Title

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Publication Date

1987-02-01

LBL-22932
Preprint

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

APPLIED SCIENCE DIVISION

Submitted to Physics and Society

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Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

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Excerpted in *Physics and Society*
A quarterly publication of the American Physical Society

LBL-22932

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February 1987

The work described in this report was funded by the Assistant Secretary for Conservation and Renewable Energy, Office of Buildings and Community Systems, Building Services Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

ABSTRACT

California's mandatory building and appliance efficiency standards, aided by a few billion dollars of utility conservation programs, have greatly slowed projected growth of electricity demand in that state. Electricity demand is growing much more slowly in California than in Texas where almost no energy-efficiency standards have been imposed. Recently Texas has begun trying to control this growth.

KEYWORDS

Electricity Demand, Energy Conservation, Utility Regulation, Economics, Forecasting

In the early 1970s, electricity demand in the U.S. was expected to continue to double every decade. By under-estimating the potential for conservation, planners and regulators approved the construction of far too many power plants. Had the projected growth materialized, today's $150-billion electricity bill would be far higher and customers would be paying more than they are now to cover construction costs for power plants they didn't need. Growth has declined primarily because conservation turned out to be far less expensive than new supply—3-5 times cheaper than new power plants. Today, energy-efficiency standards like those in California have stretched the demand doubling time from one to three decades, saving billions of dollars annually. However, progress has varied greatly among the states. California and Texas illustrate the effects of regulation versus laissez faire on conservation.

Using federal data and simple corrections, we can see how the normalized demand for electricity declines in California while it steadily increases in Texas and across the country. Progress in California has been hastened by mandatory building and appliance-efficiency standards. The 1993 refrigerator standards alone (already partially implemented), compared to the 1977 refrigerator, will save 1200 kWh/household or 15 BkWh for California each year—the equivalent of three, 1000-MW base-load power plants. Other California standards and conservation programs target commercial and industrial customers. In contrast, Texas has left matters almost entirely to the marketplace and still has electricity growth rates of 4½%/year.

The data in Table 1 show that California, which has 11% of the U.S. population and 12% of the national income, consumes only 8% of the electricity, while Texas, which represents only 7% of national population and income, consumes 9% of the electricity. Californians use less than half as much electricity per dollar of gross state product (GSP) than do Texans, although both have had declining growth in kWh/$GSP. Texas' climate, construction activity, and industrial structure are different from California's. Nonetheless, the *rates* of electricity demand growth—normalized for population growth in the residential sector, floor area growth in the commercial sector, and value-added in the industrial sector—reveal the rewards of energy demand planning in California. The rates of electricity price increases are slightly higher in Texas.

During the seven-year period of 1977-84, the average Californian's annual electricity use declined by 267 kWh while by 1984 the average Texan used 1424 kWh *more* than in 1977 (see Figures 1-5 and Table 2). Industrial conservation

efforts have been especially effective in California where, in 1982, energy costs represented only 3.5¢ of each dollar of value-added versus 4.5¢ and 7.1¢ in the U.S. and Texas, respectively. (The cogeneration of electricity and process heat may account for part of the differences between Texas and California). The sum of all the above effects is that during the seven-year period California has built or acquired the electricity corresponding to three new plants and Texas eleven.* See Tables 3-5 for the annual data and normalizations.

Texas is now following in California's footsteps, advancing a range of conservation and load-management initiatives. The Texas Public Utilities Commission is planning to "construct" an 800-MW "conservation power plant" for the city of Austin by deploying a package of residential retrofits that will cost several times less than new generation capacity. Texas is also pursuing load-management strategies, such as thermal storage for cooling commercial buildings, as a means of avoiding the construction of new plants. One-third of new commercial floor space in Dallas now employs thermal storage, which shifts 20-25% of new cooling load to off-peak times.†

As a result of conservation efforts, the overzealous projections of demand growth and the accompanying construction plans of the early 1970s have not become a reality. From the data presented here, we cannot tell precisely how much of the difference between California and Texas is due to regulation, but it is clear that California has demonstrated more of a will to conserve at both the government and private levels.

* A 1000-MW_e power plant sells roughly 5 BkWh per year.
† Personal communication: Leo Stambaugh, Texas Utilities. January 1987.

Table 1. Economic comparison of Texas and California (1984).

