Energy Codes & Standards
Time Dependent Valuation, a New Source Energy Basis

Gary Fernstrom, Pacific Gas & Electric Company
Pat Eilert, Pacific Gas & Electric Company
Doug Mahone, Heschong Mahone Group
John McHugh, Heschong Mahone Group
Brian Horii, E3
Snuller Price, E3
Dan Engel, Consultant

ABSTRACT

A new time-dependent source-energy basis for state energy codes is being considered in California. The basis of energy codes has been controversial as the building, electric, and gas industries have vied for approaches consistent with their needs, but which do not necessarily best serve the public interest. California's current code, Title 24[1], uses a "fuel neutral" source-energy budget (kBTU/sq.ft./Yr.) which is differentiated only by climate zone, building occupancy, shape, and glazing area, but which ignores time-dependent costs.

With gas and electric industry deregulation, and impending capacity concerns, it is appropriate to reexamine how Title 24 might be improved to better serve the public interest. Since building investment decision-makers are often not those paying the energy bills, there is an important public benefit associated with properly valuing in codes, energy efficiency measures which make economic sense over the long life of most buildings. Additionally, the energy savings benefits of improvements in equipment, materials, and design practices influenced by public policy energy-efficiency programs, may not be captured for society, if overall energy budgets are not appropriately lowered to reflect these improvements.

This joint Pacific Gas and Electric Company (PG&E) / California Energy Commission (CEC) project studies the opportunity to differentiate source-energy budgets by time-dependent values, including commodity cost, and time and temperature-sensitive transmission and distribution marginal cost. This methodology is sustainable and can be implemented without adding complexity to current compliance calculations. Lower utility costs for society will result by facilitating better generation, transmission, and distribution asset utilization.

Introduction

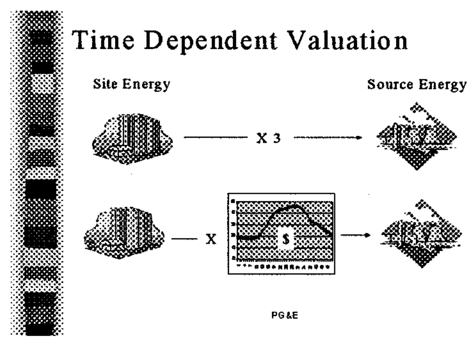
Building energy codes are intended to serve the public interest by requiring cost-effective investment in energy efficiency over the likely, 50-year life of buildings, especially where speculative developers, or owners who do not pay the utility bill, might choose to minimize initial investment in deference to higher operating cost. Such codes save energy,

[1] The California energy standards are known more formally as the Title 24 Building Energy Efficiency Standards, or Title 24 for short. They apply to both residential and nonresidential new construction projects.

improve environmental quality by reducing emissions associated with energy production, and result in lower long-term operating costs.

Current energy codes are based on either *site*[2] or *source* energy, where code compliant buildings are determined through energy modeling or prescriptive methods, to use less energy than base-case buildings which are judged to include reasonable, cost-effective measures. The key issue here is *site* versus *source*. In the former, a kWh of electricity is considered to be equal to the physical constant of 3,413 Btu of *site* energy. In the latter, the approximately 33% efficiency of electric production, transmission and distribution are considered, and a kWh is brought back to the source by being equated to 10,239 Btu's of *source* energy. From an energy efficiency perspective, the *source* method influences choices that result in greater efficiency and lower emissions. The *source* method is used by Title 24 in California, and reflects the amount of raw fuel burned in fossil-fueled power plants to produce, transmit, and distribute the electrical energy.

Neither of these methods takes into consideration the time-dependency of energy use. With increasingly non-regulated generation markets, power exchange prices spike radically and the adequacy of capacity may be uncertain during peak-load periods. The cost and therefore the contribution to profit margin of utility transmission and distribution systems is strongly influenced by asset utilization, where high demands for short periods of time can lead to large construction investments with poor financial recovery. The cost of non-pipeline, liquefied petroleum gasses such as propane is also time-dependent, but not as significantly as with the electric system,



This paper examines methods of time-dependent valuation and the resulting code change implications which might better characterize the public's interest in building energy use and life cycle cost decisions.

Current Codes

Building codes, which frequently refer to standards authored by such organizations as American Society of Heating Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE), Illuminating Engineering Society of North America (IESNA), National Electrical Manufacturer's Association (NEMA), or National Electrical Code (NEC), are a mixed blessing. They provide the public with a semblance of safety and security and give designers a framework in which their work is consistent with commonly accepted practice. In the case of energy, codes attempt to assure that long-lived buildings include measures that appropriately

[2] Source energy is distinct from site energy. For fuels burned at a site, source energy is the heat content of the fuel and site energy is the usable heat delivered to the end use. For electricity, source energy is consumed at the power plant and site energy is the usable energy delivered to the end use. The difference is the efficiency of the delivery system. Fuels typically have a combustion-efficiency at the site of 85% or 90%. California assumes that the site to source energy conversion efficiency for electricity is 33%. For comparison purposes, all energy sources are converted into units of BTUs (British Thermal Units, a basic unit of heat energy).

balance initial investment and life cycle utility cost savings. Conversely, standards complicate the design and building process, limit flexibility, and often dictate investment that does not directly add to factors which are highly valued by homebuyers, speculative developers or landlords who do not pay the utility bill. Regardless of the pros and cons, once enacted, codes and standards are sustainable to the extent that they are actually implemented and enforced in the field as intended by their authors. Therefore, codes are a natural exit strategy or end point in the market / industry transformation model.

