IMPACT OF A CONTINUING ELECTRICITY CRISIS ON THE CALIFORNIA ECONOMY

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EXECUTIVE SUMMARY

Businesses, industry, and consumers in California are suffering from a serious shortfall of electricity supply and high wholesale power prices. This situation has its roots in a mix of energy policy miscues, faulty deregulation, ineffective electricity demand planning, and sharply higher natural gas prices that have increased the cost of generating electricity.

Despite recent sharp increases in wholesale electricity prices, the basic imbalance between supplies of electricity and demand in California remains severe. Higher electricity prices will likely reduce growth in demand, both for households and industrial consumers. New generation capacity in California is under construction. However it will take several years before this provides significant relief from increasing demand pressures. The California Independent System Operator (CAISO) anticipates an electricity supply deficiency, or shortfall, of between 666 and 3,647 mega watts (MW) for the June through September 2001 summer period. At peak load demand levels projected by CAISO this could lead to 110 hours of potential rolling blackouts. Considering that the average electricity shutoff period during the eight-hour March 2001 rolling blackout was 90 minutes, this translates into 20 hours of outage per customer this summer.

Rolling blackouts that culminate in 20 hours of electricity outage will have significant adverse implications for growth of the State economy and will result in lost jobs and reduced income for Californians.

- Gross State Output (GSP) for California would be reduced by $21.8 billion (constant 1996 dollars), or 1.7 percent, in 2001. This would reduce the growth rate of California GSP from the 2.3 percent currently projected by the UCLA Anderson Forecast to 0.6 percent for all of 2001. This loss has two components:
  - A direct loss of output experienced by all industries due to the effects of the blackouts in the amount of $6.8 billion. Of this, California's manufacturers would lose 18 percent, or more than $1.2 billion.

  - An indirect effect reflecting the fact that each dollar of output by one industry represents the purchase of output (i.e. goods and services) by other industries. This amounts to $14.9 billion.

- A loss of output of this magnitude would reduce household income for Californians by $4.6 billion. This is a loss of $104 for every one of California's 11.5 million households. Important to note is that this loss is in addition to the impact of higher electricity costs resulting from recent rate increases.

- 135,755 jobs would be lost in all industries in the California economy.

The CAISO projection is most likely a "best case" scenario. The electric power situation in California will likely become more unstable over the summer. This could result in more and longer periods of supply disruption, greater unpredictability regarding supply, and higher prices for electricity. A number of factors could combine to increase the rolling blackout period and effective blackouts.

- Stronger demand than is currently projected due to a hotter and drier than expected summer.

- Reduced electricity supply due to any number of factors such as unscheduled plant shutdowns.

- Longer duration of outages than the average 90 minutes experienced earlier this year.

If any, or all, of these occur, the output loss to California business and industry will be larger, as will the aggregate loss to GSP, California household income, and jobs. Any additional periods of effective electricity loss in excess of 20 hours due to rolling blackouts would be sufficient to push the California economy into recession this year.

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Businesses, industry, and consumers in California are suffering from a serious shortfall of electricity supply and high wholesale power prices. This situation, frequently referred to in crisis terms, has its roots in a mix of energy policy miscues, faulty deregulation, ineffective electricity demand planning, and sharply higher natural gas prices that have increased the cost of generating electricity.

Until recently most of the policy emphasis in California has focused on supply and not demand. Protection of retail consumers from higher electricity prices through the maintenance of price caps provides no incentive for consumers to reduce demand through conservation. This squeeze between increasing costs for electricity and the inability to pass these higher costs along to a large segment of the consumer base has pushed several California electricity distributors to the point of bankruptcy. Customers will have more incentive to conserve starting in June when rate increases approved by the California Public Utility Commission (CPUC) in March go into effect.

The basic imbalance between supplies of electricity and demand in California remains. Higher electricity prices will likely reduce growth in demand, both for households and industrial consumers. New generation capacity in California is under construction, however, it will take several years before this provides significant relief from increasing demand pressures. The seriousness of the current situation and the scenario that will play out for California will depend in large part on weather conditions this summer. The West is experiencing drought conditions that have resulted in a smaller than normal winter snow pack. As a consequence, low water levels in dams are constraining hydroelectric power generation. A hotter and drier than normal summer will further stress hydro production and increase electricity demand on hot summer afternoons.

Considering these factors, the electric power situation in California will likely become more unstable for California businesses. They could experience more and longer periods of supply disruption, greater unpredictability regarding supply, and higher prices for electricity. The combination of the higher costs associated with the necessity to adapt operating procedures to cope with unstable energy supplies and higher electricity and other energy prices can be expected to adversely affect output in all California industries; prompting firms and industries to move operations out of California, and discouraging new firms from locating or expanding in the State. This will, in turn, reduce the rate of job creation and

accelerate the loss of jobs already exacerbated by a slowdown in the national economy, reducing household income, and lowering tax receipts for the State and local governments.

The objective of this study is to quantify the impact on California's major industries of continued electricity shortfalls throughout the summer of 2001 that result in continuing rolling blackouts. Specific attention is devoted to estimating the implications of continued rolling blackouts for growth in Gross State Output, employment, and household income.

Methodology

The results of this study are based on a combination of qualitative and quantitative analysis. The quantitative estimates of the impact of the continuing electricity crisis and rolling blackouts on the California economy were based on data developed through qualitative survey research. Information regarding the anticipated response of business and industry to power outages was gathered from key informants representing businesses in the various sectors of California's private economy. Telephone interviews were conducted with representatives from thirty-four companies representing most of the California economy.

