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Does California's Electricity Rate Structure Protect the Poor?

Since the 1980s, low-income households in California have been eligible for electricity discounts of 20% or more through the CARE (California Alternate Rates for Energy) program. Nonetheless, when rates increased suddenly following the 2000-01 California electricity crisis legislators were still concerned that the poor would be hit hard. The State's response to the crisis attempted to further protect low-income consumers by freezing the rates regulated utilities charge to low-consumption households.

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This strategy assumes that there is a strong correlation between income and electricity consumption, but the evidence on that correlation has until now been largely anecdotal. In "Equity Effects of Increasing-Block Electricity Pricing" (CSEM WP-180), Severin Borenstein presents the most detailed empirical analysis to date of the effect of California's rate structure on low-income customers.

Under the pre-crisis two-tier residential rate structure, a household paid the first-tier rate on electricity consumed up to a certain baseline consumption level and then paid a slightly-higher (about 16% higher) second-tier rate for all their consumption beyond that baseline. After the rate structure expanded to five tiers in 2001, households marched up the five rate tiers as their monthly electricity consumption grew. The 2001 rate restructuring froze the rates for lower consumption levels - the two lowest tiers - at pre-2000 levels and imposed higher (and progressively increasing) rates for tiers 3, 4, and 5.

If a household doesn't consume very much electricity in a month, it may only reach the second tier and never be exposed to the upper-tiered rates. Households that consume a lot of electricity now face each of the five rates and pay the highest rate for their marginal consumption. In 2008, the rate for baseline consumption has been around 11 cents per kilowatt-hour, but the rate for the highest tier has averaged as high as 35 cents per kWh, as shown in table 1.

The top panel of table 2 shows, by utility, the percentage of residential CARE and non-CARE consumption that was billed at each tier during 2006. The lower panel shows the proportion of CARE and non-CARE

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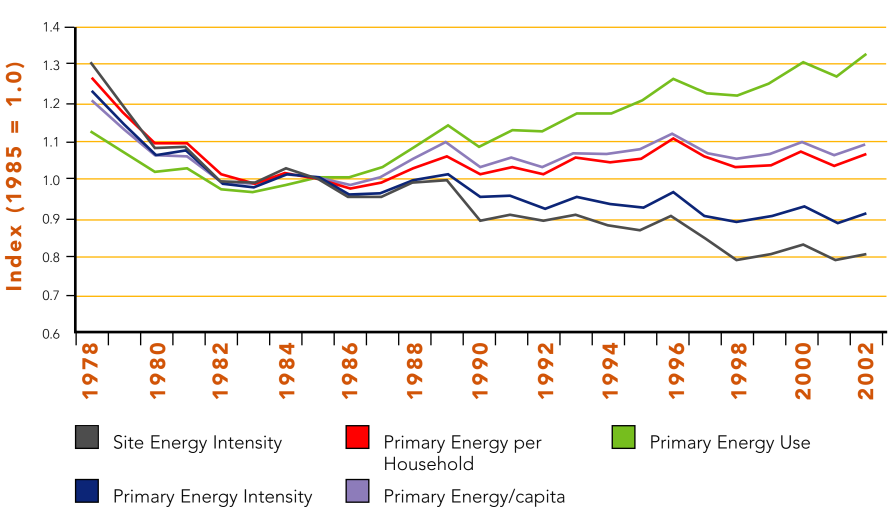
Time to Push Energy Conservation AND Energy Efficiency

Over the last quarter century, the energy efficiency community has worked hard to sell energy efficiency to the American consumer. It has drawn a sharp distinction between energy efficiency and energy conservation, which implies sacrifice. The message has been you can live as well or better than before while consuming less energy if you purchase energy efficient homes and appliances. Concerns about global warming and the limits of energy resources have led some researchers to conclude that it is critical we now also embrace the idea of conserving energy.