All states and local jurisdictions in the U.S. have building codes. All but one (South Dakota) have energy codes of some kind.[3] No state codes are strictly applicable to Federal buildings. 12 state codes do not cover state buildings, 10 do not cover residential, and 15 do not cover commercial buildings. The applicability and technical basis of the energy codes varies, but refer most commonly to the ASHRAE Standards, the Model Energy Code (MEC), or the National Energy Conservation Code (NECC). In 19 cases enforcement is state or local, 17 states defer to local jurisdictions, 9 are state only, 2 are state or builder, and 2 (Kansas and South Dakota) have no enforcement at all.

ASHRAE 90.1

The most common state energy code, ASHRAE/IES 90.1, principally applies to commercial buildings. It is a consensus standard, currently in the continuous maintenance mode. In the consensus process, dissenters exercise considerable influence by their capacity to raise objections in comments, which need to be carefully considered by the entire committee. Then, changes are acted upon by majority vote of the committee. As in any political process, actions are highly dependent on the make-up of the committee and final reviewer, the Board of Directors. Representation on the committee is further influenced by a self-selection bias, where those with highly vested interests are willing to spend the money to be well represented. In contrast, environmental groups and associations of building owners are usually not very well represented. By definition consensus is a nearly lowest-common-denominator standard, where no key stakeholder risks being unable to actively defend their self-interests. The continuous maintenance mode requires that anyone seeking to make a change must introduce the idea, do the technical supporting work, and successfully convince the entire committee that the proposed change is desirable. This is difficult, and places a significant and costly burden on change agents.

ASHRAE/IES 90.1 uses a dollar cost basis for the energy cost budget (whole building) and prescriptive approaches to compliance. In practice, with the energy cost (whole building) approach, designers develop a base-case building using design practices, equipment, and materials that meet ASHRAE specified minimum efficiency levels. This design is then used as a base case. The base-case energy cost budget is established by pricing out the annual energy cost, using rates set by the adopting authority. Where the adopting authority does not specify rates, the responsibility for choosing the applicable rates presumable lies with the designer. The designer then models the actual design to demonstrate that the energy cost of the actual design meets or is less than this base-case budget. In the more commonly used

[3] National Conference of States on Building Codes and Standards, Inc., 505 Huntmar Park Drive, Suite 210, Herndon, Virginia 22070. 1998. *Directory of Building Codes and Regulations, State Directory.*

prescriptive approach, national energy cost and building models have been used to arrive at minimum efficiency levels for design practices, equipment, and materials.

Model Energy Code

The Model Energy Code, which principally applies to residential buildings, has evolved into a chapter of the International Energy Code, part of the International Residential Code, which is part of the International Council of Codes. This body developed out of the consolidation of the 3 councils of building officials around the country.

The IEC deals with changes through a majority negative ballot process. Changes proposed by building officials, the building industry, or the public at large, come before the council of 9 officials. Most commonly initial proposals, submitted by a single or small group of individuals, are rejected by majority vote. Proposals may be resubmitted, provided they have gained broader support. After an extensive review process and if they are approved by a majority of the council, they become part of the code.

A major energy issue with the IEC is its use of site energy basis and the resulting treatment of gas versus electric energy sources. Here, 1 kilowatt hour (kWh) of electricity is equal to 3,413 British Thermal Units. This physical energy relationship does not take into account the cost, price, or generation, transmission, and distribution efficiencies of the electrical system, which are typically 30-40%. Alternatively, some states such as California use source energy values, where 1 kWh is equal to 10, 239 BTU's. Very large vested interests and key stakeholders in this site versus source energy issue are the Edison Electric Institute and the American Gas Association, national trade associations of the electric and gas industries. The electric industry would have the site energy approach, because it favors electrification. The gas industry would have the source energy approach because it favors direct use of natural gas and propane. The environmental lobby would similarly have the source energy approach because it favors less raw energy use and lower power plant air emissions. This is a very complicated issue affecting the trade-offs in the standards between electric and gas fuels. Seemingly rational arguments can be made for all perspectives, but the source fuel approach is clearly the most environmentally friendly.

