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TRENDS IN ELECTRICITY CONSUMPTION, PEAK DEMAND, AND GENERATING CAPACITY IN CALIFORNIA AND THE WESTERN GRID 1977-2000

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Abstract

This study analyzes state and regional electricity supply and demand trends for the eleven states in the Western Systems Coordinating Council (WSCC) from 1977 to 2000. New utility capacity additions dropped off throughout the west beginning around 1989-1990, lowering reserve margins and installed capacity per consumption ratios. Only two of the eleven western states installed more new utility-owned capacity during the second decade of the 1977-1998 period than during the first decade. California's installed utility capacity grew by only 28% from 1977 to 1998, but the state added another 10,000 MW of non-utility capacity (resulting in an overall capacity increase of 57%). California therefore added new generating capacity relative to increases in its consumption at a higher rate than all but two states (in part because California is the lowest user of electricity per capita and per dollar of gross state product in the west). Annual WSCC consumption increased 64% from 1977 to 1998, but California's consumption grew by only 44% during this period. Summer peak demand increased throughout the WSCC from 1995 to 1999 by roughly 13,000 MW, but California accounted for only 5-6% of the total increase during this period. Finally, winter peak demand increased throughout the WSCC from 1995 to 1999 by roughly 6,700 MW; California accounted for about 45% of the total increase during this period.

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EXECUTIVE SUMMARY

Much of the debate about the causes of physical and financial problems in California's electricity system has focused on recent events within California, but the state's electricity system is interconnected with and depends upon other states in the western grid. Eleven states are closely interconnected to California as part of the Western Systems Coordinating Council (WSCC) area: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming.[1] This study therefore examines long-term trends in consumption, peak demand, and generating capacity throughout the western grid from 1977 to 2000.[2] Changes in any of those parameters of supply and demand have a bearing on the situation in the California system.

Several trends stand out as significant when California is examined in this broader context:

- New utility capacity additions dropped off precipitously throughout the west beginning around 1988-1989, lowering reserve margins and installed capacity per consumption ratios.[3] *See Chart ES-1*.

- Only two of the eleven western states (Nevada and Idaho) installed more new utility-owned capacity during the second decade of the 1977-1998 period than during the first decade. *See Chart ES-2*.

- California's installed capacity grew by only 28% from 1977 to 1998 if only utility capacity is included, but a successful independent electricity program added another 10,000 MW of non-utility capacity in the form of qualifying facilities (QFs), resulting in an overall capacity increase of 57%.[4] *See Chart ES-3*. Oregon and Washington added just over 1,000 MW of non-utility capacity, but the other eight states averaged less than 400 MW of new non-utility capacity.[5] *See Chart ES-4*. California therefore added new generating capacity relative to increases in its consumption at a higher rate than every state except Montana, Utah, and Wyoming.

- California is the lowest user of electricity per capita and per dollar of gross state product, but the size of its population and economy mean that it accounts for about two-fifths of WSCC

[1] The WSCC includes not only these eleven states but also some regions of Mexico and Canada, as well as small pieces of South Dakota, Nebraska, and Texas. (For a complete map, see page 29.) This report studies only the consumption and capacity of these eleven states. Only when the official WSCC regions are referenced do the data refer to the full WSCC.

[2] The relevant time periods vary by data set. Consumption and capacity data run from 1977 to 1998. Peak annual demand data run from 1982 to 1998. Peak summer demand data run from 1995 to 1999. Peak winter demand data run from 1995/1996 to 1999/2000.

[3] Utility capacity data include both investor-owned utilities and municipal utility districts.

[4] Public Utility Regulatory Policies Act (PURPA; see *16 USCS § 824 et seq.*). Though not the legislation's primary goal, PURPA regulations encouraged the development of independent electricity, particularly from cogeneration and renewable resources ("qualifying facilities" under PURPA).

[5] These data come from the Department of Energy (DOE), while the California QF capacity data come from California Energy Commission (CEC) data sources. The DOE data include all non-utility capacity, which represents a larger universe of categories than the CEC data, which include only QFs.

annual consumption and summer peak demand, and about one-third of winter peak demand. *See Chart ES-5*.

- Annual consumption increased 64% throughout the WSCC from 350,000 GWh in 1977 to nearly 570,000 GWh in 1998, but California's consumption grew only 44% during this period. Its share of overall WSCC consumption therefore declined from 45% to 40%. *See Charts ES-6 and ES-7*.

- Non-coincidental summer peak demand increased throughout the WSCC from 1995 to 1999 by roughly 13,000 MW. California, which uses about 40% of the peak summer demand, accounted for only 5% of the total increase during this period.[6]

- Non-coincidental winter peak demand increased throughout the WSCC from 1995/1996 to 1999/2000 by roughly 6,700 MW. California, which uses about 35% of the peak winter demand, accounted for 45% of the total increase during this period.

Data limitations sometimes make it difficult to make consistent comparisons across states or sub-regions of the WSCC, and more detailed annual data (*e.g.*, for winter vs. summer peak demand by state) are sometimes only available for limited periods. Moreover, very little data are available for 2000 in a consistent form at an appropriate level of disaggregation. The analysis in this study is nevertheless a useful historical foundation for more detailed examination of the 2000-2001 period. More detailed discussion of individual trends is presented below by state and region.

A. CONSUMPTION

Consumption in all states has risen since 1977. Consumption by the states of the western grid rose from 350,000 GWh in 1977 to nearly 570,000 GWh in 1998, an average annual growth rate of 2.4%. Growth rates fluctuated widely during the first half of the time period and leveled off after 1988, with all staying below 10% and most hovering near the WSCC mean. In total, the WSCC's consumption rose by 64%.

During the twenty years between 1977 and 1998, California's share of total electricity consumption fell from over 45% to 40%, as its consumption grew from about 160,000 GWh to nearly 230,000 GWh. Arizona overtook Oregon, the state with the smallest percentage increase in consumption, as the third largest consumer of electricity during this period. Nevada had the highest percentage increase; its consumption more than tripled. The northwest region, Oregon, Washington, Idaho, and Montana, had its share of total consumption drop from 34% to 30%. In contrast, the southwest region of Arizona, Nevada, and New Mexico had its share rise from 11% to over 17% and the Rocky Mountain region of Colorado, Utah, and Wyoming, saw its share rise from 9% to nearly 13%.

[6] This is only an approximate value. The overall WSCC peak is not necessarily the sum of the individual regional peaks.

Officially, the WSCC is divided into four regions: the Northwest Power Pool (NWPP), the Rocky Mountain Power Association (RMPA), the California and Mexico region (CA/MX), and the Arizona, New Mexico, and southern Nevada region (AZ/NM/SNV).[7] The last two regions, CA/MX and AZ/NM/SNV, were reorganized in 1997 and Mexico was added. Prior to that date, the California region had instead included California and southern Nevada and the Arizona region had included only Arizona and New Mexico. Unfortunately, the data are not uniform throughout the time period, but the changes do not drastically alter the results. Nevertheless, the data should be taken only as approximate. In addition, some data are only available as far back as 1995, but go through 1999, so they can only be used as a snapshot of current usage, not historical change. Using these geographic breakdowns, the NWPP uses about 37% of the WSCC total, the RMPA uses about 6%, AZ/NM/SNV uses about 16%, and CA/MX uses the remaining 42% of the WSCC total. These percentages have held steady over the five years for which data are available.

B. Consumption per capita

Consumption per capita varies widely among states in the WSCC and has not converged considerably during the past two decades. Some states have decreased their consumption per capita slightly, as other states have increased their consumption per capita greatly. In general, most states' per capita consumption varied during the 1980s and then stabilized during the 1990s. Some states experienced net increases in the 1980s, peaked at the turn of the decade, and then began a decline in per capita usage during the 1990s. Overall, the WSCC's per capita consumption rose by 9.4%, from 8.9 to 9.7 MWh/person.

California's electricity use per capita is now the lowest of any state in the WSCC, though it ended the 1970s with only the fourth lowest rate. While California's consumption per capita dropped slightly during the last two decades, to below 7 MWh/person, California's current relative rank is primarily a result of increases in consumption per capita by other states. New Mexico, Colorado, and Utah began the period with lower per capita consumption, but those values all increased during the time period. Wyoming's per capita consumption grew by more than 85%, to over 24 MWh/person.

C. Consumption per dollar of gross state product

All states exhibited a marked decline in consumption per dollar of gross state product (GSP) between 1977 and 1998. The values all converged to within 0.5 kWh/$GSP of each other and had all fallen below 0.7 kWh/$GSP. In general, per GSP consumption varied widely in the 1980s, and then exhibited a generally steady decline over the remaining period.

California began the two decades with per GSP consumption nearly three times less than the highest per GSP user. The state's consumption per GSP then dropped by more then 70%, from 0.69 to 0.20 kWh/$GSP. More than 80% of the decline came during the first decade. Its 1998 per GSP consumption was three times less than that of the largest per GSP consuming state and

[7] For a complete map of these regions, see page 30.

40% less than the consumption of the next most efficient state. On a regional basis, the northwest is the highest per GSP user of electricity, a result of high usage by Montana and Idaho moderated by the usage of Washington and Oregon. In the southwest, the second highest regional user of electricity on a per GSP basis, the high usage is driven equally by all three states. The Rocky Mountain region's low usage is driven by Colorado and moderated by Wyoming, the state that experienced the smallest per GSP consumption decline of any state in the WSCC.

D. PEAK DEMAND

For peak demand, data are available for the time period from 1982 to 1998. Since 1982, the peak electricity consumption of the total WSCC rose by nearly 50,000 MW, from 84,000 MW to over 130,000 MW. Regionally, the NWPP continued to have the highest peak electricity demand from 1982 through 1998, but the region's percentage growth was the smallest in the WSCC, rising by 37% to 60,000 MW. The CA/MX region's peak consumption grew by 55%, to 55,000 MW. The greatest increase in peak demand occurred in the AZ/NM/SNV region, which grew by 135%, to more than 20,000 MW. The RMPA has a comparatively small peak demand and its peak grew by less than 50%, to 8,000 MW.

Peak summer demand data are available for the time period from 1995 to 1999.[8] Peak winter demand data are available for the time period from 1995/1996 to 1999/2000. The peak summer demand for the WSCC increased by 10% from 1995 to 130,000 MW in 1999. The WSCC's peak winter demand rose by 5% from 1995/1996 to 120,000 in 1999/2000. The AZ/NM/SNV region experienced the greatest peak demand. The region's winter and summer peak demand both increased by more than 30%. The NWPP winter peak dropped while its summer peak increased by nearly 10%, to over 48,000 MW and began to approach the CA/MX peak summer usage. The RMPA experienced a summer peak increase of 5%, rising to 7,700 MW. Its winter peak rose by over 10%, to 7,600 MW. The CA/MX region experienced the smallest peak demand increases in both summer and winter of any of the regions in the WSCC. Its summer peak rose 1% to 53,100 MW, accounting for 6% of the combined regional summer peak increase. The state's winter peak rose by 7% to 40,000 MW.

E. CAPACITY

Over the last decade, capacity additions dropped off dramatically. While there was considerable utility capacity addition during the 1980s, installations nearly stopped in 1988 when the eleven-state average growth rate dropped from 4.5% to less than 0.5% during the second decade. The WSCC average growth rate dropped from 3.5% to two-tenths of a percent during this period. Only Arizona, Nevada, and, to a lesser extent, Utah had real growth during the second decade. Overall, the WSCC increased its capacity by 48% to 133,000 MW.[9]

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[8] Peak summer demand crested in 1998 and then dropped slightly in 1999. The values reported here refer to 1999; when 1998 values are used the trends are unchanged.

[9] The capacity data included in this report indicate a generator's nameplate capacity. While nameplate capacity matches closely the average annual peak capacity of fossil fuel generators, it can be significantly

California's utility capacity additions came entirely during the first decade, when the state added 10,000 MW of capacity. During the second decade, the state had a net loss of nameplate utility capacity. Overall, the state increased its utility capacity by 28%, to 44,000 MW.

The four regions, California, the northwest, the southwest, and the Rocky Mountain states, added between 9,500 and 12,000 MW of utility capacity during both decades. Only in the southwest did any significant utility capacity building occur during the second decade. Driven by Nevada and, to a lesser extent, Arizona, more than 50% of this region's capacity was built in the later ten years. The northwest's utility capacity grew by less than 40% over the two decades. The southwest's utility capacity rose by nearly 75%. The utility capacity stock in the Rocky Mountain region rose by over 100%, driven largely by Utah's phenomenal growth.

When capacity additions made by independent electricity producers are included, however, California's overall capacity stock increase moves from 28% to over 57%. Independent capacity additions totaled more than 10,000 MW between 1977 and 1998; 6,500 MW were added between 1987 and 1991. Oregon and Washington each added about 1,000 MW of non-utility capacity during both decades, but the eight other states averaged less than 400 MW of non-utility additions. California therefore stands out as unique in the scale of its non-utility capacity.

F. CAPACITY PER CONSUMPTION

Overall, the WSCC experienced a decline in new utility capacity of 10%, falling from 0.26 to 0.23 MW of capacity per GWh of annual consumption.[10, 11] Only two states, Montana and Utah, experienced increases in their net utility capacity per consumption over the time period, although these were small. California also saw an increase in net installed capacity per consumption when non-utility capacity is included. The WSCC added just 0.19 MW of new utility capacity for every GWh of new consumption. This is 25% less than its ratio at the beginning of the period.

In total, California's utility capacity per consumption moved little during these two decades, dropping 10%, from 0.22 to 0.20 MW/GWh, a ratio less than the WSCC total.[12] Its relative rank within the WSCC did not change; its utility capacity per consumption ratio is the third lowest. During the period, the state added just 0.15 MW of utility capacity for every GWh of new consumption. When independent non-utility electricity supply is included, however, the state's capacity per consumption increases, instead of declines, from 0.22 to 0.24 MW/GWh. The

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higher than the average annual peak capacity of hydro, wind, and solar electricity sources. Therefore, the capacity figures cited in this report are higher than the peak level of generation that could be sustained over an extended period of time. In particular, variation in annual and seasonal hydro conditions may result in "firm" capacity for hydro resources that is well below the installed nameplate capacity.

[10] This ratio is used for comparison only. Differences in utilization rates and other qualities of capacity and consumption prevent the ratio from providing specific information about the ability of a particular amount of capacity to meet the demand of a particular amount of consumption.

[11] This can also be interpreted as an increase in average utilization rates of installed capacity.

[12] The "utility" figures for 1977-1998 include those utility-owned generating facilities that were divested by the California utilities in 1996-1998. The DOE data show approximately 23,000 MW of non-utility capacity in 1998, for example, but just over 10,000 MW of that total represents capacity that was not originally owned by California utilities. Data after 1998 become less clear as further divestiture occurred.

state's total new capacity per total new consumption between 1977 and 1998 ratio moves from 0.14 MW/GWh without independent capacity to 0.30 MW/GWh with independent capacity. This latter ratio shifts California from the third-lowest to the third-highest position in the west.

During this period, the four regions maintained their relative positions. The order, from lowest utility capacity per consumption ratio to highest, remained: California, the northwest, the Rocky Mountain states, and the southwest. The differences between the four regions converged, however, as all regions experienced a decline in their utility capacity per consumption ratios. In 1977, the southwest had a ratio nearly double that of California. By 1998, the difference was more than halved, a result of the southwest's slowed capacity additions in relation to its high consumption growth. While California, the northwest, and the Rocky Mountain region had declines in utility capacity per consumption of less than 10%, the southwest's ratio declined by more than 30%. Nevertheless, the region's ratio of 0.28 MW/GWh continued to be the highest in the WSCC. The Rocky Mountain region had the highest ratio of new utility capacity per new consumption, 0.24 MW/GWh. California had the highest ratio of total new capacity per new consumption, 0.30 MW/GWh, however, due to 10,000 MW of non-utility capacity additions.

CONCLUSION

This study shows how long-term trends in consumption, peak demand, and generating capacity have changed throughout the western grid from 1977 to 2000 and affected California's supply and demand balance. It shows that California has been similar to other states in some respects (*e.g.*, increasing installed capacity to consumption ratios at a greater rate from 1977 to 1988 than from 1989 to 1998), but that it has also been quite different in many other respects. The most important differences include heavy reliance on non-utility capacity additions in the 1980s and early 1990s and significantly lower growth in either annual consumption or summer peak demand on either a per capita or per dollar of GSP basis than other western states. California's winter peak demand grew at a relatively high rate, however, compared to other parts of the west.

Although California has been widely criticized for not building adequate generating capacity during the 1990s, the state actually exceeded the WSCC average for new capacity additions relative to increases in demand from 1977 to 1998. California's higher-than-average new capacity to consumption ratio is due to both demand factors and supply factors. On the demand side, California accounted for a disproportionately lower level of growth in overall WSCC demand from 1977 to 1998 as other states grew at a faster rate and failed to achieve California's low consumption per capita or per dollar of GSP ratio. On the supply side, investment has been driven primarily by non-utility capacity additions since 1987. The state's growth in new capacity appears low when only utility-owned generation is included, but QF capacity more than doubled the total increase in generating capacity installed in the state from 1977 to 1998.

Neither increases in California's annual consumption (or peak demand) nor decreases in California's historical share of WSCC-wide generating capacity is therefore at the heart of the state's supply and demand relationship from 1977 to 1998. Instead, the tightening of supplies throughout the WSCC during this period primarily reflects increases in consumption and peak demand in other states and a region-wide decline in new capacity additions relative to those increases in consumption. Above-average hydropower production (especially in the Pacific

Northwest) from 1996 to 1999 masked this shift, then hydropower availability decreased significantly in 2000 (combined with significant increases in consumption in California and throughout the WSCC) to reveal apparent shortages. This study does not examine production or operating data, however, so we are unable to address how weather and other factors may have affected apparent shortages in 2000 and 2001. This study only addresses installed generating capacity.

These findings clearly have important policy implications, but this study is focused only on exploratory compilation and analysis of the historical data for electricity consumption, peak demand, and generating capacity in California and the western grid. We will leave it to others and future papers to address the relationship between these data and the electricity crisis that continues to grip California and the west. We are hopeful that this study offers some of the historical data necessary to address those policy issues in a well-informed manner.

Chart ES-1

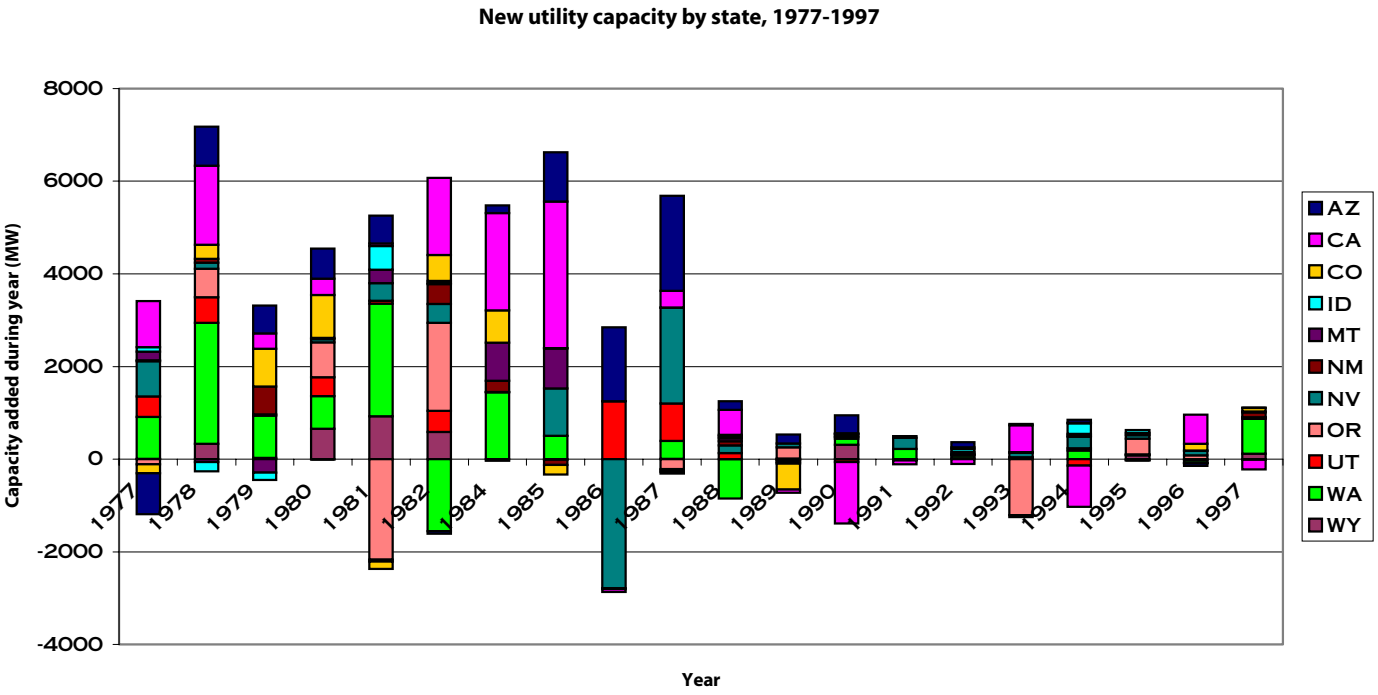


Chart ES-2

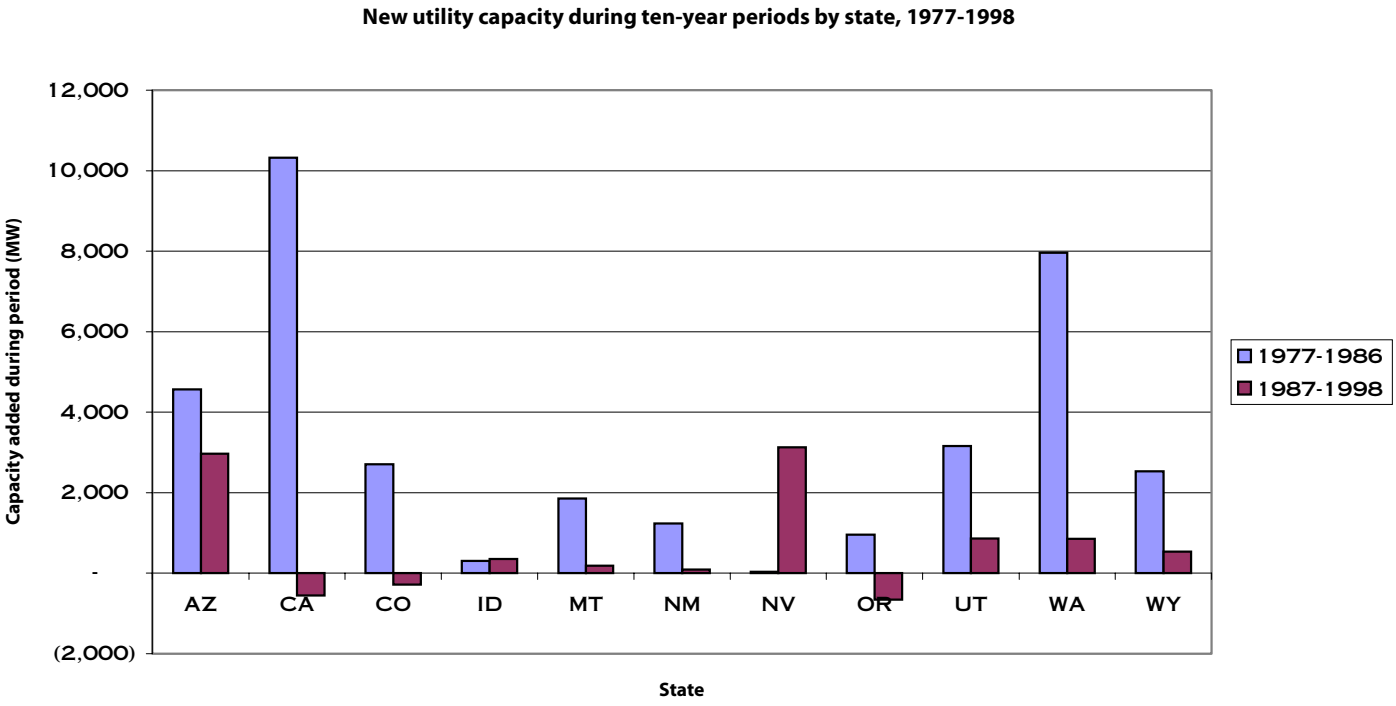


Chart ES-3

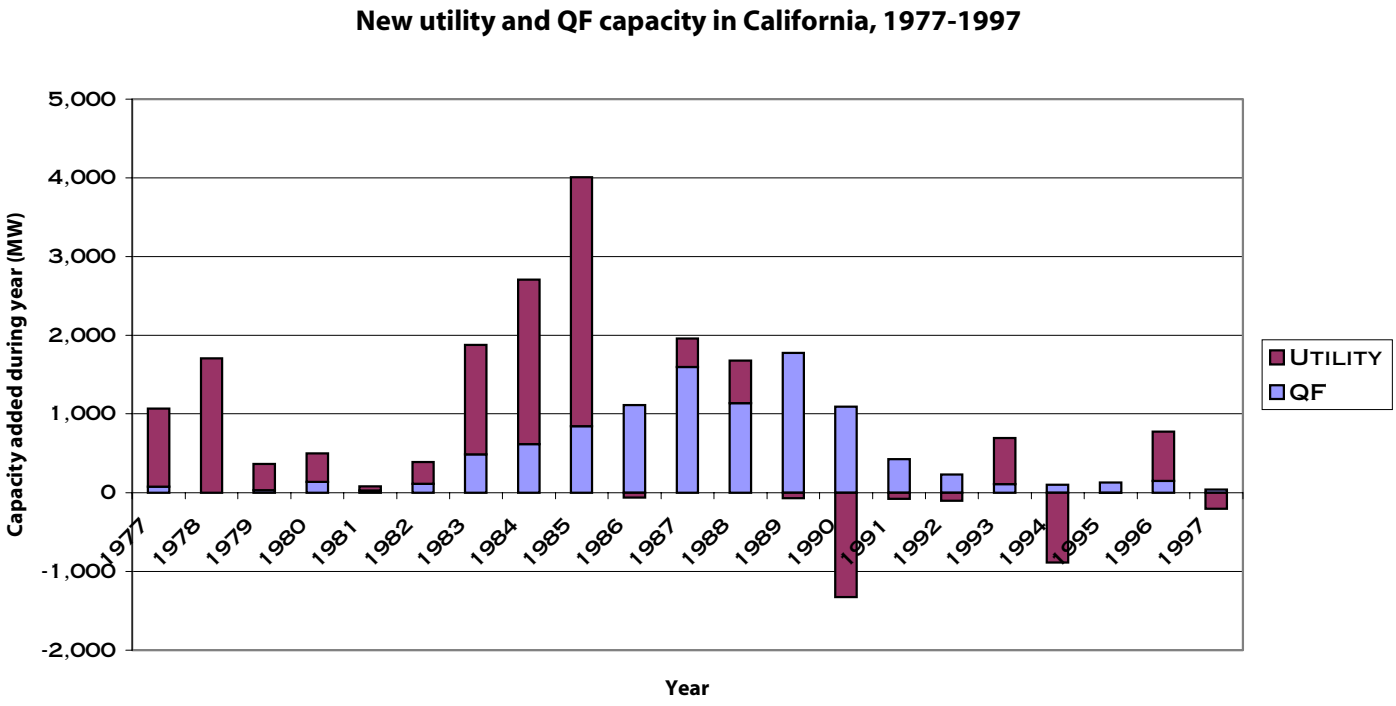


Chart ES-4

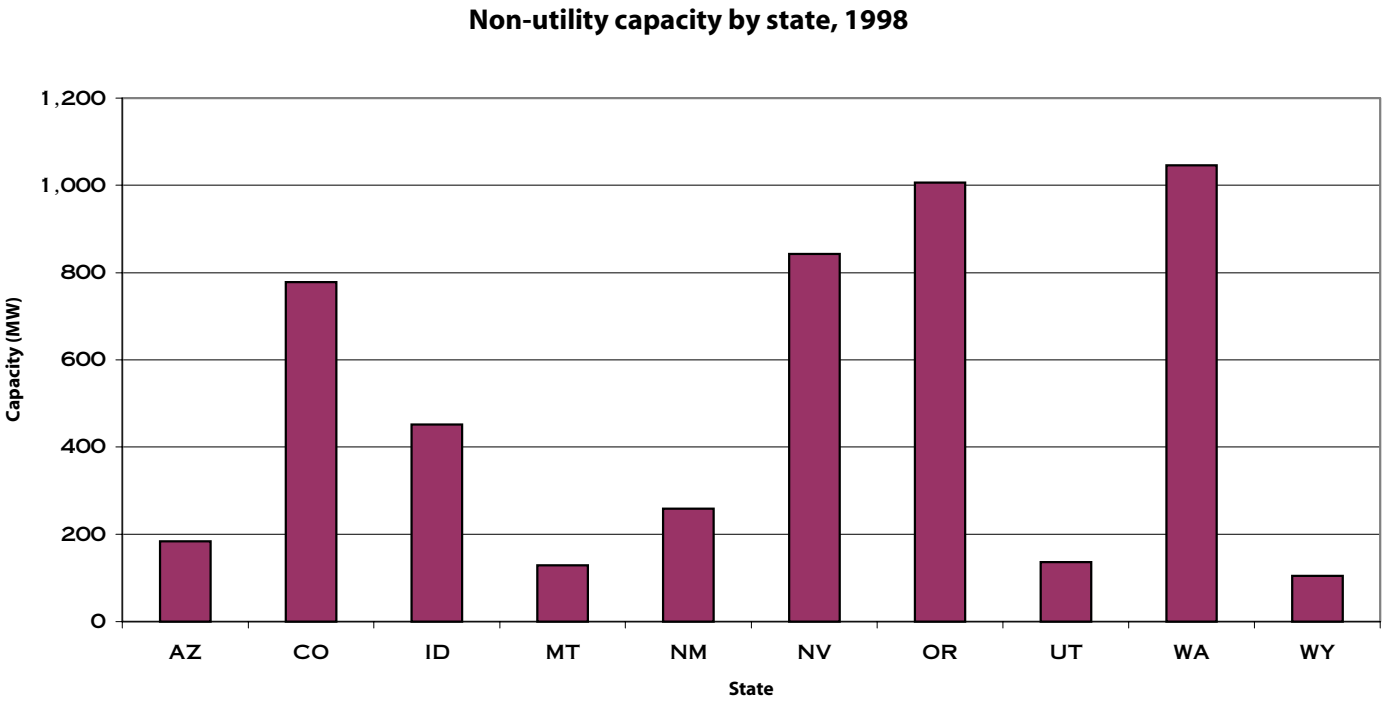
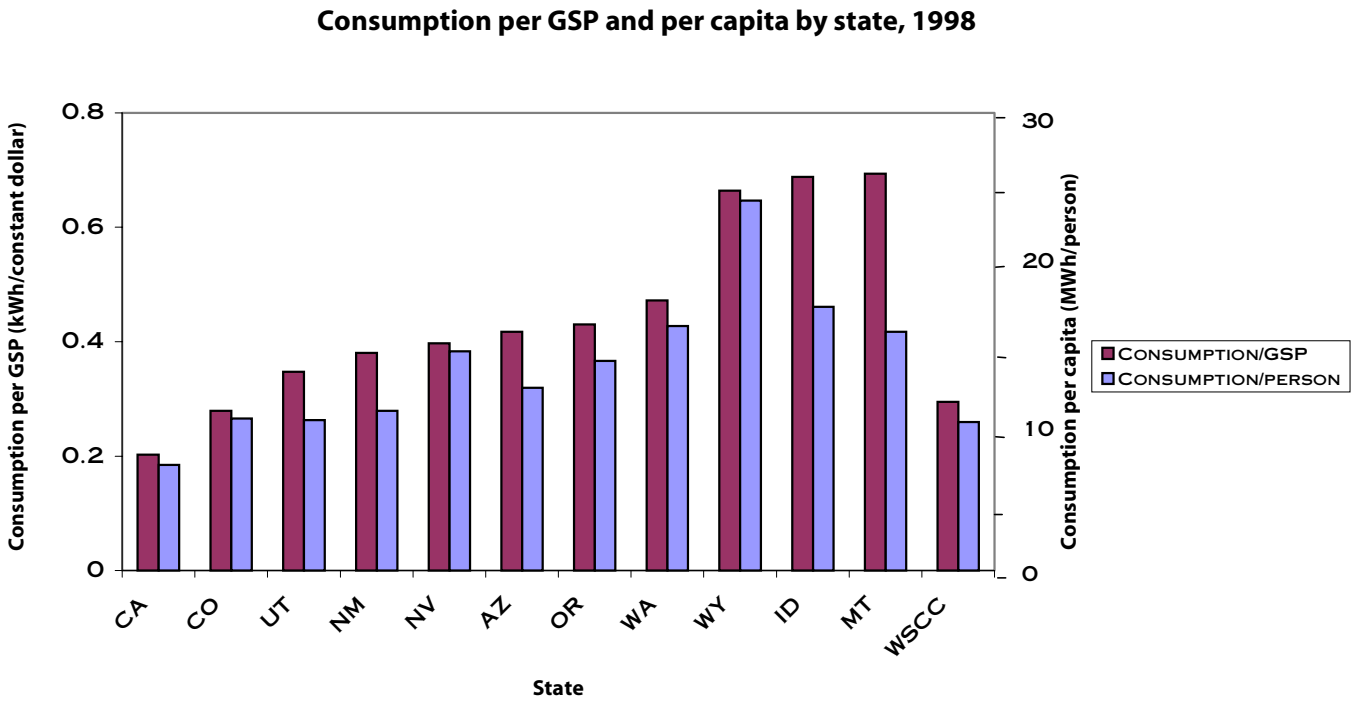


Chart ES-5



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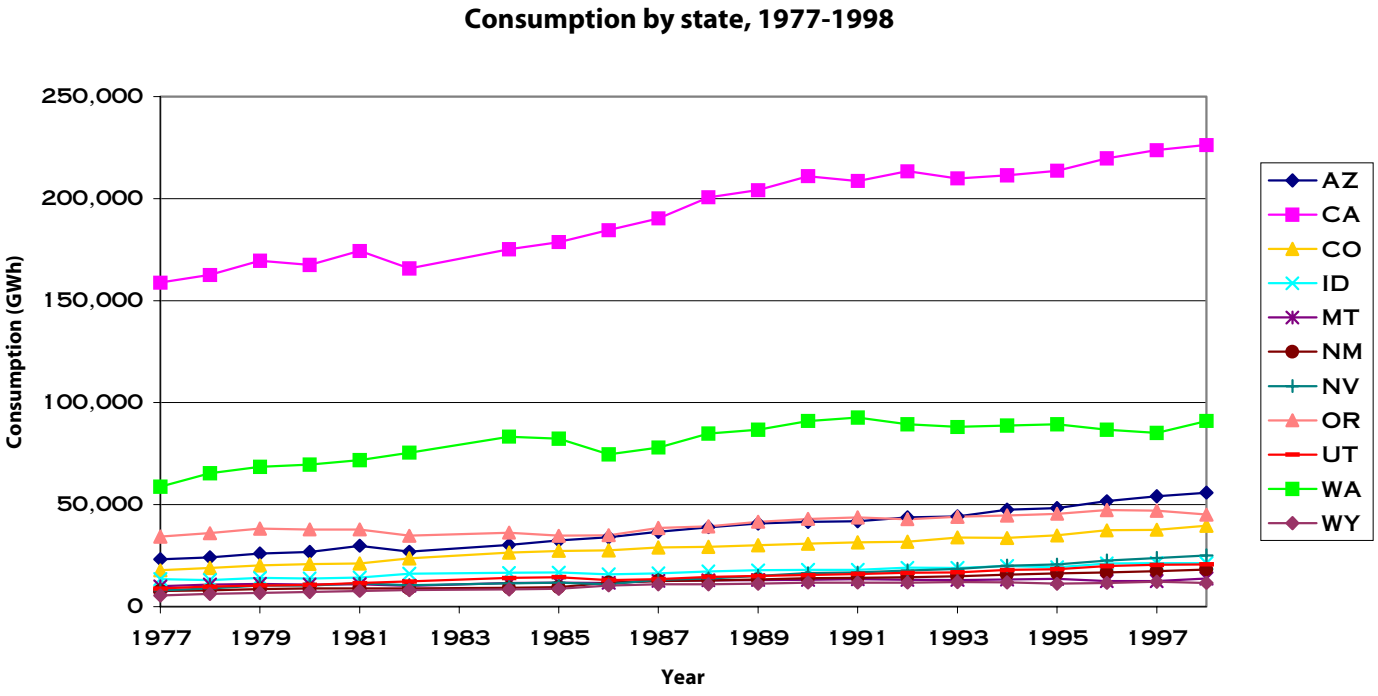
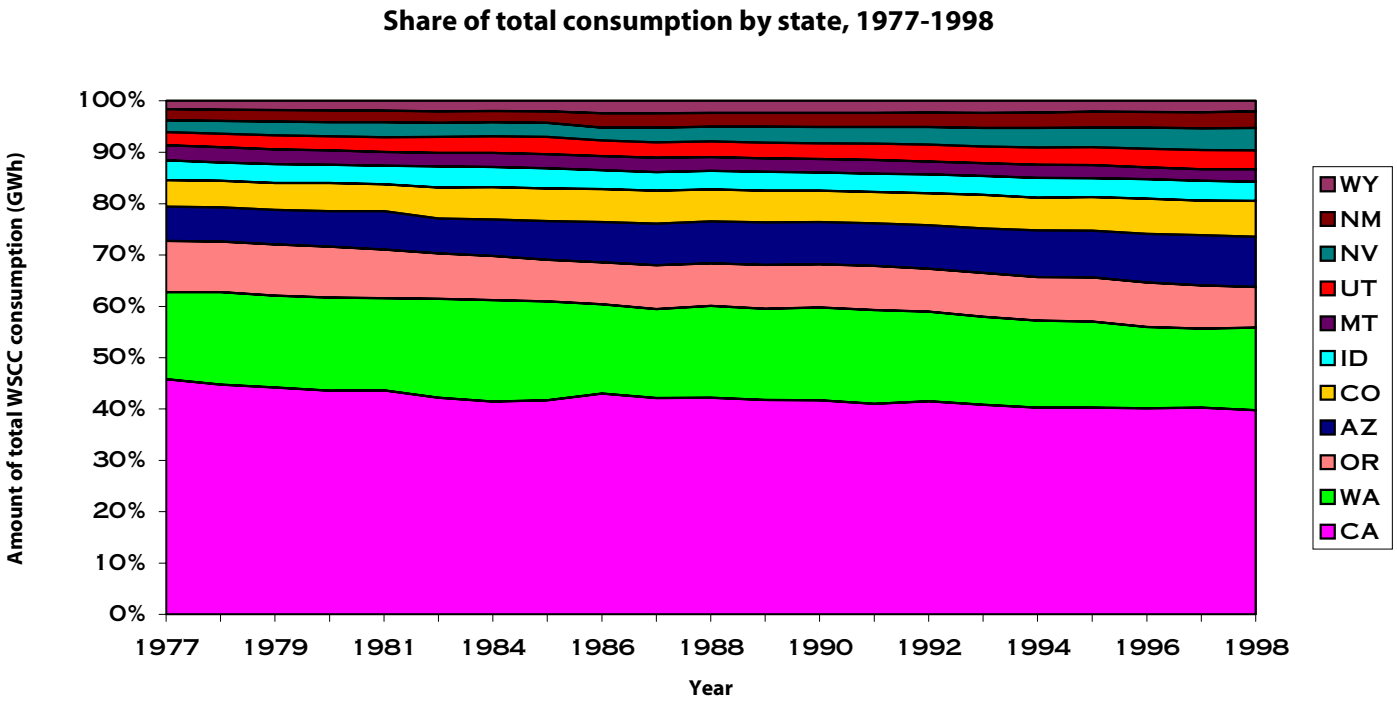


Chart ES-7


Share of total consumption by state, 1977-1998
Amount of total WSCC consumption (GWh)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1977
1979
1981
1984
1986
1988
1990
1992
1994
1996
1998
Year
WY
NM
NV
UT
MT
ID
CO
AZ
OR
WA
CA

A. CONSUMPTION

Consumption in all states has risen since 1977. Consumption by the states of the western grid, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming rose from 350,000 GWh in 1977 to nearly 570,000 GWh in 1998.[13] This corresponds to an average annual growth rate of 2.4%. While growth rates fluctuated widely during the first half of the time period, from between 25% and -10%, the growth rates leveled off after 1988, with all staying below 10% and most hovering near the 2.4% average. In total, the WSCC's consumption rose by 64%.