Energy efficiency has made an enormous contribution over the years and reduced growth in energy demand well below what it otherwise might have been. But this has not been enough. Across the globe, other factors have been driving increased energy consumption: population growth, increased wealth and income, and our collective preference for ever larger and more energy-intensive products and services. Despite notable gains in the energy efficiency of building envelopes, lighting, HVAC, and plug loads, since 1978 total U.S. primary energy use has increased over 30% in residential buildings and more than 65% in commercial buildings.

In "Towards a Sustainable Energy Balance: Progressive Efficiency and the Return of Energy Conservation," (CSEM WP–171) the authors1 introduce the concept of "progressive efficiency." Their central idea is that the level of energy efficiency should increase as the scale of energy use or energy service increases. Having a more energy efficient refrigerator is good but if the new refrigerator is larger, it will still consume more energy than your old one. In a world of limited resources, the authors want us to reduce our overall energy consumption. To do so, they advocate measuring energy consumption in addition to energy efficiency. The authors seek to enhance the energy efficiency gains through a re-introduction of energy conservation as a legitimate and desirable policy goal, and by drawing attention to trends in energy consumption as well as in energy efficiency.

FIGURE 1: INDICES OF U.S. RESIDENTIAL ENERGY



In this paper, the authors offer three examples of how to incorporate energy consumption information with energy efficiency standards. The first example is the choice of energy indicators – should we measure and track energy efficiency or energy consumption? The politics of focusing on energy efficiency has generally been preferred and so most of our energy indicators are measured in terms of consumption per unit, e.g., miles per gallon or energy per square meter of floor space. However, some of these indicators can be misleading depending on the denominator used. The authors argue that both for establishing policy targets and tracking progress multiple indicators that reflect both energy consumption and energy efficiency should be used. Figure 1 demonstrates the range of energy indicators that can be used and the different answers they each offer. So what do the data tell us – over the period 1978 – 2002, did we gain ground by 20% based on the reduction in site energy per square foot? Or fall behind by 32% based on the increase in total primary energy? Or something in between? The answer depends on whether we are thinking in terms of energy consumption or energy efficiency.

1 Jeffrey Harris (Alliance to Save Energy), Rick Diamond, Maithili Iyer, and Christopher Payne (Lawrence Berkeley National Laboratory), Carl Blumstein (UC Energy Institute), and Hans-Paul Siderius (SenterNovem).

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Permits to Pollute: Insights on How to Design a Pollution Market

A market where firms can buy and sell the right to pollute strikes some as just plain wrong. In theory though, such a market allows firms to find the least expensive means to meet a pollution cap, which is established by a regulator. Since pollution markets – or cap-and-trade programs – are now the presumptive approach to implementing environmental regulations, such as those addressing global warming, a thorough look at one of the longest running pollution markets in the U.S. should give important insights on the optimal design for a pollution market.

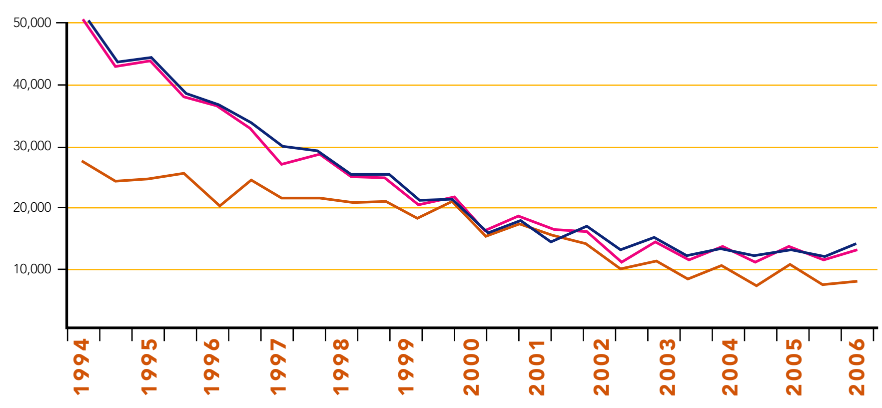
The Los Angeles Regional Clean Air Incentives Market (RECLAIM) began in 1994 and established tradable permits for NOx and SO2 emissions. RECLAIM defined steadily decreasing caps for NOx and SO2 emissions as part of a program to reduce smog in the Los Angeles air basin. Stephen Holland (University of North Carolina at Greensboro) and Michael Moore (University of Michigan) take a careful look at the design of the RECLAIM NOx market in their paper "When to Pollute, When to Abate? Intertemporal Permit Use in the Los Angeles NOx Market" (CSEM WP-178) and arrive at a set of policy recommendations for future pollution markets.

