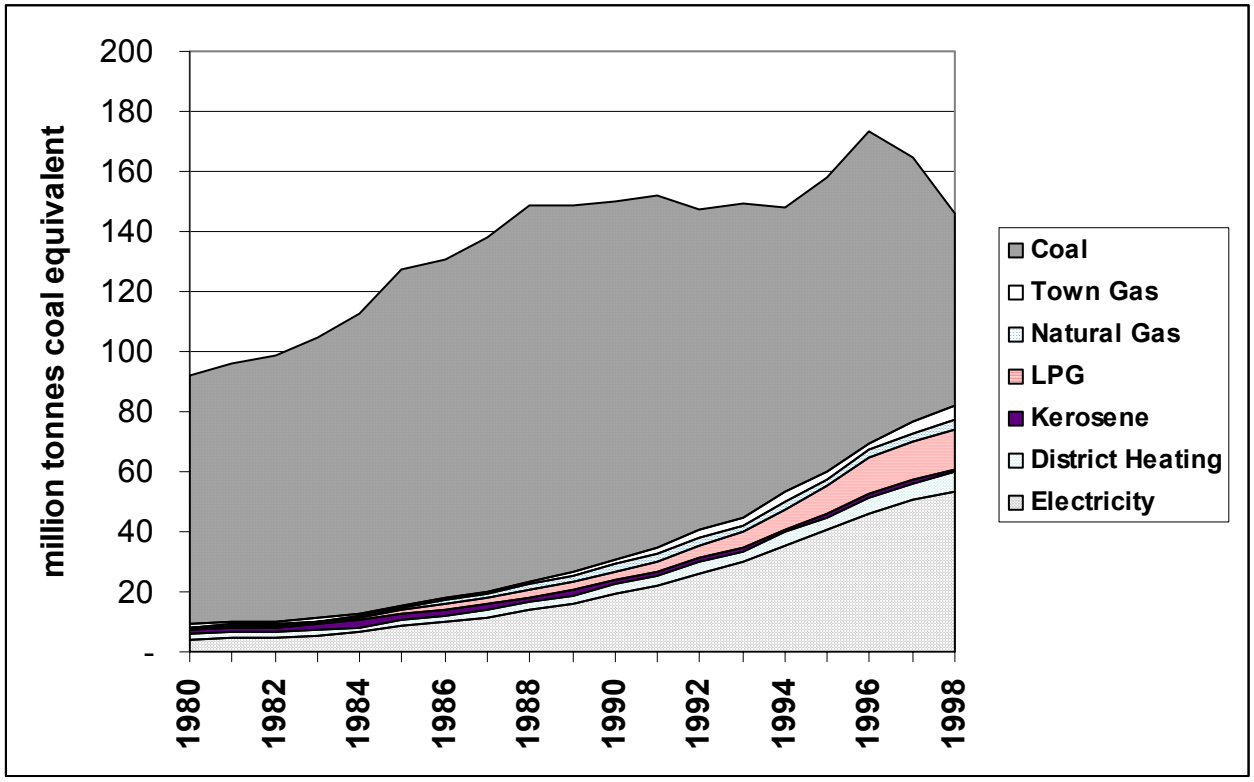
1. Why are standards important? Trends in residential energy consumption.

The picture of Chinese households fueling their energy needs with piles of coal briquettes has changed dramatically in the last two decades. In 1980, fully 90% of household energy needs derived from coal, but in 1998, this proportion fell to 44% (See Figure 1). In its place was substituted a number of "modern" forms of energy, including LPG, natural gas, but most significantly, electricity.

Figure 1. Residential Energy Consumption in China 1980-1998



These higher quality forms of energy have allowed the provision of equal or larger amounts of energy services at a lower total energy consumption level than before; indeed, since peaking in 1996, coal consumption alone has fallen by 56 million tonnes, or 39%.

The increase in electricity consumption has supported the proliferation of household appliances, from televisions, refrigerators, and washing machines which took off in the 1980s, to air conditioners in the 1990s, and computers, fax machines, cell phone rechargers, DVDs and stereo systems, which populate the households of many urban residents in the 2000s. As a result, growth in electricity consumption has remained high throughout this period; between 1980 and 1998, demand growth averaged 15.1% per year.

Although the residential sector accounts for only about 11% of total energy consumption in China, it is the rapid substitution from coal to electricity that focuses attention on the potential for significant savings in this sector and is expected to be the driver for demand growth into the near future. Even with electricity demand growth slowing to "only" 10% per year over the next decade, and coal accelerating its decline, and assuming current plans for supplying more cities with natural gas are implemented, total residential sector energy consumption by 2010 may reach 230-250 Mtce, up from 145 Mtce in 1998. By that point, electricity is likely to account for at least 60% of household energy consumption. No other sector in China's economy has experienced such a rapid shift in energy composition, nor recorded such high sustained rates of electricity growth.

