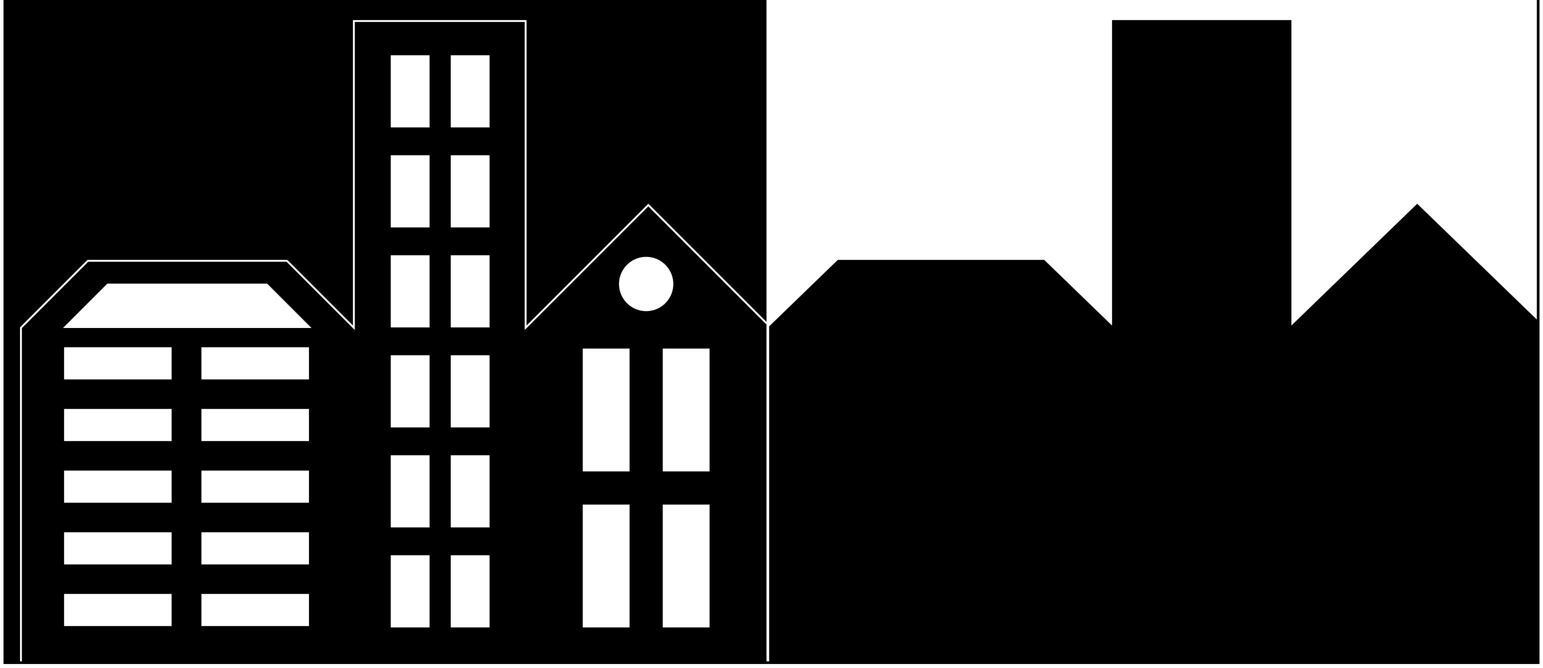
STAYING cool

How Energy-Efficient Air Conditioners Can Prevent Blackouts, Cut Pollution and Save Money

Appliance Standards
Awareness Project

July 2000



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Contents

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About ASAP

The Appliance Standards Awareness Project is dedicated to increasing awareness of and support for appliance and equipment efficiency standards. Founded by the American Council for an Energy-Efficient Economy, the Alliance to Save Energy, and the Natural Resources Defense Council, ASAP is led by a steering committee that includes representatives from the environmental community, consumer groups, utilities, and state government. For more information, visit www.standardsASAP.org.

Steering Committee

Executive Summary

Record-breaking heat waves over the past few summers have been accompanied by power outages in many regions of the country. Policymakers, utility executives, and power system planners and regulators predict that outages and shortages will continue until actions are taken to improve the reliability of the nation's electric system. Effective solutions to our electric system reliability problems will consider the long-term economic costs and benefits as well as impacts on the environment and public health.

The summer months are particularly taxing on the electric system. Soaring temperatures lead to increased peak demand as consumers and businesses crank up their air conditioners to stay cool. The greatest demand for air conditioning generally occurs in the mid-afternoon hours, coinciding with the highest demand for other electricity uses. High temperatures also negatively impact the performance of electricity generation, transmission, and distribution equipment, reducing the availability of generation and transmission capacity and increasing the likelihood of distribution system failures. As a result, the electricity system is called on to meet the highest demand at the time when its components are most prone to problems.

A range of solutions has been proposed to address electric system reliability problems and reduce the likelihood of power outages, including constructing new power plants, expanding the transmission and distribution system, improving energy efficiency, and investing in distributed generation resources (e.g., renewables and combined heat and power). Building additional generation, transmission, and distribution capacity is very expensive, particularly when the power is only needed in the peak summer months. Furthermore, additional power generation imposes costs to the environment and public health — electricity generation is a leading source of the air pollution that contributes global warming and increases the incidence and severity of asthma and other respiratory and cardiopulmonary diseases. These environmental and health issues, along with concerns about the disappearance of open space and added noise, are driving community opposition to power plants and transmission line construction across the country. In contrast, energy efficiency and distributed power generation offer low-cost alternatives that reduce the need for additional central station generation and distribution capacity while reducing pollutant emissions and saving consumers and businesses billions of dollars.

Increased peak demand is at the heart of reliability problems, so efforts designed to reduce peak demand are an important part of any strategy to improve electric system reliability. Since air conditioning is a leading contributor to peak demand during times of system vulnerability, improved central air conditioning efficiency must be a key part of the solution to our reliability problems. Minimum efficiency standards are a proven method for cost-effectively reducing energy consumption and peak demand. As a result of current standards, the need for more than 20,000 MW of peak generating capacity has been eliminated in 2000 alone. Without these savings, the additional peak demand would be further intensifying the reliability problems the nation is experiencing today.

This report demonstrates the additional peak demand reductions possible from updated efficiency standards for residential and commercial central air conditioners. We provide estimates of the peak demand reductions, electricity savings, cost savings, and pollutant emissions reductions possible with adoption of new standards effective in 2006. Estimates are given for 2010 and 2020 at the national and regional level and for the four most populous states (i.e., California, Texas, New York, and Florida). In addition, we present four case studies illustrating the important role that standards can play in mid- and long-term efforts to reduce the likelihood of power outages and improve electric system reliability.

Findings

- Our savings estimates are based on sensible improvements to the current standards based on the legally required criteria for upgrades. These improvements would require a 30% improvement in the residential central air conditioner standard as well as set a cap on peak demand and include technical advancements that minimize how much product efficiency deteriorates over time. For commercial equipment, a 20% improvement in the standard would lead to the greatest level of cost-effective savings.

- The use of central air conditioning in American homes has soared from 25% of households to more than 50% of households over the past twenty years. And central air conditioners have become practically a standard feature in new homes. As a result, air conditioning has had a growing impact on peak electricity demand and electric system reliability.

- Updated central air conditioning standards would eliminate the need for an estimated 23,850 megawatts (MW) of summer peak generating capacity in 2010 — the equivalent of the power produced by 48 large (i.e., 500 MW) fossil-fuel power plants. In 2020, peak capacity reductions grow to 77,700 MW — the equivalent of 155 large power plants and more than 10% of anticipated nationwide peak demand for the summer of 2000.

- Upgrading the standards to the level we propose would cut peak demand in every region of the country. The map on page 5 shows how many large power plants would be unneeded in each region if standards are upgraded. Peak reductions are largest in the hottest parts of the South and Midwest where demand for air conditioning is highest.

- Nationwide, estimated end-use electricity savings from updated standards would total more than 25 billion kWh in 2010, just four years after the standards take effect. Annual savings are projected to grow to 82 billion kWh in 2020, approximately 26% of projected residential and commercial electricity consumption for space cooling and 3% of overall residential and commercial energy consumption in 2020.

- Consumer electricity bill savings would be cut by an estimated $1.9 billion in 2010 and more than $6 billion in 2020.

UPDATED CENTRAL AIR CONDITIONING STANDARDS WOULD:

- **Reduce Peak Demand:** 77,700 MW in 2020
- **Reduce Carbon Emissions:** 15 MMT in 2020
- **Save Electricity:** 82 billion kWh in 2020
- **Reduce NO_X Emissions:** 40,600 MT in 2020
- **Cut Electricity Bills:** $6 billion in 2020
- **Reduce SO_2 Emissions:** 208,500 MT in 2020
- **Save Money:** $16 billion net savings by 2020

Cumulative net savings from updated central air conditioning standards will exceed $7 billion for products purchased by 2010 and grow to more than $16 billion for products purchased by 2020. For every dollar of increased equipment purchase price, consumers will save more than two dollars on their electricity bills.

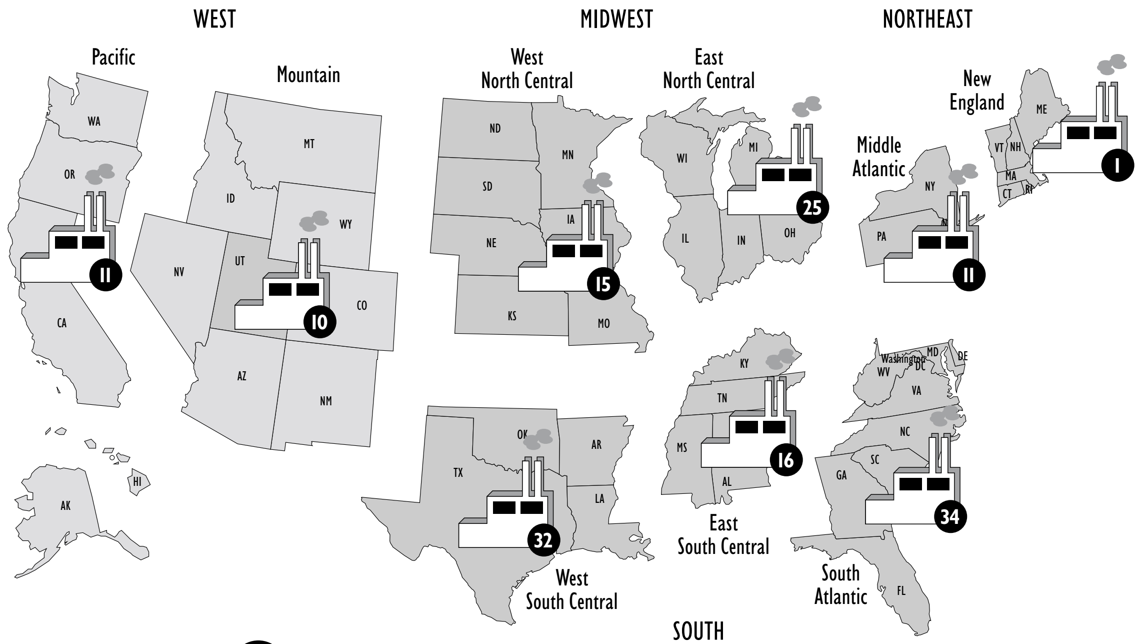
- Updated standards would reduce carbon emissions by more than 5 million metric tons (MMT) in 2010. In 2020, carbon reductions would approach 15 MMT. Carbon dioxide is the leading contributor to global warming. This is the equivalent of removing more than 4 million cars from the roads in 2010 and 12 million cars in 2020.

- Improved central air conditioning standards would reduce smog-forming nitrogen oxide emissions by 17,500 metric tons (MT) in 2010 and 40,600 MT in 2020. Sulfur dioxide emissions (the main component of acid rain) would be cut by approximately 77,500 MT in 2010 and 208,500 MT in 2020. Particulate (soot) emissions would be cut by more than 700 MT in 2010 and 2,100 MT in 2020. By reducing these pollutants, updated standards would help to alleviate public health problems and environmental degradation.

- Updated standards can play an important part in improving the reliability of the electric system. Had updated standards taken effect in 1990, outages experienced by customers in the Entergy service territory (i.e., Louisiana, Arkansas, Mississippi, and Texas) in 1999 could have been avoided, while the likelihood of outages in Long Island and Chicago could have been significantly reduced. In addition, updated standards could "supply" enough power to more than make up the shortages anticipated in California in 2000.

LARGE POWER PLANTS AVOIDED IN 2020 BY REGION

Improved air conditioner efficiency avoids the need for new power plants.
Large Power Plant = 500 MW



National Total = 155 power plants unneeded in 2020

Introduction

As summer approaches, headlines around the country are reporting on electric system reliability and concerns about potential power outages that leave consumers and businesses in the dark (DJN 2000; Gerber 2000; Howe 2000b; Smith 2000; Stouffer 2000). Air pollution, much of it from the electric utility industry, also becomes a regular news item with the advent of summer as local weather reports provide a daily air quality index and smog and ozone alerts warn of pollution-related health threats. These issues rank high on the agenda of utility executives, policy-makers, and power system planners and regulators as memories and, in some cases, repercussions of the costly and well-publicized power outages of summer 1999 linger. Businesses, consumers, and community leaders are also concerned about potential power outages and air pollution levels and their implications for business operations, public health and safety, and the environment.

This paper explores the role that updated efficiency standards for central air conditioning equipment can play in improving electric system reliability and reducing the likelihood of power outages.[1]

In determining the role of efficiency standards, we address several broader questions about power outages: What are the causes of summer power outages and how do outages impact consumers and business? What actions can be taken to reduce the likelihood of outages and what are the advantages and disadvantages of each option? What is the potential for economically and environmentally sound solutions to ensure that our electric system can continue to meet our needs for power this summer and in the coming years?

Background

When summer heat arrives, demand for electricity increases as consumers and businesses crank up their air conditioning to stay cool. The highest demand for air conditioning generally occurs during the mid-afternoon hours, when other electricity demands tend to be highest. Electricity generation and distribution resources are taxed by the added load — and by the reduced availability of generation and transmission capacity due to cooling water limits and heat-related transmission constraints — and may be insufficient to meet the required power demand. Most regions meet this peak demand through a combination of running all available power plants at full capacity and importing power from neighboring regions over the transmission system.

The power system is made up of three major components: generation (power plants), transmission (long distance wires) and distribution (local wires that bring power to homes and businesses and transformers that reduce the power to a usable voltage level). Figure 1 presents a diagram of these components and how they work together. If the power supply falls short of demand — in other words, if power plants cannot produce enough electricity to meet customer demands — the utility system operator must institute measures to prevent the system's collapse. Typically, a utility will institute voltage reductions and then call on power consumers to reduce their electric use and ask companies and governments to voluntarily shut down. In New England during the summer of 1999, the governors of Massachusetts, Connecticut, and Rhode Island shut down state government and asked many businesses to curtail operations — sending workers home in some cases — to help prevent region-wide outages. If such voluntary measures are inadequate, the power system operator typically cuts off power on a rolling basis to different parts of its service area, resulting in "rolling blackouts." In the summer of 1999, Entergy, a utility serving parts of Louisiana, Texas, Arkansas, and Mississippi, instituted rolling blackouts across the Southeast affecting more than 500,000 customers. And in June 2000, Pacific Gas and Electric also resorted to rolling blackouts which cut off power to 97,000 customers in California.

