The Energy Crisis Gold Rush: Is It Curtailment or Operational Savings?

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ABSTRACT

Soaring electric costs last summer created a rush to shed electric load throughout the western U.S. Eugene Water & Electric Board, a Northwest public utility implemented a curtailment program that shared savings with large customers based on spot market costs. Shutting down production is not an option in the institutional sector. Since there was not time for efficiency measure installation, customers who achieved significant savings turned to traditional operational energy saving techniques. The focus was turning off fans, lights, and computers. One customer used cogeneration to reduce grid load.

This paper looks at the varying levels of success institutional and commercial customers had in reducing energy use and the methods they used to achieve savings. Customer response to a curtailment incentive program was found to be significant compared with savings produced by media coverage of the energy crisis. A case study reviews operational savings methods used at the local university. Persistence of savings activity after the end of the curtailment payment period is also reviewed.

Overview and Background

Amid wild fluctuations in the wholesale electric market, rolling blackouts in California, and expensive mid- and short-term power purchases, Northwest electric utilities had a need to produce immediate load reductions in the winter of 2001. The dramatic increase in wholesale market prices gave *saved* megawatt-hours new meaning in the utility industry. The issue of lost margin,[1] long a hurdle for conservation programs, disappeared almost overnight. Utility executives turned to Demand-Side Management (DSM) professionals to ramp up their conservation programs. Eugene Water & Electric Board (EWEB), an Oregon municipal utility with 72,000 residential and 4,000 general service customers, had an active conservation program focused on energy analysis and efficiency improvement or Energy Conservation Measure (ECM) incentives. In the face of what might be short-term market fluctuations, more rapid approaches were needed. Large customers with demand greater than 500 kW were contacted to investigate uses of on-site generation, operational savings, and curtailment of production or facility use.

The savings potential and load reduction impact of DSM have been clearly demonstrated over the past two decades (Hamzawi & Messenger 1994). DSM has historically focused on energy efficiency improvements developed over the long term. Recently, demand side solutions to generation shortages were proposed, extending DSM from average load reduction to real time load management (Kirby & Kueck 2000; Miller & Swaminathan 2000).

[1] When conservation programs reduce total electric revenue, then the margin between wholesale cost and retail prices is lost for sales not made. While conservation helps overall customer bills go down, the lost margin must be made up to cover fixed costs which can result in higher electric rates.

In a challenging presentation, Rudin pointed out that our focus on efficiency improvements merely slows the growth rate of per capita energy use and does not reduce it (Rudin 2000). Taking the message of "use less energy" to heart in the recent crisis, utilities asked customers to reduce load through behavior—not just with ECMs. Dedicated facility managers have demonstrated that focused operational efforts reliably save 10% to 20% of energy bills (Duff 1999; Herzog & LaVine 1992; Manczyk 2000). Yet the application of these techniques seems sporadic and underused. In one example, after a successful pilot providing no-cost resource managers to Oregon school districts, marketing the same services—at a fee expected to provide large net positive results—failed to attract buyers (Miller 1999). Perhaps behind all this is the fact that even on the heels of an energy crisis, only half of Americans believe that there is an energy shortage (AP 2002).

So, real energy savings can be achieved through behavioral changes. In response to energy crisis news alone, large EWEB customers saved a significant amount of energy. Yet, carrying these behavioral changes beyond a crisis period may be difficult if there are questions about the severity of the crisis. EWEB implemented a large customer curtailment incentive program that did expand the energy reductions. While industrial customers were included, this paper focuses on the institutional and commercial customers in relation to the following questions:

- How can utilities influence customer (and non-customer) energy use behavior?
- What results were produced in the commercial/institutional sector by a 6-month curtailment incentive program that rewarded energy savings?
- What did participants report about their motivation and approach to saving?
- What education program elements were used to extend operation and maintenance (O&M) savings efforts to a broader audience?
- How did a local university apply methods to change energy use behavior?

The Wholesale Problem

As Pacific Northwest utilities faced increasing wholesale prices in a low-water year, market electric rates became a serious factor for EWEB, since short-term purchased power meets the last 5% to 10% increment of EWEB load. When market rates are high, the marginal load is disproportionately expensive compared to owned generation and longer-term contracts. For the year beginning in October 2000, EWEB faced a situation where a 1% rate increase would gain about $1,000,000 while reducing load 1% would save $5,000,000 in wholesale power cost.[2] This five-to-one ratio called for immediate action to achieve customer energy load reductions.