When residential energy consumption was dominated by coal, few measures could be taken to increase efficiency beyond processing the coal into briquettes and offering higher efficiency coal cook stoves. As households are now increasingly dominated by electricity (and in some cases gas)-powered appliances, the potential for savings in this sector are substantial. Nearly all the products now in use in Chinese households have been subject of minimum efficiency standards (or energy efficiency labeling) in other countries; their widespread and quick application in China can thus have a dramatic impact on the future growth of electricity demand. As most of the appliances that Chinese households will own in 2010 have not yet been produced, early action promises the largest scope for impact.

2. What could be saved from standards? Estimated scope of potential savings.

Many of the standards in place, under development, and proposed in China concern residential and commercial sector equipment. Unlike the US and many developed countries, where the residential and commercial sectors consume about one-third of total energy, these two sectors in China account for 18% of China's total energy end use, which totaled 1.26 billion tonnes of coal equivalent (tce) in 1998. Industry alone accounted for 72% of this total. Nonetheless, with the continuing drop in industrial energy consumption and the expansion of the importance of the residential and commercial sectors, their share is expected to increase. Total carbon emissions from the residential and commercial sector reached nearly 150 million tonnes in 1998.

Despite the smaller share of total energy consumption in China, potential savings from the widespread adoption of standards in these sectors are significant. No estimates currently exist of the magnitude of these savings, but comparisons with global estimates and analysis of the US experience can be instructive.

According to a report from the Intergovernmental Panel on Climate Change,[1] by 2010 potential reductions from energy-efficient technologies captured through mandatory energy-efficiency standards could total 5.4 to 9% of the 2.5 billion tonnes of carbon (tC—note the capital C for carbon, small c for coal) projected for the residential and commercial sectors worldwide in that year, or a total of 135-225 million tC in reductions. Assuming a similar rate of savings in China alone, the annual savings of mandatory energy efficiency standards in 2010 could reach 13 to 21 million tC, or about 10% of the worldwide total. A one-year estimate, however, does not accurately reflect the long-term impact of the standard, as the savings accrue rapidly owing to the incorporation of the standard into new stock.

This range of figures compares well with the historical experience of the US, where mandatory standards have been in place for two decades. In 2000, the estimated savings attributable to mandatory standards in the US totaled 0.64 quadrillion Btus, equivalent to about 14.5 million tC.

China, however, under terms of the Energy Conservation Law of 1998, is attempting to extend the range of mandatory standards from equipment in the commercial and residential sectors to industry. Given the lack of international parallels for implementing industrial equipment minimum standards, it is difficult to estimate the potential impact in China. Moreover, industry relies on many complex production processes, complicating any analysis based on individual equipment savings, such as refrigerators or air conditioners. However, a recent study[2] of China's major energy-consuming industrial sectors identified the potential savings in selected industries from raising China's efficiency level to 'advanced international levels'—that is, levels actually observed elsewhere in the world. Some of those savings could be captured by minimum efficiency standards, providing a rough estimate of the magnitude of savings possible from minimum standards. Considering the iron and steel, copper, aluminum, cement, ammonia, and petroleum refining sectors alone, potential annual savings from increased efficiency could reduce carbon emissions by about 47 million tonnes annually. If standards could 'capture' about 25% of these savings, then about 12 million tC of annual savings could be attributed to efficiency standards alone. These numbers are intended to be indicative only, as further research into the potential for savings in the industrial sector would be needed first to provide a better estimate.

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[1] Intergovernmental Panel on Climate Change, *Technologies, Policies and Measures for Mitigating Climate Change: IPCC Technical Paper I*, IPCC, November 1996.
[2] Dong Lie, Jiang, Gao, Chen, *Developing Chinese Regulatory Infrastructure Project—Phase I: Final Report on Industrial Energy Efficiency Policy Research*, China Energy Conservation Association, Draft Report, 31 March 2001.

Table 1. Possible Range of Savings from Standards in China

Sector	**2010 Estimated Annual Savings** *(million tonnes of carbon)*
Residential/Commercial	13-21
Industrial (selected)	~ 12
Total	~ 25-33

3. Focus on products: estimate of savings potential from water heaters and commercial HVAC equipment

Products now in consideration for development of minimum standards in China include residential water heaters and commercial HVAC equipment. Prior to in-depth data collection concerning the ownership, usage, energy consumption and technical features of these equipment types, it is difficult to assess the current market and estimate the savings potential, but given the rapid growth in these products, the potential should be significant.