[1]In this paper, we use the term "central air conditioning" to refer to residential central air conditioners and heat pumps and commercial packaged air conditioners and heat pumps. The U.S. Department of Energy is currently reviewing minimum efficiency standards for these residential products and will soon begin review of standards for these commercial products.

More localized outages occur when distribution lines are not sufficient to carry the power load or when high temperatures negatively affect the performance of power generation, transmission, and distribution equipment. During hot weather, transmission and distribution lines and distribution transformers are more likely to fail as a result of thermal overloading. Such localized bottlenecks and system failures resulted in the outages that hit New Jersey, the Delmarva Peninsula, the New York City region and the Chicago area last summer.

Power outages have serious consequences for consumers and business. The U.S. Department of Energy (DOE) estimates that power outages and other fluctuations in power delivery cost nearly $30 billion a year in lost production (EMS 2000c). The costs to industry at large and to individual businesses are tremendous:

- Companies throughout the high technology sector – including semiconductor manufacturers, biotechnology companies, financial and information services, and e-commerce firms — are particularly vulnerable to power outages. E-commerce firms can lose millions of dollars every minute without power (Konrad 2000).
- On August 12, 1999, the Chicago Board of Trade was unable to execute more than $20 trillion worth of trades during a one-hour power outage (EMS 2000c).
- The same heat wave caused power outages in Ohio that cost Honda $250,000 in payroll alone (EMS 2000c).
- In New York City, millions of dollars worth of medical experiments at Columbia University were damaged requiring months of time and untold dollars to recover (Romm 1999).
- Individual consumers and businesses that use computers lose unquantifiable amounts of time and money due to data losses and equipment damage from power outages.

Outages during hot weather also pose serious public health and safety risks. Dangerously high temperatures that contributed to power outages in 1999 were blamed for eight deaths in New York City and more than 50 deaths in Chicago (Barboza and Belluck 1999; Barstow 1999). These disasters continue a pattern of heat waves during recent summers (Stevens 1999). Although power outages have not been directly related to these deaths, the loss of

FIG. 1 THE POWER SYSTEM

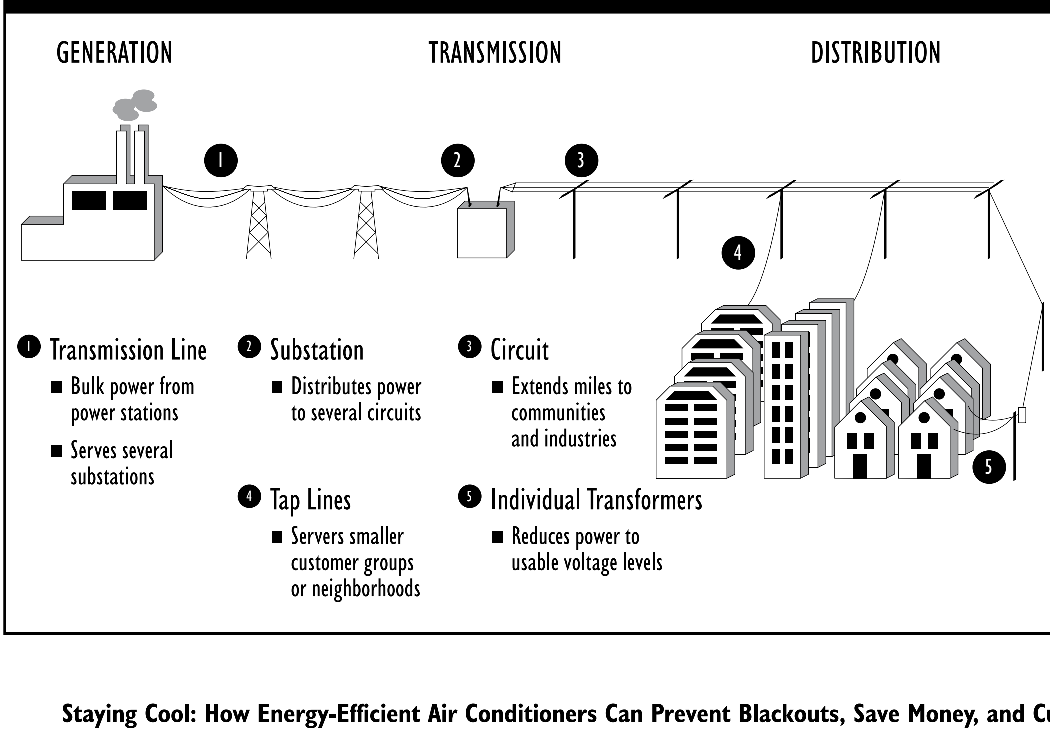


TABLE I: RECENT POWER OUTAGES AND SHORTAGES AROUND THE U.S.

REGION	UTILITY/SYSTEM	DATES	CUSTOMERS AFFECTED	CAUSES
California – San Francisco Bay area	Pacific Gas & Electric	6/14/00	97,000	Heat wave and high peak load led to rolling blackouts
Chicago	Commonwealth Edison	7/30 - 8/1/99	89,300	Heat wave and record peak load led to distribution failures within aging system
Chicago	Commonwealth Edison	8/12/99	3,188	Transformer and cable overloads cut power to Chicago's business district
Delmarva Peninsula	Delmarva Power & Light	7/5/99	138,000	Heat wave and record peak load coupled with maintenance-related generation outages led to power outages
Long Island	Long Island Power Authority	7/2 - 7/8/99	110,000	Heat wave, record peak load, and reduced power imports led to transformer overloads, power shortages, and voltage reductions
Mid-Atlantic (DC, DE, MD, NJ, PA, VA)	PJM Interconnection	7/6 and 7/19/99	n/a	Heat waves and record peak load (over more than 12 consecutive hours) led to voltage reductions on 2 separate occasions
New England (CT, MA, ME, NH, RI, VT)	ISO-New England	6/7 - 6/8/99	n/a	Early heat wave, near-record peak loads, generation units out for scheduled and unscheduled maintenance led to voluntary shut-downs and voltage reductions
New Jersey	Public Service Electric & Gas	7/5 - 7/8/99	20,000	Heat wave and cable/switchgear failures led to outages
New Jersey	GPU Energy	7/5 - 7/8/99	100,000	Heat wave and transformer failures caused scheduled and unscheduled outages
New York City	Consolidated Edison	7/6 - 7/7/99	68,000	Heat wave and record peak load led to failures in aging distribution system resulting in outages
South-Central States (AR, LA, MI, TX)	Entergy	7/23/99	550,000	High peak load, generation deratings, and loss of anticipated power imports forced rolling blackouts

power to air conditioners and fans during such extreme conditions increases the risk for heat-related illness and death, particularly among the elderly and other vulnerable populations. Additional outage-related risks to public safety include: darkened streets and intersections from the loss of street lights and traffic signals, and people trapped as elevators and mass transit services are suspended.

Table 1 provides details on the causes and impacts of recent power outages and shortages that have occurred around the U.S.

Air Conditioning Load Growth: Past and Future Trends

The recent spate of power outages and other reliability problems is related to record levels of peak power demand. Much of this increase in demand comes from the growing air conditioning load in residential and commercial buildings. The share of U.S. homes with central air conditioning has increased from 25% of households in 1981 to more than 52% of households — for a total of more than 52.3 million households — in 1998 (US

Census Bureau 1999; Wenzel et al 1997). Throughout the country, central air conditioning has practically become a standard feature in new homes — 83% of single-family homes constructed in 1998 had central air conditioning installed at the time of construction compared with 63% in 1980 and 34% in 1970 (US Census Bureau 1999).

Air conditioning typically accounts for more than half of household electricity consumption during summer months. Nationwide, residential central air conditioners and heat pumps consumed approximately 101 billion kWh of electricity in 1997, accounting for almost 10% of residential electricity consumption that year (EIA 1999b).[2] Primary energy use for air conditioning in homes totaled 1.44 quadrillion British thermal units (quads) in 1997 and is projected to grow to 1.8 quads in 2010 and 1.96 quads in 2020 (EIA 1999c).[3]

Commercial buildings also contribute to peak power demands related to air conditioning. Nationwide, primary energy use for air conditioning in commercial buildings totaled 1.19 quads in 1997 and grew to 1.46 quads in 1998, but is projected to decline to 1.33 quads in 2010 and 1.25 quads in 2020. Much of this decline is due to increased equipment efficiency and building shell improvements which reduce cooling load. Despite these declines, space cooling is projected to account for almost 7.5% of commercial energy use in 2010 and almost 6.9% in 2020 (EIA 1999c).

The growth of air conditioning load has had a tremendous impact on peak power demand. Historically, electricity demand in the U.S. peaked in the winter when power was needed in factories and cities in the industrial north. As the economy continues to shift towards information and service industries and as increasing numbers of businesses and consumers have moved to the Sun Belt, this pattern has changed. Electricity demand in the U.S. now peaks in summer when power is needed to provide cooling for high-tech industries, offices, and homes. From 1989 to 1998, national summer peak demand grew from 523,432 MW to 660,293 MW, an average annual growth rate of more than 15,000 MW or 2.6%. This annual growth is equivalent to the addition of 30 large (i.e., 500 MW) power plants each year. Peak demand is forecast to continue growing at an average of approximately 13,000 MW or 2% per year through 2008 (NERC 2000).

Central air conditioning has practically become a standard feature in new homes — 83% of single-family homes constructed in 1998 had central air conditioning installed at the time of construction compared with 63% in 1980 and 34% in 1970.

Solving Our Electric System Reliability Problems

A range of solutions has been proposed to address electric system reliability problems and reduce the likelihood of power outages (DOE 2000a; DOE 2000c; EMS 2000a; EMS 2000b). Options for consideration by utilities and public policy makers can be categorized as: 1) investments in additional supply-side resources, such as building power generation plants and upgrading or adding to the distribution and transmission system; or 2) investments in customer-held resources, such as energy efficiency and customer-owned generation (e.g., renewables and combined heat and power). An effective solution will incorporate a combination of these options, which are discussed below.

Investments in Supply-Side Resources

At first glance, it may appear that adding generation resources to produce the additional power needed to meet peak demand is an

[2]Represents electricity consumption of residential central air conditioners and heat pumps used in homes only. This equipment is commonly used in small commercial buildings as well.

[3]Primary energy includes the energy consumed by end users as well as energy losses associated with the generation, transmission, and distribution of electricity. These losses account for approximately two -thirds of the energy consumed in the process and actual electricity delivered to end users accounts for the remaining third.

obvious and straightforward way to eliminate reliability problems. Indeed, extensive power plant construction projects are being planned to address anticipated capacity shortages. However, there are serious implications to widespread construction of additional power plants, transmission lines, and distribution facilities.

First, building or buying power plants and transmission and distribution equipment is very expensive. A conventional combustion turbine plant used 80 hours per year (i.e., 20 hours per week for 4 weeks) to meet peak demand has a capital cost of approximately $1 per kWh – if the peaking plant is needed less frequently, the costs per kWh grow even further (RAP 1999).[4] To put this cost in perspective, the average retail cost of electricity in 1998 was 8.4¢ per kWh for residential customers and 7.4¢ per kWh for commercial customers (EIA 1999c). In Florida, 15% of the state's generating capacity is needed less than 1% of the time to meet peak demands (Energy Insight 1998). Significant customer price increases could be required to pay for the high cost of added generating capacity which would be needed only during brief intervals of high peak demand. Utilities in Massachusetts and Rhode Island have filed requests with state regulators for price hikes to cover the costs of summer peak power — other states are beginning to follow their lead (Howe 2000a; Providence Journal 2000; Rivera Brooks 2000).

In the first four months of 2000, developers have proposed construction of more than 13,000 MW of generating capacity (Wagman 2000). Ironically, the current shortage problems could soon be replaced by costly overcapacity in some areas. Regions such as Texas, New England, and New York could have excess capacity by 2004 as a result of significant power plant construction currently underway (Logan, Piper and Neil 2000). Even if only a fraction of the proposed construction projects are completed, these parts of the country could be left with significant levels of overcapacity. As a result, large public and private investments will be tied up in unneeded and unused generation facilities.

Building additional transmission and distribution capacity will also require serious capital investments. Proposed transmission and distribution system upgrades within the New England Power Pool totaling $100 million — to be passed on and paid by ratepayers — are under review by the Federal Energy Regulatory Commission (Clemmer 2000). System upgrades in distribution lines, transformers, and transmission lines for distribution constrained areas (i.e., areas where immediate investment is needed) of the Midwest will cost an estimated 16¢ per kWh (Weston 2000). In many cases, these enormous investments are required because utilities have failed to invest in ongoing upgrades and adequate maintenance of transmission and distribution facilities. The power outages in Chicago in 1999 were all distribution-related — many parts of the aging system are beyond their life expectancy, were not properly maintained, and were operated for extended periods under conditions exceeding their recommended load capacities (ICC 1999). Repairs and upgrades will cost the regional utility, Commonwealth Edison, more than $100 million and take as long as five or six years to complete (Stouffer 2000).

Second, the environmental and public health costs of additional power generation must be considered. Electricity generation is responsible for one-third of all U.S. emissions of carbon dioxide, the primary gas contributing to global warming (State Department 1997). It is also a leading source of air pollutants that pose threats to human health and the environment. Power plants are the source of 64% of sulfur dioxide emissions, 33% of mercury emissions, 26% of smog-forming nitrogen oxide emissions, and 9% of primary particulate emissions (EPA 1998).[5] These pollutants have been shown to increase the incidence and severity of asthma and other respiratory and cardiopulmonary diseases (ALA 1996; ALA 1997). A recent study by the Harvard School

[4]Numbers based on an analysis by the Regulatory Assistance Project assuming typical combustion turbine plant construction cost of $400 per kW plus $80 per year of depreciation, property taxes, and other annual carrying costs.

[5]Most particulates form in the atmosphere around sulfur dioxide or nitrogen oxide molecules. Thus, power plants are a major source of the precursors that lead to elevated levels of particulate or "soot" pollution.

of Public Health linked air pollution from two coal-burning power plants in New England to more than 43,000 asthma attacks and approximately 159 premature deaths each year and found that up to 32 million people in the Northeast could be exposed to pollution from these facilities (HSPH 2000).

These pollutants are also responsible for a number of severe and costly environmental problems. Smog-forming nitrogen oxides are damaging to plant tissues, leaving forests and crop lands vulnerable to pests, bad weather, and other environmental stressors. Smog-related losses to crop lands alone are estimated at more than a billion dollars a year (EPA 1997). Forests, lakes, and streams in the northeastern U.S. continue to suffer degradation from acid rain which is formed by sulfur and nitrogen oxide emissions. Urban skylines and national park vistas are less visible to residents and visitors due to the haze that results from particulate emissions (or soot). And, finally, fish, birds, and mammal populations are subject to illnesses and reproductive disruptions from mercury emissions which leach into lakes and streams.