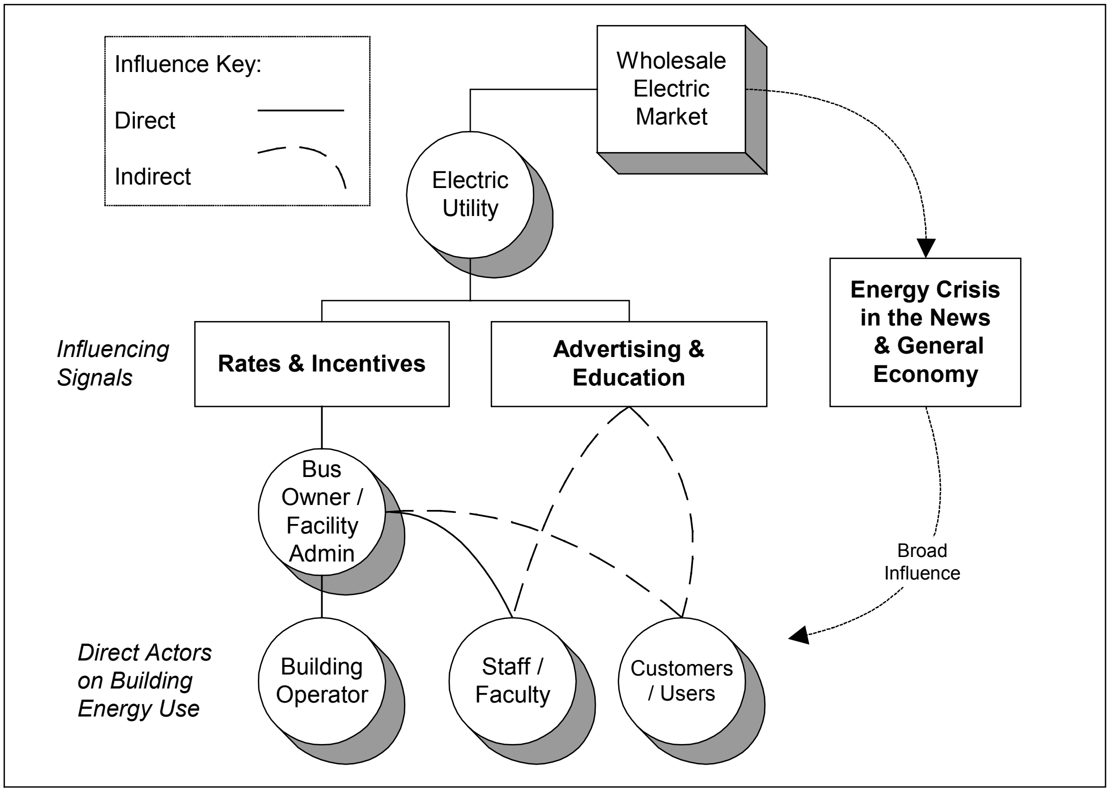
Utility Influence on Customer Behavior

The ways an electric utility can influence customers and other energy users are shown in Figure 1. Traditional signals to customers include retail rates and incentives for efficiency installation. The business owner or facility management implements efficiency

[2] EWEB could use its position as a generating utility in the Northwest—where a primarily hydro system buffers peak load most of the time—so that savings acquired at any time could essentially be stored to meet peak loads.

improvements and manages utility budgets. Utility relationships with these parties have developed through DSM programs and key account management. EWEB's efforts to achieve immediate savings focused on these established relationships, especially with large customers where the savings potential was higher. This worked very well with customers who could dispatch generation with a simple order.

Figure 1. Ways for Utilities to Influence Behavior of Energy Users



To move beyond generation and efficiency improvement and achieve behavior-based energy use reductions, actors at a layer below direct utility contact must be reached. The program must target behavior of building operators, general staff, and non-staff occupants such as customers and students. To reach this broader and more removed audience, the utility must provide general education to energy users, or encourage direct customers to engage their end users. The various influence methods available to a utility are:

- **Retail Rate Signals:** Monthly escalation charges or real-time rates would send immediate price signals to energy buyers. However, customers prefer stable rates that do not reflect short-term market swings, so retail rates[3] are often designed to recover average costs and are updated on a 6- or 12-month cycle.
- **Efficiency Incentives:** Efficiency incentives get long-term efficiency measures installed and reduce the overall load growth, but do not produce fast reductions.

[3] In 2001, the difference between peak and off-peak wholesale costs in the Northwest was much less than the difference between the short-term market cost and EWEB's cost of self-generated or regionally contracted (BPA) power. Long-term seasonal differences are minor, so a simple energy and demand schedule is used. During the curtailment incentive program, large general service rates were \$0.02652/kWh and \$3.80/kW.

- **Curtailment Incentives:** Energy reduction incentives can be adjusted rapidly to reward reduction of grid load, either through on-site generation, facility shutdown, shift management, or aggressive operational savings programs.
- **Energy Analysis:** This traditional technical assistance can have a stronger emphasis on operational procedures and energy tracking to induce more rapid saving results.
- **Energy Education:** The utility can participate in energy use education by support of building operator enrollment in third party programs, on-site training for staff, direct operational training, speaking engagements, and general advertising of "energy tips."

Curtailment Incentive Program

In the face of high marginal wholesale electric costs, EWEB rapidly implemented a contracted shared savings program that offered Large General Service[4] customers a credit on their monthly utility bill for reducing their monthly energy use by at least 5%[5] below the same period the prior year (EWEB 2001a). The credit offered was one-half the cost of electricity saved during the period based on peak and off-peak wholesale market prices[6]. The remainder of the savings would be retained by EWEB for the benefit of all customers after covering administrative costs and free ridership. Monthly wholesale prices, incentive payments and MWh reductions are shown in Table 1.

