UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON ENERGY AND COMMERCE

SUBCOMMITTEE ON ENERGY AND AIR QUALITY
HONORABLE RICK BOUCHER, CHAIRMAN

HEARING:
"ACHIEVING - AT LONG LAST –
APPLIANCE EFFICIENCY STANDARDS"
May 1, 2007
10:00 a.m.
2322 Rayburn House Office Building

TESTIMONY OF ARTHUR H. ROSENFELD, Ph.D.
COMMISSIONER
CALIFORNIA ENERGY COMMISSION

TO OBTAIN CRUCIAL IMPROVEMENTS
IN APPLIANCE EFFICIENCY STANDARDS,
FEDERAL APPLIANCE LAW MUST BE CHANGED,
AND THE ACTIVITIES
OF THE DEPARTMENT OF ENERGY
MUST BE IMPROVED

Introduction and Summary

Chairman Boucher, Ranking Member Hastert, Members of the Subcommittee, Ladies and Gentlemen:

Thank you for the opportunity to be here today.

First, I want to give a brief overview of the under-appreciated importance of efficiency to the economy in terms of energy and dollar savings. The first figure in Appendix B shows the downward trend in energy intensity going back to 1949, and highlights the change that occurred following the 1973 oil embargo. Before 1973 energy intensity, measured in terms of energy per dollar of GDP, was improving at a rate of about 0.4% per year—which reflects the fact that technology has been improving and is incorporated into the economy. However, the 1973 oil crisis both raised prices and motivated us to create energy policies like CAFÉ that saved a lot of energy, and the rate of energy intensity improvement has increased to 2.1% per year.

The second figure shows what this change meant in terms of energy. The blue line is reality; i.e., after 1973 physical energy supply increased from 75 Quads per year to 100 Quads. The red line shows that if the rate of efficiency improvement had stayed at 0.4%, physical energy supply would have been 175 Quads. This means that since 1973 we added 25 Quads of physical energy, and 75 Quads of efficiency, so efficiency met 75% of our new energy needs. It also means that our energy bill, which is now about $1.0 trillion per year, would be been $1.7 trillion, or $700 billion per year higher than it is today.

The third figure shows what California achieved over a similar period, compared to the U.S. as a whole, in terms of electricity use per person. You can see that both the U.S. and California were increasing at about 4% per year—and that California is slightly lower due to our milder climate. But in 1973 California's electricity use per person becomes flat, while the U.S. continues to grow at about 2% per year. The result is that California's electricity use per person is about one-half that of the U.S. If California had continued to grow at the U.S. rate, the light blue wedge shows that our electricity use would be 50% higher. Even though California's electricity prices are higher than the U.S. average price, bill savings from this 50% avoided use, in 2005, were $165 per person, so, for 36 million Californians, over $5 billion per year, a good stimulus to the California economy.

The fourth figure shows electricity savings attributed to our three major efficiency initiatives: utility funded programs, and efficiency standards for buildings

and appliances (both federal and state appliance standards). Based on our detailed analysis of changes in end-use efficiency, utility programs are responsible for about one-half of the savings, and building and appliance standards split the remaining half equally. This concludes my pep-talk on the importance of efficiency in general and of standards in particular.

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Since 1987, when NAECA was enacted, DOE has been charged with implementing the most important appliance efficiency law in the world, a law in which Congress, with great foresight, established a foundation of energy efficiency for a few basic appliances and then told DOE to build great things. Unfortunately, the law has failed to achieve anything near its promise, in part because of DOE's failures, but also partly because of flaws in the statute. DOE has massively failed to improve the efficiencies of appliances on a nationwide basis, and the law, with DOE's support, has been a roadblock to the states' efforts to fill the gap the DOE has left.

This testimony describes needed changes in the law and needed changes at DOE. To summarize, they are:

I. <u>Changes in the Statute</u>

A. Adoption of Standards:

1. Simplify the rulemaking process – eliminate the ANOPR, reduce the required complexity of analysis; eliminate or streamline OMB review.

2. Establish meaningful deadlines for standards updates: if DOE misses a deadline, preemption of state standards for that appliance ends immediately.

3. Clarify that DOE has broader authority than it has interpreted:

a. DOE can establish different standards for different regions, based on, e.g., climate differences.

b. DOE can regulate all aspects of an appliance.

4. Standards adopted by DOE with a sound analytic basis, achieving the maximum improvement in energy efficiency that is

technologically feasible and economically justified, are preferable to negotiated standards without such a basis.

B. Preemption of state standards:

1. Revise the current disproportionate criteria for preemption waivers, and allow a state standard to take effect if the benefits of the standard exceed the burdens.

2. Allow states to base their performance-based building codes on heating, cooling, and water heating appliances that exceed the federal minimum standards.

