IX. The Unsung Hero in American Innovation

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This chapter looks at the regulatory attempts to address five serious problems: wasteful light bulbs, emissions of harmful sulfur dioxide from coal plants, workers' exposure to carcinogenic vinyl chloride, releases of ozone-destroying chlorofluorocarbons from aerosol cans, and inefficient home appliances.

Each case presented a challenge to industry: How to continue offering the same products while complying with the federal regulation? Industry officials fiercely resisted most of these regulations, often claiming that they would be put out of business if the rule under consideration were implemented. Yet, as each proposed rule covered in this chapter took effect, the industries met the standard—typically by developing better systems or products—and their doomsday scenarios did not occur.

Increasing Light Bulb Efficiency

The Problem

Traditional incandescent light bulbs are extremely inefficient. They are based on technology invented in 1879 by Thomas Edison. They waste 90 percent of their energy emitting heat, not light, and average just 750 to 2,500 hours of operating life.[3] It requires 82 pounds of coal to generate the amount of electricity that an average

light bulb burns in its life.[4] Lighting accounts for 30 percent of all electricity used in our country.[5]

The Regulatory Response

In 2007, the Energy Independence and Security Act was signed "to move the United States toward greater energy independence and security." The law established a series of efficiency standards for light bulbs. The first phase requires a 25 to 30 percent increase in efficiency over traditional light bulbs by 2012. The second stage requires a 60 percent improvement by 2020.

The Resistance

In 2011, the incandescent light bulb became the *cause celebre* of members of Congress playing to the Tea Party hostility over anything smacking of government regulation. Several bills—including the "Light Bulb Freedom of Choice Act" put forward by Representative Michele Bachmann (R-Minn.)—were introduced in Congress to eliminate the light bulb efficiency standard. Bachmann also incorporated an attack on the light bulb standards into her campaign for the White House, promising that "President Bachmann will allow you to buy any light bulb you want."[6]

Critics of the efficiency standard either imply or outright assert that it will ban the use of incandescent bulbs, forcing consumers to use compact fluorescent bulbs, which many dislike because they emit a bluish-white hue. For example, a June 2011 *Wall Street Journal* editorial led with the claim that in seven months, "Washington will effectively ban the sale of conventional 100 watt incandescent light bulbs that Americans have used nearly since the days of Thomas Edison. Instead we will all be required to buy compact fluorescent lights."[7] Watchdog group Media Matters counted 40 times in which conservative news outlets have claimed that rules slated to take effect in 2012 will require consumers to use compact fluorescents.[8]

"There have been more incandescent innovations in the last three years than in the last two decades."

—Chris Calwell, Ecos consulting (2009)

The Results

The law does not ban incandescent light bulbs.[9] It simply requires that light bulbs sold in 2012 be at least 30 percent more efficient than Edison's 1879 model. Ultimately, the law spurred companies to produce Edison's light with much less waste.

"There's a massive misperception that incandescents are going away quickly," Chris Calwell, a researcher with Ecos Consulting, an energy consulting firm said in 2009. "There have been more incandescent innovations in the last three years than in the last two decades."[10]

In anticipation of the first phase of requirements under the 2007 energy bill, manufacturers began investing in new bulbs that would both meet the new standards and still produce the soft light of incandescent light bulbs. In 2009, Philips Lighting, a Dutch electronics company, brought to market a new halogen incandescent that emits light that is almost indistinguishable from traditional bulbs, is 30 percent more efficient, and lasts three times longer.[11]

In contrast to old incandescents, Philips' halogen bulbs use a reflective coating that captures heat and transforms it into light.[12] Other manufacturers, including General Electric and Osram Sylvania, also have introduced energy-efficient halogen incandescents.

The new bulbs cost more than the traditional bulbs. For example, a Philips 100 watt-equivalent halogen incandescent costs about $4, compared to 25 cents for traditional incandescent light bulbs.[13] But with their increased energy efficiency and longer lifespans, the new bulbs will save consumers money over time, according to the Department of Energy.[14]

Additional Innovation: LED Bulbs

Concern over energy efficiency and a government incentives program also have inspired the development of bulbs using light emitting diodes (LEDs)—the type of lights often used in home electronics—that offer efficiency beyond halogen incandescents or even compact fluorescents.

