Changing the Efficiency in New Buildings: California's Perspective

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California is the fifth largest consumer of energy in the world, with one of the world's most diverse portfolio of electric generating systems including hydroelectric, geothermal, wind, solar, and nuclear. The key component of the California portfolio is improved energy efficiency that has reduced the State's per capita energy consumption by 15 percent since 1978 (California Energy Plan 1991). This reduction has been achieved in part by implementing demand-side management programs for new buildings and appliances.

The recent coupling of two demand-side management programs, the Energy Efficiency Standards and utility new construction programs, placed California in the forefront of statewide energy efficiency programs. This report will focus on the integration of these programs and their effects on changing the efficiency of new commercial buildings. It will include a brief discussion of the history of their programs, the tools used to implement those programs, the impediments encountered during program implementation, and their efforts at quantifying program results. See reference to figures further on that report this. The study of California's experience in integrating its demand-side management programs was undertaken to disseminate the practical knowledge gained by California during the evolution of its program.

Introduction

The National Academy of Sciences recently urged the entire country to "make conservation and efficiency the chief element in energy policy." The first efficiency recommendation was simple: "adopt nationwide energy efficient building standards." California has been in the national forefront of promoting energy efficiency and conservation for nearly two decades prior to the National Academy's findings.

California's Energy Plan lists energy efficiency and new building and appliance efficiency as its number one and number two goals. This plan, signed by the Governor in July, 1991 is the principal energy and planning document for the state.

Despite its rapidly increasing population, California has reduced its per capita energy consumption by 15% since 1978 (Goldstein 1990). This reduction has been achieved in part by implementing statewide energy efficiency standards for new buildings and appliances, and by encouraging utility-sponsored energy conservation programs.

The following discussion will identify the key elements of California's energy plan, the relationships between utility and state programs, how these programs interact, and key issues regarding the implementation of these programs.

Defining Program Savings

In order to identify the benefits associated with new programs, a common definition of savings needed to be identified (Messenger 1991.) The potential for program savings must be compared to savings that would occur in the absence of a program, savings that would be technically feasible, and the savings that are economically viable. In order to plan, implement and evaluate a program, these savings potentials must be identified.

Technical savings is an estimate of the potential energy peak savings that would result over the next 20 years from the installation of the most efficient equipment and building designs that are commercially available and technically feasible.

Maximum economic potential is an estimate of the potential energy and peak savings that could be obtained from the installation of all technologies that are cost effective from the either consumer's or society's perspective over the 20 year forecast horizon. Societies perspective is used in developing Title 24 and a consumer perspective is considered in utility incentive programs.

Achievable program savings is an estimate of the amount of peak and energy savings that could be achieved by conservation programs over the next 20 years after considering market and political barriers that may impede the attainment of maximum economic potential.

Naturally occurring energy savings are the energy savings expected to occur from conservation investments made in response to energy price increases or general technology innovations.

These definitions were developed to assist the utilities and the state in developing common terms when referring to conservation potential. California's savings potential are shown in Figure 1 (*Energy Efficiency Report* 1990).

Achievable program savings in new building efficiency programs is defined as savings potential. The role of regulatory and economic programs is to raise the achievable program savings through improved minimum standards and increase the cost-effectiveness of conservation technologies.

California's Efficiency Policies

In 1974, the California Legislature enacted the Warren-Alquist Act as the foundation for state new building efficiency. As a part of the Public Resources Code, it mandates the Energy Commission to "...prescribe, by regulation lighting, insulation, climate control system, and other building design and construction standards which increase the efficiency in the use of energy for new residential buildings"; and "...prescribe, by regulation energy conservation design standards for new residential and nonresidential buildings ... [which] shall be performance standards and shall be promulgated in terms of energy consumed per gross square foot of floor space, but may also include devices, systems, and techniques required to conserve energy"(*Public Resources Code* 1991.) These provisions form the basis for the Energy Efficiency Standard for Buildings (Title 24). The Warren-Alquist Act also contained a provision to provide funding for the formation of the California Energy Commission.

Sixteen years later, representatives of California's major energy policy stakeholders worked together with environmentalists and industry to forge a collaborative agreement to reassert California's leadership in energy efficiency. Their goal was to develop a consensus on major new energy efficiency programs and regulatory initiatives. In January, 1990 they reached an agreement titled "An Energy Efficiency Blueprint for California" that made possible the single biggest leap forward for energy efficiency in California since the formation of the California Energy Commission (CEC). The California Public Utility Commission (CPUC) was the key public agency charged by the legislature with implementing this agreement. Together, the CEC and the CPUC, are responsible for implementing the policies that change the energy efficiency in new buildings.

