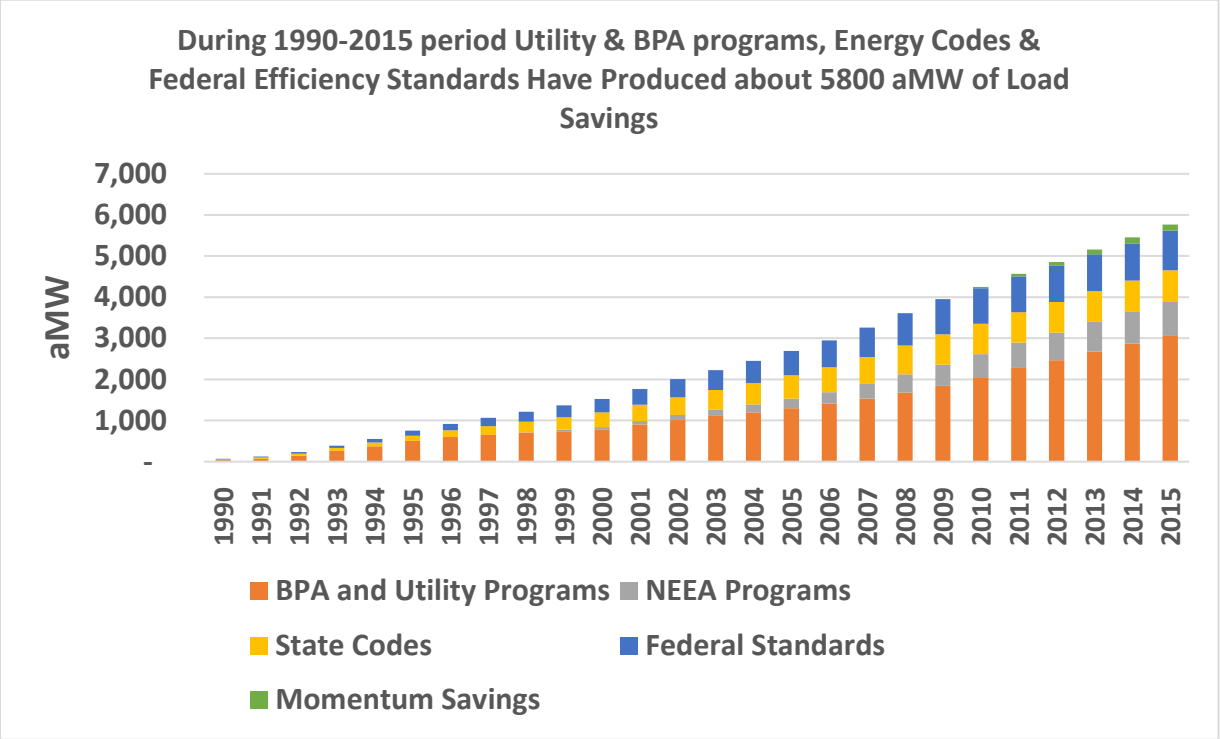
Recent Trends in Energy Consumption and Their Impact on the Northwest Economy

Summary

Since the Council published its first Power Plan in 1983, energy efficiency has been a primary resource to meet the Northwest region's electricity needs, over 6,000 aMW have been claimed through Bonneville and utility programs, NEEA initiatives, state building codes and federal appliance standards.

Figure 1 - Energy Efficiency Achievements in the Northwest, 1990-2015



However, savings claims are inexact. The Regional Technical Forum, formed in 1999, was established to develop standards to verify and evaluation energy efficiency savings. As such, savings claimed since the formation of the RTF are generally more accurate. The RTF is also continually improving its rigor so that savings estimates today are improved over those done in the RTF's early years. Plus, the data collected to inform the savings claims have become more granular and comprehensive, further improving the estimates. Therefore, the Council recognizes that the 6,000 aMW over 30 years of claimed savings is only an estimate. This may lead some to conclude that there is no basis to the claimed savings and thus little evidence that

energy efficiency is a long-term resource. There are many evaluation, measurement, and verification (EM&V) studies that have demonstrated savings from specific energy efficiency programs, but this white paper will explore economic trends as a macroeconomic evidence to energy efficiency's impact. It's important to note the macroeconomic trends reflect both structural changes in the region's economy as well as investment in energy efficiency and this paper will explore this relationship, primarily at the sector level.

Overall Trends in Total Energy Use and Economic Activity

Overall per capita energy use has decreased by about 25% in the region since 1990. This trend holds true for electricity as well; in 2015, the region produced almost twice the economic output from a megawatt hour of electricity than it did in 1990. The electricity demand in 2015 would have been about 12,000 aMW greater if the region had the same energy intensities as in 1990. Table 1 summarizes the differences by sector and in aggregate for the region, due to changes in energy efficiency, labor productivity improvements, and changes in the mix of the region's economy.

Table 1. Impact on Regional Electricity Demand Due to Changes in the Region's Economy and Efficiency Improvements (aMW)

	WN 2015 Electricity Demand	**2015 Electricity Demand with 1990 energy intensities**	**Difference in Demand**
Residential*	7,404	8,308	834
Commercial*	6,071	8,452	2,375
Industrial	4,934	12,668	8,376
Aggregated	18,409	29,428	11,585

* Residential and commercial demands are weather normalized.

This reduced demand at the customer site translates to lower loads at the generator. Accounting for distribution and transmission system losses increases loads by roughly 10 percent, bringing the total reduction in load in 2015 to 12,743 average megawatts.

Figure 2 shows the trend in total energy consumption per person by state, including all forms of energy (electricity, natural gas, oil, gasoline, and diesel) and across multiple sectors (residential, commercial, industrial, and transportation). Since 1990, there has been a gradual decline in per capita total energy use across all four Northwest states.

Figure 2. State Trends in Total Energy Use per Capita, All Sectors All Fuels, 1990 - 2015

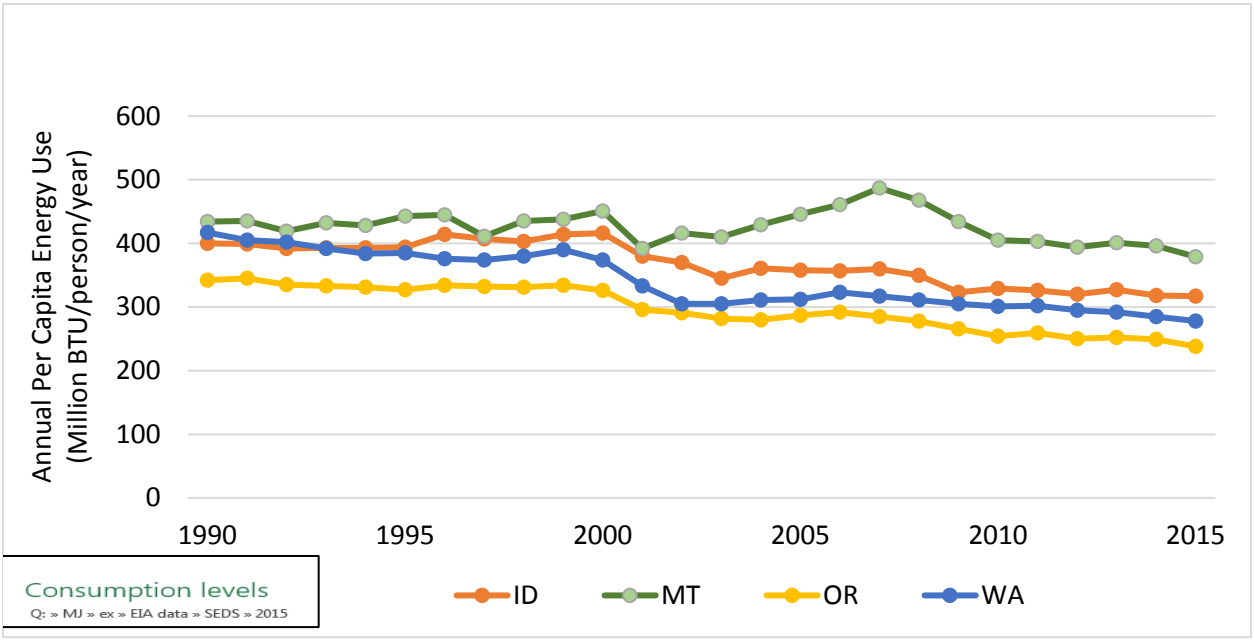


Figure 3 compares the actual annual average per capita total energy consumption averaged across the four states with the regional average per capita total energy consumption held constant at the 1990 level. In 2015, the average annual total energy use per capita was around 300 million BTU compared to around 400 million BTU in 1990, or about 25 percent less.