California's electricity usage dwarfs that of all other states; its consumption is nearly two and a half times that of the next largest user. The state's annual consumption rose by nearly 70,000 GWh, from about 160,000 GWh to nearly 230,000 GWh. This corresponds to an annual growth rate of 1.7%, below the WSCC average. This trend can also be observed by analyzing the state's share of total consumption in the WSCC. During the twenty years between 1977 and 1998, **California**'s share of total electricity consumption fell from over 45% to below 40%.

Washington remained the second largest user of electricity during this time period; it showed similar trends to **California**, growing at rates slower than the average. The state's annual consumption grew by over 50%, from under 60,000 GWh to over 90,000 GWh, at an average annual rate of 2.1%. While the state peaked in its share of consumption, using close to 20% of the WSCC total in 1984, its final share in 1998 dropped only slightly from its 1977 share, both near 16%.

While **Oregon** had been the third largest user of electricity, it was overtaken by **Arizona** in 1992. **Oregon**'s consumption grew by nearly one-third, from 34,000 GWh to over 45,000 GWh, equaling an average annual growth rate of 1.3%, the lowest in the western grid. The state's share of electricity consumption fell from nearly 10% to under 8%.

Arizona exhibited phenomenal growth in electricity consumption, as it overtook **Oregon** as the third largest user of electricity in the WSCC. Its consumption grew by nearly 140%, from under 24,000 GWh to over 55,000 GWh. Its annual average growth rate of 4.2% was exceeded only by **Nevada**. During this time its share of total electricity consumption grew from under 7% to nearly 10%, switching profiles with **Oregon**.

Colorado experienced considerable growth as well, adding over 20,000 GWh of new annual consumption, more than doubling its 1977 consumption. Its annual consumption rose from over 17,000 GWh, about 5% of the WSCC total, to nearly 40,000 GWh, nearly 7% of the WSCC total. While the state remains the fifth largest user of electricity, its growth indicates that it is likely to overtake **Oregon** within the next decade.

[13] The WSCC includes not only these eleven states but also some regions of Mexico and Canada, as well as small pieces of South Dakota, Nebraska, and Texas. (For a complete map, see page 29.) This report studies only the consumption and capacity of these eleven states. Only when the official WSCC regions are referenced do the data refer to the full WSCC.

Idaho is the largest of the small users in the WSCC, each of which uses less than 5% of the total. Over the past two decades, the state's usage has increased by over one-half, making it a slow growth state, comparatively. Its usage has grown from 13,500 GWh per year to over 21,000 GWh per year, converting to an average annual growth rate of 2.2%. Idaho has exhibited marked fluctuations in its consumption; in five of twenty years its consumption fell.

Over the past two decades, **Montana** has dropped from seventh to tenth in total electricity usage; only **Wyoming** uses less electricity. Its average annual growth rate, 1.5%, is the second lowest. During that time period, its consumption grew by one-third, from 10,000 GWh per year to nearly 14,000 GWh per year. The state's share of total electricity consumption dropped slightly from 2.9% to 2.4%. The state's consumption also varied similarly to Idaho's.

Utah has experienced significant growth in electricity consumption, more than doubling over the last twenty years. Its consumption grew from less than 9,000 GWh per year to over 20,000 GWh. In spite of this growth of 4.2% per year, which is above the western grid's average, the state remained the eighth smallest user of electricity in the western grid. As a percentage of the grid's total consumption, however, the state's share rose from 2.5% to over 3.6%.

Nevada experienced phenomenal growth over the last two decades, outpacing **Arizona** in rate, though not absolute growth. The state's consumption more than tripled over the last two decades, rising from 8,000 GWh per year to over 25,000 GWh per year. This rise corresponds to the highest average annual growth rate, 5.6%, in the entire western grid. As a result of this growth, **Nevada** moved from ninth to sixth in total electricity usage. The state's share of the WSCC total rose from 2.3% to 4.4%.

New Mexico experienced growth similar to that of **Nevada**. Its share of the western grid's electricity usage remains small, moving from 2.2% to 3.2%. Its total consumption more than doubled, growing from under 8,000 GWh per year to over 18,000 GWh per year, a 4.2% growth rate. During these decades, the state moved from tenth to ninth in total electricity consumption in the western grid.

Finally, **Wyoming** has paralleled the trend of **Nevada** and **New Mexico** over the last decade, more than doubling from 5,000 GWh per year to over 11,000 GWh per year. Its average annual growth rate, 3.7%, is above the western grid's average, but the state remains last in total consumption. **Wyoming**'s share of total electricity consumption rose during this time, from 1.6% to 2.1%.

Total consumption can also be broken down by region. **California**'s trends over the last two decades mirror the aggregate trend of the **northwest** states of **Oregon**, **Washington**, **Montana**, and **Idaho**. While **California**'s total usage moved from 46% to 40%, this group's share dropped from 34% to 30%. In contrast, two smaller regions, the **southwest** states of **Arizona**, **Nevada**, and **New Mexico** and the **Rocky Mountain** states of **Colorado**, **Utah**, and **Wyoming**, experienced more significant growth in electricity consumption. The **southwest** region's consumption grew by over 150%, from 39,000 GWh to nearly 100,000 GWh per year. Its share rose from 11% to over 17%. The **Rocky Mountain** region's consumption rose by over 120% during this period, rising from 32,000 GWh to nearly 72,000 GWh. The region's share of total consumption rose from 9% to nearly 13%.

Officially, the WSCC is divided into four regions: the Northwest Power Pool (**NWPP**), the Rocky Mountain Power Association (**RMPA**), the California and Mexico region (**CA/MX**), and the Arizona, New Mexico, and southern Nevada region (**AZ/NM/SNV**).[14] The last two regions, **CA/MX** and **AZ/NM/SNV**, were reorganized in 1997 and Mexico was added. Prior to that date, the California region had instead included California and southern Nevada and the Arizona region had included only Arizona and New Mexico. Unfortunately, the data are not uniform throughout the time period, but the changes do not drastically alter the results. Nevertheless, the data should be taken only as approximate. In addition, some data are only available as far back as 1995, but go through 1999, so they can only be used as a snapshot of current usage, not historical change. Using these geographic breakdowns, the **NWPP** uses about 37% of the WSCC total, the **RMPA** uses about 6%, **AZ/NM/SNV** uses about 16%, and **CA/MX** uses the remaining 42% of the WSCC total. These percentages have held steady over the five years for which data are available.

B. CONSUMPTION PER CAPITA

As expected, total consumption is related to each state's population. However, consumption per capita varies widely among states in the WSCC and has not converged considerably during the past two decades. While some states have decreased their consumption per capita slightly, some states have increased their consumption per capita greatly. In general, most states' per capita consumption varied during the 1980s and then stabilized during the 1990s. Some states experienced net increases in the 1980s, peaked at the turn of the decade, and then began a decline in per capita usage during the 1990s.

As a rough measure, a state's consumption per capita value is inversely proportional to its total electricity usage, *e.g.*, the state with the highest total electricity usage will have the lowest per capita electricity usage. It is difficult to use consumption per capita to compare across states, because the states of the WSCC are very heterogeneous. Weather, geography, and industry are primary determinates in total electricity usage, along with population. However, comparisons are valuable for giving general trends in consumption efficiency. Overall, the WSCC's per capita consumption rose by 9.4%, from 8.9 to 9.7 MWh/person.

California's electricity use per capita is now the lowest of any state in the WSCC, though it ended the 1970s with only the fourth lowest rate. While **California**'s consumption per capita dropped slightly during the last two decades, from slightly above to slightly below 7 MWh/person, **California**'s rank is mainly a result of increases in consumption per capita by other states. **New Mexico**, **Colorado**, and **Utah** began the two-decade period with the first, second, and third lowest consumptions per capita, respectively, but those values all increased during the period. **New Mexico**'s usage per person nearly doubled, from 6 MWh/person to over 10 MWh/person and dropping from first to fourth in lowest electricity consumed per person. **Colorado** and **Utah**'s usage each rose by about 50% during this time, from below 7 MWh/person to nearly 10 MWh/person.

[14] For a complete map of these regions, see page 30.

Arizona's consumption per capita rose by one-quarter over the two decades, from under 10 MWh/person to nearly 12 MWh/person. This slight increase in consumption per capita resulted in no net change in the state's relative consumption; it continues to be the fifth smallest user of consumption on a per capita basis.

Nevada's per capita consumption rose more than 20%, from under 12 MWh to over 14 MWh during the two-decade period. As a result of this relatively small increase, the state's rank in per capita consumption moved from sixth to seventh lowest.

Montana's consumption per capita grew a relatively modest 20% during the past two decades. Its relative position dropped slightly as well, from the seventh to the eighth smallest consumer of electricity per capita. Its consumption moved from 13 MWh/person to nearly 16 MWh/person.

Wyoming experienced phenomenal growth in consumption per capita, increasing by more than 85%. While its usage began near the WSCC average of 10.8 MWh/person (averaged over the eleven states, not total population), its ultimate consumption ballooned to over 24 MWh/person, 40% higher than the closest state. Nearly all of this growth occurred during the 1980s; 77% of the change occurred between 1985 and 1989 when annual consumption per capita rose by nearly 9 MWh. During the 1990s, the state's consumption per capita began to decline slightly each year, falling from 26 MWh/person to its final value.

Like most states, **Oregon**'s per capita consumption varied during the 1980s and steadied in the 1990s. Along with **California**, **Oregon** was one of just two states to experience a decline in per capita consumption. The state's consumption per capita dropped slightly from its 1977 value, falling only 0.3 MWh/person to nearly exactly the eleven-state average of 13.7 MWh/person. As a result of this slight decline, the state's relative position in the WSCC changed significantly; it moved from the ninth to the sixth lowest user of electricity per capita.

Idaho's per capita usage remains high after two decades; the state remains tenth out of 11 in terms of lowest consumption per capita. The state's usage per person grew a modest 13%, from 15.3 to 17.3 MWh annually. The state's consumption growth varied during the 1980s, like most states, and leveled off during the 1990s. All of the state's consumption per capita growth occurred during the 1980s; the state's consumption dropped just slightly from the beginning to the end of the 1990s.

Two decades ago, **Washington** had the highest annual per capita consumption. Its 15.6 MWh/person was two and a half times that of the lowest per capita user, **New Mexico**. **Washington**'s consumption per capita exhibited strong growth during the 1980s and strong decline during the 1990s. In aggregate, the state's consumption rose slightly, less than 3%, to 16 MWh/person. As a result of **Wyoming** and **Idaho**'s larger increases, however, the state's relative ranking moved to ninth overall.

C. CONSUMPTION PER DOLLAR OF GROSS STATE PRODUCT

All states exhibited a marked decline in consumption per dollar of gross state product (GSP) between the 1977 and 1998. While values ranged from 0.7 to nearly 2 kWh per dollar of GSP

($GSP) in 1977, by 1998 the values had all converged to within 0.5 kWh/$GSP of each other and had all fallen below 0.7 kWh/$GSP. Similar to the pattern of per capita consumption, per GSP consumption varied widely in the 1980s, with some states increasing and decreasing in alternating years. While some states switched places in terms of relative consumption per GSP, in general the relative positions of states remained the same, *e.g.* those states with high relative per GSP consumption in 1977 had high per GSP consumption in 1998, though the absolute value was much lower. Except for one, all states exhibited a generally steady decline in per GSP consumption over the two decades, though the first decade had more fluctuating noise and generally accounted for a larger share of the total decline. Only **Wyoming** experienced an increase in per GSP consumption during the first decade, a peak, and then a decline. Nevertheless, it also ended the 1990s with a net decrease, though small, in per GSP consumption.

California began the two decades with per GSP consumption nearly three times less than the highest per GSP user. Over the course of the two decades its consumption per GSP dropped by more then 70%, from 0.69 kWh/$GSP to 0.20 kWh/$GSP. More than 80% of the decline came during the first decade. In fact, more than half of the decrease occurred during the first five years, between 1977 and 1982. During those years the decline hovered near 10% per year, after which time it dropped to near 3% or 4% per year. Its 1998 per GSP consumption was three times less than that of the largest per GSP consuming state and 40% less than the consumption of the next most efficient state per GSP.

Colorado's decline mimicked that of **California**. It experienced a decline in per GSP consumption of over 60%, more than half of which occurred during the first five years after 1977. Overall, its per GSP usage fell from 0.71 to 0.28 kWh/$GSP.

New Mexico experienced a pronounced decline during the 1980s, an increase beginning in 1986, and then another decline beginning in 1990. The steady decline during the 1990s more than offset the increases of the late 1980s. Overall, the state's per GSP usage dropped 50%, from 0.74 to 0.38 kWh/$GSP. Nevertheless, the state's ranking rose slightly; it moved from the third to the fourth lowest user of electricity on a per capita basis.

Utah's initial per GSP consumption was close to **California**'s, within 20%, but because it experienced a less pronounced decline than **California**, its final value diverged from **California**'s by more than 70%. The state's overall decline was slightly less than 60%, falling from 0.85 to 0.35 kWh/$GSP. **Utah**'s relative rank changed slightly during the period; it moved from the fourth to the third smallest consumer on a per GSP basis, switching rankings with **New Mexico**.

Due in part to fluctuating population, **Wyoming**'s per GSP consumption varied widely during the 1980s. The state fell from 0.95 kWh/$GSP to a low of 0.58 kWh/$GSP in 1981. By 1987, however, the state exceeded the 1977 value and peaked at nearly 1 kWh/$GSP. Over the next decade the state's per GSP consumption began a steady decline, and finally settled at 0.66 kWh/$GSP. Overall, the state's per GSP usage fell by 30%. The state fell from the fifth to the ninth lowest consumer per dollar of GSP.

Nevada, **Arizona**, and **Oregon** all experienced significant declines in per GSP consumption during this period, about 70%. These declines were generally steady, though higher declines

were seen in the first five years. **Nevada**'s usage fell from above 1 to below 0.4 kWh/$GSP. The state's rank moved from the sixth to the fifth lowest per GSP consumer. **Arizona**'s per GSP consumption fell from 1.2 to nearly 0.42 kWh/$GSP as it moved from the seventh to the sixth smallest per GSP consumer of electricity. **Oregon** experienced the greatest percentage decline of any state, 72%, falling from over 1.5 to nearly 0.43 kWh/$GSP. Its rank moved from eighth to seventh.

Montana, **Washington**, and **Idaho** began the 1980s with the highest per GSP usage in the WSCC. Only **Washington** experienced sufficient decline in consumption to become a mid-range user of electricity per GSP. Its consumption fell from over 1.6 kWh/$GSP to under 0.5, a decline of over 70%. As a result, its rank fell from the tenth to the sixth smallest consumer of electricity per GSP. **Montana** and **Idaho** remained the highest users of electricity per GSP. **Idaho**'s usage fell from nearly 2 kWh/$GSP to 0.7. **Montana**'s usage fell from 1.6 kWh/$GSP to less than 0.7. Montana's 1998 per GSP consumption was higher than California's 1977 per GSP consumption.

On a regional basis, the differences are slightly obfuscated. Within each region, individual states drive the differences and there is not a strong geographic similarity driving the per GSP consumption trends. For example, the **northwest** is the highest per GSP user of electricity, but this is a result of high usage by **Montana** and **Idaho** moderated by the usage of **Washington** and **Oregon**. While in 1977 these four states were the four highest users of per GSP electricity, during the last two decades **Oregon** and **Washington** have reduced their usage per GSP significantly. In the **southwest**, the second highest regional user of electricity on a per GSP basis, the high usage is driven almost equally by all three states. Finally, the **Rocky Mountain** region's low usage is driven by **Colorado** and moderated by **Wyoming**, the state that experienced the smallest per GSP consumption decline of any state in the WSCC.

D. PEAK DEMAND

The data of historical peak demand are available only by WSCC region and for the time period from 1982 to 1998. These data indicate the incidental peak electricity demand in each year.[15] Since 1982, all regions have experienced an increase of at least one-third. Generally, the growth progressed steadily over the sixteen years, though all regions experienced both increases and decreases in peak demand from year to year. From 1982 to 1998 the peak electricity consumption of the total WSCC rose by nearly 50,000 MW, from 84,000 MW to over 130,000 MW, a greater than 50% increase.

The **NWPP** continued to have the highest peak electricity demand from 1982 through 1998, but the region's percentage growth was the smallest in the WSCC. Its peak demand rose 16,000 MW, 37%, from 44,000 MW to 60,000 MW. The state's demand fluctuated by as much as 15% from a previous year, though in most of the 1990s its peak demand fluctuated less.

[15] These data indicate the peak demand on a single day during the year or a particular season. Because peak demand is heavily weather-dependent, an individual region's peak demand may not occur on the same day as the WSCC's peak demand. Therefore the overall WSCC peak demand may be less than the sum of regional peak demands.

The **CA/MX** region's peak consumption grew by 55%, from 36,000 MW to 55,000 MW. While the region's peak demand remained below the **NWPP**, it often approached the **NWPP** region's level. In both 1986 and 1988, **CA/MX**'s demand came within 1,000 MW of the **NWPP**'s peak demand. The state's demand fluctuated widely as well, alternating increased and decreased peak demand for ten years, from 1987 through 1996.

The greatest increase in peak demand occurred in the **AZ/NM/SNV** region. Between 1982 and 1998 the region's peak demand grew by 135%, more than doubling from 8,700 MW to above 20,000 MW. Unlike the other regions, which experienced frequent increased and decreased peak demand, the **AZ/NM/SNV** had only one year when the peak demand decreased from the year before.

The **RMPA** has a comparatively small peak demand and its peak grew at a rate similar to that of **CA/MX** and the **NWPP**, by less than 50%. Between 1982 and 1998, the region's peak rose from 5,400 MW to 8,000 MW. Its year-to-year fluctuations were less pronounced than the other regions. In particular, it had only a few years where its peak demand dropped from the previous year. Nevertheless, it did have increases of over 7% in one year.

A small set of data shows the western grid's winter and summer peak demands separately. For summer the data span 1995 to 1999. For winter the data span 1995/1996 to 1999/2000. However, the geographic definitions underlying these data were changed in 1997 (southern Nevada was moved to a different region and Mexico was added to a region), so the data are only approximate. The summer peak for all regions crested in 1998 and then dropped down slightly in 1999. The following discussion refers to the 1999 values, but the trends do not change if the previous year's numbers are used.

Overall, these data follow the trends observed in the annual incidental peak data. The peak summer demand for the WSCC increased by 10%, 13,000 MW, from 117,000 MW in 1995 to 130,000 MW in 1999. The WSCC's peak winter demand rose by 5%, 8,000 MW, from 112,000 MW in 1995/1996 to 118,000 in 1999/2000.

The **AZ/NM/SNV** region experienced the greatest increase in peak demand. Both its winter and summer peak demand had the greatest increases of any region. The summer-peaking region had a 37% increase, 5,000 MW, in its summer peak, moving from 15,000 MW to 20,000 MW. The winter peak rose 32%, 3,000 MW, from 11,000 MW to 14,000 MW.

As a winter peaking region, the **NWPP** summer peak increase is obfuscated by the annual peak value. In fact, its winter peak dropped slightly from 1995/1996 to 1999/2000, but this may be a result of the data re-aggregation. Its summer peak, however, increased by nearly 10%, 4,000 MW, from 44,000 MW to over 48,000 MW. During this time, the **NWPP**'s summer peak of electricity usage approached that of **CA/MX**. By the summer of 1999, the **NWPP** was within of 5,000 MW of **CA/MX**, a differential decrease of over 40% over the five years.

The **RMPA**'s winter and summer peak demand increased modestly during this five-year period. The region, which peaks in the winter, experienced a summer peak increase of 5%, just 400 MW, rising to 7,700 MW. Its winter peak rose by 11%, 700 MW, from 6,900 MW to 7,600 MW.

The **CA/MX** region experienced the smallest peak demand increases in both summer and winter of any of the regions in the WSCC. The region, which peaks in the summer, experienced only a 1% increase in its summer peak, just 600 MW, rising from 52,500 MW in 1995 to 53,100 MW in 1999. The 600 MW rise accounts for only 5% of the combined summer peak increases for all of the regions in the WSCC. In the winter, the region's peak demand increased by nearly 7%, 3,000 MW, from 37,500 MW to 40,000 MW. The region therefore accounted for more than 45% of the combined winter peak increase for all of the regions in the WSCC.

E. CAPACITY

Over the last decade, utility capacity additions dropped off dramatically.[16, 17] There was considerable capacity addition during the 1980s, but installations nearly stopped in 1988. While new additions averaged 4.5% over the eleven states from 1978 to 1988, the eleven-state average growth rate dropped to less than 0.5% during the second decade. Looking at the WSCC as a single unit, the numbers are even smaller. In total, the WSCC's growth rate was 3.5% during the first decade and fell to two-tenths of a percent during the second decade. Only a handful of states had real growth during the second decade: **Idaho**, **Nevada**, and, to a lesser extent, **Arizona**. Some states had capacity removals during some periods. Overall, the WSCC increased its capacity by 48%, to 133,000 MW.

California's utility capacity additions came entirely during the first decade. During this time period the state added 10,000 MW of capacity. Between 1977 and 1981 the state added 3,400 MW. Between 1982 and 1986, 6,900 MW were added. During the second decade, the state had a net loss of nameplate capacity. Between 1987 and 1992 the state removed 675 MW of capacity, which was replaced by only 123 MW during the most recent five-year period, 1993 through 1998. Overall, the state increased its capacity from 35,000 in 1977 to 44,000 MW in 1998, an increase of 28%, the second smallest increase.

Overall, **Arizona**'s capacity increased by 83% during the last two decades. The state added 7,500 MW of capacity during the period, giving it a total of 16,600 MW. Unlike most states, **Arizona** had significant capacity additions during the second decade, though most of that occurred during the first half of the decade. Between 1977 and 1981 the state added 1,200 MW of capacity. During the next five years the state added another 3,400 MW. Between 1987 and 1992 the state increased its installed capacity by 2,900 MW. Finally, during the final five years the state added just 40 MW of new capacity.

Colorado's installed nameplate capacity rose by 50% between 1977 and 1998, from 4,600 to 7,000 MW. Like **California**, all of these additions occurred during the first half of the two

[16] Utility capacity data include both investor-owned utilities and municipal utility districts.

[17] The capacity data included in this report indicate a generator's nameplate capacity. While nameplate capacity matches closely the average annual peak capacity of fossil fuel generators, it can be significantly higher than the average annual peak capacity of hydro, wind, and solar electricity sources. Therefore, the capacity figures cited in this report are higher than the peak level of generation that could be sustained over an extended period of time. In particular, variation in annual and seasonal hydro conditions may result in "firm" capacity for hydro resources that is well below the installed nameplate capacity.

decades. Between 1977 and 1981 the state added 1,800 MW of capacity. It added 900 more during the next half-decade. Between 1987 and 1992 the state lost 520 MW of capacity. In the following five years only 240 MW were replaced. The drop in capacity came entirely from a single year decline in 1990.

Idaho is one of only two states that had a larger capacity increase during the second half of the two-decade period than the first (the other is Nevada). The state lost 270MW between 1977 and 1981 but added 570 MW of capacity between 1982 and 1986. During the next five years the state added 93 MW of capacity. During the final five years, 1993 to 1998, the state added 260 MW. The increase was not the greatest absolute addition during this period, but as a percentage of a state's total new capacity, it dwarfs all other states. Overall, the state's capacity increased by 38%, from 1,700 to 2,400 MW.

Montana added more than 2,000 MW of capacity, an increase of close to 70%. Most of the additions occurred during the period between 1982 and 1986, when it added 2,000 MW of capacity. It lost 160 MW in the preceding five years. In the last ten years the state added less than 200 MW of capacity.

New Mexico had the third smallest percentage increase in capacity during the last two decades. The state's installed capacity rose by 30%, from 4,300 MW to 5,600 MW. Almost all of these additions occurred during the first half of the two-decade period. Between 1977 and 1981 the state's capacity increased by 760 MW. During the next five years the state added 500 MW. During the next decade the state added 85 MW.

Although **Nevada** had high net capacity growth during the last two decades, nearly none of this growth occurred during the first half of the time period. The state added 1,000 MW of new capacity between 1977 and 1981 but lost nearly all of that capacity during the next five years, the largest decrease of any five-year period. Between 1987 and 1992, however, the state added 2,600 MW of capacity. Finally, during the most recent five-year period, the state added 530 MW of capacity, resulting in a net increase over the twenty-year period of over 3,000 MW, or 115%. Only **Utah** had a greater percentage increase. Overall, the state increased its capacity from 2,700 MW in 1977 to 5,900 MW in 1998.

Oregon had only a tiny capacity increase during the last two decades. Its net capacity rose by less than 3%, or 300 MW, to 9,900 MW. The capacity dropped by nearly 1,000 MW during the first five years of the time period. In the following five years, all new capacity for the entire twenty-year period was added, nearly 1,900 MW. In the next decade some of these additions were eroded by reductions of over 750 MW.

Overall, **Utah**'s installed capacity rose by a phenomenal 360%. The state added over 4,000 MW of capacity to its existing stock of 1,100. In one year, 1987, the state added 1,250 MW of capacity. In total, nearly 80% of these additions came during the first decade, roughly equally divided between the first and second half of the decade. The state added nearly 1,000 new MW of capacity between 1987 and 1992. During the last five years, the state's stock declined by 126 MW.

Washington's capacity growth was the most skewed towards the early decade. More than 90% of the state's 8,800 new MW of capacity were added during the first half of the time period. The state lost 72 MW between 1987 and 1992 and gained 900 MW from 1992 to 1998. In total, the state's capacity stock rose by 60%, to 25,000 MW.

Wyoming capacity additions were also heavily skewed to the early years. The state added more than 80% of its total additions during the first decade. Between 1977 and 1981, the state added 1,000 MW of capacity. During the years between 1982 and 1986, the state added more than 1,500 MW. Between 1987 and 1992, only 350 MW were added. Finally, during the last five years the state's capacity increased by only 180 MW. In aggregate, the state's capacity stock rose by over 3,000 MW, or 90%, to 6,400 MW.

When analyzed regionally, the new capacity additions appear less divergent. The four regions, **California**, the **northwest**, the **southwest**, and the **Rocky Mountain** states, added similar amounts of capacity, between 9,500 and 12,000 MW. Only in the **southwest** did any significant capacity building occur during the second decade. Driven by **Nevada** and, to a lesser extent, **Arizona**, more than 50% of this region's capacity was built in the later ten years.

While the capacity additions by the **northwest** and **California** were large in magnitude, they were smaller on a percentage basis than other regions. Overall, **California**'s capacity grew less than 30% over the period, and the **northwest**'s capacity grew by less than 40%. In contrast, the **southwest**'s capacity rose by nearly 75%. The capacity stock in the **Rocky Mountain** region rose by over 100%, driven largely by **Utah**'s phenomenal growth. In total, the western grid's capacity rose by about 50%.

Non-utility capacity

Utility-only capacity data partially obfuscate the real trends in installed capacity in the western grid. In particular, **California** experienced significant growth in capacity between 1986 and 1990 as a result of the newly-created qualifying facility (QF) category. Federal legislation adopted in 1978 required that independent electricity producers be allowed to sell electricity back to utilities.[18] **California**, which developed generous payment rates for QF electricity, had the sharpest capacity additions of any state in the nation. Unfortunately, data limitations prevent a rigorous quantitative comparison across states in the western grid.

While **California**'s utility-owned capacity additions nearly stopped in 1987, additions made through the QF program were relatively large. In fact, the state's overall capacity stock increase doubles from 28% without QF supply to over 57% with QF supply. The state's utility-owned capacity stock declined by nearly 600 MW between 1987 and 1998 but QF additions totaled nearly 8,000 MW during the same period. Most of these additions occurred between 1987 and 1991, when more than 6,500 MW were added. By 1992, QF additions had also declined to an average of less than 170 MW per year. In spite of these declines, by 1998 QF facility capacity accounted for nearly 20 percent of the state's total.

[18] Public Utility Regulatory Policies Act (PURPA; see *16 USCS § 824 et seq.*). Though not the legislation's primary goal, PURPA regulations encouraged the development of independent electricity, particularly from cogeneration and renewable resources ("qualifying facilities" under PURPA).

Time series data of other states' QF capacity are not available, but the 1998 single-year non-utility capacity totals for the rest of the western grid are available. While **California**'s QF capacity totaled more than 10,000 MW, only 2 other states had more than 1,000 MW of QFs (**Washington** had 1,046 MW and **Oregon** had 1,006 MW). The other eight states had an average of less than 400 MW each.[20] The unavailability of QF data for these other states before 1998 should therefore not significantly affect the general trends in installed capacity outlined above.

F. CAPACITY PER CONSUMPTION

While absolute capacity additions by state or region are important measures of capacity stock growth, they do not account for the consumption differences across these areas. **California** is likely to make the largest absolute additions to its stock simply due to its size, but the magnitude of each state's additions does not indicate whether those additions were in proportion to its usage. A more useful statistic is installed capacity per consumption. States or regions with high capacity per consumption are likely to be exporters of electricity and states with lower values are likely to import a share of theirs.[21] While not exact markers, these statistics suggest whether a state or region is supporting its consumption increases with its existing capacity and imports or with new capacity and possibly exporting the excess.[22]

Overall, the WSCC experienced a decline in its utility capacity-to-consumption ratio of 10%, falling from 0.26 to 0.23 MW of capacity per GWh of annual consumption.[23] Only two states, **Montana** and **Utah**, opposed this trend and experienced net utility capacity per consumption increases over the time period. **California** increased its total net capacity per consumption ratio through extensive non-utility additions, however, that are discussed below. **Washington**'s ratio remained nearly unchanged. Consistent with the capacity building trends, many states experienced utility capacity per consumption peaks during the first half of the two decades, only to see these increases eroded during the subsequent decade

This ratio can also be analyzed entirely from the perspective of new capacity and new consumption. This measure can be used to account for the general decline of most states. Like total capacity additions, the measure can be separated into smaller time periods to see when a state's increase or decline occurred. The WSCC added just 0.19 MW of new capacity for every GWh of new consumption. This is 25% less than its ratio at the beginning of the period.

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[20] These data come from the Department of Energy (DOE), while the California QF capacity data come from California Energy Commission (CEC) data sources. The DOE data include all non-utility capacity, which represents a larger universe of categories than the CEC data, which include only QFs.

[21] This ratio is used for comparison only. Differences in utilization rates and other qualities of capacity and consumption prevent the ratio from providing specific information about the ability of a particular amount of capacity to meet the demand of a particular amount of consumption.

[22] As noted above, however, variations in these figures could also reflect fuel availability or generating technology choice. Areas with high levels of dependence on hydro, wind, or solar resources will generally require higher installed nameplate generating capacity to meet a given level of annual loads. The load profile (*e.g.*, winter- vs. summer-peaking, load factors, etc.) also influences capacity utilization. The ratios described here are meant to serve as general indicators.

[23] This can also be interpreted as an increase in average utilization rates of installed capacity.

In total, **California**'s installed utility capacity per consumption moved little during these two decades, dropping 10%, from 0.22 to 0.20 MW/GWh, a ratio less than the WSCC value.[24] Its relative rank within the WSCC did not change; its capacity per consumption ratio is the third lowest. During the two-decade period, the state added just 0.15 MW of utility-owned capacity for every GWh of new consumption. This is the fifth lowest capacity addition ratio. Between 1977 and 1981 the state added utility capacity at a rate of 0.22 MW/GWh. The ratio rose to 0.44 MW/GWh between 1982 and 1986. In the following decade the utility capacity addition ratios became negligible, resulting in a net decline.

The data used in these ratios understate significantly **California**'s total installed generating capacity per consumption, however, since they do not include California's QF capacity. When QF supply is included, the state's capacity per consumption ratios increase dramatically. For example, instead of declining, the state's overall installed capacity per consumption ratio rose from 0.22 to 0.24 MW/GWh. In addition, the state's new capacity per new consumption between 1977 and 1998 ratio moves from 0.14 MW/GWh without QF capacity to 0.30 MW/GWh with QF capacity, well above the WSCC average of 0.24 MW/GWh. **California** therefore added new capacity between 1977 and 1998 at a higher rate relative to its increases in consumption than any other state except **Montana**, **Utah**, and **Wyoming**. Inclusion of QF capacity shifts **California**'s position from being the third-lowest to the third-highest state in the WSCC from 1977 to 1998 in terms of capacity per consumption.

Arizona's ratio of installed capacity to consumption remained relatively high during these two decades, but it dropped from third to fourth as its ratio fell by 24%. The state's ratio fell from 0.39 MW of capacity per GWh of consumption to 0.30 MW/GWh, a result of adding 0.23 MW of capacity for every GWh of new consumption between 1977 and 1998. In the decade from 1982 to 1992, the state added capacity in excess of its initial ratio, but these additions were tempered by small capacity additions per new consumption between 1977 and 1981 and negligible new additions in the last five years of the period.

Colorado fell from eighth to tenth in capacity per consumption in the WSCC as a result of a 30% decline in capacity per consumption during the period. The state added new capacity on a per consumption basis at a rate of just 40% of its ratio in 1977. Its new capacity per new consumption additions were the third smallest in the WSCC, less than 0.11 MW/GWh. All of these additions occurred during the first half of the two-decade period; the state was a net loser of capacity in the remaining decade.

Idaho added the second smallest stock of new capacity per new consumption in the WSCC. As a result of the state's 13% decline overall, its relative ranking fell from second lowest to lowest. The state added just 0.08 MW of new capacity for each GWh of new consumption, dropping its total ratio from 0.13 to 0.11 MW capacity/GWh consumption. Nearly all of the state's capacity additions per consumption occurred in the five-year period between 1982 and 1986, when it

[24] The "utility" figures for 1977-1998 include those utility-owned generating facilities that were divested by the California utilities in 1996-1998. The DOE data show approximately 23,000 MW of non-utility capacity in 1998, for example, but just over 10,000 MW of that total represents capacity that was not originally owned by California utilities. Data after 1998 become less clear as further divestiture occurred.

added 0.30 MW of capacity for each GWh of new consumption. During the final five years of the period, the state added some new capacity at a rate of 0.11 MW/GWh, its final ratio.