California's Title 24

California's Energy Efficiency Standards for Residential and Nonresidential Buildings, Title 24, regulate the energy performance of building envelopes, lighting, water heating and Heating Ventilating and Air Conditioning (HVAC) systems. These standards provide powerful signals to the new construction market, and they can influence the long-term energy efficiency of the state's energy delivery system. Under the Warren-Alquist Act, the California legislature charged the California Energy Commission with, "developing energy efficiency building standards that were cost-effective when taken in their entirety, and when amortized over the economic life of the structure when compared with historic practice." [4]

Cost-effectiveness is determined by energy costs which were based upon the annual average price of electricity ($/kWh) or natural gas ($/therm) paid by residential or commercial

[4] Section 25402 Division 15 California's Public Resources Code (Warren-Alquist Act)

consumers throughout the state. The economic values were set in 1991 from present-valuing a 20 year stream of forecast generation, transmission, and distribution prices. The resulting values were $.96/kWh, and $6.80/therm for commercial buildings (3% real discount rate, 15 year life), and approximately double that for residential buildings (3% real discount rate, 30 year life).[5] These economic values were used in constructing a set of ideal, cost-effective buildings, which when modeled in California's 16 different climate zones yielded the KBTU/sq.ft., energy budgets now in use. In determining the budgets, and by statewide agreement, even though the heat rate of power generation then varied with the supplying utility, electric energy was converted into KBTU/ sq.ft., on the basis of 10,239 BTU/kWh. The energy budgets actually vary with occupancy type (office buildings and retail spaces need more energy than warehouses), climate zone (buildings located in climates with more severe weather need more space heating and cooling energy), volume (heat gain and loss is a function of building shape), and window area (for commercial buildings, energy budgets adjust within the range of approximately 10-40% glass). A critical point however, is that past development and revisions of the Title 24 energy standards were derived from electricity and natural gas costs that did not account for seasonal or time-of-use patterns. Therefore, the energy budgets do not in any way depend on the season or time of use. However, both the price Californians pay and the cost of delivering energy depends upon when and where the energy is needed.

The Time Dependent (Energy) Valuation Project

The objective of the TDV Project is to explore the feasibility of updating the economic assumptions that underlie the building energy efficiency standards in California. This could lead to Title 24 amendments that would, in turn, encourage the design and construction of buildings would which reduce the peak demands on the energy system in California. Over time, this would result in cost savings for utilities, customers and society at large.

PG&E, under its 2000 Codes and Standards Program[6], has assembled a team to carry out this investigation. The team includes a project manager, experts in building energy efficiency and in the economics of utility costs and rates. Advising the team, and participating in our discussions, are representatives from the California Energy Commission, the California utilities, research teams working on building efficiency problems, and experts in Title 24 compliance methods.

How Title 24 Energy Standards Work

The Title 24 energy standards work over the long run to affect design and construction practices, and the efficiency of buildings, because all new buildings must meet the standards. California's Title 24 standards have been in effect since the late 1970s, and are now part of standard building practices. Although no more beloved than any other type of building

[5] Leber, Jonathan. March, 29, 1990. *Summary of Cost-Effectiveness Methodology and Assumptions.* California Energy Commission. Sacramento, California.

[6] The Codes & Standards Program is funded by public benefits monies collected under California Public Utilities Commission order from the ratepayers in California, and directed toward projects that will transform the California market toward greater energy efficiency.

code, the Title 24 standards are accepted and respected. California buildings are widely acknowledged to be among the most energy efficient in the nation, however opportunity for cost-effective improvement exists, and particularly in establishing time dependent of energy values.

This efficiency not only saves building owners and occupants energy costs, but has profound societal benefits in the form of reduced environmental impacts and reduced vulnerability to energy supply problems. The current oil price hikes (March, 2000) might have been worse if our overall energy efficiency had not substantially improved over the past 25 years.

The public policy decisions embedded in Title 24 can have a substantial impact on design practices, and we can use the standards to implement new policy choices that could not be accomplished by any other means. In this project, we are talking about using energy standards to influence the time distribution of energy loads in a way that they have not done in the past.

Rationale for Considering Changes

- **Energy Codes Provide Clear, Lasting Market Signals.** Energy codes are a powerful public policy mechanism for influencing the design of new and renovated buildings. They have a profound effect on the market for energy efficiency products and services because they apply to all buildings, and they are permanent (for practical purposes). The effects of new energy codes on the building stock may take years to achieve significant impacts, but those impacts are ultimately large and are long lasting.
- **Time of Use of Energy Is a Significant Issue.** High on-peak, short duration energy demand and usage, especially when accompanied by low off-peak energy demand and usage, presents a very real problem for the energy system in California. High on-peak demand places strains on the T&D[7] system and drives the need for increased investment in capacity. Inefficient fossil fueled generation used to meet peak demands increases the negative environmental impacts of increasing energy usage. All of this increases costs to utilities and consumers alike.
- **Buildings Aggravate Time-of-Use Problems.** Building energy use is a major cause of poor T&D asset utilization, and is very coincident with high market prices. Lighting and air conditioning loads, for example, are major components of peak demand.
- **Buildings Can Be Designed to Either Aggravate or Mitigate Time of Use Peak Demand Problems.** Design of the building envelope, glazing, lighting and HVAC controls, and other components of buildings can increase peaking problems. Alternatively, good design practices can help to level building loads.
- **Energy Codes Can Improve Building Design Practices.** Given the large numbers of buildings that make up the system load, changes to many building designs would be

[7] T&D is the abbreviation for transmission and distribution – the transmission lines, power towers, substations, transformers, distribution wires and other components which deliver power to utility customers. The analogy for natural gas is the transmission pipelines and local distribution piping system, which delivers gas to a customer site.

required to significantly mitigate the time of use problems. Energy codes are the only mechanism we have for implementing this kind of widespread change over time.