	Population (Millions)	%	Income ($B)	%	Electricity (BkWh)	%
US	236	100	3000	100	2278	100
CA	26	11	367	12	175	8
TX	16	7	202	7	208	9

Table 2. Normalized growth in electricity demand since 1977: CA, TX, and U.S.

	U.S.	CA	TX
I. TOTAL 1984 kWh/capita	9648	6838	13021
• Δ (kWh/capita) 1977-84	782	-267	1424
• Annual growth rate	1.2%	-0.5%	1.7%
II. TOTAL 1984 kWh/1000 1984$ GSP	760	477	1,030
• Δ (kWh/1000 1984$ GSP) 1980-84	-26	-80	-33
• Annual growth rate	-0.5%	-2.2%	-0.4%
III. TOTAL BkWh growth 1977-84	330	16	55
IV. Plants 1977-84[a]	66	3	11
V. RESIDENTIAL growth/capita 1977-84			
• Δ (kWh/capita)	357	136	652
• Annual growth rate	1.7%	0.9%	2.4%
VI. COMMERCIAL growth/ft^2 1977-83			
• Δ (kWh/ft^2)	12.8%	-2.4%	14.3%
• Annual growth rate	2.0%	-0.4%	2.2%
VII. INDUSTRIAL growth/1982$ value-added 1977-82			
• Δ (kWh/1982$ value-added)	0.06	-0.08	0.14
• Annual growth rate	1.5%	-3.0%	2.0%
VIII. 1982 ENERGY PRICES (all sectors)			
• Δ ($82/kWh) 1977-82	$0.010	$0.016	$0.017
• Annual growth rate	2.6%	3.6%	4.5%

[a] 5 BkWh/year = 1 "Plant".

Sources for Tables 1 & 2: Electricity—Electric Power Annual 1984, Energy Information Administration (EIA), U.S. Department of Energy EIA-03048, Table 45, pages 127-31, September 1985. Energy Prices—State Energy Price and Expenditure Report 1970-1982, EIA-0376, pages 17, 67, and 457. Population, Industrial Value-added, and Income—1986 Statistical Abstract of the United States, Table 12, page 12; Table 1336, page 750; and Table 735, page 440 respectively, U.S. Department of Commerce. (1977 income, 1978 Statistical Abstract, Table 725, page 449. Income data are used as a proxy for GSP). Commercial floor space—1985 NBECS Survey DOE/EIA-0246(83) (data by Census Region) and DOE/EIA-0453 Model Documentation: Commercial Sector Energy Model, August 1984.

Table 3. California

YEAR	TOTAL BkWh	ACTUAL RESID'L BkWh	ACTUAL COMM'L BkWh	ACTUAL IND'L BkWh	POP-ULATION (millions)	POPULATION-CORRECTED TOTAL (kWh/capita)	POPULATION-CORRECTED RESID'L (kWh/cap)	COMM'L FLOORSPACE (10^9 sqft)	FLOORSPACE-CORRECTED COMM'L (Index)	VALUE ADDED BY MF'R. (nominal Bil. $)	PRODUCER PRICE INDEX	IND'L kWh PER $ VALUE ADDED (kWh/1982$)
notes:	(1)	(2)	(3)	(4)	(5)	*	*	(6)	*	(7)	(8)	*
1977	158.8	46.6	53.3	51.2	22.4	7105	2083	6.22	100.0	54.9	195.1	0.6
1978	162.6	49.3	52.4	51.8	22.8	7122	2160	6.34	96.5	61.2	209.4	0.6
1979	169.6	52.4	55.0	54.1	23.3	7292	2254	6.45	99.6	68.2	236.5	0.6
1980	167.6	52.0	56.2	51.9	23.7	7080	2198	6.57	100.0	76.0	274.8	0.6
1981	170.4	52.8	58.3	49.6	24.2	7037	2180	6.68	101.8	84.7	304.1	0.6
1982	165.8	51.9	56.4	47.3	24.7	6717	2101	6.81	96.7	94.4	312.3	0.5
1983	165.2	53.9	57.9	48.2	25.2	6559	2139	6.93	97.6			
1984	175.2	56.9	63.3	50.8	25.6	6863	2219					
Annual growth rate	7-yr 1.4%	7-yr 2.9%	6-yr 1.4%	5-yr -0.1%	2.0%	-0.5%	0.9%	1.8%	-0.4%	11.5%	9.9%	-3.0%
Change	16.4	10.3	4.6	-3.9	—	-267	137	—	-2.4	—	—	-0.08
Plants	3.3	2.1	0.9	-0.8	—	—	—	—	—	—	—	—

NOTES:

* Calculated value

1. Total U.S. Electricity Consumption: Electric Power Annual 1985, DOE/EIA-0348(85), Table 45, page 131, July 1986 and EIA-0348(82), Table 117, page 167, August 1983.