Montana is one of just two states that exhibited a net rise in capacity per consumption during the two decades. The state's capacity per consumption ratio rose by 21%, increasing the state's ratio of consumption per capacity from the fifth highest to the second highest in the western grid. Overall the state added capacity at a rate of 0.54 MW of new capacity per GWh of new consumption. The state's ratio rose from 0.30 to 0.37 MW/GWh. The state made above average additions to its capacity stock during the first decade; it continued to add capacity during the second decade, but at a ratio lower than its net average. Unlike most states, the lower addition ratio in the second decade did not significantly erode the gains made from the high capacity addition rate of the previous decade.

New Mexico had the third lowest new capacity per new consumption ratio of the two decades following 1977. Despite this low ratio, the state maintained its relatively high ratio of capacity to consumption, dropping from second to third. The ratio fell by 45%, from 0.56 to 0.31 MW/GWh. While the state had a high new capacity per new consumption ratio in the first five years of the two decades, 0.57 MW/GWh, the ratio dropped by nearly an order of magnitude in the following 15 years, to 0.06 MW/GWh.

Nevada experienced dramatic fluctuations in its ratio of capacity to consumption. In aggregate the state's ratio fell by 31%, dropping its ranking from fourth to seventh. In the process, the state's ratio fell from 0.34 MW/GWh to 0.24 MW/GWh. In terms of new capacity per new consumption, the state's ratio was the western grid's median and mean, 0.19 new MW per new GWh. Large increases that occurred during the first five years were entirely offset by decreases in the second five years. Between 1987 and 1992 the state had the largest new capacity per new consumption of any state in the WSCC, 0.48 MW/GWh, but these gains were also offset by the weak per new consumption additions made in the following five years when it added just 0.08 MW of new capacity per GWh of new consumption.

Oregon's new capacity per new consumption ratio was the smallest in the western grid during these two decades. It added just 0.03 MW of new capacity per GWh of new consumption, a rate almost twenty times smaller than that of **Montana**, the state with the highest ratio of new capacity to new consumption over the period. As a result of these small ratios, **Oregon**'s capacity per consumption fell by 22% during these two decades, from 0.28 to 0.22 MW/GWh. This decline is a result of capacity removals during the second and last five years of the two decades, when the state lost more than 1,000 MW of capacity. These losses were partially offset by a relatively high capacity addition per new consumption ratio of 0.35 MW/GWh between 1977 and 1981.

Utah, along with **Montana**, is the only other state that had a utility capacity per consumption increase during these two decades. (**California** also saw an increase when QF capacity is included.) The state, which had the lowest capacity per consumption ratio in 1977, rose to be the median state as a result of its 96% growth in capacity per consumption. The state rose from 0.13 MW/GWh to 0.25 MW/GWh. Overall, the state's ratio of new capacity per new consumption was 0.34 MW/GWh, the third highest in the western grid. Although the state had high new capacity per new consumption ratios during the first half of the two decades, nearly all of its

growth occurred between 1982 and 1986 when the state had a new capacity per new consumption ratio of 0.9 MW/GWh, the highest of any comparable period.

Washington's capacity per consumption trends mirrored those of **California** during these two decades. Overall the state's capacity per consumption ratio was flat; it increased by half a percent. As a result, the state's relative ranking rose from seventh to fifth, while its ratio held at 0.27 MW/GWh. The state had moderate ratios during most of the two decades; between 1987 and 1992, however, the state had a slightly negative ratio, the result of a small net loss of capacity.

Although **Wyoming** experienced a decline in its capacity per consumption ratio between 1977 and 1998, it remained the state with the highest capacity per consumption ratio in the western grid. It began the period with a ratio of 0.61 MW/GWh, more than double the WSCC average and nearly five times that of the lowest ratio. Overall, the state's ratio dropped by just 10%, to 0.55 MW/GWh. Between 1977 and 1986 the state had a moderate capacity addition ratio of 0.44. During the last five years the state technically had negative growth, but this is a false statistic; the state had a decline in consumption so it actually added net capacity when its consumption was reduced. In total, the state had the second highest ratio of added capacity to new consumption, 0.49 MW/GWh.

Regionally, the utility capacity per consumption statistics mirror the absolute capacity trends. The four regions maintained their relative positions. The order from lowest utility capacity per consumption ratio to highest remained **California**, the **northwest**, the **Rocky Mountain** states, and the **southwest**. However the differences between the four regions converged during the two decades as all regions experienced a decline in their utility capacity per consumption ratios. In 1977 the **southwest** had a ratio nearly double that of **California**. By 1998, the percentage and absolute differences were more than halved. This is a result of the **southwest**'s slowed utility capacity additions in relation to its high consumption growth. While **California**, the **northwest**, and the **Rocky Mountain** states had declines in utility capacity per consumption of 10% or less, the **southwest**'s ratio declined by more than 30%. Nevertheless, the region's ratio of 0.28 MW/GWh continued to be the highest in the WSCC.

In terms of new utility capacity per new consumption, the **Rocky Mountain** region had the highest ratio. The region added 0.24 MW of capacity for each new GWh of consumption. The **northwest**'s capacity additions per consumption were also slightly larger than the **southwest**'s, though they both added approximately 0.20 MW/GWh during the two-decade period. **California** had the lowest new utility capacity per new consumption ratio, less than 0.15 MW/GWh. Inclusion of QF capacity additions pushes **California** into a leadership position, however; the state added 0.30 MW/GWh during the two decades, the highest rate in the WSCC.

CONCLUSION

This study shows how long-term trends in consumption, peak demand, and generating capacity have changed throughout the western grid from 1977 to 2000 and affected **California**'s supply and demand balance. It shows that **California** has been similar to other states in some respects (*e.g.*, increasing installed capacity to consumption ratios at a greater rate from 1977 to 1988 than

from 1989 to 1998), but that it has also been quite different in many other respects. The most important differences include heavy reliance on non-utility capacity additions in the 1980s and early 1990s and significantly lower growth in either annual consumption or summer peak demand on either a per capita or per dollar of GSP basis than other western states. **California**'s winter peak demand grew at a relatively high rate, however, compared to other parts of the west.

Although **California** has been widely criticized for not building adequate generating capacity during the 1990s, the state actually exceeded the WSCC average for new capacity additions relative to increases in demand from 1977 to 1998. **California**'s higher-than-average new capacity to consumption ratio is due to both demand factors and supply factors. On the demand side, California accounted for a disproportionately lower level of growth in overall WSCC demand from 1977 to 1998 as other states grew at a faster rate and failed to achieve **California**'s low consumption per capita or per dollar of GSP. On the supply side, investment has been driven primarily by non-utility capacity additions since 1987. The state's growth in new capacity appears low when only utility-owned generation is included, but QF capacity more than doubled the total increase in generating capacity installed in the state from 1977 to 1998.

Neither increases in **California**'s annual consumption (or peak demand) nor decreases in **California**'s historical share of WSCC-wide generating capacity is therefore at the heart of the state's supply and demand relationship from 1977 to 1998. Instead, the tightening of supplies throughout the WSCC during this period primarily reflects increases in consumption and peak demand in other states and a region-wide decline in new capacity additions relative to those increases in consumption. Above-average hydropower production (especially in the Pacific Northwest) between 1996 and 1999 masked this shift, then hydropower availability decreased significantly in 2000 (combined with significant increases in consumption in **California** and throughout the WSCC) to reveal apparent shortages. This study does not examine production or operating data, however, so we are unable to address how weather and other factors may have affected apparent shortages in 2000 and 2001. This study only addresses installed generating capacity.

To summarize, the following trends stand out from our analysis of trends in electricity consumption, peak demand, and generating capacity in **California** and the western grid:

- New utility capacity additions dropped off precipitously throughout the west beginning around 1988-1989, lowering reserve margins and installed capacity per consumption ratios.

- Only two of the eleven western states (**Nevada** and **Idaho**) installed more new utility-owned capacity during the second decade of the 1977-1998 period than during the first decade.

- **California**'s installed capacity grew by only 28% from 1977 to 1998 if only utility capacity is included, but a successful QF program added another 10,000 MW of non-utility capacity (resulting in an overall capacity increase of 57%). Oregon and Washington added just over 1,000 MW of non-utility capacity, but the other eight states averaged less than 400 MW of new non-utility capacity. California therefore added new generating capacity relative to increases in its consumption at a higher rate than every state except **Montana**, **Utah**, and **Wyoming**.

- **California** is the lowest user of electricity per capita and per dollar of gross state product, but the size of its population and economy mean that it accounts for about two-fifths of WSCC annual consumption and summer peak demand, and about one-third of winter peak demand.

- Annual consumption increased 64% throughout the WSCC from 350,000 GWh in 1977 to nearly 570,000 GWh in 1998, but **California**'s consumption grew only 44% during this period. Its share of overall WSCC consumption therefore declined from 45% to 40%.

- Non-coincidental summer peak demand increased throughout the WSCC from 1995 to 1999 by roughly 13,000 MW, but **California** accounted for only 5% of the total increase during this period.

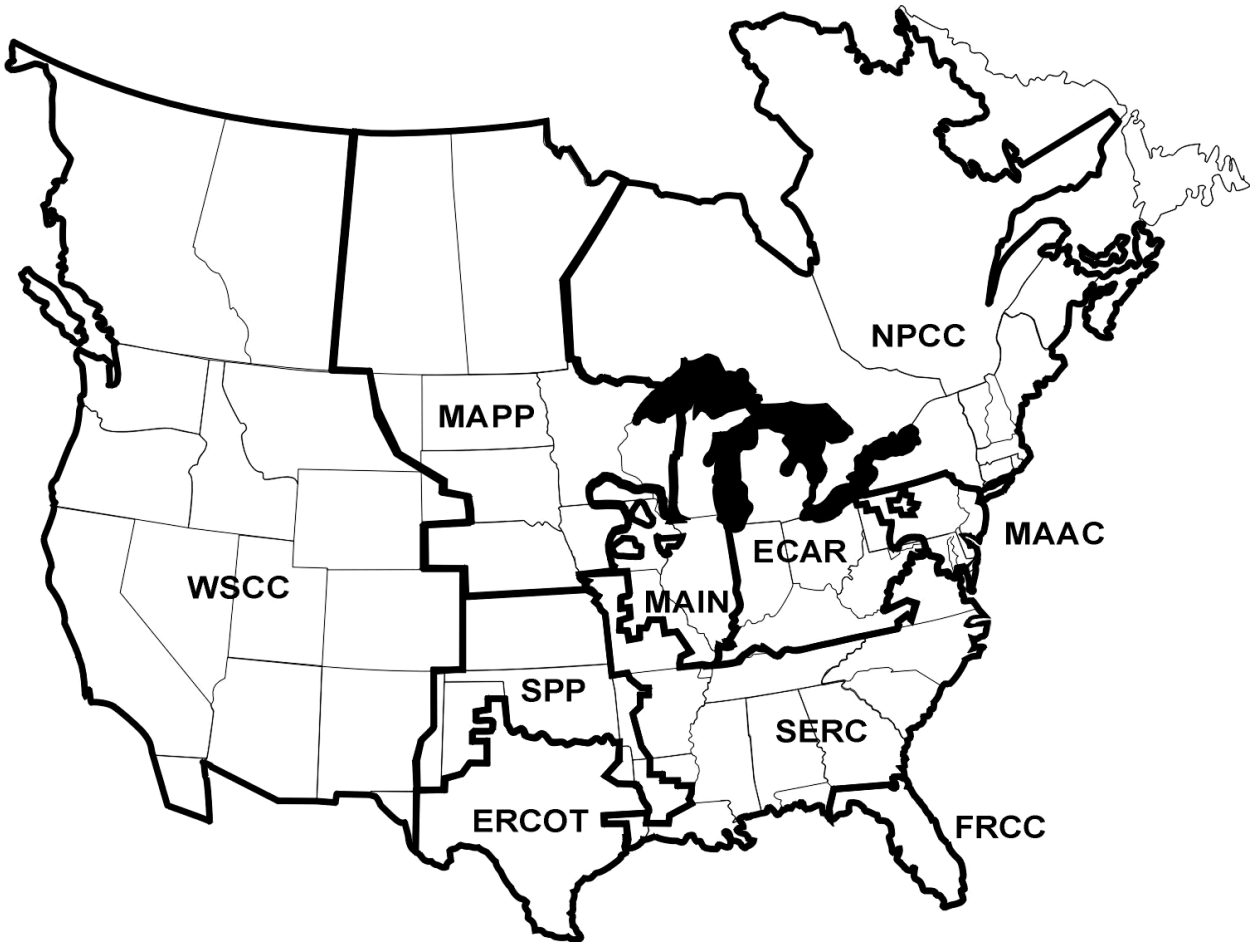
- Non-coincidental winter peak demand increased throughout the WSCC from 1995/1996 to 1999/2000 by roughly 6,700 MW, but **California** accounted for 45% of the total increase during this period.

These findings clearly have important policy implications, but this study is focused only on exploratory compilation and analysis of the historical data for electricity consumption, peak demand, and generating capacity in **California** and the western grid. We will leave it to others and future papers to address the relationship between these data and the electricity crisis that continues to grip **California** and the west. We are hopeful that this study offers some of the historical data necessary to address those policy issues in a well-informed manner.

KEY TO ACRONYMS AND REGIONS

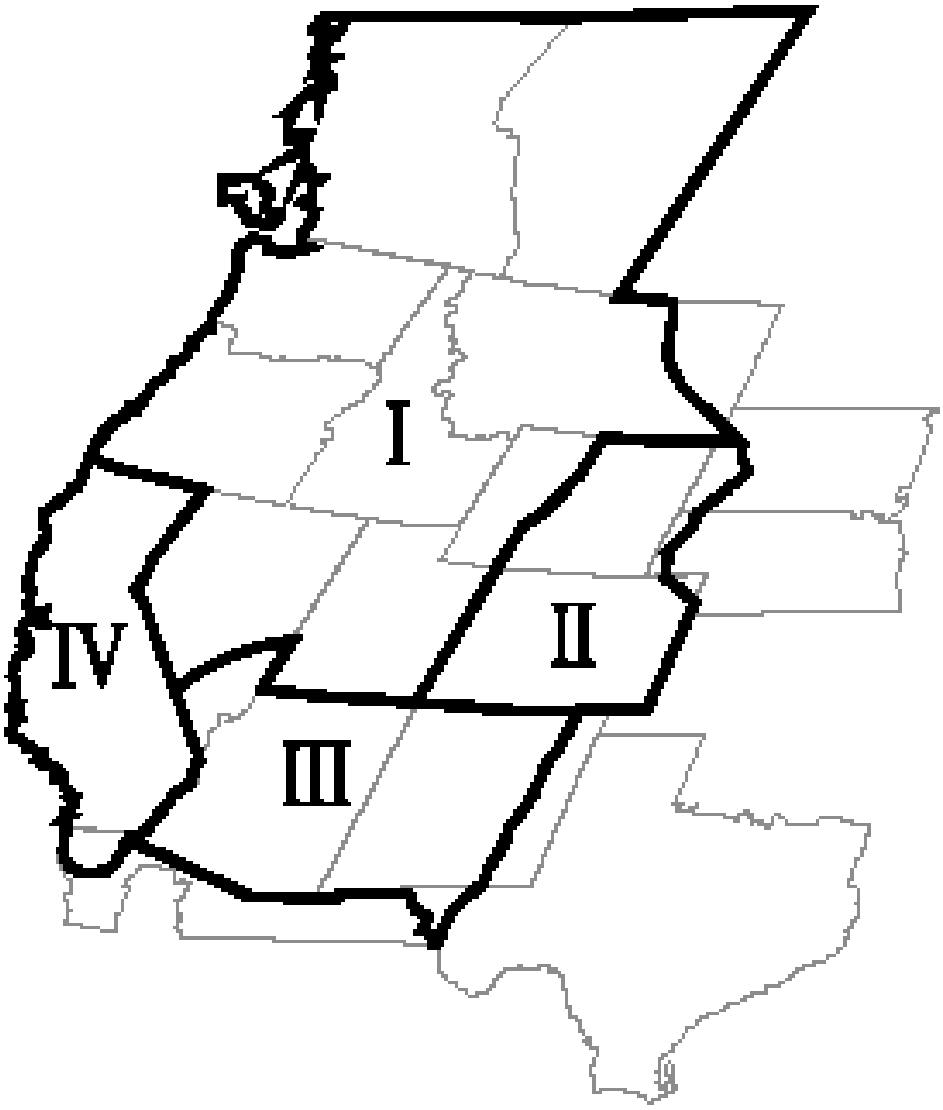
AZ/NM/SNV	Arizona-New Mexico-Southern Nevada Power Area, subregion of the WSCC that also includes the western tip of Texas
CA/MX	California-Mexico Power Area, subregion of the WSCC
NWPP	Northwest Power Pool, subregion of the WSCC that includes Washington, Oregon, northern California, Idaho, Wyoming, western Montana, northern Nevada, Utah, southwestern South Dakota, and western Canada
RMPA	Rocky Mountain Power Area, subregion of the WSCC that covers Colorado
WSCC	Western Systems Coordinating Council, one of ten state or regional electricity grids in the United States; see regional map
Northwest region	Idaho, Montana, Oregon, and Washington
Rocky Mountain region	Colorado, Utah, and Wyoming
Southwest region	Arizona, New Mexico, and Nevada
GSP	gross state product
GWh	gigawatt-hour, one billion watt-hours of electricity
$GSP	constant dollar of gross state product
kWh	kilowatt-hour, one thousand watt-hours of electricity
MW	megawatt, one million watts of electricity generation capacity
MWh	megawatt-hour, one million watt-hours of electricity

REGIONAL ELECTRICITY GRIDS IN NORTH AMERICA



Western Systems Coordinating Council
- British Columbia, Canada
- Alberta, Canada
- Washington
- Idaho
- Wyoming
- California
- Nevada
- Utah
- Arizona
- Oregon
- Western Montana
- Western New Mexico
- Western tip of Texas
- Southwestern tip of South Dakota
- Southern tip of Mexico

REGIONS OF THE WESTERN SYSTEMS COORDINATING COUNCIL



Western Systems Coordinating Council

I	Northwest Power Pool Area (NWPP)
II	Rocky Mountain Power Area (RMPA)
III	Arizona-New Mexico-Southern Nevada Power Area (AZ/NM/SNV)
IV	California-Mexico Power Area (CA/MX)

SOURCES OF DATA

Population

1970-1990	United States Census Bureau, *Historical Annual Time Series of State Population Estimates and Demographic Components of Change 1900 to 1990: Total Population Estimate,* [cited 12 February 2001]; available from www.census.gov/population/www/estimates/st_stts.html.
1990-1999	United States Census Bureau, *State Population Estimates: Annual Time Series, July 1, 1990 to July 1, 1999*, ST-99-3, [cited 12 February 2001]; available from www.census.gov/population/estimates/state/st-99-3.txt.
2000	United States Census Bureau, *Resident Population Census 2000 Results*, [cited 12 February 2001]; available from www.census.gov/population/www/cen2000/respop.html#t2.

Capacity

Utility	United States Department of Energy, Energy Information Administration, *Inventory of Electric Utility Power Plants in the United States*, DOE/EIA-0095(XX)/1, "Table 17/18. Operable Capacity and Planned Capacity Additions at U.S. Electric Utilities by Energy Source and State"; recent issues available from www.eia.doe.gov/cneaf/electricity/ipp/ipp99_sum.html.
California QF	California Energy Commission, Databases, *Database of California Power Plants*, [cited 20 June 2001]; available from http://38.144.192.166/database/index.html.
WSCC non-utility	United States Department of Energy, Energy Information Administration, *Inventory of Nonutility Electric Power Plants in the United States 1998*, DOE/EIA-0095(98)/2, "Table 6. Existing Capacity and Planned Capacity Additions at U.S. Nonutilities by Energy Source and State, 1998"; available from http://www.eia.doe.gov/cneaf/electricity/ipp/ipp_sum2.html.

Peak demand

Western Systems Coordinating Council, *Documents and Publications*, "WSCC Information Summary," [cited 12 February 2001]; available from www.wscc.com.

Consumption

United States Department of Energy, Energy Information Administration, *Electric Power Annual,* DOE/EIA-0348(XX/1), "Table 26. Estimated Retail Sales by U.S. Electric Utilities to Ultimate Consumers by Sector, Census Division, and State"; recent issues available from www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html.

Note: Data from 1983 diverges widely from the year before and after. Typically the value is always less than one-half and often close to one-quarter of the value of consumption in 1982 and 1984. Since this is likely an error in the data, the value has been omitted from the analysis. When necessary, modifications or omissions of other data have been made. These changes do not alter the results of this report.

GSP

United States Department of Commerce, Bureau of Economic Analysis, *Regional Accounts Data: Gross State Product Data*, [cited 12 February 2001]; available from www.bea.doc.gov/bea/regional/gsp/.

Chart index

Chart	Title	X-axis	Y-axis	Category
A-1	Consumption by state, 1977-1998	Year	Consumption (GWh)	State
A-2	Consumption by state, 1977-1998	Year	Consumption (GWh)	State
A-3	Share of total consumption by state, 1977-1998	Year	Amount of total WSCC consumption (GWh)	State
A-4	Consumption by region, 1977-1998	Year	Consumption (GWh)	Group 1
A-5	Share of total consumption by region, 1977-1998	Year	Amount of total WSCC consumption (GWh)	Group 1
A-6	Consumption by region, 1982-1998	Year	Consumption (GWh)	Group 2
B-1	Consumption per capita by state, 1977-1998	Year	Consumption per capita (MWh/person)	State & WSCC
B-2	Consumption per capita by state; 1977, 1988, 1998	State	Consumption per capita (MWh/person)	State & WSCC
B-3	Consumption per capita by region; 1977, 1988, 1998	Region	Consumption per capita (MWh/person)	Group 1 & WSCC
B-4, C-1	Consumption per GSP and per capita by state, 1998	State	Consumption per GSP (kWh/constant dollar) Consumption per capita (MWh/person)	State & WSCC
C-2	Consumption per GSP by state, 1977-1998	Year	Consumption per GSP (kWh/constant dollar)	State & WSCC
C-3	Consumption per GSP by state; 1977, 1988, 1998	State	Consumption per GSP (kWh/constant dollar)	State & WSCC
C-4	Consumption per GSP by region; 1977, 1988, 1998	Region	Consumption per GSP (kWh/constant dollar)	Group 1 & WSCC
D-1	Peak incidental demand by region, 1982-1998	Year	Peak incidental demand (MW)	Group 2
D-2	Peak incidental demand by region; 1982, 1990, 1998	Region	Peak incidental demand (MW)	Group 2
D-3	Peak incidental summer demand by region, 1995-1999	Summer	Peak incidental demand (MW)	Group 2
D-4	Peak incidental winter demand by region, 1995-2000	Winter	Peak incidental demand (MW)	Group 2
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E-1	Utility capacity by state, 1977-1998	Year	Capacity (MW)	State
E-2	New utility capacity by state, 1977-1997	Year	Capacity added during year (MW)	State
E-3	New utility capacity by state, 1977-1998	State	Capacity added during period (1977-1998; MW)	State
E-4	New utility capacity during ten-year periods by state, 1977-1998	State	Capacity added during period (MW)	State
E-5	New utility capacity during five-year periods by state, 1977-1998	State	Capacity added during period (MW)	State
E-6	New utility capacity during five-year periods by state, 1977-1998	State	Capacity added during period (MW)	State
E-7	Share of total new utility capacity during five-year periods by state, 1977-1998	State	Amount of capacity added during period (MW)	State & WSCC
E-8	New utility capacity during five-year periods by region, 1977-1998	Region	Capacity added during period (MW)	Group 1

Key to categories
Group 1: CA; ID, MT, OR, & WA; AZ, NM, & NV; CO, UT, & WY
Group 2: NWPP, RMPA, AZ/NM/SNV, CA/MX
State: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

Chart index

Chart	Title	X-axis	Y-axis	Category
E-9	New utility capacity during five-year periods by region, 1977-1998	Region	Capacity added during period (MW)	Group 1
E-10	Utility and QF capacity in California, 1977-1998	Year	Capacity (MW)	California
E-11	New utility and QF capacity in California, 1977-1997	Year	Capacity added during year (MW)	California
E-12	New utility and QF capacity in California, 1977-1997	Year	Capacity added during year (MW)	California
E-13	New utility capacity during five-year periods by state including QF capacity in California, 1977-1998	State	Capacity added during period (MW)	State
E-14	New utility capacity during five-year periods by state including QF capacity in California, 1977-1998	State	Capacity added during period (MW)	State
E-15	Non-utility capacity by state, 1998	State	Capacity (MW)	State w/o CA
F-1	Utility capacity per consumption by state, 1977-1998	Year	Capacity per consumption (MW/GWh)	State & WSCC
F-2	Utility capacity per consumption by state, 1977-1998	State	Capacity per consumption (MW/GWh)	State & WSCC
F-3	Utility capacity per consumption by region, 1977-1998	Region	Capacity per consumption (MW/GWh)	Group 1 & WSCC
F-4	New utility capacity per new consumption by state, 1977-1998	State	Total new capacity per total new consumption during period (1977-1998; MW/GWh)	State & WSCC
F-5	New utility capacity per new consumption during five-year periods by state, 1977-1998	State	New capacity per new consumption during period (MW/GWh)	State & WSCC
F-6	New utility capacity per new consumption by region, 1977-1998	Region	Total new capacity per total new consumption during period (1977-1998; MW/GWh)	Group 1 & WSCC
F-7	New utility capacity per new consumption during five-year periods by region, 1977-1998	Region	New capacity per new consumption during period (MW/GWh)	Group 1 & WSCC

Key to categories

Group 1: CA; ID, MT, OR, & WA; AZ, NM, & NV; CO, UT, & WY
Group 2: NWPP, RMPA, AZ/NM/SNV, CA/MX
State: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

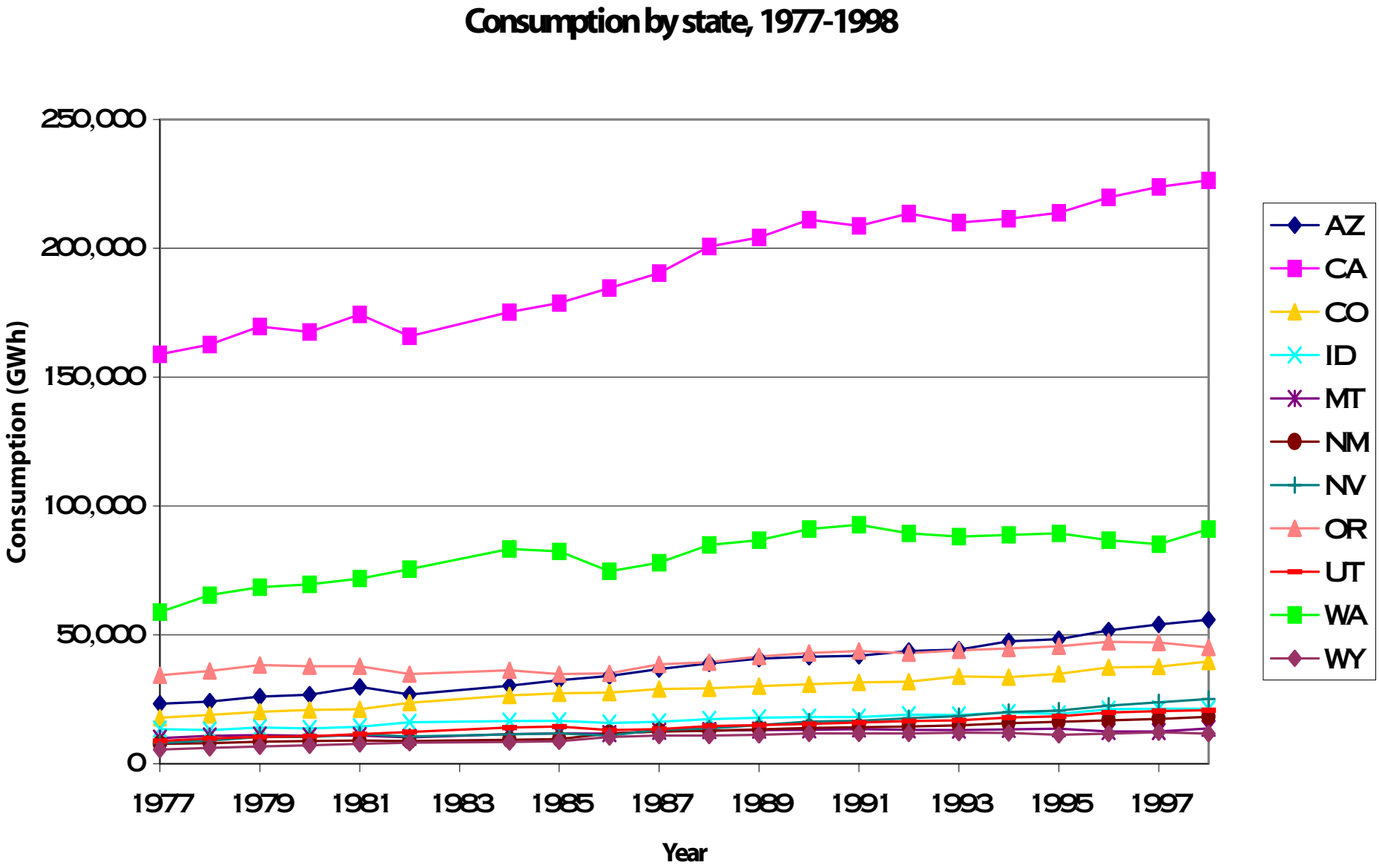
Consumption by state, 1977-1998
250,000
200,000
150,000
100,000
50,000
0
Consumption (GWh)
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
Year
AZ
CA
CO
ID
MT
NM
NV
OR
UT
WA
WY

