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THE STATE OF ENERGY CONSUMPTION LEGISLATION FOR COMMERCIAL REACH-IN REFRIGERATORS AND FREEZERS AND OTHER REFRIGERATED PRODUCTS

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ABSTRACT

A substantial amount of energy is used each year to power commercial refrigeration equipment in restaurants, grocery stores, convenience stores, and fast food establishments. This paper reviews the history and near future of commercial refrigerator and freezer energy regulations in the US and Canada. This paper also reviews energy consumption regulations for commercial ice machines and walk-in refrigerators and freezers. Published test results are compared to the existing standards so a current state of technology can be reviewed. Manufacturers and engineers for all commercial refrigeration equipment must be aware of these standards, and must prepare their products to meet these increasingly more stringent standards.

1. INTRODUCTION

The production, acquisition, and use of energy in the United States have become frequently discussed topics with environmental, social, political, and economic implications. A substantial amount of energy is used each year to power commercial refrigeration equipment in restaurants, grocery stores, convenience stores, and fast food establishments. This paper discusses the consumption of electricity by refrigeration equipment primarily in foodservice industries, the status of regulation of this consumption, and technologies available that reduce the demand for this increasingly limited resource.

The US Environmental Protection Agency (EPA) released the first voluntary energy consumption standard for commercial refrigerators and freezers in 2001. Several states, led by California, have since released legislation mandating maximum energy consumption, with effective dates from March 2003 through January 2008. The standards typically start less stringent than Energy Star, but over time achieve the Energy Star recommended limits. The states are also releasing similar legislation to limit the allowable energy consumption of commercial ice cream freezers, vending machines, ice machines, and walk-in refrigerators and freezers. In 2005, the Air-Conditioning and Refrigeration Institute (ARI) released a proposal to the federal government to nationalize energy consumption standards for commercial refrigerators and freezers. The effective date in this proposal was recommended to be January 2010, with the final energy consumption standards equal to both the original Energy Star proposals and the final California standards. In August 2005, President Bush signed the Energy Policy Act of 2005, which adopted these recommendations. Table 1 summarizes the effective dates of these energy consumption limits, as well as the test methods used for determining the energy consumption. Manufacturers of all commercial refrigeration equipment must be aware of these standards, and must prepare their products to meet these increasingly more stringent standards.

Table 1 - Effective Dates of Energy Consumption Standards

Program	Solid Door Reach-In	Glass-Door Reach-In	Walk-Ins	Ice Machines
EPA Energy Star (Fall, 2001)	2001 (Voluntary)	N/A	N/A	N/A
California Energy Commission (CEC) (August, 2003)	2003-2004	2003-2004	N/A	N/A
California Energy Commission (CEC) (April, 2005)	2006-2007	2006-2007	2006	2008
Energy Policy Act of 2005	2010	2010	N/A	N/A
Test Procedure	ASHRAE 117	ASHRAE 117	Component Selection	ARI 810

2. ENERGY LEGISLATION FOR REFRIGERATION EQUIPMENT

The production, acquisition, and use of energy in the United States have become frequently discussed topics with environmental, social, political, and economic implications. One subset of these discussions is the increasing demand for electricity. From 1970 to 2000, annual electricity consumption by the commercial sector in the United