A Philips LED bulb—which was awarded a $10 million prize by the DOE as the best replacement for a traditional 60-watt incandescent—emits light that is indistinguishable from that of traditional incandescents while using only one-sixth the energy.

If every 60-watt incandescent bulb in the U.S. were replaced with the prize winner, the United States would save about $3.9 billion worth of electricity annually, enough to power Washington, D.C., for three years.[15] LED bulbs still cost $25 or more, which most consumers would not readily pay, even though the bulbs are purported to offer overall savings over their 20-year lives because of their increased energy efficiency. But if history is a guide, the cost of LED bulbs will steadily decline.

Reducing Sulfur Dioxide Emissions

The Problem

Sulfur Dioxide, SO_2, is a major air pollutant that causes acid rain and smog, and has long been recognized as a serious health hazard. It contributes to thousands of premature deaths annually in the United States.[16] Most infamously, it caused the 1952 smog inversion in London that killed 4,000 people in one week.[17]

The Regulatory Response

About two-thirds of SO_2 emissions come from coal-fired power plants.[18]

The Clean Air Act of 1970 instructed the newly formed Environmental Protection Agency to set maximum allowable emissions for stationary sources (most importantly, coal plants) and required states to develop federally approved pollution control plans. Nearly all of the resulting state plans called for ongoing reductions in SO_2 emissions.[19] The effect of these plans was to

require utilities operating coal-fired plants to implement "scrubbing" technologies to capture SO_2 emissions before they reached the atmosphere.

Subsequently, amendments made in 1977 to the Clean Air Act required installation of scrubbers in new plants and in existing plants undergoing renovations. Additional Clean Air Act amendments passed in 1990 established a cap-and-trade system that required owners of coal-fired power plants that exceeded set amounts of emissions to purchase credits from companies whose emissions were below the established limits.

The Resistance

Industry has fought the implementation of scrubbers all along. It challenged the initial regulations issued under the Clean Air Act of 1970 and lost before the Supreme Court in 1976.[20] Throughout the 1980s, industry opposed the standards that were eventually created by the Clean Air Act of 1990. "Utilities predicted a cost of $1,000 to $1,500 for every ton of sulfur dioxide removed. Some said it could not be done even at that exorbitant price," an op-ed writer recalled years later, noting that the eventual cost ended up being about a tenth as much.[21] Meanwhile, coal-fired utilities largely ignored requirements in the 1977 Clean Air Act to install scrubbers in plants undergoing renovations. The U.S. Department of Justice sued nine utilities in 1999 and 2000 for flouting the law.[22]

The Results

There are many ways to reduce sulfur dioxide (SO_2) emissions from coal plants, including pre-combustion treatment (in which coal is prepared before its use to improve its burning efficiency) and the use of low-sulfur coal (which naturally emits less sulfur dioxide). But when the Clean Air Act was passed in 1970, flue gas desulfurization (FGD)—commonly known as "scrubbing technology"—was thought to offer the greatest potential for a comprehensive solution.[23]

Although fewer than 100 patents for sulfur dioxide pollution control were issued before 1967, more than 2,500 patents were issued from 1967 through 1997.

The emphasis was on "potential." Although scrubbers were first implemented in London in 1926, they had never worked well. The first scrubbers were not installed in the United States until 1965.[24]

In the 1960s, scrubbers caused serious plugging in boilers and air heaters.[25] In 1970, a National Research Council panel on sulfur dioxide found that commercially proven technologies for control of sulfur oxides from combustion processes did not exist.[26] But the panel predicted that a feasible solution could be developed in one-to-three years.

The stringency of rules instituted in response to the 1970 Clean Air Act "provided an important incentive for the development of FGD technology," researchers Margaret Taylor and others wrote in 2005.[27]

In other words, the law prompted innovation. Although fewer than 100 patents for sulfur dioxide pollution control were issued before 1967, more than 2,500 patents were issued from 1967 through 1997.[28] During the 1970s, the number of scrubber vendors increased from 1 to 16.[29]

In the wake of the Clean Air Act, scrubbers became significantly more effective at capturing sulfur dioxide and less costly to install.