In addition to the high economic, health, and environmental costs of building power plants and transmission lines, siting of these facilities is a highly contentious issue which has led to divisive, costly, and time-consuming battles in communities throughout the country. Environmentalists, public health advocates, and others are actively fighting to keep transmission and generation facilities out of neighborhoods, greenfields, and environmentally-sensitive spaces. For example, in Indiana, power plant developers have withdrawn petitions for four plants with more than 1600 MW of generation capacity due to stiff opposition from the public over pollution, ground water, and aesthetic impacts of the plants (de Rouffignac 2000a). Furthermore, existing air quality problems can complicate new power plant siting, particularly in areas classified as non-attainment under federal Clean Air Act regulations.

Investments in Demand-Side and Customer-Based Resources

Energy efficiency, renewable energy, and distributed generation offer low-cost alternatives that reduce the need for additional central station generation and distribution capacity. Improving energy efficiency reduces demand, thereby eliminating the need for costly and environmentally harmful investments in new capacity. Throughout the 1990s, utility energy efficiency programs generated annual energy savings ranging from 20 billion kWh in 1990 to a high of 61 billion kWh in 1996 including peak load reductions of 13,000 MW in 1990 and almost 29,000 MW in 1996 (Nadel, Kubo, and Geller 2000). Thus, these improvements eliminated the need for 26 large power plants (i.e., 500 MW) in 1990 and 58 large power plants in 1996. These savings cost utilities an average of 3¢ per kWh or less — a fraction of the cost of peak generating capacity or distribution and transmission upgrades. Unfortunately, utilities cut spending on these end-use efficiency programs by almost 50% between 1993 and 1998 (Nadel, Kubo, and Geller 2000). Renewed investments to increase the purchase of efficient appliances, improve building efficiency, and build the market for efficient products and services could reduce electricity demand and improve system reliability.

Onsite generation of power by residential, commercial and industrial customers, known as distributed generation, can reduce peak loads in two ways. First, users produce electricity to meet their own needs, thereby eliminating demand on the utility grid. The losses associated with electricity distribution and transmission over long distances are also reduced. A recent study found that distributed generation projects could provide 690 MW of electricity on Long Island alone — enough energy to power more than 410,000 homes (EMS 2000a). Second, distributed generation resources could supply power to the broader power system during times of peak demand, reducing the need for the expensive peaker plants that operate only a small portion of the year. And, since many distributed generation technologies rely on renewable power sources (e.g., solar, wind, biomass, geothermal heat), highly-efficient processes (e.g., microturbines, combined heat and power), or clean technology (e.g., fuel cells which produce electricity without combustion) the environmental and public health concerns associated with traditional power generation are minimized (Cowart 2000; Moskovitz 2000).

Increased peak demand is at the heart of reliability problems, so efficiency efforts designed to reduce peak demand are an important part of any strategy to improve system reliability. Since air conditioning is a leading contributor to peak demand during times of system vulnerability, improved central air conditioning efficiency must be a key part of the solution to our reliability problems.

The Case for Updated Central Air Conditioning Efficiency Standards

Minimum efficiency standards are a proven method for cost-effectively reducing energy consumption. National minimum efficiency standards, established with passage of the National Appliance Energy Conservation Act of 1987 (NAECA), remove inefficient products from the market and ensure that efficiency improvements are incorporated into all new products. Standards already in effect will save 1.2 quadrillion British thermal units (quads) in 2000 – equivalent to the annual energy use of about 6.5 million American households (Nadel and Pye 1996). And savings from updating the standards on products currently designated as "high priority" in the U.S. Department of Energy's (DOE) review process would yield additional energy savings of 0.7 quads in 2010 and 1.8 quads in 2020, the energy use of approximately 3.5 million and 9 million households in 2010 and 2020, respectively (Thorne, Kubo and Nadel 2000). Standards have also played an important part in reducing peak demand – as a result of current standards, the need for more than 20,000 MW of peak generating capacity has been eliminated in 2000 alone (Nadel and Pye 1996). Without these savings, the additional peak demand would be further intensifying the reliability problems the nation is experiencing today.

Improved central air conditioning efficiency must be a key part of the solution to our reliability problems.

The current efficiency standards for residential central air conditioners and heat pumps, set in 1987, require a minimum cooling efficiency of 10 SEER (Seasonal Energy Efficiency Ratio – a ratio of seasonal cooling output to seasonal energy input for an average U.S. climate) and, for heat pumps, a minimum heating efficiency of 6.8 HSPF (Heating Season Performance Factor – a ratio of seasonal heating output to seasonal energy input for an average U.S. climate). For commercial packaged air conditioners and heat pumps, the minimum cooling efficiency is 8.9 EER (Energy Efficiency Ratio – a ratio of cooling output to energy input).[6] Energy-saving innovations, such as high-efficiency compressors and improved heat exchangers, have made it possible for manufacturers to offer products that exceed these standards. For example, the best residential central air conditioners on the market today exceed the current standard by 60% to 70%, reaching SEER levels of 16 and 17. Products 30% to 40% above the current standard are common. Updating the standards on each of these products to account for efficiency gains will reduce peak demand, save consumers and businesses money by lowering their electric bills, improve air quality, and reduce carbon emissions. The following section analyzes the savings potential of updated standards for residential and commercial central air conditioners and heat pumps.

Proposed Standard Level

Our analysis estimates the energy savings and peak demand reductions possible with adoption of new standards for residential and commercial central air conditioning equipment. Utility bill savings and pollutant emission reductions are also estimated. Because of the structure of our power system, outages are not experienced at the national level but, rather, they occur at the regional, state, and local level depending on the cause and type of outage. Therefore, to determine how updated national standards will help alleviate power outages, it is important to look at energy savings and, in particular, peak demand reductions on a regional and local level. We provide savings estimates for the U.S. as a whole and

[6] 8.9 EER is the current standard level for commercial packaged air conditioners and heat pumps with cooling capacities of 65,000 to 135,000 Btu (the most common sizes). The current standards for units ranging from 135,000 to 240,000 is 8.5 EER.

then present estimates broken down for the nine U.S. census divisions (see the map in the Executive Summary for a breakdown of U.S. census divisions) and for the four most populous states (i.e., California, Texas, New York, and Florida). Appendix 2 contains individual data sheets for each census division and the four largest states, providing information on the costs and benefits of updated air conditioning standards broken down by residential and commercial equipment.

For the purpose of our analysis, we use proposed new standard levels based on our estimates of sensible improvements that meet the legislated criteria, based on DOE and national lab analyses.[7] The proposed effective date – 2006 – assumes that DOE makes progress based on its current schedule for standards rulemakings, including a commitment from the Secretary of Energy, Bill Richardson, to issue an updated standard for residential central air conditioners and heat pumps in 2000.

Specifically, we analyze a new standard for residential products of 13 SEER for cooling (central air conditioners and heat pumps) and 8.0 HSPF for heating (heat pumps only) with additional requirements for the use of thermal expansion valves (TXVs) and an EER standard equal to the median EER value for 13 SEER equipment (i.e., 11.5 EER). This proposed level represents a 30% improvement over the current SEER standard. TXVs are a relatively low-cost way to eliminate the efficiency losses resulting from improper refrigerant charging and improper airflow across the refrigerant coil. These are common installation and maintenance problems which can reduce equipment efficiency by more than 20%. TXV's are a common-sense way to make sure consumers actually get close to the efficiency performance the government ratings claim. Adoption of an EER standard is important to ensure efficient performance during hot summer conditions and, therefore, to ensure maximum energy savings during periods of peak demand. Based on our analysis and recommended changes to the DOE draft standards analysis, this proposed level results in the minimum life-cycle cost of the proposed alternatives (ACEEE 2000; DOE 2000b). For commercial packaged air conditioners and heat pumps, we propose a new standard of 11 EER for 65,000 to 135,000 Btu units and 10.8 EER for 135,000 to 240,000 Btu units, about a 20% improvement over the current standard. Table 2 summarizes the existing and proposed standard levels. Appendix 1 provides a detailed description of our methodology for analyzing savings from these standards.

Energy and Peak Demand Savings

Nationwide, end-use electricity savings from updated standards for central air condi-

TABLE 2: PROPOSED IMPROVEMENTS TO CENTRAL AIR CONDITIONER STANDARDS

EQUIPMENT	CURRENT STANDARD	PROPOSED NEW STANDARD	AVERAGE IMPROVEMENT	EFFECTIVE DATE
Residential central air conditioners and heat pumps	10 SEER 6.8 HSPF	13 SEER w/TXV and EER 8.0 HSPF	30%	2006
Commercial packaged air conditioners and heat pumps	8.9 EER (65-135 kBtu) 8.6 EER (135-240 kBtu)	11.0 EER (65-135 kBtu) 10.8 EER (135-240 kBtu)	20%	2006

[7] *NAECA instructs DOE to periodically review the existing standards and to upgrade standards where "technically feasible and economically justified." In other words, DOE is required to upgrade efficiency standards when product innovations make efficiency improvements affordable to manufacturers and consumers. Standards for each residential product are scheduled for review approximately every 5 years. Standards on commercial equipment are upgraded when the American Society for Heating, Refrigerating, and Air Conditioning Engineers revises the model code for commercial buildings, ASHRAE 90.1.*

tioning total more than 25.2 billion kWh in 2010, just 4 years after the standards take effect. These savings are equal to 8.5% of projected residential and commercial electricity consumption for space cooling and 0.9% of overall residential and commercial electricity use in 2010 (EIA 1999c). As more consumers and businesses replace their air conditioners with units meeting the new standards, annual savings are projected to grow to 82.4 billion kWh in 2020, approximately 25.8% of projected residential and commercial electricity consumption for space cooling and 2.8% of overall residential and commercial electricity consumption in 2020 (EIA 1999c).

In general, the warmest and most highly populated regions of the country will realize the greatest savings from updated central air conditioning standards. Regionally, projected electricity savings in 2010 will be greatest in the South Atlantic (8.1 billion kWh), West South Central (5.8 billion kWh), East South Central (2.8 billion kWh), East North Central (2.4 billion kWh), and Pacific (1.6 billion kWh). In 2020, projected savings grow to 26.5 billion kWh in the South Atlantic, 19.1 billion kWh in the West South Central, 9.2 billion kWh in the East South Central, 7.9 billion kWh in the East North Central, and 5.0 billion kWh in the Pacific. To put these numbers into perspective, a billion kWh is enough power to meet the needs of 100,000 households. Figure 2 summarizes electricity savings estimates in 2010 and 2020 by region.

Projected energy savings in the four most populous states in 2010 total: 961 million kWh in California; 3.3 billion kWh in Texas; 448 million kWh in New York; and 3.0 billion kWh in Florida. In 2020, savings will reach: 3.1 billion kWh in California; 10.8 billion kWh in Texas; 1.5 billion kWh in New York; and 9.9 billion kWh in Florida.

Nationwide, peak demand reductions are projected to reach 23,853 MW in 2010 and grow to 77,704 MW by 2020. The largest projected reductions in peak demand in 2010 and 2020, respectively, are: 5,526 MW and 17,135 MW in the South Atlantic; 4,957 MW and 16,173 MW in the West South Central; 3,889 MW and 12,679 MW in the East North Central, 2,429 MW and 7,891 MW in the East South Central, and 2,297 MW and 7,479 MW in the West North Central. Again, to put these numbers into perspective, a large fossil-fueled power plant might produce a maximum output of 500 MW. Figure 3 provides estimated peak reductions by region.

Peak reductions in the four most populous states in 2010 and 2020, respectively, total: 1,144 MW and 3,603 MW in California; 2,827 MW and 9,163 MW in Texas; 464 MW and 1,504 MW in New York; and 2,216 MW and 7,204 MW in Florida.

FIG. 2 REGIONAL ELECTRICITY SAVINGS FROM IMPROVED CAC STANDARDS

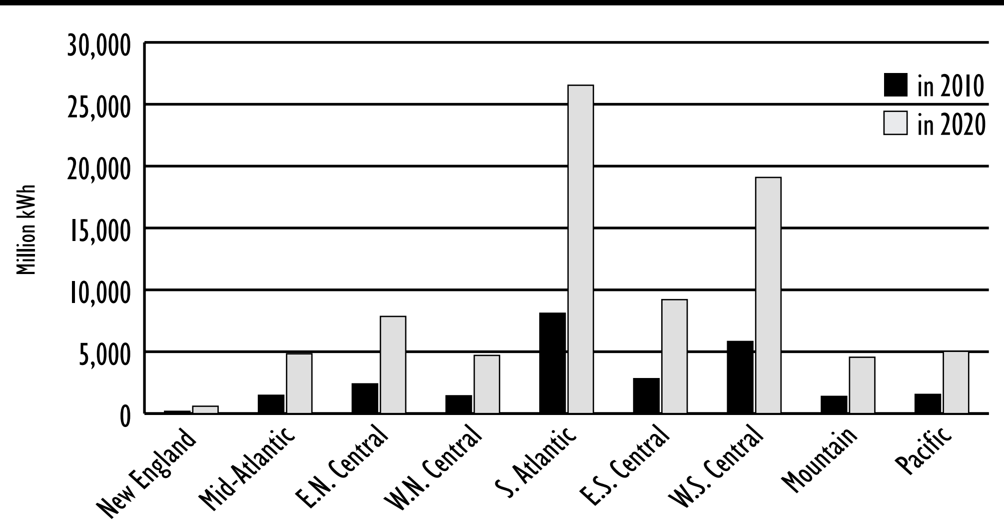
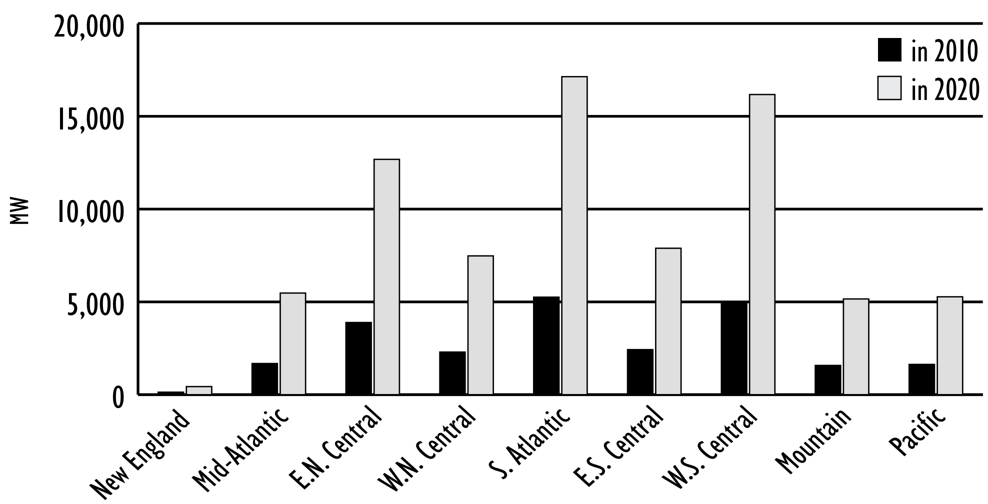


FIG. 3 REGIONAL PEAK DEMAND SAVINGS FROM IMPROVED CAC STANDARDS



Consumer Dollar Savings

In addition to the energy savings and peak demand reductions, consumers and businesses will reap tremendous economic benefits from updated standards. Projected annual electricity bill savings in 2010 total $1.9 billion and grow to more than $6.0 billion in 2020. Cumulative net savings — electricity bill savings less increased costs of higher efficiency equipment — total more than $7 billion by 2010 and grow to more than $16 billion by 2020. The benefit-cost ratio of new standards for central air conditioning equipment is more than 2:1. In other words, for each dollar of increased purchase price for higher efficiency air conditioners, consumers save more than two dollars on their electricity bills.[8] Figure 4 provides electricity bill savings by region.