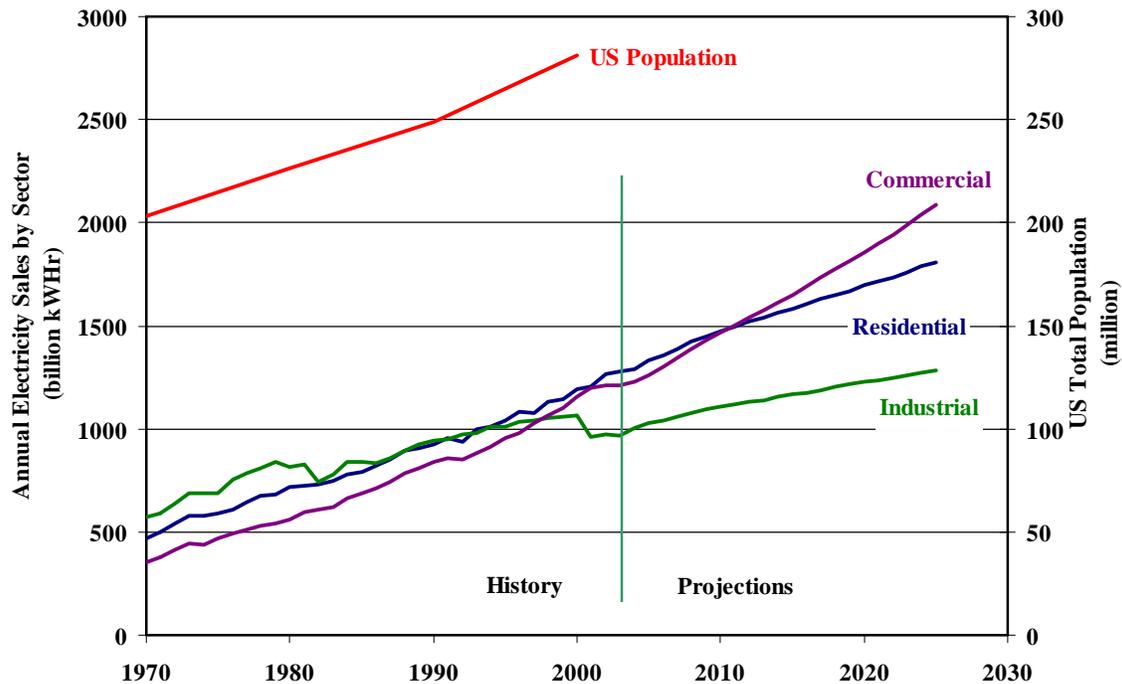


Figure 1 – Electricity Sales and US Population

States grew 229%ⁱ, as the total US population grew by 38%ⁱⁱ (see Figure 1). Electricity consumed by the commercial sector passed that consumed by industry in the late 1990s, and commercial electricity consumption is forecasted to pass residential consumption within the next decade. This massive demand for electricity, and the byproducts of producing enough electricity to meet these growing demands, has been linked to a wealth of social

and economic problems including air, ground, and water pollution, direct health issues, national security, the depletion of the ozone layer, and global warming.

A substantial amount of energy is used each year to keep food cold or frozen in commercial establishments including restaurants, grocery stores, and convenience stores. The foodservice industry has the highest rate of energy consumption per square foot due to the need for specialized, high-energy consuming equipmentⁱⁱⁱ including commercial refrigerators and freezers. Inside restaurants, refrigeration accounts for 10-16% of energy consumption^{iv}, and inside supermarkets, refrigeration accounts for 44-62%^v. It has been reported that 43 trillion BTUs (12.6 billion kWhrs) of total energy are consumed annually by refrigeration inside food service buildings^{vi}. This high use of electricity in the previously unregulated industry of commercial refrigeration equipment has led several interest groups to begin creating new regulations.

The first group in the United States to issue energy regulations on commercial refrigeration equipment was the Environmental Protection Agency (EPA), with their release of Energy Star standards for commercial refrigerators and freezers. Energy Star has become a well recognized standard, typically seen in residential refrigerators and freezers, washers and driers, and even light bulbs and other energy consuming products. Anyone who has purchased a “white good” in the last decade is likely familiar with the yellow Energy Star label detailing the expected annual cost of energy required to operate the appliance. Typically, the lower the annual energy consumption and associated cost of operating the appliance, the higher the purchase price of the appliance.

In the fall of 2001, the EPA released its first set of Energy Star guidelines for commercial refrigerators and freezers^{vii} (see Figure 2). These guidelines were only recommendations for commercial original equipment