3. Allow states to regulate aspects of covered appliances that DOE has not regulated.

4. Establish that preemption takes effect only upon the effective date of a federal efficiency standard.

C. Enforcement:

1. Direct DOE to implement a thorough, vigorous, and meaningful enforcement program.

2. Let states enforce the federal efficiency standards.

We are eager to work with this Subcommittee, DOE, and stakeholders to craft the statutory language needed to make these important changes.

II. Changes at DOE

Congress needs to ensure that the Administration and DOE will:

A. Hire more staff.

B. Create a culture of commitment and enthusiasm for energy efficiency.

I also want to take advantage of my appearance to praise the EnergyStar program, which of course is a key market mechanism that goes beyond codes and standards. In California, state and local governments, utilities, and many others use EnergyStar to help customers find and invest in energy-efficient products and services that pay back within a few short years – a big win for everyone. I encourage you to keep this very successful program focused on its important role of identifying highly cost-effective products that go beyond standards, and to maintain its funding.

I. Changes in the Statute

Although EPCA has produced some efficiency gains, much more could be accomplished. There are three areas in which improvement is needed: adoption of federal standards, preemption of state standards, and enforcement.

A. Adoption of Standards.

1. Simplify the rulemaking process

Rulemaking at DOE is a long, complicated process – too long and too complicated. Since 2001 California has adopted efficiency standards (along with test methods, data-submittal rules, and labeling requirements) for 44 appliances – in proceedings subject to a statute much like the federal Administrative Procedure Act and with post-adoption review by a control agency (as DOE's regulations as subject to post-adoption review by OMB). During the same period (since 2001), DOE adopted no standards for appliances, other than codify the standards that were enacted by Congress in the Energy Policy Act of 2005. Note that the EPAct 2005 standards were largely based on standards that had been developed and adopted by the California Energy Commission.

The problems are threefold. First, DOE begins its rulemakings with the publication of an Advanced Notice of Proposed Rulemaking (ANOPR), which is subject to public comment; then DOE publishes a Notice of Proposed Rulemaking (NOPR), which is also subject to public comment. This is unnecessary; the ANOPR should be eliminated.

Second, DOE has subjected itself to an extraordinarily complex and detailed technical analysis through its "Process Rule." I am hesitant to criticize DOE on this point, because a thorough analysis, based on appropriate methodologies, data, and

assumptions, must be the basis of any regulation. But DOE's approach often goes too far, appearing to seek the very last bit of data, or the ultimate in precision, even where clear answers can be obtained with a minimum of inquiry: paralysis by analysis. Sometimes exhaustive scrutiny is necessary – for example, if the cost-effectiveness of a proposed standard is a close question. But if, say, under all reasonable assumptions a standard has a payback of two to five years, and the appliance has a lifetime of ten years, additional work does nothing but waste time. The Process Rule should be eliminated or substantially changed.

Third, OMB's review often creates long delays. OMB should be subject to strict deadlines (with perhaps a short, one-time extension), and if the agency fails to reach a decision on time, approval should occur by operation of law.

2. Establish meaningful deadlines for standards updates: if DOE misses a deadline, preemption of state standards for that appliance ends immediately.

The recent case of *New York v. Bodman* highlighted DOE's utter failure to meet EPCA's deadlines for updating the efficiency standards according to the schedules established by Congress. Although DOE is now subject to a court order requiring updates on a reasonable schedule, which means, at least in theory, that DOE can be held in contempt of court if it does not meet the deadlines, that consequence cannot make up for the loss of energy savings that inevitably results if DOE fails to act on time. Congress should ensure that efficiency gains foregone if DOE fails to meet the deadlines (which should be established in terms of the effective dates of updates, not merely DOE's own action.) The most simple and most effective way to accomplish this is to end preemption of state standards for an appliance if DOE misses the update deadline for that appliance. That way, a state could adopt a standard in advance, but the standard would not take effect unless it was needed to fill a vacuum left by DOE inaction. (Appropriate statutory drafting could ensure that manufacturers would not be subject to multiple, conflicting state standards.)

3. Clarify that DOE has broader authority than it has interpreted.

Several opportunities for major energy (and water) savings have been lost because DOE has interpreted EPCA in an unnecessarily crabbed, narrow fashion. Congress should make several points clear.

a. DOE can establish different standards for different regions, based on, e.g., climate differences.

A key barrier in setting efficiency standards for space heating and cooling appliances has been DOE's position that Congress intended to prohibit the agency from adopting standards the reflect the conditions in the country's different climate zones. This meant that DOE was forced to adopt space conditioning standards based on "average" weather that ignored climates that were hot or cold. Fortunately DOE has recently indicated that it is open to the idea that heating appliances should be more efficient in northern climates, so as to effectively break the U.S. into **two** climates for heating.

In Appendix C, I explain why it is imperative, for cooling, to define **three** zones—hot/dry, hot/humid, and cool. To solidify the case for multiple climate zones, EPCA should be amended to clarify that DOE can adopt regional standards where appropriate, and where undue disruptions to the industry can be avoided.

b. DOE can regulate all aspects of an appliance.