Figure 3 Regional Trend in Total Energy Use per Capita, 1990 - 2015

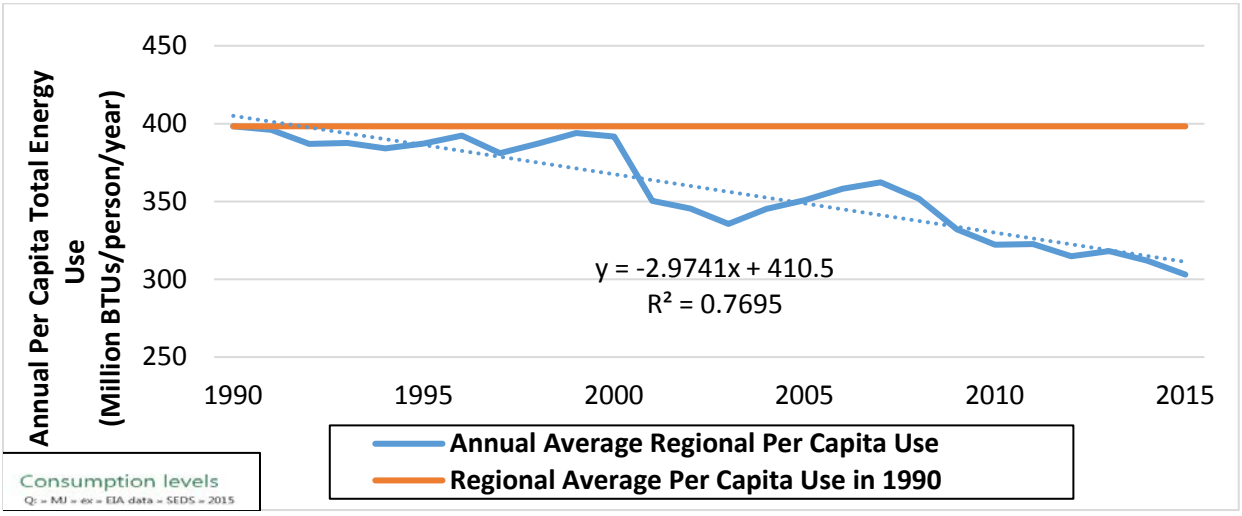
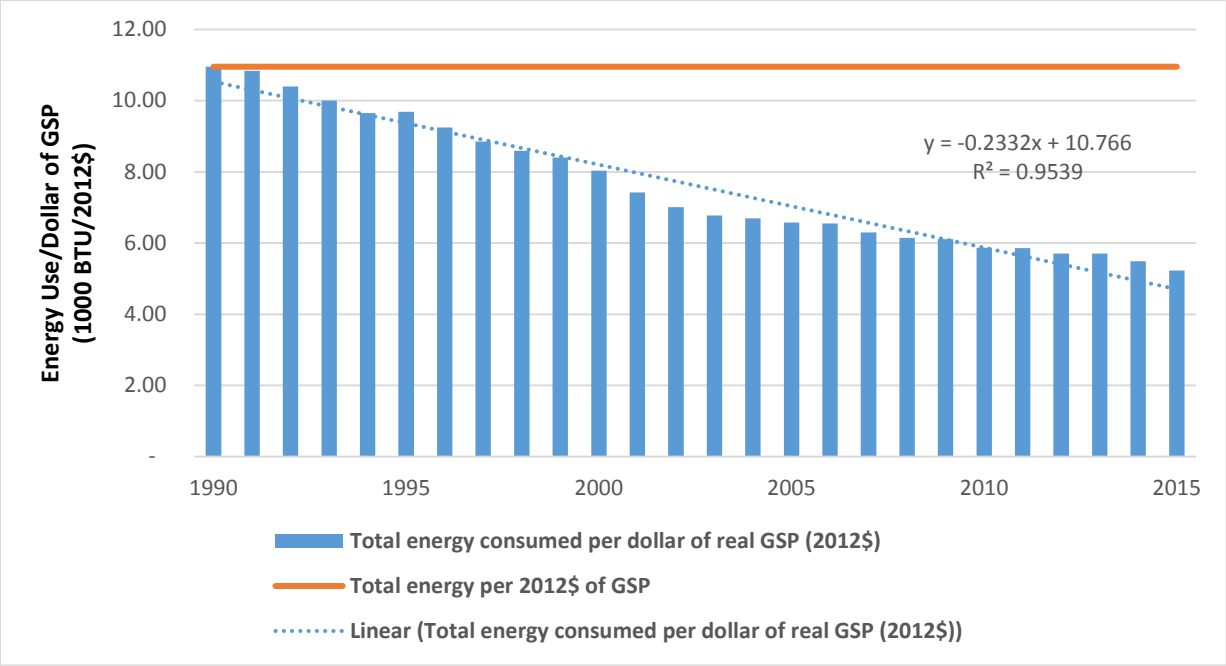


Figure 4 shows the trend in total energy consumption per dollar of gross state product. After adjusting for inflation, one observes that there has been an even greater decline in energy use per dollar of regional economic output than in energy use per capita. In 1990, the region

consumed just under 11,000 BTUs to produce a dollar of gross state product. By 2015, this had declined to just over 5,000 BTUs per dollar of gross state product, or by nearly 55 percent.

Figure 4. Total Energy Consumption per Dollar of Gross State Product, 1990 - 2015



As measured by the trends in total energy use per capita and total energy use per dollar of gross state economic output created, the energy efficiency of the regional economy has improved significantly over the past 25 years.

Trends in Electricity Use and Economic Activity

Figure 5 shows the annual average *electricity* consumption per dollar of regional gross state product (GSP) for 1990 – 2015. The relationship between electricity use and economic output shown in Figure 5 reveals a significant decrease in electricity consumption per unit of GSP. **In 2015, the region produced almost twice the economic output from a megawatt hour of electricity than it did in 1990.** This is a result of multiple factors, including both the evolving mix of industrial and commercial goods and services produced in the region and improvements in energy efficiency.

Figure 5. Trend in Regional Electricity Consumption per Million Dollars of Gross State Product

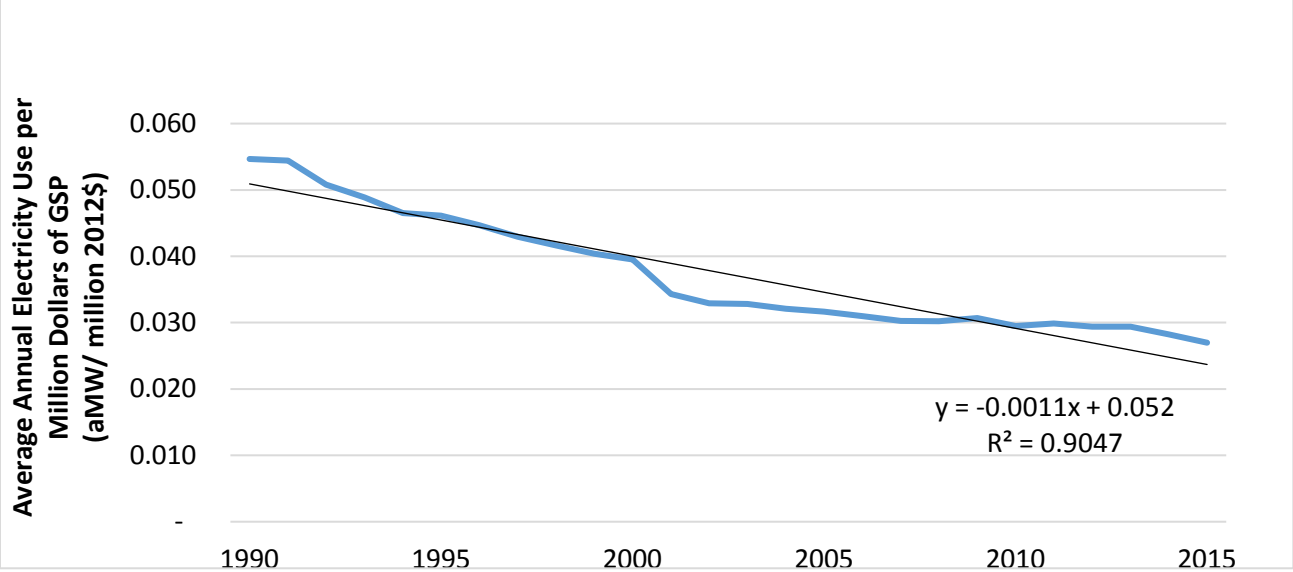
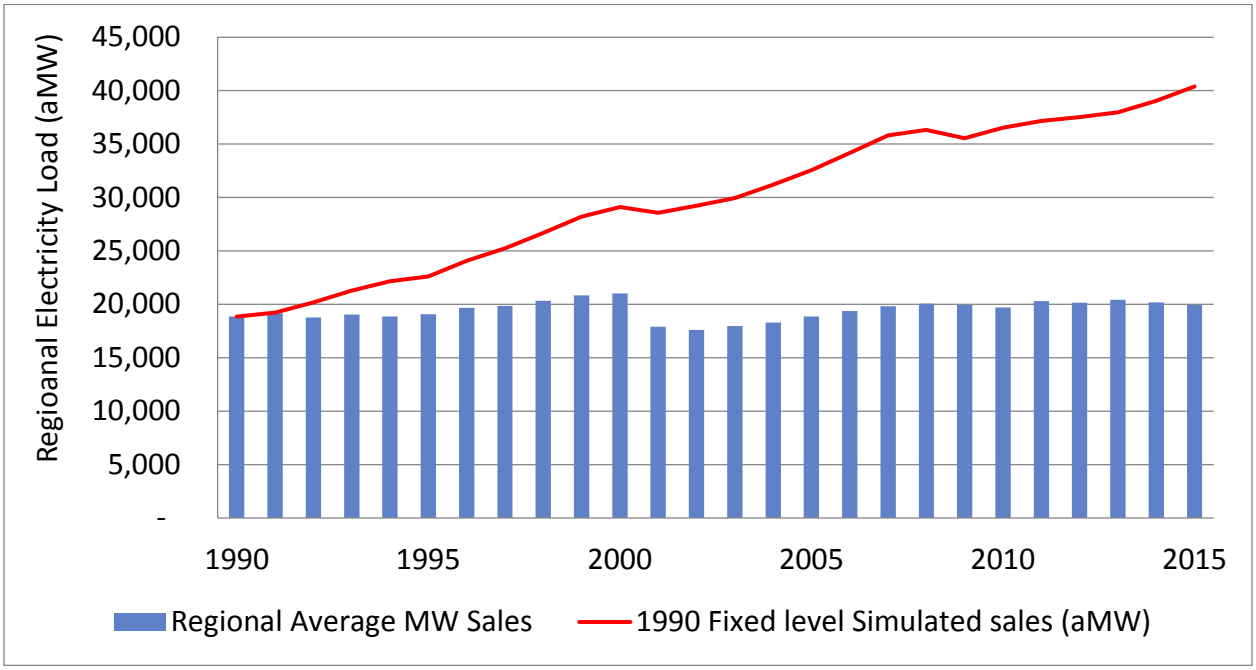


Figure 6 shows the impact on total regional electricity use if the relationship between electricity consumption per unit of economic output were held constant to 1990 values. Had this been the case, regional electricity loads in 2015 would have been double what they actually were. A big shift in regional demand for electricity was the closing of aluminum smelters during the 2000-2001 energy crisis. This is evident in the drop of close to 2,800 average megawatts in regional average megawatt of sales and in the simulated sales.