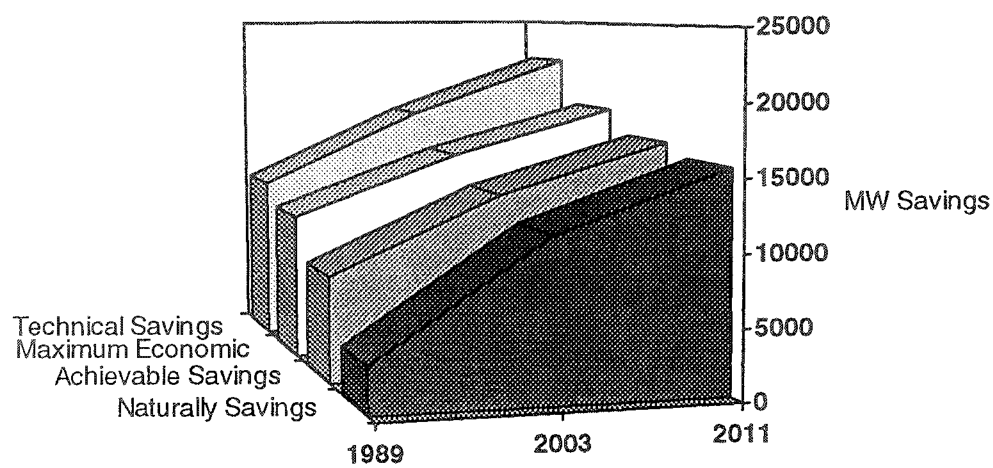

Figure 1. California DSM Potentials

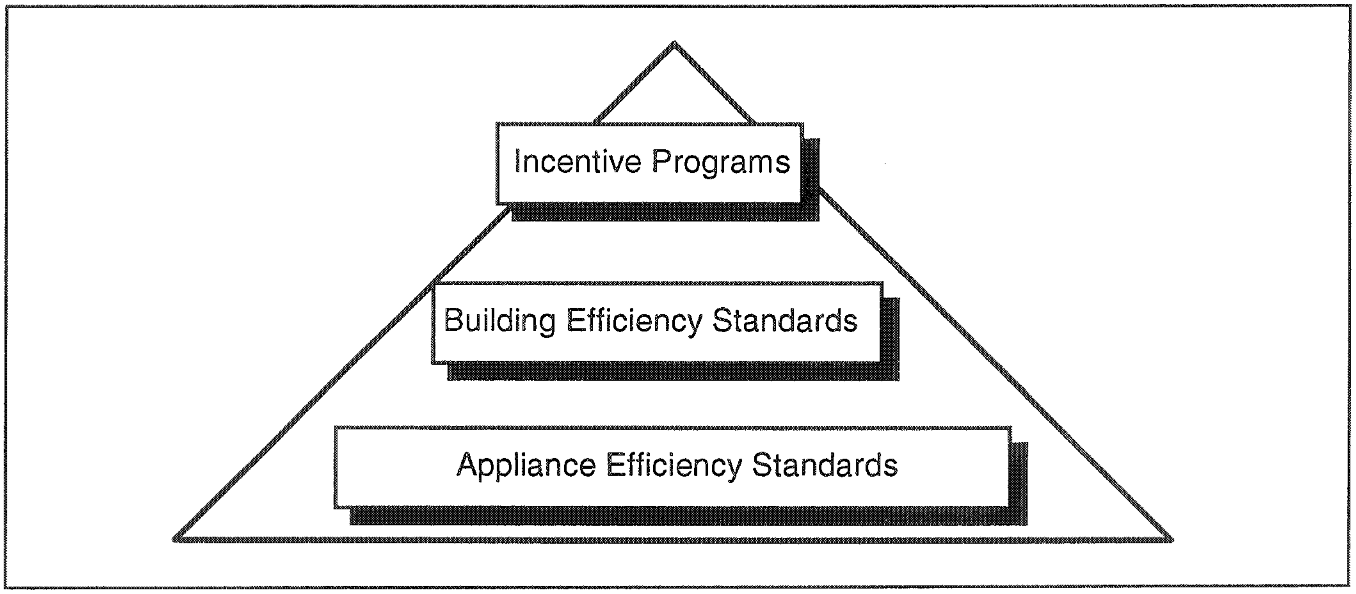

Figure 2. California's Energy Efficiency Blueprint

Regulatory Programs

The California Energy Commission rolled out its first energy efficiency code for new buildings in July, 1978. Since then the regulations have undergone numerous changes in response to new technologies and improvements in new building design. The Energy Efficiency Standards for New Buildings (Standards) cover the four major building energy components: the building envelope, the mechanical system, the water heating system, and the lighting system. They are enforced by local enforcement agencies through the building permit process. Today, these regulations are some of the most comprehensive energy regulations in the country.