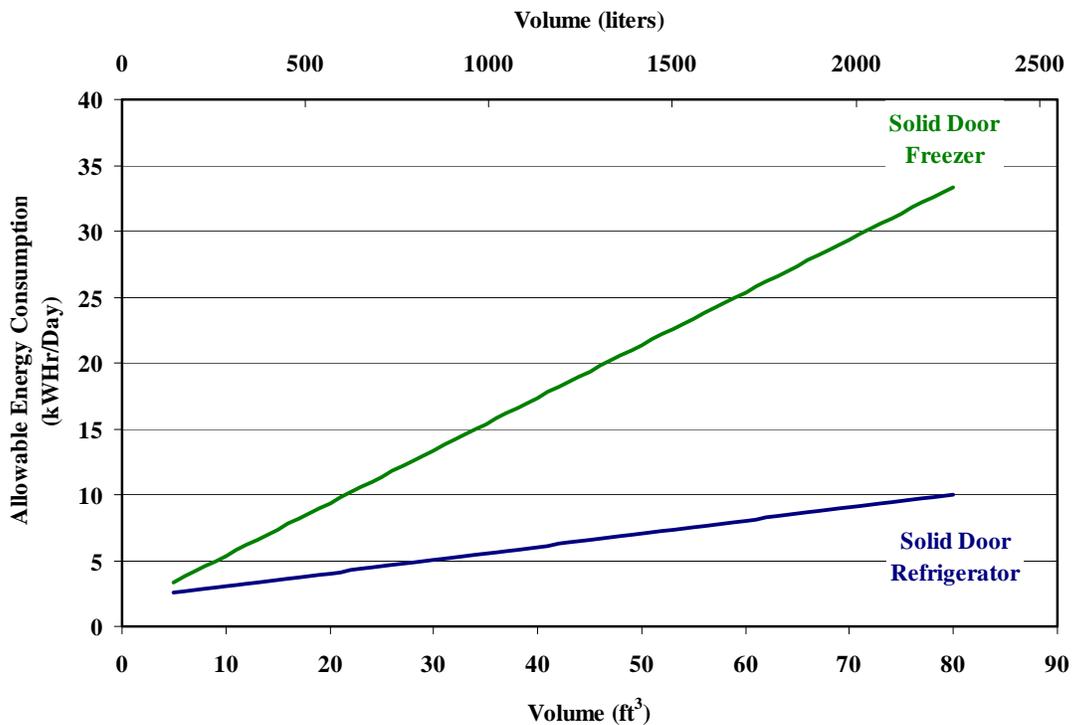


Figure 2 – Energy Star Consumption Limits

manufacturers (OEMs) to follow. The guidelines established a maximum daily energy consumption allowed per cubic foot of refrigerated space for the refrigerator or freezer to be considered Energy Star. These guidelines were intended to separate the most energy efficient 25% of the marketplace. No national legislation was put in place that would prohibit the sale of non-Energy Star rated commercial refrigerators and freezers. Rather, it was expected that the buying public would naturally move to more efficient Energy Star labeled equipment. If the equipment did meet the Energy Star guideline, and if the OEM joined the EPA Partnership Program, then the units would be allowed to

carry the familiar Energy Star logo. The effective date of the EPA’s Energy Star program was September 1, 2001. According to the Energy Star website, “Replacing all existing commercial solid door refrigerators and freezers in the US with Energy Star labeled models would result in savings of almost \$250 million per year, or roughly 25% of the energy consumed by models currently on the market -- the equivalent of eliminating the emissions from 475,000 cars.”^{viii} A list of more than 1050 commercial refrigerators and freezers that meet Energy Star guidelines is maintained on the Energy Star website.

This first voluntary standard was important for two reasons. First, it established energy consumption as an important criterion in the buying decision. Typically, the decision makers buying commercial refrigeration equipment were not concerned with the consumption of energy. At a minimum, energy consumption was low on the list of important factors at the restaurant or grocery, behind parameters like food safety, up-time (reliability), first costs, and serviceability.

The second reason Energy Star was important to commercial refrigerators and freezers was that it established the first test guideline for determining daily energy consumption. A standard by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) was established as the methodology for determining daily energy consumption, ASHRAE 117-1992. In this test, a refrigerator or freezer is loaded with simulated product, and the control is adjusted to maintain a typical set point of 0°F ±2°F (-17.8°C ±1.1°C) for freezers or 38°F ±2°F (3.3°C ±1.1°C) for refrigerators. Many refrigeration system temperatures are monitored, as are specific simulated loads. The ambient around the unit is maintained at 75°F (23.8°C). After the unit achieves a steady-state condition, each door is opened for six seconds every ten minutes for eight hours. This simulates the activity at a refrigerator during its peak use hours. After eight hours, the doors remain closed for the next sixteen hours. The total energy consumed during the eight hour door opening period, plus the total energy consumed during the sixteen hour door closed period, is the total daily energy consumption. This same standard has since been used by several other bodies seeking to limit energy consumption on commercial refrigerators and freezers.