Many appliances have more than one efficiency attribute. Several, for example, use both energy and water (e.g., clothes washers, dishwashers), and DOE should be able to establish both energy efficiency and water efficiency requirements for them. Still others use both natural gas and electricity (e.g., heating equipment that burns natural gas to produce heat and consumes electricity to power components). Some use only one type of energy, but have more than one important measure of energy efficiency (e.g., central air conditioners can be rated in terms of EER (Energy Efficiency Ratio) which depends on the actual outdoor temperature, or SEER (Seasonal EER) which is EER measured at a single seasonal average temperature, which, for the U.S. as a whole, for the cooling season, is about 82 degrees F). Finally, some appliances have several important energy-using components (e.g., to continue with air conditioners, electricity may be used to run the condenser, fans, motors, blowers, air handlers, and the like; in addition, components such as thermal expansion valves (TXVs) may be cost-effective efficiency improvements).

But DOE says it cannot take a thorough approach to energy efficiency. Instead, it has generally interpreted EPCA as prohibiting the adoption of more than one standard for an appliance. There is little justification for this in the statute, and none whatsoever in intelligent energy (and water) policy. If a standard is cost-effective and technically feasible, DOE should adopt it. Thus Congress should make clear that DOE has, and should exercise, the authority to:

establish both water and energy efficiency standards for the same appliance;

adopt different energy (or water) metrics for the same appliance (e.g., EER and SEER for air conditioners);

regulate all energy-or water-using components within a regulated appliances; and

require prescriptive components in any appliance.

A closely related matter is the states' authority to regulate where DOE has been active. Please see part I.B.3. of this Testimony, below.

4. Standards adopted by DOE with a sound analytic basis, achieving the maximum improvement in energy efficiency that is technologically feasible and economically justified, are preferable to negotiated standards without such a basis.

The most important of the federal appliance laws, the National Appliance Energy Conservation Act of 1987 (NAECA), was the result of extensive negotiations among states, efficiency advocates, and industry. Since then, there have been periodic negotiations resulting in changes to the law or to DOE's regulations, and this activity has increased in the past several years. This is good, yes – all sides on a contentious issue reaching agreement? Well, no. In general, negotiated standards have come about only because the negotiators were frustrated with DOE's long delays or were worried about what Congress might do in the absence of an agreement, and the usual result has been lowest-common-denominator standards that are much less effective than "the maximum improvement in energy efficiency [or] water efficiency [that DOE] determines is technologically feasible and economically justified." This is what the law requires, what citizens' pocketbooks want, and what the country's environmental health needs – but it far from what has resulted from negotiated standards.

Yet some stakeholders want to make negotiated standards an even more prominent feature of the regulatory landscape, by creating a streamlined rulemaking process for them. While I praise those stakeholders' tireless efforts, and while I am confident that their motives are good, I must respectfully disagree. With the changes I have outlined above – helping DOE to meet deadlines by eliminating the ANOPR, reducing complexity, and shortening or eliminating OMB review; providing an

important consequence for further delay by eliminating preemption when DOE misses deadlines); and ensuring that DOE knows that it has full authority to adopt needed standards – the DOE rulemaking process, supported by significant Congressional oversight and, if necessary, vigorous judicial review, will, I believe, produce the largest and most cost-effective efficiency gains in the least period of time.

B. Preemption of state standards.

1. Revise the current disproportionate criteria for preemption waivers, and allow a state standard to take effect if the benefits of the standard exceed the burdens.

Under current law, DOE considers three factors when deciding whether to waiver federal preemption for a state appliance standard: the state's interests in the standard, the potential burden on the national appliance industry, and the potential loss of consumer utility. This is reasonable, as far as it does; these are all important interests. What is not reasonable is that the law says that if a state standard would cause *any* "significant burden" on any aspect of the national appliance industry, or would result in the unavailability in the state of *any* appliance feature (no matter how trivial), then DOE *cannot* grant a waiver, even if the benefits of the state standard vastly outweigh the burdens. This does not make sense – why should the federal government prevent a state from taking action that is, when considering both state and national interests, beneficial? Indeed, when the courts consider, under the Commerce Clause of the U.S. Constitution, challenges to state laws that potentially burden interstate commerce, the laws are generally upheld unless "the burden on interstate commerce *clearly exceeds* the local benefits." (*Brown-Forman Distillers Corp. v. New York State Liquor Authority*, 476 U.S. 573, 579 (1986).) In essence, this is 180 degrees away from the current EPCA approach.

I propose a reasonable compromise: in considering preemption waivers, DOE should weigh the three current EPCA criteria (state interest, industry burden, consumer utility), and grant a waiver the state's interests predominate.

2. Allow states to base their performance-based building codes on heating, cooling, and water heating appliances that exceed the federal minimum standards.