Qualitative research provides depth, specificity, range, and context to understanding the economic impacts relative to outages caused by rolling blackouts. The results of the survey were used as a basis for developing quantitative estimates of the effect of outages on output by industry. Each interview followed a protocol consisting of a set of questions designed to elicit economic impact estimates relative to power outages along with supporting anecdotal comments. This particular qualitative approach is a modified Delphi technique[1], wherein individuals with expertise in a particular area are engaged in a structured analysis. The process used here is a modification of the Delphi technique in that each respondent was asked to answer the question from their company's perspective but the group was not asked to achieve consensus for each economic sector. The respondent answers were then combined to develop quantitative assumptions for the economic impact model.

Respondents were asked for information regarding their company's activities in California, number of employees, and whether they had been affected by rotating outages. Additional questions were used to

[1] The Delphi technique was first used by the Rand Corporation in 1969. Named after the Greek oracle well-known for making ambiguous predictions of the future, this structured approach is a simple, yet powerful method for analyzing multi-dimensional data. A panel of knowledgeable people are used to develop a consensus analysis relative to a particular issue. This is from W.J. Rothwell and H.J. Sredl (1992). *The ASTD Reference Guide to Professional Human Resource Development Roles and Competencies*, (2nd Ed.). Amherst, MA: HRD Press.

elicit responses about strategic moves the company has already made in response to the electricity crisis, as well as strategic moves that are being considered. Each respondent was asked to estimate the effect on production or company revenue caused by 3 hours of interrupted electricity over the span of one week. Information regarding responses to electricity price increases was elicited by asking about strategic moves that would be prompted by a 50 percent and 100 percent increase in the price of electricity. Information on self-generation capacity along with plans for expansion was also gathered.

As indicated earlier, 34 companies representing 25 industry sectors were interviewed. These industries account for almost two-thirds of California GSP. The following table summarizes the economic sectors covered by the interviews. Most industry sectors were covered by two interviews.

INTERVIEW RESULTS

The following sections summarize the responses of interviewees to questions regarding several key areas of research: effects of outages on industry output; strategic moves in the face of continuing blackouts; response to electricity price increases, and self-generation.

Effects of Outages

Two-thirds of the companies involved in the qualitative interviews were directly affected by outages. Several of those who reported no outages were affected by curtailment requirements. Some had paid large penalties to keep the power on and prevent outages.

The companies who participated in the interviews employed a total of over 340,000 people in California. Economic impacts reported by the respondents varied from none to tens of millions of dollars in lost output and costs. One respondent said, “We got absolutely killed with interruptions. It was a total triage situation.” Some could not or would not even venture to guess at the economic effect on their company.

For those reporting minimal effects, favorable geographic location was the primary reason. One respondent credited the lack of economic impact to strategic moves made years ago that included a favorable site choice for a new facility, non-interruptible electrical supply contracts, increased self-generation capacity, and the conservation of electricity.

Table 1
Industry Sectors Covered by Qualitative Research

Industry	1998 GSP (Mil $96)	Percent of Total
Total Gross State Product	$1,093,871	
Agriculture, forest., fish	$23,243	2.1%
Manufacturing		
Food & kindred products	$12,797	1.2%
Paper products	$2,688	0.2%
Chemicals	$8,073	0.7%
Petroleum products	$4,950	0.5%
Rubber & plastics and Leather	$3,951	0.4%
Lumber & wood products	$2,982	0.3%
Furniture and fixtures	$2,603	0.2%
Stone, clay, glass	$3,191	0.3%
Primary metals	$2,338	0.2%
Fabricated metals	$7,868	0.7%
Industrial machinery	$31,532	2.9%
Electronic equipment	$38,933	3.6%
Instruments and related	$11,857	1.1%
Motor vehicles	$2,921	0.3%
Other transport. equip.	$8,032	0.7%
Misc. manufacturing	$3,456	0.3%
Electric, gas, & sanitary	$18,829	1.7%
Wholesale trade	$84,299	7.7%
Retail trade	$104,543	9.6%
F.I.R.E.	$240,262	22.0%
Services		
Hotels & lodging	$6,874	0.6%
Business services	$67,985	6.2%
Motion pictures	$14,200	1.3%
Amusement and recreation	$10,910	1.0%
Industries Surveyed	$719,317	65.8%

One of the retailers considered the outages as only an inconvenience; “we have to switch from the cash register to a battery powered calculator.” A wholesaler said that his company has a portable generator that allows them to keep the phones on, which is all they really need to do business.

Others who reported minimal effects talked about employee downtime during power outages, lost work from unsaved computer files, and employee tension due to the uncertainty of the situation. Another

talked about the overall cost of living for employees and the effect that might have on retaining and attracting skilled employees.

For those that reported significant damages, several mentioned having to modify production schedules away from a 24/7 schedule. Some had to cut back to two 8-hour shifts or one 12-hour shift. One reported a two-thirds decrease in production at two facilities during the outage periods. Another respondent reported interruptions so frequent that …"we ran out of product to ship to our customers and several of those had to shut down". Others reported damage to valuable equipment due to the power outages.

Many of the companies reported that one hour of power interruption translates into many hours of downtime. This ranges from four hours for every hour of interruption to 24 hours for every hour. When processes come to a halt, re-starting takes time. This is as true for the agricultural sector as for manufacturers. One farmer said that an hour of interruption at the head of the canal system could leave someone on the other end of the system without water for 24 hours.