Chart A-1

Consumption by state, 1977-1998

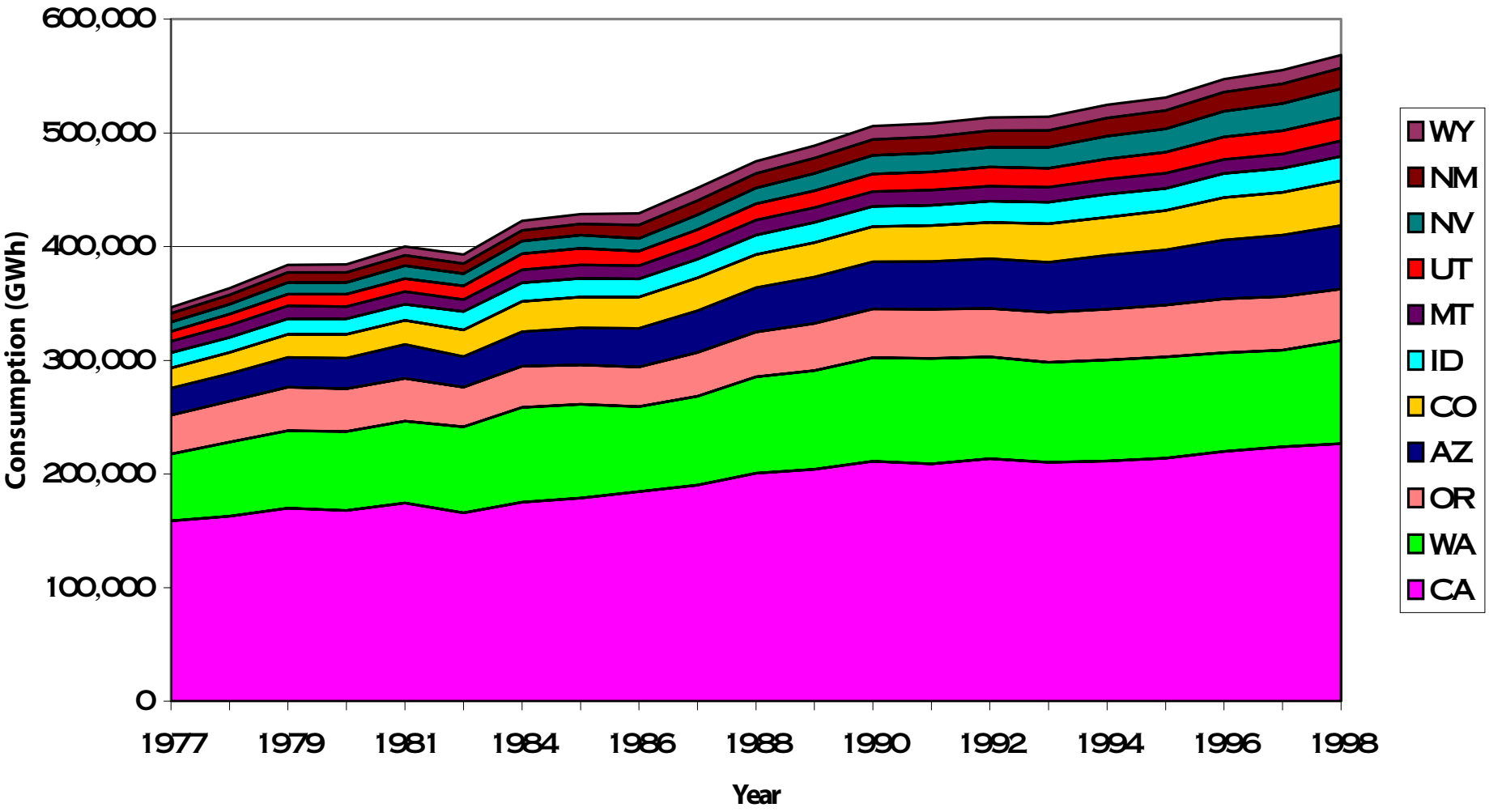

Chart A-2

Share of total consumption by state, 1977-1998

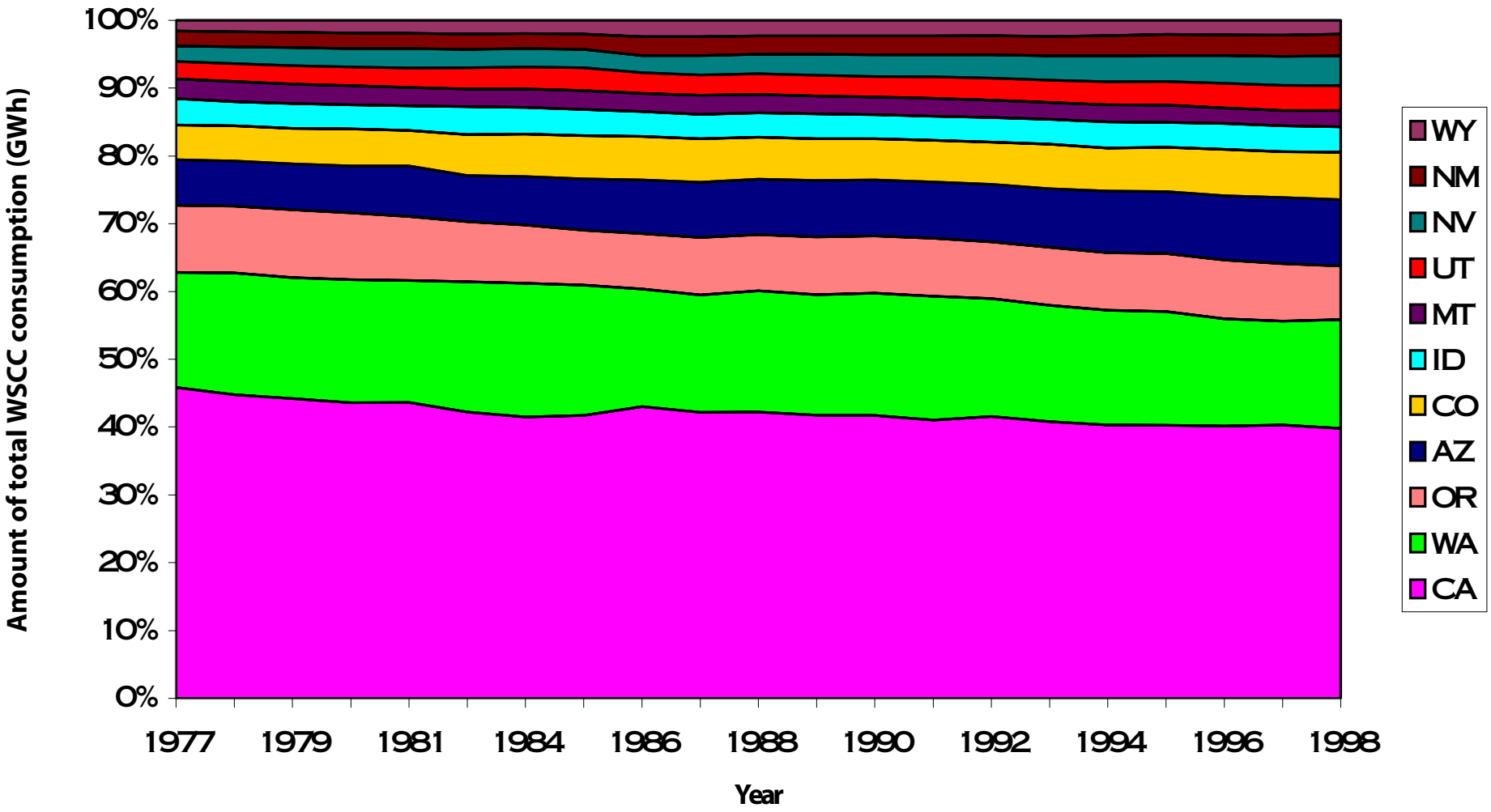

Chart A-3

Consumption by region, 1977-1998

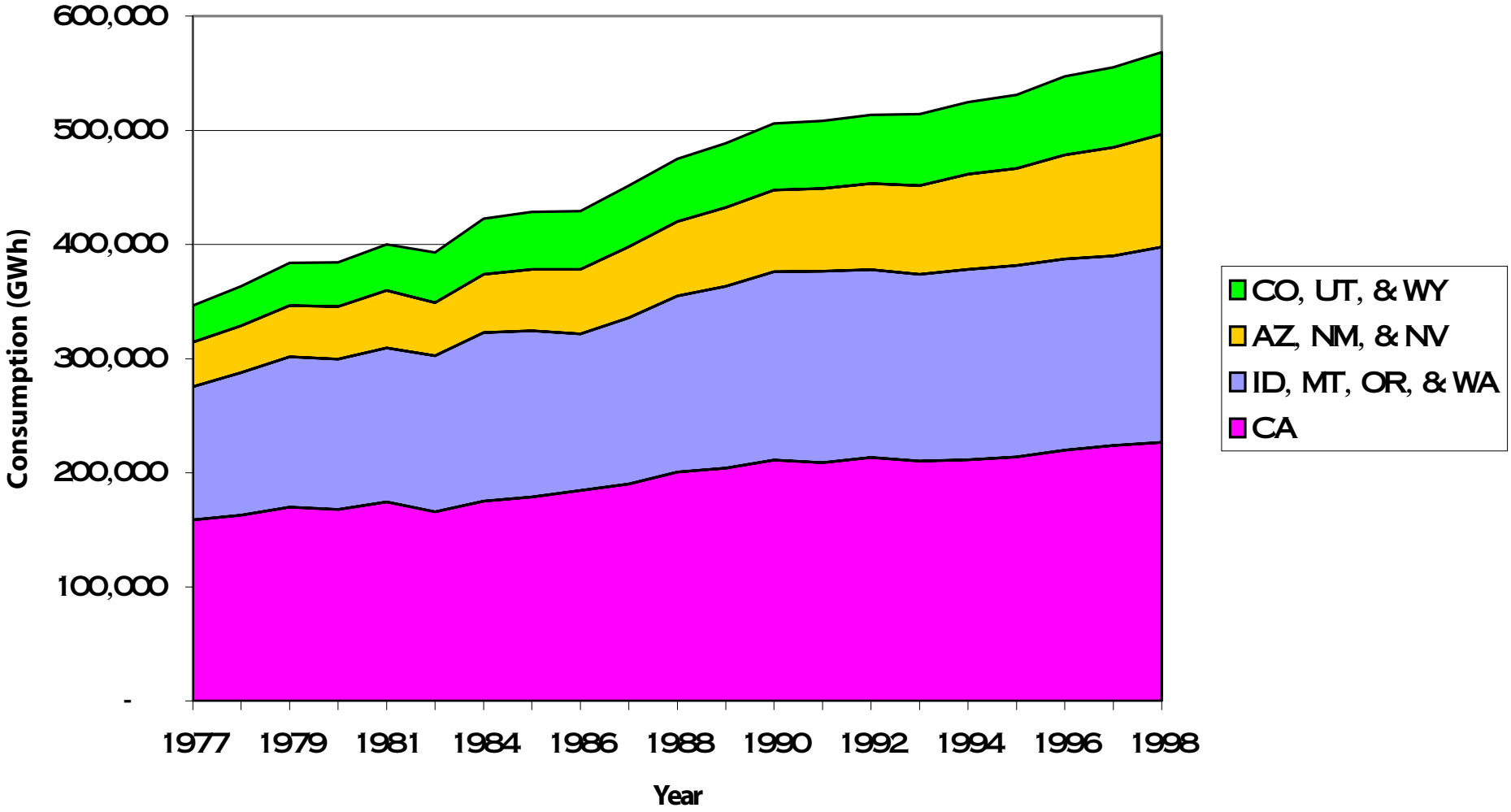

Chart A-4

Share of total consumption by region, 1977-1998

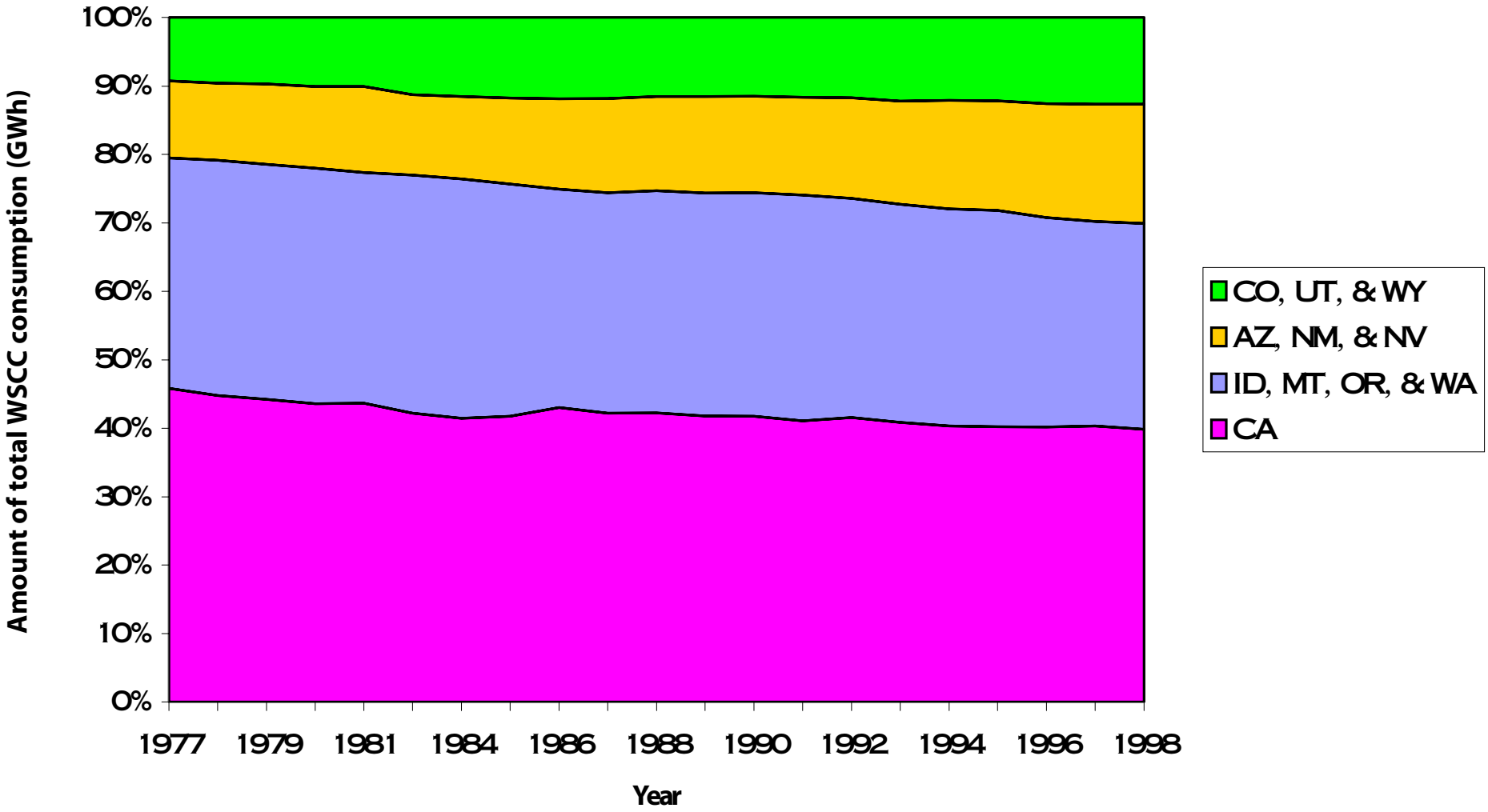

Chart A-5

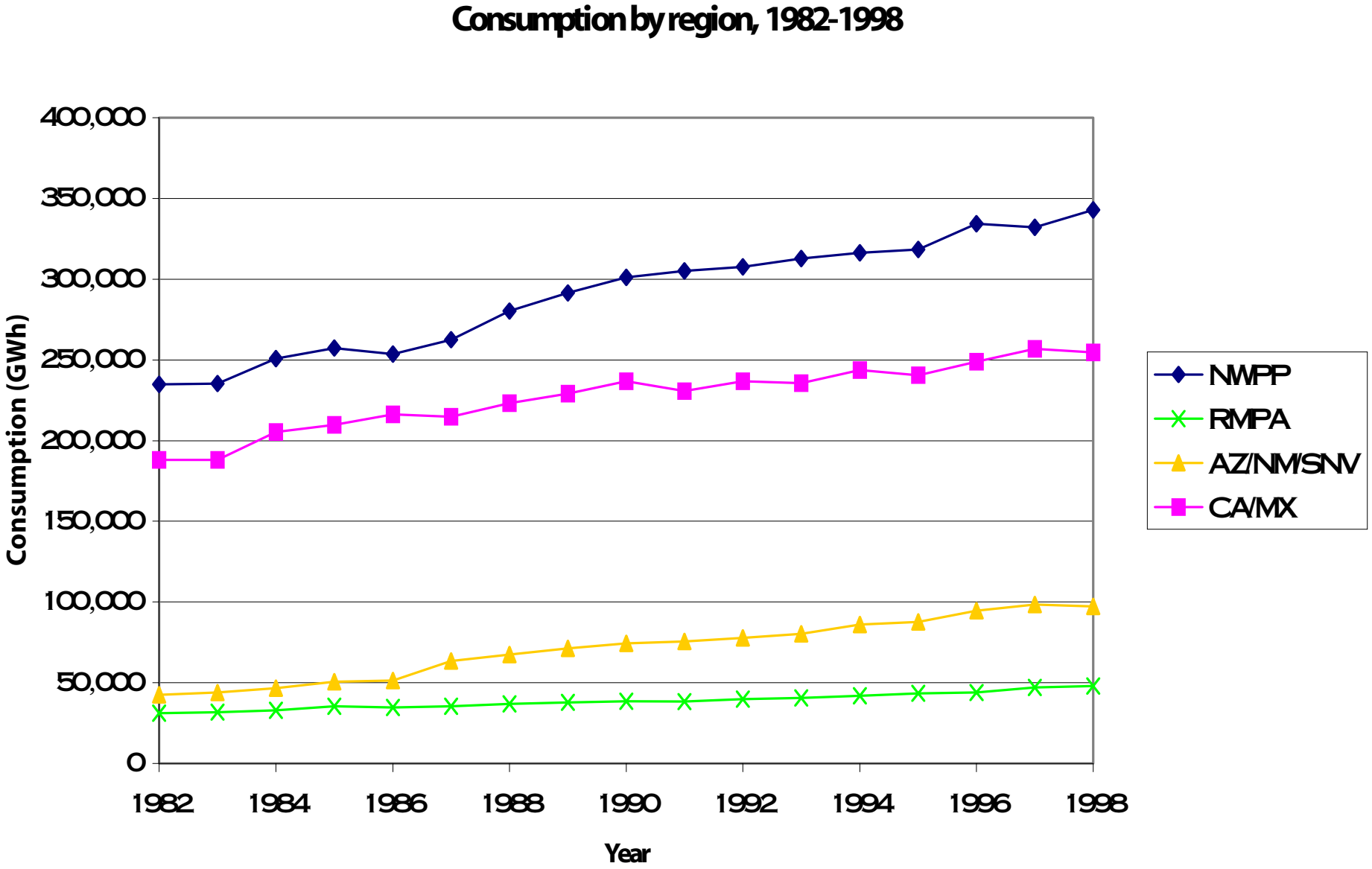
Consumption by region, 1982-1998
Consumption (GWh)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
Year
NWPP
RMPA
AZ/NM/SNV
CA/MX