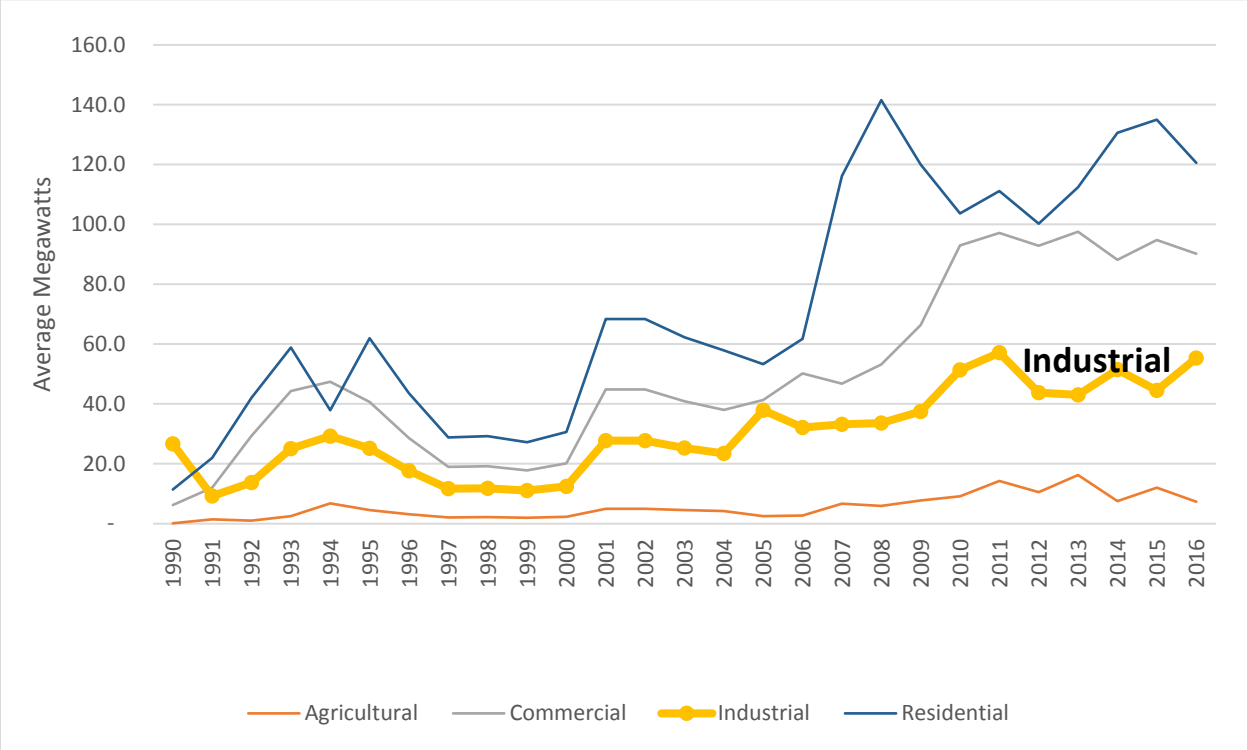
Figure 6. Regional Electricity Load, Actual vs. Load Assuming Constant 1990 aMW per $GSP



Industrial Sector

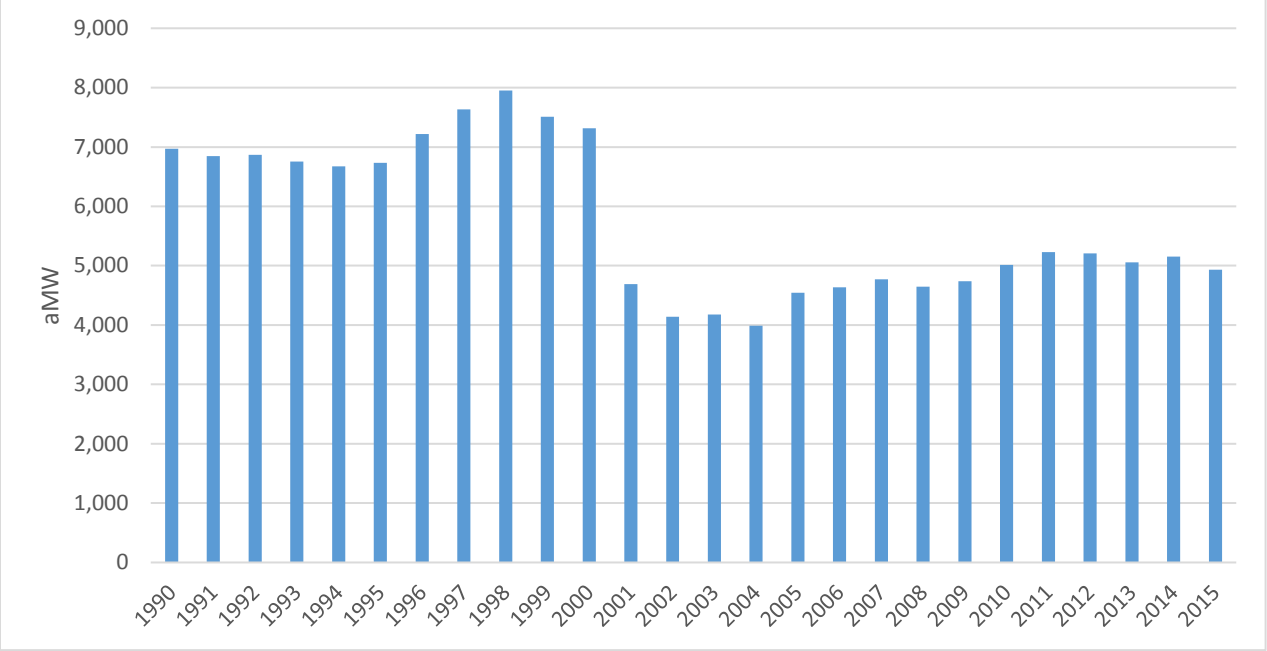
Since 1990, about 820 aMW of electricity savings have been claimed through efficiency programs in the Industrial sector. The largest single year savings claim was in 2011 at 57.1 aMW. Figure 7 shows the annual incremental energy efficiency achievements from programs (utility direct funded and NEEA) for each major sector, with the industrial sector highlighted.

Figure 7. Annual Incremental EE Achievements (aMW) – Industrial Sector



The total sales of electricity to the industrial sector has significantly declined since 1990 (see Figure 8). Energy efficiency does not fully account for the significant drop in industrial load post 2000. In 2000, the total regional load dropped by one third, primarily due to declines in the regional aluminum industry. However, energy efficiency has significantly contributed to the overall productivity increases in the Industrial sector.

Figure 8. Annual Industrial Electricity Consumption (aMW)



Trends in Manufacturing Sector Total Energy and Electricity Use

The industrial sector electricity consumption and trends can be better understood in the context of productivity and an overall shift in manufacturing. Since 1990, the region's manufacturing sector has undergone a dramatic change in the type of goods it produces. Figure 9 shows the mix of durable and non-durable goods manufactured in the region by year from 1990 through 2015 in 2012 constant dollars. Tables 2 and 3, further in the section, defined durable and non-durable manufacturing.

Between 1990 and 2015, the value of non-durable goods produced in the region grew from $15 billion to nearly $22 billion (2012 constant dollars), an increase of about 44 percent. In contrast, the value of durable goods produced in the region in 1990 was nearly $47 billion. By 2015, this had increased to nearly $90 billion (2012 constant dollars), growing by over 93 percent. The 2000-2001 drop in durable goods reflects the lost output of aluminum smelters.

Figure 9. Shift from Non-Durable to Durable Goods Products Manufacturing in the Region

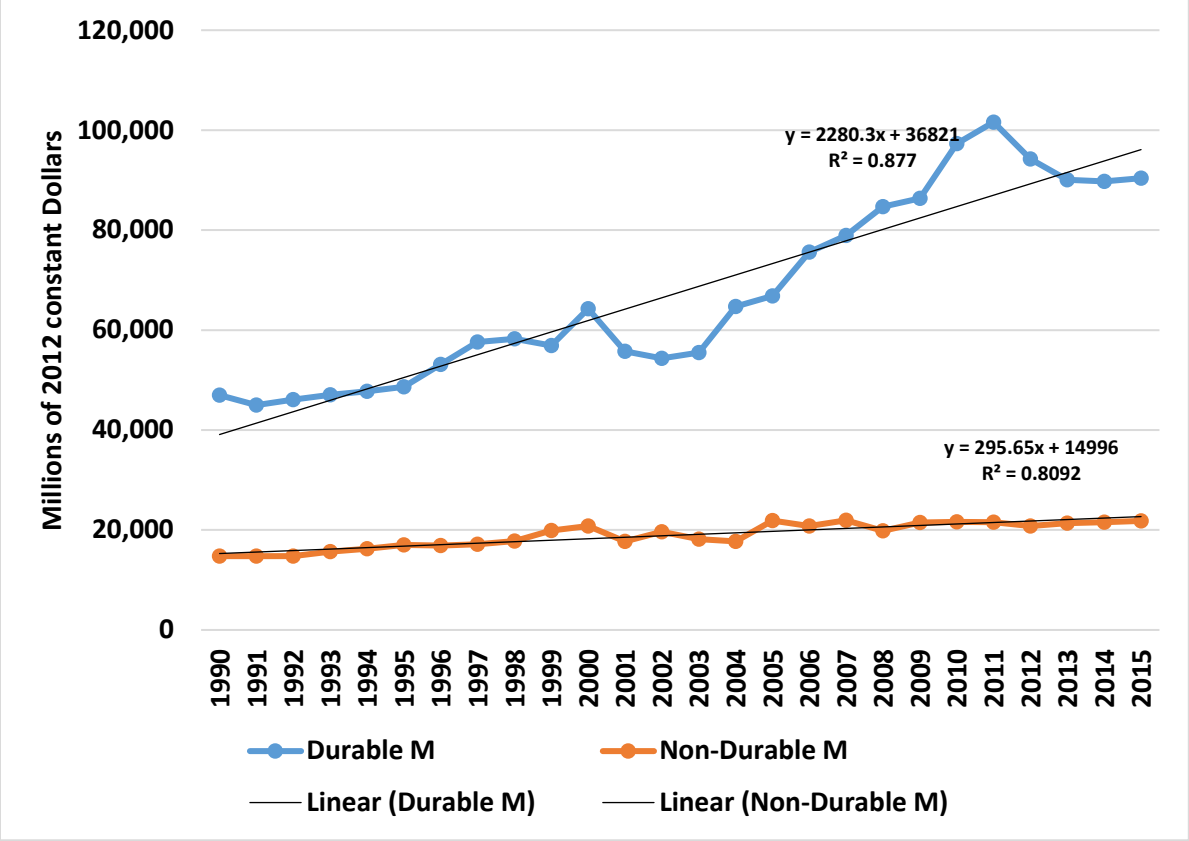


Figure 10 shows the ratio of the value of durable goods to non-durable goods produced in the region from 1990 through 2015. In 1990, this ratio was about 3.2, while by 2015 the ratio had increased to 4.1. This reflects the long-term trend across the region as it transitions from a resource extraction based economy to one based on the production of value added goods and services.