For thirty years, California has led the nation in the development of flexible, "performance-based," "energy budget" building codes. Performance-based codes set

a "budget" in terms of energy use per square foot of building space, and then "authorize builders to . . . trade off the efficiencies of the various building components so long as [the] energy goal is met." (House Report on NAECA, p. 39.) Thus builders can get "extra credit" for installing equipment of more-than-minimum specifications (e.g., a highly efficient air conditioner), and then "trade off" the extra credit by using more energy in another part of the building (e.g., reducing the amount of insulation in the ceiling or increasing the number or size of windows) in a way that reduces costs or makes the building more attractive to buyers.

When NAECA was enacted, Congress appropriately recognized that such codes provide important economic incentives to builders, and that the appliance efficiency requirements in such codes tend to create a smaller burden on the appliance industry that do state standards that are applicable at the point of sale. This is in large part because manufacturers and distributors usually ship products to retail outlets before consumers buy, but they deliver to a building site only after a contractor places an order, which allows more flexibility. Unfortunately, Congress did not go far enough in responding to these facts. The major way in which EPCA treats state building codes differently from state point-of-sale standards is merely that states can enforce the *federal minimum* efficiency standards though the states' building codes (in contrast, the states cannot enforce the federal efficiency standards at the point of sale). This is a very small benefit to the states and creates no efficiency gains: the states cannot *require* equipment exceeding the minimum federal efficiency, and even flexible energy budgets must be based on minimum-efficiency equipment.

I propose a minor change to the law that will have minimal if any burdens on the industry, but will substantially increase energy (and water) efficiency while at the same time reduce the overall cost of owning and operating a home or other building. Very simply, Congress should authorize a state to base the energy budgets in a performance-based building code on appliances with more-than-federal-minimum efficiencies, if the state finds that the resulting budget is technically feasible and cost-effective, and would not cause undue burdens on interstate commerce. Note that I am not even proposing that states be allowed to *require* greater-than minimum efficiencies. I am simply saying that when a state determines that an energy budget based on, for example, a SEER 15 air conditioner, is cost-effective for its citizens, then the federal government should not stand in the way. Builders would still be free to install federal-minimum-efficiency equipment in the building; the great attractiveness of my proposal is that the people actually in the field, on the ground, would be able to choose the combination of building components (air conditioner, furnace, water heater, lighting, insulation, roofing material, windows, etc.) that is

cheapest, and thereby provide the best deal for the buyer – while providing the maximum feasible amount of energy (and water) efficiency.

3. Allow states to regulate aspects of covered appliances that DOE has not regulated.

Part I.A.3.b., of my Testimony, above, discussed the lost efficiency opportunities resulting from DOE's failure to regulate all energy- (and water-) using aspects of appliances. The corollary of my recommendation there – which was to ensure that DOE knows that it has the legal authority to do a thorough job – is to ensure that where DOE does not act, the states can. Therefore, EPCA should clarify that where, for example, DOE has established an SEER standard for an air conditioner, but has not adopted an EER standard, the states are not preempted from doing the latter.

4. Establish that preemption takes effect only upon the effective date of a federal efficiency standard.

The basic principle of preemption seems simple enough – when the federal government regulates, state standards are preempted. But EPCA establishes several different start dates for preemption, appliances have different start dates for preemption, sometimes dependent on the time of adoption by the state, sometimes on whether a standard has been established in statute or is left to DOE, and so on. These variations are unnecessary, confusing, and unjustified. Congress should enshrine the basic principle in the law.

C. Enforcement.

DOE has never had an enforcement program for the federal appliance standards, and under the current provisions of EPCA, the states cannot themselves enforce the federal standards. With billions of consumers dollars (and tons of greenhouse gas emissions) at stake, these omissions must be rectified. Congress should provide adequate funds for DOE to verify manufacturers' performance claims through independent testing, as well as to survey for non-complying appliances being offered in retail outlets – and should require DOE to report regularly to the appropriate Congressional committees to demonstrate that DOE is taking its enforcement responsibilities seriously.

II. Changes at DOE

The statutory changes I have discussed above are necessary to get the most from the federal appliance program – but they are not sufficient. DOE needs to adopt new standards, update existing standards, and launch a major enforcement program. *Many* more staff are needed, and Congress must insist that the agency be adequately funded. But even a full complement of workers is not enough, if they do not have the will and dedication to succeed. Here Congress can cajole, coax, and encourage, but it is up to the Executive Branch to create a culture of commitment and enthusiasm for energy efficiency.

APPENDIX A

BIOGRAPHY

Arthur H. Rosenfeld, Ph.D.
Commissioner
California Energy Commission

Dr. Rosenfeld received his Ph.D. in Physics in 1954 at the University of Chicago under Nobel Laureate Enrico Fermi, and then joined the Department of Physics at the University of California at Berkeley. There he joined, and eventually led, the Nobel prize-winning particle physics group of Luis Alvarez at Lawrence Berkeley National Laboratory until 1974. At that time, he changed his research focus to the efficient use of energy, formed the Center for Building Science at Lawrence Berkeley National Laboratory (LBNL), and led it until 1994.