- **Current Energy Codes Do Not Distinguish Time of Use.** The underlying policy of the current Title 24 standards is that source energy use should be minimized, within the limits of cost-effectiveness. No distinction is made between time of use, and all energy sources are converted into source BTUs for making design trade-offs. The cost effectiveness of measures required by the standards is calculated using a flat cost per unit of energy saved. This does not accurately portray the restructured California energy market: The standards should probably be adjusted to reflect current realities.
- **It Is Possible To Base Future Energy Codes on Time of Use Differentiation.** If a rational and defensible method for recognizing time-dependent variations in energy savings (one which values on-peak savings more than off-peak savings) were to be adopted as the basis for the Title 24 Energy Standards, then building designers and owners could be given clear signals to design their buildings to mitigate time-of-use problems. As with the current Title 24 basis, such a method would represent a balance of societal and individual interests. We are developing several supportable and consistent methods for allocating time-varying costs on an hour by hour basis to various energy sources. The cost-effectiveness of energy efficiency measures contained in energy codes can be evaluated under this time-varying costing of energy by applying the hourly energy costs to the hourly energy impacts of each measure.
- **Long-Term Effects Would Benefit Everybody.** Over time, the effects on system load profile would be positive, benefiting the environment through reduced on-peak emissions, and the ratepayers through a more efficient, less expensive energy infrastructure. The enhanced standards would improve infrastructure asset management, while concurrently reducing long-term revenue requirements, resulting in lower costs to utilities and lower rates for end-users.

Summary of Benefits

The TDV Project explores ways to develop a rational and defensible mechanism for adjusting the basis for the Title 24 energy standards so that it would recognize a time-dependent valuation of energy efficiency measures, and maximize the societal benefits from long-term reductions in peak demand problems, while balancing individual and utility interests.

To date we have looked into utility system costs and the different methods for allocating them by time of use. We think this is a good way to set a value on energy savings, and to distinguish savings by time of use. We intend to use this method to propose a higher value on energy efficiency measures that save energy on-peak. We would then propose changes to Title 24 requirements that would encourage design practices that mitigate on-peak energy use. Our research will demonstrate the implications of these changes to stakeholders, and will identify a consensus on the best technical approach for the Energy Commission to adopt.

The study investigates the feasibility of using a more accurate energy costing analysis to account for variations in cost related to time of day, seasons, geography and fuel type. The geographical and temporal variability in delivered energy costs is due to differences in commodity prices (electricity prices are higher in summer than winter, natural gas and propane prices are higher in the winter than summer) and the costs of the electrical transmission and distribution system which are driven by the need for capacity in high usage times of the year. Energy standards that place a higher value on efficiency during the high cost times of the year and are more closely tied to the actual variations in energy costs, could better optimize the use of energy resources in California.

Economic Basis of TDV

In considering the economic basis for this project, the CEC wanted to explore code related implications of modifying the source energy values by time dependent post Competition Transition Cost (CTC) recovery[8] price and cost values. Factors considered were: 1) The energy and capacity components of the electric, natural gas, and propane generation, transmission, distribution systems, and 2) The customer related costs of electricity, natural gas, and propane (propane is currently considered to be the same as pipeline gas). The CEC further wanted to identify sources of price and cost data that would be publicly available and sustainable into the future so that periodic adjustments could be made in the values. The project group wanted to use post-freeze[9] prices to the extent that they could be forecast.

In the interest of brevity, this paper addresses only the PX price, temperature correlated time-dependent transmission and distribution marginal cost values, propane cost values, and some of the implications for residential buildings.

Generation / Commodity

With deregulation of the electric utility industry in California, regulated utilities were directed to divest themselves of their electric generating assets. This generation has been, or is being, bought by non-regulated enterprises. The electric production of free market generators may be sold into the California Power Pool (Power Exchange, PX), be sold through other markets, or through by-lateral contracts. The state's utilitie's transmission and distribution systems continue to be regulated.

The electricity commodity cost can be derived from a forecast of the PX price. Since the PX is an open market, the market clearing price is indicative of both the cost of the commodity and its contribution to the price that consumers pay. The CEC staff has prepared such a forecast[9] which was used in the preliminary study.

Current data on generation / energy costs is available on the web at www.caiso.com and www.calpx.com. In the TDV project, a 20 year forecast of commodity prices was used. The following table is an abbreviated form of the generation cost data used in the analysis:

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[8] In the deregulation enabling legislation, Assembly Bill 1890, provision was made for immediate rate reductions and the recovery of carrying and utility stranded costs through a financing vehicle over a maximum period of 5 years. Post recovery, or "freeze", rates are expected to approach stable market values.

[9] Joel Klein . December 19, 1997. *Interim Staff Market Clearing Price Forecast for the California Energy Market Study*. Electricity Analysis Office. California Energy Commission, Sacramento, California.