- The percentage of sulfur dioxide that scrubbers were able to prevent from reaching the atmosphere increased from about 75 percent in the mid-1970s to 95 percent by the mid-1990s;[30]
- Capital costs for scrubber technology were cut in half;[31] and

- Costs to maintain plants with scrubbers declined, as operators learned to prevent corrosion and other problems that had previously required plants to be shut down for repairs.[32]

Meanwhile, the amount of sulfur dioxide emitted into the atmosphere decreased significantly. Between 1980 and 2008, the amount of sulfur dioxide in the air declined by 71 percent, even though electricity production from coal plants grew by 26 percent.[33]

In 2003, President George W. Bush's Office of Management and Budget determined that the 1990 Clean Air Act program to reduce emissions of sulfur dioxide and nitrogen oxides (another set of coal plant pollutants) had the largest quantified human health benefits of any federal regulatory program in the previous 10 years—over $70 billion annually. OMB pegged the ratio of benefits to costs at more than 40-to-1.[34]

Sulfur dioxide emissions remain a major health scourge, not because of the inadequacy of scrubber technology but because of industry's intransigence in implementing it. Even today, the EPA regards sulfur dioxide and nitrous oxides as so dangerous that it estimated that the reductions in emissions resulting just from a new set of standards issued in 2010 will prevent up to 36,000 premature deaths a year.[35]

Protecting Workers from Poisonous Vinyl Chloride

The Problem

In January 1974, a public health emergency arose over the discovery that exposure to vinyl chloride, a substance used to produce polyvinyl chloride (PVC), caused a rare but usually fatal form of liver cancer called angiosarcoma.[36]

Industry had been aware for years of troubling evidence of health risks from workers' exposure to vinyl chloride, in large part from research it funded. But the general public did not learn about the hazards until January 1974, when B.F. Goodrich, the largest PVC manufacturer, informed the National Institute for

Occupational Safety and Health that three employees at one of its plants had died of angiosarcoma.[37]

> "If the proposed 'no-detectable-level' standard is adopted, the vinyl chloride and polyvinyl chloride resin producing industries will be forced to close down immediately."
>
> *—Ralph Harding Jr., president of the Society of the Plastics Industry (1974)*

Investigations over the next few months revealed additional cases of angiosarcoma among vinyl chloride workers, leaving little doubt that the substance was to blame. Other evidence implicated vinyl chloride in a range of other conditions, including gastrointestinal complications and chromosome damage. But as the health risks became increasingly clear, industry officials expressed doubt over the feasibility of reducing vinyl chloride exposures to assuredly safe levels.

That set up what *Fortune* dubbed "the vinyl chloride dilemma," which the magazine summarized with this chilling subtitle: "If government allows workers to be exposed to [vinyl chloride], some of them may die. If it eliminates all exposure, a valuable industry may disappear."[38]

By 1974, PVC had become ubiquitous in American society. Pipes, floor tile, house siding, wire, cables, packaging materials, furniture, bottles, rain coats, shower curtains, medical tubing, auto upholstery, credit cards, Saran Wrap, and phonograph records were among the products being fashioned from white PVC pellets.

The Regulatory Response

The Occupational Safety and Health Administration (OSHA) responded quickly to the crisis. Less than three months after the health risk was revealed, the agency issued an emergency temporary standard that lowered permissible ambient levels from 500 parts per million (ppm) to 50 ppm. The next month, the agency issued a proposed rule calling for "no detectable level" of vinyl chloride in workplaces—0 ppm.[39]

> The proposed vinyl chloride standard would cause "severe economic dislocation" and eliminate 1.7 million to 2.2 million jobs.
>
> *—Plastics industry study (1974)*

The Resistance

PVC manufacturers and industries that relied on PVC howled, arguing that the proposed standard could not be met and that they would be put out of business if it were enacted.

The proposed standard would be "technologically infeasible to achieve, even with the highly sophisticated methods of in-plant control that have been developed by the industry over the years," said Ralph Harding Jr., president of the Society of the Plastics Industry, the industry's trade association.[40]

"If the proposed 'no-detectable-level' standard is adopted, the vinyl chloride and polyvinyl chloride resin producing industries will be forced to close down immediately," Harding continued.[41]

A report commissioned by the plastics industry warned that the proposed rule would cause "severe economic dislocation," eliminating 1.7 million to 2.2 million jobs and preventing $65 billion to $90 billion in products from reaching the market. Among the casualties of the proposed rule would be the entire automobile industry, which, the report said, "would, in fact, have to shut down."[42]

Firestone, a major PVC manufacturer, said it would be forced out of the plastics business and that it would sue on the basis that the rule was infeasible. To the extent the standard might have been achievable, Firestone said it would have to double its capital costs to meet it.[43]