Chart A-6

Consumption per capita by state, 1977-1998

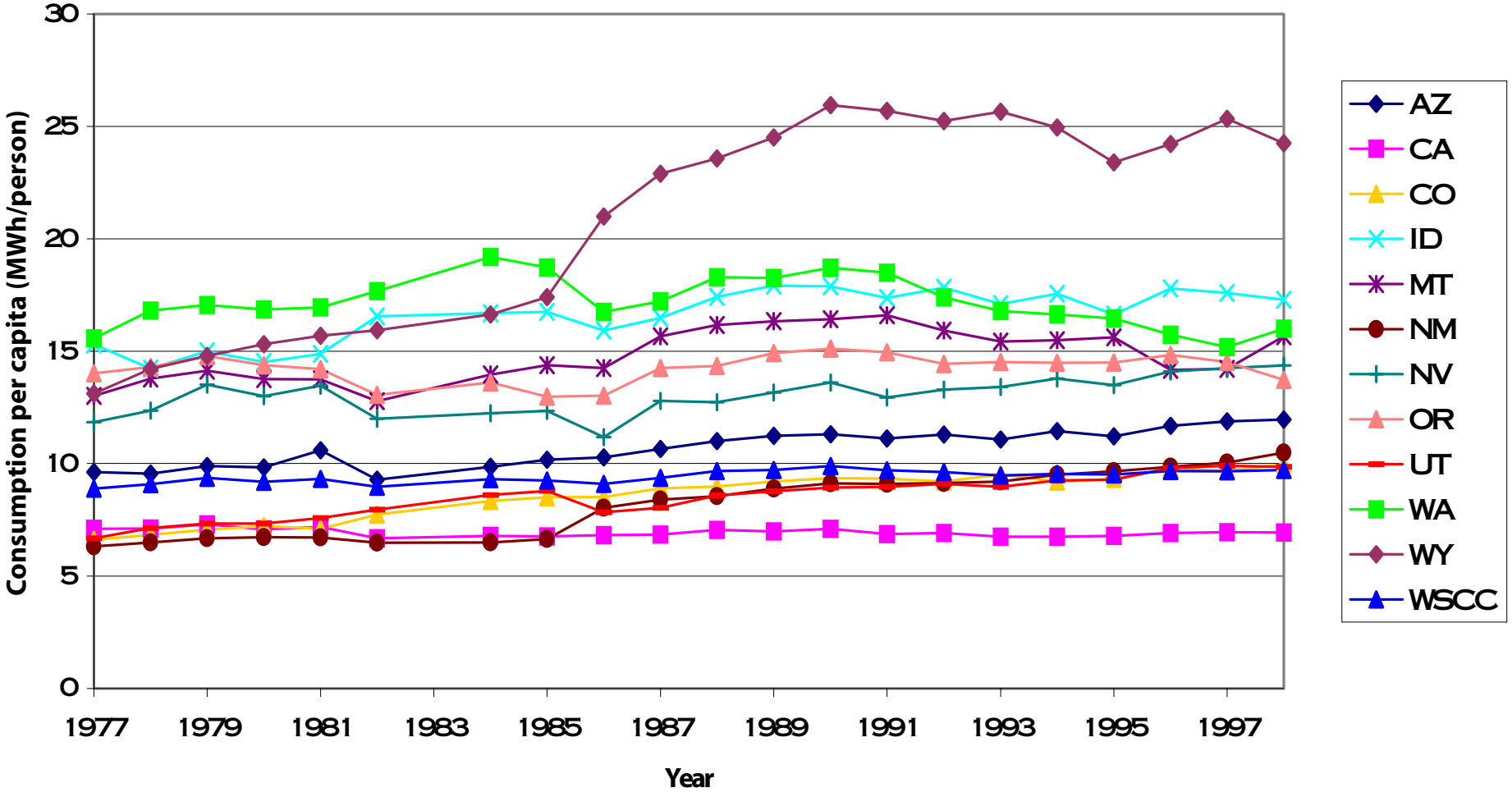

Chart B-1

Consumption per capita by state; 1977, 1988, 1998

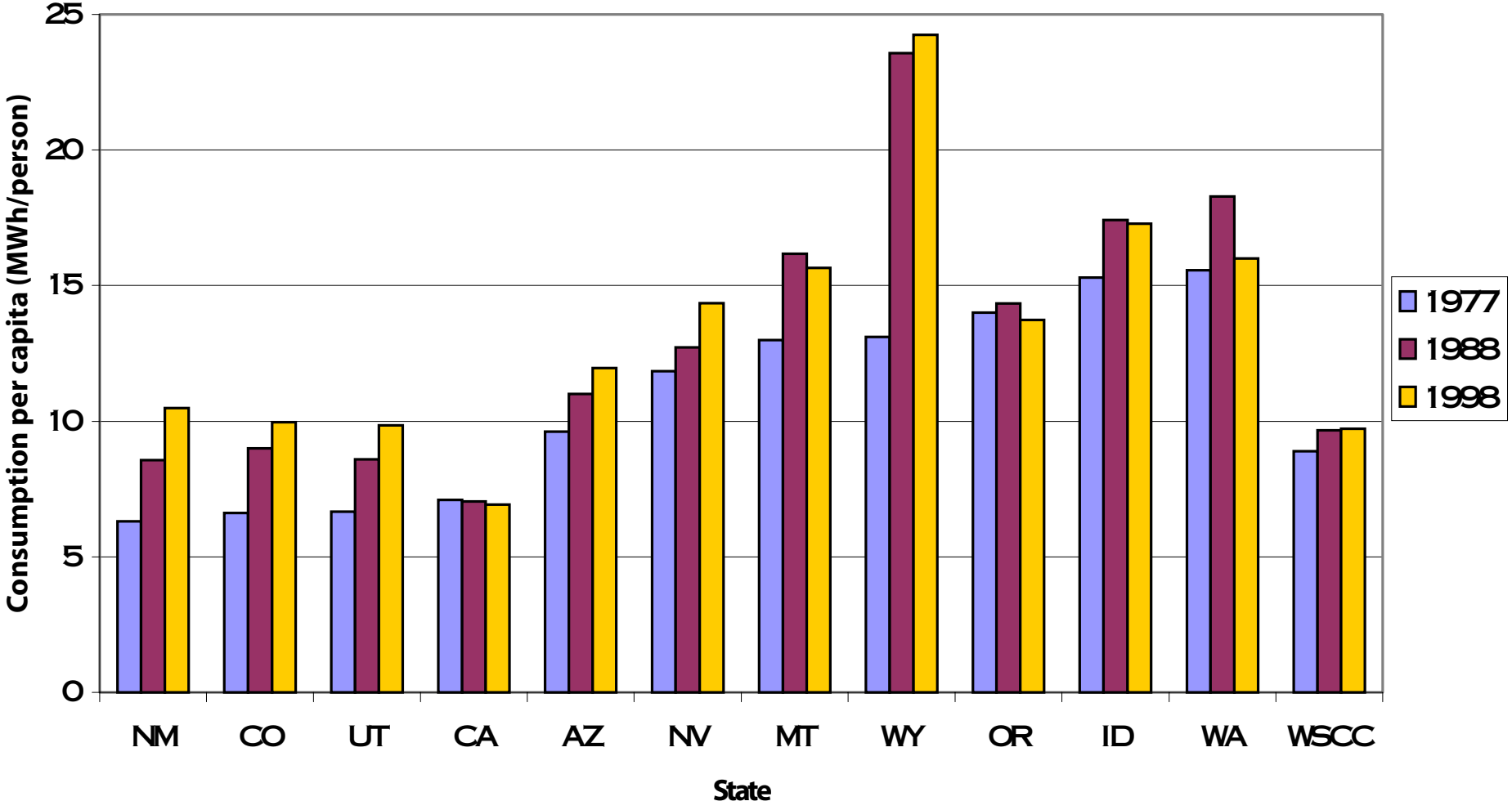

Chart B-2

Consumption per capita by region; 1977, 1988, 1998

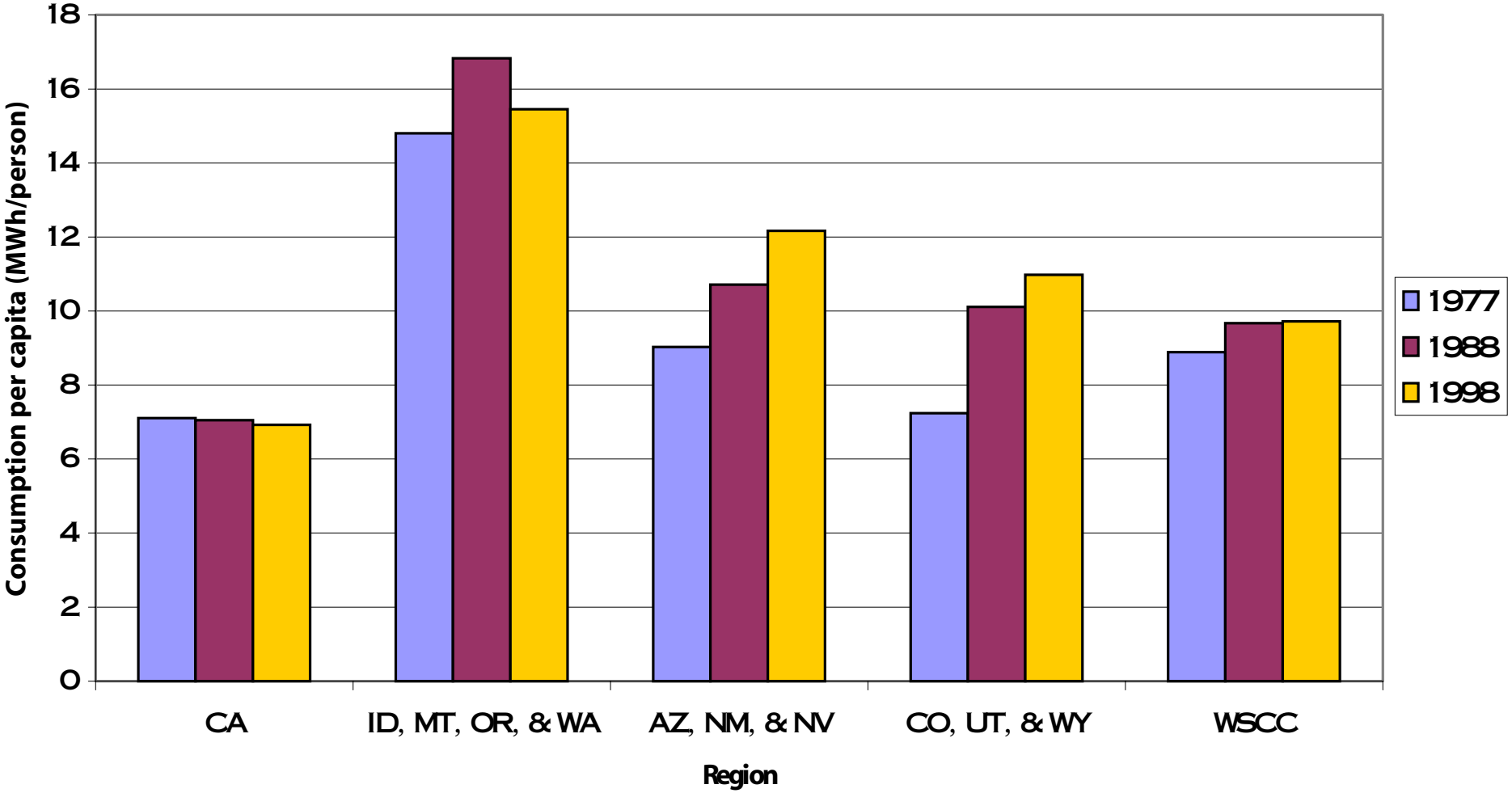

Chart B-3

Consumption per GSP and per capita by state, 1998

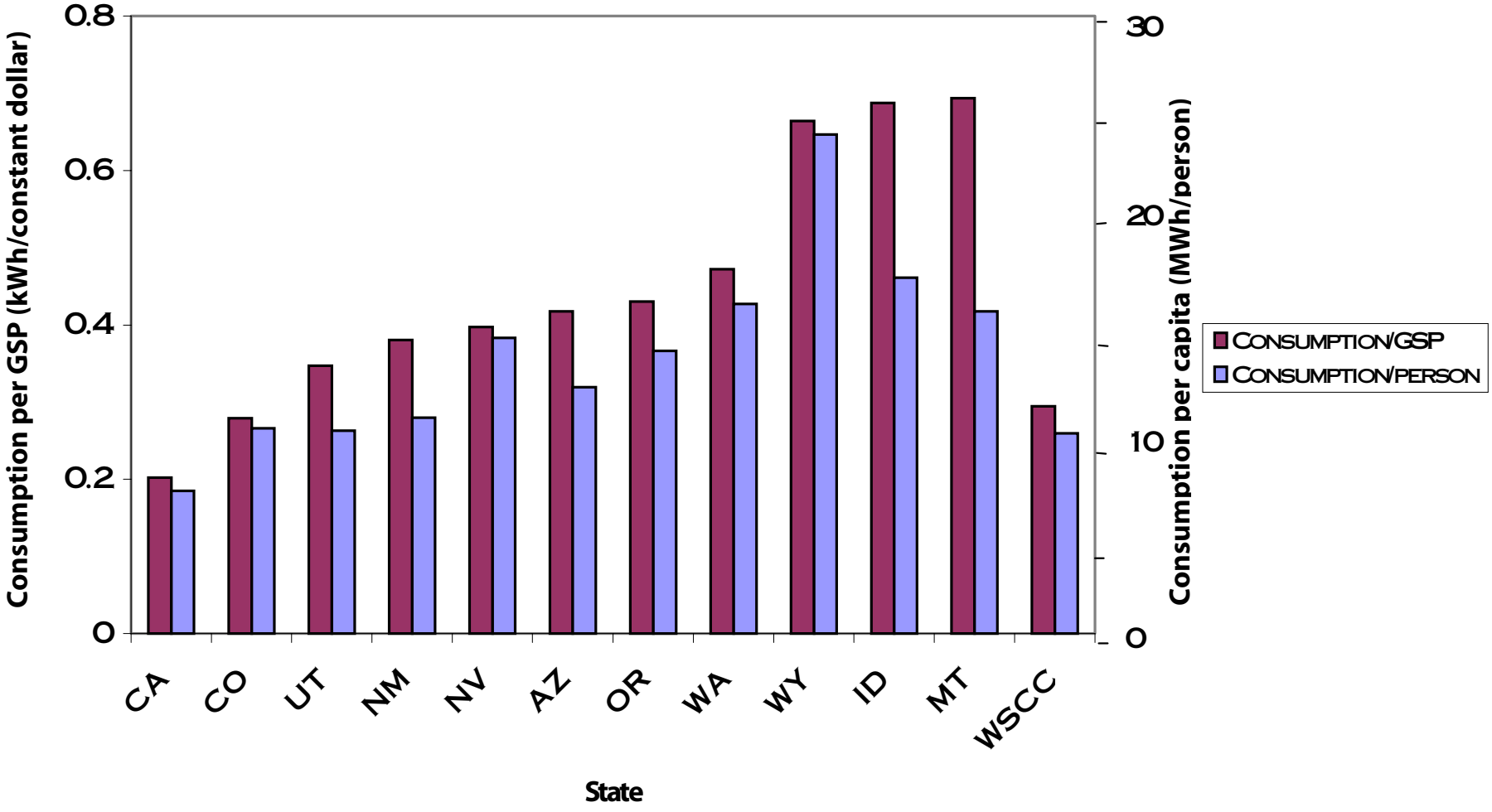

Chart B-4, C-1

Consumption per GSP by state, 1977-1998

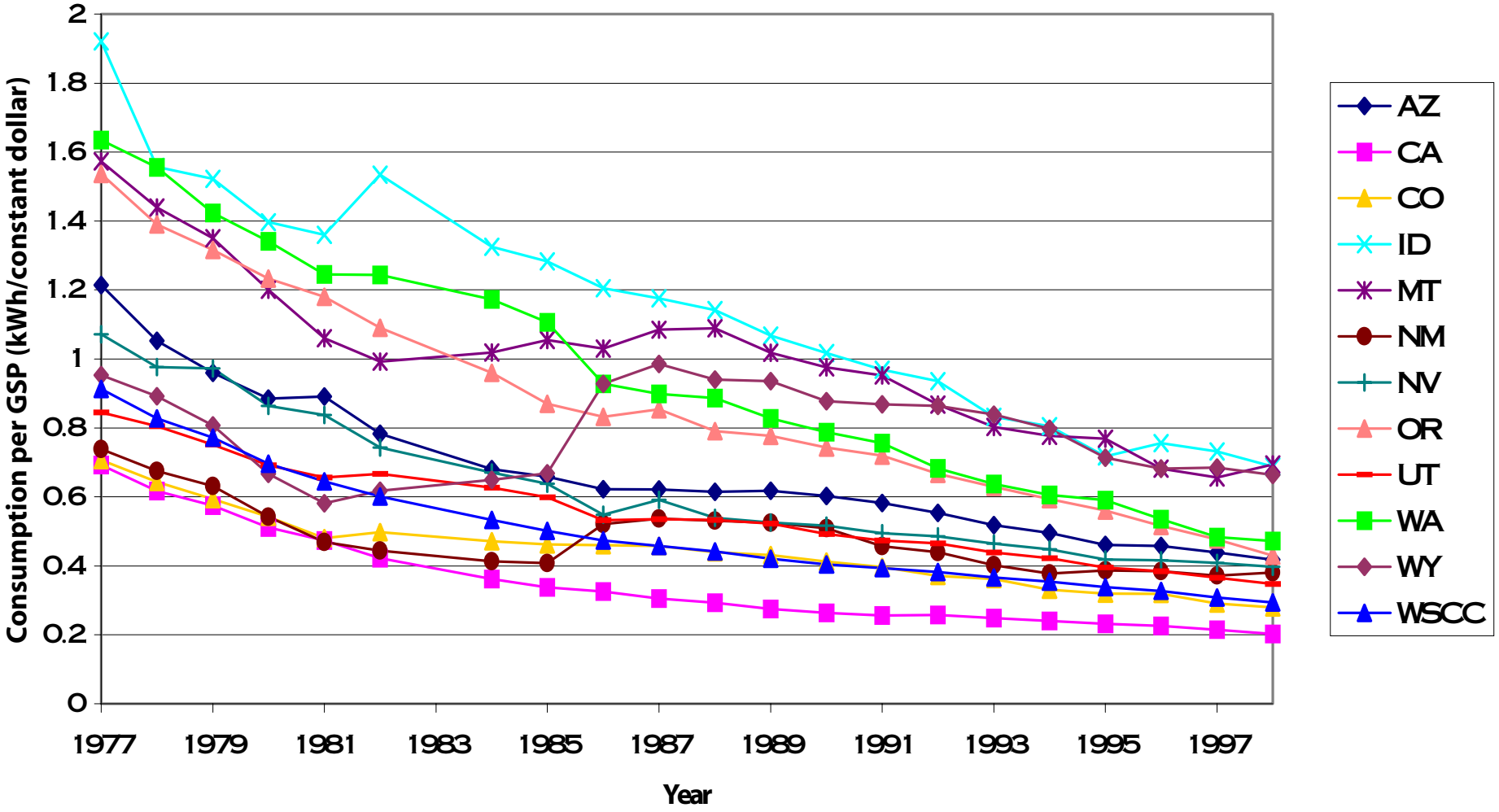

Chart C-2

Consumption per GSP by state; 1977, 1988, 1998

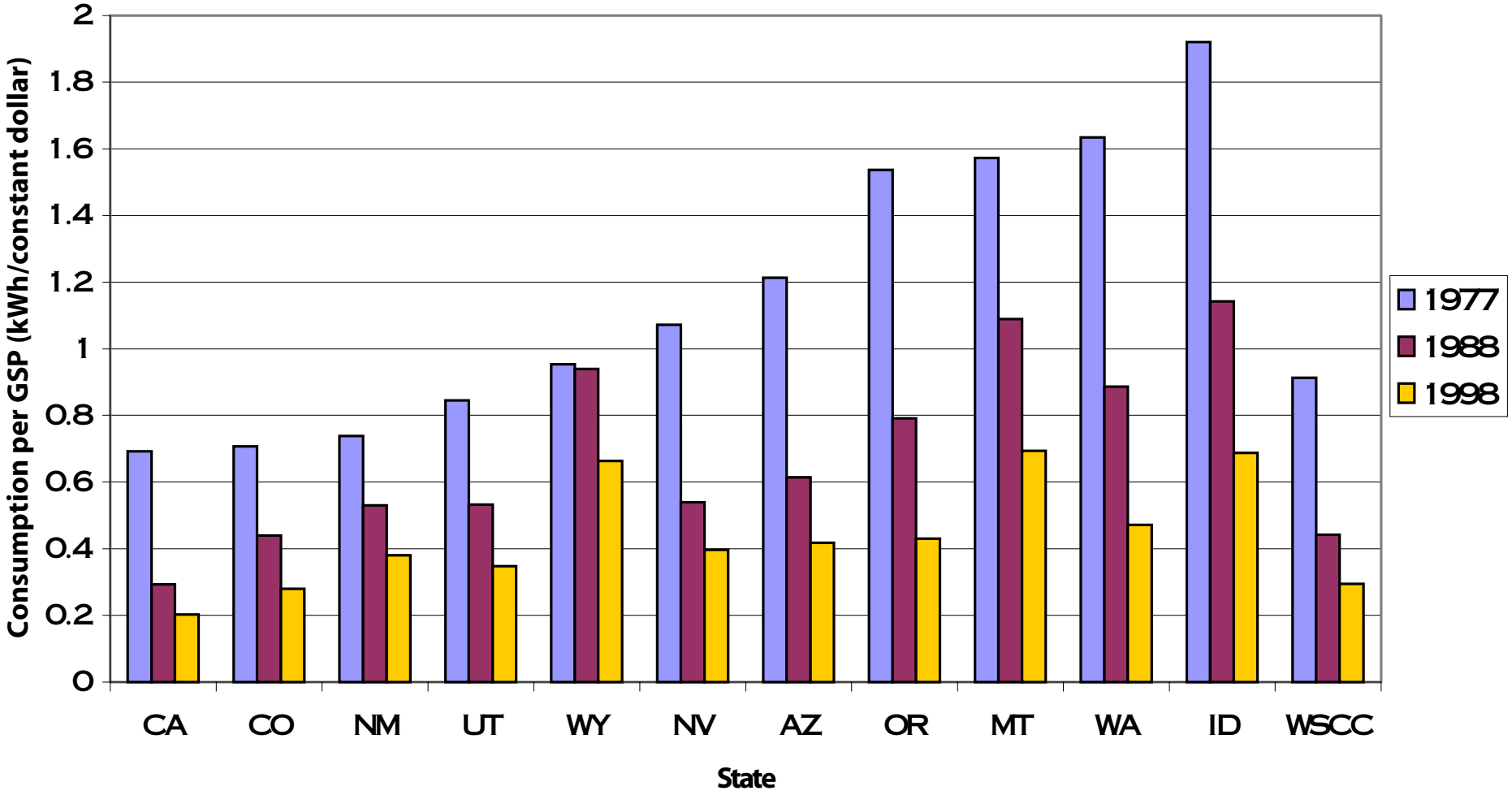

Chart C-3

Consumption per GSP by region; 1977, 1988, 1998

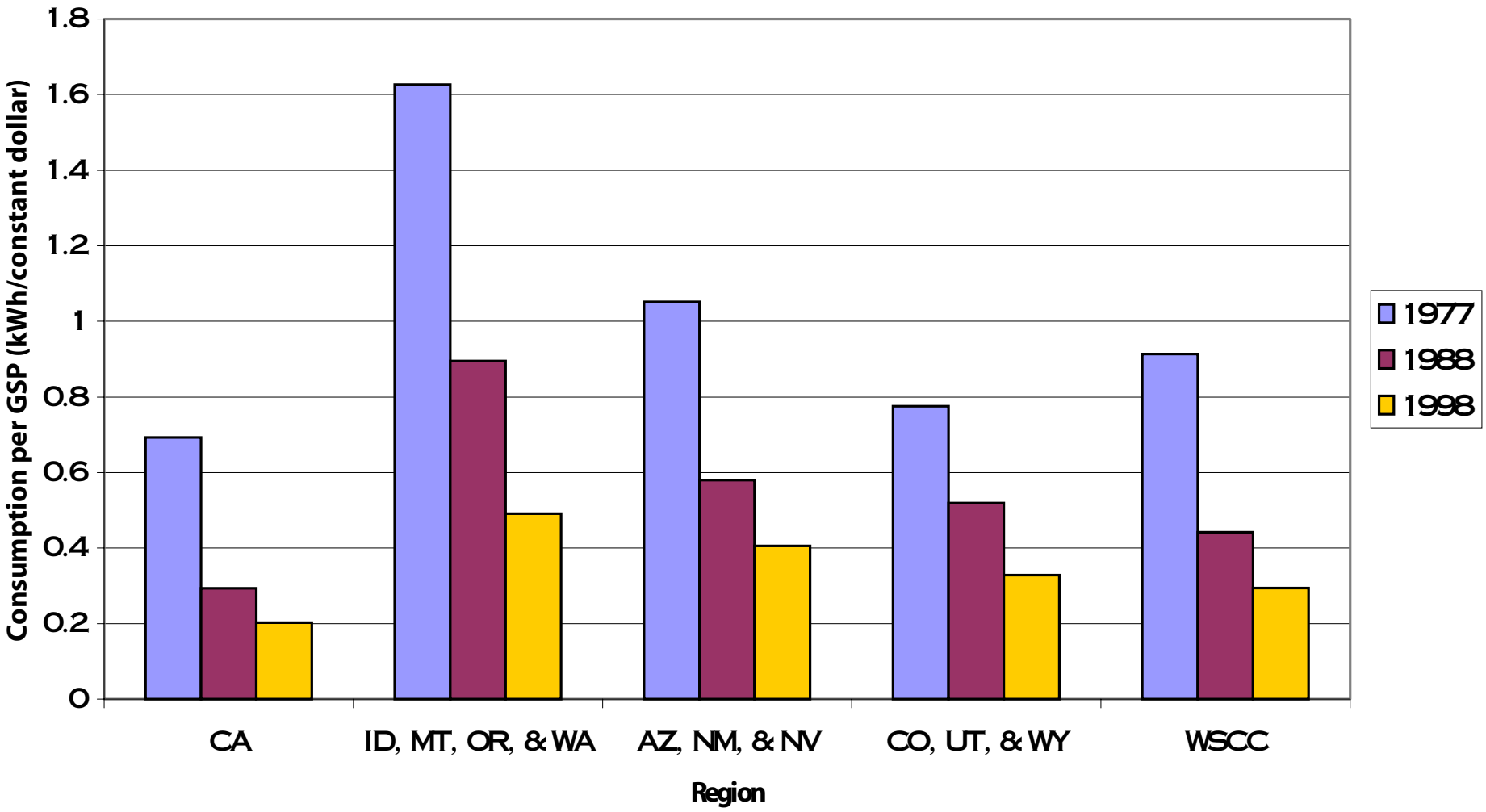

Chart C-4

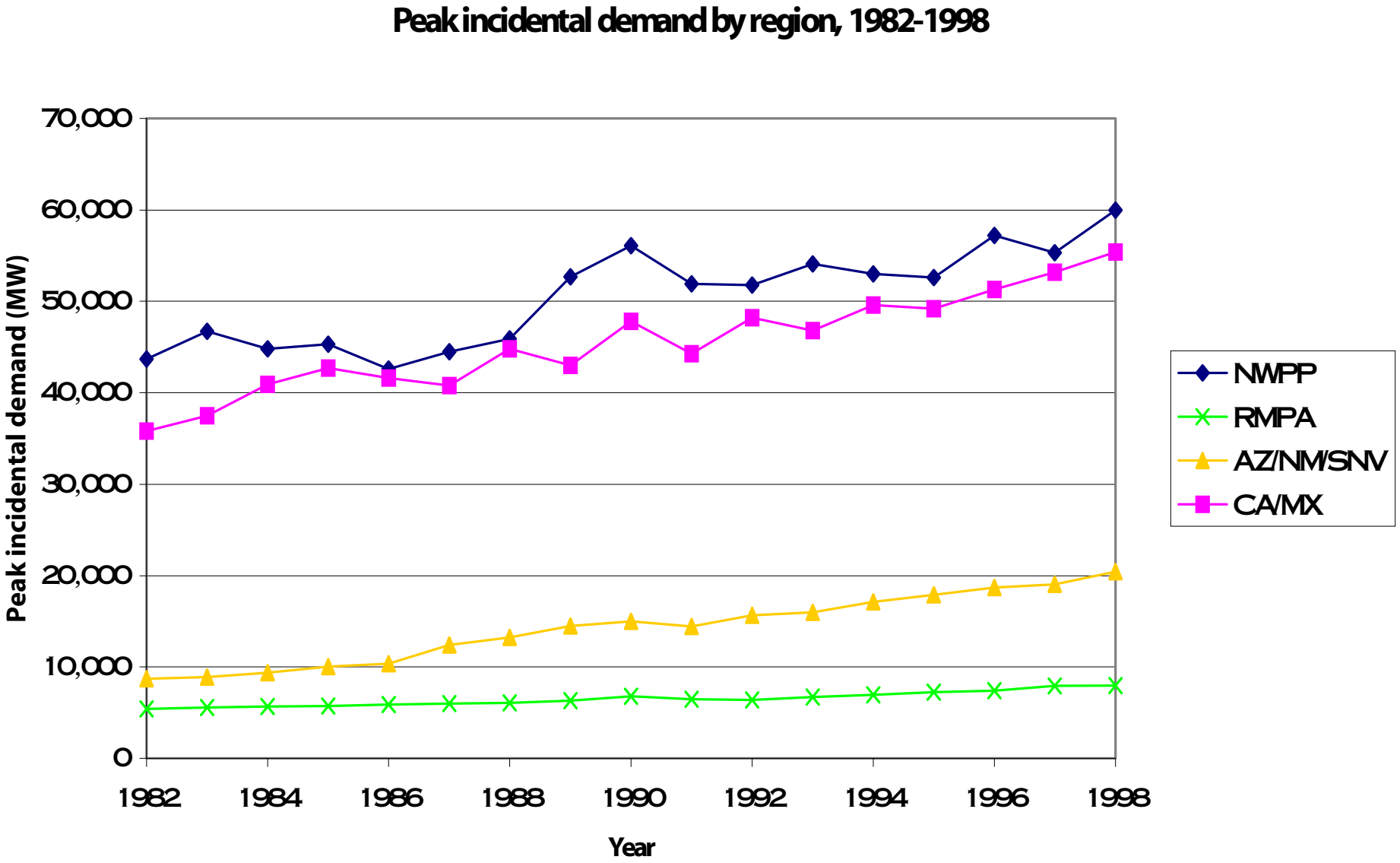
Peak incidental demand by region, 1982-1998
Peak incidental demand (MW)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
Year
NWPP
RMPA
AZ/NM/SNV
CA/MX