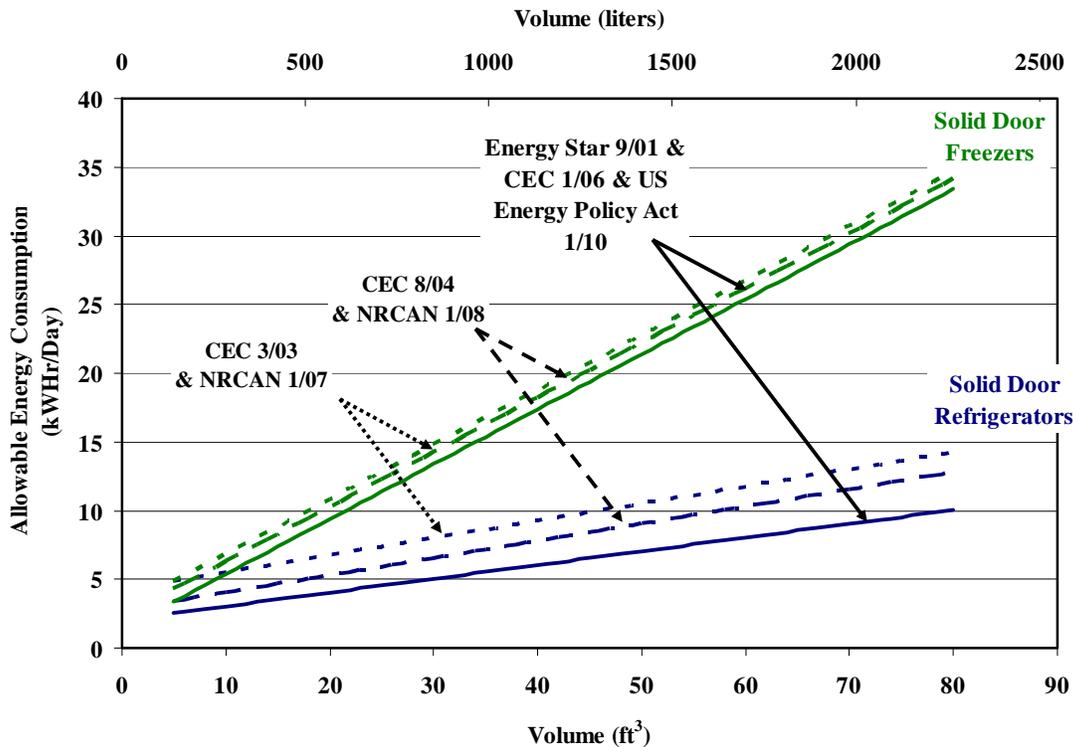


Figure 3 – Energy Star, CEC, NRCAN, & US Energy Policy Act Consumption Limits

One limit of the Energy Star program was that it did not prohibit the sale of non-energy efficient equipment. Rather, Energy Star provided consumers with decision making information such that market dynamics would effectively become the governing body.

A second limit of the Energy Star program was that it only covered solid door commercial refrigerators and freezers. Excluded from the program were all self-contained glass door commercial refrigerators and freezers, which by their nature consume more energy, although they are less popular in the marketplace than solid door units.

California addressed both these shortcomings with its first release of commercial refrigerator and freezer standards. The California Energy Commission (CEC) released an update to its standard titled *Appliance Efficiency Regulations* in August 2003. This updated standard addressed the energy consumption of 20 categories of products ranging from air conditioners to illuminated exit signs. Included in this list for the first time were commercial refrigerators and freezers, with both solid and glass doors. Energy consumption standards were established for each type of unit, with the maximum allowable energy consumption being reduced over time. The effective date of the first consumption standard was March 1, 2003. The more stringent second standard became effective August 1, 2004 (see Figure 3). As of these dates, units not specifically listed by the CEC as having been proven through testing to consume less than the allowable energy could not be legally sold in the state of California.

This was the first legislative attempt to limit the sale of non-energy efficient commercial refrigerators and freezers. Although the new standard included for the first time guidelines for glass as well as solid door models, it is interesting to note that the standards set for allowable energy consumption were less stringent than those previously recommended by Energy Star. The March 2003 standard allowed 40 – 90% more energy consumption for commercial refrigerators versus the voluntary Energy Star guideline, while the August 2004 standard only allowed 27 – 33% more. For commercial freezers, the March 2003 standard allowed 4-40% more consumption than the Energy Star recommended limit; the August 2004 standard reduced to 2-26% more. California also followed Energy Star by using the same criteria for judging daily energy consumption, ASHRAE 117-1992.