In written comments submitted to OSHA, MCA Records said if PVC production were halted, "our industry would be forced out of business." The National Association of Home Builders said the proposed rule threatened to put "sorely needed housing…beyond the reach of an increasingly large segment of the public."[44]

> New technology to meet the OSHA standard "will be simple to operate [and] will increase raw material efficiency."
>
> *—B.F. Goodrich, display ad (1975)*

A company that produced medical tubing warned that curbing supplies of PVC would jeopardize the availability of critical equipment used for kidney dialysis and heart surgery.[45]

There were widespread calls for compromise, such as setting the standard at 25 parts per million, which scientists could not affirm to be safe. To the author of a debate-framing article in *Fortune*, the answer was clear: OSHA should compromise, not only to protect the viability of the industry but also to ensure society's continued access to the bounty of PVC products.

"It is clear that [OSHA's] task should be to find the right 'trade offs'—to devise regulations in which the benefit of increased health for workers is balanced against the increased cost to the plastic industry and society as a whole," *Fortune's* Paul H. Weaver wrote.[46]

In the end, OSHA barely budged. Fewer than nine months after news had broken of hazards posed by vinyl chloride, OSHA issued a final rule calling for exposures of no more than 1 part per million, except in sealed-off areas in which workers would be required to wear respirators to ensure that they did not inhale any fumes.[47]

OSHA's small concession did not placate industry. The plastics industry trade association said the standard was unrealistic and would likely be impossible for most to meet. Firestone said the rule "puts the vinyl plastics industry on a collision course with economic disaster"[48] and would "throw 2 million jobs down the drain."[49]

The Results

What happened next was wholly unexpected.

In August 1975, just 10 months after a final rule was issued, B.F. Goodrich announced that it had developed a process that would meet the OSHA standards without requiring respirator use.

Its system captured residual vinyl chloride in the manufacturing process without allowing it to come into contact with workers.[50] A few months later, B.F. Goodrich ran a *Wall Street Journal* display ad claiming that its new system "will be simple to operate [and] will increase raw material efficiency."[51]

In April 1976, B.F. Goodrich announced that it had signed licensing agreements for its containment technology with six corporations, and that it planned to expand its own vinyl chloride manufacturing capacity at several plants that year.[52] By August, at least three other companies announced they were licensing safety technology or soon intended to.[53]

Shortly thereafter, demand for PVC boomed, prompting the industry to embark on an enormous expansion in manufacturing capacity. "PVC Rolls out of Jeopardy, into Jubilation," headlined a *Chemical Week* article published just 22 months after the final rule was announced.[54]

In addition to B.F. Goodrich's expansion plans, *Chemical Week* reported, Borden was building a PVC plant; Diamond Plastics planned to build two plants; Tenneco was building a new plant; Dow Chemical was building a large plant; Stauffer Chemical was adding capacity to an existing plant; Robintech was increasing an existing plant's capacity by two-thirds; Shintech was expanding a plant by 50 percent; and Continental Oil was adding on to an existing plant.[55]

Even Firestone, which less than two years earlier had said the vinyl chloride rule would force it out of the plastics industry, announced plans to bring a new PVC plant online by mid-1979 that would more than triple its manufacturing capacity.[56]

"Clearly, those actions signify U.S. vinyl producers' confidence that they have solved the 'OSHA problem' that threatened the viability of their industry less than two years ago," *Chemical Week* wrote.[57]

The planned increases in capacity would supplement an already booming business. PVC shipments in the first half of 1976 were up nearly 52 percent over the previous year, according to the plastic industry's trade association.[58]

> The technological advances the rule inspired "enhanced manufacturing productivity, eliminated the need for manual reactor cleaning…and provided a new source of income to the technology's developers."
> —*Congressional Office of Technology Management (1995)*

Even as a recession loomed in the late-1970s, the PVC industry continued to roar. "Producers of polyvinyl chloride are so convinced of the plastic resin's potential that they're scurrying with expansion plans, at the onset of a recession," began an August 1979 *Wall Street Journal* article.[59]

The *Journal* article ticked off a series of recently announced expansion plans. As demand for PVC was leveling off in some markets, new uses for the product were being developed, such as making window frames and creating automobile coatings.[60]