Pollutant Reductions

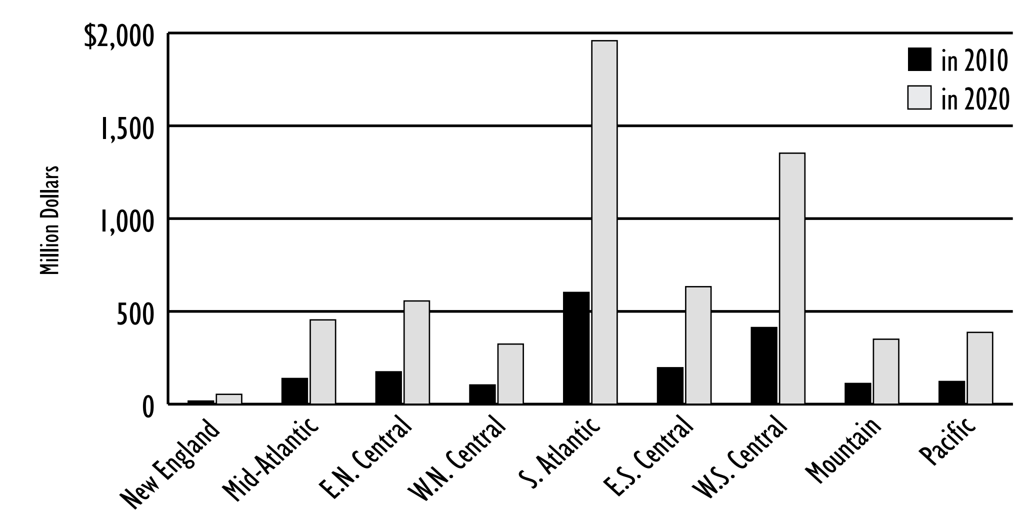
Public health and the environment will also benefit from the pollutant reductions associated with updated air conditioning efficiency standards. Carbon emissions will be reduced by an estimated 5.3 million metric tons (MMT) in 2010 with reductions approaching 15 MMT in 2020. This is the equivalent to removing more than 4 million cars from the roads in 2010 and approximately 12 million cars in 2020. Smog-forming nitrogen oxides will be reduced by more than 17,500 metric tons (MT) in 2010 and 40,600 MT in 2020. Projected reductions in sulfur dioxide emissions are close to 77,500 MT in 2010 and more than 208,500 in 2020. Finally, particulate emission reductions surpass 700 MT in 2010 and 2,100 MT in 2020. Figure 5 summarizes carbon, nitrogen oxide, and sulfur dioxide emissions reductions.

Comparison to Alternate Standard Levels

When DOE issued its original analysis for developing a new standard in November 1999, the government stated that it was considering upgrading the residential standard by 10% to 30%. As discussed above, a 30%

[8]*Costs are cumulative for units sold from 2006, the effective date of the standard, through 2020. Benefits are cumulative for the lifetime of units sold through 2020. These projected net benefits are based on a projected increase in retail costs of $337 for residential and $612 for commercial equipment. Based on prior experience, these projected costs are probably too high, leading us to underestimate the consumer savings. The last time a standard was set for residential central air conditioners in the 1980s, manufacturers predicted prices would increase by $780 and the government predicted prices would increase by $360. When the standard became effective in 1992, prices did not increase at all (ACEEE 2000; Greening et al 1996). This pattern has proven true for other appliances as well. In a nutshell, innovation and competition have kept prices low even as products are required to improve.*

FIG. 4 REGIONAL ELECTRICITY BILL SAVINGS FROM IMPROVED CAC STANDARDS



improvement to the current standard (i.e., 13 SEER) with TXV and EER requirements is the level that meets the legal requirements to achieve the greatest savings economically justified. Set lower, a new standard would forego between 14% and 43% of net savings and 11% and 40% of peak reductions by 2020. Furthermore, lower standards would result in the emission of 1,900 to 4,900 MMT of carbon, 5,100 to 13,300 MT of nitrogen, and 27,000 to 70,000 MT of sulfur dioxide which would be eliminated by the strongest standard justified. Figure 6 summarizes the peak reductions and net dollar savings associated with each of the alternate residential equipment standards under consideration.

For commercial equipment, an alternate standard of 10.3 EER is included in the ASHRAE standard 90.1 published last year. Under federal law, because this standard was adopted by ASHRAE, it can take effect in 2004, two years earlier than an 11 EER standard. Because this standard would take effect two years earlier, peak reductions and net consumer savings in 2010 would be modestly higher (i.e., 1.3% and 10%, respectively) than

FIG. 5 NAT'L POLLUTANT EMISSIONS REDUCTIONS FROM IMPROVED CAC STANDARDS

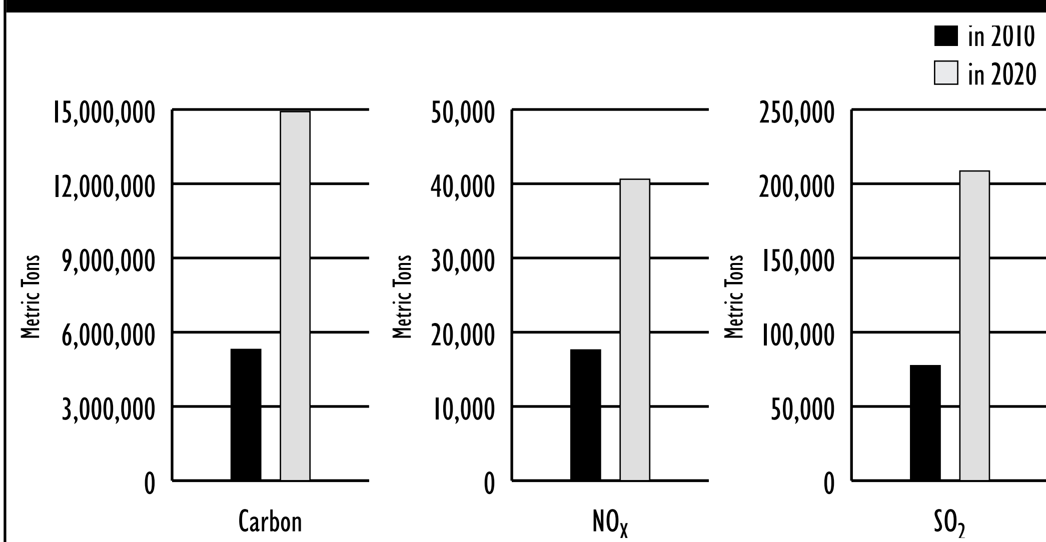
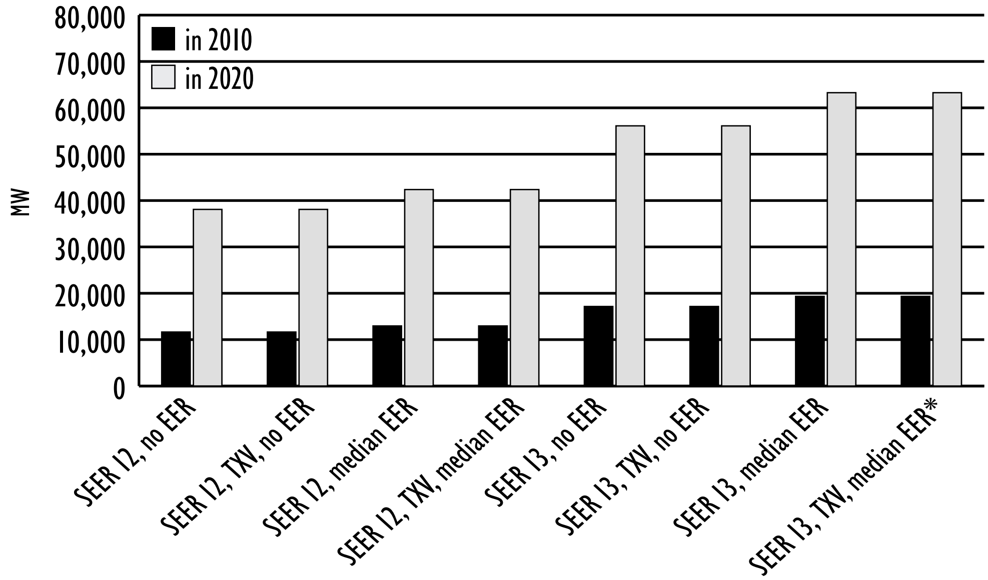


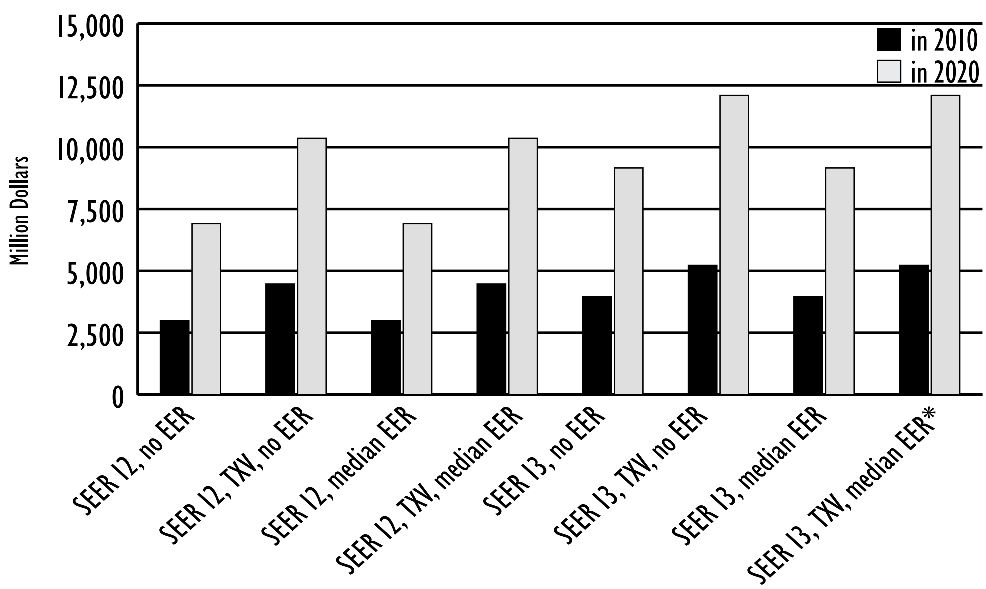
FIG. 6-1 PEAK DEMAND SAVINGS FROM ALTERNATE STANDARD LEVELS FOR RESIDENTIAL AC



*** Our proposed standard level**

the stronger standard. However, by 2020 the lower standard would reduce net savings by 9% ($362 million) and peak reductions by 26% (more than 3,800 MW) and result in the emission of 864 MMT of carbon, 2,400 MT of nitrogen oxide, 11,100 MT of sulfur dioxide eliminated by the stronger standard. Figure 7 summarizes the peak reductions and net dollar savings associated with the alternate commercial equipment standards under consideration. Appendix 3 provides details on the costs and savings for each alternative level.

FIG. 6-2 NET DOLLAR SAVINGS FROM ALTERNATE STANDARD LEVELS FOR RESIDENTIAL AC



*** Our proposed standard level**

FIG. 7-1 PEAK DEMAND SAVINGS FROM ALTERNATE STANDARD LEVELS FOR COMMERCIAL AC

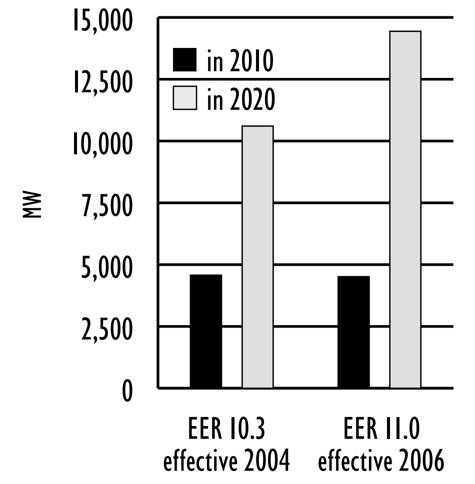
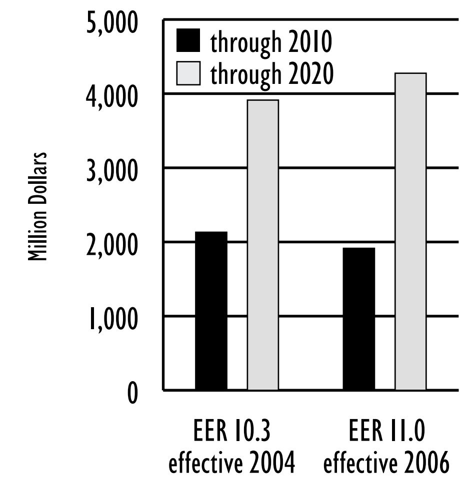


FIG. 7-2 NET DOLLAR SAVINGS FROM ALTERNATE STANDARD LEVELS FOR COMMERCIAL AC



Case Studies of Recent Power Outages

The proposed new standards for central air conditioning equipment will not take effect until 2006 and, as a result, they will not reduce the likelihood of power outages in the immediate future. However, they are an important part of mid- and long-term efforts to alleviate these problems and improve system reliability. In order to illustrate how standards set in 2000 (and taking effect in 2006) can alleviate future problems, we look at the impact the proposed standards would have had in 1999 and 2000 had they taken effect in 1990. We are not arguing that standards at the levels proposed should have gone into effect in 1990, but merely using these dates to show the impact that upgraded standards can have in the future.

For the purpose of our analysis, we selected three utilities that experienced outages and reliability problems during the summer of 1999 to serve as case studies. In each case, we explore how the situation in 1999 might have been different had an updated air conditioning standard been in effect. We also present an analysis for the state of California. Although California did not experience power outages during 1999, many analysts anticipate reliability problems in the state during the summer of 2000 (CEC 1999; Stouffer 2000). In fact, these predictions proved true on June 14th when Pacific Gas and Electric was forced to institute rolling blackouts affecting 97,000 customers in the San Francisco area when temperatures reached more than 100 degrees in many parts of the state. In this case, we demonstrate how peak demand reductions from upgraded air conditioning standards would impact demand forecasts for summer 2000. Two of the case studies — Commonwealth Edison in Chicago and the Long Island Power Authority — focus on specific portions of the utilities' service areas and address localized outages and reliability issues. Because these events occurred in largely residential portions of the utility service territories, we analyze only the affects of an upgraded standard for residential central air conditioners and heat pumps. The other case studies — Entergy and California — take a broader view, exploring reliability problems and concerns at a system-wide level. These cases include analysis of savings from both residential and commercial equipment.