In the RECLAIM program, a tradable emissions permit is identified as a RECLAIM Trading Credit (RTC). One RTC entitles the owner to emit one pound of pollution within a twelve-month interval after which the RTC expires, i.e., RTC's are not bankable. Initial allocations of RTCs were distributed free of charge to facilities. Over time, fewer RTCs are allocated annually to achieve a lower pollution cap. Two key features of RECLAIM are its overlapping compliance cycles and overlapping permit cycles. Facilities and RTCs are assigned either to Cycle 1, which runs from January to December, or to cycle 2, which runs from July to June. For example, a facility assigned to cycle 1 has a compliance year that ends in December. Similarly, an RTC assigned to cycle 1 expires in December. However, each facility can comply using valid permits of either cycle. For example, a cycle 1 facility can purchase and use cycle 2 RTCs, although the cycle 2 RTCs remain valid only in the cycle 2 period. These overlapping compliance and permit cycles are unique features of the RECLAIM program and create opportunities to trade pollution across time.

Holland and Moore were interested in intertemporal trading in RECLAIM and ask whether the design of RECLAIM was dynamically efficient. The researchers develop a theoretical model of the market under perfectly competitive conditions and find that the market design is cost effective and can lead to limited intertemporal trading.

To test some of the predictions of their model, the authors divide the RECLAIM program into three periods: 1994-1999, 2000-2001, and 2002-2006. In the first period, more permits were allocated than were needed. These excess permits meant that the decline in available permits did not lead to an equivalent reduction in emissions. Average prices for the permits were very low during this period: $154 per ton in 1996; $227 per ton in 1997; and $451 per ton in 1998. The California electricity crisis defined the period 2000-2001.

FIGURE 1: RECLAIM Trading Credits (Thousands)



Initial allocations, available RTCs, and used RTCs for permits expiring in June or December of each year from December 1994 to June 2006.

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PERMITS TO POLLUTE: INSIGHTS ON HOW TO DESIGN A POLLUTION MARKET

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During the crisis, the number of permits used closely tracked the number of permits available. Permit prices increased from about $3000 per ton in early 2000 to nearly $20,000 per ton in June and $70,000 in August! Average permit prices during the crisis – May 2000 to June 2001 – were $50,000 per ton. The third period is a post-crisis transition period. Permit prices dropped down to an average price per ton of $2,000 in every year but 2004. Figure 1 illustrates the relationship between the number of permits issued, the number of permits used, and those that were available over the three periods.

Holland and Moore found that facilities did trade across time periods by using a considerable proportion of permits of the opposite cycle. Moreover, during the years when RECLAIM did not have excessive permits, the median number of unused permits held by facilities in the program was zero. In other words, over 50% of the facilities completely used or sold all of their permits of each vintage as predicted by theory. However, the authors found evidence that a few facilities held a substantial number of unused permits, even of the most valuable vintages.

Based on their findings, Holland and Moore argue that certain aspects of RECLAIM might be used in future pollution markets. They recommend that regulators consider assigning expiration dates to permits. Setting an expiration date can limit the number of unused permits and avoid potential pollution hotspots or, more generally, noncompliance with an air quality standard. However, a looming expiration date may paradoxically increase pollution since the permits will have no value after the expiration date. If regulators do assign expiration dates, the authors recommend overlapping cycles of permits to smooth compliance costs across the expiration date.