Figure 10. Trends in the Value of Durable and Non-Durable Goods Produced in the Region 1990-2015

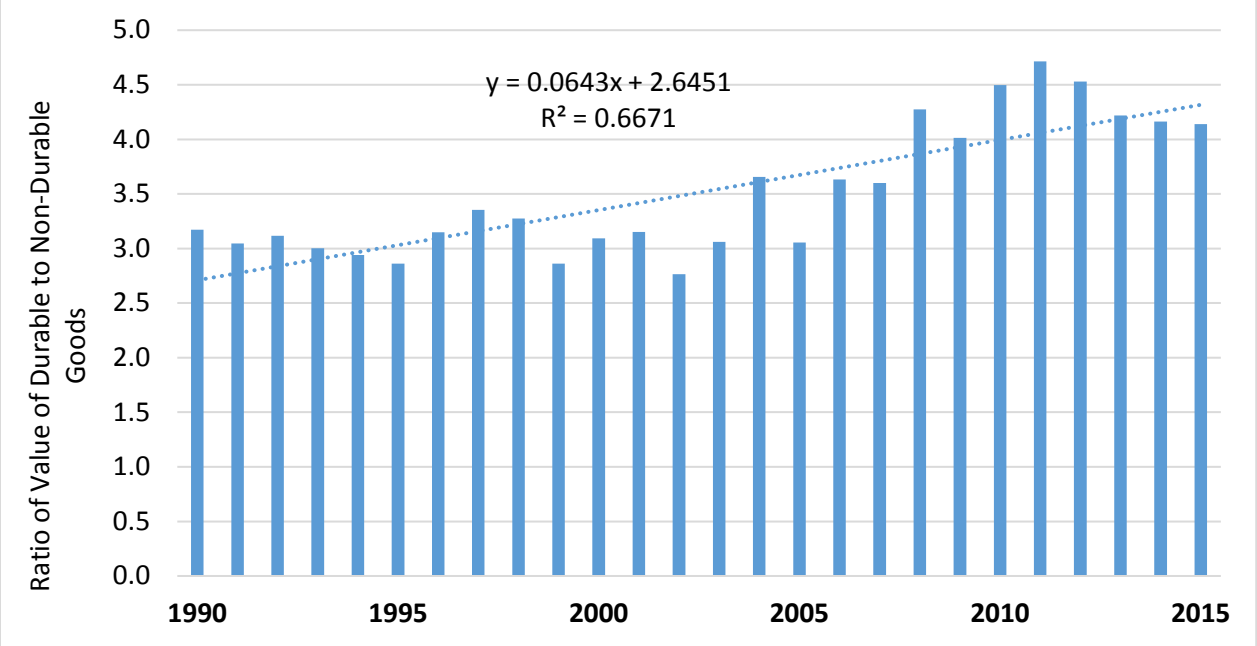
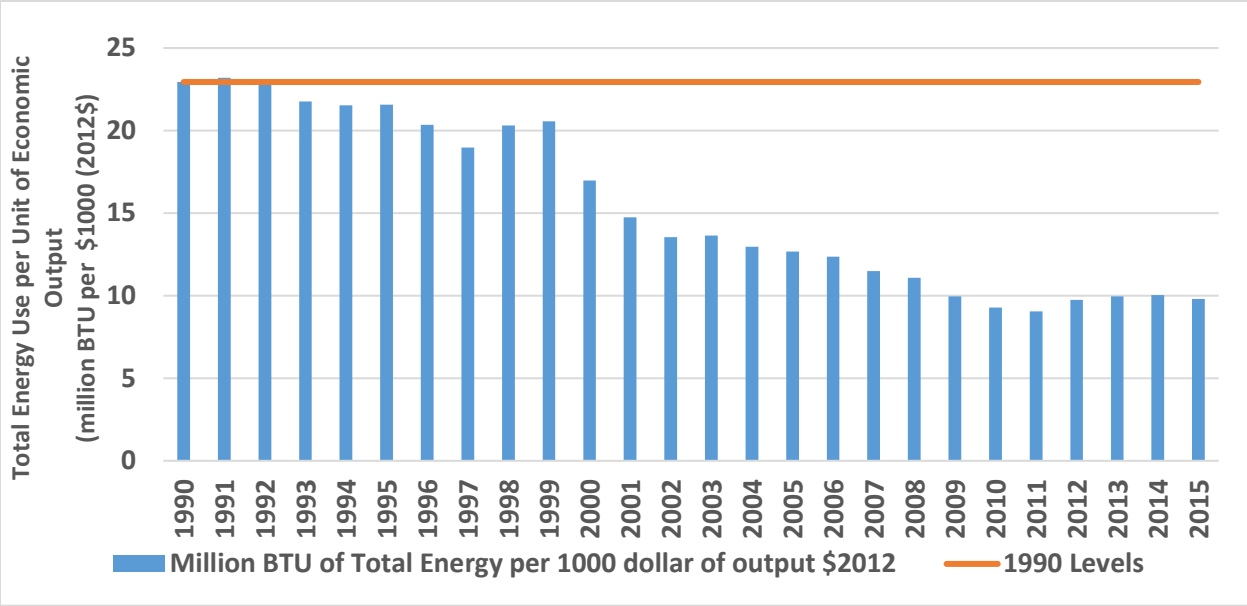


Figure 11 shows the total annual energy consumption per $1,000 (2012$) of economic output in the industrial sector for Montana, Idaho, Oregon, and Washington from 1990 through 2015. This figure also shows what the total energy consumption per $1,000 dollars of output in the industrial sector would have been if the 1990 levels of use per dollar of output had remained constant at the 1990 level. Energy use per dollar of economic output in the industrial sector declined from 22 million BTUs per $1,000 dollars in 1990 to 10 million BTUs per $1,000 in 2015. **Had average industrial energy consumption per unit of economic output remained constant at 1990 levels, total energy consumption in the industrial sector in 2015 would have been 157 percent higher**.

Figure 11. Total Energy Consumption in the Industrial Sector



The continuing trend in the changing regional manufacturing mix has had a significant impact on electricity use in this sector because it reflects the dramatic shift away from electricity intensive industries (e.g., aluminum smelting, pulp and paper production) that produce relatively low-value products to industries that produce higher value products.

The aluminum smelting industry was hit hard by the 2000-2001 energy crisis. This industry shrank from employing about 9,000 employees in 2000 to about less than 1,997 employees in 2005. Their firm demand for electricity plummeted from almost 3,000 average megawatts in 1998 to under 300 average megawatts by 2001.

Table 2 and Table 3 show the average annual growth rate in the level of output (dollar amounts from 1997-2015) and industry electricity intensity compared to the average of all regional manufacturing as measured by electricity use per employee.[1] If the industry's electricity intensity per employee is less than 1.0, then that industry is less electricity intensive than the regional average. If an industry's ratio is greater than 1.0, then that industry is more electricity intensive than the regional average.

Table 2 shows that industries producing durable goods, such as wood panel and high tech silicon manufacturers, are more electricity intensive than the regional average, and had negative average annual growth rate between 1997 and 2015.

[1] Based on 2006 Council analysis for manufacturing sectors

Table 2 - Ratio of Durable Goods Industry Electricity Intensity and Average Annual Growth Rate (AAGR)

1997-2015 AAGR	Durable Goods Industries*	Ratio of Electricity Use per Employee to Regional Average Electricity Use per Employee
3.4%	Hi Tech chip fab	0.24
2.9%	Elect Manufacturing	1.24
2.6%	Machines & Computer	1.24
2.4%	Foundries	1.00
2.4%	Transportation, Equip	0.22
2.0%	Electric Equipment	1.24
2.0%	SGC	0.44
1.7%	Cement	0.54
1.3%	Metal Fab	0.63
1.0%	Light Manufacturing	1.90
0.1%	Furniture	0.03
-0.2%	Wood lumber	0.77
-0.7%	Wood Panel	2.32
-0.7%	Hi Tech Silicon	2.14

*Excluding Aluminum Smelters

Table 3 shows this same information for industries that produce non-durable goods. Like the durable goods manufacturers, whose electricity intensity is above the regional average, non-durable goods manufacturers with above average energy intensity (e.g., Kraft and Mechanical Pulping, Textiles and Pulp and Paper) also experienced a negative growth rate since 1997.