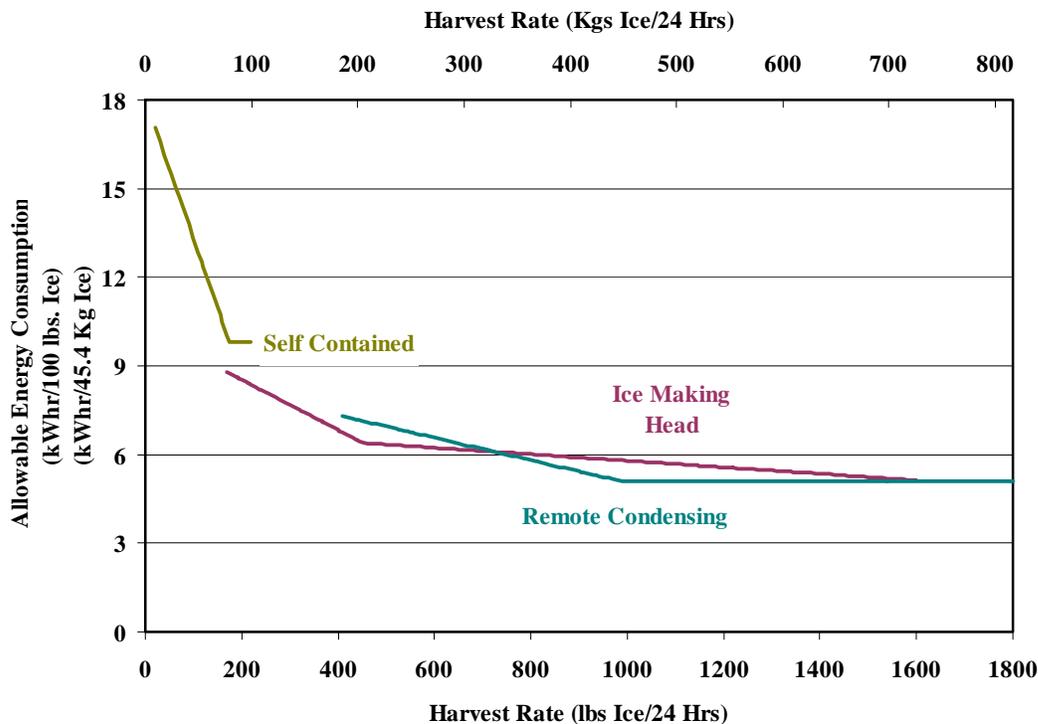


Figure 4 – Ice Machine CEC Energy Consumption Standards

In April 2005, the California Energy Commission released a revised version of its *Appliance Efficiency Regulations* covering more product categories, and more discreet products per category. Two new tiers of energy consumption for commercial refrigerators and freezers were introduced with this release, each with decreasing allowances for daily energy consumption. The new CEC standard set for January 2006 ultimately achieves the original voluntary standard set by Energy Star in 2001 for commercial solid door refrigerators and freezers (shown as the solid lines in Figure 3). The January 2007 CEC standard also reduces the allowable energy consumption on glass door refrigerators by 33 – 40% and glass door freezers by 20% from the March 2003 levels. New standards specifically for ice cream freezers, with either solid or glass doors, were introduced in this release as well, with an effective date of January 2007. Specific vending machine energy consumption standards were also introduced in this revision, with an effective date of January 2006. The formulas to calculate the allowable energy consumption for vending machines are based on the unit’s rated capacity to store 12 oz. (0.35 liter) cans.

The April 2005 CEC guidelines also introduced for the first time energy consumptions standards for ice machines (see Figure 4). These standards go into effect in January 2008 and cover self-contained units as well as ice making heads and remote condenser models.

Walk-in refrigerators and freezers are also addressed for the first time in the April 2005 release of the updated CEC standards. For walk-ins, explicit energy consumption limits are not given. Instead, design guidelines are outlined for the construction of these rooms, effective January 2006. These guidelines include mandates that all walk-ins utilize automatic door openers, high efficiency wall insulation, and high efficiency evaporator and condenser fan motors. Additionally, walk-ins with glass doors must use triple-pane glass doors, and must control or limit the total power used by anti-sweat heaters.