Safety issues emerged as a major consequence of blackouts. Many manufacturing processes involve large-scale equipment and machines. Having adequate notice of a power loss so that equipment can be shut down, and notice of a return of service so that machinery and equipment does not restart while employees and workers are in vulnerable positions is essential to protecting employees in the workplace.

Many manufacturing processes are extremely sensitive to power interruptions. In the extreme, an eight-second lapse in power at a critical stage can result in nine months of lost output for one manufacturer. Another reported that their power interruption had occurred at a "non-critical" point in the company's processing. If it had occurred at a critical point, the loss would have been close to $800 million. One respondent said, "Our production decreased to 24 percent of normal with curtailments! We absolutely can not operate if power is interrupted, our manufacturing process is too 'power critical'." Another said that 20 minutes of down time means a loss of all production on the lines, plus the cost of removing the ruined product from the lines. Yet another said that for every hour they are off line, it costs up to $2 million. Others mentioned the penalties already paid as a result of contracts that required curtailments the company could not meet. One said, "we had to stay on power and it cost us $3 million for that day".

This information obtained through our surveys is supported by other research. The Bay Area Economic Forum recently published research that found companies could lose as much as $1 million dollars per

minute of blackout. Power outages among 190 high technology companies in the Bay Area in January 2001 were reported to have idled 100,000 employees at a cost of tens of millions of dollars[2].

The farmers who were interviewed confirmed that the irrigation aspects of their business were the most vulnerable to electricity outages. Much of California is a desert and without irrigation, crop failure can reach 100 percent. Many irrigation systems employed in the State are gravity flow or siphon style. This means that if the power is interrupted, the flow stops and the entire system must be restarted or primed. One farmer indicated that continued interruptions could drive him out of business.

Strategic Moves to Continuing Rolling Blackouts

Few respondents reported that they would not change business strategy in the face of continuing rolling blackouts and outages. One said, "we prefer to think this won't happen." Others mentioned trying to negotiate with electric suppliers to eliminate the uncertainty of when the power would go down. Another thought maybe they could arrange to have the power go down on Friday afternoon so employees could be sent home early.

Most respondents indicated that the risk of continuing rolling blackouts would prompt changes in the way they do business. Almost all respondents mentioned conservation measures that are already in place or being implemented. "No more sweaters at the office," one respondent said. Several companies mentioned switching to laptops with battery backups to avoid the loss of files when power is cut. Others have put emergency reaction plans in place to minimize the safety hazards brought about by the electricity outages.

Many manufacturers are tied to location because of access to inputs and raw materials. Consequently, their strategic choices are limited to conservation measures, adjusting work schedules, negotiations with the electricity suppliers, and self-generation.

One company reported already receiving 15 new generators. Another mentioned the installation of a back-up generator at a cost of $1.5 million. Yet another said they were re-starting a previously unused internal power plant. A majority of those interviewed are investigating the economics of self-generation. One representative of a very large manufacturing firm indicated that the company plans to become self sufficient in electric generation and leave the grid completely.

[2] McKinsey & Company, "The Bay Area—A Knowledge Economy Needs Power: A Report on California's Energy Crisis and Its Impact on the Bay Area Economy." Report submitted to the Bay Area Economic Forum, a partnership

Several respondents indicated that production lines may have to be shut down and product brought in from out of state if blackouts continue. One said, "we will have to move functions that are not location critical out of state." Others will have to adjust the work schedules, maybe going from a 24/7 operation to one 12-hour shift. Many respondents mentioned the need to develop creative production scheduling.

Everyone expects costs to increase both due to rate hikes and production distortions. Some plan to attempt to pass on cost increases to their customers, though a majority indicated that competition from producers in lower energy cost states would restrain the ability to successfully charge higher prices.

Response to Price Increases

Respondents were asked about strategic moves they might consider if electricity prices increased 50 percent and 100 percent. As mentioned above, very few firms indicated that there was sufficient room in the marketplace to pass higher costs along to customers in the form of higher prices. Several respondents said they would have to eat the price increases. One said, "we'll sit and wring our hands, there is no way out."

The responses to electricity price increases generally fall into six categories:[3]

- Pass on costs to consumers.
- Initiate energy conservation measures.
- Increase self-generation.
- Cut costs in other areas and become more efficient.
- Shift to alternative scheduling or reduce hours of production.
- Move out of state.

The action each company takes is a matter of individual situation and options. The fifty percent price increase appeared to result in less dramatic adjustment than a 100 percent price increase. When asked about the 50 percent increase the most frequently mentioned responses were to increase conservation measures, look at other (alternative) sources of energy, and pass on costs to customer if possible.

Many firms indicated that a 100 percent price increase, coupled with an uncertain electrical supply, would force them to seriously consider moving out of state. More than a third of those interviewed indicated

of the Bay Area Council and the Association of Bay Area Governments, April 2001. Available at www.bayeconfor.org.

[3] These were the same response categories that the Bay Area Economic Forum found in their research. See previous reference.

they would consider moving out of state. These firms currently employ more than 104,000 California residents.

Several firms indicated that faced with a 100 percent price increase, they would expand out of state and under no circumstances would new growth occur in California. Many indicated that margins are just too tight and competition too intense to stay profitable with large increases in electricity costs.

One dairy farmer who was interviewed said that the price of milk was at a 20 year low. A 100 percent increase in electricity prices combined with higher prices for crops that would result from the impact of electricity outages on irrigation and yields, could force him out of business. Large price increases for electricity could force farms in all commodities – livestock, poultry, dairy, row crop, cotton, vegetable, and fruit - already in a financially precarious position due to low commodity prices to sell out or file bankruptcy.