The Energy Commission works with the Residential Advisory Group (RAG), the Professional Advisory Group (PAG), and the California Building Officials (CALBO) to interpret and update the regulations. The RAG consists of various members of the building community, including energy consultants, architects, contractors, and enforcement agency personnel. The PAG consists of members of the building industry including designers and architects, engineers, contractors, American Association of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and Illuminating Engineers Society (IES) representatives, trade groups, energy consultants, developers, building owners and operators, public interest groups, and enforcement agency personnel. CALBO consists of enforcement agency personnel from throughout the state.

The Standards follows a three year standard revision process that coincides with the triennial edition of the State Building Code. The Standards are based on life-cycle cost effectiveness from a societal viewpoint, using a real discount rate of 3% and the average cost of energy (Leber 1990). Time-of-use rates and demand rates are not taken into account when performing the life-cycle cost analysis.

Collaborative Process

The guidelines for developing the collaborative agreement focused on a number of issues including the program ground rules, persistence of savings, minimum performance requirements, and incentives based on measurement and evaluation. An additional goal included developing a regulatory focus for the programs (California Collaborative 1990.) All of these goals forged the basis for an integrated policy approach to new building efficiency.

One of the principles agreed to in the collaborative process was to develop a relationship between the California Energy Commission (CEC) and the state's utilities in order to capture lost opportunities in new building construction. This included having the utilities cooperate with the CEC in administering and funding demonstration projects and developing programs that reward customers and builders for going beyond the state's energy efficiency Standards for new buildings. The purpose of this was to increase the efficiency of new building stock, prevent lost opportunities in new construction, and reduce the environmental costs associated with using electricity generating facilities to meet the growth in electricity demand from new buildings.

Efficiency Programs

Efficiency programs in California consist of a variety of both regulatory and economic programs. The main regulatory program that will be discussed is Title 24. The main economic programs that will be discussed are the new construction DSM programs of the investor owned utilities.

Title 24

Title 24 applies to any new construction that requires a building permit, whether it be for an entire building or merely for adding a few lighting fixtures. The primary enforcement mechanism is through the building permitting process; until the Building Department is satisfied that the building complies with all applicable code requirements, including the energy standards, it may withhold the building permit (or, after construction, the occupancy permit).

History. In 1974, new building efficiency was identified as one of the principal regulatory focuses of energy policy. The large construction industry was perceived as an excellent target for improved efficiency. This was the beginning of the first regulatory energy efficiency program in the state, Title 24.

These Standards have evolved from a simple building envelope standard to a comprehensive Standard that covers lighting, service water heating, and space heating and cooling energy. Daylighting, recovered energy, and thermal energy storage are also recognized by the Standards. The performance methods required by the Standards use some of the most advanced methodologies in the world.

The so-called "First Generation" Title 24 Standard took effect in 1978 for all building types. That Standard remained in effect until 1987. In 1987, the Second Generation Standard took effect for office buildings. Second Generation Standards for retail and wholesale buildings took effect in July, 1988, at which time nonresidential lighting compliance requirements switched to the format of the Second Generation Standards (*Nonresidential Manual* 1992). In January, 1993, all nonresidential, high-rise residential, and hotel/motel occupancies will come under one Standard, the 1992 Energy Efficiency Standards for Nonresidential, High-Rise Residential, and Hotel/Motel Buildings (1992 Nonresidential Standards). Low-rise residential buildings will have to comply with the revised Second Generation Standards that also takes effect in January, 1993.

The 1992 Nonresidential Standard is the result of over 14 years of experience. It has an envelope, lighting and building performance methods that are being considered by ASHRAE in the development of the next version of Standard 90.1. It was developed in response to the building community's need to simplify and clarify the Standards, to improve enforcement, and to be more compatible with the building construction process.

Development. The development of energy efficiency standards is a complex public process. The building industry is one of the major industries in the state and a balance must be achieved between energy efficiency and economic development. The development of the 1992 Nonresidential Standard began at an informal meeting between industry and the Energy Commission. The PAG, CALBO and other interested parties provided feedback on the success of the Standards, implementation problems, and enforcement issues.