Table 1. Monthly Results, Incentive Payouts, Wholesale Prices, and Value

Month 2001	MWh Reduction[1]			Paid to Participants		Market $/MWh		Value to EWEB[3]
	Commercial	Industrial[2]	Total	Incentive	$/MWh	Peak	Off-Peak	
Apr	1,399	11,266	12,665	$1,717,691	$135.6	$311.1	$240.4	$3,380,325
May	1,500	2,206	3,706	$405,187	$109.3	$222.7	$161.9	$675,080
Jun	2,613	1,256	3,869	$404,301	$104.5	$72.5	$53.3	$242,720
Jul	2,837	1,877	4,713	$456,110	$96.8	$48.2	$34.3	$198,624
Aug	2,830	1,826	4,656	$251,255	$54.0	$40.0	$30.5	$165,113
Sep	2,187	1,924	4,111	$28,202	$6.9	$23.5	$19.1	$56,570
Sum/*Avg*	**13,365**	**20,355**	**33,720**	**$3,262,745**	***$96.8***	***$119.7***	***$89.9***	**$4,718,431**

1 Includes 3 customers with measurable savings who did not meet the 5% minimum needed for a billing credit.
2 Industrial results reduced dramatically after the first month when EWEB terminated a contract with a large industrial participant based on the "no layoff" requirement.
3 Value after incentives was $1,455,686 or 31% of wholesale value. This was less than 50% due to the future price contract option and is not adjusted for administration, lost margin, or free ridership.

Customers were offered a six-month contract, from April 1 through September 30, 2001. EWEB's Board of Commissioners approved the concept if curtailment did not come

4 Limiting participation to the smaller group of large general service and contract customers with existing interval metering made administering the program manageable. EWEB staff contemplated expanding the curtailment program into a savings rebate program for a broader group of 4000 general service customers. After analysis, staff determined that communicating curtailment rules would be difficult and coding the calculations into our customer billing system would be infeasible in the rapid time frame needed.
5 A 5% savings in the calendar month v. the same month in 2000 was required to qualify for a billing credit for the month. Once a site qualified for the month, the credit was based on the total savings.
6 Wholesale prices were based on two daily (non-firm) prices from the Mid-Columbia Wholesale Power Price Index: one for heavy-load hours (peak: 6 a.m. to 10 p.m. Mon.-Sat.) and one for light-load hours (off-peak). These prices were averaged for each month and applied at 50% to the customer peak and off-peak kWh savings during the month based on interval metering comparisons with the reference (prior) year.

from employee layoffs. The contract included two options for customers to choose from: (1) an actual market price option or (2) a fixed price option based on forward prices.[7]

In all, 29 customers participated in the curtailment program, 14 of them in the institutional and commercial sector. The overall results from the program are shown by sector and source in Table 2. While industrial generation and savings were significant, this paper will focus on the 40% share of energy reduction from curtailment incentives in the commercial and institutional sector, where half of the reductions came from one generator and half of the reductions came from operational and efficiency savings.

Table 2. Overall Curtailment Program Results by Sector

Sector/Source	Customers	MWh Reduction	Contribution	Incentive Paid
Industrial Savings & Generation[1]	15	20,355	60.4%	$1,803,304
General Commercial/Institutional Savings	13	3,932	11.7%	$240,187
University Savings	1	2,601	7.7%	$336,194
University Generation	-	6,832	20.3%	$883,059
Total	**29**	**33,720**	**100.0%**	**$3,262,745**

[1]Only one industrial customer (wastewater treatment) had generation (methane-source) at less than 543 MWh.

To quantify savings for periods matching peak and off-peak hours, interval metering was required. EWEB had a network of 15-minute interval meters[8] already in place on most of the Large General Service meters. EWEB also had 50 meters previously subscribed to a meter data service that gave customers access to hourly load profiles via the Internet. Subscription was required for curtailment program participation, and the remaining 37 meters were added to the online data service.[9] Each customer was provided with secure, password-protected access to a website, where the previous day's hourly load profiles could be accessed, enabling them to directly see the results of their load reduction efforts. The customer could review hourly savings versus the 2000 baseline, and see the cumulative curtailment billing credit thus far for the month, based on actual wholesale prices. Several participating customers said the next-day feedback was a strong motivator and helped them fine-tune their curtailment efforts daily.

On-site generation. Two commercial/institutional customers had on-site generation,[10] but only the University of Oregon (UO) increased generation under the curtailment contract. The

[7] The forward price option indicated EWEB's strong expectation of continued rising prices. Since prices dropped faster than expected (see Table 1), it was fortunate that only 3 of the 29 customers chose forward prices. When market prices softened, EWEB executed a 30 day notification clause resulting in lost benefit.

[8] Meters were installed in 1998 to support load research. Data included kW, kWh, kVAR and kVAR hours. Separate retrofit data recorders (that can store 30 days of data) upload daily over inbound phone lines. Data is validated, archived, and transferred to a host website for online access by customers the next day.

[9] In order for two key account managers to administer the 87 meters included in the program, EWEB upgraded the web-based profile viewing software to track and quantify energy savings and estimated credits based on wholesale prices. The load curtailment software used interval baseline data extracted manually from 2000 interval data consumption history. The software calculated the curtailment savings, but required key account managers to compile the information and manually transfer the credits to the billing system monthly.