Table 1: Northern California Generation Market Clearing Price Forecast by TOU Period, in $/megawatt-hour (mWh)

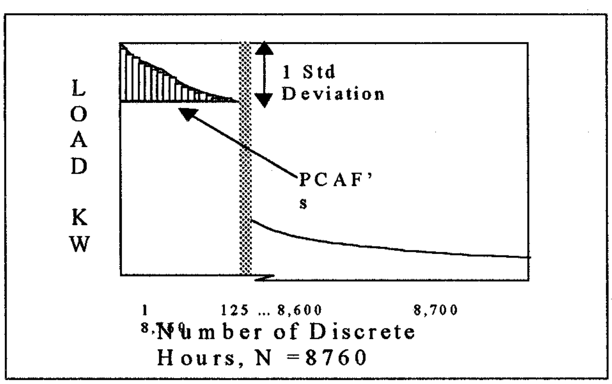
	Summer On-Peak	Summer Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak
1998	38.37	31.25	24.55	30.06	25.56
1999	34.85	28.35	23.51	28.06	24.93
2000	39.90	30.44	23.90	28.25	25.29
2001	41.50	31.17	24.95	29.31	26.42
2002	49.28	33.31	25.91	30.84	27.76

Actual experience in 1999 and 2000 indicate that capacity shortages may be pushing the price above forecast levels. Therefore the generation prices used in the analysis are currently being reexamined. Also, work in progress will perform regression analysis of the generation marginal cost against temperature, so that time and temperature correlated values can be established.

Transmission / Distribution

Determining transmission and distribution costs is much more difficult than generation. PG&E in the past estimated its T&D marginal costs by Distribution Planning Area (DPA). It was at first thought that this might be a good way to capture the climatic variations in costs, which correlate with geography. However, determining T&D marginal costs by DPA is burdensome, may be undesirable from a competitive standpoint, and is not required in filings with the California Public Utilities Commission. Neither the Southern California Edison Company, nor San Diego Gas and Electric provide their costs in such a manner, consequently this approach was considered unsustainable. Another difficulty with the strict marginal cost approach is that marginal costs in an area are high, until distribution improvements are made, then the costs drop dramatically. In reality, the problem is the poor investment recovery of necessary-to-meet-peak-load, but poorly utilized feeders. A long-term methodology was needed, which would roll through these as short as 7 year construction cycles in fast growing areas, and be more consistent with 50-year building lifetimes. A novel and innovative approach was developed to derive Title 24, climate-zone-specific, time-of-use cost variables, from the utility's construction budget and typical climate-zone-specific peak-capacity allocation factors.

Figure 1. Peak Capacity Allocation Factors



This approach stems from the load duration curve, where loads for selected typical distribution feeders are ranked and time-stamped for all the hours of the year, from the peak load hour, to the lightest load hour. The highest one-standard deviation of values is used for peak capacity allocation, where the marginal cost is prorated according to each hour's weight relative to the total for the selected portion of the data. The graph above illustrates this concept.

The table below illustrates the result of the Peak Capacity Allocation by selected PG&E Divisions. It is clear that heavy weight is given to summer part and on-peak values for hot inland Divisions such as Kern, while more balance can be seen in coastal Divisions such as Peninsula.

Table 2: PG&E Peak Capacity Allocation Factors (PCAFs) for Selected Divisions

	Summer On-Peak	Summer Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak
Central Coast	20.4%	16.7%	3.0%	25.3%	34.6%
Diablo	55.7%	16.6%	2.7%	10.9%	14.1%
East Bay	7.2%	5.9%	2.2%	28.6%	56.1%
Fresno	47.0%	19.3%	0.5%	1.9%	31.3%
Kern	60.5%	25.5%	0.8%	1.4%	11.8%
Mission	48.4%	11.0%	1.1%	27.6%	11.8%
North Bay	17.1%	5.6%	7.9%	44.2%	25.2%
North Valley	40.1%	20.8%	2.1%	4.0%	33.0%
Sacramento	48.0%	15.5%	1.0%	1.6%	33.9%
San Francisco	17.5%	7.6%	2.3%	32.9%	39.7%
San Jose	43.5%	12.9%	4.4%	22.2%	17.1%
Stockton	43.7%	13.2%	2.7%	2.9%	37.6%

PG&E TOU Periods are:
Summer: May through October; Peak Noon to 6pm. Monday to Friday, Excluding Holidays; Partial Peak: 8:30am to Noon, 6pm to 9:30pm. Monday to Friday, Excluding Holidays; Off: All other hours. Winter: November through April; Partial Peak: 8:30am to 9:30pm. Monday to Friday, Excluding Holidays; Off: All other hours

The PCAF'S were then regressed against weather, yielding tables of time and temperature correlated values, which are illustrated graphically below:

Figure 2. Fresno Daily Temperatures, Hours Above 85 Degrees

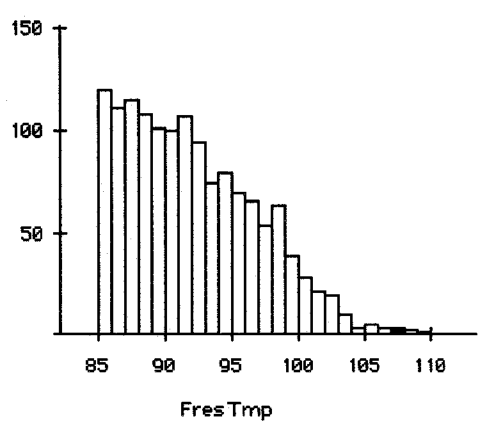
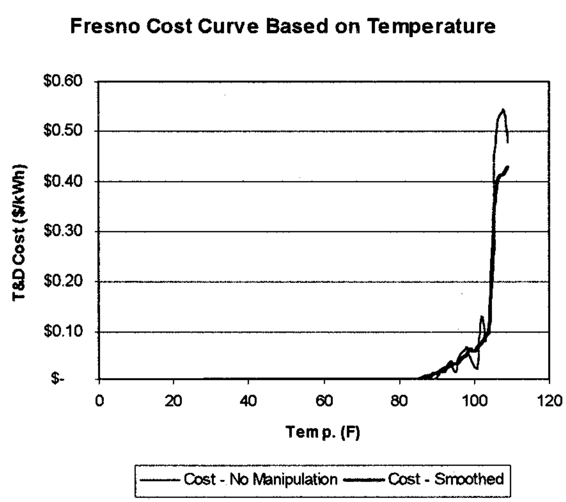


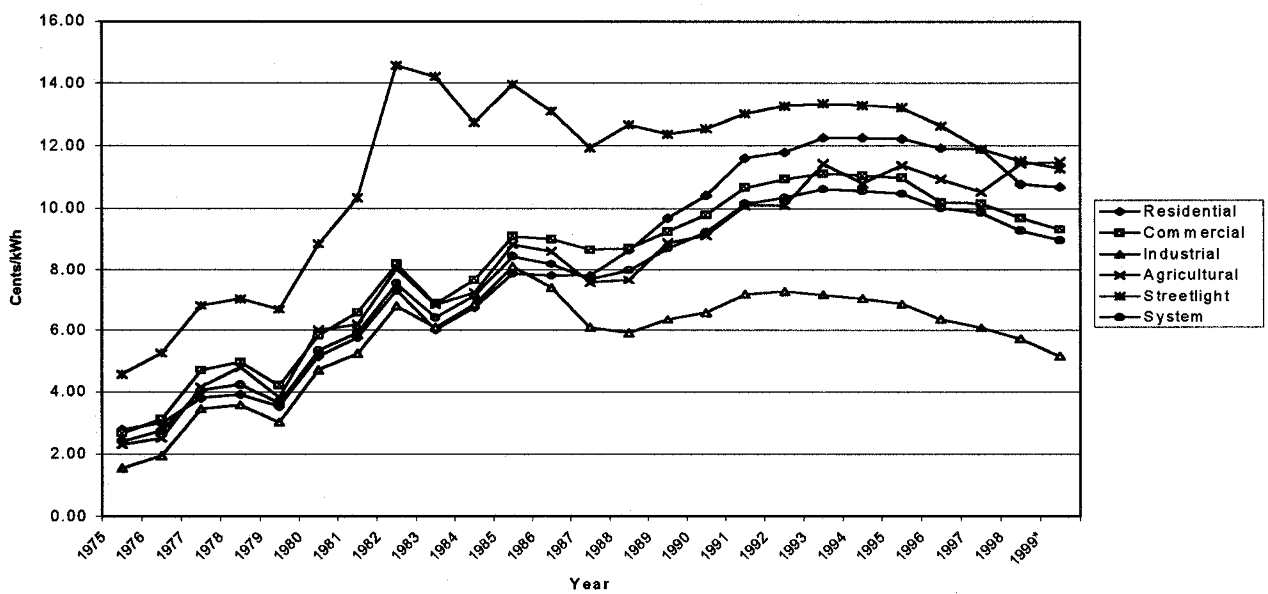
Figure 3. Fresno Cost Curve Based on Temperature, $/kWh



Why Not Just Use Retail Prices

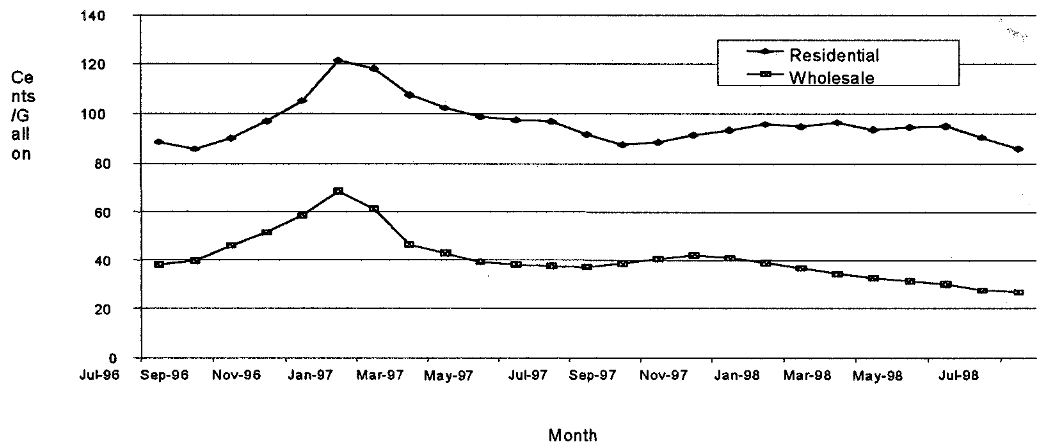
Price factors should be easy to acquire and should provide correct signals. However, utility prices (rates) are set in a socially, politically, and competitively litigious regulatory process where a previously decided gross revenue figure must be met by the sum of energy sales at regulated prices in each customer class. In this process, there are many competing objectives: Fairness and rationality (cost-basis), competitive issues, equity, simplicity, acceptability and aversion to complaints, etc. From a social and public policy perspective, prices may not be the best basis to determine time dependent energy values. In many ways and for many reasons, they mask the true societal cost structure. Figure 4, below shows a history of PG&E's average cost per customer class from 1975 through 1999, for PG&E as determined from it's annual statistical report. Presuming that the cost basis of the business has not changed much over time, one can infer from the variations in relative cost over time that there must be some strong influences in rate-making other that of those of true cost to serve.