Self-Generation

Two-thirds of survey respondents already have some ability to self-generate electricity. The amount of self-generated electricity ranges from enough emergency power to get employees out of the building safely to being able to finish milking cows. As mentioned above, one company hopes to completely leave the grid when their self-generation ability reaches 100 percent of their requirements. However, most self-generation can supply only back-up power.

Nearly all those interviewed are considering expanding their ability to self-generate, and many have feasibility studies well underway. One firm indicated that they had already paid nearly $800,000 for a new generator.

Several respondents mentioned the downsides of self-generation. Air quality is a consideration and obtaining permits is an issue. There are currently rate penalties imposed by the power companies on those who self generate.

One company interviewed manufactures and sells generators. Their business is booming and inventory is at zero.

ECONOMIC EFFECTS OF ROLLING BLACKOUTS AND POWER OUTAGES

A major thrust of the interview process was to determine the impact of a power outage on the output of the firm and industry. Specifically, interviewees were asked to estimate the percent of one week's production output that would be lost during three hours of outage over the span of a week. The interviews provided *ad hoc* estimates of the impact on a company's production when electricity is lost. The quantitative estimates and anecdotal information were combined to generate an estimate of the percent of production that would be lost for each hour of outage across the various sectors of the California economy. It is a challenge to estimate the effect of an hour of electricity outage to the cost of a ruined production run, or of business lost when an outage shuts a down a firm[4].

The production decline was typically not a number that respondents had previously estimated. Many of the calculations were arrived at by estimating how much lost production is associated with each hour of downtime, by knowing how many hours a week the business operates, and estimating the percent of lost production for every hour of outage.

The impact of outages on commercial and industrial customers is difficult to quantify. In some industries one hour of downtime due to a power outage actually means that six hours of production are lost because production lines have to be cleaned out and machinery re-started. For others, one hour of lost electricity results in only one hour of production loss. In industry sectors with multiple observations or interviews, the estimates of production declines were averaged.

The loss estimates were further adjusted based on researcher knowledge and anecdotal information to derive the final production decline numbers. This additional analysis and adjustment is key to effective use of the qualitative process since the estimates provided are not completely statistically representative. The following table summarizes the estimates for each of the industry sectors obtained through the qualitative research and subsequent analysis. Estimates of production declines for industries for which no qualitative data were available were "derived" using results from industries with similar production characteristics.

[4] California Public Utilities Commission, "Energy Division's Report on Interruptible Programs and Rotating Outages," February 8, 2001, pp. 31. Available from the CA PUC website.

Table 2
Estimates of Output and Production Declines
Resulting From Outages

	Decline in output per week for 1 hr of outage (%)	Average Work Hours per week (Hours)	Industry Capacity Utilization (%)	Effective Work Hours Per week (Hours)	Decline in output per hour for 1 hr of outage (%)
Agriculture, forest., fisheries	5%	168	90.0%	151	0.033%
Manufacturing					
Food & kindred products	10%	168	79.0%	133	0.075%
Paper products	4%	168	80.1%	135	0.030%
Chemicals/Petroleum	10%	168	74.5%	125	0.080%
Rubber & plastics	2%	168	79.2%	133	0.015%
Lumber & wood/furniture	2%	168	72.9%	122	0.016%
Stone, clay, glass	10%	168	83.0%	139	0.072%
Primary metals	2%	168	80.9%	136	0.015%
Fabricated metals	2%	168	72.4%	122	0.016%
Industrial machinery	2%	168	80.0%	134	0.015%
Electronic equipment	5%	168	81.4%	137	0.037%
Instruments and related	5%	168	80.5%	135	0.037%
Motor vehicles	1%	168	68.8%	116	0.009%
Other transport. equip.	2%	168	72.4%	122	0.016%
Misc. manufacturing	2%	168	79.3%	133	0.015%
Electric, gas, & sanitary	1%	168	80.0%	134	0.007%
Wholesale trade	2%	84	90.0%	76	0.026%
Retail trade	3%	84	90.0%	76	0.040%
F.I.R.E.	3%	84	90.0%	76	0.040%
Services					
Personal services	2%	40	90.0%	36	0.056%
Business services	2%	40	90.0%	36	0.056%
Hotels/Amusement	5%	112	90.0%	101	0.050%
All other services	1%	112	90.0%	101	0.010%

Manufacturing

The manufacturing sector of California is diverse and contributed over $163 billion (1996 dollars), or 15 percent, of the Gross State Product of California in 1998. Estimates for production losses due to power outages within manufacturing vary widely depending on the energy intensiveness of the industry and the need to maintain continuous production lines. The sub-sectors most vulnerable to lost production include food and kindred products, chemical and petroleum products, and stone, clay and glass products. These businesses are affected most strongly because manufacturing processes are quickly compromised if power is lost and every hour of outage could lead to as much as a 10 percent decline in output per week.

Firms that manufacture paper products, electronic equipment, and instruments and related products also are dependent on electricity for production processes. However, many firms in these industries have made production adjustments or have found alternatives sources of electricity so as to minimize the potential effects of power outages. These firms indicated potential output losses of four to five percent of weekly output for every hour of outage.

Manufacturers of motor vehicles, rubber and plastics, lumber and wood and furniture, primary metals, fabricated metals, industrial machinery, other transportation equipment, and miscellaneous manufacturing report less sensitivity to power loss. Outages are serious for these manufacturers but the qualitative data indicate that these sub-sectors are able to absorb outages somewhat easier than other processes. Consequently, firms in these industries anticipate loses of one to two percent of weekly production if power is lost for one hour.