However, the authors do not endorse other aspects of RECLAIM. They argue that RECLAIM's assignment of facilities to one of two compliance cycles had no effect on emissions and likely made the program more confusing. Instead, Holland and Moore recommend that compliance take place as frequently as possible for each facility. If larger facilities are reporting emissions hourly, there is no reason that permits cannot be deducted daily or weekly from their accounts of unused permits. More frequent compliance has the advantages of smoothing regulators' work load, making firms more cognizant of their permit balances, and making regulators quickly aware of any shortfalls in permit balances. In effect, the authors argue that emissions markets should use standard "billing" procedures. Finally, Holland and Moore recommend that each facility receive an initial allocation of all applicable permits. RECLAIM only allocated cycle 1 permits to cycle 1 facilities, even though these facilities could also use cycle 2 permits. Although most firms learned that they could use either cycle of permits, initially allocating permits from both cycles would have removed any ambiguity.

Careful design of a pollution market can increase the efficiency of the market and lead to ever lower levels of pollution. It's attention to the details of how these markets are designed that ultimately determines the success of the program. With so much interest in implementing new cap-and-trade programs, it's instructive to learn all we can from those that have been in operation.

TIME TO PUSH ENERGY CONSERVATION AND ENERGY EFFICIENCY

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The second example is standards for rating energy-efficient homes. The average size of a new house in the U.S. doubled between 1950 and 2000 and households now hold fewer people. This has resulted in a threefold increase in average floor area per capita, from 286 sq. ft. to 847 sq. ft. per person, over those five decades. In addition, today's houses tend to be less efficient because they have more complex perimeters (more bay windows, dormers, etc.) that add to surface area and often complicate construction detailing for insulation and air sealing. Consequently, new homes are more likely to be less efficient than smaller houses with simpler designs. Building a bigger house to be energy-efficient will save more energy than building a smaller house at the same level of efficiency, but the larger house will still use more energy. A progressive efficiency policy would call for larger homes to be not only equal in efficiency to their smaller counterparts, but to deliver proportionately more efficiency and energy savings. Today the ENERGY STAR for Homes program allows a house of any size to qualify for the ENERGY STAR label and one requirement is that the house contain five or more ENERGY STAR qualified products. This requirement can be easier to meet with a larger house which is more likely to have multiple refrigerators and dishwashers, and more lighting and appliances of all types. If ENERGY STAR were to use the progressive efficiency approach, there would be a maximum energy consumption requirement (including appliances and lighting) that would be a linear function of floor area for small-to-mid size houses, but larger houses would be required to achieve steadily increasing levels of energy efficiency. And perhaps a very large house could only qualify if it used no more total energy than a home of a specified maximum size, such as 3,750 sq ft.

While the efficiency of many consumer appliances has increased notably over the years, total appliance energy consumption has remained constant and in some cases has increased due to growth in the number of appliances, their size and features and the introduction of entirely new categories of appliances and new combinations. U.S. appliance energy labeling offers a last example of how to combine energy consumption and energy efficiency considerations. The core of this problem lies in the narrow definition of product categories used for the EnergyGuide comparison label and for setting national energy efficiency standards. Narrow categories make it difficult or impossible for consumers to compare products that might be close substitutes but use very different amounts of energy. For example, grouping refrigerator-freezer models for purposes of the EnergyGuide label first by size (capacity) and then by freezer type completely masks many of the differences to which consumers should pay attention. In fact, the current label may lead consumers to conclude that a 25 ft^3 side-by-side model using 578 kWh/year is "efficient," even though it consumes 10-30% more energy than a top-freezer model with the same capacity.

The authors believe that incorporating progressive efficiency criteria for recognition labels like ENERGY STAR, utility rebates, and tax incentives, and measuring progress in terms of energy consumption as well as efficiency, offers a path for energy experts, policy-makers and the public to begin building consensus on energy policies that recognize the limits of resources and global carrying-capacity. Ultimately, they believe it is essential to manage energy consumption, not just energy efficiency, to achieve a sustainable energy balance.

DOES CALIFORNIA'S ELECTRICITY RATE STRUCTURE PROTECT THE POOR?