[10] The issue of local air pollution related to generation was raised when a neighboring utility used an emission credit (from a plant it paid to shut down) to operate rented diesel generators in a downtown substation. EWEB deferred to the Lane Regional Air Pollution Authority (LRAPA). If LRAPA authorized customers to operate generators that contributed to curtailment, EWEB would pay for that curtailment under the contract.

UO normally operated 5.5 MW of gas-boiler-served cogeneration in winter for heating steam. They operated steam turbines continuously during the curtailment period to provide 71% of their load reduction. The other commercial generation candidate was a hospital that had operated emergency diesel generation during a December 2001 electric system level 2 alert, but received noise complaints and chose not to commit to a six-month program.

Load Reduction Analysis

To give a picture of broad program impact independent of service size, site-monthly saving percentages from one year to the previous year were evaluated for participating commercial and institutional customers, excluding the UO. Figure 2 shows the average of monthly site savings for each year compared to the previous year. Note that overall, the 2001 savings is greater than the previous 4 years. A distribution of the same month-site-occurrences by 5% savings bins is shown in Figure 3, this time grouped by year. Note that the 1997 through 2000 distributions match closely, while the 2001 distribution shifts to the right due to more instances of higher-percentage savings. Clearly, 2001 had greater savings.

Figure 2. History of Monthly Savings

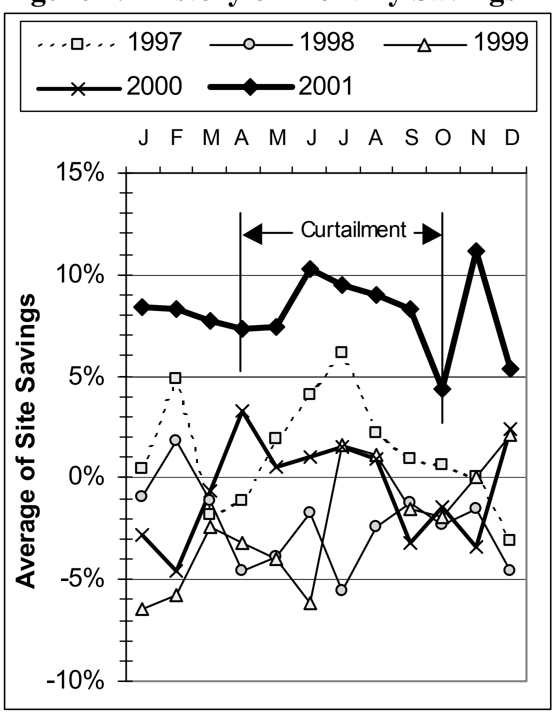
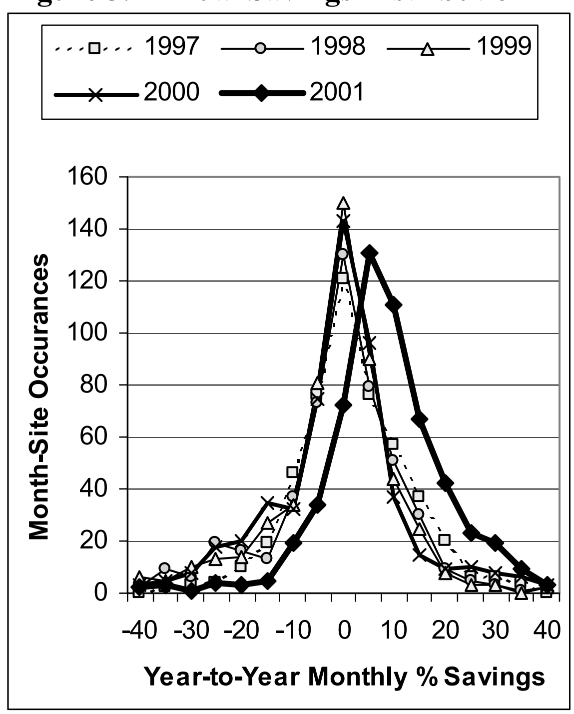


Figure 3. Annual Savings Distribution



The monthly savings percentage versus the previous year per site from each of these years is compared to a typical 1.5% growth rate (-1.5% savings) in Table 3. For the years 1998 to 2000 the sample difference compared to the expected growth rate is not significant. The 1997 sample is significantly different from expectation, although the difference is small at less than 3%. The 2001 data (570 observations) shows an average savings 9.1% higher than the expected level that is found to be significant with a population mean *t*-test.

While 2001 savings is greater, the data represented by Figure 2 shows an unanticipated high savings in the first quarter of 2001 that occurred before the curtailment incentive offer and before an April 1st 6% rate increase. One can speculate that customer savings was caused by media attention to the energy crisis, announcement of the first significant local electric rate increase in five years, or by changing economic conditions. No matter what the cause, increased monthly savings clearly occurred *before* the curtailment program began. This information was not yet available during program design.