Figure 4. PG&E Average Electric Rates by Customer Class



Natural gas marginal cost was found to have a small dependency, but propane was found to have a strong seasonal variation as shown in Figure 5, at the top of the next page. Since Liquefied Petroleum Gas (LPG), or propane, is currently treated the same as pipeline natural gas (methane) by Title 24, adding true time dependent valuation causes technologies such as electric heat pumps to gain compliance credit relative to propane.

Figure 5. National Residential and Wholesale Petroleum Prices by Month, Over the Past Two Years



Source: EIA Weekly Petrolium Status Report, September 1998

Implications for Code Compliance and Key Stakeholders

The principal difficulty of proposing a change in the standards of this magnitude and nature is that regardless of the merit and social correctness, key stakeholders immediately want to know what the implications are for their vested interests. Since the standards must go through a public process before adoption by the CEC Commissioners and the Legislature, agreement must be built. Those stakeholders who are well represented may exercise considerable influence, and those who are not represented will have little influence. As noted previously, building owners and occupants who pay utility bills are often poorly represented.

Adding to the difficulty, the implications are complicated as they are expressed by measure, in different building types, and in different climate zones. At a minimum, it has been the intention of the advocates all along that the changes would be nearly transparent to the compliance practitioners and enforcers of the code.

The techniques used in developing and applying the time dependent (energy) values are somewhat flexible. Therefore to accommodate an anticipated diversity of responses to the proposal, fine-tuning will be needed and exercised.

This paper presents generalized implications. It is beyond the scope to present detailed implications because they are very wide ranging. Depending on the application, others who choose to investigate this approach will find a detailed understanding of the results in California's climate zones to be less valuable than an overview of the process.

The project considered many economic factors, building types, and climate zones. The temperature-dependent and time-of-use values were considered most promising and are presented here. Temperature-dependent values are meaningful for states such as California with widely varying climate, where peak load costs are related to high temperatures. The simpler time-of-use values may be appropriate for states with more uniform climates.

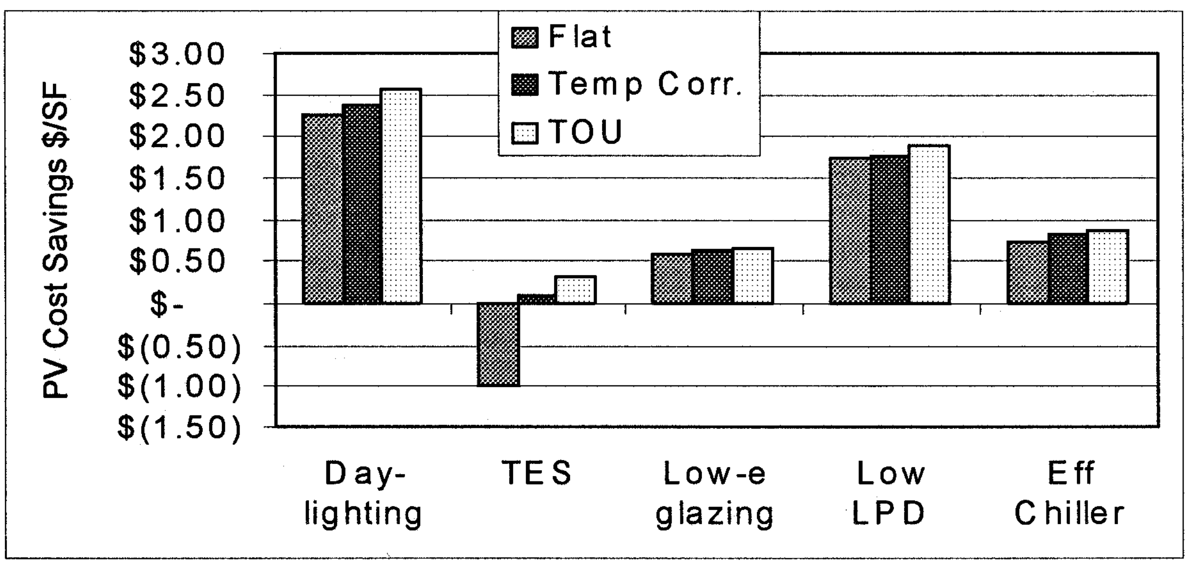
Preliminary Commercial Implications

As might be expected, commercial measures that utilize less on-peak energy, such as high energy efficiency ratio (EER) air conditioning, low-E glazing, and daylighting controls, receive additional compliance credit under the new proposal. Similarly, those that use more energy on-peak or use energy in a uniform way, receive relatively less credit. This is true particularly in the extreme climate zones.