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customers whose average daily consumption puts them on each of the five tiers for the price of their incremental consumption. In each case a larger percentage of CARE customers' electricity consumption falls in the lowest tiers but there are a significant number of CARE customers who consume enough to reach the higher tiers.

Deciphering the distributional impacts of going from a two-tier to a five-tier electricity rate structure requires customer-level residential billing data. Under strict confidentiality terms, the three regulated California utilities – Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric – provided these data to UCEI. The data do not include customer names or addresses but do include the nine-digit zip code for each residence, which allow Borenstein to match each account with census data on income.

TABLE 1: BENCHMARK AND ALTERNATE RETAIL ELECTRICTY TARIFFS

		Pacific Gas & Electric		Southern California Edison		San Diego Gas & Electric	
Tier	% of Baseline Quantity	Benchmark 5-tier	Alternate 2-tier	Benchmark 5-tier	Alternate 2-tier	Benchmark 5-tier	Alternate 2-tier
1	0-100%	$0.1153	$0.1521	$0.1172	$0.1506	$0.1294	$0.1503
2	100%-130%	$0.1311	$0.1764	$0.1374	$0.1748	$0.1500	$0.1744
3	130%-200%	$0.2256	$0.1764	$0.2176	$0.1748	$0.2076	$0.1744
4	200%-300%	$0.3128	$0.1764	$0.2533	$0.1748	$0.2250	$0.1744
5	300%+	$0.3585	$0.1764	$0.2893	$0.1748	$0.2363	$0.1744

Because CARE customers have a different rate schedule, Borenstein focuses first on the impact of the five-tiered rate structure (the "benchmark" tariff) among non-CARE customers. Among the poorest customers it is estimated that about one-third have not signed up for the CARE program, even though the program has nearly tripled in size over the last decade. Borenstein creates an alternate two-tiered tariff for non-CARE customers. This "flatter" tariff resembles the pre-crisis price structure, but the level is set so that it would generate the same total revenue as the benchmark tariff for the same consumption levels of non-CARE households. Both the benchmark and alternate tariffs are then applied to customer consumption levels for 2006, the most recent year for which the billing data are available. This yields benchmark and alternate monthly bills for each customer.

To get from customer bill changes to an analysis of effects on the poor, Borenstein next matches the customers to very localized "census block group" (CBG) income data from the U.S. Census. A CBG on average includes about 800 households. Within CBGs, however, there is still significant income

TABLE 2: DISTRIBUTION OF RETAIL CONSUMPTION ACROSS TARIFF TIERS

		Residential Usage (million-kWh)	Percentage of Total Residential Usage					CARE/ Non-CARE	Shares
			tier 1	tier 2	tier 3	tier 4	tier 5	% Usage	% customers
PG&E	Non-CARE	22,448	60.1%	11.1%	15.9%	8.9%	3.9%	78.7%	76.9%
PG&E	CARE	6,073	67.7%	10.4%	13.3%	6.4%	2.2%	21.3%	23.1%
SCE	Non-CARE	21,129	55.2%	11.1%	16.9%	10.8%	6.0%	76.7%	72.7%
SCE	CARE	6,401	66.5%	10.8%	13.6%	6.7%	2.5%	23.3%	27.3%
SDG&E	Non-CARE	5,967	56.8%	10.6%	15.7%	10.2%	6.7%	85.5%	80.9%
SDG&E	CARE	1,013	73.5%	9.2%	10.5%	4.8%	2.0%	14.5%	19.1%
			Percentage of Customers on Each Tier for Marginal Consumption						
			tier 1	tier 2	tier 3	tier 4	tier 5		
PG&E	Non-CARE		37.6%	14.7%	24.8%	15.5%	7.4%		
PG&E	CARE		47.5%	15.7%	21.8%	11.0%	4.0%		
SCE	Non-CARE		32.0%	14.5%	25.5%	17.5%	10.4%		
SCE	CARE		45.3%	16.8%	22.9%	10.9%	4.1%		
SDG&E	Non-CARE		38.1%	14.3%	23.2%	14.8%	9.7%		
SDG&E	CARE		58.9%	14.8%	17.0%	6.9%	2.5%		

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heterogeneity, a fact that is often overlooked when researchers using these data for distributional analysis match households to the median income in their CBG. The Census, however, also releases data that break down each CBG into the share of households in five income brackets.