Table 3. Year-to-Year Savings Analysis

Saving Percentages v. Typical Growth			
Savings Comparison	**Average Savings**	**St'd Dev.**	***P*-value** Ho: $\mu = -1.5\%$
1997 v. 1996	+1.25%	13.72%	.000009
1998 v. 1997	-2.36%	14.91%	.1967
1999 v. 1998	-2.15%	14.22%	.2921
2000 v. 1999	-0.58%	17.44%	.2152
2001 v. 2000	+8.10%	15.28%	.000000

Table 4. Quarterly Savings Analysis

2001 Curtailment Quarterly Comparisons[1]			
Period	**Mean Savings kWh (%)**	**Obsv'n Mo-Site**	***P*-value** Ha: $\mu > 0$
1Q 2001	7,781 (5.8%)	143	Basis: kWh monthly savings '01 v. '00
2/3Q '01	12,188 (9.4%)	284	
4Q 2001	10,744 (8.1%)	143	
1Q (before) v. 2/3Q (curtailment) 2001:			.0132
2/3Q (curtailment) v. 4Q (after) 2001:			.2452
1Q (before) v. 4Q (after) 2001:			.1087

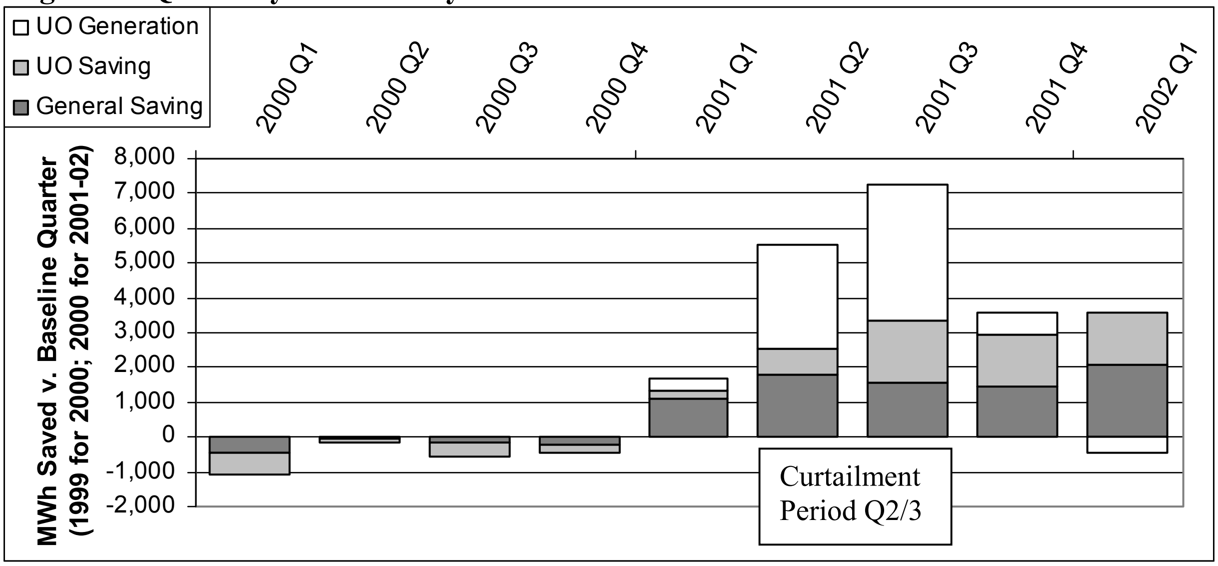
[1] Quarterly two-sample *t*-tests include general commercial/institutional curtailment participants with 6 (1.0%) outlier readings excluded beyond ±70% savings (either service start/stops or data errors). UO, community college (no savings due to building expansion), and one grocery store with construction shutdown are excluded. Seasonal effects were found insignificant by testing regressions of savings v. quarter ($R^2 < .05$) and savings v. increase or decrease in average monthly temperature ($R^2 < .02$).

To verify that actual savings resulted from the program, authors compared the monthly kWh savings in the six-month curtailment period with the preceding and following quarters as shown in Table 4. Savings during the curtailment period are 3.6% higher than the first quarter (significant at 0.05 confidence level). It is interesting that savings in the quarter following the curtailment period do not exhibit a significant difference from the curtailment period and had a marginally significant increase over the first quarter. This indicates that there may be persistence in operational savings from habits developed during the curtailment period, although the November 2001 36% rate increase is a likely influencer.

While the previous analysis is intended to look at the broad impact of the curtailment incentive program (how many commercial customers achieved savings), the total grid savings is the real utility benefit. In Figure 4, the quarterly MWh grid savings (2000 v. 1999 and 2001-2 v. 2000) for customers who received incentives is shown for nine quarters. The *general savings* category includes the commercial meters that were credited with curtailment incentives. Added to this is UO operational savings and increased generation.

If generation impacts are ignored, the 2001 first quarter savings of 1,350 MWh (that can be attributed to rate anticipation or media attention) more than doubled during the curtailment program (119% increase to almost 3,000 MWh per quarter). After curtailment payments cease, these saving levels are maintained at very close (10% increase) to curtailment period levels for two quarters. So, while the generation returns to normal without the payments, total operational savings appear to continue without curtailment incentives. This may be due to habits learned during the curtailment program that are reinforced by rate increases (6% in April 2001, 39% in November 2001, and 4% in May 2002).