Chart D-1

Peak incidental demand by region; 1982, 1990, 1998

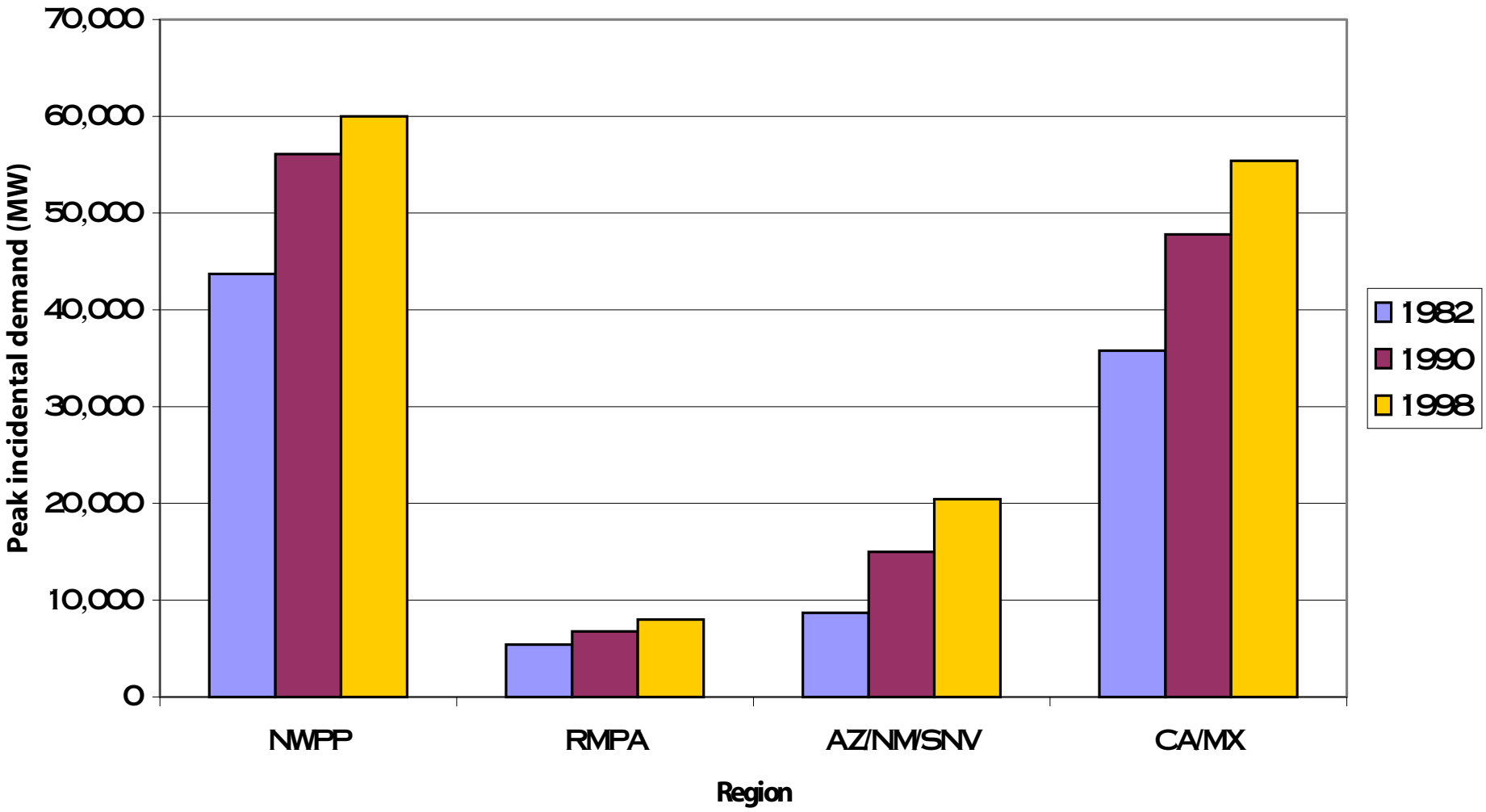

Chart D-2

Peak incidental summer demand by region, 1995-1999

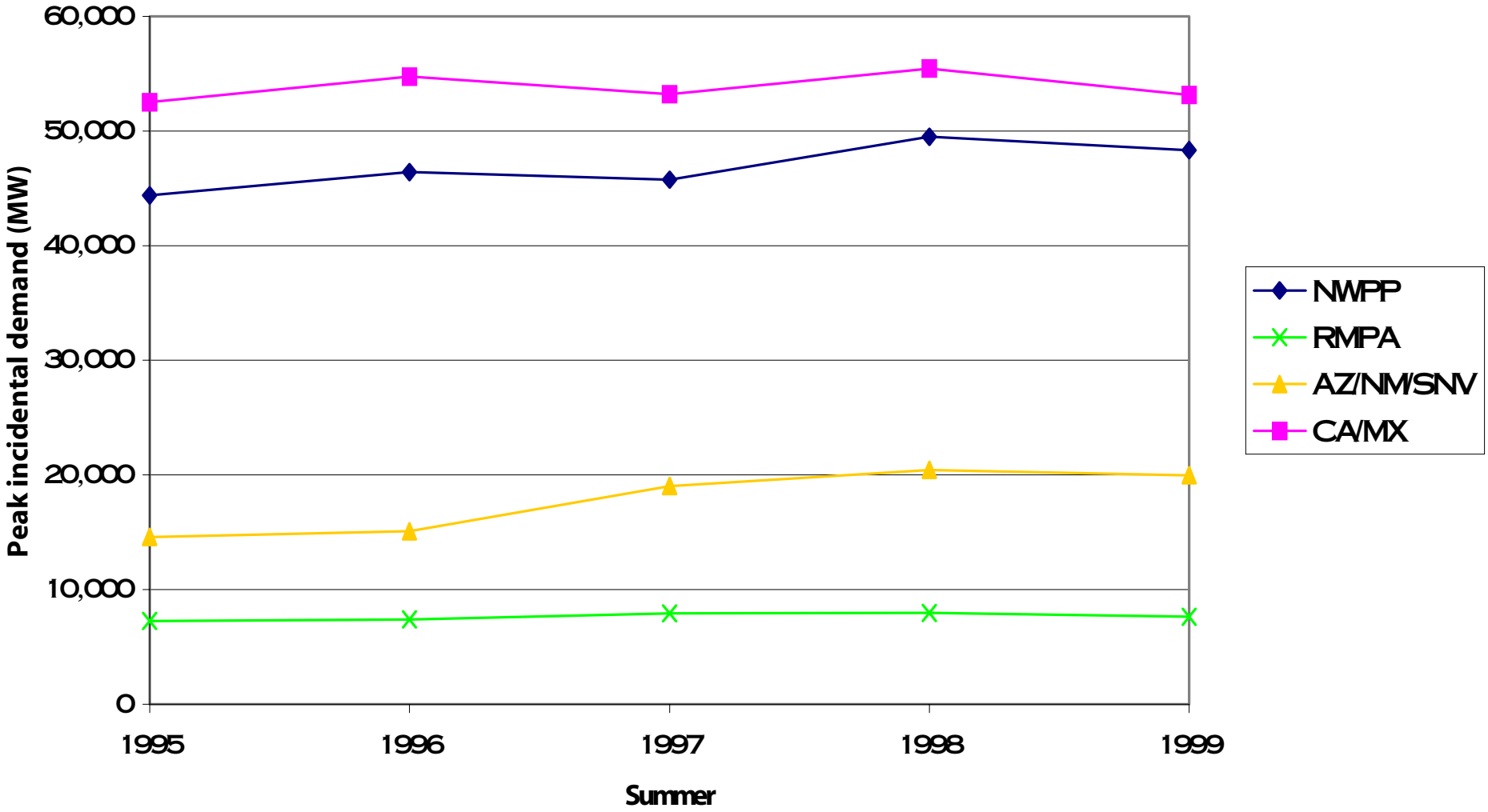

Chart D-3

Peak incidental winter demand by region, 1995-2000

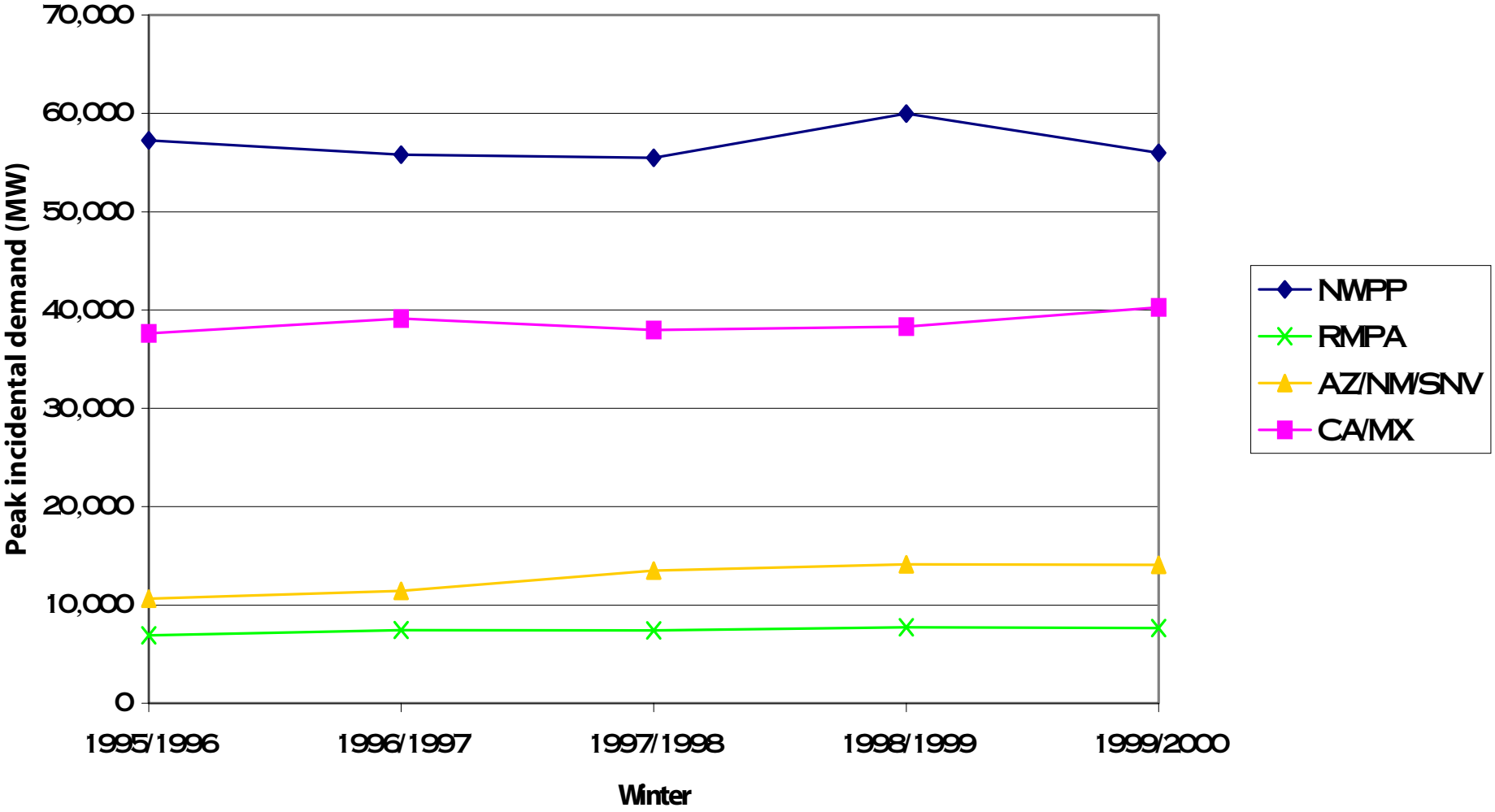

Chart D-4

Peak incidental summer and winter demand by region, 1995-2000

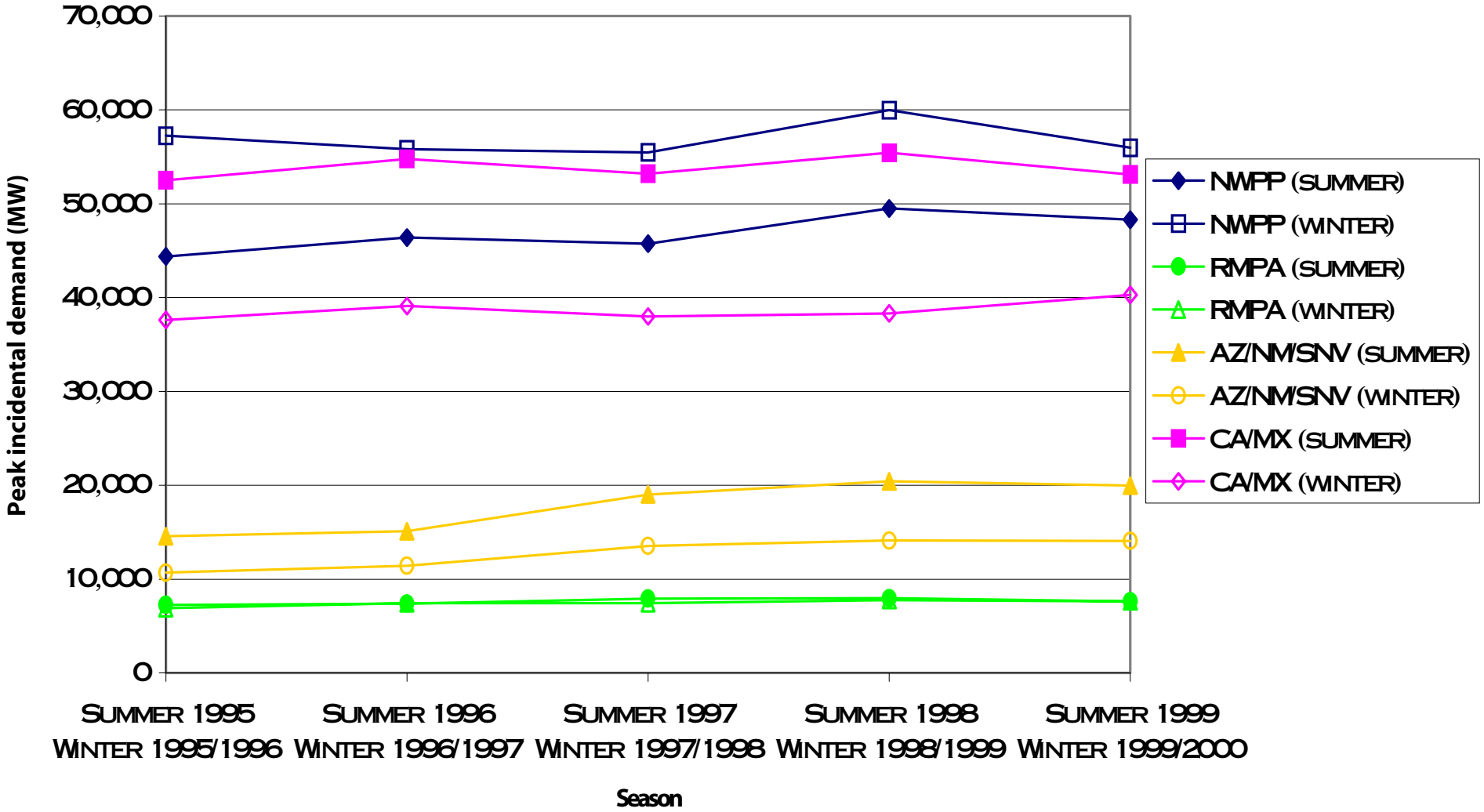

Chart D-5

Utility capacity by state, 1977-1998

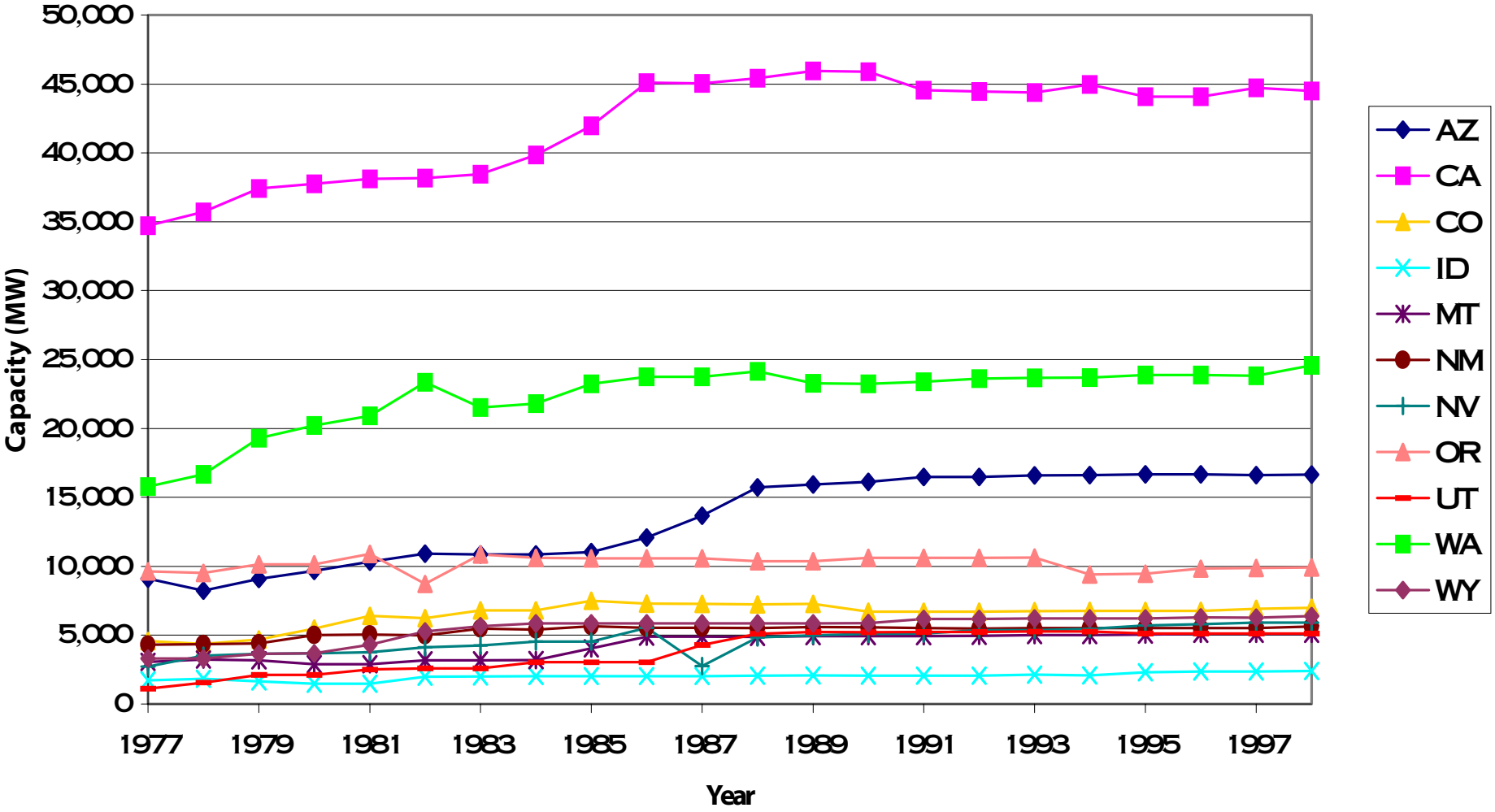

Chart E-1

New utility capacity by state, 1977-1997

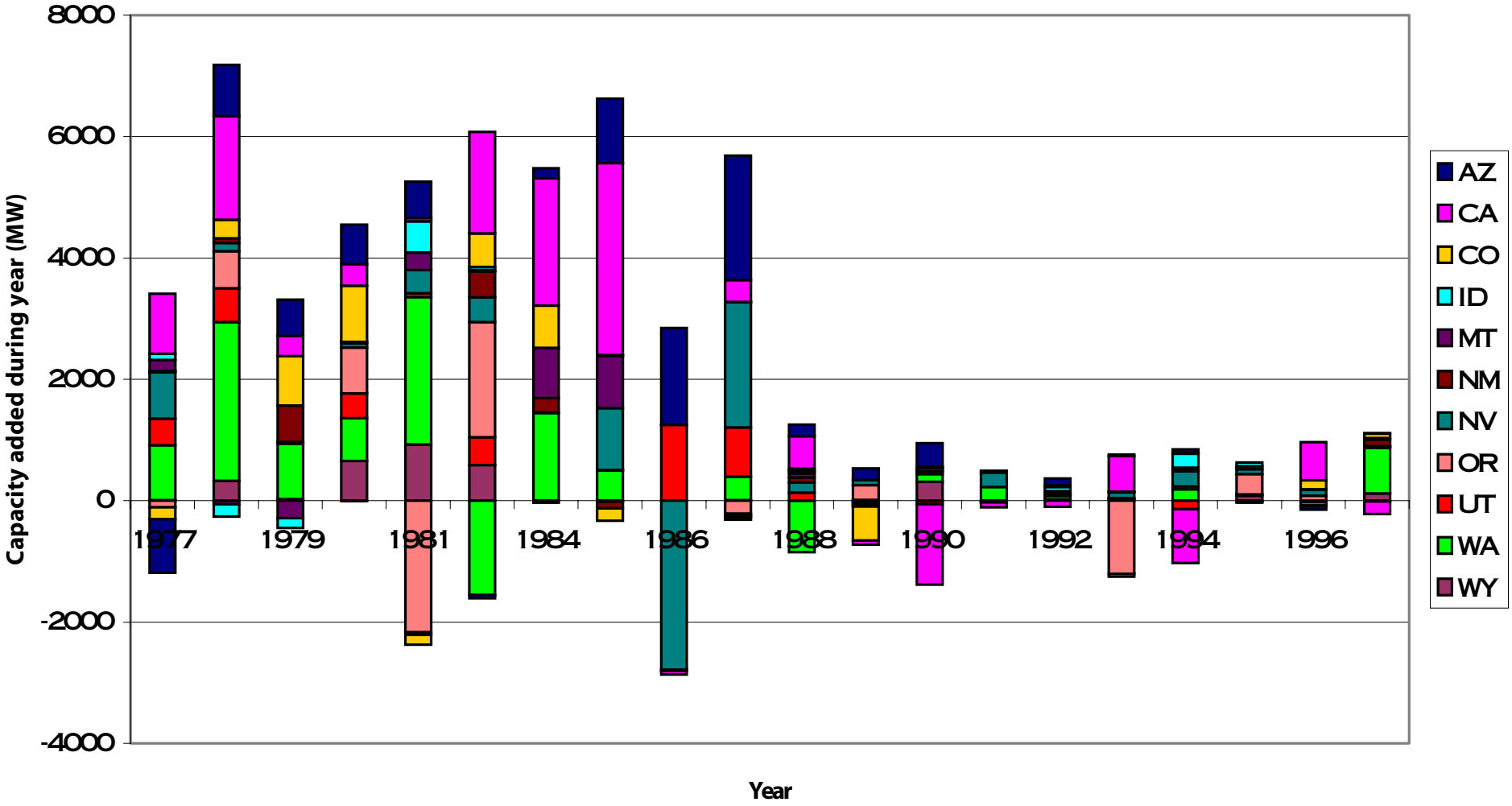

Chart E-2

New utility capacity by state, 1977-1998

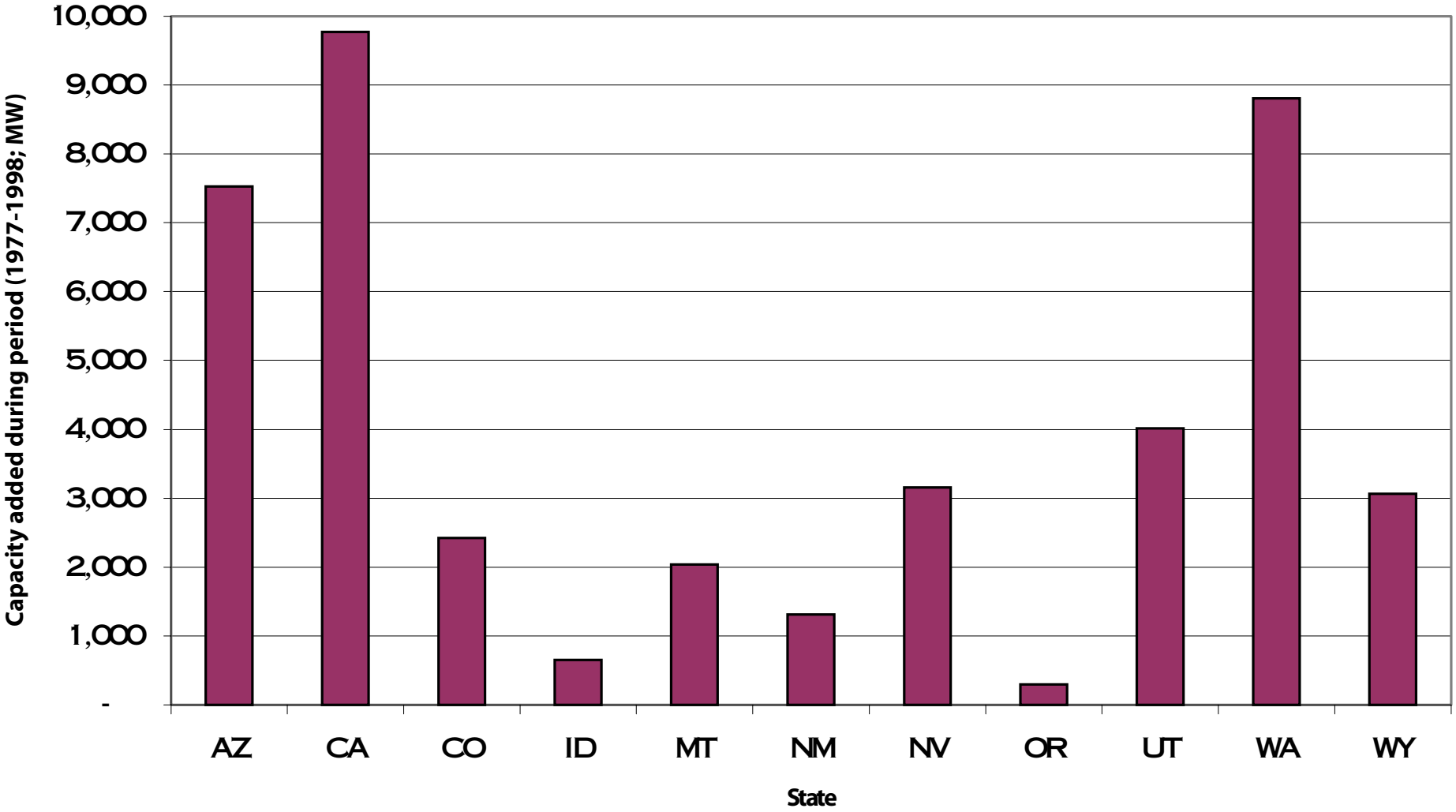

Chart E-3

New utility capacity during ten-year periods by state, 1977-1998

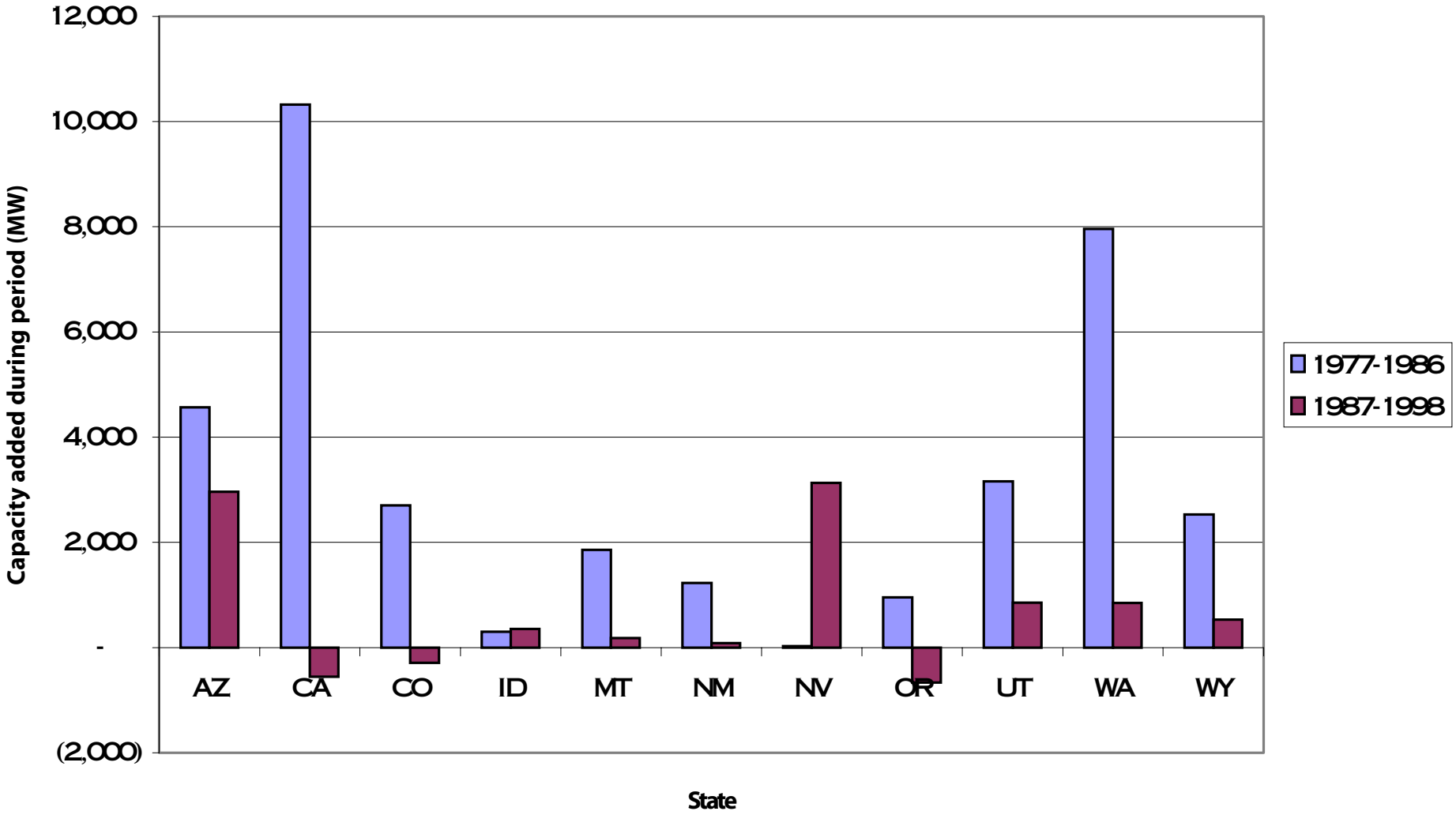

Chart E-4

New utility capacity during five-year periods by state, 1977-1998

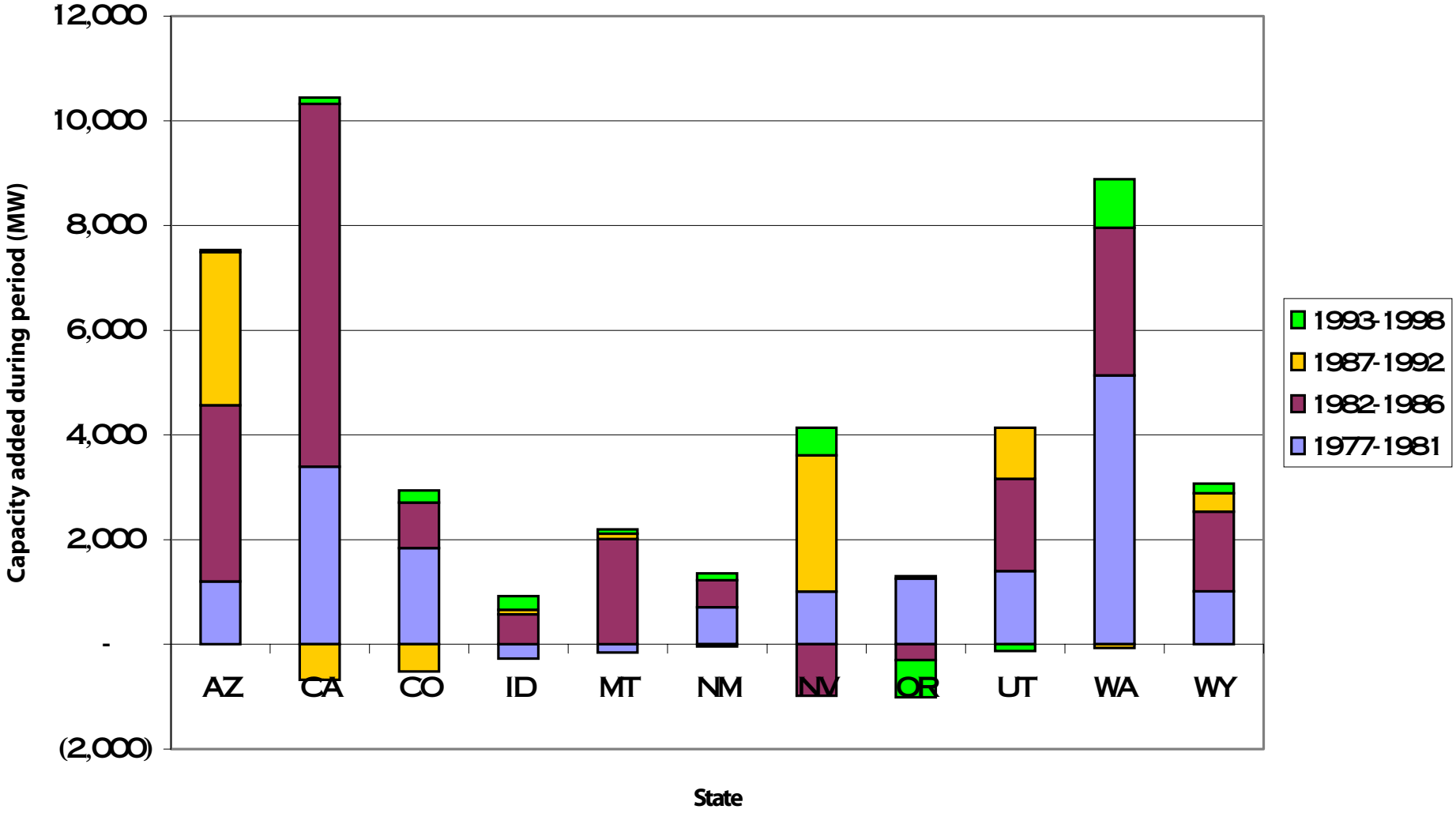

Chart E-5

New utility capacity during five-year periods by state, 1977-1998

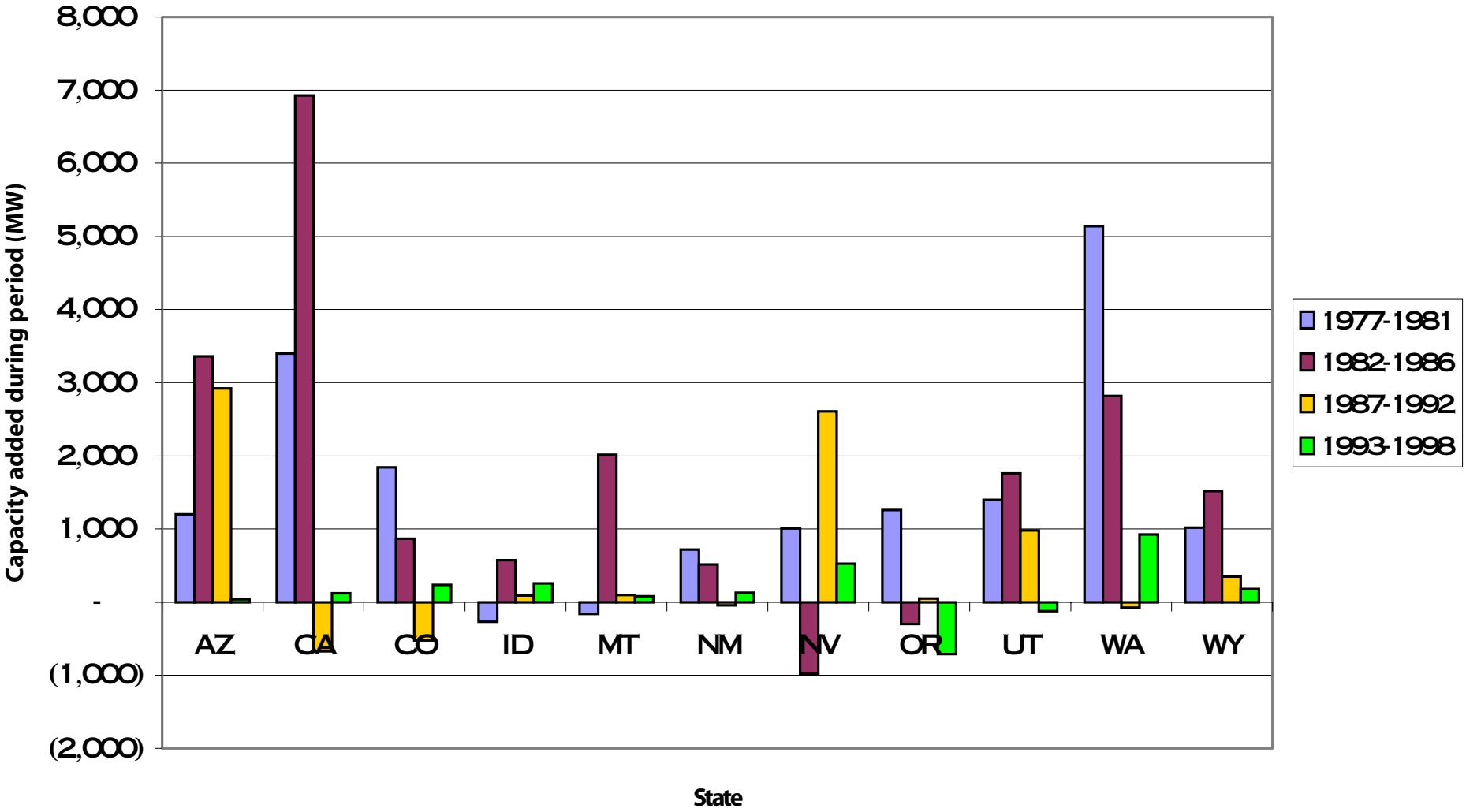

Chart E-6

Share of total new utility capacity during five-year periods by state, 1977-1998

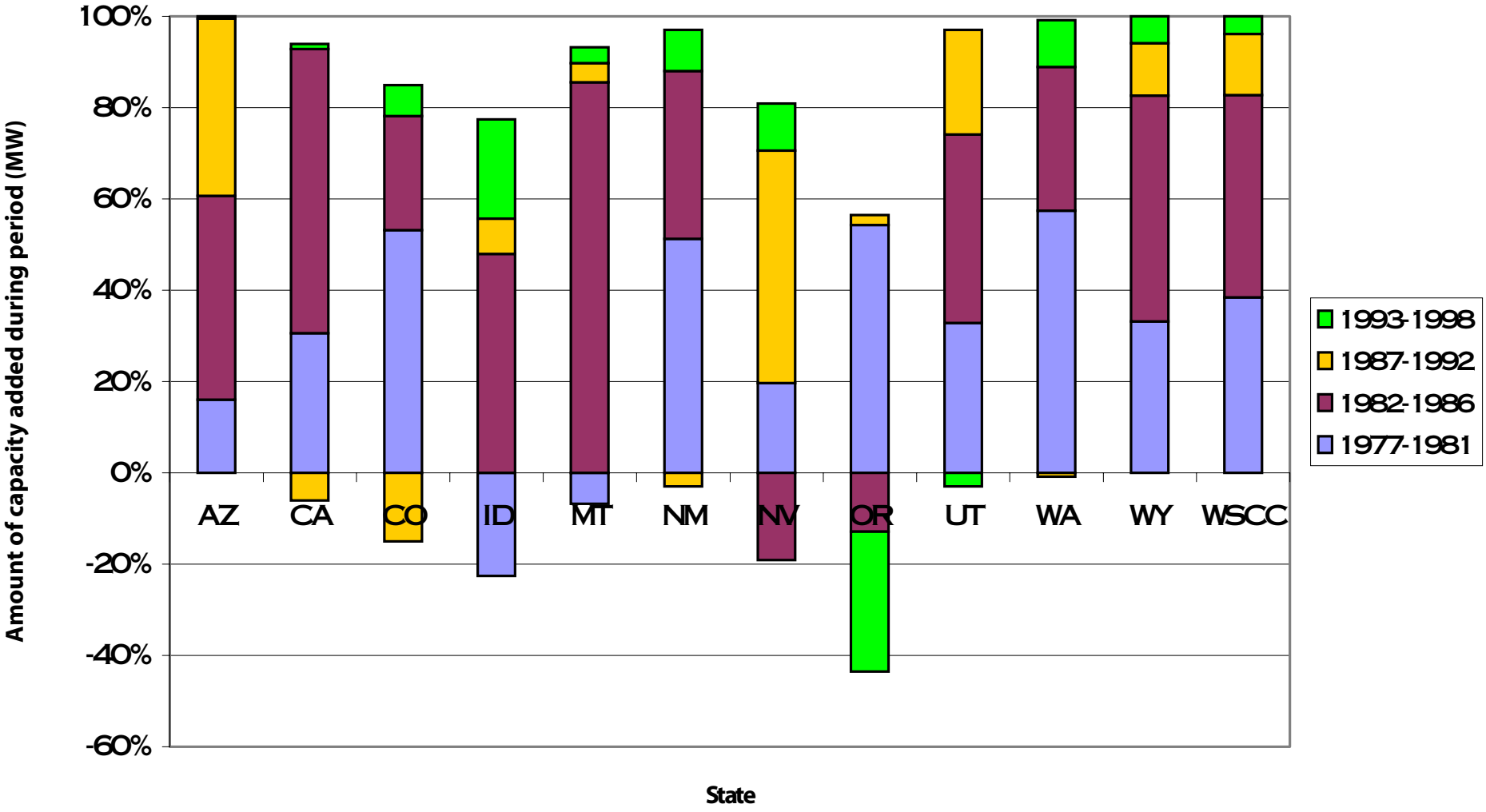

Chart E-7

New utility capacity during five-year periods by region, 1977-1998

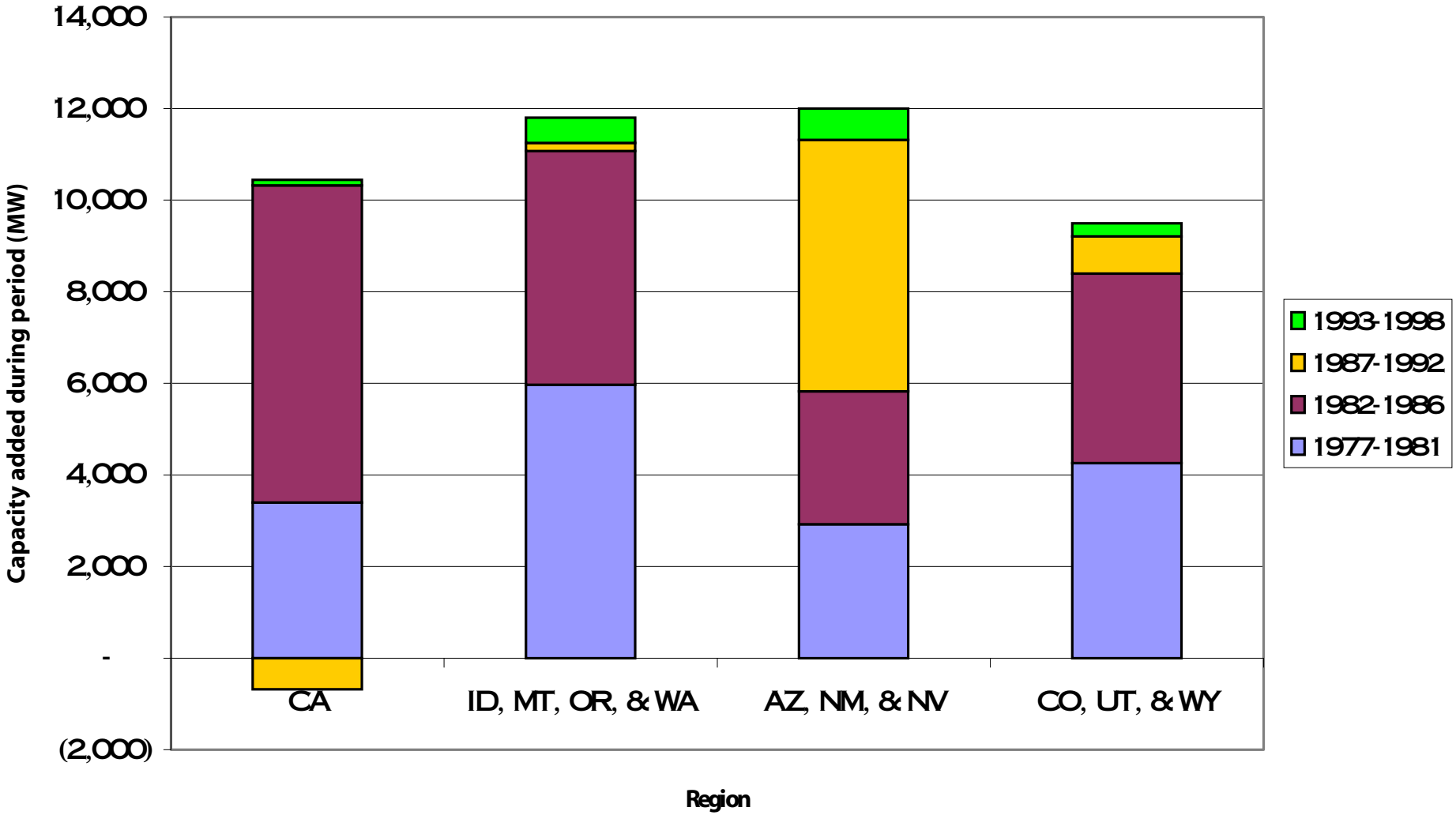

Chart E-8

New utility capacity during five-year periods by region, 1977-1998

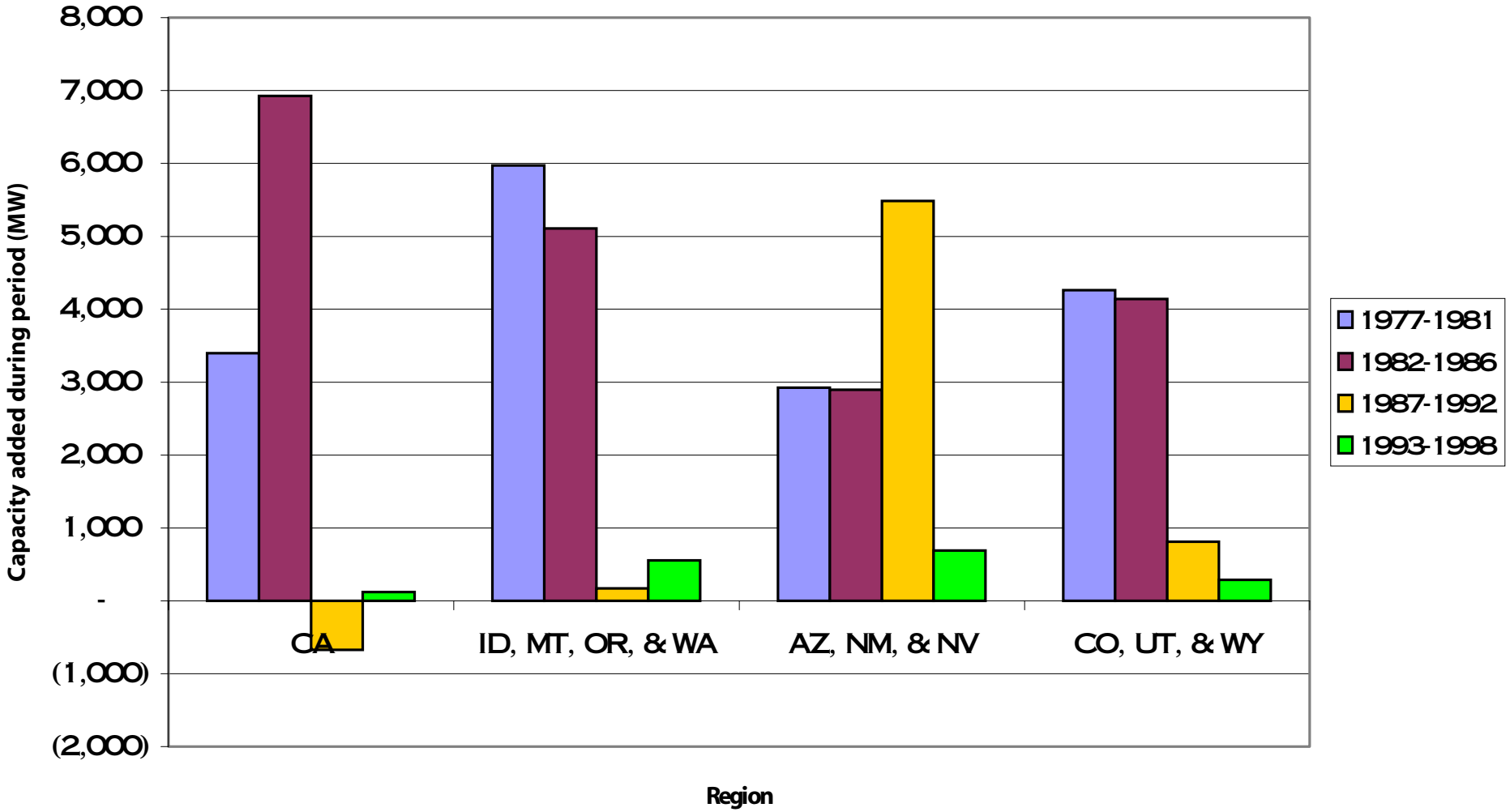

Chart E-9

Utility and QF capacity in California, 1977-1998

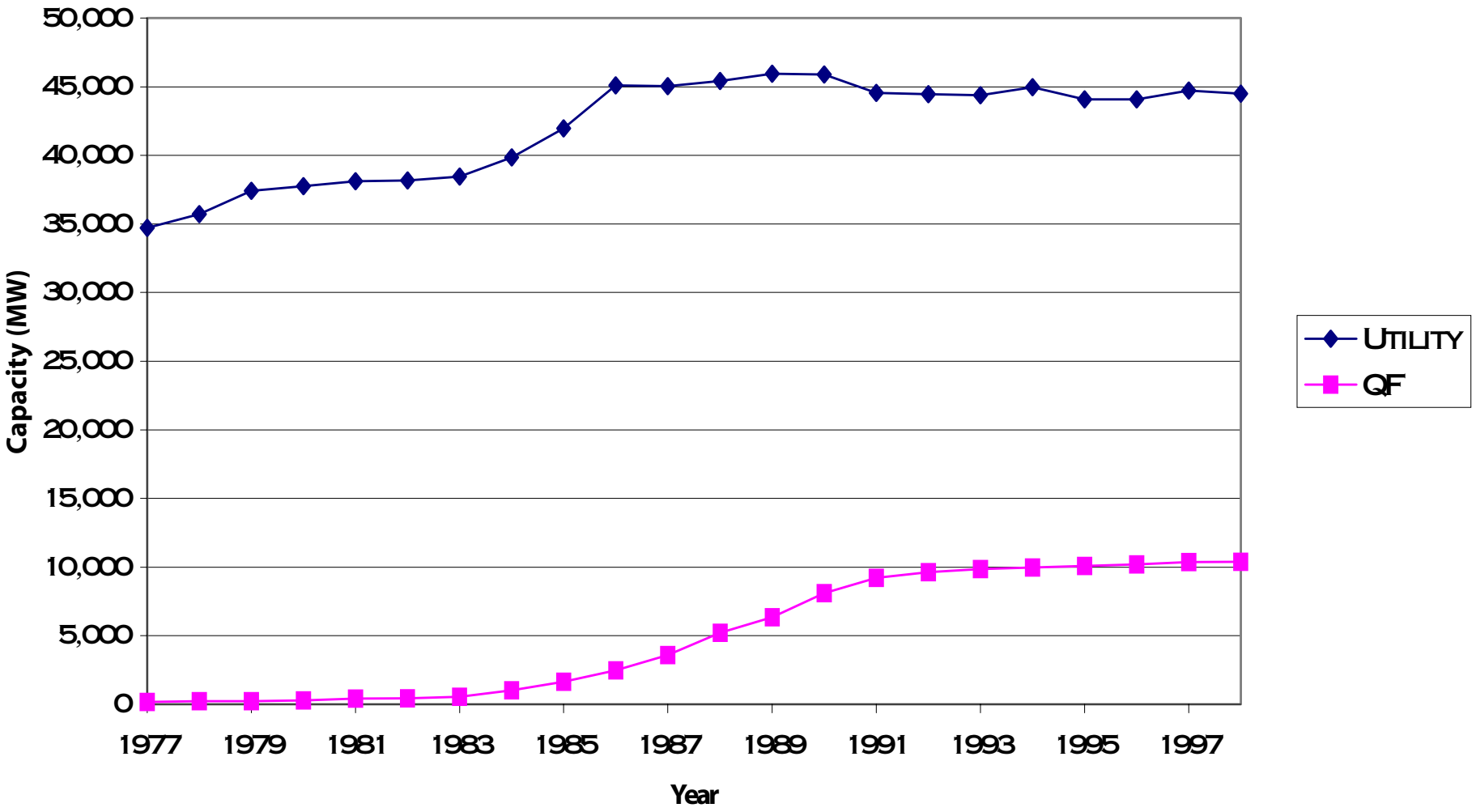

Chart E-10

New utility and QF capacity in California, 1977-1997

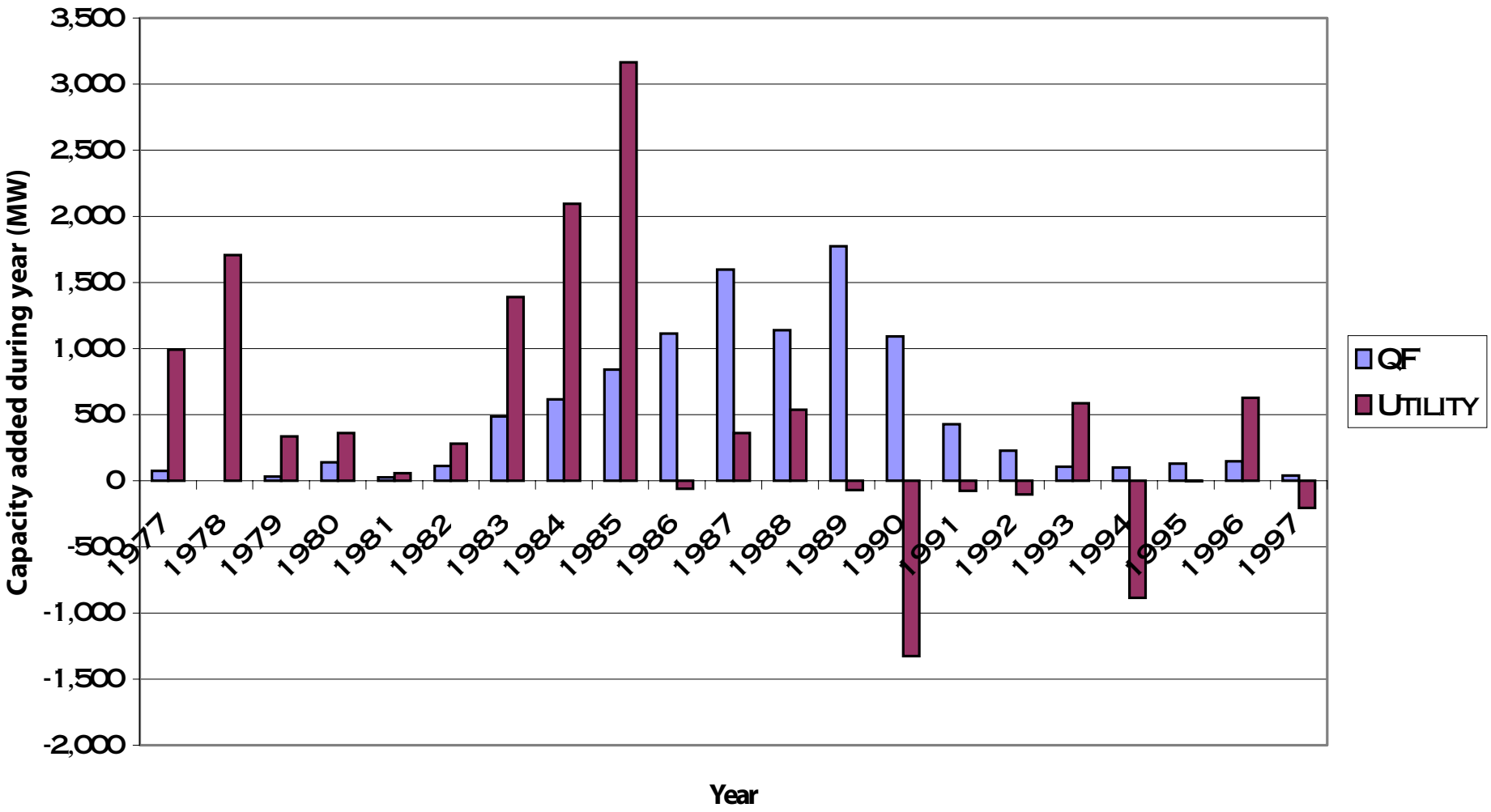

Chart E-11

New utility and QF capacity in California, 1977-1997

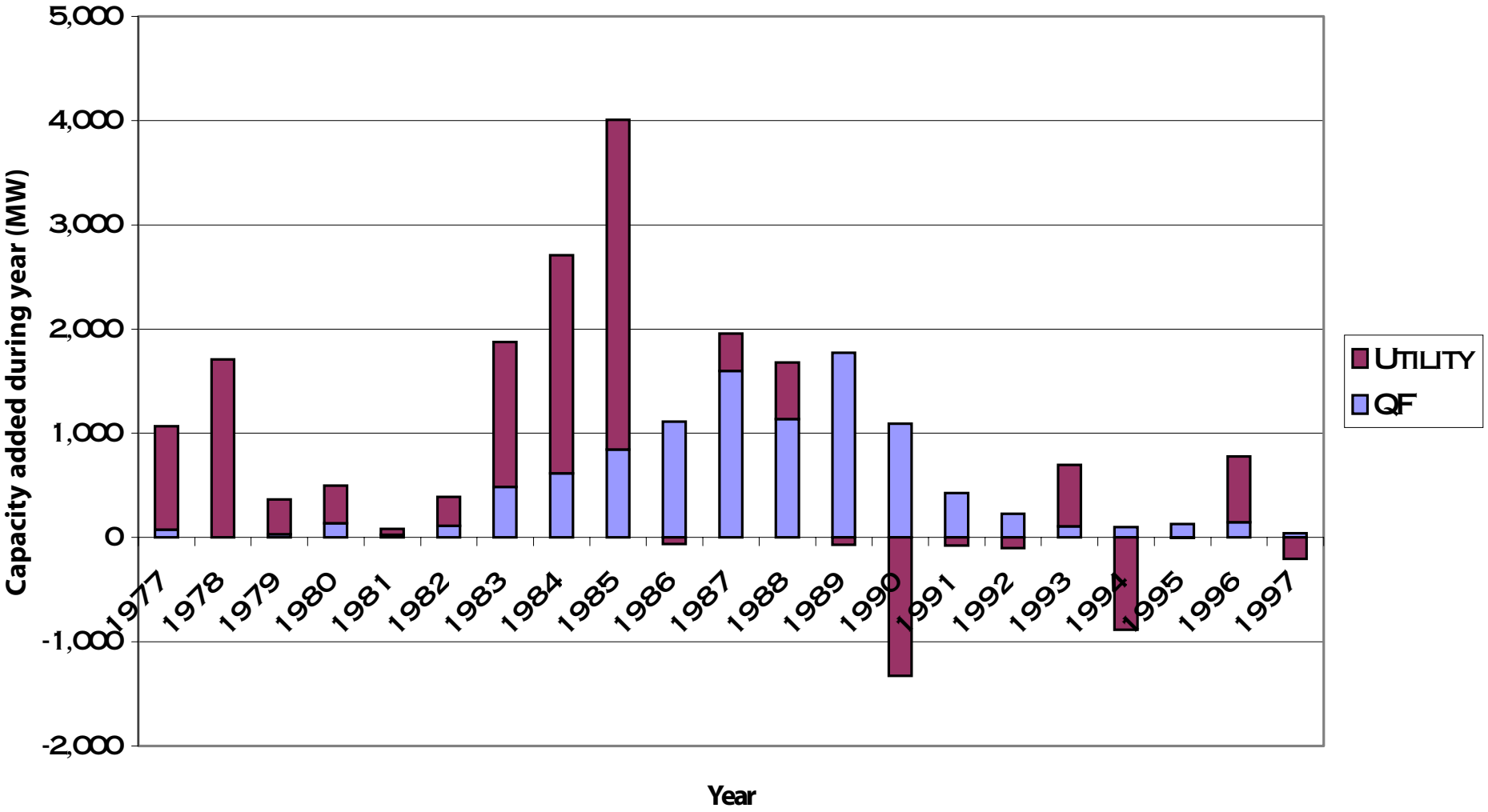

Chart E-12

New utility capacity during five-year periods by state including QF capacity in California, 1977-1998

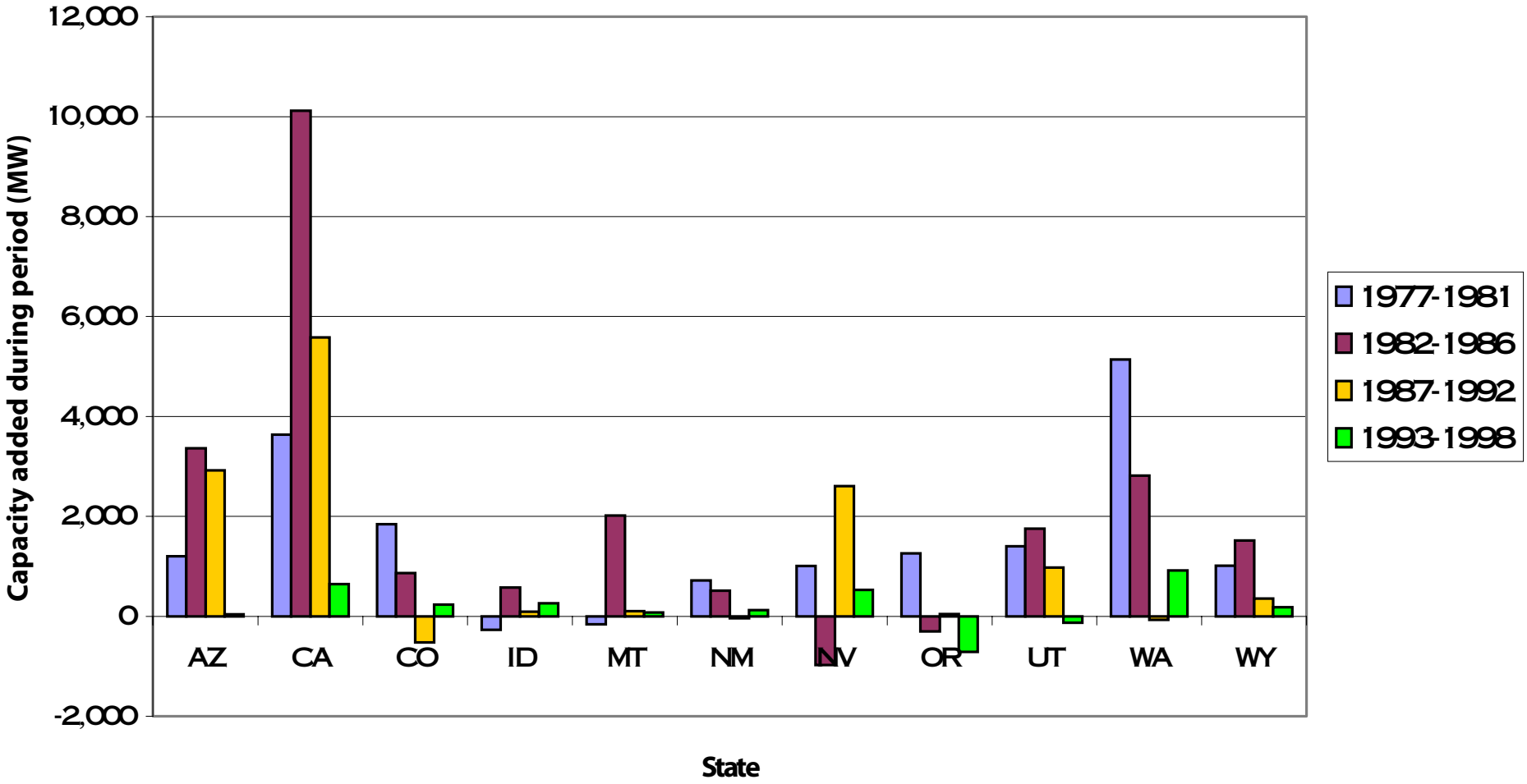

Chart E-13

New utility capacity during five-year periods by state including QF capacity in California, 1977-1998