Agriculture, Forestry, and Fisheries

Farmers in California are as dependent on electricity as any other sector. For those farmers with animals such as dairy and poultry farmers, electricity is used to keep the animals cool and provide water for the animals. Many animals reared in confinement are sensitive to temperature extremes. The shut down of cooling fans in a single poultry grow out house due to power loss or mechanical failure can lead to the loss of 50,000 or more chickens in a matter of hours on a mildly warm day.

Nearly all farmers also are involved in some way with crop production. Irrigation systems require electricity for pumping water and are highly vulnerable to power losses. As described earlier, much of the irrigation in California is gravity flow. During a power outage, water stops flowing because the pump stops. When the flow is stopped, the prime in the system is lost and the water will not begin to flow until all systems are reset.

Mining, Construction, and Transportation

No qualitative data were obtained for these industry sectors and no estimates of output loss were made. Taken together these industries account for about 11 percent of California GSP.

Electric, Gas, and Sanitation

The overall impact on this sector is a challenge since several of the businesses in the group provide electricity. Qualitative data suggests a one percent decline in industry output per week for an hour of

outage. Even though industry participants produce electricity, in most cases headquarters and office facilities are supplied with purchased power.

Wholesale and Retail Trade

The wholesale trade sector is estimated to lose two percent of output for every one hour of electricity outage in a week. Qualitative data indicate that electricity is important to wholesalers mostly in terms of office use. One said that the important part of his business was the telephone and that they had self-generation capacity to the extent to keep phones on. The employees do not go home when the power goes out but continue working if possible.

Retailing incurs a larger production loss (three percent) since many retailers have to empty their stores of customers when the electricity goes out. This is primarily for liability and security reasons. For the larger retailers such as department stores, this results in significant economic effects. The smaller retailers indicated that they are not as affected. One woman who runs her own small retailing business, indicates that she lights candles and switches to a battery powered calculator when the electricity goes out.

Finance, Insurance, and Real Estate (F.I.R.E.)

The sub-sector representing financial, insurance, and real estate businesses is similar to the retail sector regarding the effect of outages. Banks have an elevated security concern that does not extend to the insurance or real estate businesses. The banking industry is more vulnerable to the uncertainty of when blackouts will occur since security would be compromised if prior knowledge of down alarm systems were available. Most insurance, securities, and real estate firms have limited “walk in” traffic and thus the effect is primarily on office staff. Computers are an important contributor to productivity in these industries and many firms have taken precautions to provide emergency power backup to avoid loss of data and damage to computer hardware from power spikes associated with outages and the return of electricity.

Services

The services sector is broken into four sub-categories: personal services, business services, hotels/amusement/motion pictures, and all other. The effects on weekly output of one hour of outage varies from five percent for hotels/amusement/motion pictures to two percent for personal and business services, and one percent for all other services. The qualitative data indicated that loss of electricity is very costly for amusement parks and motion pictures. Amusement rides have to be completely stopped and parks emptied because of security and liability concerns.

Several service industries such as health services and education are exempt from outages during blackouts or are not vulnerable to power outages.

ESTIMATING THE ECONOMIC IMPACT OF ROLLING BLACKOUTS

The economic impact of a rolling blackout is dependent on the length and frequency of the outage. According to the California Independent System Operator (CASIO), a non-profit, private corporation created to operate the State's transmission system, the shortfall in generation capacity is projected to total 110 hours during the months of June through September 2001.[5] Assuming an average duration of 90 minutes[6], this translates into a loss of electricity, or outage, of 20 hours for each customer over the summer months.

Note that there is a difference between the total duration of a rolling blackout and the number of hours of outage any given customer can expect. For example, the last outage event in March 2001 lasted for eight hours, but each customer experienced an average of 90 minutes of outage. This is because the outages are rotated or "rolled" through the blocks of customers. Each block was deprived of power for 90 minutes, no one block was forced to bear the entire burden of eight hours of outage. The calculation of the effective hours of power loss consistent with CASIO's Summer 2001 assessment is shown in Table 3.

[5] Operations Engineering, California Independent System Operator, CAISO 2001 Summer Assessment, Version 1.0, March 22, 2001.

[6] According to the California Public Utilities Commission's, Energy Divisions Report on Interruptible Programs and Rotating Outages, February 8, 2001, outages are estimated at 60-90 minutes (p. 5). An average of 90 minutes was used for the modeling based on the recent outage events in California (San Francisco Chronicle, March 20, 2001, "Blackouts Across California After PG&E Can't Pay Bills").

Table 3
Effective Hours of Outage Forecast for Summer 2001

Month	Forecast Demand (MW)	Forecast Shortfall (MW)	Forecast Outage Hours[7]	"Effective" Blackout Hours
June	46,488	3,647	56.5	10.6
July	45,798	1,444	23.5	4.4
August	47,703	1,248	19.5	3.6
September	44,231	666	10.8	2.0
Total	184,220	7,005	110.2	20.7

The value of the decline in industry output for every hour of outage can be calculated by multiplying the percentage decline in output per hour of outage (from Table 2 above) by the baseline value of 2001 real output for that industry. Multiplying the loss in the value of output per hour by the number of hours of outage then provides the total value of industry loss.