Commonwealth Edison: Chicago, Illinois

During the summer of 1999, more than 100,000 Chicago area customers of Commonwealth Edison (ComEd) lost power during a series of well-publicized blackouts.

Three separate outages, taking place between July 30 and August 12, were the result of failures in the utility's aging distribution system. The first of these outages followed an extended heat wave during which ComEd recorded new record peak loads on seven of nine consecutive days. Here we focus on outages in the area served by ComEd's Northwest substation.

The Northwest substation has experienced higher than average load growth for the city of Chicago due to an increasing number of commercial buildings in the area. Nevertheless, the area remains predominately residential and, as a result, power demand is highest in the late afternoon and early evening when residents return home and turn up their air conditioning. High peak load on the afternoon of July 30 led to a series of cable faults and subsequent transformer overloads which left close to 80,000 customers in the area without power. Restoration efforts were undertaken over the following two days, leaving thousands of customers without power until the morning of August 1.

A series of studies on the ComEd outages, ordered by the Illinois Commerce Commission, linked the outages to a series of distribution system failures precipitated by the extreme temperatures, excessive age of many distribution system components, inadequate maintenance practices, and the longstanding ComEd practice of loading distribution cables and transformers over the manufacturers' recommended levels (ICC 1999; ICC 2000). The necessary system upgrades and equipment repairs to address these problems are expected to cost more than $100 million and take as long as six years to complete (Stouffer 2000).

Given its aging distribution infrastructure, substantial ComEd system upgrades will be required regardless of the outages that occurred in 1999. However, by reducing demand on the already overtaxed system, air conditioning standards could have eliminated some of the pressure on the system and may have made the outages less likely or at least less extensive. Furthermore, standards-related peak reductions could help alleviate reliability problems while the necessary repairs and upgrades are taking place. And, by reducing peak demand throughout ComEd's service territory, power purchases from independently operated peaker plants — which come with extremely volatile prices — could be minimized.

Updated standards for residential central air conditioners, effective in 1990, could have cut 1999 peak demand in the area served by ComEd's Northwest substation by approximately 39 MW. This is roughly equal to the power needed to serve 23,400 homes or 10% of the households in the Northwest substation service area, thereby making the outage less likely to have occurred. An updated standard for commercial equipment would add to these savings.

Long Island Power Authority: Long Island, New York

Long Island, like much of the northeastern U.S., experienced an extended heat wave in early July 1999. Over the course of the heat wave — from July 2 to July 8 — a series of power outages left more than 110,000 electric customers on Long Island without power, including a peak number of outages affecting 25,000 customers on July 7. In addition to outages, the Long Island Power Authority (LIPA) service territory experienced a system-wide 5% voltage reduction (ordered by the New York Power Pool) and the utility activated its Commercial Peak Reduction Program and appealed to large customers to undertake voluntary measures to reduce their energy consumption.

A number of factors contributed to the reliability problems on Long Island. First, the extended period of extremely high temperatures, which coincided with the July 4th holiday weekend (and thus a large number of vacationers on the Island), led to record peak power demands. On July 5, a new LIPA system peak load was set only to be broken the following day with a new peak. The July 6 peak represented a 9.1% increase over the peak load in 1998. Second, electricity demand throughout LIPA's service territory has grown at a rapid rate of 3.5% to 4% per year as a strong economy and 20% reductions in electricity rates have allowed many residents to renovate, expand, and add central air conditioning to their homes (de Rouffignac

2000b). Thirdly, LIPA's service territory is isolated from the mainland, limiting access to power from neighboring regions. During the summer of 1999, the utility's typical imports were down by 430 MW because of problems along the interconnection of the New York and New England power pools. Finally, LIPA's attempts to add capacity through construction of new generation and transmission facilities have been hampered by strong community opposition. For example, a coalition of public interest groups is currently fighting approval of a $65 million proposed transmission line. Their opposition centers on concerns over the economic and environmental impacts of the transmission line and the potential for less costly equipment and energy efficiency investments to meet the region's power needs (PII 2000).

Within Long Island, the South Fork region, which includes the towns of Southampton and East Hampton, has experienced particularly strong demand growth. As a popular vacation destination, the South Fork has experienced record levels of new home construction (average annual growth rate of 10.3% in Southampton and East Hampton from 1991 to 1999) and improvements and upgrades to the existing housing stock. While South Fork customers were not subjected to power outages, this area was on the verge of voltage collapse during the heat wave (DOE 2000a)[9] The 1999 peak load for the area reached 167 megavolts-ampere (MVA) on July 5 — 25% higher than the 1998 peak of 132 MVA and 14% higher than the forecasted peak of 146 MVA (DOE 2000a, PII 2000). LIPA clearly views central air conditioners as a key factor contributing to load growth and potential reliability problems: the utility requires customers to notify them when they add significant new load, including air conditioners, to their homes and businesses (DOE 2000a).

Had updated standards on residential central air conditioners and heat pumps taken effect in 1990, peak demand in the South Fork would have been reduced by approximately 10 MW (a little over 10 MVA) in 1999. As a result, peak demand savings from the standard would have reduced the actual 1999 peak demand of 167 MVA by close to 6% and the amount that the actual load exceeded the forecasted load of 146 MVA by almost 50%. In other words, updated standards on residential air conditioners alone would have eliminated half of the peak load in excess of the forecast. An updated standard on commercial central air conditioners would add to these savings by eliminating even more of the excess load.

Entergy: South-Central U.S.

On July 23, 1999, more than 500,000 customers of Entergy — a utility serving more than 2.5 million customers in parts of Louisiana, Texas, Arkansas, and Mississippi — lost power during a series of rolling blackouts instituted during the peak afternoon hours from approximately 2:40 pm to 5:00 pm. In planning for the summer peak season, Entergy identified the need for 1,700 to 1,900 MW of additional capacity to meet its forecasted demand and ensure system reliability. The utility expected to acquire the additional capacity needed by returning 12 unused generating facilities to service, making capacity purchases through reserve-sharing arrangements with neighboring utilities, the Tennessee Valley Authority and PECO Energy Company, and making short-term power purchases as needed from a variety of other sources.

For several reasons, Entergy was not able to acquire sufficient power from these sources to meet peak demand on July 23. First, the actual generating capacity of Entergy's plants was more than 3,000 MW below anticipated levels because of forced outages and plant deratings (DOE 2000a). Second, high levels of demand throughout the southeast left inadequate reserves available for purchase from neighboring utilities and other power sources. Finally, last-minute appeals for voluntary conservation and attempts to arrange for short-term power purchases were ineffective in

[9] *Voltage collapse refers to "an event occurs when an electric system does not have adequate reactive support to maintain voltage stability. Voltage collapse may result in outage of system elements and may include interruption in service to customers." (DOE 2000a)*

securing additional power. As a result, the utility was forced to resort to rolling blackouts. At 2:42 pm, Entergy began to curtail 900 MW of load through rolling blackouts on a 20- to 30-minute cycle lasting until 5:00 pm. In other words, customers throughout the Entergy service territory lost power for 20 to 30 minutes at a time with some customers experiencing more than one outage.

Updated central air conditioning standards, effective in 1990, would have cut 1999 peak demand in Entergy's service territory by more than 1,260 MW, thereby eliminating the shortage experienced on July 23 and preventing the rolling blackouts in the region. Peak demand reductions related to the updated standards would grow to almost 1,400 MW in 2000. This reduction in peak demand would make up 88% of the 1,600 MW Entergy estimates it will need to meet peak demand in its service territory in 2000 (Redman 1999).

California

While California did not experience any of the widespread power outages of summer 1999, system-wide shortages in generation capacity have state regulators concerned about the potential for blackouts in 2000 and the following years. These worries appear to be well-founded: as a result of an early heat wave, the California Independent System Operator (CISO) issued a stage two emergency (a situation in which operating reserves drop below 5%) in May 2000 prompting utilities to request that customers take voluntary steps to minimize their energy consumption. And on June 14, soaring temperatures forced Pacific Gas and Electric to institute rolling blackouts affecting 97,000 customers in the San Francisco area. As a result of these events, the Silicon Valley Manufacturing Group has warned its 175 members to conserve energy during heat waves to avoid the high costs that power outages entail for high-tech firms, estimated at millions of dollars per minute for e-commerce companies (Konrad 2000). The group has since hosted a conference on energy supply and demand, the Silicon Valley Energy Summit, to help its members prepare and take action to reduce their vulnerability to power disruptions.

California's problems stem from a growing demand for power — resulting from rapid population growth and unprecedented economic growth over the past decade — and the state's reliance on electricity imports from neighboring states throughout the Southwest and Northwest. The CISO reports that California's population grew by 580,000 in 1999, resulting in a total population of about 34.3 million (Konrad 2000). In the last two years, the Sacramento Municipal Utility District (SMUD) has connected 15,000 new homes to the grid in its service territory alone. Neighboring states in the Southwest and Northwest, which California has come to rely on for electricity imports, are also experiencing rapid population growth. The availability of power exports from the Southwest is expected to decline as load growth throughout the region, particularly in Southern Nevada and Mexico, outpaces load growth in California. Air conditioning accounts for a large part of the load growth in California. Fifty percent of new energy demand in SMUD's territory comes from air conditioning, while statewide nearly 30% of electricity use on a summer day is used to power air conditioners (Sacramento Bee 2000).

The CISO forecasts peak demand for the summer of 2000 — under normal weather conditions — will be 46,250 MW while main line generators are expected to supply 46,360 MW. Under unusually hot summer conditions, the peak forecast increases to 48,940 MW while the available supply forecast drops to 45,000 MW as neighboring states use their power to meet internal demands (Sacramento Bee 2000). After incorporating contributions from backup power sources, California Energy Commission analysts anticipate shortages of as much as 1,100 MW and estimate that an additional 1,000 MW will be needed each year to meet the growing electricity demand (Stouffer 2000). Peak demand forecasts through 2004 continue to predict increases in peak demand in California. Forecasted peak demand for the CISO area reaches: 46,852 MW in 2001; 47,717 MW in 2002; 48,760 MW in 2003; and 49,734 MW in 2004 (CEC 1999).

Updated standards for residential and commercial central air conditioners and heat pumps could reduce the need for additional generation capacity by substantially reducing peak demand. Assuming that the standards proposed in this report had been effective in 1990, peak demand reductions in California in 2000 would total an estimated 2,300 MW, almost 5% of forecasted peak demand, with electricity savings of 2.5 billion kWh. These savings would more than cover the shortages anticipated for the summer of 2000. Air conditioning standards could "supply" enough electricity to address more than two years of anticipated load growth.

Summary of Case Study Findings

These case studies demonstrate the role that updated central air conditioning standards can play in preventing or alleviating local and regional reliability problems. By reducing the air conditioning load on the electric system during the hot summer months, improved standards would relieve the stresses on generation, transmission, and distribution equipment that contribute to power outages. The California and Entergy case studies illustrate how standards can reduce the need for additional generation capacity and minimize the risk associated with reliance on imported power and power purchases by lowering peak demand. Efficiency standards "supply" the power to meet peak demand without costly investments in power plants or expensive — and volatile — summer peak power purchases. And, standards "supply" peak power while reducing air pollution and avoiding the public battles over facilities siting. At the local level, updated efficiency standards reduce the peak loads that tax distribution equipment, particularly when high temperatures are stressing components and negatively impacting performance. In Chicago, standards-related reductions in peak demand would ease the burden on the overloaded distribution system, reducing the likelihood of outages while the system undergoes necessary modernization. In Long Island, peak demand reductions would help curb rapid demand growth and buy time for implementation of efficiency programs and other alternatives to investment in costly and unpopular transmission lines.

Conclusion

Power outages and electric reliability issues have become a major concern for utilities, governments, businesses, and consumers. As of June 2000, Massachusetts and Pennsylvania had already experienced close calls and California experienced power outages as unseasonably high temperatures swept across the country. By using energy more efficiently, we can reduce the incidence of power outages and improve the reliability of the power system while avoiding the high economic, public health, and environmental costs that are consequences of increased power generation. Updated standards provide a low-cost means of ensuring sustainable, long-term reductions in energy consumption and peak demand burdens on the electric power system. In addition, improved standards save consumers and businesses billions of dollars and alleviate the public health and environmental problems associated with electricity generation. The Secretary of Energy has committed to updating efficiency standards on residential and commercial central air conditioners and heat pumps. DOE should act on this commitment and issue the strongest standards justified.

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Appendix I: Methodology

Summary

Our study involves the following three analyses:

1) Future impact of updated *residential* central air conditioner and heat pump standards,

2) Future impact of updated *commercial* packaged air conditioner and heat pump standards, and

3) *Case studies* on the power shortages of Summer 1999 and expected shortages of Summer 2000; impacts of updated residential and commercial air conditioner and heat pump standards if updated in 1990.

For the residential and commercial analyses, we calculated the impacts of updated standards in the years 2010 and 2020 for the U.S., each census division, and the four most populous states. For the case studies, we chose two locales which experienced local distribution system problems B the South Fork of Long Island, and the area served by Commonwealth Edison's Northwest substation; and two system-wide problems where growth in total demand is exceeding the growth in generation capacity B the Entergy service region and the State of California. Each stage of the analyses involves multiple steps as described below.

We obtained total end-use electricity savings from proposed new standards by multiplying projected annual sales figures by per-unit electricity savings. To calculate peak generation savings, we multiplied electric generation savings by a peak factor (kilowatt per kilowatt-hour [kW/kWh]). The peak factor is the average coincident power demand of the appliance during peak periods divided by the annual energy consumption of the appliance. We determined the financial savings by multiplying forecasted electricity rates by the energy savings, while we calculated financial costs by multiplying the per-unit incremental cost by the number of units sold. We derived emission reductions by multiplying emission factors (in pounds/kWh) to the total electricity savings. For cumulative costs and savings, we discounted to 2000 using a 6 percent real discount rate. Cumulative costs and savings cover the period from the effective date of the standard to 2010 and 2020. The net present value of savings also includes savings after 2020 for equipment sold prior to 2020.

The following provides a detailed, step-by-step description of our methodology.

Detailed Methodology

1) Obtaining annual sales figures for each appliance.

We used different methods for estimating annual sales figures in each analysis due to unavailability of census divisional data for the commercial analysis and lack of local data for the case studies. However, each analysis uses the same formulas to calculate end-use electricity savings, coincidental peak savings, financial savings, and emissions reductions, using the estimated annual sales figures (We calculate only the end-use electricity savings and coincidental peak savings for the case studies).

1-1) Residential Analysis

For the residential analysis, we estimate central air conditioner and heat pump stock and stock growth in each census division and the four most populous states using the Residential Energy Consumption Surveys (RECS) (EIA 1993; EIA 1995; EIA 1999b). We obtained the annual sales figures using the following formula:

Annual sales =
(Stock in 2006 (standard effective year)
÷ Average equipment life
+ Annual stock growth)
x Sales adjustment factor

The annual stock growth is calibrated so the national total would equal the figures used in "Supplement to the AEO 2000" (EIA 1999d). However, we consider that DOE estimates are conservative and apply a sales adjustment factor to calibrate the 1998 sales obtained from the above formula to match the actual sales volume in Appliance Magazine (1999).