One important but perverse issue that arises is that aside from high performance glazing, building shell measures receive relatively less credit as the benefits of shell measures are not particularly coincident with peak periods. However, passive building measures may be more durable than active measures such as thermal energy storage. They are subject to less deterioration on account of less than optimal maintenance practices.

Figure 6 below, shows some typical implications for the hot California Central Valley Community of Fresno. Changes are shown on the vertical axis in $/sq. ft. For reference, the typical value of savings is $18-19/ sq. ft. Therefore, changes of $1.00 would represent about 5-6% increase in compliance credit. The measures shown are daylighting, thermal energy storage, low emisisivity glass, low lighting power density in watts/ft. sq., and high efficiency chillers. The valuation cases are flat (the current methodology), time of use, and temperature dependent. For illustration, thermal energy storage goes from a negative $1.00 value under the current code, to a positive $.35 under time of use valuation.

Table 6. Commercial Implications



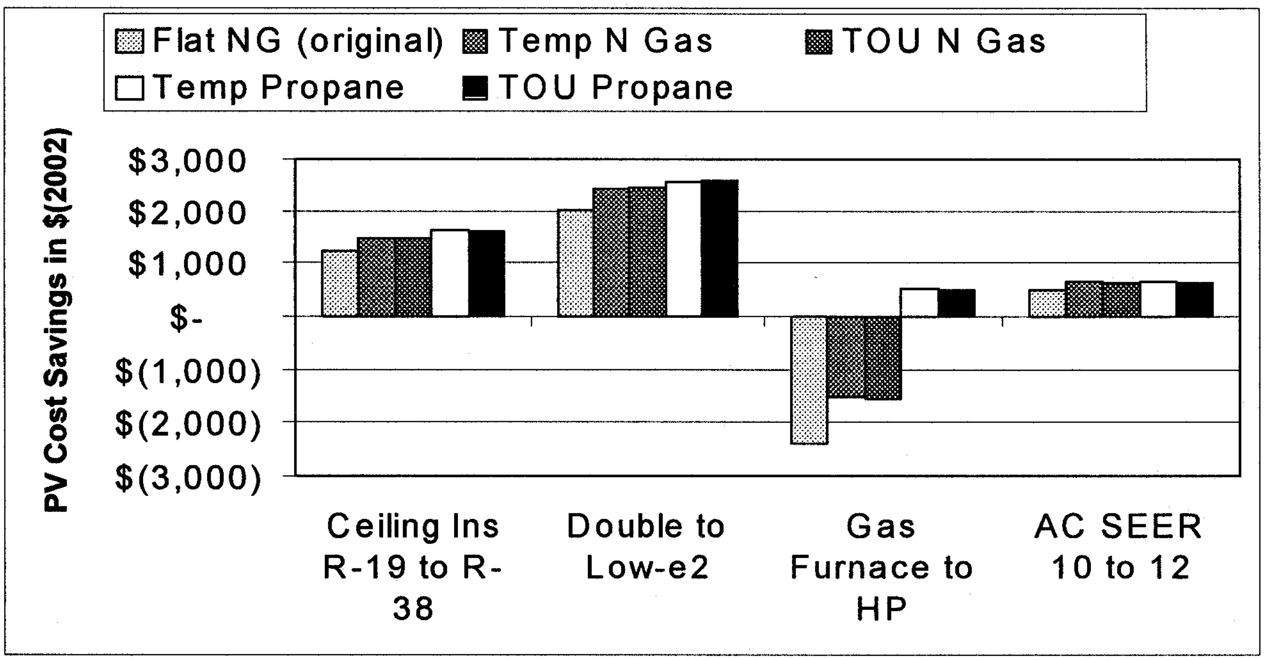
Preliminary Residential Implications:

As with commercial, those residential measures that are peak load friendly gain credit and those with poor load factors loose credit. In the hot California Central Valley community of Fresno, moving from R 19 to R 38 ceiling insulation, from standard dual pane to low-E glazing, and standard to high EER air conditioning gain credit.

The project looked at the peak load performance of split system and package unit air conditioning. The peak load demand of high Seasonal Energy Efficiency Ratio (SEER) air conditioning does not improve (reduce) commensurate with the reduction in energy use. Therefore, the high SEER air conditioning does not gain compliance credit as much as might be expected.

Figure 7 at the top of the next page, shows the implications for going from R19 to R38 ceiling insulation, standard double to low-E glazing, furnace to an electric heat pump, and an SEER 10 to an SEER 12 air conditioner. The valuation cases are flat (the current methodology), time of use, and temperature, for propane and natural gas situations.

Table 7. Residential Implications



Summary and Recommendations

This paper has emphasized the rationale and methodology for considering time dependent valuation of the source energy basis of state energy codes. Society will benefit through energy savings, improved environmental quality, and lower utility costs if code adopting authorities utilize time dependent valuation, source energy based codes. Since this work is very diverse and application specific, studies of its implications and advocacy for adoption in multiple venues are recommended.