The development process consisted of working with the groups to achieve consensus and support for modifications to the Standards. Figure 3 depicts the various groups mentioned above that interact in the Nonresidential Standards development process.

Resolving issued identified at this meeting became the goal of the Standards revision process. These goals were developed through years of experience in trying to implement energy efficiency standards throughout the state. Additionally, they addressed the key issues that standards development must face; that efficiency only occurs if the Standards can be successfully implemented and enforced.

The objective of the design of an efficiency program is to have the achievable program savings approach the maximum economic potential. This can be accomplished by raising the minimum standard for new construction through regulation, and lowering the economic hurdle of achieving the maximum economic potential through utility incentive programs. If a balance is not struck between these two programs, the achievable savings is compromised.

If a regulation is set too tightly, tremendous pressure is placed on the structure of the standards and if loopholes exist, they will be exploited. Additionally, the building community will fight the regulation on the job site by

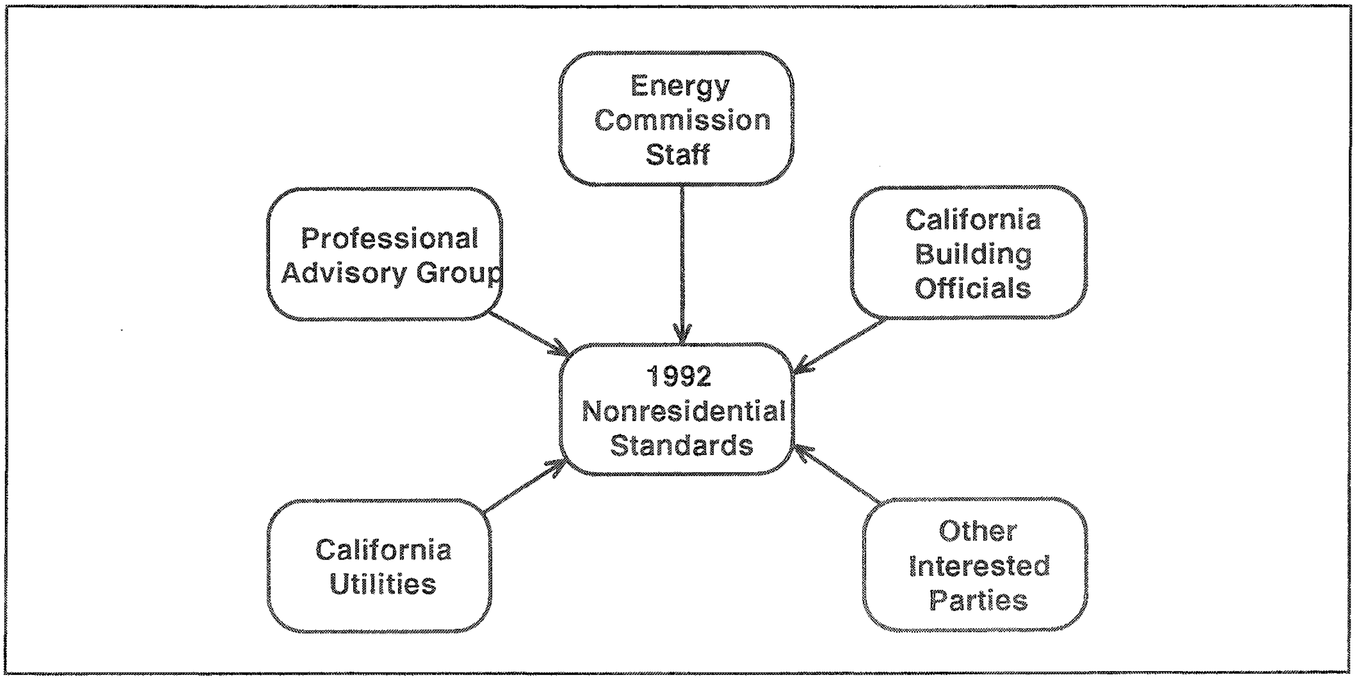

Figure 3. Parties Involved in Standards Development

trying to circumvent the standards process. This is demonstrated in Figure 4. As regulation approaches the maximum economic potential, the compliance rate drops and savings opportunities are lost.