The baseline value of real output for 2001 (GSP in millions of 1996 dollars) for California is consistent with the March 2001 UCLA Anderson Forecast for the Nation and California.[8] Specifically, we applied the annual growth rates for real GSP for the period 1998 through 2001 to the estimate of California GSP for 1998 published by the U.S. Bureau of Economic Analysis (BEA). This indicates that real GSP in California in 2001 is projected to be 17.1 percent above 1998 levels, or $1,286 million (1996 dollars). The UCLA Forecast provides a projection of growth for the entire California economy. In order to arrive at estimates for industry output, we applied the industry-level shares of GSP published by BEA to the aggregate value of 2001 GSP. The levels of industry GSP, dollar value loss for every hour of effective blackout, and estimates of the direct loss by industry for outages of 20 hours and 40 hours are illustrated in Table 4.

[7] This was calculated using the total number of hours per month to calculate average MW/hr use of electricity.

[8] *The UCLA Anderson Forecast for the Nation and California*. The Anderson School at UCLA, March 2001.

Table 4
Direct Effects of Power Outages on 2001 Industry Output

	2001 CA GSP (Mil 96$)	Output Loss for 1 hr (Mil 96$)	Direct Output Loss (Mil 96$)	
			20 Hours	40 Hours
Total Gross State Product	$1,286,392		$6,833	$13,667
Agriculture, forest., fisheries	$27,334	$9.0	$181	$362
Manufacturing	$191,717		$1,216	$2,431
Food & kindred products	$15,049	$11.3	$227	$454
Paper products	$3,161	$0.9	$19	$38
Chemicals/Petro	$15,321	$12.2	$245	$490
Rubber & plastics	$4,383	$0.7	$13	$26
Lumber & wood/furniture	$6,568	$1.1	$21	$43
Stone, clay, glass	$3,753	$2.7	$54	$108
Primary metals	$2,749	$0.4	$8	$16
Fabricated metals	$9,253	$1.5	$30	$61
Industrial machinery	$37,082	$5.5	$110	$221
Electronic equipment	$45,785	$16.7	$335	$670
Instruments and related	$13,944	$5.2	$103	$206
Motor vehicles	$3,435	$0.3	$6	$12
Other transport. equip.	$9,446	$1.6	$31	$62
Misc. manufacturing	$4,328	$0.6	$13	$26
Electric, gas, & sanitary	$22,143	$1.6	$33	$66
Wholesale trade	$99,136	$26.2	$525	$1,049
Retail trade	$122,943	$48.8	$976	$1,951
F.I.R.E.	$282,548	$112.1	$2,242	$4,485
Services	$281,908		$1,661	$3,322
Personal services	$8,069	$4.5	$90	$179
Business services	$79,950	$44.4	$888	$1,777
Hotels/Amusements	$37,613	$18.7	$373	$746
All other services	$156,276	$15.5	$310	$620

Important to note is that the estimates shown in Table 4 are only the direct losses of output for each industry associated with outages caused by rolling blackouts. The full impact of outages on California GSP must take into account the fact that each industry affected by outages purchases the output of other industries. That is, every dollar of direct output lost by a California industry due to an external event such as a an outage caused by a rolling blackout is multiplied several times over as the firms, whose production is curtailed, spend less on goods and services from all other industries.

The implications of output declines in selected industries due to outages were evaluated by applying output, employment, and household earnings (income) multipliers to the direct output losses presented in

Table 4. The multipliers for California used in this study are the updated RIMS II multipliers prepared by the U.S. Department of Commerce Bureau of Economic Analysis.[9] The BEA/RIMS II multipliers and calculation of the impacts of 110 hours or rolling blackouts and 20 hours of outage per customer during the remainder of 2001 are illustrated in Table 5.

Table 5
Calculation of the Economic Impacts of Rolling Blackouts

	RIMS II Multipliers			Direct Output	Indirect Output	Total Output	Income	Jobs
	Output	Earnings	Jobs	(Mil 96$)	(Mil 96$)	(Mil 96$)	(Mil 96$)	
Total Gross State Product				$6,833	$14,932	$21,765	$4,466	135,755
Agriculture, forest., fisheries	2.253	0.687	31.4	$181	$407	$588	$124	5,143
Manufacturing				$1,216	$2,590	$3,805	$629	15,957
Food & kindred products	2.160	0.450	15.5	$227	$490	$717	$102	3,181
Paper products	1.842	0.427	12.4	$19	$35	$53	$8	211
Chemicals/Petroleum	1.979	0.340	9.0	$245	$485	$729	$83	1,994
Rubber & plastics	1.913	0.474	15.6	$13	$25	$38	$6	186
Lumber & wood	2.085	0.545	19.2	$21	$45	$66	$12	373
Stone, clay, glass	2.116	0.570	17.3	$54	$114	$168	$31	843
Primary metals	1.962	0.466	13.3	$8	$16	$24	$4	97
Fabricated metals	2.061	0.555	16.8	$30	$63	$93	$17	463
Industrial machinery	2.243	0.597	15.2	$110	$248	$358	$66	1,518
Electronic equipment	2.205	0.603	15.8	$335	$738	$1,073	$202	4,787
Instruments and related	2.152	0.660	16.4	$103	$222	$325	$68	1,530
Motor vehicles	2.016	0.444	12.9	$6	$12	$18	$3	69
Other transport equip.	2.257	0.658	16.1	$31	$70	$101	$20	453
Misc. manufacturing	2.196	0.591	21.4	$13	$29	$42	$8	252
Electric, gas, & sanitary	2.135	0.382	9.5	$33	$70	$103	$13	283
Wholesale trade	2.051	0.654	19.1	$525	$1,076	$1,600	$343	9,066
Retail trade	2.102	0.688	30.0	$976	$2,051	$3,027	$671	26,491
F.I.R.E.	2.142	0.587	17.5	$2,242	$4,804	$7,047	$1,317	35,446
Services				$1,661	$3,934	$5,595	$1,369	43,369
Personal services	2.333	0.790	40.3	$90	$209	$299	$71	3,270
Business services	2.289	0.856	26.7	$888	$2,033	$2,921	$761	21,465
Hotels/Amusement	2.604	0.850	31.5	$373	$972	$1,345	$317	10,637
All other services	2.322	0.709	28.5	$310	$720	$1,030	$220	7,997

RIMS II Multipliers are based on the 1992 BEA Benchmark Input-Output table for the Nation and 1997 regional data.