2. U.S. Residential Electricity Consumption: Electric Power Annual 1985, DOE/EIA-0348(85), Table 45, page 127, July 1986 and EIA-0348(82), Table 113, page 163, August 1983.

3. U.S. Commerical Electricity Consumption: Electric Power Annual 1985, DOE/EIA-0348(85), Table 45, page 128, July 1986 and EIA-0348(82), Table 114, page 164, August 1983.

4. U.S. Industrial Electricity Consumption: Electric Power Annual 1985, DOE/EIA-0348(85), Table 45, page 129, July 1986 and EIA-0348(82), Table 115, page 165, August 1983.

5. 1986 Statistical Abstracts of the U.S.: Resident Population by State, Table 12, page 12.

6. Commercial Floorspace—1985 NBECS Survey DOE/EIA-0246(83) Characteristics of Commerical Buildings 1983, published July 1985. Table 8, Location of Buildings By Census Region-West, page 65. Real data for 1983 only; previous years backcasted by J. Holte—see DOE/EIA-0453: Model Documentation: Commercial Sector Energy Model, August 1984. Data excludes NBECS categories of "vacant" and "residential/commercial" buildings.

7. 1986 Statistical Abstracts of the U.S.: Value Added by Manufacture, Table 1336, page 750. Real data for 1977 and 1982, extrapolated for intermediate years

8. 1986 Statistical Abstracts of the U.S.: Producer Price Indices, Table 788, page 471.

Table 4. Texas

YEAR	TOTAL BkWh	ACTUAL RESID'L BkWh	ACTUAL COMM'L BkWh	ACTUAL IND'L BkWh	POP-ULATION (millions)	POPULATION-CORRECTED TOTAL (kWh/capita)	POPULATION-CORRECTED RESID'L (kWh/cap)	COMM'L FLOORSPACE (10^9 sqft)	FLOORSPACE-CORRECTED COMM'L (Index)	VALUE ADDED BY MF'R. (nominal Bil. $)	PRODUCER PRICE INDEX	IND'L kWh PER $ VALUE ADDED (kWh/1982$)
notes:	(1)	(2)	(3)	(4)	(5)	*	*	(6)	*	(7)	(8)	*
1977	153.0	46.8	33.3	68.3	13.2	11596	3550	12.79	100.0	33.1	195.1	1.3
1978	163.8	51.1	35.6	72.2	13.5	12135	3786	13.22	103.5	36.4	209.4	1.3
1979	167.7	50.4	36.4	76.4	13.9	12078	3628	13.66	102.6	40.1	236.5	1.4
1980	179.4	57.2	39.5	78.2	14.2	12610	4018	14.12	107.6	44.1	274.8	1.6
1981	184.8	57.6	42.7	79.9	14.8	12525	3906	14.59	112.5	48.5	304.1	1.6
1982	186.1	60.7	44.6	76.1	15.3	12126	3957	15.08	113.9	53.4	312.3	1.4
1983	191.2	60.3	46.3	79.6	15.8	12116	3823	15.58	114.3			
1984	208.2	67.2	50.2	85.6	16.0	13021	4202					
Annual growth rate	7-yr 4.5%	7-yr 5.3%	6-yr 5.7%	5-yr 2.2%	2.8%	1.7%	2.4%	3.3%	2.2%	10.0%	9.9%	2.0%
Change	55.2	20.4	13.0	7.8	—	1424	652	—	14.3	—	—	0.14
Plants	11.0	4.1	2.6	1.6	—	—	—	—	—	—	—	—

NOTES:

* Calculated value

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8. 1986 Statistical Abstracts of the U.S.: Producer Price Indices, Table 788, page 471.