Figure 4. Quarterly Total Utility Load Reductions



Comparison to Other Curtailment Programs

While a detailed analysis of other utility curtailment programs is beyond the scope of this paper, they deserve some mention. In 2001, these programs fell into two general types, and had different results based on informal information gathering.

- Payment was offered for curtailment during high cost periods (independent of alerts) by several utilities (primarily in the Northwest), including EWEB, PGE, Pacific Power, Seattle City Light, and others. Payment ranged from a 20/20 program where those who saved 20% in a month got 20% off their bill, to specific peak/off-peak curtailment agreements with large customers like the EWEB program. Overall, savings was in the range of 5% to 10% of monthly energy use for these programs.
- In California, with the presence of repeated alerts and rolling blackouts, several utilities rewarded large customers who reduced load during alert events by reducing their chance of firm load interruption. Typically if a customer reduced their load by 20% when notified (helping general system loads), their feeder would move lower on the planned interruption rotation list. With the carrot of improved reliability, incentive payments were not needed. These types of programs had higher peak savings of around 15%, but for limited periods of time during alerts.

Customer Actions Save Energy

Participating customers made a combination of operational changes and efficiency changes. EWEB staff conducted a scripted telephone survey of participating customer facility managers five months after the curtailment period. A summary of reported actions is included in Table 5. The most common method reported by customers was operational: turning off interior lights and office equipment. Of the efficiency changes reported, lighting retrofits were the most common. No commercial or institutional customers reported shutdown of buildings or portions of buildings to achieve reductions.

In addition to the standard survey responses, participants also commented on the program. University Housing "lowered lighting levels to legal [*sic*] minimums by using light meters and removing lamps." They found it "difficult to save because they could not control [residents'] behavior." UO Athletics "required people to unplug unused equipment;" however, they found some staff "reluctant to shut off lights when out of offices."

Table 5. Customer-Stated Motivation and Actions Taken

Customer[1]	**Participant Motivation**[2]				**Actions Taken**													
					Operational Changes							**Efficiency Changes**					**Other**	
	Reduce Energy Costs	Receive Utility Curtailment Credit	Help With Energy Crisis (Civic Duty)	Other Reason	Reduce Facility Use	Interior Lights, Office Equipment	Night / Weekend Tempe. Set-Back	Exterior Lights	De-Lamp Luminaires	Temperature Settings	HVAC Controls	Lighting Retrofit	Lighting Controls	HVAC Controls	Replace HVAC	Replace Chiller or Boiler	On-site Generation	Other Action
UO Main Campus	5	5	3	5		●	●		●	●	●	●	●	●			●	●
UO Housing	4	5	2	4		●	●		●	●		●						
UO Athletics	5	5	4	-		●	●	●	●	●	●	●	●					
Community Col.	5	5	3	3		●	●	●	●									
School Dist 1	3	5	1	-		●	●	●										
School Dist 2	4	4	2	4		●	●				●							
City Facilities	5	5	3	5		●	●	●	●	●	●	●	●					●
County Facilities	5	-	5	-		●	●	●	●			●	●	●	●	●		
County Fair	5	5	5	-		●	●	●	●	●		●	●	●				
Federal Office	5	3	3	-		●	●	●	●	●	●	●						
Grocery 1	5	5	1	-		●			●									
Grocery 2	5	5	3	-		●	●		●	●	●		●					
Avg Score/ % Total	4.7	4.7	2.9	4.2	0%	100%	92%	58%	83%	58%	50%	58%	50%	25%	8%	8%	8%	17%

[1] One retail department/grocery customer was unavailable for survey due to staff reductions.
[2] Scale of 1 to 5, with 5 being the highest motivation as indicated by the customer in phone survey response.

The community college did not meet the 5% incentive minimum due to added load from new construction, but focused on saving anyway, with "executive support for the curtailment effort;" however, they also reported that some students and staff "felt unsafe with reduced lighting." A school district reported that "occupants complained about temperature setbacks, [so] thermostats were adjusted in response to those complaints." A city energy manager indicated "management issued a formal Administrative Order to demonstrate the importance of the program, [but the] short time frame for the program made it difficult to start up projects and achieve results before the end of the program."

Internal communication methods used. Participating customers used a variety of internal communication resources and methods as summarized in Table 6. Internal communication, suggestions from staff, and supervisor communication were the most common. One participant reported that the most exciting part of the curtailment effort was seeing staff going online daily to view the results of their efforts. This information motivated staff to participate in discussions to identify and implement solutions.

Savings achieved. Table 6 shows that all survey respondents reported that savings methods initiated during the curtailment period continued after the end of the program The survey responses are validated by the data (see Table 4 and Figure 4) that show the savings in the two quarters following the two-quarter curtailment period was not significantly different from the curtailment period.