From 1994 -1999 Dr. Rosenfeld served as Senior Advisor to the U. S. Department of Energy's Assistant Secretary for Energy Efficiency and Renewable Energy. In 2000 California Governor Gray Davis appointed him Commissioner at the California Energy Commission, and in 2005 he was re-appointed by Governor Arnold Schwarzenegger. He is responsible for the Public Interest Energy Research program, with an annual budget of $82 M; for energy efficiency, including the California energy efficiency standards for buildings and for appliances; and is the Assigned Commissioner to collaborate with the Public Utilities Commission proceeding on demand response, critical peak pricing and advanced metering, and the proceeding on energy efficiency programs, with an annual budget of $600 M.

Dr. Rosenfeld is the co-founder of the American Council for an Energy Efficiency Economy (ACEEE), and the University of California's Institute for Energy and the Environment (CIEE).

He is the author or co-author of nearly 400 refereed publications, received the Szilard Award for Physics in the Public Interest in 1986, the Carnot Award for Energy Efficiency from the U.S. Department of Energy in 1993 and the Berkeley Citation in 2001 from the University of California. He is most proud to have received the Enrico Fermi Award, the oldest and one of the most prestigious science and technology awards given by the U.S. Government. He received this prestigious award on June 21, 2006 from the Department of Energy, Secretary Samuel W. Bodman, on behalf or the president of the United States, for a lifetime of achievement ranging from pioneering scientific discoveries in experimental nuclear and particle physics to innovations in science, technology, and public policy for energy conservation that continue to benefit humanity. This award recognizes scientists of international stature for their lifetimes of exceptional achievement in the development, use, control, or production of energy. This award is particularly important to Dr. Rosenfeld because he was one of Enrico Fermi's last graduate students.

Art's website, which includes many of his talks and papers, is:

http://energy.ca.gov/commission/commissioners/rosenfeld.html

APPENDIX B

INTRODUCTORY SLIDES

The Un-Appreciated Importance of Standards

Hearing on Appliance Standards
House Committee on Energy and Commerce
May 1, 2007

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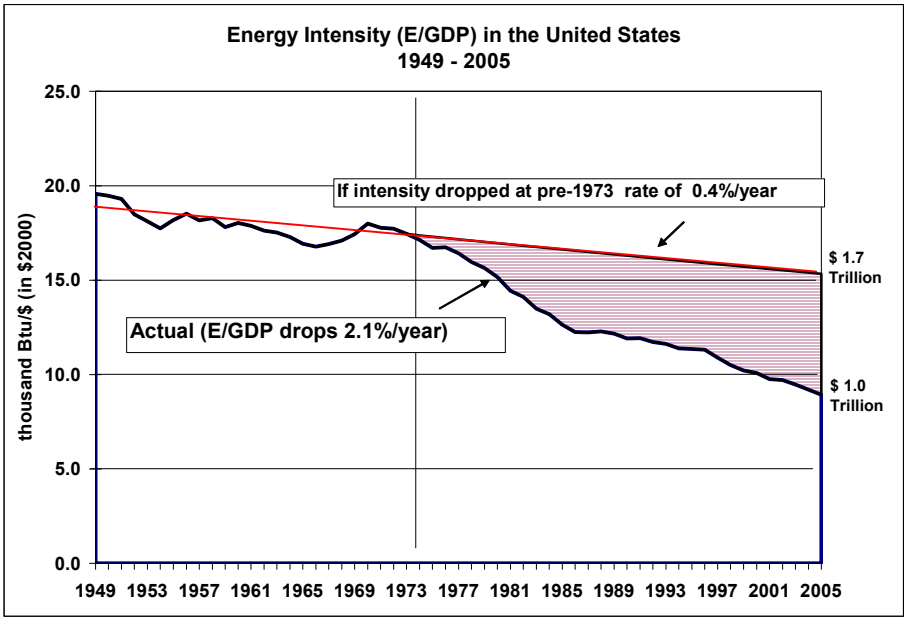
http://www.energy.ca.gov/commission/commissioners/rosenfeld.html
or just Google "Art Rosenfeld"