1-2) Commercial Analysis

For the commercial analysis, we obtained 1998 annual sales volume from Census Bureau data (U.S. Census Bureau 1998). We estimated national sales between 1998 and 2020 using the estimated growth in commercial floor space in AEO 2000 (EIA 1999c). We allocated the national sales figure to each census division according to the portion of cooled floor space using packaged air conditioning equipment, indicated in the 1995 Commercial Buildings Energy Consumption Survey (CBECS) (EIA 1998a). To obtain annual sales volume for the four most populous states, we prorated the census divisional sales figures according to the states= commercial sector electricity use in 1998 (EIA 1999a).

1-3) Case Studies

We estimated the annual sales figure for each case study using the following formula:

Annual sales =
Air conditioner & heat pump Stock in 1990 ÷
Average equipment life
+ (Stock in 1999 - Stock in 1990))
÷ 9yrs

To estimate air conditioner and heat pump stock in 1990 and 1999, we used 1990 decennial census data and publicly available information by utilities and public service commissions for the number of households, and RECS data for saturation.

2) Calculating energy savings

We calculate electricity savings in 2010 and 2020 using the following equation:

End-use elec. savings =
Annual sales volume
x (Years from effective date - 0.5)
x Per-unit elec. Savings
x Usage adjustment factor

We subtract 0.5 from the number of effective years to account for sales throughout the year (2010 or 2020), so the *savings* from units installed during the year will be equivalent to only half-year sales times annual savings per unit. Only for the alternative standards for commercial packaged air conditioners and heat pumps (EER10.3 effective 2004), we use the average equipment life instead of the years from effective date, in order to avoid double-counting the savings from replacements after 100 percent saturation.

Equipment life and per-unit energy savings for residential equipment are from the most recent DOE analysis for the air conditioner standard rulemaking (DOE 1999b). For commercial equipment, equipment life is from 1999 DOE BTS Core Databook (1999a) and per-unit savings are from the 1998 New England Energy Efficiency Partnership (NEEP) survey of current prices (Linn 2000). We assume that in the absence of standards, efficiency levels of new equipment remain at present levels. For residential equipment this is a reasonable assumption as the average efficiency of new equipment has been essentially unchanged for the past several years. For commercial equipment, efficiencies are increasing but so are sales. Neither of these trends are included in our analysis. Thus, we implicitly assume that these factors counterbalance each other.

The usage adjustment factor is the ratio of annual cooling/heating energy use in the census division/state/locale to the national average annual consumption. We apply this factor to adjust for the differences in per unit electricity savings. We used data from RECS 1997 and CBECS 1995 for the residential and commercial analyses, respectively (EIA 1998a; EIA 1999b). For the case studies, we adjusted the above factors using the difference in average size of houses between our focus locale and census division, using data from the 1990 Census (U.S. Census Bureau 1995).

We calculate total primary energy savings using the following equation:

Total primary energy savings =
End-use elec. savings
x T&D loss factor
x Elec. generation heat rate

For electric generation heat rate, we use 10207 Btu/kWh for 2010 and 9690 Btu/kWh for 2020 (EIA 1998b). For the T&D loss factor, we use 1.0695 for 2010 and 1.0650 for 2020 (EIA 1998b).

Peak generation savings are calculated as:

Peak generation savings =
End-use elec. savings
x T&D loss factor
÷ Reserve factor
x Peak factor

We assume a conservative 10 percent reserve margin, thus the reserve factor in the formula is 0.9. Historically, a reserve margin of 20 percent has been used, but utilities have been cutting down their margins with the recent restructuring of the electric utility industry. We obtained peak factors from a review of regional data on the ratio of annual energy use to average coincident peak demand by end-use. For the residential analysis, we use data from Neme, Proctor, and Nadel (1999). Revised figures for Florida and Texas come from data provided by Parker (1999) and Brooks (1999). These data were used for the southern states. Revised figures for the northwest come from Eckman (2000). For the commercial analysis we also use data from Neme, Proctor and Nadel (1999) covering Rhode Island, New York, Indiana and California. We use these data for Northeast, Mid-Atlantic, and East North Central regions as well as for our California analysis. For the other regions we project peak factors based on the four regions for which we have peak factors, and based on design load and annual full-load operating hours for commercial cooling in cities in each region as analyzed by Pacific Northwest National Laboratory (PNNL 1993).

For the case studies, we used an estimated peak factor from publicly available information for Long Island, peak factor for the E.N. Central region for Commonwealth Edison, average of E.S. Central and W.S. Central data for Entergy, and CEC data for California (CEC 1993).

3) Calculating financial costs and savings

We calculate consumer bill savings using the following formula:

Consumer bill savings =
End-use elec. savings
x Divisional forecast elec. price
x Seasonal price adjustment factor

We use forecast electricity prices for the residential and commercial sectors by each census division, as reported in the Supplement to the AEO 2000 (EIA 1999d).

Net present value (NPV) is calculated as:

NPV expected investment =
{PV(Annual sales volume
x Per-unit incremental cost)}

NPV savings for sales =
{PV(Installed volume x Per-unit energy savings
x Elec. price
x Seasonal price adjustment factor)}

Present value (PV) calculations are discounted to 2000 assuming a 6 percent real discount rate and expressed in terms of 1998 dollars. The NPV of expected investment aggregates the present value of annual investments from the effective date of each standard through 2010 and 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 2010 and 2020 die out. Essentially, these two measures give us the cumulative costs and benefits of standard-complying products installed through 2010 or 2020.

Per-unit incremental costs for residential equipment were obtained from the most recent DOE analysis for the residential air conditioner standard rulemaking. We then adjusted these costs to account for the impacts of new technology (DOE 1999b), typical distributor mark-ups (DOE 1999b), historic productivity improvements (U.S. Census Bureau 1998), and to correct an error made by DOE on the repair costs for SEER 13 equipment. Costs are expressed in 1998 dollars. For commercial air conditioning equipment, incremental costs are based on current costs as reported in a NEEP survey (Linn 2000). For electricity savings for space cooling, we increase average annual electricity prices by 10 percent since savings are primarily in summer when electricity prices are higher. This 10% adder is likely conservative; for example, a utility in New England recently increased summer electric rates by more than 50% due to the rising cost of peak summer electricity (Howe 2000a).

4) Calculating emission reductions

We calculate carbon, nitrogen oxides, sulfur dioxide, and particulate emissions reductions from electric products using the following equation:

Emission reductions =
End-use elec. savings
x T&D loss factor
x Marginal emission factors

We use marginal emissions factors rather than straight emissions factors from the projected generation fuel mix. This gives a more accurate estimate of emissions reductions from new standards. For example, coal-fired power plants are often non-marginal C they are the dirtiest, but also the cheapest, and will most likely remain in operation. Projections from the National Energy Modeling System (NEMS) were used to develop the emissions factors used in the analysis. We calculate emissions factors as the change in total emissions divided by the change in total generation when moving from the NEMS base case to an ACEEE policy case based on upgraded appliance standards and other policies (Geller, Bernow, and Dougherty 1999). Emissions factors through 2010 are calculated based on the following:

- For carbon, direct NEMS outputs are used (regional emissions and regional generation).
- NEMS does not report regional emissions for particulate matter. We calculate an average national emissions factor by applying a national emissions factor (determined by dividing actual national emissions by fuel by actual fuel consumption) to regional fuel consumption. Consumption by new coal units was tracked.
- For nitrogen oxide, the NEMS version used does not report regional emissions. Marginal emissions factors were calculated based on regional outputs from the reference and low growth cases of the 1999 AEO (EIA 1998b).
- For sulfur dioxide, NEMS does not report regional emissions. Marginal emissions factors were calculated based on regional outputs from the reference and low growth cases of the 1999 AEO (EIA 1998b). However, to ignore sulfur dioxide cap and trade system effects, regional sulfur dioxide emissions in the low demand case are computed using the average regional emissions factor from the reference case (i.e., emissions are calculated based on fossil generation only; total sulfur dioxide emitted divided by coal, oil, and natural gas generation as reported by EIA 1998b).

Emissions factors beyond 2010 are calculated based on the following:

- The percentage of regional fuel and electric generation savings in 2010 apply in 2020.
- The emissions levels of carbon and particulates are calculated based on estimated fuel consumption.
- For nitrogen oxide, marginal emissions factors are calculated based on regional outputs from the reference and low growth cases of the 1999 AEO (EIA 1998b).
- For sulfur dioxide, marginal emissions factors are calculated based on regional outputs from the reference and low growth cases of the 1999 AEO (EIA 1998b), except for those low growth case emissions calculated by the same method as the 2010 emissions factors.

Appendix 2: Regional and State Data Sheets

National		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	23,853	19,338	4,515	77,704	63,265	14,440
End-use Electricity Savings	GWh	25,207	19,717	5,490	82,400	64,768	17,633
Primary Energy Savings	Tril Btus	275	215	60	850	668	182
Consumer Energy Bill Savings	$Million	1,880	1,499	380	6,069	4,874	1,195
Net NPV Savings from Sales	$Million	7,140	5,225	1,915	16,369	12,093	4,275
Carbon Emission Reduction	1000MT	5,305	4,129	1,175	14,913	11,659	3,254
NOx Emission Reduction	MetTons	17,612	13,766	3,846	40,609	31,560	9,049
SO2 Emission Reduction	MetTons	77,479	61,651	15,828	208,584	166,597	41,987
PM10 Emission Reduction	MetTons	705	532	173	2,131	1,637	494

New England		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	136	42	94	437	135	302
End-use Electricity Savings	GWh	185	60	125	595	192	403
Total Primary Energy Savings	Tril Btus	2	1	1	6	2	4
Consumer Energy Bill Savings	$Million	17	6	11	53	20	33
Net NPV Savings from Sales	$Million	61	16	45	133	38	96
Carbon Emission Reduction	1000MT	44	14	30	126	41	86
NOx Emission Reduction	MetTons	147	47	99	535	173	362
SO2 Emission Reduction	MetTons	186	60	126	698	226	472
PM10 Emission Reduction	MetTons	8	2	5	23	7	16

Middle Atlantic		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	1,680	1,266	414	5,477	4,153	1,324
End-use Electricity Savings	GWh	1,481	896	585	4,830	2,952	1,878
Primary Energy Savings	Tril Btus	16	10	6	50	30	19
Consumer Energy Bill Savings	$Million	139	90	48	454	301	153
Net NPV Savings from Sales	$Million	343	117	225	796	287	509
Carbon Emission Reduction	1000MT	344	208	136	833	509	324
NOx Emission Reduction	MetTons	1,221	739	482	4,330	2,647	1,683
SO2 Emission Reduction	MetTons	3,560	2,155	1,406	11,793	7,209	4,584
PM10 Emission Reduction	MetTons	127	77	50	179	109	69

East North Central		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	3,889	3,203	686	12,679	10,486	2,193
End-use Electricity Savings	GWh	2,402	1,817	585	7,852	5,975	1,878
Primary Energy Savings	Tril Btus	26	20	6	81	62	19
Consumer Energy Bill Savings	$Million	174	136	38	556	437	119
Net NPV Savings from Sales	$Million	163	0	163	324	-32	356
Carbon Emission Reduction	1000MT	518	392	126	1,501	1,142	359
NOx Emission Reduction	MetTons	2,228	1,686	542	7,426	5,651	1,776
SO2 Emission Reduction	MetTons	12,233	9,256	2,977	29,279	22,277	7,002
PM10 Emission Reduction	MetTons	68	51	17	250	190	60

Note:1) Coincidental Peak Savings = Peak Load Reduction at the time of Summer Peak Demand
2) Net NPV Savings from Sales = Present Value of (Lifetime Energy Bill Savings - Incremental Costs)

West North Central		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	2,297	1,860	437	7,479	6,082	1,397
End-use Electricity Savings	GWh	1,439	1,143	296	4,702	3,751	951
Primary Energy Savings	Tril Btus	16	12	3	49	39	10
Consumer Energy Bill Savings	$Million	104	84	20	324	263	61
Net NPV Savings from Sales	$Million	190	103	88	392	204	188
Carbon Emission Reduction	1000MT	330	262	68	963	768	195
NOx Emission Reduction	MetTons	1,329	1,056	273	1,252	999	253
SO2 Emission Reduction	MetTons	4,200	3,336	864	11,025	8,796	2,229
PM10 Emission Reduction	MetTons	54	43	11	186	148	38

South Atlantic		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	5,256	4,541	715	17,135	14,850	2,286
End-use Electricity Savings	GWh	8,110	6,782	1,328	26,537	22,273	4,264
Primary Energy Savings	Tril Btus	89	74	14	274	230	44
Consumer Energy Bill Savings	$Million	602	517	86	1,958	1,690	269
Net NPV Savings from Sales	$Million	2,656	2,192	464	6,155	5,119	1,036
Carbon Emission Reduction	1000MT	1,666	1,394	273	4,576	3,841	735
NOx Emission Reduction	MetTons	6,167	5,158	1,010	13,785	11,570	2,215
SO2 Emission Reduction	MetTons	29,194	24,415	4,779	80,734	67,761	12,973
PM10 Emission Reduction	MetTons	241	202	40	619	520	99

East South Central		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	2,429	1,900	529	7,891	6,198	1,693
End-use Electricity Savings	GWh	2,822	2,251	571	9,210	7,375	1,835
Primary Energy Savings	Tril Btus	31	25	6	95	76	19
Consumer Energy Bill Savings	$Million	196	159	37	633	516	117
Net NPV Savings from Sales	$Million	899	701	198	2,065	1,621	445
Carbon Emission Reduction	1000MT	569	454	115	1,620	1,298	323
NOx Emission Reduction	MetTons	2,165	1,727	438	6,555	5,249	1,306
SO2 Emission Reduction	MetTons	12,923	10,308	2,616	33,441	26,779	6,661
PM10 Emission Reduction	MetTons	57	46	12	216	173	43

West South Central		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	4,957	4,283	674	16,173	14,017	2,156
End-use Electricity Savings	GWh	5,828	4,889	939	19,085	16,069	3,017
Primary Energy Savings	Tril Btus	64	53	10	197	166	31
Consumer Energy Bill Savings	$Million	413	350	63	1,353	1,153	200
Net NPV Savings from Sales	$Million	2,001	1,656	345	4,675	3,887	788
Carbon Emission Reduction	1000MT	1,209	1,014	195	3,434	2,891	543
NOx Emission Reduction	MetTons	2,772	2,325	447	4,991	4,202	789
SO2 Emission Reduction	MetTons	11,824	9,918	1,905	33,293	28,031	5,262
PM10 Emission Reduction	MetTons	87	73	14	383	322	61

Note:1) Coincidental Peak Savings = Peak Load Reduction at the time of Summer Peak Demand

2) Net NPV Savings from Sales = Present Value of (Lifetime Energy Bill Savings - Incremental Costs)

Mountain		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	1,577	1,343	234	5,158	4,409	749
End-use Electricity Savings	GWh	1,390	1,045	345	4,554	3,446	1,108
Primary Energy Savings	Tril Btus	15	11	4	47	36	11
Consumer Energy Bill Savings	$Million	112	88	24	350	276	74
Net NPV Savings from Sales	$Million	467	347	120	1,038	776	262
Carbon Emission Reduction	1000MT	260	196	65	744	563	181
NOx Emission Reduction	MetTons	827	622	205	599	453	146
SO2 Emission Reduction	MetTons	1,852	1,393	460	4,679	3,541	1,138
PM10 Emission Reduction	MetTons	18	13	4	81	61	20