Table 5. United States

YEAR	TOTAL BkWh	ACTUAL RESID'L BkWh	ACTUAL COMM'L BkWh	ACTUAL IND'L BkWh	POP-ULATION (millions)	POPULATION-CORRECTED TOTAL (kWh/capita)	POPULATION-CORRECTED RESID'L (kWh/cap)	COMM'L FLOORSPACE (10^9 sqft)	FLOORSPACE-CORRECTED COMM'L (Index)	VALUE ADDED BY MF'R. (nominal Bil. $)	PRODUCER PRICE INDEX	IND'L kWh PER $ VALUE ADDED (kWh/1982$)
notes:	(1)	(2)	(3)	(4)	(5)	*	*	(6)	*	(7)	(8)	*
1977	1948.4	645.2	446.5	786.0	220	8866	2936	43096	100.0	585.2	195.1	0.8
1978	2017.9	674.5	461.2	809.1	222	9086	3037	43650	102.0	626.6	209.4	0.9
1979	2071.1	682.8	473.3	841.9	225	9223	3041	44211	103.3	671.1	236.5	1.0
1980	2094.4	717.5	488.2	815.1	227	9245	3167	44780	105.2	718.6	274.8	1.0
1981	2147.1	722.3	514.3	825.7	230	9354	3147	45355	109.4	769.6	304.1	1.0
1982	2086.4	729.5	526.4	744.9	232	9000	3147	45938	110.6	824.1	312.3	0.9
1983	2151.0	750.9	543.8	776.0	234	9191	3209	46529	112.8			
1984	2278.4	777.7	578.5	840.6	236	9648	3293					
Annual growth rate	7-yr 2.3%	7-yr 2.7%	6-yr 3.3%	5-yr -1.1%	1.0%	1.2%	1.7%	1.3%	2.0%	7.1%	9.9%	1.5%
Change	330.0	132.5	97.3	-41.1	—	782	357	—	12.8	—	—	0.06
Plants	66.0	26.5	19.5	-8.2	—	—	—	—	—	—	—	—

NOTES:

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1. Total U.S. Electricity Consumption: Electric Power Annual 1985, DOE/EIA-0348(85), Table 45, page 131, July 1986 and EIA-0348(82), Table 117, page 167, August 1983.

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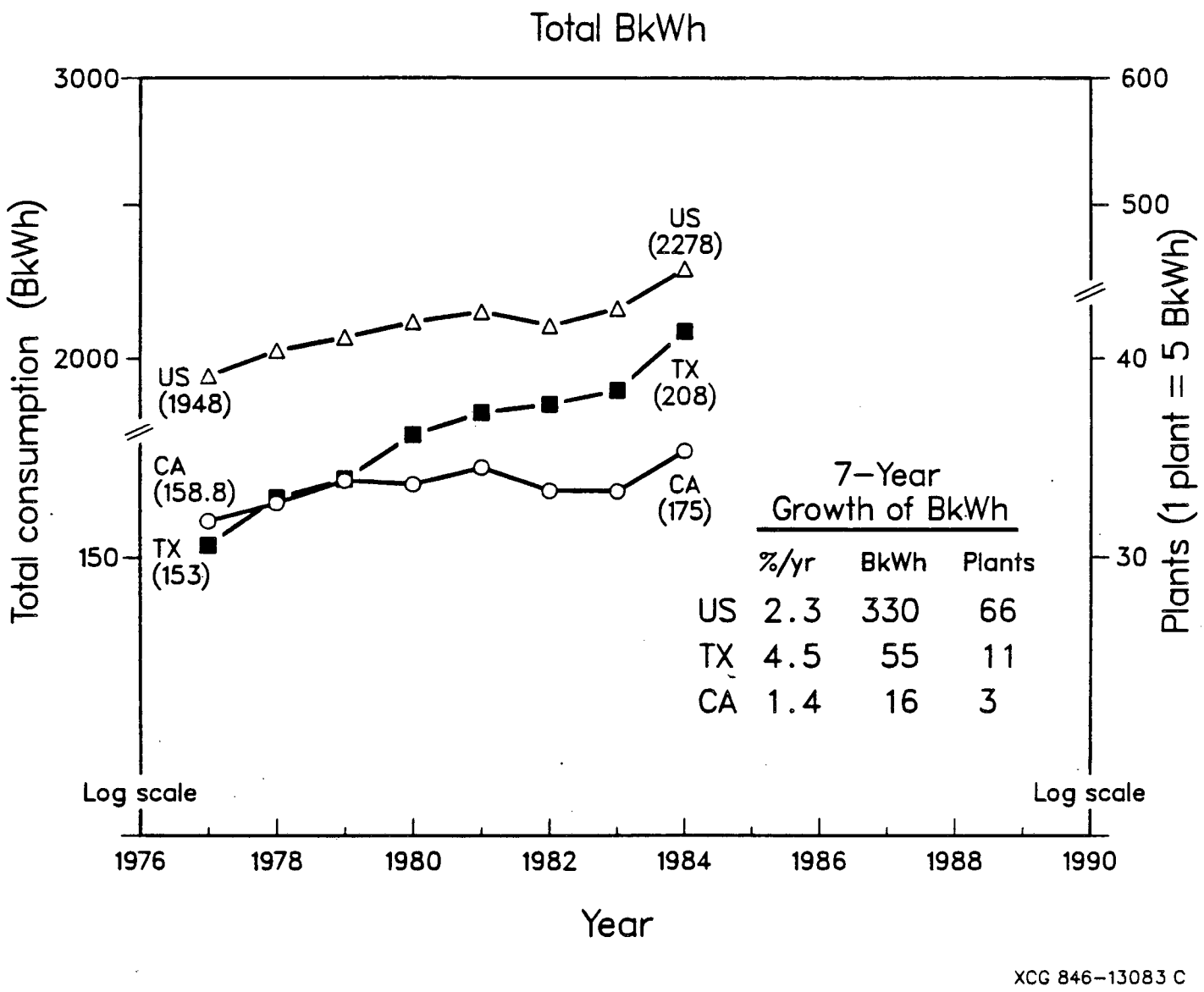