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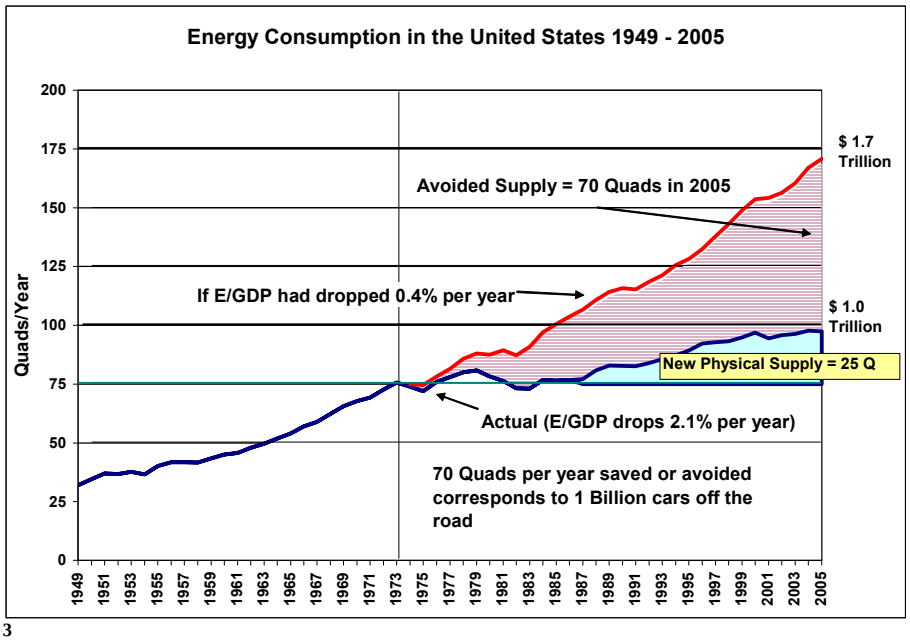
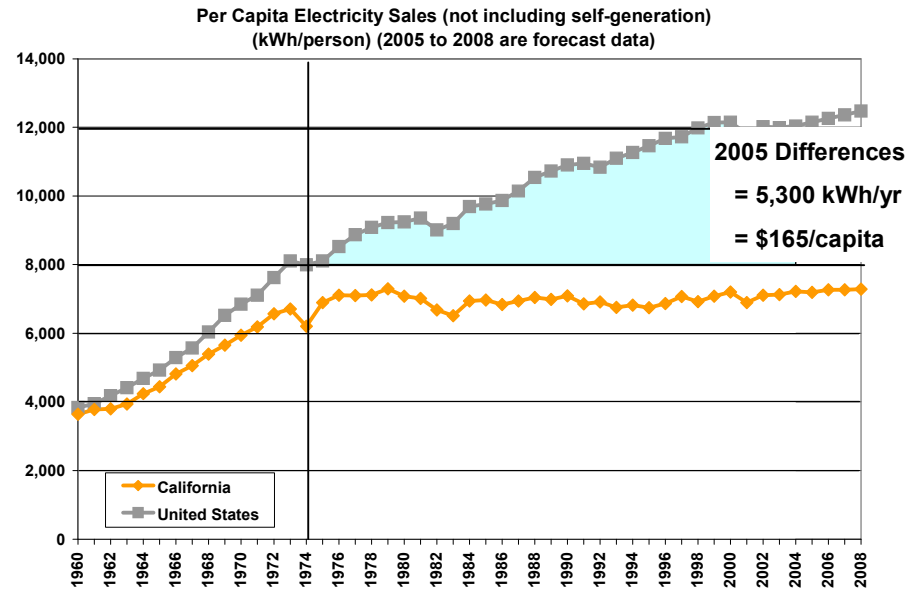

Energy Consumption in the United States 1949 - 2005
Quads/Year
200
175
150
125
100
75
50
25
0
$ 1.7 Trillion
Avoided Supply = 70 Quads in 2005
If E/GDP had dropped 0.4% per year
$ 1.0 Trillion
New Physical Supply = 25 Q
Actual (E/GDP drops 2.1% per year)
70 Quads per year saved or avoided corresponds to 1 Billion cars off the road
1949 1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005

3


Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2005 to 2008 are forecast data)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2005 Differences
= 5,300 kWh/yr
= $165/capita
California
United States
1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008

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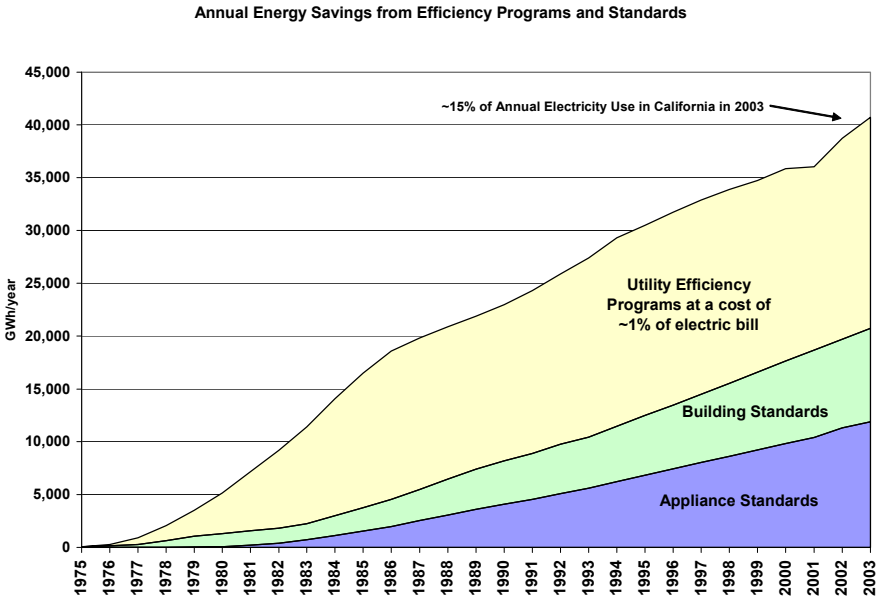