[9] *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II),* U.S. Department of Commerce, Bureau of Economic Analysis, Second Edition, May 1992.

The BEA/RIMS II multipliers calculate the direct and indirect effects of expenditures on output (final demand), employment, and household earnings. A reduction in output such as that caused by outages is analogous to a change in expenditures for the affected industry. The sum of these effects reflects the fact that every dollar of output (final demand) of one industry purchased by another industry circulates throughout the economy several times as businesses purchase supplies and inputs from other businesses and pay their employees who, in turn spend their income on a wide range of goods and services in the local economy.

RESULTS AND CONCLUSIONS

The California economy will experience significant adverse consequents from a continuation of rolling blackouts and outages during the remainder of 2001 or beyond. The direct loss of output for California industry and businesses resulting from 20 hours of electricity outages consistent with CASIO's current assessment for the summer of 2001 are estimated to reach $6.8 billion. Rolling blackouts of this duration and magnitude will restrain growth for the entire economy and will result in lost jobs and reduced income for all Californians. Specifically, 20 hours of electricity outages will have the following impact on California:

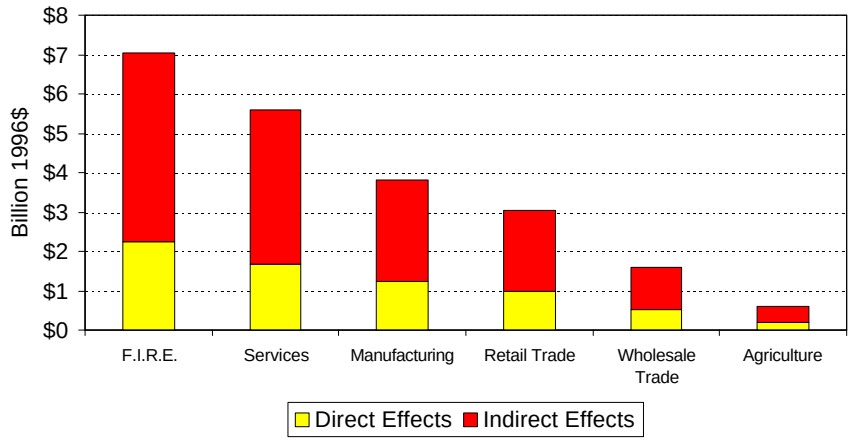
- Gross State Output (GSP) for California would be reduced by $21.8 billion (constant 1996 dollars), or 1.7 percent, in 2001. This would reduce the growth rate of California GSP from the 2.3 percent currently projected by the UCLA Anderson Forecast to 0.6 percent for all of 2001. This loss has two components:

  - A direct loss of output experienced all industries due to the effects of outages in the amount of $6.8 billion.

  - The indirect effect reflecting the fact that each dollar of output by one industry represents the purchase of output (i.e. goods and services) of other industries. This amounts to $14.9 billion.

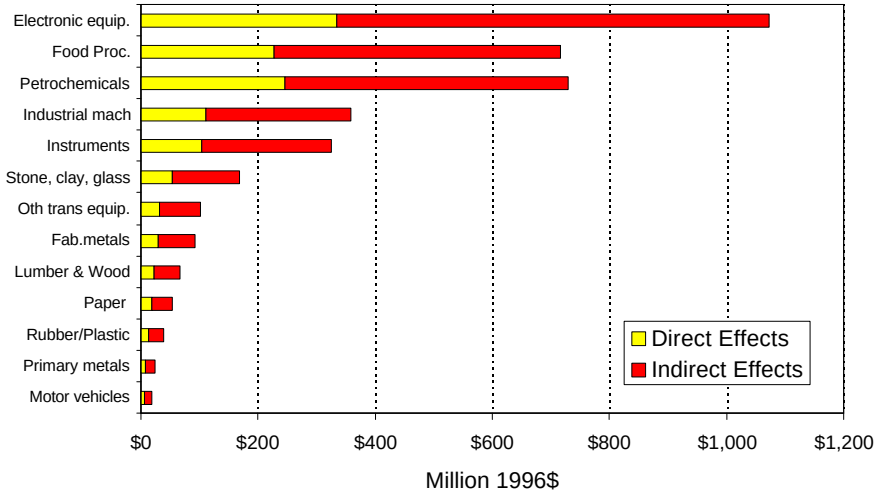
  As shown in Figure 1, the finance, insurance, and real estate and services industries would suffer the largest output reductions. In large part this is a reflection of the relative importance of these sectors to the California economy.

Figure 1
2001 Output Losses for California Industries
Resulting from 20 Hours of Electricity Outages



Manufacturing sector losses due to continued rolling blackouts are estimated at $3.8 billion. As shown in Figure 2, the electrical and electronic equipment, food processing, and chemicals and petroleum industries will experience the most significant effects.