Figure 1. Total electric consumption by all customers for CA, TX and the U.S. Comparative populations in 1984 were: CA 25.6 M and TX 16.0 M. In the seven years 1977-1984, annual growth rates were: CA 2.0% and TX 2.8%; TX - CA = 0.8%, whereas for annual BkWh growth, TX - CA = 3.1%. Electricity price increases in TX were less than one percent greater than in CA. The y-axis is logarithmic and the U.S. is shifted down one decade. BkWh are converted to 1000 MW (1 BW or 1 GW) using "1 Plant" = 5 BkWh/year. Sources: Consumption—Electric Power Annual (EIA 0348(84) p. 124 and EIA 0348(82) p. 167). GW—Annual Energy Review (EIA 0348(83) p. 195 and 201.)

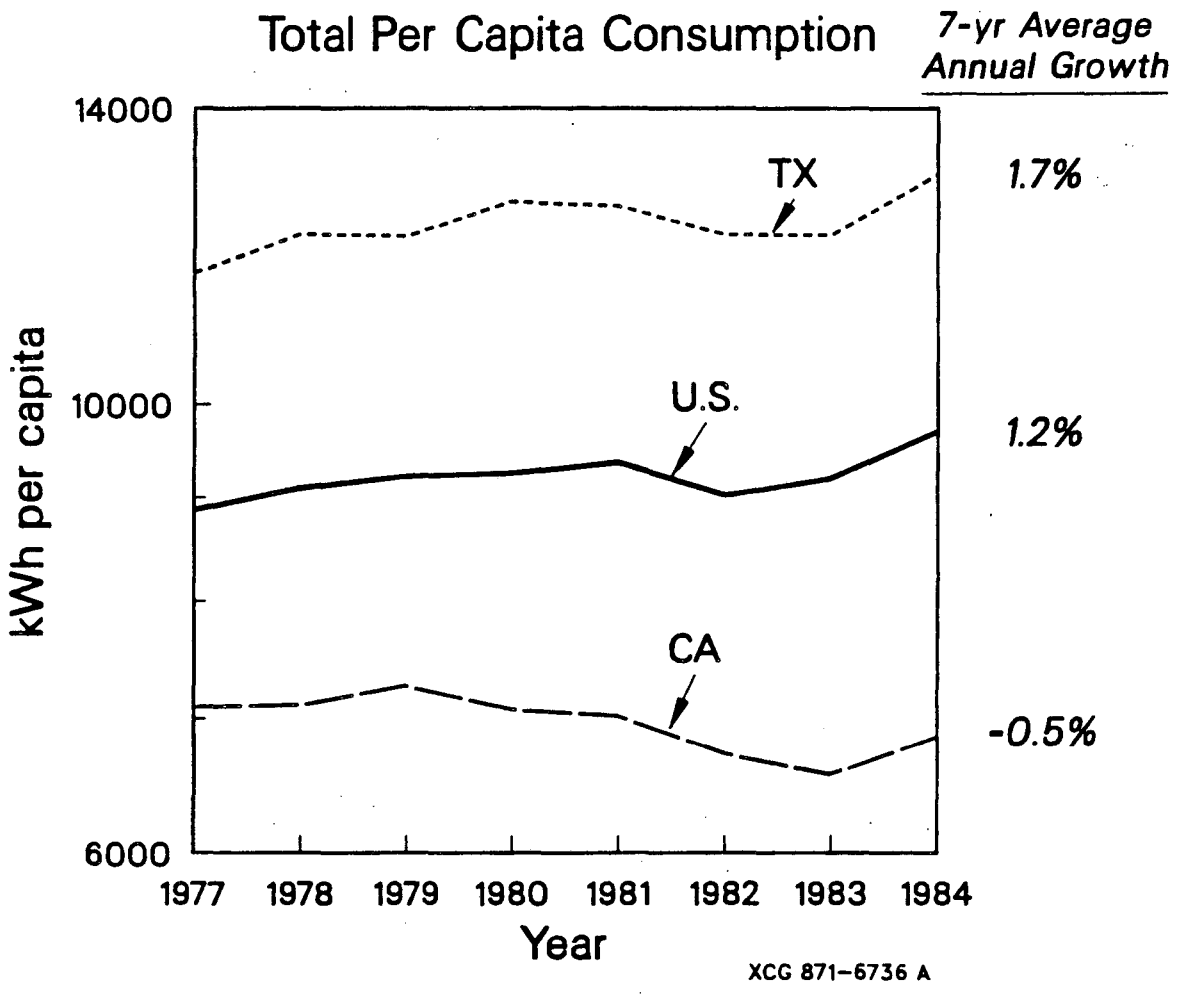

Figure 2. Total electricity consumption per capita by all customers for CA, TX, and US. The y-axis is logarithmic.