Pacific		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	1,632	900	732	5,275	2,935	2,340
End-use Electricity Savings	GWh	1,552	835	716	5,035	2,734	2,301
Primary Energy Savings	Tril Btus	17	9	8	52	28	24
Consumer Energy Bill Savings	$Million	122	69	54	387	218	169
Net NPV Savings from Sales	$Million	359	92	267	791	194	598
Carbon Emission Reduction	1000MT	364	196	168	1,114	605	509
NOx Emission Reduction	MetTons	755	406	349	1,137	617	520
SO2 Emission Reduction	MetTons	1,507	811	696	3,643	1,978	1,665
PM10 Emission Reduction	MetTons	44	24	20	194	105	89

Note:1) Coincidental Peak Savings = Peak Load Reduction at the time of Summer Peak Demand

2) Net NPV Savings from Sales = Present Value of (Lifetime Energy Bill Savings - Incremental Costs)

California		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	1,114	800	314	3,603	2,597	1,006
End-use Electricity Savings	GWh	961	478	483	3,112	1,561	1,551
Primary Energy Savings	Tril Btus	10	5	5	32	16	16
Consumer Energy Bill Savings	$Million	91	50	42	289	157	132
Net NPV Savings from Sales	$Million	267	50	217	588	101	487
Carbon Emission Reduction	1000MT	244	121	122	751	377	374
NOx Emission Reduction	MetTons	303	151	152	562	282	280
SO2 Emission Reduction	MetTons	838	417	421	2,111	1,059	1,052
PM10 Emission Reduction	MetTons	26	13	13	124	62	62

Florida		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	2,216	1,995	221	7,204	6,498	706
End-use Electricity Savings	GWh	3,026	2,616	410	9,873	8,556	1,317
Primary Energy Savings	Tril Btus	33	29	4	102	88	14
Consumer Energy Bill Savings	$Million	231	204	26	748	666	82
Net NPV Savings from Sales	$Million	1,128	986	142	2,612	2,296	316
Carbon Emission Reduction	1000MT	630	545	85	1,580	1,369	211
NOx Emission Reduction	MetTons	2,972	2,569	403	2,043	1,771	272
SO2 Emission Reduction	MetTons	7,131	6,165	966	21,392	18,539	2,853
PM10 Emission Reduction	MetTons	145	126	20	215	186	29

New York		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	464	281	183	1,504	920	584
End-use Electricity Savings	GWh	448	190	258	1,451	623	829
Primary Energy Savings	Tril Btus	5	2	3	15	6	9
Consumer Energy Bill Savings	$Million	47	22	24	152	75	77
Net NPV Savings from Sales	$Million	125	6	119	286	18	269
Carbon Emission Reduction	1000MT	103	44	59	193	83	110
NOx Emission Reduction	MetTons	351	149	202	1,332	572	760
SO2 Emission Reduction	MetTons	928	393	535	3,823	1,641	2,182
PM10 Emission Reduction	MetTons	62	26	36	54	23	31

Texas		Year 2010			Year 2020		
Category	Units	Total	Residential	Commercial	Total	Residential	Commercial
Coincidental Peak Savings	MW	2,827	2,375	452	9,163	7,717	1,446
End-use Electricity Savings	GWh	3,310	2,680	630	10,770	8,747	2,023
Primary Energy Savings	Tril Btus	36	29	7	111	90	21
Consumer Energy Bill Savings	$Million	241	198	43	785	647	137
Net NPV Savings from Sales	$Million	1,217	979	238	2,827	2,284	543
Carbon Emission Reduction	1000MT	697	564	133	1,971	1,601	370
NOx Emission Reduction	MetTons	1,419	1,149	270	3,425	2,781	643
SO2 Emission Reduction	MetTons	5,842	4,731	1,112	16,661	13,532	3,129
PM10 Emission Reduction	MetTons	50	41	10	219	178	41

Note:1) Coincidental Peak Savings = Peak Load Reduction at the time of Summer Peak Demand
2) Net NPV Savings from Sales = Present Value of (Lifetime Energy Bill Savings - Incremental Costs)

RESIDENTIAL

PROPOSED STANDARD - SEER 13 ; with TXV ; Median EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	19,338	42	1,266	3,203	1,860	4,541	1,900	4,283	1,343	900	800	1,995	281	2,375
In 2010	Total End-use Electricity Savings	GWh	19,717	60	896	1,817	1,143	6,782	2,251	4,889	1,045	835	478	2,616	190	2,680
In 2010	Total Primary Energy Savings	Tril Btus	215	1	10	20	12	74	25	53	11	9	5	29	2	29
In 2010	Consumer Electricity Bill Savings	$Million	1,499	6	90	136	84	517	159	350	88	69	50	204	22	198
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	5,225	16	117	0	103	2,192	701	1,656	347	92	50	986	6	979
In 2010	Carbon Emission Reduction	1000MT	4,129	14	208	392	262	1,394	454	1,014	196	196	121	545	44	564
In 2010	NOx Emission Reduction	MetTons	13,766	47	739	1,686	1,056	5,158	1,727	2,325	622	406	151	2,569	149	1,149
In 2010	SO2 Emission Reduction	MetTons	61,651	60	2,155	9,256	3,336	24,415	10,308	9,918	1,393	811	417	6,165	393	4,731
In 2010	PM10 Emission Reduction	MetTons	532	2	77	51	43	202	46	73	13	24	13	126	26	41
In 2020	Summer Coincidental Peak Savings	MW	63,265	135	4,153	10,486	6,082	14,850	6,198	14,017	4,409	2,935	2,597	6,498	920	7,717
In 2020	Total End-use Electricity Savings	GWh	64,768	192	2,952	5,975	3,751	22,273	7,375	16,069	3,446	2,734	1,561	8,556	623	8,747
In 2020	Total Primary Energy Savings	Tril Btus	668	2	30	62	39	230	76	166	36	28	16	88	6	90
In 2020	Consumer Electricity Bill Savings	$Million	4,874	20	301	437	263	1,690	516	1,153	276	218	157	666	75	647
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	12,093	38	287	-32	204	5,119	1,621	3,887	776	194	101	2,296	18	2,284
In 2020	Carbon Emission Reduction	1000MT	11,659	41	509	1,142	768	3,841	1,298	2,891	563	605	377	1,369	83	1,601
In 2020	NOx Emission Reduction	MetTons	31,560	173	2,647	5,651	999	11,570	5,249	4,202	453	617	282	1,771	572	2,781
In 2020	SO2 Emission Reduction	MetTons	166,597	226	7,209	22,277	8,796	67,761	26,779	28,031	3,541	1,978	1,059	18,539	1,641	13,532
In 2020	PM10 Emission Reduction	MetTons	1,637	7	109	190	148	520	173	322	61	105	62	186	23	178

Alternative Standard 1 - SEER 13 ; no TXV ; Median EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	19,338	42	1,266	3,203	1,860	4,541	1,900	4,283	1,343	900	800	1,995	281	2,375
In 2010	Total End-use Electricity Savings	GWh	16,524	50	751	1,523	958	5,684	1,886	4,097	876	700	401	2,193	159	2,246
In 2010	Total Primary Energy Savings	Tril Btus	180	1	8	17	10	62	21	45	10	8	4	24	2	25
In 2010	Consumer Electricity Bill Savings	$Million	1,257	5	76	114	70	433	133	294	74	58	42	171	19	166
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	3,963	12	59	-72	49	1,722	554	1,322	269	47	19	790	-6	786
In 2010	Carbon Emission Reduction	1000MT	3,461	12	174	328	220	1,168	381	850	164	164	102	457	37	473
In 2010	NOx Emission Reduction	MetTons	11,537	40	619	1,413	885	4,322	1,447	1,949	521	341	126	2,153	125	963
In 2010	SO2 Emission Reduction	MetTons	51,667	50	1,806	7,757	2,796	20,461	8,638	8,312	1,167	680	349	5,167	330	3,965
In 2010	PM10 Emission Reduction	MetTons	446	2	65	43	36	169	38	61	11	20	11	105	22	34
In 2020	Summer Coincidental Peak Savings	MW	63,265	135	4,153	10,486	6,082	14,850	6,198	14,017	4,409	2,935	2,597	6,498	920	7,717
In 2020	Total End-use Electricity Savings	GWh	54,279	161	2,474	5,007	3,144	18,666	6,181	13,466	2,888	2,291	1,308	7,171	522	7,331
In 2020	Total Primary Energy Savings	Tril Btus	560	2	26	52	32	193	64	139	30	24	13	74	5	76
In 2020	Consumer Electricity Bill Savings	$Million	4,085	17	252	367	221	1,416	432	966	231	183	132	558	63	542
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	9,160	27	149	-195	85	4,020	1,279	3,102	600	93	32	1,837	-12	1,834
In 2020	Carbon Emission Reduction	1000MT	9,771	34	427	957	644	3,219	1,087	2,423	472	507	316	1,147	70	1,342
In 2020	NOx Emission Reduction	MetTons	26,449	145	2,218	4,735	837	9,696	4,399	3,522	380	517	236	1,484	479	2,331
In 2020	SO2 Emission Reduction	MetTons	139,618	189	6,041	18,670	7,372	56,787	22,442	23,491	2,967	1,658	887	15,537	1,375	11,340
In 2020	PM10 Emission Reduction	MetTons	1,372	6	92	159	124	435	145	270	51	88	52	156	19	149

RESIDENTIAL

Alternative Standard 2 - SEER 13 ; with TXV ; no EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	17,152	37	1,123	2,841	1,650	4,028	1,685	3,799	1,191	799	709	1,770	249	2,106
In 2010	Total End-use Electricity Savings	GWh	19,717	60	896	1,817	1,143	6,782	2,251	4,889	1,045	835	478	2,616	190	2,680
In 2010	Total Primary Energy Savings	Tril Btus	215	1	10	20	12	74	25	53	11	9	5	29	2	29
In 2010	Consumer Electricity Bill Savings	$Million	1,499	6	90	136	84	517	159	350	88	69	50	204	22	198
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	5,225	16	117	0	103	2,192	701	1,656	347	92	50	986	6	979
In 2010	Carbon Emission Reduction	1000MT	4,129	14	208	392	262	1,394	454	1,014	196	196	121	545	44	564
In 2010	NOx Emission Reduction	MetTons	13,766	47	739	1,686	1,056	5,158	1,727	2,325	622	406	151	2,569	149	1,149
In 2010	SO2 Emission Reduction	MetTons	61,651	60	2,155	9,256	3,336	24,415	10,308	9,918	1,393	811	417	6,165	393	4,731
In 2010	PM10 Emission Reduction	MetTons	532	2	77	51	43	202	46	73	13	24	13	126	26	41
In 2020	Summer Coincidental Peak Savings	MW	56,113	120	3,684	9,301	5,394	13,171	5,497	12,432	3,911	2,603	2,304	5,763	816	6,845
In 2020	Total End-use Electricity Savings	GWh	64,768	192	2,952	5,975	3,751	22,273	7,375	16,069	3,446	2,734	1,561	8,556	623	8,747
In 2020	Total Primary Energy Savings	Tril Btus	668	2	30	62	39	230	76	166	36	28	16	88	6	90
In 2020	Consumer Electricity Bill Savings	$Million	4,874	20	301	437	263	1,690	516	1,153	276	218	157	666	75	647
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	12,093	38	287	-32	204	5,119	1,621	3,887	776	194	101	2,296	18	2,284
In 2020	Carbon Emission Reduction	1000MT	11,659	41	509	1,142	768	3,841	1,298	2,891	563	605	377	1,369	83	1,601
In 2020	NOx Emission Reduction	MetTons	31,560	173	2,647	5,651	999	11,570	5,249	4,202	453	617	282	1,771	572	2,781
In 2020	SO2 Emission Reduction	MetTons	166,597	226	7,209	22,277	8,796	67,761	26,779	28,031	3,541	1,978	1,059	18,539	1,641	13,532
In 2020	PM10 Emission Reduction	MetTons	1,637	7	109	190	148	520	173	322	61	105	62	186	23	178

Alternative Standard 3 - SEER 13 ; no TXV ; no EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	17,152	37	1,123	2,841	1,650	4,028	1,685	3,799	1,191	799	709	1,770	249	2,106
In 2010	Total End-use Electricity Savings	GWh	16,524	50	751	1,523	958	5,684	1,886	4,097	876	700	401	2,193	159	2,246
In 2010	Total Primary Energy Savings	Tril Btus	180	1	8	17	10	62	21	45	10	8	4	24	2	25
In 2010	Consumer Electricity Bill Savings	$Million	1,257	5	76	114	70	433	133	294	74	58	42	171	19	166
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	3,963	12	59	-72	49	1,722	554	1,322	269	47	19	790	-6	786
In 2010	Carbon Emission Reduction	1000MT	3,461	12	174	328	220	1,168	381	850	164	164	102	457	37	473
In 2010	NOx Emission Reduction	MetTons	11,537	40	619	1,413	885	4,322	1,447	1,949	521	341	126	2,153	125	963
In 2010	SO2 Emission Reduction	MetTons	51,667	50	1,806	7,757	2,796	20,461	8,638	8,312	1,167	680	349	5,167	330	3,965
In 2010	PM10 Emission Reduction	MetTons	446	2	65	43	36	169	38	61	11	20	11	105	22	34
In 2020	Summer Coincidental Peak Savings	MW	56,113	120	3,684	9,301	5,394	13,171	5,497	12,432	3,911	2,603	2,304	5,763	816	6,845
In 2020	Total End-use Electricity Savings	GWh	54,279	161	2,474	5,007	3,144	18,666	6,181	13,466	2,888	2,291	1,308	7,171	522	7,331
In 2020	Total Primary Energy Savings	Tril Btus	560	2	26	52	32	193	64	139	30	24	13	74	5	76
In 2020	Consumer Electricity Bill Savings	$Million	4,085	17	252	367	221	1,416	432	966	231	183	132	558	63	542
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	9,160	27	149	-195	85	4,020	1,279	3,102	600	93	32	1,837	-12	1,834
In 2020	Carbon Emission Reduction	1000MT	9,771	34	427	957	644	3,219	1,087	2,423	472	507	316	1,147	70	1,342
In 2020	NOx Emission Reduction	MetTons	26,449	145	2,218	4,735	837	9,696	4,399	3,522	380	517	236	1,484	479	2,331
In 2020	SO2 Emission Reduction	MetTons	139,618	189	6,041	18,670	7,372	56,787	22,442	23,491	2,967	1,658	887	15,537	1,375	11,340
In 2020	PM10 Emission Reduction	MetTons	1,372	6	92	159	124	435	145	270	51	88	52	156	19	149