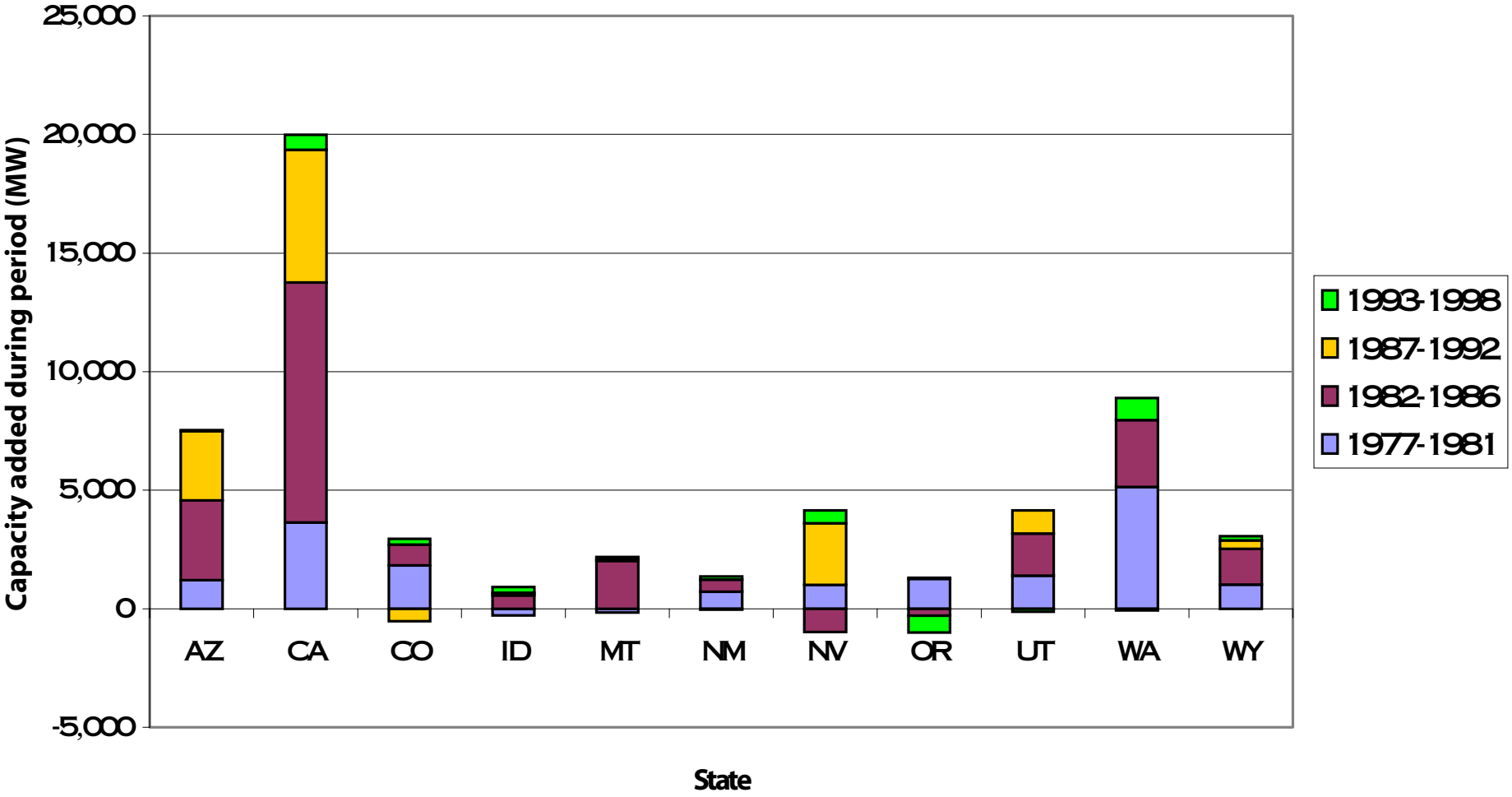

Chart E-14

Non-utility capacity by state, 1998

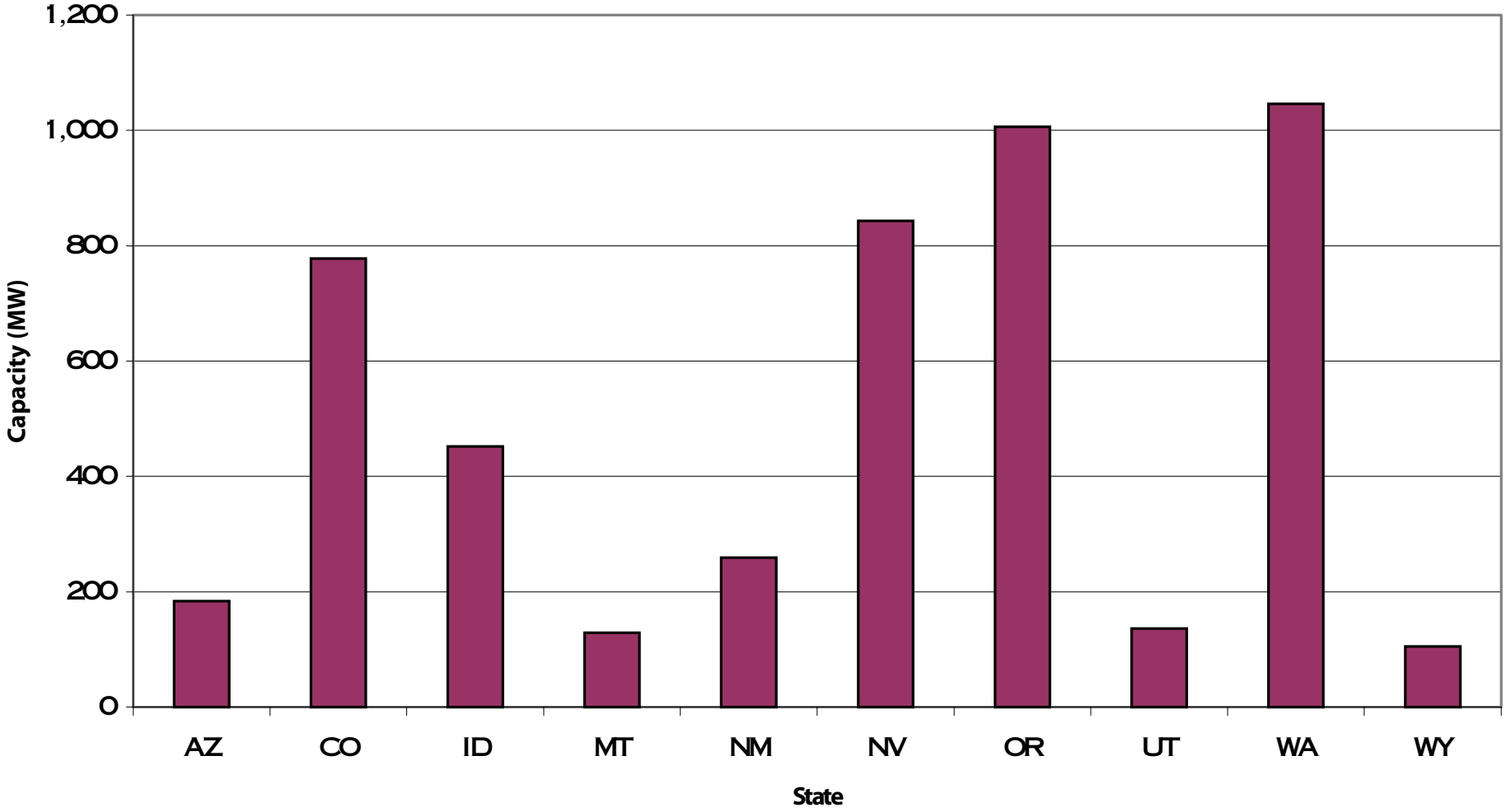

Chart E-15

Utility capacity per consumption by state, 1977-1998

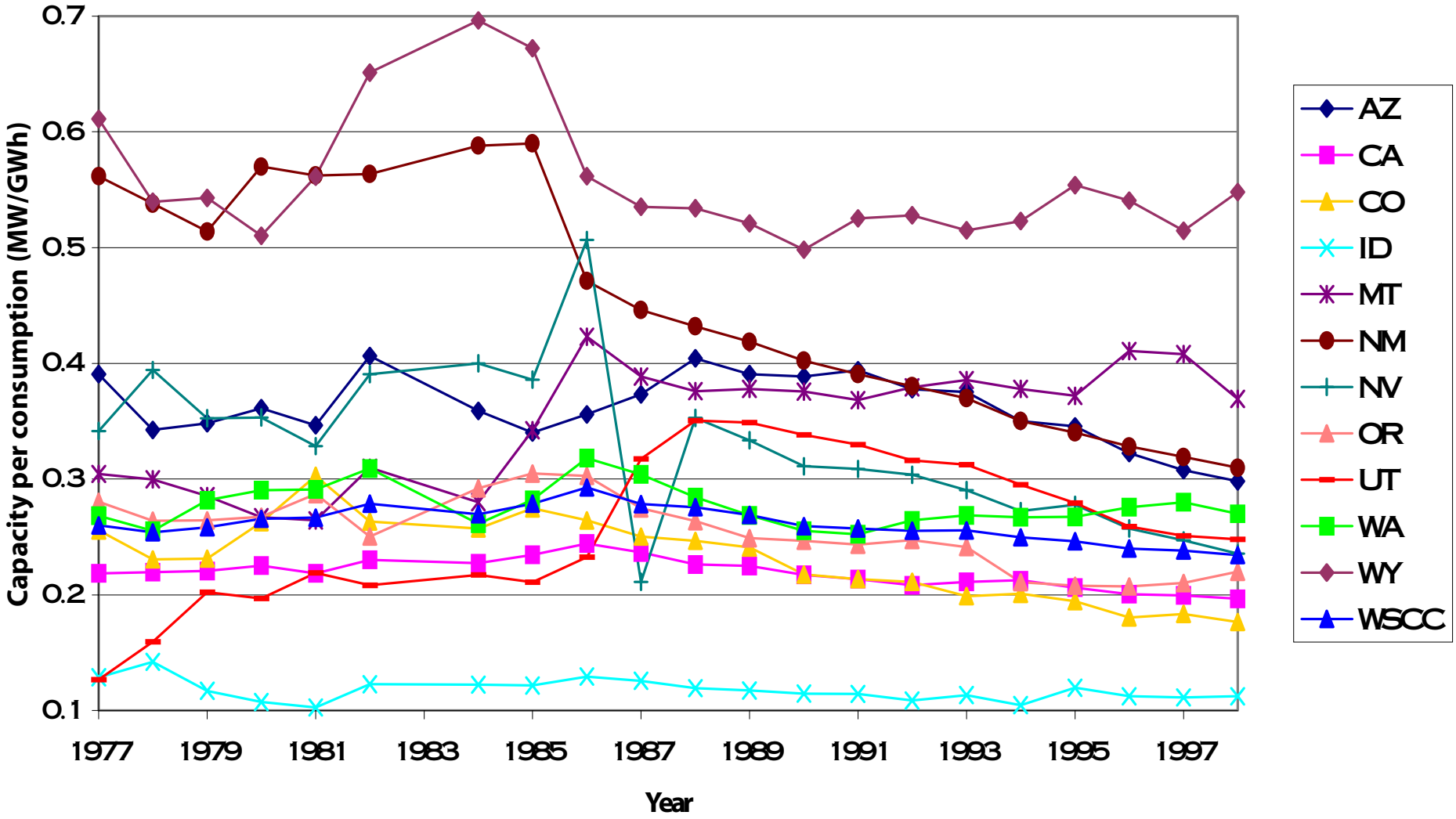

Chart F-1

Utility capacity per consumption by state, 1977-1998

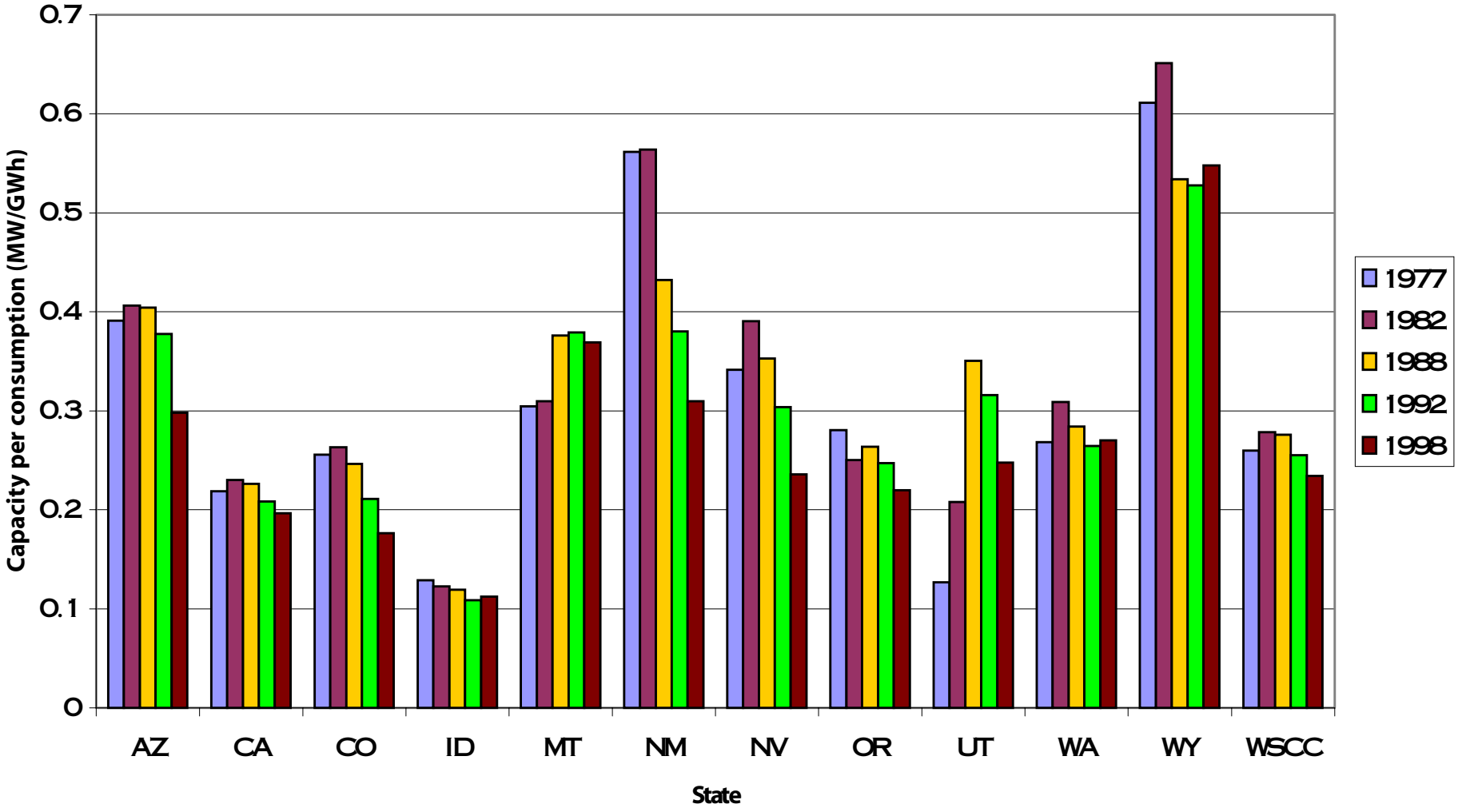

Chart F-2

Utility capacity per consumption by region, 1977-1998

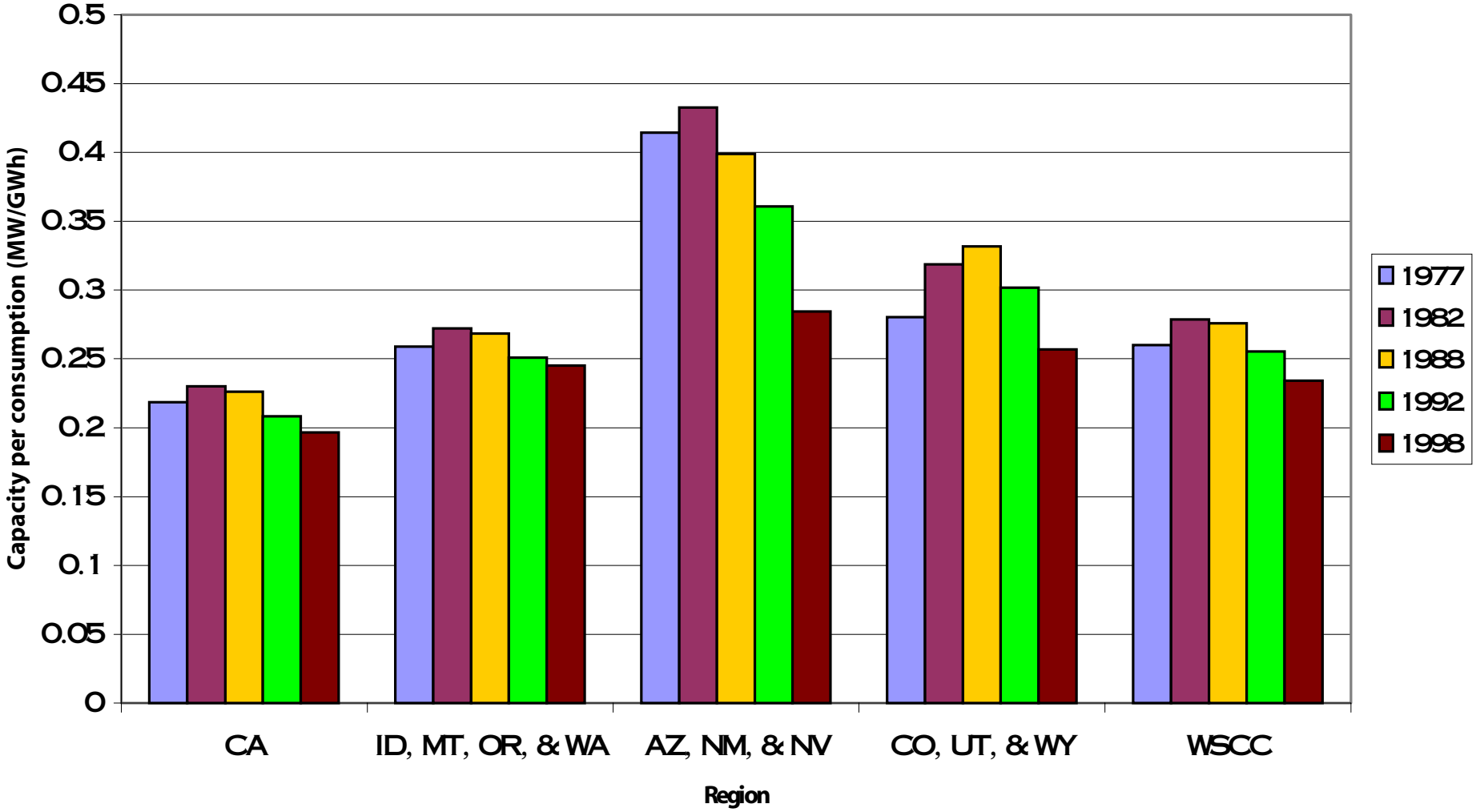

Chart F-3

New utility capacity per new consumption by state, 1977-1998

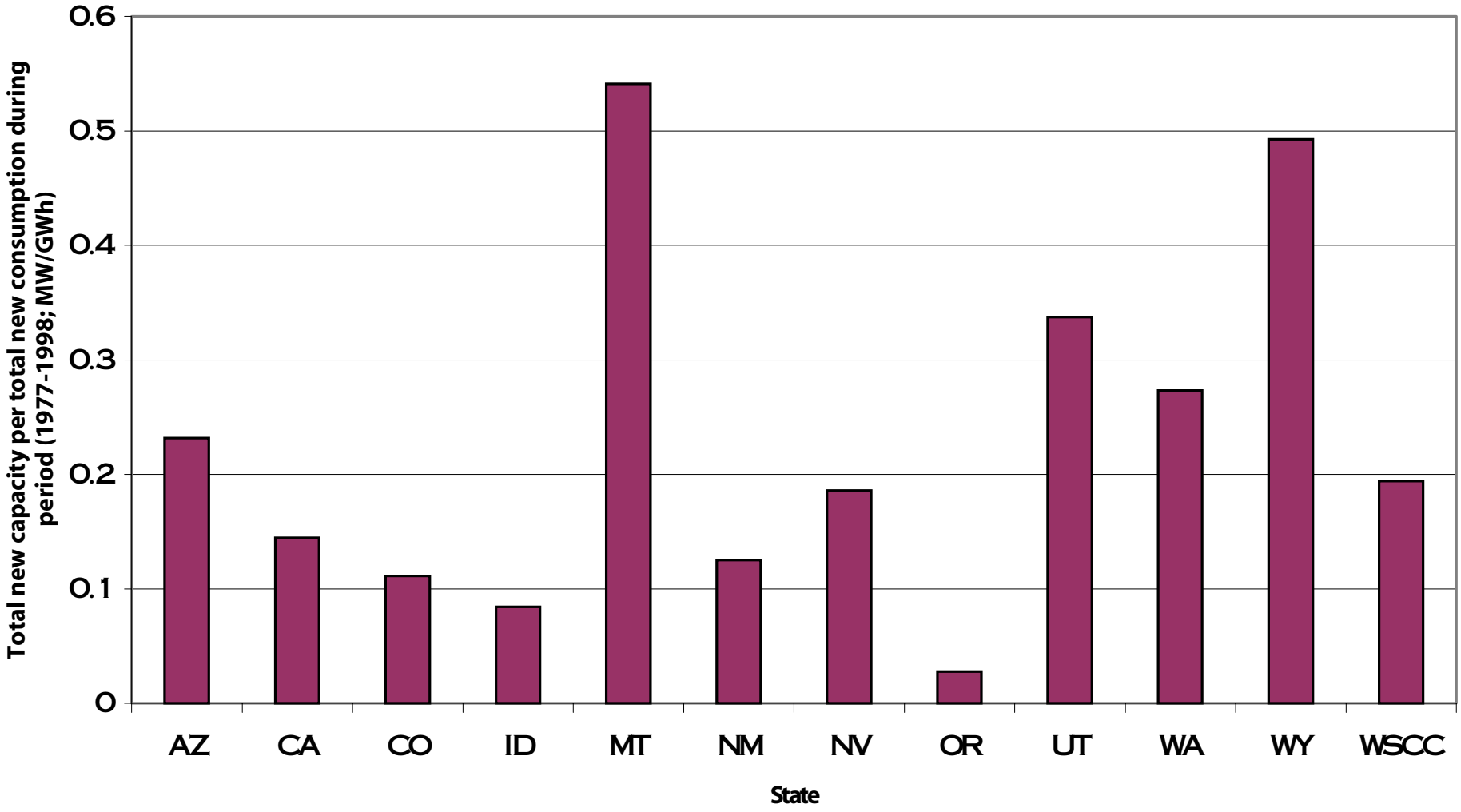

Chart F-4

New utility capacity per new consumption during five-year periods by state, 1977-1998

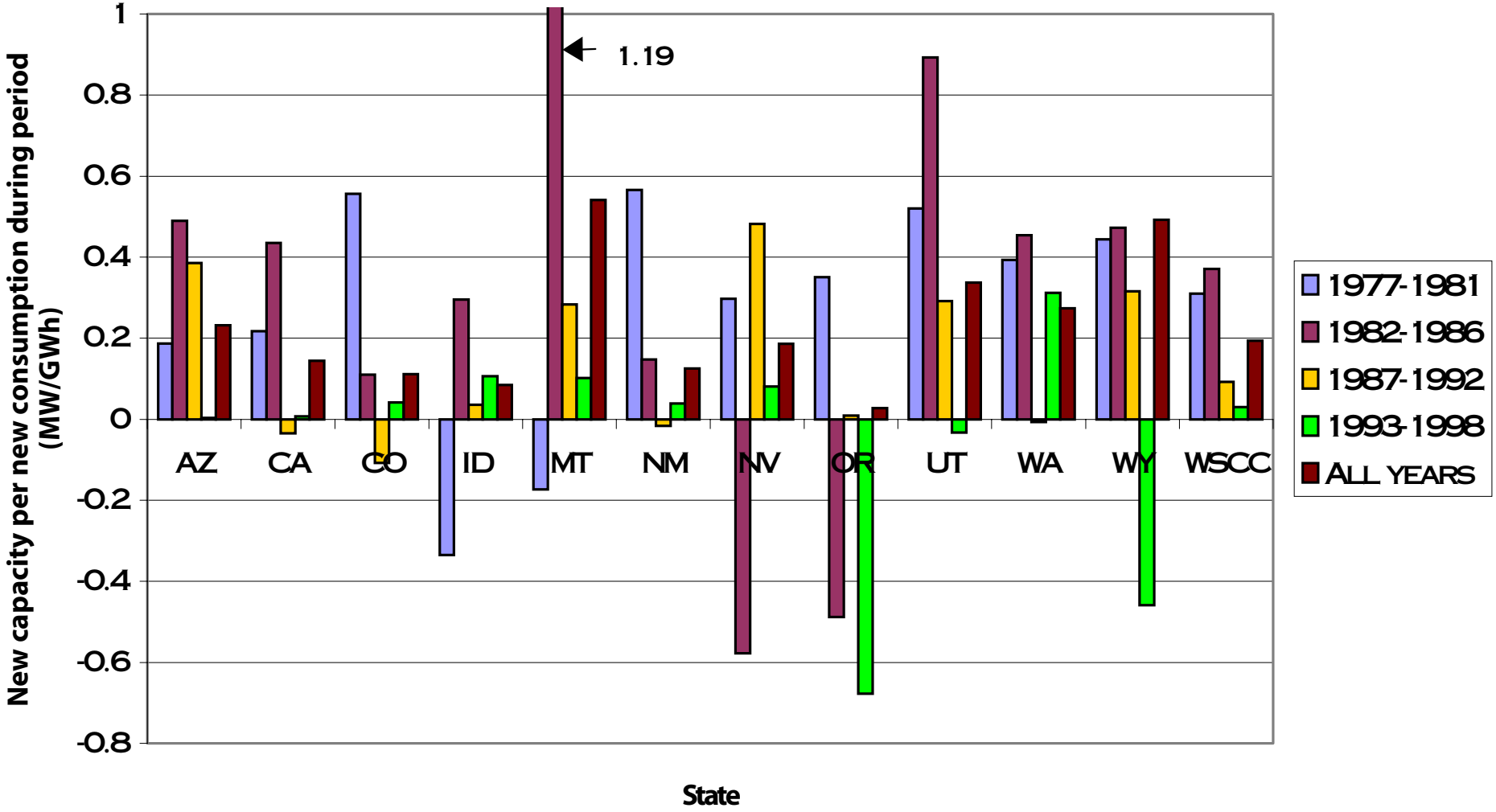

Chart F-5

New utility capacity per new consumption by region, 1977-1998

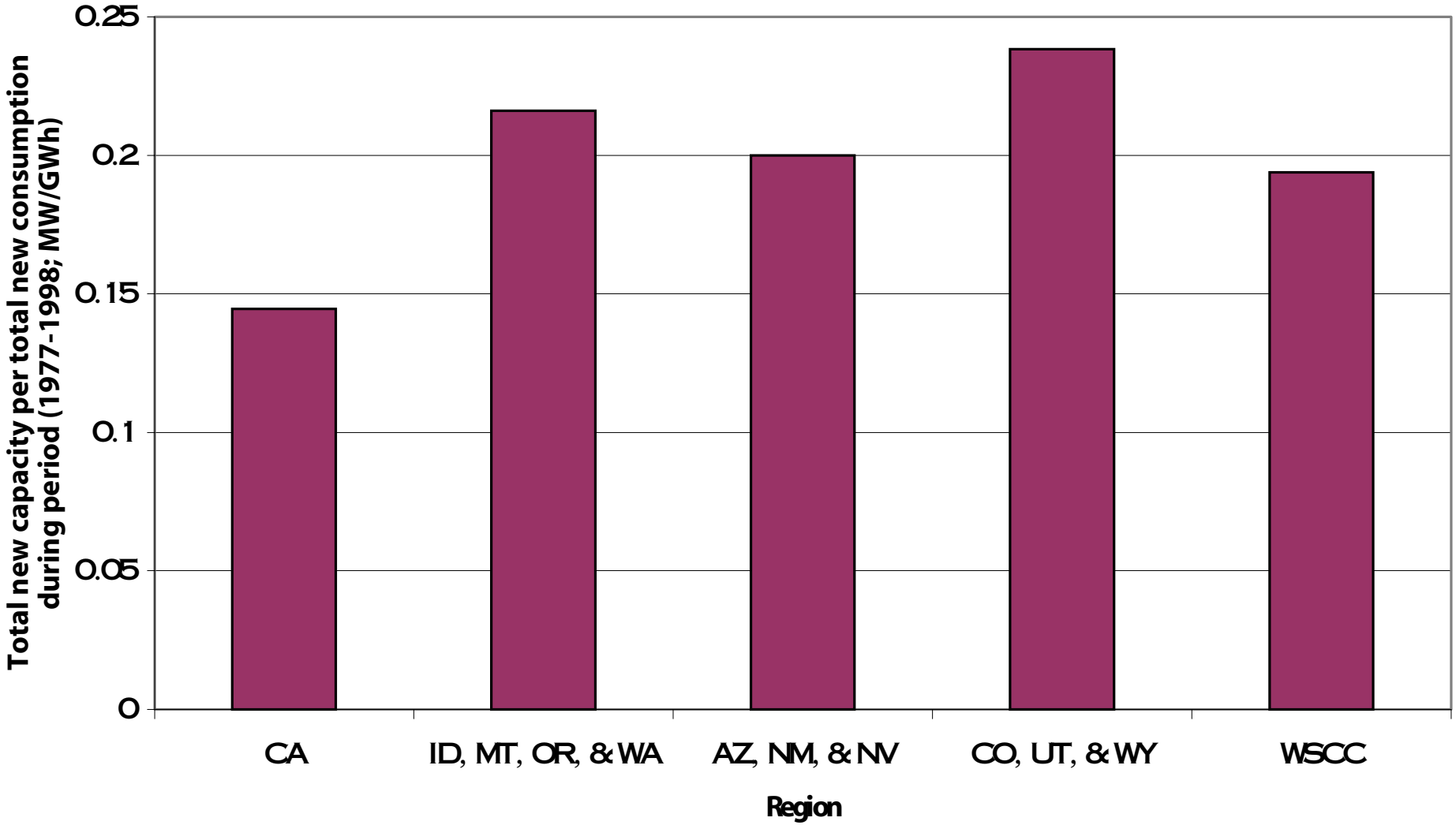

Chart F-6

New utility capacity per new consumption during five-year periods by region, 1977-1998

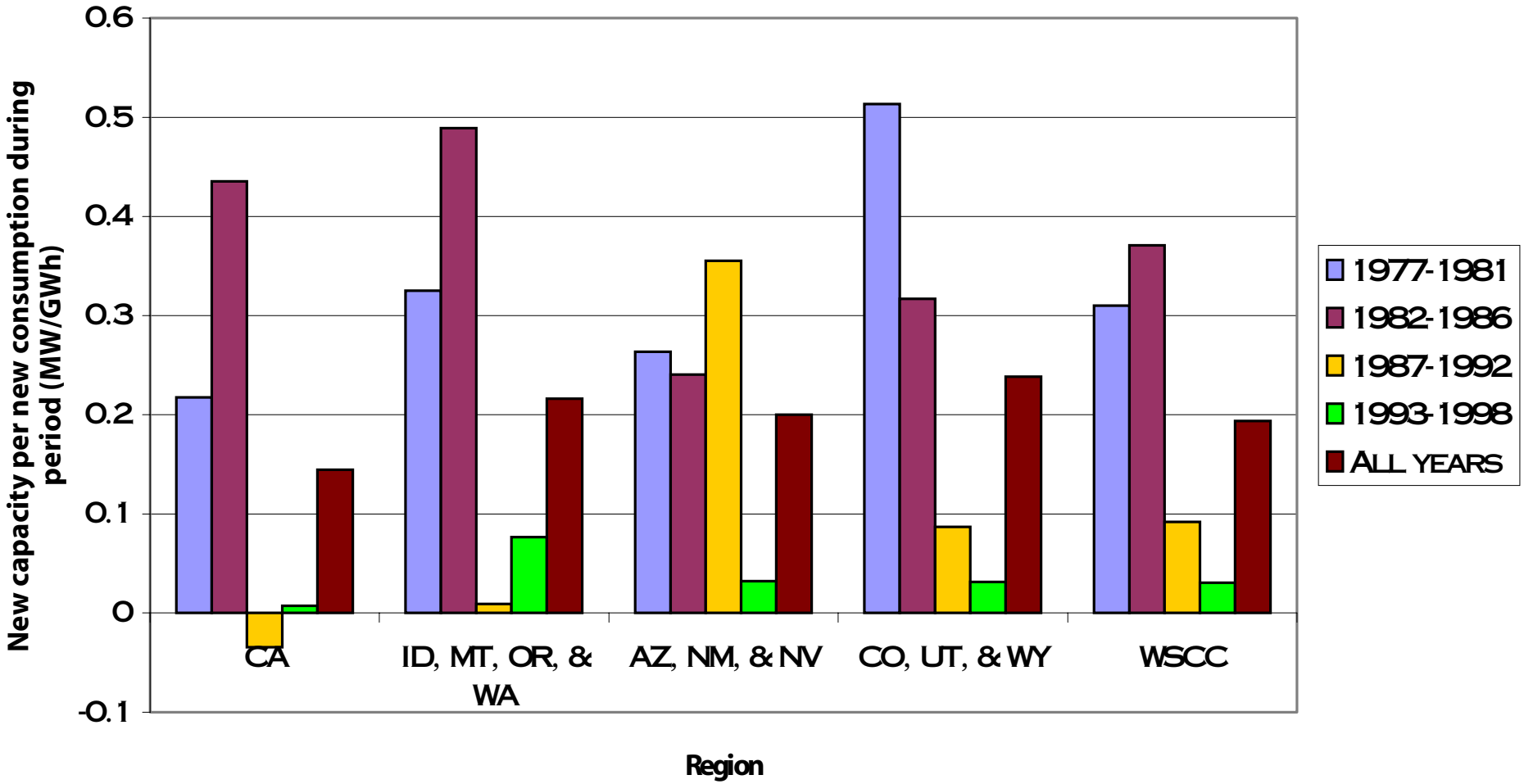

Chart F-7

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Key to categories
Group 1: CA; ID, MT, OR, WA; AZ, NM, NV; CO, UT, WY
Group 2: NWPP, RMPA, AZ/NM/SNV, CA/MX
State: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

Consumption by state (gigawatt-hours)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	23,315	158,800	17,836	13,514	10,013	7,679	8,032	34,288	8,808	58,789	5,418	346,492
1978	24,028	162,647	18,908	12,961	10,786	8,050	8,896	36,004	9,748	65,340	6,150	363,518
1979	26,052	169,590	20,153	13,988	11,129	8,582	10,340	38,273	10,415	68,551	6,716	383,789
1980	26,762	167,567	20,870	13,707	10,825	8,778	10,408	37,848	10,705	69,658	7,196	384,324
1981	29,769	174,419	21,145	14,316	10,931	8,944	11,409	37,878	11,502	71,842	7,710	399,865
1982	26,863	165,843	23,692	16,117	10,276	8,847	10,568	34,791	12,391	75,549	8,073	393,010
1984	30,252	175,197	26,414	16,542	11,466	9,204	11,332	36,302	13,958	83,342	8,396	422,405
1985	32,409	178,767	27,264	16,649	11,822	9,570	11,742	34,708	14,428	82,359	8,696	428,414
1986	33,968	184,613	27,554	15,767	11,593	11,756	10,966	34,945	13,025	74,618	10,407	429,212
1987	36,647	190,324	29,027	16,247	12,616	12,421	13,102	38,491	13,473	78,047	10,921	451,316
1988	38,916	200,637	29,335	17,165	12,942	12,755	13,684	39,312	14,507	84,832	10,964	475,049
1989	40,748	204,139	30,139	17,821	13,061	13,370	14,968	41,619	14,965	86,674	11,234	488,738
1990	41,470	211,093	30,795	18,003	13,125	13,821	16,352	42,977	15,402	91,046	11,769	505,853
1991	41,848	208,650	31,457	18,046	13,407	14,084	16,625	43,651	15,907	92,714	11,757	508,146
1992	43,651	213,447	31,822	19,008	13,096	14,431	17,696	42,910	16,567	89,319	11,700	513,647
1993	44,234	209,971	33,882	18,839	12,966	14,876	18,506	44,036	16,831	88,086	12,036	514,263
1994	47,453	211,531	33,639	19,941	13,237	15,703	20,067	44,695	17,860	88,727	11,850	524,703
1995	48,295	213,693	34,869	19,389	13,567	16,230	20,582	45,526	18,358	89,322	11,196	531,027
1996	51,719	219,802	37,400	21,121	12,413	16,824	22,502	47,391	19,824	86,661	11,624	547,281
1997	54,035	223,857	37,667	21,288	12,497	17,307	23,871	47,059	20,449	85,090	12,164	555,284
1998	55,843	226,396	39,574	21,276	13,774	18,173	25,037	45,083	20,700	91,050	11,641	568,547
Rank (1-highest)												
1977	4	1	5	6	7	10	9	3	8	2	11	
1998	3	1	5	7	10	9	6	4	8	2	11	
Share of total												
1977	6.7%	45.8%	5.1%	3.9%	2.9%	2.2%	2.3%	9.9%	2.5%	17.0%	1.6%	
1998	9.8%	39.8%	7.0%	3.7%	2.4%	3.2%	4.4%	7.9%	3.6%	16.0%	2.0%	
Total increase												
Percent	139.5%	42.6%	121.9%	57.4%	37.6%	136.7%	211.7%	31.5%	135.0%	54.9%	114.9%	64.1%
Absolute	32,528	67,596	21,738	7,762	3,761	10,494	17,005	10,795	11,892	32,261	6,223	222,055
Average annual growth rate												
	4.2%	1.7%	3.9%	2.2%	1.5%	4.2%	5.6%	1.3%	4.2%	2.1%	3.7%	2.4%

Table A-1

Consumption by region (gigawatt-hours)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	158,800	116,604	39,026	32,062	346,492
1978	162,647	125,091	40,974	34,806	363,518
1979	169,590	131,941	44,974	37,284	383,789
1980	167,567	132,038	45,948	38,771	384,324
1981	174,419	134,967	50,122	40,357	399,865
1982	165,843	136,733	46,278	44,156	393,010
1984	175,197	147,652	50,788	48,768	422,405
1985	178,767	145,538	53,721	50,388	428,414
1986	184,613	136,923	56,690	50,986	429,212
1987	190,324	145,401	62,170	53,421	451,316
1988	200,637	154,251	65,355	54,806	475,049
1989	204,139	159,175	69,086	56,338	488,738
1990	211,093	165,151	71,643	57,966	505,853
1991	208,650	167,818	72,557	59,121	508,146
1992	213,447	164,333	75,778	60,089	513,647
1993	209,971	163,927	77,616	62,749	514,263
1994	211,531	166,600	83,223	63,349	524,703
1995	213,693	167,804	85,107	64,423	531,027
1996	219,802	167,586	91,045	68,848	547,281
1997	223,857	165,934	95,213	70,280	555,284
1998	226,396	171,183	99,053	71,915	568,547
Rank (1-highest)					
1977	1	2	3	4	
1998	1	2	3	4	
Share of total					
1977	45.8%	33.7%	11.3%	9.3%	
1998	39.8%	30.1%	17.4%	12.6%	
Total increase					
Percent	42.6%	46.8%	153.8%	124.3%	64.1%
Absolute	67,596	54,579	60,027	39,853	222,055