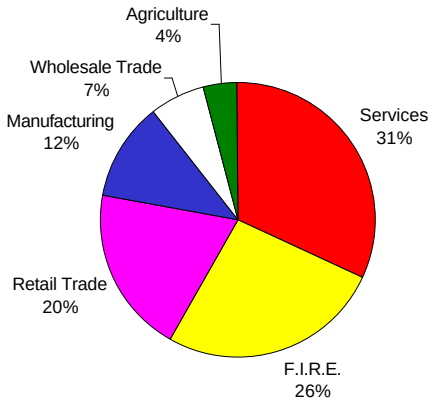
Figure 2
2001 Output Losses for California Manufacturers
Resulting from 20 Hours of Electricity Outages



- A loss of output of this magnitude would reduce household income for Californians by $4.6 billion. This is equivalent to a loss of $104 for every one of California's 11.5 million households. It is important to note that this loss is in addition to the impact of higher electricity costs resulting from recent rate increases.

- Nearly 136,000 jobs would be lost across all industries in the California economy. As shown in Figure 3., more than half of job losses would occur in the services and F.I.R.E. sectors. A continuation of rolling blackouts resulting in outages would reduce employment among California manufacturers by almost 16,000 jobs during 2001.

Figure 3
Distribution of Job Losses by Industry in California
Resulting from 20 Hours of Electricity Outages



The CAISO projection is most likely a "best case" scenario. The electric power situation in California will likely become more not less unstable over the summer. This will result in more and longer periods of supply disruption, greater unpredictability regarding supply, and higher prices for electricity. A number of factors could combine to increase the rolling blackout period and hours of effective blackouts.

- Stronger electricity demand than is currently projected due to a hotter and drier than expected summer.

- Smaller electricity supply due to any number of factors such as unscheduled plant shutdowns.

- Longer duration of outages than the average 90 minutes experienced earlier this year.

If any, or all, of these occur, the output loss to California business and industry will be larger. Aggregate losses to GSP, California household income, and jobs also will increase. Any additional periods of effective electricity loss in excess of 20 hours due to rolling blackouts would be sufficient to push the California economy into recession this year.

ADDENDUM: ECONOMIC EFFECTS OF PRICE INCREASES

On March 27, 2001, the California Public Utility Commission approved electricity rate increases of up to 46 percent for the State's two largest electric utilities. These utilities serve 68 percent of California electricity customers[10]. What will be the effect of rate increases on the California economy?

Energy intensity, measured as energy use per dollar of Gross Domestic Product, has declined at an average annual rate of 1.3 percent between 1986 and 1999 for the overall U.S. economy. This energy intensity is projected to decline at an average annual rate of 1.6 percent through 2020, as the overall U.S. economy shifts to less energy-intensive industries and more efficient technologies in light of energy price increases. This is indicative of what will happen to a greater extent within the California economy[11]. The qualitative data supports this. Many of the respondents discussed conservation measures and becoming more "electricity efficient" as likely strategic moves in response to price increases. If these firms cannot adjust to the higher costs, shutting down will be the only option.

Significantly higher electricity costs in the future are obviously a concern for the businesses in California. Record setting prices for electricity in other parts of the Northwest have already pushed a number of agricultural producers beyond profitability and forced some manufacturers to shut down[12]. Qualitative data indicate that the businesses are struggling with how to absorb the price increases. A 100 percent rate increase will likely cause several manufacturing businesses to shut down all or part of their California operations. The agricultural sector will be seriously affected. Expansion plans for many California businesses will be put on hold. Self-generation strategies will be developed and implemented.

The resulting effect on California's overall economy is difficult to estimate. Output will be affected, but to what degree is not clear. According the Bay Area Economic Forum, a 50 percent increase in commercial and industrial rates would result in more than a half billion dollars in lost output to the Bay Area, slowing overall growth by about 0.2 percent per year and resulting in a loss of 15,000 jobs over three years. Their analysis is based on a similar study done for the Washington State Economy.[13]

[10] "Trends in California's Electricity Retail Prices: Fact Sheet," Energy Information Administration, available at http://www.eia.doc.gov. Spring 2001.

[11] Energy Information Administration, "Annual Energy Outlook 2001," Report DOE/EIA-0383, 2001.

[12] Federal Reserve Bank of San Francisco, "Western Economic Developments," December 2000.

[13] WA State Office of Trade and Economic Development and the WA State Office of Financial Management, "Impact of the Current Energy Situation on Washington State's Economy," April 13, 2001.

Personal communication with a Washington State researcher indicated that its report was based on a 1987 data input/output model. A necessary assumption the Washington State economists had to make was the elasticity of output with respect to energy price increases. They assumed a unitary elasticity meaning that a one-percent increase in energy costs leads to a one percent decrease in production. There is little published research to support this assumption.

Recent theoretical research indicates that the short-run elasticity of capital stock with respect to the energy price is -0.95. Since capital stock is only one element of a firm's production function, this estimate has to be further interpreted to relate a change in price to a change in output.[14] The actual effect of an increase in electricity prices on output is likely to be less than the impact on capital stock. Consequently, the estimates of the impact of a 50 percent price increase in electricity prices for the Bay Area should be considered as a rough indication of the impact on output for only a portion of the California economy.

[14] Atkeson, Andrew and Patrick J. Kehoe, "Models of Energy Use: Putty-Putty Versus Putty Clay," Federal Reserve Bank of Minneapolis, Research Department Staff Report 230/JV, March 1997.