A 1995 report on OSHA rules by Congress's Office of Technology Management found that actual costs to implement the vinyl chloride rule were at most $278 million, compared to OSHA's $1 billion forecast. But, the OTA wrote, the technological advances the rule inspired "enhanced manufacturing productivity, allowed better rationalization of material inputs, largely eliminated the need for manual reactor cleaning…and provided a new source of income to the technology's developers through licensing arrangements."[61]

In 1997, the Centers for Disease Control reported that the 1 ppm standard for exposure to vinyl chloride in the workplace was "readily achieved" and that "new cases of hepatic angiosarcoma in vinyl chloride polymerization workers have been virtually eliminated."[62]

Preventing Ozone-Destroying CFC Emissions from Aerosols

The Problem

First developed in the 1920s by the U.S Department of Agriculture for use as a refrigerant, chlorofluorocarbons, or CFCs, became the preferred substance for use in aerosol cans due to their ability to convert easily between liquid and gas states.[63]

DuPont Corp., the world's largest manufacturer of CFCs, spent an average of nearly $1 million a year from 1972 to 1982 to challenge the findings that CFCs were depleting the ozone layer.

But a groundbreaking 1974 study demonstrated the ability of CFCs to break down ozone. Evidence showed that CFCs were diffusing slowly into the stratosphere and depleting the ozone layer, exposing people to more ultra-violet (UV) radiation, thus increasing the risk of skin cancer. Excessive UV radiation also contributes to the greenhouse effect and harms the earth's vegetation and animal life.[64] About half of CFC emissions in the United States in the early 1970s came from aerosols.[65]

The Regulatory Response

In 1977, the EPA, the Consumer Product Safety Commission and the Food and Drug Administration called for phasing out almost all use of CFCs in aerosol propellants.[66]

The Resistance

Industry preferred to use CFC aerosol propellants because they were non-flammable and produced a fine spray. After 1974, in anticipation of a CFC ban, aerosol manufacturers began looking for alternatives.[67] Still, industry denied the scientific premise for the CFC ban. DuPont Corp., the world's largest manufacturer of CFCs, spent an average of nearly $1 million a year from 1972 to 1982 to challenge the findings that CFCs were depleting the ozone layer.[68]

DuPont, with funding from the Chemical Manufacturers Association, also created the Fluorocarbon Program Panel and, later, the Alliance for Responsible CFC Policy to dispute theories that CFCs harmed the environment.

> "Had the controversy not arisen, and this development had come along, it would have wiped out fluorocarbons anyway."
>
> *—Robert H. Abplanalp, inventor of original aerosol on his subsequent invention of a non-CFC aerosol*

A separate industry group hired Dr. Joyce Brothers, a well-known psychologist, to lead a campaign against anti-CFC news.[69] *Aerosol Age*, an industry trade publication, argued "the chlorine-ozone hypothesis is purely speculative at this time with no concrete evidence having been developed to support it."[70]

Industry also criticized the EPA's proposed timeline for phasing out aerosols. "Finding a substitute for chlorofluorocarbons has not been easy," *Newsweek* wrote in summary of industry's comments. "No single alternative possesses their combination of chemical inertness, non-flammability, fast-drying spray and efficiency in ejecting the entire contents of a can."[71]

In 1976, *Chemical Week* asked, "Will consumers abandon the aerosol package completely, or will alternative propellant systems be acceptable?"

The Results

On May 14, 1977, just one day after the issuance of a federal regulation declaring CFC propellants an environmental hazard and ordering them to be phased out, the inventor of the original aerosol valve announced that he had the solved the problem. Robert H. Abplanalp said he had developed an aerosol system with a non-CFC propellant that worked better than existing systems.

"Had the controversy not arisen, and this development had come along, it would have wiped out fluorocarbons anyway," said Abplanalp.[72]

While the new system "was perhaps developed in response to government regulation," said Abplanalp, a skeptic of the allegations surrounding CFCs, "this is one of the few times that consumers won't have to foot the bill."

> "Doomsayers were ready to write their obituary, and many consumers think they have been banned. But far from being dead or banned, aerosols are making a comeback."
>
> —*Chemical Week (1979)*

Abplanalp's innovation was advantageous because it used a 6:1 product-to-propellant ratio, in contrast to the 1:1 ratio in conventional aerosol applications.[73] It also included a new valve that did not clog as easily and permitted users to fine-tune the spray.