This occurred in California with the adoption of the Second Generation Nonresidential Standard for retail buildings. These Standards were set at 80% of the maximum economic potential but only 10% of the builders complied with the standards in the first year. This produced an overall savings of only 8% of the maximum economic potential in their first year, a 22% reduction from the previous Standard (*Monitoring Report* 1989). The reason for the low savings was because the performance method was the weakest link in the standards structure. Knowledge that a loophole existed in the performance method resulted in the method being used for over 66% of the permit applications. The resulting enforcement problems (because of the performance methods weak structure) resulted in lower achievable savings.

Implementation. Implementation is a key element of achieving program savings. The structure of the Standards, or the way that it regulates buildings, is critical to the ability to implement the Standard. The key goals of the Standards implementation process are: (1) Establish a partnership between the regulatory agency and enforcement agency. The partnership must include a commitment to working together in standards development, design manual development and training; (2) Establish a feedback loop between the design, and enforcement community and the state code officials. Make consistent and timely interpretations and have a formal review process established to accomplish this; (3) Create a process that allows for exceptional methods and designs so as to encourage creativity while maintaining a minimum standard of practice.

These goals form the foundation of California's efforts to enforce the Standards. They have been developed with over thirteen years of experience working with the design and enforcement community to implement Standards.

The implementation of a standard is greatly dependent on the structure and clarity of the standard itself. In 1978, the First Generation Standards were not enforced by the building departments because they had not been trained in time. The surprising fact was that the Standard was so simple and clear that builders were installing the measures required by the standards (*Monitoring Report* 1980). In contrast, the Second Generation Nonresidential Standards were sufficiently complex that enforcement has been a major problem.

Another example of how standards structure effects implementation is through the documentation requirements. New buildings are usually built in parts; the shell or envelope, the mechanical systems, and the electrical