In order to legally sell commercial refrigerators or freezers in California, a production sample of the model must be tested by a CEC certified test laboratory and the data submitted to and approved by the CEC. The California Energy Commission maintains records on its website of all submitted data. Figure 5 shows all commercial solid door refrigerators listed through February 27, 2006. As the figure reveals, many units pass the most stringent standard.

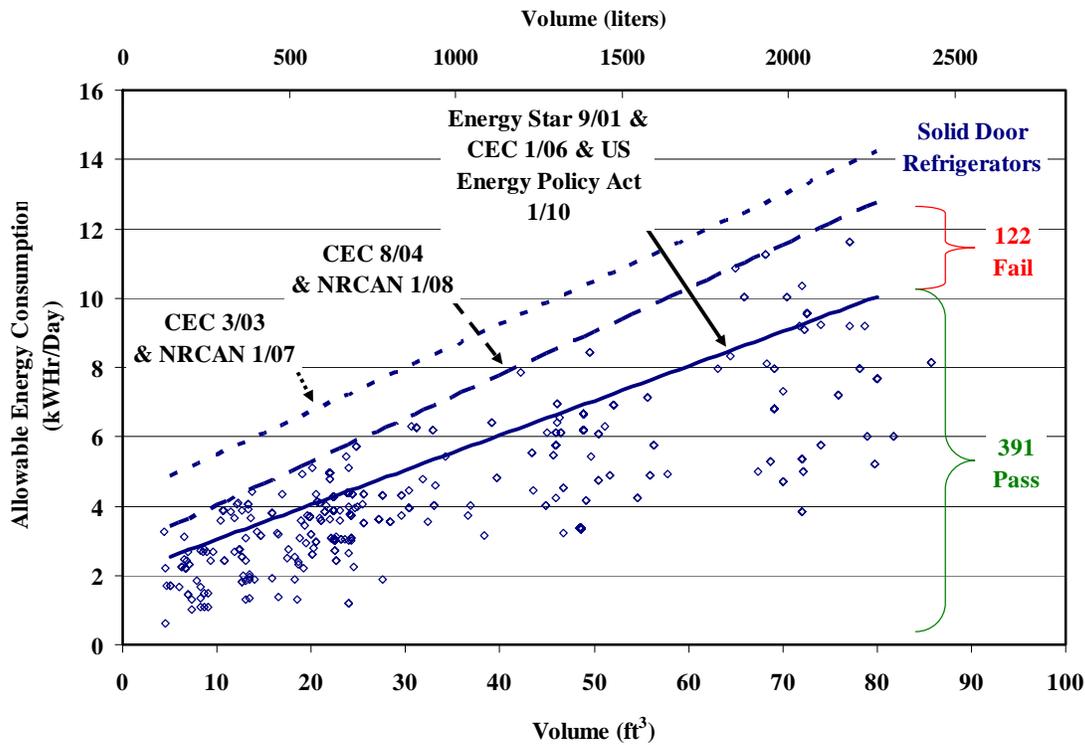


Figure 5 – CEC Listed Solid Door Refrigerators

However, there is also a group of units that pass the August 2004 standard but fail the January 2006 standard. These units will need to be improved and certified in order to be legally sold in California in 2006.

Once California released standards limiting the sale of energy inefficient commercial refrigerators and freezers, other states started releasing similar legislation. Maryland, Connecticut, and Arizona enacted legislation limiting the sale of non-energy efficient commercial refrigerators and freezers. Legislation is proposed or pending in several other states including Massachusetts, Oregon, Rhode Island, New York, and New Jersey, and is expected soon in several other states. Most proposals closely follow the released California standards. As of the writing of this paper, however, no other states have released as comprehensive a program as California. A dissenting opinion was provided by Colorado, where the Governor vetoed a bill proposing similar standards. Reasons given for this veto include the expected effect of market forces, and the expectation and appropriateness of federal standards instead of state standards.

In 2005, the Air-Conditioning and Refrigeration Institute (ARI) released a proposal to the federal government to nationalize energy consumption standards for commercial refrigerators and freezers. According to their website, ARI is “the national trade association representing manufacturers of more than 90 percent of North American produced central air-conditioning and commercial refrigeration equipment.”^{ix} The manufacturers of these products feared that each state would have its own standard and own test data submittal and approval process. This would result in mountains of paperwork and increased costs for the OEMs. A national standard, however, would only require a single submittal and would be much more manageable, limiting the increase in costs OEMs would ultimately be passing on to consumers. On April 5, 2005 ARI formally recommended to congress energy consumption guidelines equivalent to the most stringent California Energy Commission standards (and the original Energy Star guidelines), with a proposed effective date of January 1, 2010.^x According to the American Council for an Energy-Efficient Economy (ACEEE), if enacted, this standard would reduce U.S. electricity use by about 2.3 billion kWh annually by 2020, and would save consumers and businesses more than \$1 billion from products purchased through 2030.