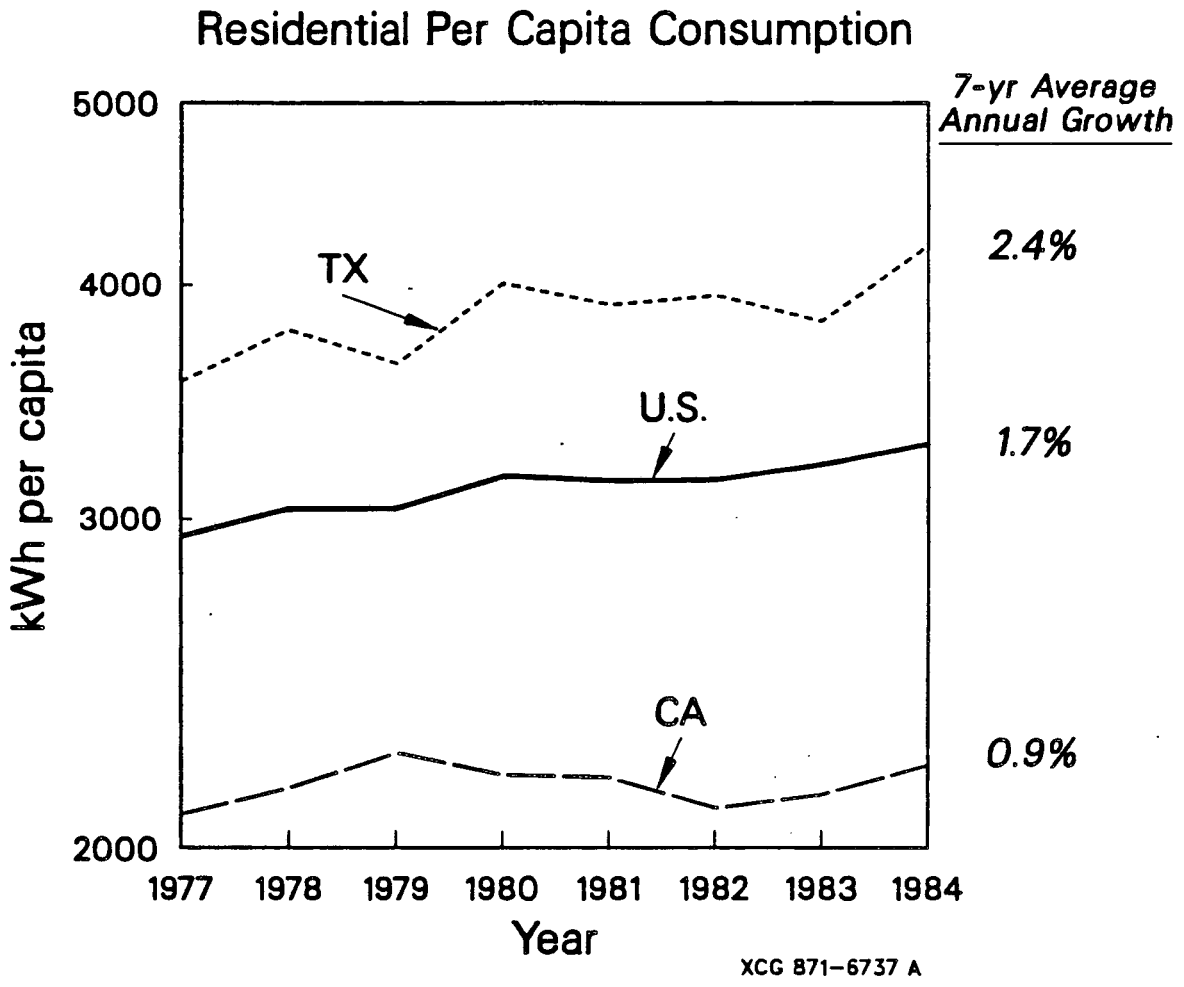

Figure 3. Residential electricity consumption per capita, 1977-1984. The y-axis is logarithmic.