Within two years of the announcement of the rule to ban CFCs in aerosols, CFCs were being used in less than 3 percent of all aerosols.[74] The industry, having suffered from a wave of bad publicity in the middle of the decade, experienced a resurgence.

"Doomsayers were ready to write their obituary, and many consumers think they have been banned. But far from being dead or banned, aerosols are making a comeback," *Chemical Week* wrote.[75]

"Marketers are talking about new-product introductions," said the aerosols development director at Phillips Chemicals. "Aerosols in the homes are no longer hidden under the sink. People do not feel guilty when they buy aerosols."[76]

The crackdown on CFCs, both worldwide and in the United States, continued with increasing urgency, especially with the discovery in the mid-1980s of a substantial hole in the ozone layer over Antarctica, for which CFCs were blamed. Eventually, a worldwide ban was imposed against CFC use in air conditioners, refrigerators and electrical cleaning supplies. By 2005, scientists reported that the ozone layer was recovering.[77]

Improving Home Appliance Efficiency

The Problem

Residential buildings account for more than 20 percent of the nation's energy consumption.[78] Historically, the refrigerators, air conditioners, furnaces and other appliances that burn that energy were not nearly as efficient as possible.

"What our competitors have been unable to do—namely, put us out of business—it now appears that our government will do."

—President of air conditioner maker Marvair Co.(1981). Today, Marvair boasts of a patent for technology to yield "substantial energy savings" in air conditioners.

Their waste has cost consumers billions of dollars in increased energy bills, while poisoning the atmosphere with extra pollution from unnecessary energy generation.

The Regulatory Response

The Energy Policy and Conservation Act of 1975 established test procedures, targets and labeling requirements for household appliances. The National Energy Act of 1978 instructed the DOE to set efficiency standards for 13 appliances. But President Reagan halted the drafting of regulations shortly after his inauguration in 1981,[79] putting the federal appliance efficiency program on hold for the better part of a decade.

Amid the Reagan administration's hands-off approach to efficiency standards, many states issued their own rules. This eventually convinced industry to lobby for uniform federal standards.[80]

After being rebuffed by a presidential veto in 1986, Congress in 1987 assembled a veto-proof majority to pass a law setting deadlines to enact efficiency standards for most new home appliances.[81] Subsequent efficiency laws required creation of standards for commercial and industrial products. The energy efficiency program now covers products responsible for 82 percent of residential building energy use, 67 percent of commercial building energy use, and about half of industrial energy use.[82]

The Resistance

When the first standards were being drafted in the late 1970s and early 1980s, small businesses predicted that they would suffer dire consequences.

> The bill "intrudes unduly on the free market, limits the freedom of choice available to consumers who would be denied the opportunity to purchase low-cost appliances and constitutes a substantial intrusion into traditional state responsibilities and prerogatives."
>
> *—President Reagan, statement accompanying veto of appliance efficiency law (1986)*

"What our competitors have been unable to do—namely, put us out of business—it now appears that our government will do," the president of air conditioner maker Marvair Co. said in 1981. A report published in the early 1980s estimated that requirements to verify that appliances met the standards would put 65 percent of small-businesses manufacturers at risk of bankruptcy.[83]

Meanwhile, larger manufacturers and their trade associations expressed general opposition to the program and warned that instituting efficiency standards might spell the end of familiar products such as self-cleaning ovens, automatically defrosting refrigerators and portable air conditioners.[84] But the manufacturers' opposition began to wane by the mid-1980s.

Much of the strident opposition to federal efficiency standards came from the political sector. For example, the Reagan administration said the initial wave of proposed standards "would impose massive regulatory burdens on the private sector."[85] Later, in a statement accompanying his veto of the 1986 standards-setting bill, Reagan said the "bill intrudes unduly on the free market, limits the freedom of choice available to consumers who would be denied the opportunity to purchase low-cost appliances and constitutes a substantial intrusion into traditional state responsibilities and prerogatives."[86]

In the mid-1990s, the newly elected Republican Congress targeted efficiency standards as part of an overall assault on federal regulations.[87] In the 2000s, President George W. Bush's administration also slowed the issuance of new standards, prompting a lawsuit from 14 states and other parties. The Department of Energy settled the case in 2006 by entering into a

consent decree in which it agreed to publish standards for 22 product categories.[88]

The Results

Despite the halting progress of the program, federal energy efficiency standards have been an unqualified success. Appliances have become dramatically more efficient, their costs have steadily dropped, and industry now stands in alliance with the DOE and consumer environmental groups in touting the accomplishments of the standards.