Table 6. Customer Communication Methods and Savings Achieved

Customer	**People and Communications**													**Savings Achieved**	
	Communication					Training		Expertise			Administration				
	Newsletter	Posters/Banner	Switch Signs /Stickers	Supervisor	Other Methods	Utility Training	Other Training	Internal Staff	Consultant	Utility	Committee	Energy Manager		Achieved 5%	Continued Savings Efforts
UO Main Campus	●	●	●	●	●			●	●	●	●	●		●	●
UO Housing		●	●	●	●		●	●	●		●			●	●
UO Athletics					●			●	●					●	●
Community College	●				●	●	●	●	●			●			●
School Dist 1				●	●	●				●				●	●
School Dist 2					●		●	●			●			●	●
City Facilities			●	●	●		●	●		●	●	●		●	●
County Facilities	●		●	●					●	●	●			●	●
County Fair		●		●		●			●	●	●	●		●	●
Federal Office	●			●	●			●		●		●		●	●
Grocery 1		●		●	●			●						●	●
Grocery 2				●	●						●	●		●	●
Percentage of Respondents	33%	33%	33%	75%	83%	25%	33%	67%	50%	50%	58%	50%		92%	100%

Operational Savings Through Energy Education

A review of customer actions indicates that except for one generating customer, all the reductions in the commercial and institutional sector were due primarily to operational changes with some efficiency improvements. This sector did not actually curtail any activities or building use under the curtailment program. So, O&M savings are important to the success of curtailment programs in the commercial/institutional sector.

To support the curtailment program, and extend the savings benefit to other commercial customers, an existing operational savings education program was expanded. Four years ago, EWEB's *Energy Smart Operations* program focused on HVAC system commissioning. Two years ago, operational measure identification was added. In late 2000, the program expanded further to include general customer education.

Rather than repeat President Carter's "moral equivalent of war" message, a "wise energy use" tone was adopted. Load monitoring showed commercial after-hours energy use was a rich target for savings. Beyond just providing energy saving ideas and methods, motivational information about *why* energy needs to be saved was important. EWEB declared that this was the place for a "Ready, Fire, Aim" approach, with fast deployment of easy and effective measures. Several program components were added:

- A flyer with occupant measures "Save Energy at Work" on one side and a "Building Operator Checklist" on the back was mailed to business customers (EWEB 2001b).
- Talks to community business groups focused on occupant action measures.
- EWEB launched an operational savings program at their headquarters to "prove it could be done" and find out what it took. Staff achieved 9.2% annual savings.
- A search for a moderately detailed operations saving manual for customers found either brief check lists or more comprehensive information than most customers would use (EIC 2001; Haasl & Dodds 1998). Carter-era checklists were re-written into a 24-page manual that outlines a detailed operational savings program, including management and motivation topics as well as measures (Hart 2001).
- A three-hour operational training was presented monthly in fall 2001 to winter 2002.
- A local newspaper advertising campaign was launched in the fall of 2001 that alternated between 'energy tip of the week' and announcements of the O&M training.

Determining an actual behavior and savings result from advertising efforts is possible but difficult (Peters et al. 1998). Since the cost of the advertising and training program was low, evaluation was not undertaken. The educational effort was viewed as having a positive (if unknown) savings benefit and as creating goodwill in the face of large rate increases.

A Case Study: University Savings

The University of Oregon's past energy program participation and generation made them worthwhile candidates for our curtailment incentive program. In the fall of 2000, UO Facilities Services management appointed an energy committee that set a goal of reducing utility electrical load use by 15%. In early 2001, the governor asked State agencies to reduce energy use by 10%. EWEB increased ECM incentives by $0.05 cents per annual kWh saved for 2001 installations and provided a curtailment program from April through September 2001.

Daily campus electric load profiles shown in Figure 5 demonstrated that unoccupied energy loads exceeded 50% of the occupied load. As previously discussed and shown in Figure 1, energy users on campus are detached from their energy use choices because utility budgets are paid centrally with the exception of Housing and Athletics who pay for metered use.

Facilities management educated University faculty, staff, and students through campus newsletter articles, email announcements, and a web page; asking them to help save energy and accept shorter hours in several buildings. Armed with the hourly profile, discussions with computer services department resulted in a policy change to encourage overnight shutdown of computer lab workstations. Starting fall term 2001, the UO Administration added a $30 per term energy surcharge to all students. Students responded by forming a *Doin' It in the Dark* energy awareness campaign (Huber 2002). Subsequently, the surcharge has been reduced to $20 per term and may be eliminated if savings persist.

Facilities management found the most success where they had direct control. Building operators shut down building systems during unoccupied times and reduced lighting. ECM implementation was accelerated, including design/build lighting control installation, time control installation, and occupancy sensor controlled power strips to reduce unoccupied plug loads. Large savings were obtained during spring break and summer with better focus on schedule control. EWEB also worked with the UO Housing and Athletic Departments to upgrade lighting and controls and implement similar educational outreach.