Table A-2

Population by state (number of people)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	2,425,197	22,352,396	2,696,140	883,469	769,953	1,215,720	678,333	2,446,673	1,319,512	3,776,050	413,354	38,976,797
1978	2,515,316	22,835,958	2,766,748	910,690	782,317	1,238,034	719,436	2,518,298	1,367,510	3,889,073	432,880	39,976,260
1979	2,635,571	23,256,880	2,849,234	932,627	787,305	1,284,722	765,367	2,588,012	1,420,238	4,017,632	454,378	40,991,966
1980	2,718,215	23,667,902	2,889,964	943,935	786,690	1,302,894	800,493	2,633,105	1,461,037	4,132,156	469,557	41,805,948
1981	2,810,107	24,285,933	2,977,898	962,204	795,328	1,332,748	847,655	2,667,982	1,515,471	4,235,731	491,712	42,922,769
1982	2,889,861	24,820,009	3,061,564	973,721	803,986	1,363,823	881,537	2,664,922	1,558,314	4,276,552	506,400	43,800,689
1983	2,968,925	25,360,026	3,133,630	981,869	814,031	1,394,361	901,977	2,653,066	1,594,943	4,300,266	510,345	44,613,439
1984	3,067,135	25,844,393	3,169,992	990,839	820,905	1,416,717	924,922	2,666,588	1,622,342	4,343,656	504,896	45,372,385
1985	3,183,538	26,441,109	3,208,723	994,051	822,320	1,438,361	951,030	2,672,652	1,642,910	4,400,098	499,695	46,254,487
1986	3,308,262	27,102,237	3,237,450	990,224	813,739	1,462,729	980,613	2,683,528	1,662,834	4,452,720	495,633	47,189,969
1987	3,437,103	27,777,158	3,260,480	984,997	805,063	1,478,520	1,023,376	2,700,991	1,678,119	4,531,901	476,965	48,154,673
1988	3,535,183	28,464,249	3,262,281	985,664	800,202	1,490,337	1,075,022	2,741,297	1,689,372	4,639,893	465,101	49,148,601
1989	3,622,185	29,218,164	3,275,818	994,416	799,636	1,503,901	1,137,382	2,790,575	1,705,864	4,746,316	458,374	50,252,631
1990	3,665,228	29,760,021	3,294,394	1,006,749	799,065	1,515,069	1,201,833	2,842,321	1,722,850	4,866,692	453,588	51,127,810
1991	3,762,394	30,414,114	3,367,567	1,038,915	807,837	1,547,115	1,285,046	2,918,745	1,771,941	5,013,443	457,739	52,384,856
1992	3,867,333	30,875,920	3,459,995	1,066,490	822,436	1,580,750	1,330,694	2,973,934	1,821,498	5,139,011	463,491	53,401,552
1993	3,993,390	31,147,208	3,560,884	1,101,204	839,876	1,614,937	1,380,197	3,034,490	1,875,993	5,247,704	469,033	54,264,916
1994	4,147,561	31,317,179	3,653,910	1,135,459	854,923	1,653,329	1,456,388	3,087,142	1,930,436	5,334,896	474,982	55,046,205
1995	4,306,908	31,493,525	3,738,061	1,165,000	868,522	1,682,417	1,525,777	3,141,421	1,976,774	5,431,024	478,447	55,807,876
1996	4,432,308	31,780,829	3,812,716	1,187,706	876,656	1,706,151	1,596,476	3,195,087	2,022,253	5,509,963	480,085	56,600,230
1997	4,552,207	32,217,708	3,891,293	1,210,638	878,706	1,722,939	1,675,581	3,243,254	2,065,397	5,604,105	480,031	57,541,859
1998	4,667,277	32,682,794	3,968,967	1,230,923	879,533	1,733,535	1,743,772	3,282,055	2,100,562	5,687,832	480,045	58,457,295
Rank (1-highest)												
1977	5	1	3	8	9	7	10	4	6	2	11	
1998	3	1	4	9	10	8	7	5	6	2	11	
Share of total												
1977	6.2%	57.3%	6.9%	2.3%	2.0%	3.1%	1.7%	6.3%	3.4%	9.7%	1.1%	
1998	8.0%	55.9%	6.8%	2.1%	1.5%	3.0%	3.0%	5.6%	3.6%	9.7%	0.8%	
Total increase												
Percent	92.4%	46.2%	47.2%	39.3%	14.2%	42.6%	157.1%	34.1%	59.2%	50.6%	16.1%	50.0%
Absolute	2,242,080	10,330,398	1,272,827	347,454	109,580	517,815	1,065,439	835,382	781,050	1,911,782	66,691	19,480,498
Average annual growth rate												
	3.2%	1.8%	1.9%	1.6%	0.6%	1.7%	4.6%	1.4%	2.2%	2.0%	0.7%	1.9%

Table B-1

Consumption per capita by state (megawatt-hours/person)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	9.61	7.10	6.62	15.30	13.00	6.32	11.84	14.01	6.68	15.57	13.11	8.89
1978	9.55	7.12	6.83	14.23	13.79	6.50	12.37	14.30	7.13	16.80	14.21	9.09
1979	9.88	7.29	7.07	15.00	14.14	6.68	13.51	14.79	7.33	17.06	14.78	9.36
1980	9.85	7.08	7.22	14.52	13.76	6.74	13.00	14.37	7.33	16.86	15.33	9.19
1981	10.59	7.18	7.10	14.88	13.74	6.71	13.46	14.20	7.59	16.96	15.68	9.32
1982	9.30	6.68	7.74	16.55	12.78	6.49	11.99	13.06	7.95	17.67	15.94	8.97
1984	9.86	6.78	8.33	16.69	13.97	6.50	12.25	13.61	8.60	19.19	16.63	9.31
1985	10.18	6.76	8.50	16.75	14.38	6.65	12.35	12.99	8.78	18.72	17.40	9.26
1986	10.27	6.81	8.51	15.92	14.25	8.04	11.18	13.02	7.83	16.76	21.00	9.10
1987	10.66	6.85	8.90	16.49	15.67	8.40	12.80	14.25	8.03	17.22	22.90	9.37
1988	11.01	7.05	8.99	17.41	16.17	8.56	12.73	14.34	8.59	18.28	23.57	9.67
1989	11.25	6.99	9.20	17.92	16.33	8.89	13.16	14.91	8.77	18.26	24.51	9.73
1990	11.31	7.09	9.35	17.88	16.43	9.12	13.61	15.12	8.94	18.71	25.95	9.89
1991	11.12	6.86	9.34	17.37	16.60	9.10	12.94	14.96	8.98	18.49	25.68	9.70
1992	11.29	6.91	9.20	17.82	15.92	9.13	13.30	14.43	9.10	17.38	25.24	9.62
1993	11.08	6.74	9.52	17.11	15.44	9.21	13.41	14.51	8.97	16.79	25.66	9.48
1994	11.44	6.75	9.21	17.56	15.48	9.50	13.78	14.48	9.25	16.63	24.95	9.53
1995	11.21	6.79	9.33	16.64	15.62	9.65	13.49	14.49	9.29	16.45	23.40	9.52
1996	11.67	6.92	9.81	17.78	14.16	9.86	14.09	14.83	9.80	15.73	24.21	9.67
1997	11.87	6.95	9.68	17.58	14.22	10.05	14.25	14.51	9.90	15.18	25.34	9.65
1998	11.96	6.93	9.97	17.28	15.66	10.48	14.36	13.74	9.85	16.01	24.25	9.73
Rank (1-lowest)												
1977	5	4	2	10	7	1	6	9	3	11	8	
1998	5	1	3	10	8	4	7	6	2	9	11	
Difference from lowest												
1977	52.2%	12.5%	4.7%	142.2%	105.9%	-	87.5%	121.9%	5.7%	146.5%	107.5%	
1998	72.7%	-	43.9%	149.5%	126.1%	51.3%	107.3%	98.3%	42.3%	131.1%	250.1%	
Total increase												
Percent	24.5%	-2.5%	50.7%	13.0%	20.4%	66.0%	21.3%	-2.0%	47.6%	2.8%	85.0%	9.4%

Consumption per capita by region (megawatt-hours/person)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	7.10	14.80	9.04	7.24	8.89
1978	7.12	15.44	9.16	7.62	9.09
1979	7.29	15.85	9.60	7.89	9.36
1980	7.08	15.54	9.53	8.04	9.19
1981	7.18	15.58	10.04	8.10	9.32
1982	6.68	15.68	9.01	8.61	8.97
1984	6.78	16.74	9.39	9.21	9.31
1985	6.76	16.37	9.64	9.42	9.26
1986	6.81	15.32	9.86	9.45	9.10
1987	6.85	16.11	10.47	9.86	9.37
1988	7.05	16.83	10.71	10.12	9.67
1989	6.99	17.06	11.03	10.36	9.73
1990	7.09	17.36	11.23	10.60	9.89
1991	6.86	17.16	11.00	10.56	9.70
1992	6.91	16.43	11.18	10.46	9.62
1993	6.74	16.03	11.11	10.62	9.48
1994	6.75	16.00	11.47	10.45	9.53
1995	6.79	15.82	11.32	10.40	9.52
1996	6.92	15.56	11.77	10.90	9.67
1997	6.95	15.17	11.98	10.92	9.65
1998	6.93	15.45	12.16	10.98	9.73
Rank (1-lowest)					
1977	1	4	3	2	
1998	1	4	3	2	
Difference from lowest					
1977	-	108.4%	27.2%	1.9%	25.1%
1998	-	123.0%	75.6%	58.5%	40.4%
Total increase					
Percent	-2.5%	4.4%	34.6%	51.7%	9.4%

Gross state product by state (millions of constant dollars)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	19,214	229,311	25,216	7,035	6,370	10,403	7,494	22,310	10,426	35,965	5,681	379,425
1978	22,823	263,435	29,396	8,323	7,494	11,921	9,105	25,908	12,114	42,014	6,897	439,430
1979	27,154	294,882	33,956	9,190	8,248	13,587	10,634	29,083	13,858	48,181	8,320	497,093
1980	30,231	327,907	38,446	9,816	9,016	16,186	12,047	30,700	15,479	51,964	10,779	552,571
1981	33,405	368,301	44,071	10,533	10,311	19,068	13,626	32,081	17,542	57,694	13,256	619,888
1982	34,307	392,914	47,649	10,506	10,361	19,913	14,237	31,899	18,573	60,731	13,056	654,146
1983	38,252	425,811	50,484	11,580	10,677	20,564	15,316	33,890	19,878	65,380	12,212	704,044
1984	44,471	484,068	56,013	12,483	11,256	22,263	16,908	37,821	22,257	71,086	12,932	791,558
1985	49,261	528,950	59,034	12,979	11,211	23,481	18,417	39,923	24,094	74,494	13,022	854,866
1986	54,615	567,025	59,914	13,083	11,257	22,539	20,030	42,004	24,453	80,462	11,224	906,606
1987	58,996	624,022	63,346	13,814	11,629	23,154	22,156	45,046	25,177	86,898	11,084	985,322
1988	63,328	684,452	66,720	15,036	11,887	24,032	25,389	49,715	27,215	95,651	11,668	1,075,093
1989	65,938	742,866	70,004	16,689	12,826	25,479	28,473	53,522	28,683	104,758	12,011	1,161,249
1990	68,780	798,237	74,649	17,714	13,449	27,151	31,630	57,853	31,325	115,642	13,416	1,249,846
1991	71,798	814,216	79,396	18,627	14,088	30,835	33,652	60,666	33,626	122,597	13,532	1,293,033
1992	78,930	830,950	85,786	20,326	15,097	32,824	36,468	64,297	35,632	130,772	13,535	1,344,617
1993	85,442	846,994	93,553	22,662	16,148	37,021	39,844	70,050	38,407	138,379	14,360	1,402,860
1994	95,780	878,124	101,636	24,773	17,023	41,651	44,842	75,328	42,295	146,543	14,871	1,482,866
1995	104,638	924,582	109,198	27,020	17,664	42,016	49,094	81,301	46,424	151,469	15,697	1,569,103
1996	113,099	971,777	117,470	27,948	18,214	43,825	54,033	91,902	51,631	161,954	17,059	1,668,912
1997	123,132	1,043,669	129,653	29,086	19,060	46,484	58,488	98,837	56,062	176,226	17,770	1,798,467
1998	133,801	1,118,945	141,791	30,936	19,861	47,736	63,044	104,771	59,624	192,864	17,530	1,930,903
Rank (1-highest)												
1977	5	1	3	9	10	7	8	4	6	2	11	
1998	4	1	3	9	10	8	6	5	7	2	11	
Share of total												
1977	5.1%	60.4%	6.6%	1.9%	1.7%	2.7%	2.0%	5.9%	2.7%	9.5%	1.5%	
1998	6.9%	57.9%	7.3%	1.6%	1.0%	2.5%	3.3%	5.4%	3.1%	10.0%	0.9%	
Total increase												
Percent	596.4%	388.0%	462.3%	339.7%	211.8%	358.9%	741.3%	369.6%	471.9%	436.3%	208.6%	408.9%
Absolute	114,587	889,634	116,575	23,901	13,491	37,333	55,550	82,461	49,198	156,899	11,849	1,551,478

Table C-1

Consumption per GSP by state (kilowatt-hours/constant dollar)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	1.21	0.69	0.71	1.92	1.57	0.74	1.07	1.54	0.84	1.63	0.95	0.91
1978	1.05	0.62	0.64	1.56	1.44	0.68	0.98	1.39	0.80	1.56	0.89	0.83
1979	0.96	0.58	0.59	1.52	1.35	0.63	0.97	1.32	0.75	1.42	0.81	0.77
1980	0.89	0.51	0.54	1.40	1.20	0.54	0.86	1.23	0.69	1.34	0.67	0.70
1981	0.89	0.47	0.48	1.36	1.06	0.47	0.84	1.18	0.66	1.25	0.58	0.65
1982	0.78	0.42	0.50	1.53	0.99	0.44	0.74	1.09	0.67	1.24	0.62	0.60
1984	0.68	0.36	0.47	1.33	1.02	0.41	0.67	0.96	0.63	1.17	0.65	0.53
1985	0.66	0.34	0.46	1.28	1.05	0.41	0.64	0.87	0.60	1.11	0.67	0.50
1986	0.62	0.33	0.46	1.21	1.03	0.52	0.55	0.83	0.53	0.93	0.93	0.47
1987	0.62	0.30	0.46	1.18	1.08	0.54	0.59	0.85	0.54	0.90	0.99	0.46
1988	0.61	0.29	0.44	1.14	1.09	0.53	0.54	0.79	0.53	0.89	0.94	0.44
1989	0.62	0.27	0.43	1.07	1.02	0.52	0.53	0.78	0.52	0.83	0.94	0.42
1990	0.60	0.26	0.41	1.02	0.98	0.51	0.52	0.74	0.49	0.79	0.88	0.40
1991	0.58	0.26	0.40	0.97	0.95	0.46	0.49	0.72	0.47	0.76	0.87	0.39
1992	0.55	0.26	0.37	0.94	0.87	0.44	0.49	0.67	0.46	0.68	0.86	0.38
1993	0.52	0.25	0.36	0.83	0.80	0.40	0.46	0.63	0.44	0.64	0.84	0.37
1994	0.50	0.24	0.33	0.80	0.78	0.38	0.45	0.59	0.42	0.61	0.80	0.35
1995	0.46	0.23	0.32	0.72	0.77	0.39	0.42	0.56	0.40	0.59	0.71	0.34
1996	0.46	0.23	0.32	0.76	0.68	0.38	0.42	0.52	0.38	0.54	0.68	0.33
1997	0.44	0.21	0.29	0.73	0.66	0.37	0.41	0.48	0.36	0.48	0.68	0.31
1998	0.42	0.20	0.28	0.69	0.69	0.38	0.40	0.43	0.35	0.47	0.66	0.29
Rank (1-lowest)												
1977	7	1	2	11	9	3	6	8	4	10	5	
1998	6	1	2	10	11	4	5	7	3	8	9	
Difference from lowest												
1977	75.2%	-	2.1%	177.4%	127.0%	6.6%	54.8%	121.9%	22.0%	136.0%	37.7%	
1998	106.3%	-	37.9%	239.9%	242.8%	88.2%	96.3%	112.7%	71.6%	133.3%	228.2%	
Total increase												
Percent	-65.6%	-70.8%	-60.5%	-64.2%	-55.9%	-48.4%	-62.9%	-72.0%	-58.9%	-71.1%	-30.4%	-67.8%

Consumption per GSP by region (kilowatt-hours/constant dollar)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	0.69	1.63	1.05	0.78	0.91
1978	0.62	1.49	0.93	0.72	0.83
1979	0.58	1.39	0.88	0.66	0.77
1980	0.51	1.30	0.79	0.60	0.70
1981	0.47	1.22	0.76	0.54	0.65
1982	0.42	1.20	0.68	0.56	0.60
1984	0.36	1.11	0.61	0.53	0.53
1985	0.34	1.05	0.59	0.52	0.50
1986	0.33	0.93	0.58	0.53	0.47
1987	0.30	0.92	0.60	0.54	0.46
1988	0.29	0.90	0.58	0.52	0.44
1989	0.27	0.85	0.58	0.51	0.42
1990	0.26	0.81	0.56	0.49	0.40
1991	0.26	0.78	0.53	0.47	0.39
1992	0.26	0.71	0.51	0.45	0.38
1993	0.25	0.66	0.48	0.43	0.37
1994	0.24	0.63	0.46	0.40	0.35
1995	0.23	0.60	0.43	0.38	0.34
1996	0.23	0.56	0.43	0.37	0.33
1997	0.21	0.51	0.42	0.35	0.31
1998	0.20	0.49	0.40	0.33	0.29
Rank (1-lowest)					
1977	1	4	3	2	
1998	1	4	3	2	
Difference from lowest					
1977	-	134.9%	51.9%	12.0%	31.9%
1998	-	142.8%	100.2%	62.3%	45.5%
Total increase					
Percent	-70.8%	-69.8%	-61.5%	-57.7%	-67.8%

Peak annual incidental demand by region (megawatts)

	NWPP	RMPA	AZ/NM/SNV	CA/MX	WSCC
1982	43,700	5,410	8,710	35,800	84,100
1983	46,700	5,590	8,900	37,500	88,400
1984	44,800	5,700	9,380	40,900	89,200
1985	45,300	5,740	10,070	42,700	93,200
1986	42,600	5,900	10,350	41,600	91,800
1987	44,500	6,020	12,410	40,800	94,000
1988	45,900	6,100	13,240	44,800	101,900
1989	52,700	6,330	14,470	43,000	103,000
1990	56,100	6,790	14,990	47,800	110,000
1991	51,900	6,490	14,450	44,300	107,900
1992	51,800	6,380	15,670	48,200	112,300
1993	54,100	6,730	15,960	46,800	111,000
1994	53,000	6,960	17,130	49,600	115,800
1995	52,600	7,270	17,890	49,200	117,400
1996	57,200	7,430	18,700	51,300	123,400
1997	55,300	7,930	19,030	53,200	124,900
1998	60,000	7,980	20,430	55,400	131,700
Total increase					
Percent	37.3%	47.5%	134.6%	54.7%	56.6%
Absolute	16,300	2,570	11,720	19,600	47,600

Table D-1

Peak seasonal incidental demand by region (megawatts)

Summer	NWPP	RMPA	AZ/NM/SNV	CA/MX	WSCC
1995	44,371	7,266	14,566	52,510	117,386
1996	46,405	7,404	15,087	54,760	123,375
1997	45,753	7,926	19,026	53,217	124,935
1998	49,484	7,975	20,430	55,441	131,680
1999	48,319	7,640	19,954	53,146	129,059
Total increase					
Percent	8.9%	5.1%	37.0%	1.2%	9.9%
Absolute	3,948	374	5,388	636	11,673
Share of peak in 1999†	37.4%	5.9%	15.5%	41.2%	
Share of increase in peak†	33.8%	3.2%	46.2%	5.4%	

Winter	NWPP	RMPA	AZ/NM/SNV	CA/MX	WSCC
1995/96	57,238	6,889	10,667	37,628	112,232
1996/97	55,800	7,434	11,427	39,121	112,892
1997/98	55,479	7,423	13,518	37,981	111,955
1998/99	59,972	7,740	14,106	38,304	120,122
1999/00	55,986	7,635	14,083	40,281	117,985
Total increase					
Percent	-2.2%	10.8%	32.0%	7.1%	5.1%
Absolute	-1,252	746	3,416	2,653	5,753
Share of peak in 1999/00†	47.5%	6.5%	11.9%	34.1%	
Share of increase in peak†	-21.8%	13.0%	59.4%	46.1%	

† Values will not sum to 100; approximate share since regional values are from non-coincidental peak occurrences.

Table D-2

Utility capacity by state (megawatts)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	9,111	34,724	4,559	1,739	3,049	4,314	2,742	9,620	1,117	15,779	3,312	90,066
1978	8,227	35,716	4,363	1,842	3,233	4,331	3,508	9,510	1,554	16,687	3,318	92,289
1979	9,068	37,425	4,664	1,636	3,176	4,410	3,646	10,121	2,107	19,303	3,647	99,203
1980	9,667	37,760	5,479	1,472	2,890	5,003	3,676	10,121	2,109	20,219	3,671	102,067
1981	10,316	38,120	6,400	1,470	2,890	5,029	3,747	10,877	2,518	20,919	4,328	106,614
1982	10,916	38,176	6,242	1,978	3,183	4,988	4,127	8,707	2,580	23,346	5,258	109,501
1983	10,862	38,456	6,785	2,002	3,163	5,494	4,262	10,847	2,579	21,530	5,638	111,618
1984	10,862	39,847	6,797	2,027	3,212	5,413	4,532	10,609	3,034	21,795	5,846	113,974
1985	11,026	41,942	7,493	2,026	4,044	5,648	4,532	10,573	3,044	23,239	5,846	119,413
1986	12,089	45,107	7,285	2,040	4,903	5,540	5,554	10,578	3,028	23,739	5,845	125,707
1987	13,680	45,045	7,265	2,041	4,903	5,542	2,769	10,578	4,278	23,739	5,845	125,685
1988	15,732	45,405	7,231	2,048	4,867	5,512	4,831	10,366	5,087	24,127	5,854	131,060
1989	15,923	45,944	7,263	2,089	4,936	5,598	4,993	10,366	5,221	23,276	5,853	131,462
1990	16,112	45,876	6,704	2,063	4,929	5,562	5,085	10,606	5,209	23,258	5,865	131,269
1991	16,494	44,548	6,722	2,064	4,936	5,502	5,133	10,616	5,247	23,389	6,176	130,827
1992	16,488	44,473	6,717	2,063	4,967	5,488	5,374	10,616	5,236	23,615	6,176	131,213
1993	16,603	44,370	6,744	2,134	5,002	5,501	5,374	10,628	5,257	23,667	6,197	131,477
1994	16,627	44,957	6,757	2,089	5,002	5,501	5,464	9,422	5,273	23,699	6,197	130,988
1995	16,682	44,073	6,778	2,318	5,044	5,519	5,714	9,471	5,132	23,880	6,201	130,812
1996	16,687	44,071	6,754	2,375	5,096	5,519	5,792	9,814	5,134	23,895	6,283	131,420
1997	16,634	44,699	6,907	2,369	5,097	5,521	5,893	9,894	5,130	23,840	6,258	132,242
1998	16,642	44,493	6,979	2,393	5,084	5,627	5,901	9,919	5,131	24,590	6,378	133,137
Rank (1-highest)												
1977	4	1	5	10	8	6	9	3	11	2	7	
1998	3	1	5	11	10	8	7	4	9	2	6	
Share of total												
1977	10.1%	38.6%	5.1%	1.9%	3.4%	4.8%	3.0%	10.7%	1.2%	17.5%	3.7%	
1998	12.5%	33.4%	5.2%	1.8%	3.8%	4.2%	4.4%	7.5%	3.9%	18.5%	4.8%	
Total increase												
Percent	82.7%	28.1%	53.1%	37.6%	66.7%	30.4%	115.2%	3.1%	359.4%	55.8%	92.6%	47.8%
Absolute	7,531	9,769	2,420	654	2,035	1,313	3,159	299	4,014	8,811	3,066	43,071
Average annual growth rate												
	2.9%	1.2%	2.0%	1.5%	2.5%	1.3%	3.7%	0.1%	7.5%	2.1%	3.2%	1.9%

Table E-1

Utility capacity by region (megawatts)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	34,724	30,187	16,167	8,988	90,066
1978	35,716	31,272	16,066	9,235	92,289
1979	37,425	34,236	17,124	10,418	99,203
1980	37,760	34,702	18,346	11,259	102,067
1981	38,120	36,156	19,092	13,246	106,614
1982	38,176	37,214	20,031	14,080	109,501
1983	38,456	37,542	20,618	15,002	111,618
1984	39,847	37,643	20,807	15,677	113,974
1985	41,942	39,882	21,206	16,383	119,413
1986	45,107	41,260	23,183	16,158	125,707
1987	45,045	41,261	21,991	17,388	125,685
1988	45,405	41,408	26,075	18,172	131,060
1989	45,944	40,667	26,514	18,337	131,462
1990	45,876	40,856	26,759	17,778	131,269
1991	44,548	41,005	27,129	18,145	130,827
1992	44,473	41,261	27,350	18,129	131,213
1993	44,370	41,431	27,478	18,198	131,477
1994	44,957	40,212	27,592	18,227	130,988
1995	44,073	40,713	27,915	18,111	130,812
1996	44,071	41,180	27,998	18,171	131,420
1997	44,699	41,200	28,048	18,295	132,242
1998	44,493	41,986	28,170	18,488	133,137
Rank (1-highest)					
1977	1	2	3	4	
1998	1	2	3	4	
Share of total					
1977	38.6%	33.5%	18.0%	10.0%	
1998	33.4%	31.5%	21.2%	13.9%	
Total increase					
Percent	28.1%	39.1%	74.2%	105.7%	47.8%
Absolute	9,769	11,799	12,003	9,500	43,071

Capacity in California (megawatts)

	Utility-owned	Qualifying facilities	Total
1977	34,724	163	34,887
1978	35,716	237	35,953
1979	37,425	237	37,662
1980	37,760	269	38,028
1981	38,120	407	38,527
1982	38,176	433	38,609
1983	38,456	545	39,001
1984	39,847	1,030	40,877
1985	41,942	1,645	43,587
1986	45,107	2,487	47,594
1987	45,045	3,599	48,644
1988	45,405	5,198	50,603
1989	45,944	6,336	52,280
1990	45,876	8,109	53,985
1991	44,548	9,203	53,751
1992	44,473	9,631	54,104
1993	44,370	9,859	54,229
1994	44,957	9,967	54,924
1995	44,073	10,067	54,140
1996	44,071	10,196	54,267
1997	44,699	10,344	55,043
1998	44,493	10,386	54,879
Total increase			
Percent	28.1%	6287.0%	57.3%
Absolute	9,769	10,223	19,992

Non-utility capacity in 1998 (megawatts)

US	98,085
AZ	184
CA	23,513
CO	778
ID	452
MT	843
NM	129
NV	259
OR	1,006
UT	136
WA	1,046
WY	105

Capacity by state (including QF capacity in California; megawatts)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	9,111	34,887	4,559	1,739	3,049	4,314	2,742	9,620	1,117	15,779	3,312	90,229
1978	8,227	35,953	4,363	1,842	3,233	4,331	3,508	9,510	1,554	16,687	3,318	92,526
1979	9,068	37,662	4,664	1,636	3,176	4,410	3,646	10,121	2,107	19,303	3,647	99,440
1980	9,667	38,028	5,479	1,472	2,890	5,003	3,676	10,121	2,109	20,219	3,671	102,336
1981	10,316	38,527	6,400	1,470	2,890	5,029	3,747	10,877	2,518	20,919	4,328	107,021
1982	10,916	38,609	6,242	1,978	3,183	4,988	4,127	8,707	2,580	23,346	5,258	109,934
1983	10,862	39,001	6,785	2,002	3,163	5,494	4,262	10,847	2,579	21,530	5,638	112,163
1984	10,862	40,877	6,797	2,027	3,212	5,413	4,532	10,609	3,034	21,795	5,846	115,004
1985	11,026	43,587	7,493	2,026	4,044	5,648	4,532	10,573	3,044	23,239	5,846	121,058
1986	12,089	47,594	7,285	2,040	4,903	5,540	5,554	10,578	3,028	23,739	5,845	128,194
1987	13,680	48,644	7,265	2,041	4,903	5,542	2,769	10,578	4,278	23,739	5,845	129,284
1988	15,732	50,603	7,231	2,048	4,867	5,512	4,831	10,366	5,087	24,127	5,854	136,258
1989	15,923	52,280	7,263	2,089	4,936	5,598	4,993	10,366	5,221	23,276	5,853	137,798
1990	16,112	53,985	6,704	2,063	4,929	5,562	5,085	10,606	5,209	23,258	5,865	139,378
1991	16,494	53,751	6,722	2,064	4,936	5,502	5,133	10,616	5,247	23,389	6,176	140,030
1992	16,488	54,104	6,717	2,063	4,967	5,488	5,374	10,616	5,236	23,615	6,176	140,844
1993	16,603	54,229	6,744	2,134	5,002	5,501	5,374	10,628	5,257	23,667	6,197	141,336
1994	16,627	54,924	6,757	2,089	5,002	5,501	5,464	9,422	5,273	23,699	6,197	140,955
1995	16,682	54,140	6,778	2,318	5,044	5,519	5,714	9,471	5,132	23,880	6,201	140,879
1996	16,687	54,267	6,754	2,375	5,096	5,519	5,792	9,814	5,134	23,895	6,283	141,616
1997	16,634	55,043	6,907	2,369	5,097	5,521	5,893	9,894	5,130	23,840	6,258	142,586
1998	16,642	54,879	6,979	2,393	5,084	5,627	5,901	9,919	5,131	24,590	6,378	143,523
Rank (1-highest)												
1977	4	1	5	10	8	6	9	3	11	2	7	
1998	3	1	5	11	10	8	7	4	9	2	6	
Share of total												
1977	10.1%	38.7%	5.1%	1.9%	3.4%	4.8%	3.0%	10.7%	1.2%	17.5%	3.7%	
1998	11.6%	38.2%	4.9%	1.7%	3.5%	3.9%	4.1%	6.9%	3.6%	17.1%	4.4%	
Total increase												
Percent	82.7%	57.3%	53.1%	37.6%	66.7%	30.4%	115.2%	3.1%	359.4%	55.8%	92.6%	59.1%
Absolute	7,531	19,992	2,420	654	2,035	1,313	3,159	299	4,014	8,811	3,066	53,294

Utility capacity per consumption by state (megawatts/gigawatt-hour)

	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY	WSCC
1977	0.39	0.22	0.26	0.13	0.30	0.56	0.34	0.28	0.13	0.27	0.61	0.26
1978	0.34	0.22	0.23	0.14	0.30	0.54	0.39	0.26	0.16	0.26	0.54	0.25
1979	0.35	0.22	0.23	0.12	0.29	0.51	0.35	0.26	0.20	0.28	0.54	0.26
1980	0.36	0.23	0.26	0.11	0.27	0.57	0.35	0.27	0.20	0.29	0.51	0.27
1981	0.35	0.22	0.30	0.10	0.26	0.56	0.33	0.29	0.22	0.29	0.56	0.27
1982	0.41	0.23	0.26	0.12	0.31	0.56	0.39	0.25	0.21	0.31	0.65	0.28
1984	0.36	0.23	0.26	0.12	0.28	0.59	0.40	0.29	0.22	0.26	0.70	0.27
1985	0.34	0.23	0.27	0.12	0.34	0.59	0.39	0.30	0.21	0.28	0.67	0.28
1986	0.36	0.24	0.26	0.13	0.42	0.47	0.51	0.30	0.23	0.32	0.56	0.29
1987	0.37	0.24	0.25	0.13	0.39	0.45	0.21	0.27	0.32	0.30	0.54	0.28
1988	0.40	0.23	0.25	0.12	0.38	0.43	0.35	0.26	0.35	0.28	0.53	0.28
1989	0.39	0.23	0.24	0.12	0.38	0.42	0.33	0.25	0.35	0.27	0.52	0.27
1990	0.39	0.22	0.22	0.11	0.38	0.40	0.31	0.25	0.34	0.26	0.50	0.26
1991	0.39	0.21	0.21	0.11	0.37	0.39	0.31	0.24	0.33	0.25	0.53	0.26
1992	0.38	0.21	0.21	0.11	0.38	0.38	0.30	0.25	0.32	0.26	0.53	0.26
1993	0.38	0.21	0.20	0.11	0.39	0.37	0.29	0.24	0.31	0.27	0.51	0.26
1994	0.35	0.21	0.20	0.10	0.38	0.35	0.27	0.21	0.30	0.27	0.52	0.25
1995	0.35	0.21	0.19	0.12	0.37	0.34	0.28	0.21	0.28	0.27	0.55	0.25
1996	0.32	0.20	0.18	0.11	0.41	0.33	0.26	0.21	0.26	0.28	0.54	0.24
1997	0.31	0.20	0.18	0.11	0.41	0.32	0.25	0.21	0.25	0.28	0.51	0.24
1998	0.30	0.20	0.18	0.11	0.37	0.31	0.24	0.22	0.25	0.27	0.55	0.23
Rank (1-highest)												
1977	3	9	8	10	5	2	4	6	11	7	1	
1998	4	9	10	11	2	3	7	8	6	5	1	
Difference from highest												
1977	-36.1%	-64.2%	-58.2%	-78.9%	-50.2%	-8.1%	-44.2%	-54.1%	-79.3%	-56.1%	-	
1998	-45.6%	-64.1%	-67.8%	-79.5%	-32.6%	-43.5%	-57.0%	-59.8%	-54.8%	-50.7%	-	
Total increase												
Percent	-23.7%	-10.1%	-31.0%	-12.6%	21.2%	-44.9%	-31.0%	-21.6%	95.5%	0.6%	-10.4%	-9.9%
New capacity/new consumption												
1977-1998	0.23	0.14	0.11	0.08	0.54	0.13	0.19	0.03	0.34	0.27	0.49	0.19

Table F-1

Utility capacity per consumption by region (megawatts/gigawatt-hour)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	0.22	0.26	0.41	0.28	0.26
1978	0.22	0.25	0.39	0.27	0.25
1979	0.22	0.26	0.38	0.28	0.26
1980	0.23	0.26	0.40	0.29	0.27
1981	0.22	0.27	0.38	0.33	0.27
1982	0.23	0.27	0.43	0.32	0.28
1984	0.23	0.25	0.41	0.32	0.27
1985	0.23	0.27	0.39	0.33	0.28
1986	0.24	0.30	0.41	0.32	0.29
1987	0.24	0.28	0.35	0.33	0.28
1988	0.23	0.27	0.40	0.33	0.28
1989	0.23	0.26	0.38	0.33	0.27
1990	0.22	0.25	0.37	0.31	0.26
1991	0.21	0.24	0.37	0.31	0.26
1992	0.21	0.25	0.36	0.30	0.26
1993	0.21	0.25	0.35	0.29	0.26
1994	0.21	0.24	0.33	0.29	0.25
1995	0.21	0.24	0.33	0.28	0.25
1996	0.20	0.25	0.31	0.26	0.24
1997	0.20	0.25	0.29	0.26	0.24
1998	0.20	0.25	0.28	0.26	0.23
Rank (1-highest)					
1977	4	3	1	2	
1998	4	3	1	2	
Difference from highest					
1977	-47.2%	-37.5%	-	-32.3%	-37.3%
1998	-30.9%	-13.8%	-	-9.6%	-17.7%
Total increase					
Percent	-10.1%	-5.3%	-31.3%	-8.3%	-9.9%
New capacity/new consumption					
1977-1998	0.14	0.22	0.20	0.24	0.19

Capacity per consumption by region (including QF capacity in California; megawatts/gigawatt-hour)

	CA	ID, MT, OR, & WA	AZ, NM, & NV	CO, UT, & WY	WSCC
1977	0.22	0.26	0.41	0.28	0.26
1978	0.22	0.25	0.39	0.27	0.25
1979	0.22	0.26	0.38	0.28	0.26
1980	0.23	0.26	0.40	0.29	0.27
1981	0.22	0.27	0.38	0.33	0.27
1982	0.23	0.27	0.43	0.32	0.28
1984	0.23	0.25	0.41	0.32	0.27
1985	0.24	0.27	0.39	0.33	0.28
1986	0.26	0.30	0.41	0.32	0.29
1987	0.26	0.28	0.35	0.33	0.28
1988	0.25	0.27	0.40	0.33	0.28
1989	0.26	0.26	0.38	0.33	0.27
1990	0.26	0.25	0.37	0.31	0.26
1991	0.26	0.24	0.37	0.31	0.26
1992	0.25	0.25	0.36	0.30	0.26
1993	0.26	0.25	0.35	0.29	0.26
1994	0.26	0.24	0.33	0.29	0.25
1995	0.25	0.24	0.33	0.28	0.25
1996	0.25	0.25	0.31	0.26	0.24
1997	0.25	0.25	0.29	0.26	0.24
1998	0.24	0.25	0.28	0.26	0.23
Rank (1-highest)					
1977	4	3	1	2	
1998	4	3	1	2	
Difference from highest					
1977	-47.0%	-37.5%	-	-32.3%	-37.3%
1998	-14.8%	-13.8%	-	-9.6%	-17.7%
Total increase					
Percent	10.3%	-5.3%	-31.3%	-8.3%	-9.9%