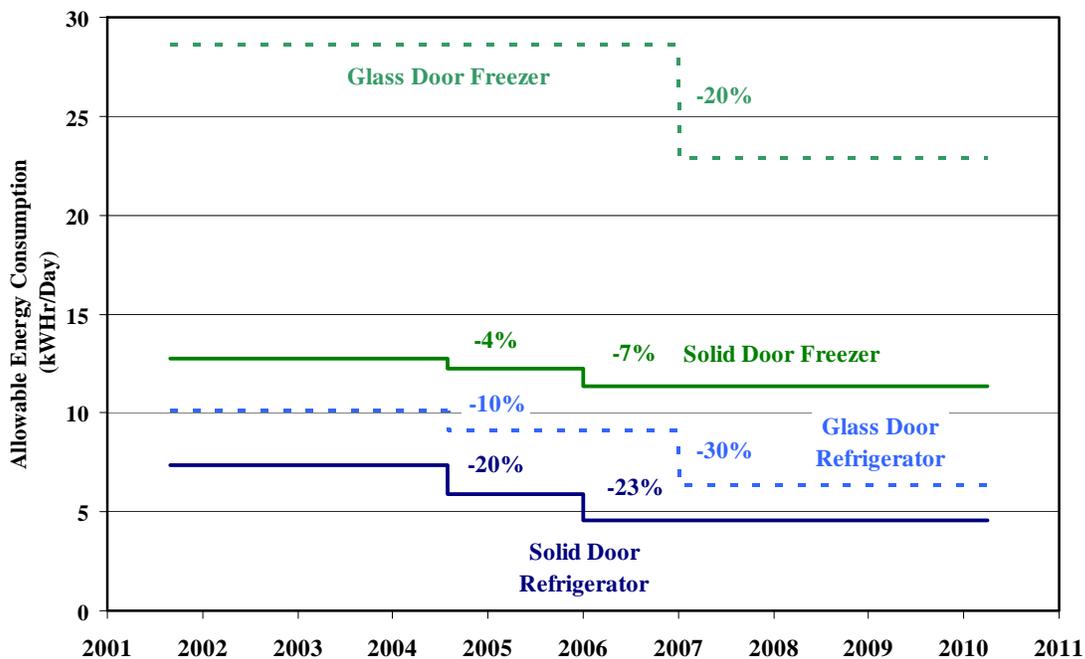


Figure 6 – CEC Standards for All 25 ft³ (707.9 liter) Units

On August 8, 2005 President Bush signed into law the Energy Policy Act of 2005, which included the ARI and ACEEE recommendations for reach-in refrigerator and freezer energy consumption limits discussed above, as well

as increasingly stringent standards for air conditioners and other equipment. According to ARI, “The efficiency levels contained in the law will reduce peak power needs by an estimated 8,000 megawatts by 2020, which is equivalent to the output of 27 new power plants of 300-MW each.”^{xi}

Taking a sample size of 25 ft³ (708 liter) units, Figure 6 shows the energy reduction over time imposed by the California Energy Commission. The ultimate result of these standards, combined with the Energy Policy Act of 2005, will be that the original Energy Star recommended levels will be legally mandated nationally at the beginning of 2010.

3. CONCLUSION

Energy efficiency standards for commercial reach-in refrigerators and freezers are now legislated in several states. Through a coordinated effort, the manufacturers of these products proposed a national standard of energy efficiency, with a proposed effective date of January 2010. This proposal was adopted by the federal government and signed into law during 2005. The national standard is consistent with the originally suggested EPA Energy Star level of energy consumption released in 2001. Individual states have also released legislation that will limit the energy consumption of commercial ice cream freezers, vending machines, ice machines, and walk-in refrigerators and freezers over the next several years. A similar effort to nationalize these standards is anticipated. Manufacturers of all commercial refrigeration equipment must be aware of these standards, and must prepare their products to reduce energy consumption such that they meet these increasingly more stringent standards.

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