Table 3. Ratio of Non-Durable Goods Industry Electricity Intensity and Average Annual Growth Rate (AAGR)

1997-2015 AAGR	Non-Durable Goods Industries	Ratio of Electricity Use per Employee to Regional Average Electricity Use per Employee*
1.8%	Sugar	2.22
1.4%	Other Food	0.59
1.2%	Chemical	3.65
0.7%	Rubber, plastic	0.95
0.6%	Refinery	5.62
-0.1%	Frozen Food	0.82
-0.2%	Fruit Storage	0.83
-0.3%	Kraft Pulp	5.60
-0.5%	Mechanical Pulp	8.10
-0.8%	Textiles	3.10
-1.1%	Apparel	0.01
-1.1%	Leather	0.10
-1.7%	Printing	0.22
-2.0%	Pulp and Paper	6.85
-3.1%	Cold Storage	0.76

Table 2 and Table 3 show that regional manufacturing is shifting away of electricity intensive industries. These changes in the regions' industrial mix resulted in significant reductions in that sector's demand for electricity.

Figure 12 shows that if the electricity intensity of manufacturing had remained at its average 1990 level, industrial sector electricity demand in 2015 would have been almost three times greater than it was that year. **Without improvements in the efficiency of industrial electricity use and structural changes in this sector, demand in 2015 would have been about 7,700 average megawatts higher.** Table 4 shows the numeric values for Figure 12.

Figure 12. Trends in Industrial Electricity Demand 1990 – 2015

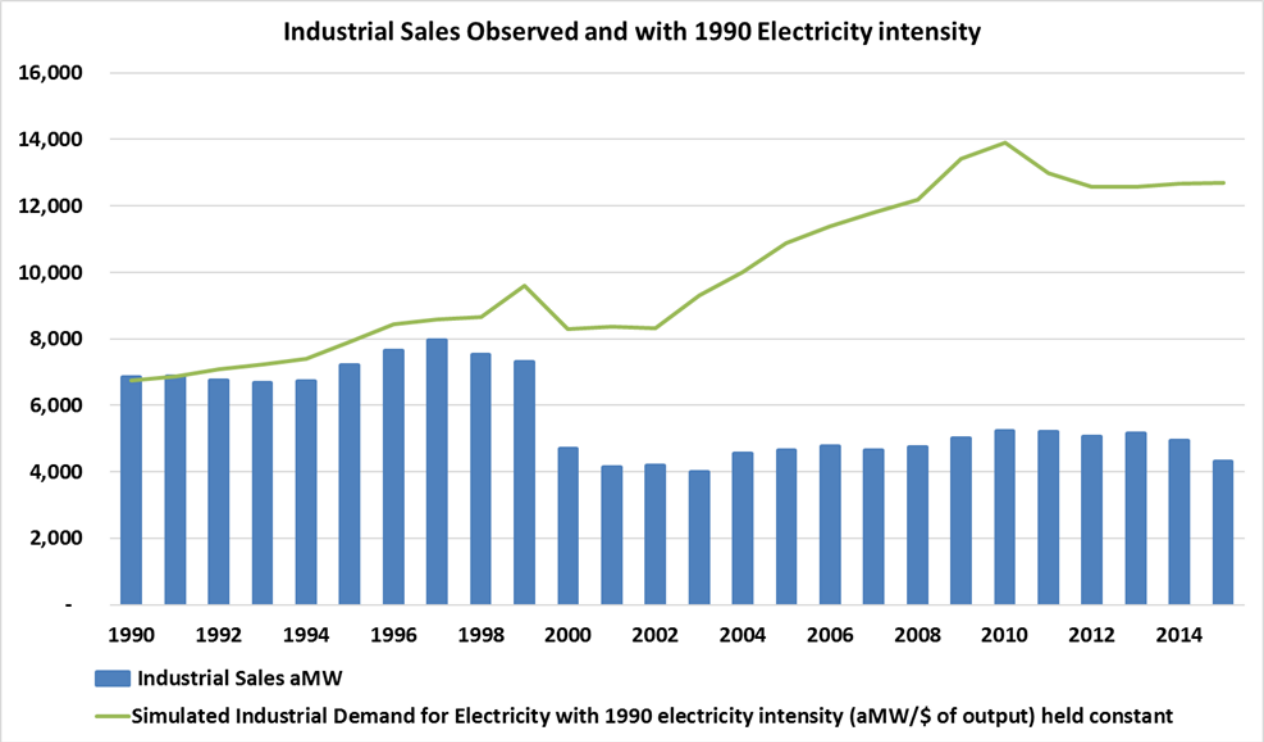


Table 4. Trends in Industrial Electricity Demand and Electricity Intensity 1990 - 2015

Year	Actual Industrial Electricity Demand (aMW)	Electricity Intensity aMW per $2012 of output	Industrial Demand for Electricity with 1990 Electricity Intensity/$ of output
1990	6,971	0.11	6,971
1991	6,844	0.17	6,745
1992	6,870	0.17	6,873
1993	6,753	0.16	7,077
1994	6,674	0.15	7,221
1995	6,731	0.14	7,407
1996	7,218	0.14	7,903
1997	7,633	0.14	8,442
1998	7,953	0.14	8,585
1999	7,510	0.13	8,669
2000	7,315	0.11	9,605
2001	4,688	0.08	8,294
2002	4,139	0.07	8,356
2003	4,179	0.07	8,314
2004	3,987	0.06	9,309
2005	4,547	0.06	10,014
2006	4,636	0.05	10,889
2007	4,770	0.05	11,389
2008	4,648	0.05	11,799
2009	4,736	0.05	12,181
2010	5,016	0.04	13,426
2011	5,230	0.04	13,904
2012	5,210	0.05	12,990
2013	5,055	0.04	12,578
2014	5,152	0.04	12,564
2015	4,934	0.04	12,668

Residential Sector

About 3,000 aMW of electricity savings have been claimed through efficiency programs, building codes, and appliance standards; about 1,800 aMW of that is claimed as programmatic savings. Figure 13 provides the annual incremental achievements for programmatic activities, where the dark blue line provides residential

Figure 13. Annual incremental EE achievements (aMW) - Residential Sector

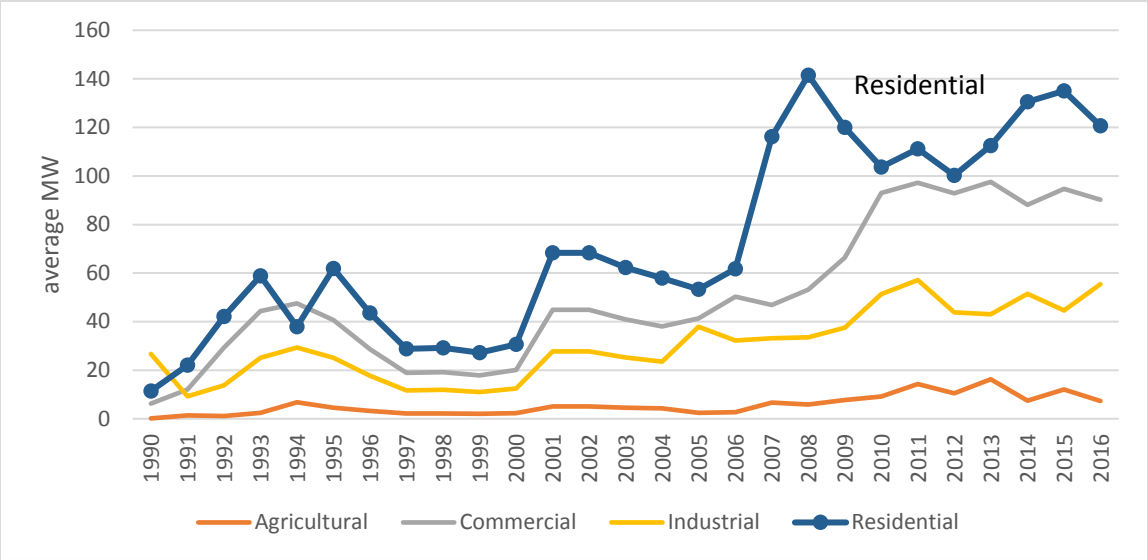


Figure 14 shows per capita total annual energy consumption by the residential sector for the region from 1990 through 2015. This also shows what the per capita energy consumption in the residential sector would have been if the 1990 levels of per capita energy use had remained constant at the 1990 level with the population growth since 1990. Per capita total energy use in the residential sector declined from 79 million BTUs per year in 1990 to just over 60 million BTUs per capita in 2015. Had average residential energy consumption per person remained constant at 1990 levels, total energy consumption in the residential sector in 2015 would have been 26 percent higher.