Annual Energy Savings from Efficiency Programs and Standards
GWh/year
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
~15% of Annual Electricity Use in California in 2003
Utility Efficiency Programs at a cost of ~1% of electric bill
Building Standards
Appliance Standards

5

APPENDIX C

WE NEED REGIONAL STANDARDS FOR CLIMATE-SENSITIVE APPLIANCES

Here we have an absurd situation which is a severe handicap for aggressive states like California. For its Title 24 New Building Energy Performance Standards, California has 16 climate zones; yet the entire US has only one climate zone for heating and cooling appliances

Thankfully DOE plans to grant waivers, to cold states, **for home furnaces and boilers** but that still has two defects:

1. With the cold tier removed, warm states will have to comply with a national standard which is too strict, so they also will want waivers.
2. It has been very difficult to get waivers, on any appliances, from DOE --- states should not have to put up with this waiver barrier.

It is far better just to give DOE the power to create several climate zones.

In the case of air conditioning (a/c) the minimum number of regions is not two, but three. The reason for three is that an a/c unit designed for Atlanta or Miami is different from one designed for Phoenix or the Central Valley of California. In Atlanta an a/c spends most of its time (and uses most of its energy) condensing water vapor out of damp 90 deg. F outside air. So the a/c is mainly a dehumidifier. In contrast in Phoenix it runs mainly at temperatures above 100 deg. F, so its job is merely to cool, but not dehumidify, dry outside air. So the Phoenix a/c is mainly a chiller.

Technical Note To dry air in the soggy South the cold coil of an a/c runs at ~50 F, with water dripping from it. Then when the cold damp air heats up to room temperature it is dry enough to be comfortable. In Phoenix the cold coil can run up to 10 F hotter (so up to ~60 F) and keep the room equally comfortable. The 60 F air requires slightly higher air flow (larger fan and ducts) but is thermodynamically more efficient than cooling down all the way to 50 F. Hence, for the same first cost, a Phoenix a/c system can (and should) be designed to be more efficient than its Atlanta counterpart.

At the back of this text are seven slides extracted from a longer 2005 presentation (courtesy of DOE). A series of computer runs started with the current US-wide a/c baseline (SEER 13 = Seasonal Energy Efficiency Ratio 13), which is optimized for

roughly Pennsylvania climate. The runs covered three cost-effective modifications, and calculated the gains in performance and in Simple Payback Period (SPP).

Slide 2 shows that Design 1 was simply to increase the area of the cold coil of the heat exchanger (for a retail cost of $100). Design 2 called, in addition, to a blower motor upgrade to a more efficient, variable speed, model (for #350). Let's stop with those two modifications, and see the gains in the large, hot-dry Phoenix market.

Slide 4, design 2 shows an 18% gain in annual kWh use, and a gratifying drop in peak demand of 0.75 kW (15%). Slide 6, shows a Simple Payback Period of just 3.7 years, clearly an attractive gain for hot-dry Western states.

DOE should complete this modeling experiment and come up with parameters (like SEER and EER – Seasonal Energy Efficiency Ratio, and Energy Efficiency Ratio) for three independently optimized a/c's. I'll call them ----
SEER Southeast, optimized for Atlanta climate,
SEER Southwest, for Phoenix, and
SEER North, for Chicago
Then DOE will be able to join States and Efficiency Advocates in calling for more US climate zones.

A state like California, with its 16 climate zones for building standards, would then specify SEER Southwest for its warmer zones, and SEER North for its cooler zones. Even more than three US climate zones would help a/c efficiency, but manufacturers will probably object to even three, and even more strongly to four or more.

Economic Evaluation of Residential Air Conditioner Designs for Hot and Dry Climates

Arthur Rosenfeld, California Energy Commission
Gregory Rosenquist, Lawrence Berkeley National Laboratory
C. Keith Rice, Oak Ridge National Laboratory

ARI Spring Product Section Meeting
Reston, VA. Update to April 18, 2005
(version 3.1, April 20, 2007)

ARosenfe@Energy.State.CA.US

DOE has funded research at ORNL to develop A/C designs for hot/dry climates

- Several Hot/Dry designs were developed by ORNL relative to a conventional baseline design
- Three Hot/Dry designs were adapted for economic evaluation
  - Baseline design: 13 SEER, R-410A
  - Hot/Dry designs
    - Design 1: 1.4X Evap HX surface area
    - Design 2: 1.4X Evap HX surface area; ECM Blower Motor
    - Design 3: 1.4X Evap HX surface area; ECM Blower Motor; Rated Ducts