RESIDENTIAL

Alternative Standard 4 - SEER 12 ; with TXV ; Median EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	12,952	28	848	2,146	1,246	3,041	1,272	2,868	899	603	536	1,336	188	1,591
In 2010	Total End-use Electricity Savings	GWh	15,007	41	677	1,422	897	5,114	1,664	3,773	814	605	369	2,031	145	2,074
In 2010	Total Primary Energy Savings	Tril Btus	164	0	7	16	10	56	18	41	9	7	4	22	2	23
In 2010	Consumer Electricity Bill Savings	$Million	1,146	4	69	107	66	392	119	271	69	50	38	159	17	154
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	4,470	11	131	102	134	1,785	551	1,368	301	87	67	818	18	805
In 2010	Carbon Emission Reduction	1000MT	3,143	10	157	307	206	1,051	336	783	152	142	94	423	33	437
In 2010	NOx Emission Reduction	MetTons	10,478	32	558	1,319	829	3,889	1,276	1,795	485	294	116	1,994	113	889
In 2010	SO2 Emission Reduction	MetTons	46,887	41	1,628	7,243	2,617	18,412	7,618	7,656	1,085	588	322	4,786	300	3,661
In 2010	PM10 Emission Reduction	MetTons	404	2	58	40	34	152	34	56	10	17	10	98	20	31
In 2020	Summer Coincidental Peak Savings	MW	42,373	90	2,782	7,023	4,073	9,946	4,151	9,388	2,953	1,966	1,740	4,352	616	5,169
In 2020	Total End-use Electricity Savings	GWh	49,296	131	2,230	4,675	2,943	16,796	5,451	12,403	2,686	1,981	1,204	6,642	476	6,770
In 2020	Total Primary Energy Savings	Tril Btus	509	1	23	48	30	173	56	128	28	20	12	69	5	70
In 2020	Consumer Electricity Bill Savings	$Million	3,725	14	229	343	207	1,282	384	893	216	159	122	519	57	503
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	10,359	26	317	214	285	4,168	1,275	3,210	676	188	145	1,903	45	1,878
In 2020	Carbon Emission Reduction	1000MT	8,874	28	385	894	603	2,896	959	2,232	439	438	291	1,063	63	1,239
In 2020	NOx Emission Reduction	MetTons	23,971	118	1,999	4,422	784	8,725	3,879	3,244	353	447	217	1,374	436	2,152
In 2020	SO2 Emission Reduction	MetTons	126,653	153	5,446	17,433	6,902	51,098	19,792	21,636	2,759	1,433	817	14,391	1,253	10,472
In 2020	PM10 Emission Reduction	MetTons	1,245	5	82	149	116	392	128	249	47	76	48	145	18	138

Alternative Standard 5 - SEER 12 ; no TXV ; Median EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	12,952	28	848	2,146	1,246	3,041	1,272	2,868	899	603	536	1,336	188	1,591
In 2010	Total End-use Electricity Savings	GWh	11,434	31	516	1,084	683	3,897	1,268	2,875	620	461	281	1,547	110	1,580
In 2010	Total Primary Energy Savings	Tril Btus	125	0	6	12	7	43	14	31	7	5	3	17	1	17
In 2010	Consumer Electricity Bill Savings	$Million	873	3	52	81	50	298	90	207	52	38	29	121	13	117
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	2,987	7	61	5	65	1,244	386	976	207	37	29	586	3	579
In 2010	Carbon Emission Reduction	1000MT	2,394	7	120	234	157	801	256	596	116	108	71	322	25	333
In 2010	NOx Emission Reduction	MetTons	7,983	25	425	1,005	631	2,963	972	1,368	369	224	89	1,520	86	678
In 2010	SO2 Emission Reduction	MetTons	35,723	31	1,240	5,518	1,994	14,028	5,804	5,833	827	448	245	3,646	229	2,789
In 2010	PM10 Emission Reduction	MetTons	308	1	44	31	26	116	26	43	8	13	8	74	15	24
In 2020	Summer Coincidental Peak Savings	MW	42,373	90	2,782	7,023	4,073	9,946	4,151	9,388	2,953	1,966	1,740	4,352	616	5,169
In 2020	Total End-use Electricity Savings	GWh	37,559	100	1,699	3,562	2,243	12,797	4,153	9,450	2,046	1,509	917	5,061	362	5,158
In 2020	Total Primary Energy Savings	Tril Btus	388	1	18	37	23	132	43	98	21	16	9	52	4	53
In 2020	Consumer Electricity Bill Savings	$Million	2,838	10	174	261	158	976	292	680	164	121	93	395	44	383
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	6,911	15	149	-7	130	2,904	892	2,289	464	74	58	1,363	7	1,351
In 2020	Carbon Emission Reduction	1000MT	6,761	21	293	681	459	2,207	731	1,700	335	334	221	810	48	944
In 2020	NOx Emission Reduction	MetTons	18,263	90	1,523	3,369	597	6,648	2,956	2,471	269	341	166	1,047	332	1,640
In 2020	SO2 Emission Reduction	MetTons	96,498	117	4,149	13,282	5,258	38,932	15,079	16,485	2,102	1,092	622	10,965	954	7,979
In 2020	PM10 Emission Reduction	MetTons	949	4	63	113	89	299	97	190	36	58	37	110	13	105

RESIDENTIAL

Alternative Standard 6 - SEER 12 ; with TXV ; no EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	11,644	25	762	1,929	1,120	2,734	1,144	2,579	808	542	481	1,201	169	1,430
In 2010	Total End-use Electricity Savings	GWh	15,007	41	677	1,422	897	5,114	1,664	3,773	814	605	369	2,031	145	2,074
In 2010	Total Primary Energy Savings	Tril Btus	164	0	7	16	10	56	18	41	9	7	4	22	2	23
In 2010	Consumer Electricity Bill Savings	$Million	1,146	4	69	107	66	392	119	271	69	50	38	159	17	154
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	4,470	11	131	102	134	1,785	551	1,368	301	87	67	818	18	805
In 2010	Carbon Emission Reduction	1000MT	3,143	10	157	307	206	1,051	336	783	152	142	94	423	33	437
In 2010	NOx Emission Reduction	MetTons	10,478	32	558	1,319	829	3,889	1,276	1,795	485	294	116	1,994	113	889
In 2010	SO2 Emission Reduction	MetTons	46,887	41	1,628	7,243	2,617	18,412	7,618	7,656	1,085	588	322	4,786	300	3,661
In 2010	PM10 Emission Reduction	MetTons	404	2	58	40	34	152	34	56	10	17	10	98	20	31
In 2020	Summer Coincidental Peak Savings	MW	38,093	81	2,501	6,314	3,662	8,941	3,732	8,440	2,655	1,767	1,564	3,912	554	4,647
In 2020	Total End-use Electricity Savings	GWh	49,296	131	2,230	4,675	2,943	16,796	5,451	12,403	2,686	1,981	1,204	6,642	476	6,770
In 2020	Total Primary Energy Savings	Tril Btus	509	1	23	48	30	173	56	128	28	20	12	69	5	70
In 2020	Consumer Electricity Bill Savings	$Million	3,725	14	229	343	207	1,282	384	893	216	159	122	519	57	503
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	10,359	26	317	214	285	4,168	1,275	3,210	676	188	145	1,903	45	1,878
In 2020	Carbon Emission Reduction	1000MT	8,874	28	385	894	603	2,896	959	2,232	439	438	291	1,063	63	1,239
In 2020	NOx Emission Reduction	MetTons	23,971	118	1,999	4,422	784	8,725	3,879	3,244	353	447	217	1,374	436	2,152
In 2020	SO2 Emission Reduction	MetTons	126,653	153	5,446	17,433	6,902	51,098	19,792	21,636	2,759	1,433	817	14,391	1,253	10,472
In 2020	PM10 Emission Reduction	MetTons	1,245	5	82	149	116	392	128	249	47	76	48	145	18	138

Alternative Standard 7 - SEER 12 ; no TXV ; no EER ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	11,644	25	762	1,929	1,120	2,734	1,144	2,579	808	542	481	1,201	169	1,430
In 2010	Total End-use Electricity Savings	GWh	11,434	31	516	1,084	683	3,897	1,268	2,875	620	461	281	1,547	110	1,580
In 2010	Total Primary Energy Savings	Tril Btus	125	0	6	12	7	43	14	31	7	5	3	17	1	17
In 2010	Consumer Electricity Bill Savings	$Million	873	3	52	81	50	298	90	207	52	38	29	121	13	117
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	2,987	7	61	5	65	1,244	386	976	207	37	29	586	3	579
In 2010	Carbon Emission Reduction	1000MT	2,394	7	120	234	157	801	256	596	116	108	71	322	25	333
In 2010	NOx Emission Reduction	MetTons	7,983	25	425	1,005	631	2,963	972	1,368	369	224	89	1,520	86	678
In 2010	SO2 Emission Reduction	MetTons	35,723	31	1,240	5,518	1,994	14,028	5,804	5,833	827	448	245	3,646	229	2,789
In 2010	PM10 Emission Reduction	MetTons	308	1	44	31	26	116	26	43	8	13	8	74	15	24
In 2020	Summer Coincidental Peak Savings	MW	38,093	81	2,501	6,314	3,662	8,941	3,732	8,440	2,655	1,767	1,564	3,912	554	4,647
In 2020	Total End-use Electricity Savings	GWh	37,559	100	1,699	3,562	2,243	12,797	4,153	9,450	2,046	1,509	917	5,061	362	5,158
In 2020	Total Primary Energy Savings	Tril Btus	388	1	18	37	23	132	43	98	21	16	9	52	4	53
In 2020	Consumer Electricity Bill Savings	$Million	2,838	10	174	261	158	976	292	680	164	121	93	395	44	383
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	6,911	15	149	-7	130	2,904	892	2,289	464	74	58	1,363	7	1,351
In 2020	Carbon Emission Reduction	1000MT	6,761	21	293	681	459	2,207	731	1,700	335	334	221	810	48	944
In 2020	NOx Emission Reduction	MetTons	18,263	90	1,523	3,369	597	6,648	2,956	2,471	269	341	166	1,047	332	1,640
In 2020	SO2 Emission Reduction	MetTons	96,498	117	4,149	13,282	5,258	38,932	15,079	16,485	2,102	1,092	622	10,965	954	7,979
In 2020	PM10 Emission Reduction	MetTons	949	4	63	113	89	299	97	190	36	58	37	110	13	105

COMMERCIAL

PROPOSED STANDARD - EER 11.0 ; effective 2006

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	4,515	94	414	686	437	715	529	674	234	732	314	221	183	452
In 2010	Total End-use Electricity Savings	GWh	5,490	125	585	585	296	1,328	571	939	345	716	483	410	258	630
In 2010	Total Primary Energy Savings	Tril Btus	60	1	6	6	3	14	6	10	4	8	5	4	3	7
In 2010	Consumer Electricity Bill Savings	$Million	380	11	48	38	20	86	37	63	24	54	42	26	24	43
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	1,915	45	225	163	88	464	198	345	120	267	217	142	119	238
In 2010	Carbon Emission Reduction	1000MT	1,175	30	136	126	68	273	115	195	65	168	122	85	59	133
In 2010	NOx Emission Reduction	MetTons	3,846	99	482	542	273	1,010	438	447	205	349	152	403	202	270
In 2010	SO2 Emission Reduction	MetTons	15,828	126	1,406	2,977	864	4,779	2,616	1,905	460	696	421	966	535	1,112
In 2010	PM10 Emission Reduction	MetTons	173	5	50	17	11	40	12	14	4	20	13	20	36	10
In 2020	Summer Coincidental Peak Savings	MW	14,440	302	1,324	2,193	1,397	2,286	1,693	2,156	749	2,340	1,006	706	584	1,446
In 2020	Total End-use Electricity Savings	GWh	17,633	403	1,878	1,878	951	4,264	1,835	3,017	1,108	2,301	1,551	1,317	829	2,023
In 2020	Total Primary Energy Savings	Tril Btus	182	4	19	19	10	44	19	31	11	24	16	14	9	21
In 2020	Consumer Electricity Bill Savings	$Million	1,195	33	153	119	61	269	117	200	74	169	132	82	77	137
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	4,275	96	509	356	188	1,036	445	788	262	598	487	316	269	543
In 2020	Carbon Emission Reduction	1000MT	3,254	86	324	359	195	735	323	543	181	509	374	211	110	370
In 2020	NOx Emission Reduction	MetTons	9,049	362	1,683	1,776	253	2,215	1,306	789	146	520	280	272	760	643
In 2020	SO2 Emission Reduction	MetTons	41,987	472	4,584	7,002	2,229	12,973	6,661	5,262	1,138	1,665	1,052	2,853	2,182	3,129
In 2020	PM10 Emission Reduction	MetTons	494	16	69	60	38	99	43	61	20	89	62	29	31	41

Alternative Standard - EER 10.3 ; effective 2004

Period	Category	Units	US	New England	Mid-Atlantic	E.N. Central	W.N. Central	S. Atlantic	E.S. Central	W.S. Central	Mountain	Pacific	CA	FL	NY	TX
In 2010	Summer Coincidental Peak Savings	MW	4,575	96	420	695	443	724	537	683	237	741	319	224	185	458
In 2010	Total End-use Electricity Savings	GWh	5,563	127	592	592	300	1,345	579	952	350	726	489	415	261	638
In 2010	Total Primary Energy Savings	Tril Btus	61	1	6	6	3	15	6	10	4	8	5	5	3	7
In 2010	Consumer Electricity Bill Savings	$Million	385	11	49	39	20	87	38	63	24	54	42	27	25	44
Thru 2010	Net NPV(Y2k) Savings from Sales	$Million	2,131	53	256	190	101	507	217	375	134	298	240	155	133	258
In 2010	Carbon Emission Reduction	1000MT	1,191	30	138	128	69	276	117	197	65	170	124	87	60	134
In 2010	NOx Emission Reduction	MetTons	3,897	101	489	550	277	1,023	444	453	208	353	154	408	205	274
In 2010	SO2 Emission Reduction	MetTons	16,041	128	1,424	3,017	875	4,843	2,651	1,931	466	705	426	979	542	1,127
In 2010	PM10 Emission Reduction	MetTons	175	5	51	17	11	40	12	14	4	21	13	20	36	10
In 2020	Summer Coincidental Peak Savings	MW	10,607	222	973	1,611	1,026	1,679	1,244	1,584	550	1,719	739	519	429	1,062
In 2020	Total End-use Electricity Savings	GWh	12,952	296	1,379	1,379	698	3,132	1,348	2,216	814	1,690	1,139	967	609	1,486
In 2020	Total Primary Energy Savings	Tril Btus	134	3	14	14	7	32	14	23	8	17	12	10	6	15
In 2020	Consumer Electricity Bill Savings	$Million	878	24	113	87	45	197	86	147	54	124	97	60	57	101
Thru 2020	Net NPV(Y2k) Savings from Sales	$Million	3,913	93	475	342	179	930	401	704	241	549	442	284	248	484
In 2020	Carbon Emission Reduction	1000MT	2,390	63	238	264	143	540	237	399	133	374	275	155	81	272
In 2020	NOx Emission Reduction	MetTons	6,647	266	1,236	1,305	186	1,627	959	580	107	382	206	200	558	472
In 2020	SO2 Emission Reduction	MetTons	30,841	347	3,367	5,143	1,637	9,529	4,893	3,865	836	1,223	773	2,096	1,603	2,299
In 2020	PM10 Emission Reduction	MetTons	363	11	51	44	28	73	32	44	14	65	46	21	23	30