Figure 14. Trends in Residential Total Energy Use, 1990-2015

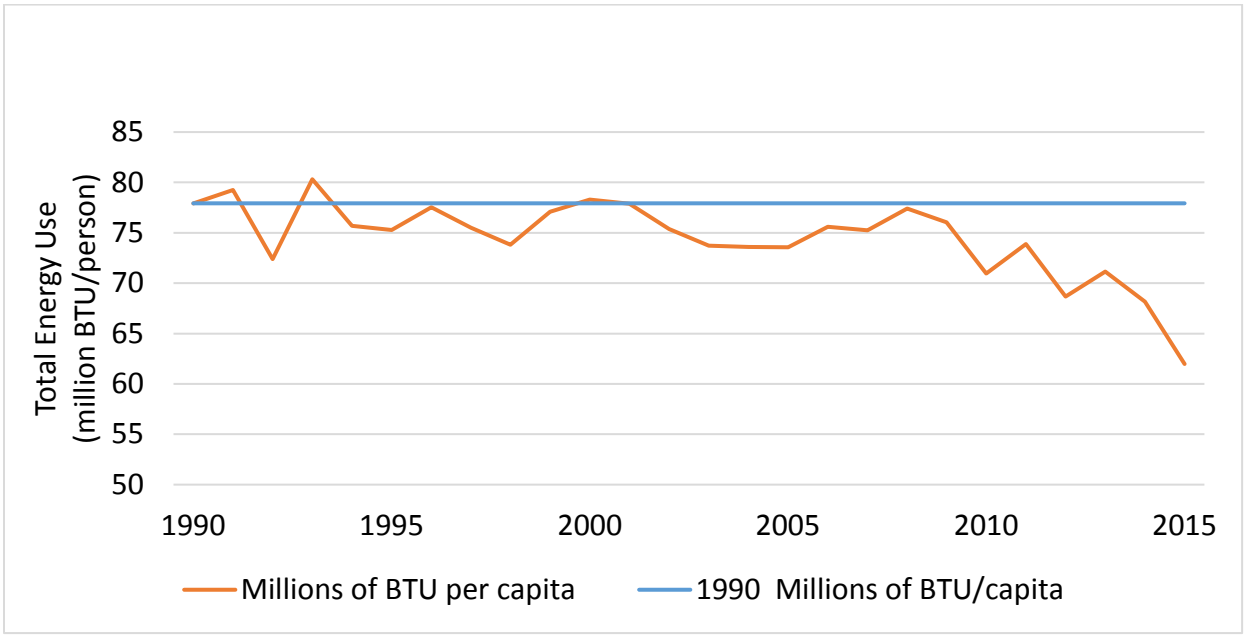
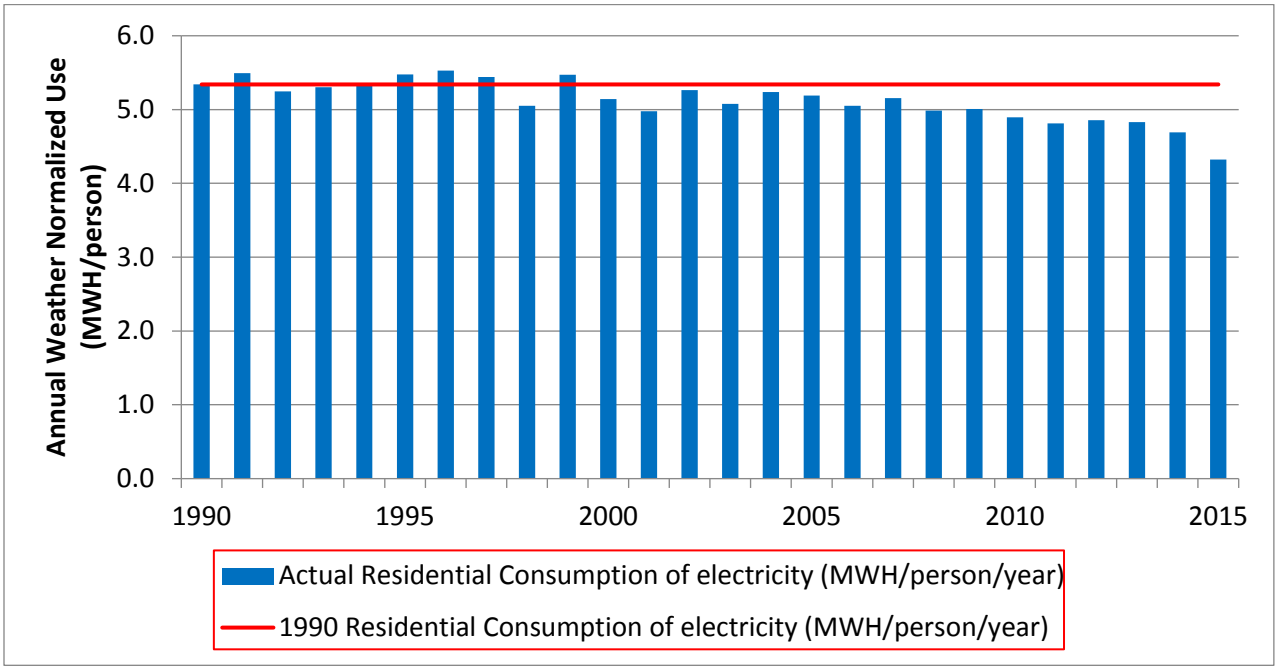


Figure 15 shows the trend in residential sector *electricity* use per person since 1990.[2] Electricity use per capita remained nearly constant through around 2005, but has declined more significantly over the past 10 years. Regional residential sector electricity use in 2015 was one megawatt-hour per year less per person than in 1990, or a 20 percent reduction. Overall consumption in the residential sector would have been about 1,600 aMW higher today if usage were at 1990 per capita consumption levels.

Figure 15. Trends in Regional Residential Electricity Use 1990-2015



As is apparent, the claimed electric savings for the residential sector from 1990 through 2015 are greater than the economic trends would indicate. It is important to recognize the multiple countervailing factors impacting energy use outside of energy efficiency programs. Some of these structural changes are provided in Table 5.

[2] Because residential sector electricity use depends on weather conditions, due to the impact of space heating and air conditioning, the annual sales shown in Figure 12 have been adjusted to reflect long-term normal weather conditions.

Table 5. Structural factors increasing or decreasing per capita electricity consumption (not including energy efficiency).

Increasing Consumption	Decreasing Consumption
Increasing size of home	Increased use of natural gas for space and water heating
Expansion of electricity-using appliances/devices	Increasing electricity prices
Increased air conditioning	
Increasing appliance size (e.g. refrigerators)	

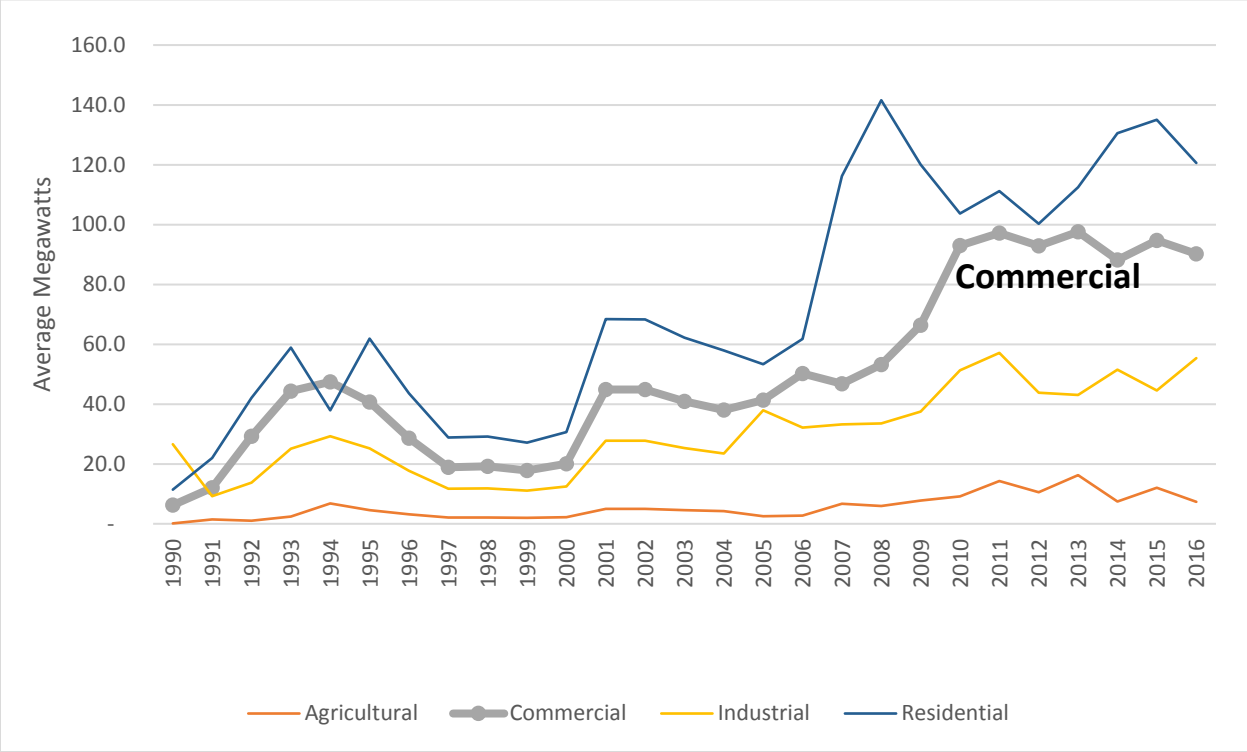
Data from the recently released Residential Building Stock Assessment[3] (RBSA) can inform these trends; however we do not have similar data collected in 1990 on residential building characteristics that can determine the magnitude of these trends. The RBSA can be reviewed by home vintage cohort to provide information on the likelihood of an older home having, for example, electricity versus natural gas for space heating. The data do support that newer homes have higher gas fuel shares than older homes. Similarly, newer homes have higher air conditioning saturation. However, without having a 1990 stock assessment, we do not know how older homes may have changed their characteristics since being built.

[3] The RBSA provides detailed characteristics of homes across the region; the 2016-2017 report and data available here: https://neea.org/data/residential-building-stock-assessment

Commercial Sector

The commercial sector has achieved 1,356 aMW of energy efficiency cumulatively since 1990. The highest individual achievement was 98 aMW in 2013 and has averaged over 93 aMW per year since 2010. Figure 16 shows the annual incremental energy efficiency achievements for all sectors, with the commercial sector highlighted. This figure does not include savings from codes and standards.

Figure 16. Annual Incremental EE Achievements – Commercial Sector (aMW)



The main driver for energy growth in the commercial sector is the total floor area of the sector. Figure 17 shows plots of both total commercial sector floor area (million square feet) over time and commercial sector electricity consumption (aMW per year). In the early years they grow at similar paces, but by around 2006 the energy consumption flattens out while the total floor area continues to grow. This corresponds with the significant growth in energy efficiency achievements between 2006 and 2010.