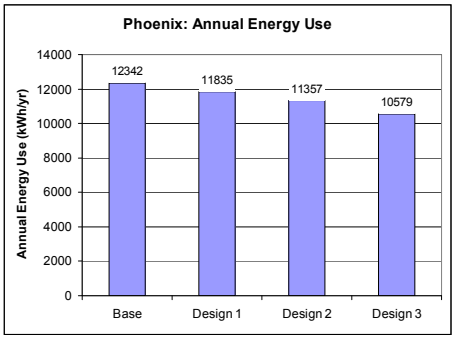
	System		Evaporator				Compressor	Ducts
Design	**SEER**	**Hot/Dry EER** Out: 115°F In: 80°F/62°F	**Face Area** *Sq.ft.*	**Flow** *CFM*	**Fan Power** 115°F; 80/62°F *Watts*	**Evap Temp** Out: 95°F In: 80°F/67°F	*Percent of Baseline Displacement*	**Type / Ext. Static** *Inches H_2O*
Baseline	13.1	7.5	5.0	1200	355	48°F	-	Typical / 0.5"@1200 CFM
Design 1	13.8	8.0	7.2	1200	330	52°F	94%	Typical / 0.5"@1200 CFM
Design 2	14.6	8.4	7.2	1200	265	52°F	91%	Typical / 0.5"@1200 CFM
Design 3	15.4	9.2	7.2	1500	250	55°F	84%	Rated / 0.15" fixed

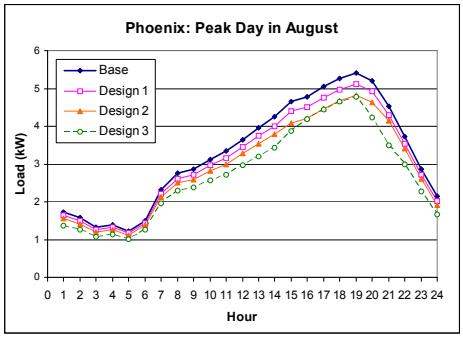
Prototypical house chosen for two hot/dry locations: Fresno, CA and Phoenix, AZ

- California prototypical house for Fresno
- Fresno house modeled in Phoenix (only weather changed)
- Both locations modeled with DOE-2
  - — Square footage: 2258 sq.ft.
  - — Number of floors: 2
  - — Floor type: Slab-on-grade
  - — Exterior wall
    - Area: 1584 sq.ft.
    - Insulation: R-13
  - — Ceiling insulation: R-30
  - — Windows
    - Area: 251 sq.ft.
    - Window-to-Wall Ratio: 16%
    - R-value: R-1.2 (double-glazing)

3

Designs yield total home annual energy and peak demand savings in Phoenix





4

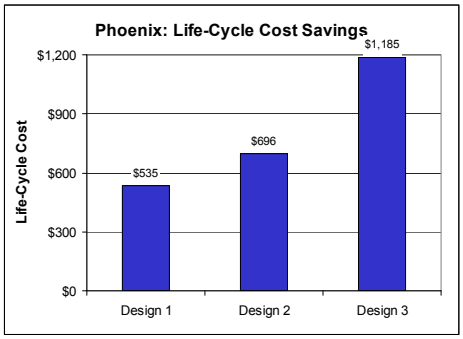
Consumer price of more efficient designs increase with efficiency

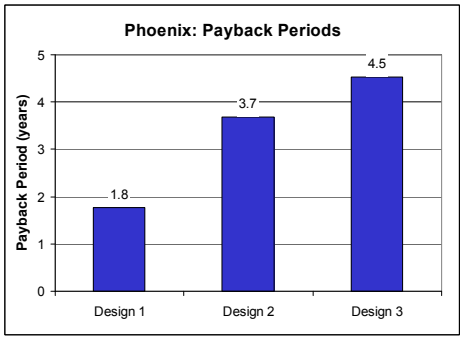
	Manufacturer Cost					Δ Consumer Price		
	Compressor	Evap Coil	Evap Motor	Total	Δ Cost	Δ Price	Δ Ducts	Δ Total
Baseline	$168	$113	$61	$342	-	-	-	-
Design 1	$158	$172	$61	$391	$49	$101	-	**$101**
Design 2	$153	$172	$185	$510	$168	$348	-	**$348**
Design 3	$141	$172	$185	$497	$155	$322	$500	**$822**

- **Manufacturer cost estimates from 2001 DOE Technical Support Document**

5

All designs provide both better LCC savings and shorter payback periods in Phoenix





6

Summary of Analysis

- All three Hot/Dry A/C designs developed by ORNL provide LCC savings and relatively short payback periods
  - — LCC savings range from:
    - ~$300 to ~$1200 based on residential electric utility tariffs
  - — Payback periods range from 2 to 7 years
  - — LCC savings and payback periods are relative to a 13 SEER baseline design
- To exploit full savings potential:
  - — Manufacturers need to offer equipment designed for Hot/Dry climates
  - — California needs to revise building standards to ensure good ducts