Figure 5. Daily Profiles Nov. '01 v. '00

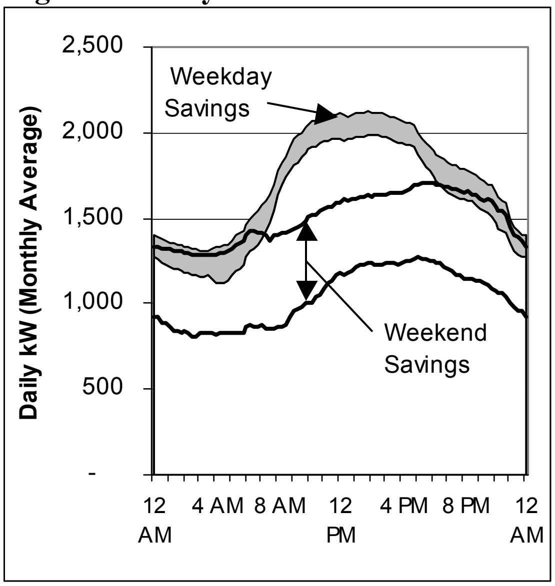
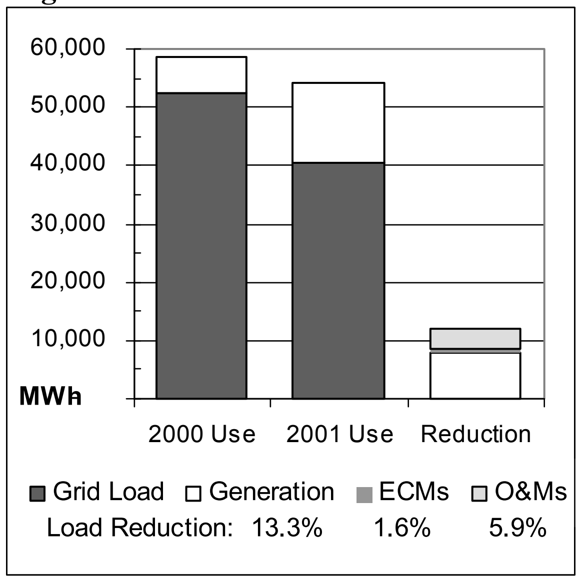


Figure 6. UO Electric Load Reductions



By the end of 2001 UO reduced monthly campus load by 11% versus a 1997 to 2000 average.

Figure 6 shows overall 2000 and 2001 grid loads and reductions due to ECMs, O&Ms, and increased generation. While electric energy use per square foot has reduced over the past decade, this is the first gross reduction in campus electric load that is clearly the result of behavioral changes and ECMs. For 2001, 75% of the savings were accomplished by O&Ms and 25% by ECM implementation. As can be seen by the increasing UO savings over time in Figure 4, the curtailment incentive was a useful lever in getting UO staff to give high priority to operational savings and accelerate ECM implementation during 2001.

Conclusions, Lessons, and Recommendations

This study of a utility curtailment incentive program in the institutional/commercial sector resulted in the following conclusions, lessons, and recommendations.

Curtailment incentive savings. The curtailment incentives produced significant results:

- Large commercial customers reacted to energy crisis media coverage or anticipated rate increases and saved significantly (5.8%) *before* curtailment incentives began.
- Additional reductions (3.9% for general, 27.2% for UO) were achieved by incenting large commercial customers to reduce load when wholesale electric costs were high.

Source of savings. Beyond generation provided by one customer, reductions came primarily from operational improvements with secondary savings from efficiency measure investment. Savings did not result from facility shutdown.

- The importance of operational measures in creating rapid and sustained load reductions indicates the value of customer energy operation training and suggests that operational education is worth utility funding.
- Savings from operational measures persisted for at least two quarters after the curtailment incentive period, although a 36% rate increase probably influenced.

Program design suggestions. Basing the credit on a published price index gave credibility to the prices used. The fact that savings occurred before the program started supported having a 5% minimum energy savings as a threshold for issuing credits. Overall, the curtailment program produced a benefit, but was hurt by the forward price contract with the UO (although there was a chance that forward price option could have increased the utility benefit). The 30-day notification clause resulted in lost benefit when market prices softened. Suggested curtailment incentive program changes are:

- The forward price option was not needed as a motivator for customer participation. Sharing the savings as a fixed percentage of actual wholesale prices provides the best balance of utility risk management and providing a sense of win-win to customers.
- Eliminating the termination notification period or adding the option for either party to suspend the contract on short notice would improve flexibility.
- It may seem prudent to reduce the participant share of the wholesale cost received; however, savings may be offset by reduced participation when customer share is less than 50%. Based on pre-curtailment savings, a fair approach would be to count savings only above a 5% threshold each month and maintain a 50% split. Larger savers would be rewarded, and a base level of free ridership eliminated.

Key accounts, metering, and software. Existing interval metering, web-based customer access to energy profiles, and key account relationships were instrumental in rapid creation and deployment of a curtailment program. Stronger program delivery across more customer rate classes would have been possible with the following added infrastructure:

- Enhancement of the interval data viewing software to provide monthly energy trend analysis would help customers save more using energy accounting principals.
- Some customers were unable to achieve simply measured savings due to building expansions. A complex method of weighted savings calculations is not the answer. Building sub-metering for campuses would allow savings in each building to be rewarded and help campus managers better target saving efforts.
- A more uniform utility bill presentation across utilities would improve customer energy data understanding (Payne & Berkeley 2000). Recent EWEB business bill improvements (monthly kWh/day comparisons to last month and a year ago) help; however, there is no utility-provided tracking that combines meters or compares facilities. Having year-to-year savings calculations built into current billings would make rapid development of a more broadly targeted energy reduction incentive program possible in the next crisis.

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