Figure 17. Commercial Sector Total Floor Area and Electricity Consumption

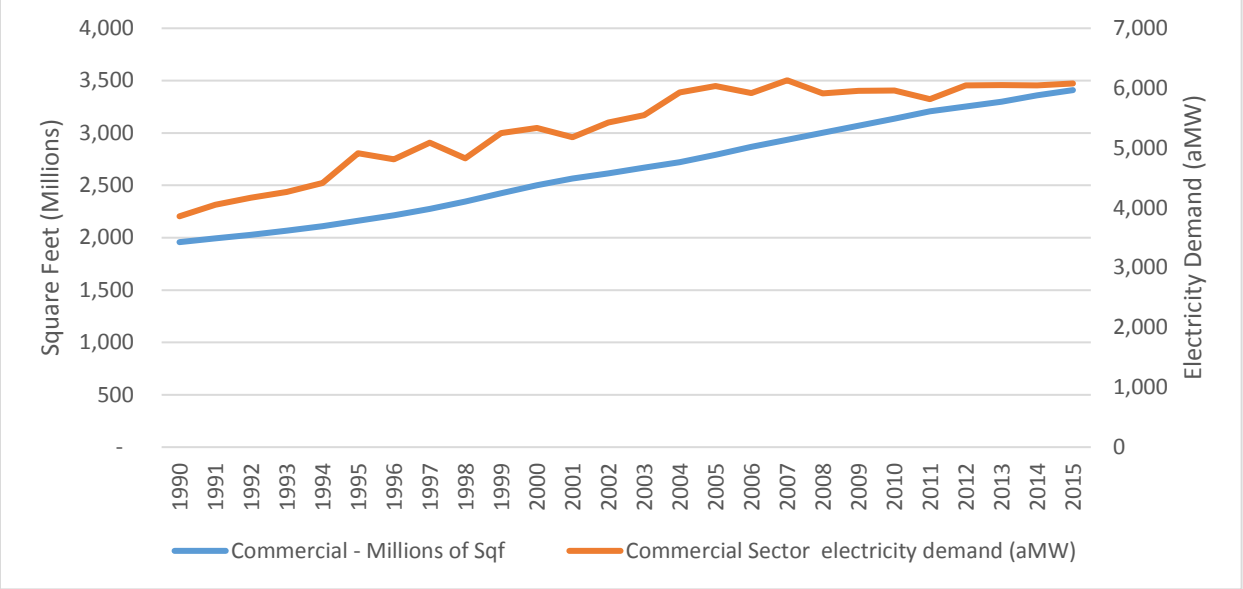
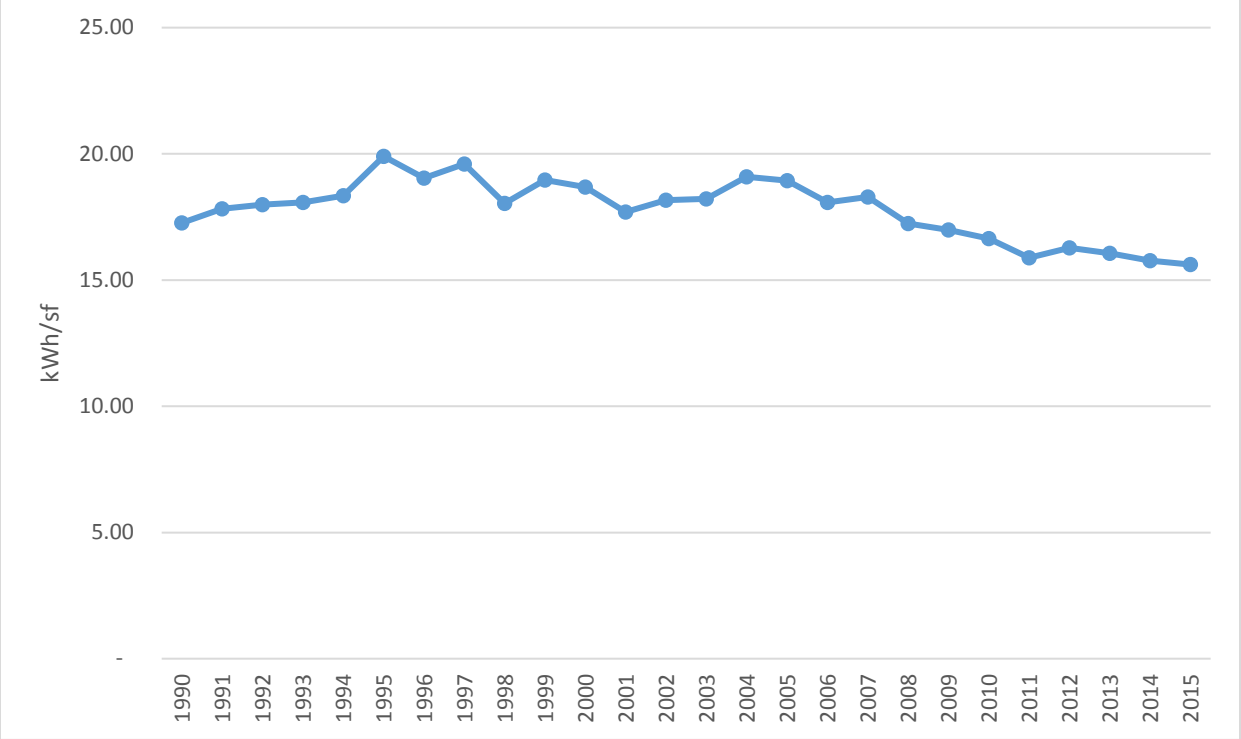


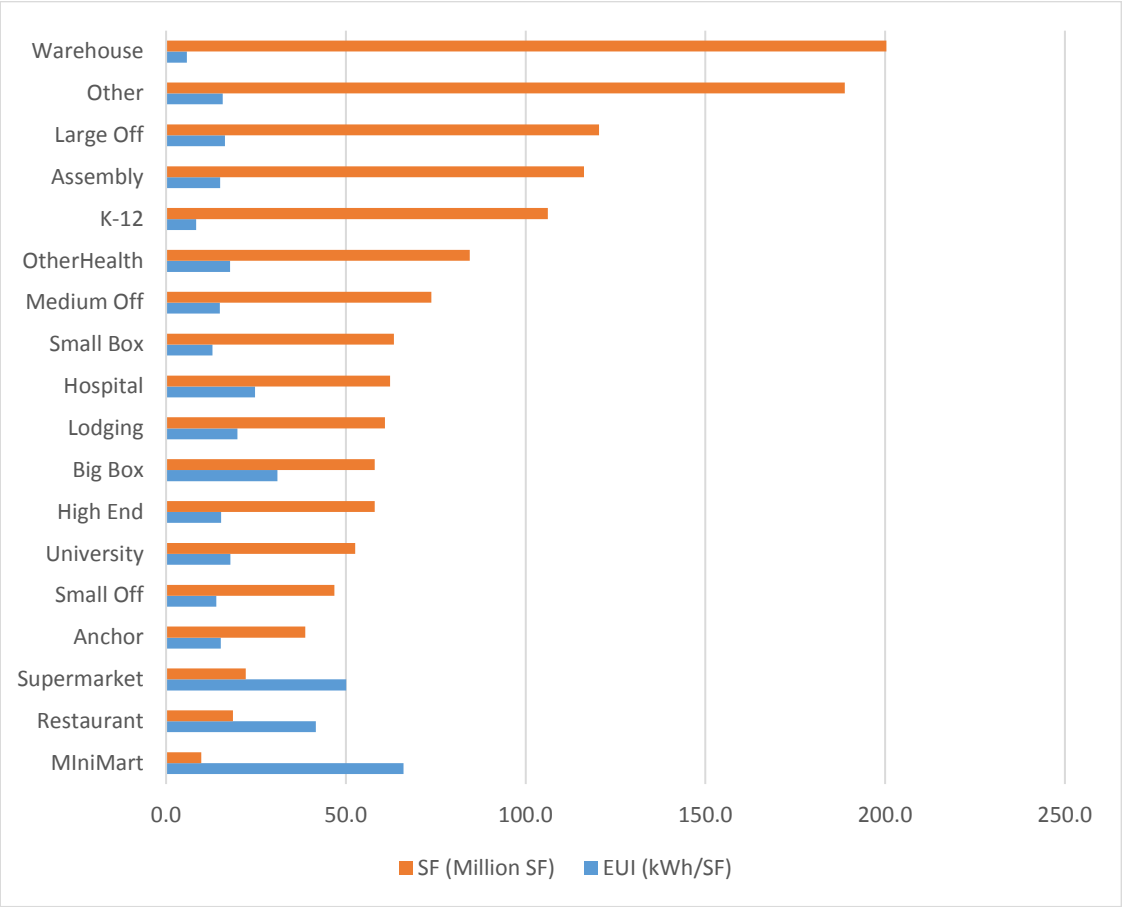
Figure 18 shows a combined version of the previous chart; the total consumption per square foot of floor area over time. The kWh/sf decreases from its peak in 1995 at 20 kWh/sf to 15.6 kWh/sf in 2015. Much of this decline can be directly attributed to energy efficiency, but there are also structural factors that cause a reduction in energy consumption.

Figure 18. Commercial Sector Consumption per Square Foot of Floor Area (kWh/sf)



Another reason for the decline in energy consumption for the commercial sector is stronger growth (floor area) from lower electricity intensity building types. For example, the Warehouse segment added the most floor area between 1990 and 2015, but it has the lowest electric intensity (EUI, kWh/sf) of any of the segments (see Figure 19). Other top growth segments such as Large Office, Assembly, and Schools also have relatively low EUIs.