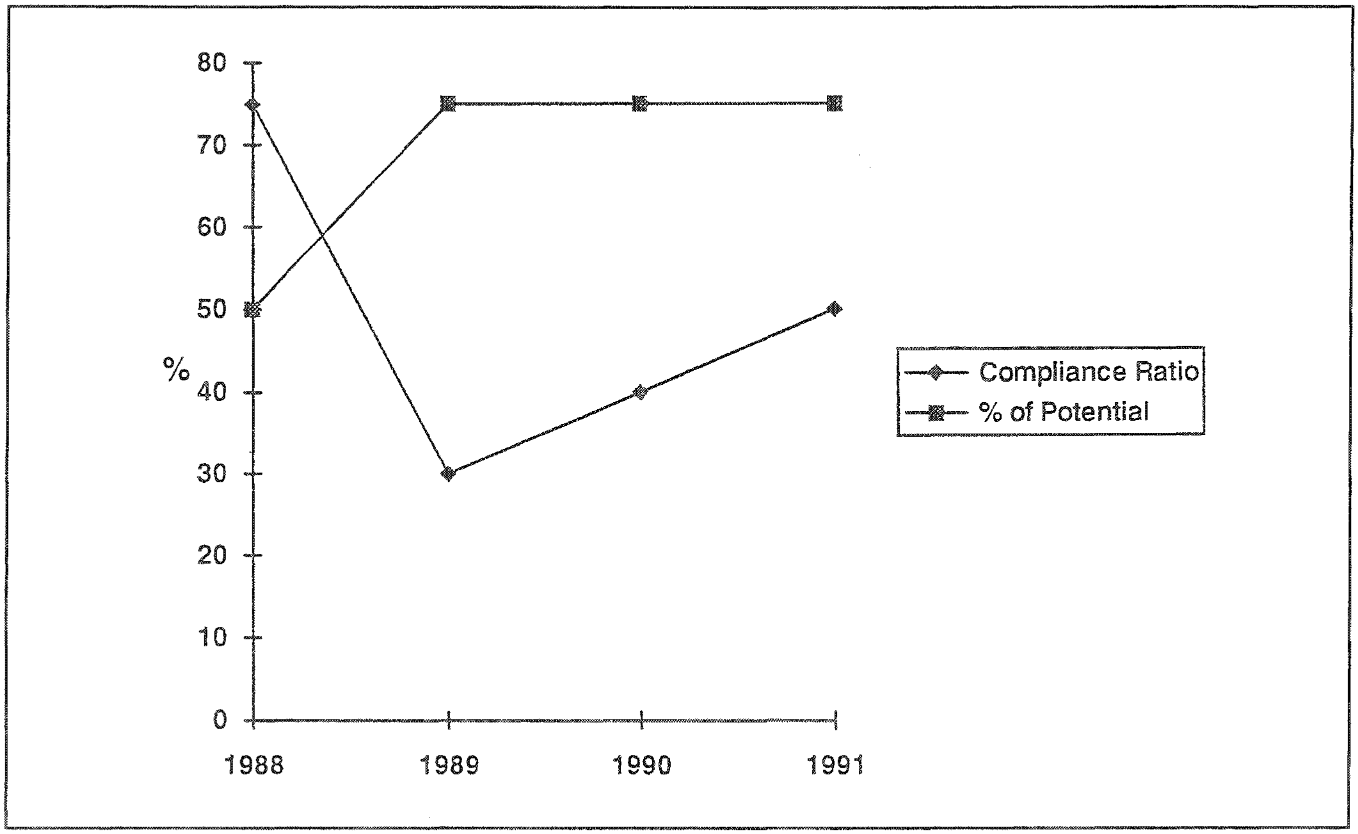

Figure 4. Compliance Ratio

systems. In order to maximize the impact of good energy design, these systems were considered as integrated components and the Standards required that when one item was considered, the others also needed to be considered. In order to keep track of this interaction, a document was created to maintain the historical record of the building's energy features. It was to be filed in the building department and when subsequent permits were sought, these requirements were to be met. This proved to be impractical because there was no way to keep track of this historical document. As a consequence, once promised efficiency measures were not required and the programs savings was reduced.

Training. Training is a critical element of implementation. California has recently teamed up with the utilities to develop training materials that can be used throughout the state to provide a consistent training program to design professionals. The California Building Codes Institute was recently established through a grant from the Legislature to provide training to CALBO members. Additional training on the Standards is provided by professional organizations including the California Association of Building Energy Consultants (CABEC). Together, these resources work with the California Energy Commission to train the designers in the state.

Training programs can help accelerate the compliance ratio, thereby increasing energy efficiency. Figure 5 depicts the impact of training and early implementation on the compliance ratio. When the Second Generation Office Standards took effect in 1987, sufficient training had been conducted by the CEC, the utilities and private sector trainers. This training resulted in an increased awareness of the changes to the Standard. Also, the utilities implemented rebate programs based on early use of the Standards for showing compliance. These standards were set at 80% of the maximum economic potential and 40% of the builders complied with the Standards in the first year. This produced an overall savings of 32% of the maximum economic potential in their first year, a 2% increase over the previous Standard (CEC 1991).

When a new regulation takes effect, there is a drop in compliance. This drop is usually takes two to three years to overcome. By providing a thorough training program, the time frame for overcoming the drop in compliance ratio is reduced, thereby increasing savings.