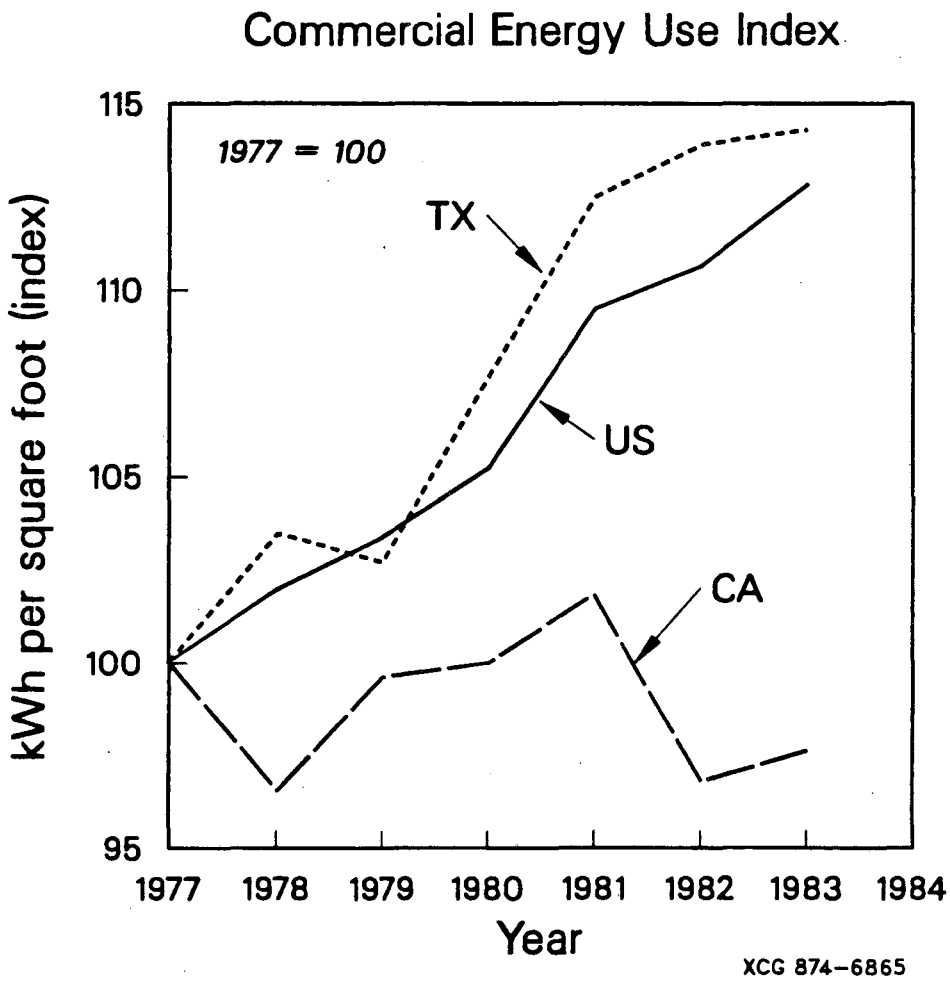

Figure 4. Commercial electricity consumption index, 1977-1983.