Borenstein first develops an innovative method of matching households to income brackets within each CBG. The approach yields upper and lower bounds on the amount of redistribution of the revenue burden that would result from switching from the benchmark five-tier tariff to the alternate two-tier tariff. With further analysis, he develops an approach to weighting these bounds that results in a more reliable estimate of the redistribution. The results are shown in table 3.

The results indicate that going from the existing rate structure (benchmark) to the alternate two-tier rate structure would result in a significant percentage increase in bills for the average customer in the lowest income bracket (household income below $20,000 per year) who is not on CARE, about a 25% increase for PG&E and SCE customers. The increase in dollar terms, however, is rather modest, about $7-$8 per month. For SDG&E customers, who face a less steeply tiered rate structure, the change would be substantially smaller.

The average percentage increase in bills would be lower for customers in the next two income brackets — $20,000-$40,000 per year and $40,000-$60,000 per year – but in dollar terms the change would be about the same as for those in the poorest bracket. Borenstein finds that the change would be about neutral on average for those in the $60,000-$100,000 bracket.

Households with an income above $100,000 would benefit on average from returning to the two-tiered structure with about a 10% decline in their bills, or about $15-$20 savings per month.

In another scenario, Borenstein examines the impact of a five-tier versus a two-tier tariff structure if there were no CARE program. He finds that the CARE program has a much greater impact in reducing the revenue burden on low-income customers than does the steep tiering of the retail tariff for non-CARE customers, twice as large or more for SCE and PG&E customers. He finds that if there were no CARE program already protecting the majority of poor customers, the impact of the change in tiering of the tariff structure would be about two and a half times larger than the estimates in the presence of the CARE program.

This suggests that if reducing the electricity bills of low income customers is a major public policy goal, it may be pursued more effectively with an income-based approach such as the CARE program, rather than through the less-direct steeply-tiered retail tariff. Assembly Bill 1X passed in 2001 prohibited the California Public Utilities Commission from increasing the rates on the two lowest tiers until the costs generated by the electricity crisis were paid off. Borenstein's work suggests that AB1X has had a much smaller effect in protecting low income households than has the CARE program and its expansion over the past decade.

TABLE 3: AVERAGE ANNUAL BILL BY INCOME BRACKET AND ALTERNATIVE TWO-TIER TARIFF

	Share of Customers	Implied Daily Use (kWh)	Average Annualized Bill: Bench	Two-tier	Percent Change	Dollar Change
PG&E						
$0-$20k	8.34%	8.01	$356	$451	26.6%	$95
$20k-$40k	15.07%	12.33	$597	$707	18.4%	$110
$40k-$60k	19.84%	15.92	$838	$926	10.5%	$88
$60k-$100k	29.89%	20.10	$1,161	$1,186	2.2%	$25
>$100k	26.87%	26.97	$1,807	$1,623	-10.2%	-$184
SCE						
$0-$20k	9.17%	7.92	$353	$441	25.0%	$88
$20k-$40k	15.74%	11.65	$550	$659	19.8%	$109
$40k-$60k	20.68%	15.62	$798	$900	12.7%	$102
$60k-$100k	31.09%	21.81	$1,262	$1,286	1.9%	$24
>$100k	23.32%	31.58	$2,137	$1,907	-10.8%	-$230
SDG&E						
$0-$20k	8.34%	4.73	$226	$261	15.3%	$35
$20k-$40k	18.41%	8.52	$416	$473	13.9%	$58
$40k-$60k	21.59%	12.78	$650	$723	11.2%	$73
$60k-$100k	29.02%	18.91	$1,063	$1,104	3.8%	$41
>$100k	22.64%	32.41	$2,142	$1,961	-8.5%	-$181