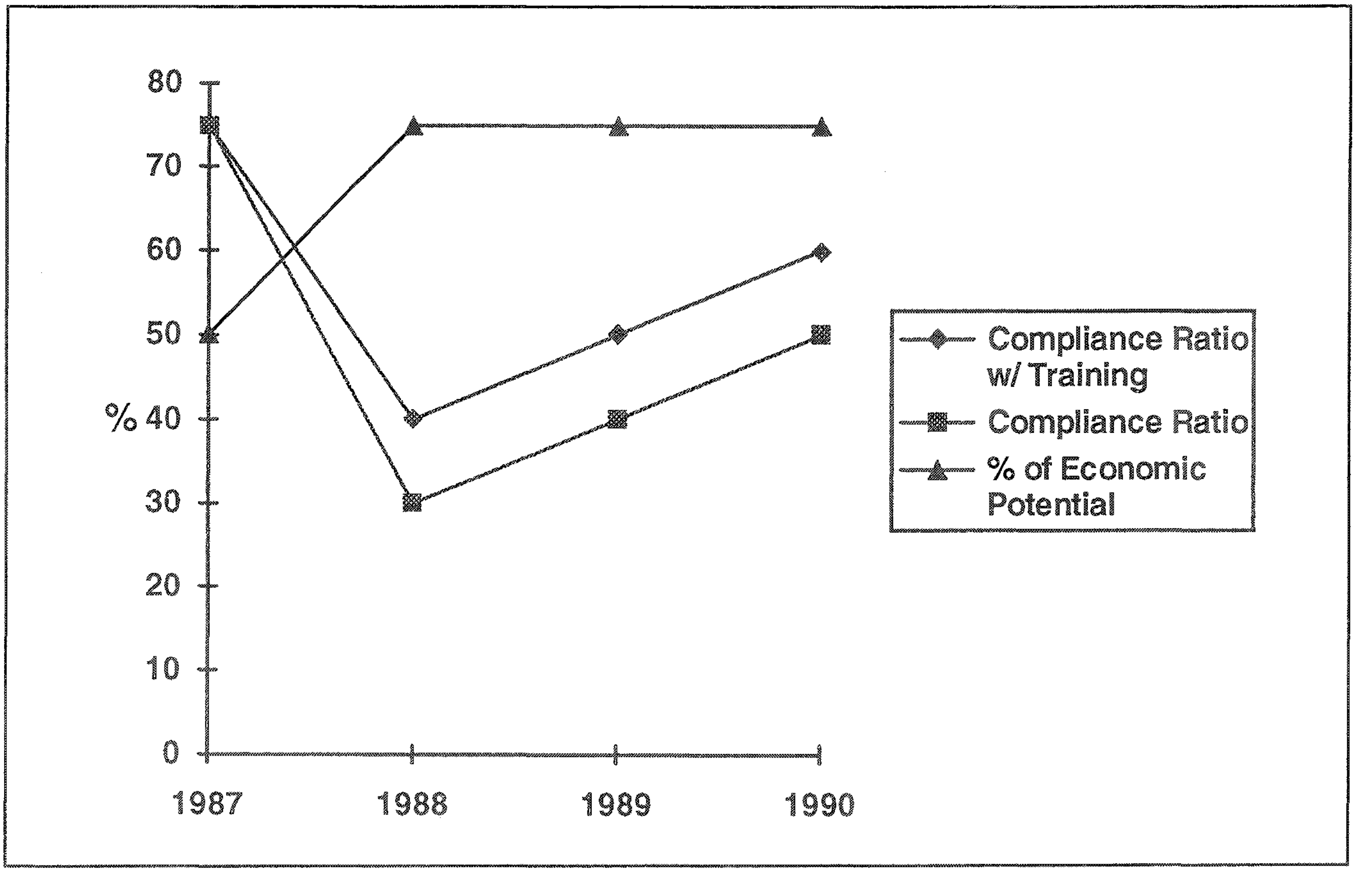

Figure 5. Training and Compliance Ratio

Enforcement. The major impediment to developing more stringent standards are is ability of the enforcement agency to enforce them. As building designers require more complex technologies to conserve energy, the ability to verify their installation is dramatically reduced. Also, when budget constraints are placed on building departments, the efforts to enforce the energy standards are usually compromised. This is especially true in light of the key role of the building official to assure the public health and welfare in buildings.

In order to ease the enforcement burden on building officials, their role in the building process needs to be identified early in the Standards development cycle. One of the guiding concepts that was used to develop the 1992 Nonresidential Standards was that of identifying Design, Plan, and Field items that are included in the Standard.

The areas where verification can be made in the inspection process is identified in Table 1. Designers can include an assumption regarding track lighting, but a length of track on the plans cannot be assigned an accurate wattage value with knowing what type of track heads will be installed. Duct sealing can be shown on the plans but is difficult to inspect because the sealant is usually covered with insulation by the time the inspector visits the job site. The equipment efficiency is even difficult to verify in the field because the make and model number usually require the removal of an access panel which adds valuable inspection time.

The key to enforcement is to focus on developing requirements that; (1) can be field checked first, (2) plan check items, and only if it is very important, (3) design items. This means that expectations are established for the enforcement community based on what can be reasonably inspected through plans examination and field verification. For example, the wattage of lamps installed in office furniture cannot be reasonably verified prior to issuing a final permit because they are an integral part of the furniture. It would be unreasonable to expect a code official to verify the watts of that equipment yet many standards require that it be included in the calculation of total actual watts. Setting expectations early helps code officials

Table 1. Design, Plan Check, Field Check

Design	Plan Check	Field Check
- Insulation	- Insulation	- Insulation
- Equipment Efficiency	- Equipment Efficiency	- Equipment Efficiency
- Glass Area	- Glass Area	- Can't Verify
- Duct Sealing	- Duct Sealing	- Can't Verify
- Track Lighting	- Can't Verify	- Can't Verify

understand their role in the inspection process and makes the Standards less frustrating to them when it is implemented.

Utility Programs

The utilities in California have been implementing new building efficiency programs for over two years. The utility programs are undergoing major revision in response to the changing Standards. This is a positive change because the same changes that make the Standards easier to implement will help improve the success of the utility programs.

The advantage to having a utility program based on an efficiency standard is that the ground rules are clearly defined. The Standards level (or exceeding the Standards) becomes the baseline for the new construction program. Program requirements only have to deal with issues related to exceeding the Standards, not establishing the baseline in the first place. The disadvantage of having a program based on the standard is that if the standard is complex and hard to enforce, the utility program must suffer the same problems. If a utility can actively assist the regulators in developing the standard, the benefits can far outweigh the costs.