Consider refrigerators, which consume about one-sixth of the electricity in a typical house, more than any other item.[89] An average-sized refrigerator from the 1980s would cost about $190 a year to run at today's electricity prices. Refrigerators purchased today—which employ high efficiency motors and compressors, and improved heat exchangers—cost about $75 a year to operate. Standards slated to take effect in 2014 will improve refrigerator efficiency by additional 15 percent.[90]

If refrigerator energy use had continued on the trajectory it was on when the first efficiency standards were implemented, the nation would be consuming an extra 160 gigawatts a year just to keep its refrigerators running, according to David Goldstein, who in 2002 received a MacArthur fellowship for spearheading the effort to develop super-efficient refrigerators. The annual savings from more efficient refrigerators alone exceeds the entire amount of electricity generated by the United States' nuclear power plants.[91]

But the tremendous advances in refrigerator efficiency have not driven up prices. In January 1987, before the efficiency standards took effect, an 18 cubic foot Kenmore refrigerator cost just under $500,[92] or $994 in 2011 dollars.[93] In August 2011, Sears was selling an 18.2 cubic foot Kenmore refrigerator for $424, less than half the inflation-adjusted cost of a comparable model from the pre-standards era.[94]

A refrigerator purchased in 1980 consumed an average of $182 a year in electricity, while today's models cost $75 a year to operate. But today's refrigerators cost less than half the 1987 inflation-adjusted price.

Likewise, clothes washers' energy consumption declined 63 percent from just 2000 to 2006, while dishwashers' water and electricity consumption were both down by about 30 percent over the same time period, according to the Association of Home Appliance Manufactures.[95] The DOE reports that central air conditioners are 30 to 50 percent more efficient than in the mid-1970s, and 20 to 40 percent more efficient than models sold just 10 years ago.[96] Window-unit air conditioners use only half as much energy as those made in the 1970s.[97]

As with refrigerators, most appliances regulated by federal standards cost much less than they did before the standards were implemented. For example, a 2005 study published by the DOE's Lawrence Berkeley National Laboratories found that the inflation-adjusted prices of freezers, room air conditioners and clothes washers all dropped by well over 40 percent between 1985 and 2002.[98]

More advances are on the way. Appliance manufacturers have agreed to standards to reduce front-loading washers' water and energy use by about 50 percent by 2015; room air conditioners will be at least 10 percent more efficient by 2014; and dishwashers will use nearly 15 percent less electricity and 25 percent less water by 2015.[99]

Standards do not deserve all of the credit for improving efficiency. Industry generally improves product performance over time, and demand for more efficient products has increased. Other government programs—such as research and development investments, the mandatory placement of energy consumption labels on appliances, and the incentives in the DOE's voluntary Energy Star program—all have contributed to improving the efficiency of appliances.

But standards have played a key role, both in prodding manufacturers to continue to improve the efficiency of their products and in ensuring that developers install highly efficient products in new buildings. For example, air conditioner maker Carrier Corp. once pointed out that contractors usually choose to install cheaper, less energy-efficient systems, leaving the buyer with the high utility bills.[100] Federal regulation ensures that inefficient products are not available for sale—to consumers or contractors.

The Lawrence Berkeley National Laboratories credits efficiency standards with saving American consumers $64 billion from 1987 to 2005, and forecasts that the standards will save consumers $241 billion through 2030.[101]

Meanwhile, Marvair Co., the air conditioner maker that once claimed federal energy standards would push it out of business, boasted in 2011 that the U.S. Patent and Trademark Office has accepted its patent application for an air conditioning system that achieves "substantial energy savings."[102]

Conclusion

This chapter illustrates a common cycle surrounding regulation. Industry typically first says that proposed solutions to generally recognized problems are too expensive—or even impossible—to meet. After the regulation takes effect, industry invariably develops a solution at far less cost than expected. By then, the once-heated controversy is all but forgotten, and both industry and the public quietly benefit from improved products or processes.

This cycle is instructive in light of the philosophical debate over regulations that permeates American politics today. If today's anti-regulatory ideologues prevailed when the issues in this report were being discussed, it is doubtful that the industries would have been pushed to develop the solutions that they eventually achieved.