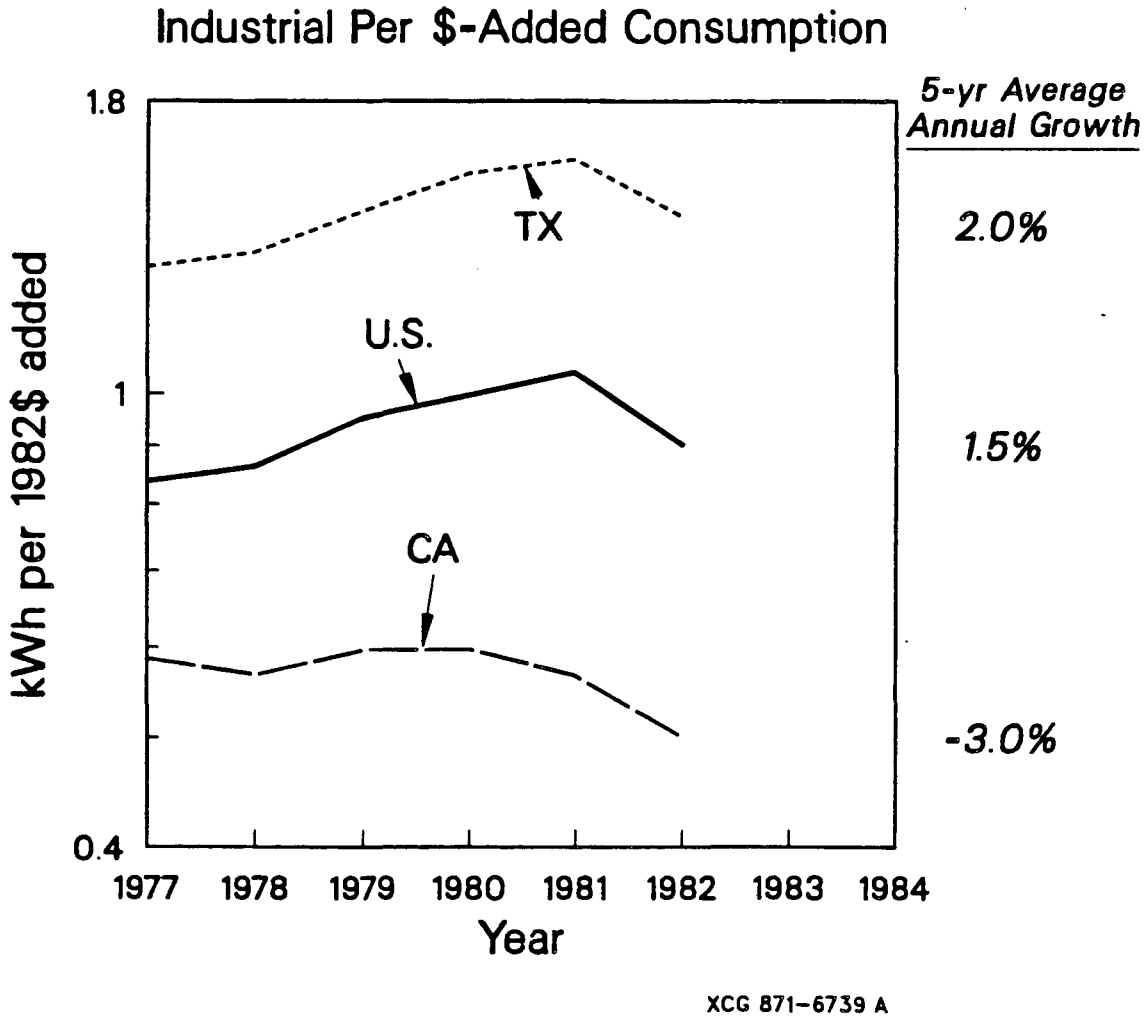

Figure 5. Industrial electricity consumption per dollar (1982) value-added, 1977-1982. The y-axis is logarithmic.

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