This summary of utility programs in California demonstrates how some of the utilities have taken advantage of the Standards as a baseline.

Performance Programs. Performance programs are based on several ground rules which establish the broad parameters for program design and operation.

1. **Exceeding Title 24** performance requirements by at least 10%. The program participant has burden of showing Title 24 compliance.
2. **Savings** in any major end-use category: heating, lighting, etc.
3. **Incentive dollars** calculated from energy savings per year (kBtu/yr).
4. **Incentive payments** not exceeding incremental equipment cost.

The incentives agreement remains in effect for a specified period of time. Purchase and installation of equipment must be completed by the participant and verified by the utility during this time period.

In addition, some utilities support these incentives programs with a design assistance service which helps guide projects into eligibility for the incentives programs, an awards competition to recognize exceptional completed projects, and commissioning programs to assure that the buildings operate as designed.

Prescriptive Programs. The prescriptive method of demonstrating eligibility for participation in the program is incorporated into some utility programs. After it is shown that a project meets program participation guidelines by achieving a set level of energy performance which is 10% better than Title 24, incentives are then paid on a basis of dollars/unit for each energy efficient measure.

The following measures are included in the various programs:

1. Lighting
2. Daylighting and High Performance Glazing
3. Motors
   a. Energy Efficient Motors
   b. Adjustable Speed Drives

   1. Fans
   2. Pumps
4. Cooling
   a. A/C or Chillers
   b. Oversized Condensers
   c. Chiller Controls
5. Heat Recovery
   a. Passive Heat Recovery
   b. Heat Pump Water Heaters
6. Refrigeration Improvements
   a. Oversized Condensers
   b. Floating Heat Pressure
   c. Variable Speed Compressors
   d. Liquid-to-suction Heat Exchangers
   e. Multiplex Compressor Systems

Integration of Regulation and Utility Programs

A fundamental goal of the California Collaborative Process is to improve the energy efficiency of new buildings beyond the base level they would achieve absent the programs. This improvement is achieved through incentive payments from the utility to the customer to encourage efficiency improvements. When the customer can demonstrate a certain level of efficiency above the base, either directly through some measure of overall efficiency or indirectly through installation of particular technologies, the incentive is paid.

Measurement and evaluation are key aspects of providing feedback to a policy action. In new construction programs it is very important to define how the energy efficiency improvements (upon which incentive payments are based) are determined.

While simple in concept, a precise definition of improved energy efficiency for a given building project can be elusive, because it involves a comparison between the energy performance of a new building (which may not even be built yet) and the performance of a non-existent base case building. Improved energy efficiency must be calculated for each individual building project participating in the program. It can be calculated on the basis of how that individual building would have been built absent the program, or it can be calculated on the basis of how a typical building would have been built (as determined by Title 24 or by statistical methods).

The more complex the Standards requirements are, the harder it is to fully evaluate the program. Additionally, enforcement problems tend to ripple through both regulatory and utility programs. Despite these problems, proper planning and program design can achieve results.

All of the California investor owned utilities are required to use the Standards as the baseline of their demand-side management programs. Preliminary results from one utility show that over 1.4 million square feet of projects have resulted in a reduced load of over 414 kW and 2.6 million kWh in estimated energy savings in their first year of program operation. This represents a market penetration of over 20% despite depressed economic conditions in the commercial sector.

Conclusions

The development of an integrated approach between regulatory standard and utility DSM incentive programs can be a successful strategy for improving energy efficiency in new buildings. Some key goals must be set in order to assure the overall policy success. They include:

- Regulatory programs must be based on the same policy standard as economic programs;
- The achievable program savings should approach the maximum economic potential;
- Programs must have the necessary implementation tools to maximize effectiveness;
- Programs must be designed to overcome impediments to implementation; and
- Program results must have a foundation that is based on the ability to measure the results in order to facilitate the feedback of the policy.

The integration of these policy concerns coupled with a coordinated effort in program development and implementation will enable integrated new building efficiency programs to achieve their maximum potentials.

Endnotes

1. California's Energy Plan, July, 1991, California Energy Commission.
2. Warren-Alquist Act, 1974, California Energy Commission.
3. *Summary of Cost Effectiveness, Methodology and Assumptions*, March 1990, Jon Leber P.E., California Energy Commission.
4. *An Energy Efficient Blueprint for California*, January 1990, Report of the Statewide Collaborative Process.

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