Few data exist on the residential water heater market, but ownership had already reached 45% in urban markets in 1999, implying a stock of about 52 million water heaters in use. The vast majority (about 85%) of those in use are gas-fired instant heaters, while about 9% are electric-powered instant heaters, and the remainder electric-powered storage heaters. Over the last decade, growth has averaged over 10% per year.

The focus of minimum efficiency standards will likely be on the gas instant heaters. Referencing research on efficiency improvements on this type of heater done in the US, requiring the implementation of electric instant ignition devices can substantially lower energy use though the elimination of pilot lights. Although this technology increases electricity use in the heater, it is more than offset by the savings in gas for a total savings of about 18%. It is not currently known the percent of instant water heaters in China that already use this technology.

Assuming market growth in water heaters continues at about 6% a year over the next decade, and that the market share of gas and electric heaters remains constant, and that energy savings from standards average only half of what has been demonstrated in the US because of lower individual usage in China and unknown penetration of the more efficient technology to date, then savings by year 10 could reach about 1.05 Mt C at a time when nearly 100 million water heaters could be in use.

The market for HVAC equipment is even more poorly characterized than water heaters. It is known from surveys and field studies[3] that about 45% of China's

[3] Tongji University, Shanghai, Waseda University, Japan, *Impact on Urban Energy and Environment from High Rise Buildings Air Conditioning in Shanghai*, Technical Report, March 2000.

commercial building space of about 3.5 billion m^2 is conditioned with HVAC equipment, and that in some cities, such as Shanghai, HVAC electricity demand has reached 30% of the city's total electricity consumption. Total national stock, level of efficiency, and total electricity consumption, however, are not known at present.

If China, however, were to develop similar to the US as reflected in the results of the Commercial Building Energy Consumption Survey (CBECS), then a rough estimate of savings could be derived. Assuming that the percentage of commercial space with HVAC equipment stays roughly constant, and that new commercial space grows at about 6% a year (lower than was recorded in the 1990s), and that new minimum standards would capture about 10% efficiency gain in new HVAC installations over this period, then by year 10, total carbon savings could reach 1.2 million tonnes annually.

These figures can be better estimated when the research phase of work on these two products begins and field data are collected in order to calculate the baseline situation and the savings potential from new standards.

4. The impact of labeling: energy-efficient TVs and printers.

China's Certification Center for Energy Conservation Products is currently collecting market, technical, cost and usage data regarding televisions and printers in China as part of a joint project with US EPA to provide new tools and analytical methodologies by which to establish energy efficiency criteria. This approach—modeled directly after the analysis done in support of US Energy Star—should allow the Chinese to determine an effective level for their labeling criteria and to calculate the impact of the label on annual carbon emissions.

In the absence of detailed data for analysis, several major unknowns prevent a solid calculation of expected benefits, but the overall magnitude of the savings can be estimated. For televisions, a major uncertainty is the prevalence and duration of the "unplugged mode"—where the television is physically unplugged from the wall (or a power strip is turned off), shutting off standby energy use entirely. Savings from labeled televisions primarily derive from lower standby energy use, so energy savings from the unplugged mode can not be attributable to the label. Moreover, the market for televisions is still growing very rapidly in China, so variations in assumptions about future sales have an enormous impact on the total amount of savings, annually and cumulatively. A similar situation exists with regard to printers, and much less is known about the sales and usage patterns of printers in China.

Assuming that current television sales of about 30 million expand to 40 million annually by 2010, and that labeled televisions grow in market share from 10% in the early years to 90% by 2010, and that each labeled television saves 33 kWh per year in energy consumption (the Energy Star average), total emission reductions in 2010 would reach 2.8 million tC annually. This compares to an estimated 170,000 tC of savings in the US in 2000 from Energy Star televisions. In China's

case, the savings would drop substantially if it were determined that the 'unplugged mode' accounts for a significant proportion of daily TV operation.

For printers, the Chinese market is not well characterized, so a number of the assumptions used to calculate estimated savings will require further data collection and analysis to increase confidence in the results. Currently, about 2 million printers are sold in China, and this may rise to over 8 million units per year by 2010, assuming current growth rates continue. Assuming early penetration of energy efficient models of only 10%, rising to 100% by 2010, and that each labeled printer saves 88 kWh per year of electricity (one-half the level in the US), then annual savings by 2010 could reach 1.2 million tC. This compares to an estimated 740,000 tC of savings from Energy Star printers in the US in 2000.