Figure 19. New Commercial Floor Space Added 1990-2015 Compared with Electricity Intensity, EUI (kWh/sf)

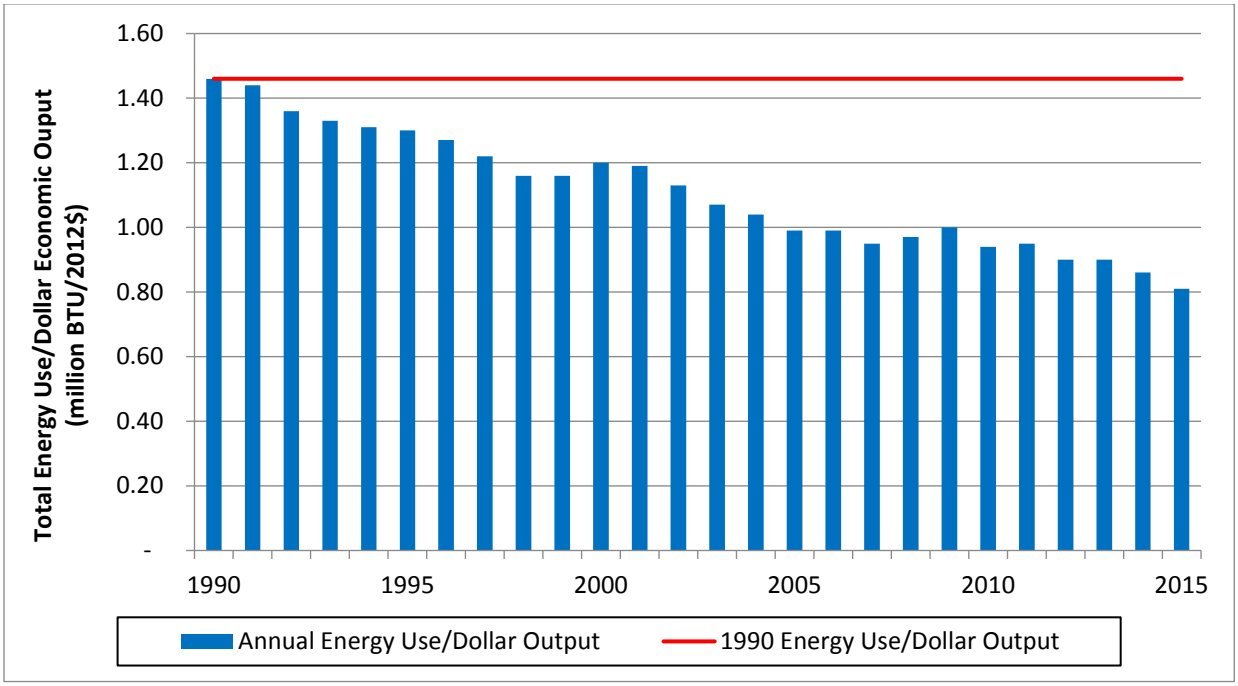


Trends in Commercial Sector Total Energy and Electricity Use[4]

Figure 20 shows the trend in the ratio of total commercial sector energy use (millions BTU per year) to commercial sector economic output (2012$) from 1990 through 2015. Figure 20 also shows what the commercial sector's total energy demand per dollar of economic output would have been if this ratio had remained constant at 1990 levels for the same period.

[4] Table 8 in the appendix lists commercial business activities are included in calculation of commercial outputs

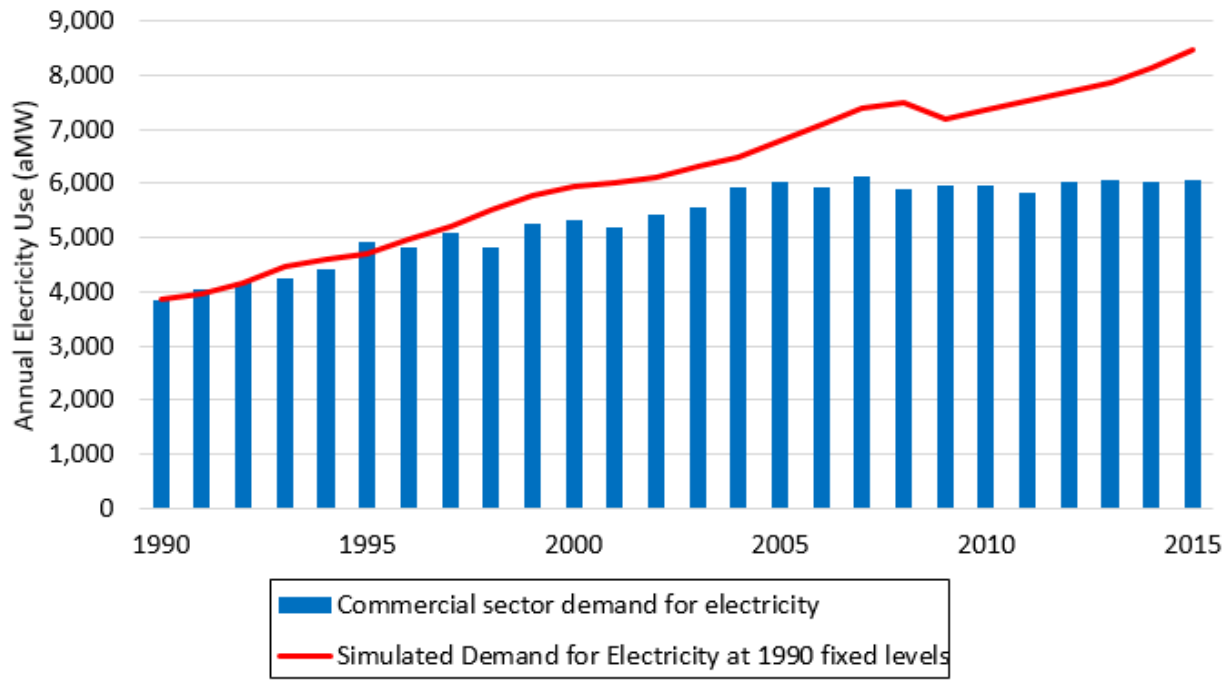
Figure 20. Trends in Total Commercial Sector Energy Use per Dollar of Economic Output 1990 - 2015



In 1990, it required about 1.5 million BTUs to produce one dollar of commercial sector economic output. By 2015, this had dropped to just 800,000 BTUs to produce that same economic output. If this ratio of energy use to economic output had not changed, total commercial sector energy consumption would have been about 80 percent higher.

Figure 21 shows the trend in regional commercial sector electricity use from 1990 through 2015. This figure shows that after adjusting for weather, commercial sector electricity use grew from around 3,800 average megawatts in 1990 to 6,000 average megawatts in 2015. However, Figure 21 also shows that **the region's commercial sector demand for electricity would have been 2,400 average megawatts (38 percent) higher, had the ratio of electricity use per unit of economic output remained at the 1990 level.**

Figure 21. Trends in Commercial Sector Electricity Use 1990 - 2015

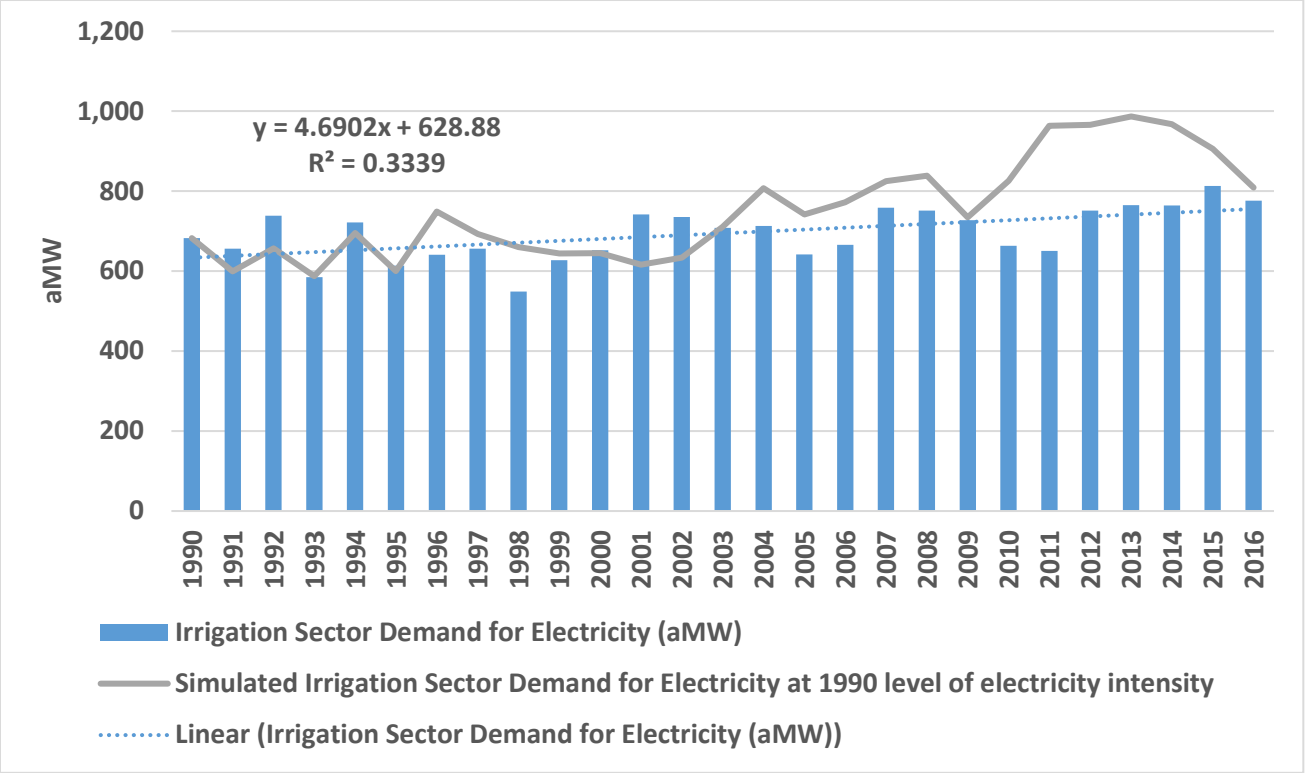


The overall electricity consumption pattern in the commercial sector shows a leveling off of total consumption since about 2005. The total floor area continues to increase, but the electricity intensity of the sector has declined. The overall efficiency of the commercial sector has improved because of energy efficiency, an increase in productivity (economic output), and a shift towards lower EUI buildings and business types.

Agricultural sector Demand for Electricity

Less granular and precise data are available for the agricultural sector. Analysis of electricity sales to agriculture sector is dominated by need for irrigation, which is dependent on rainfall and thus can vary year over year regardless of efficiency. Consumption data for 1990-2016 shows slight improvement in annual demand levels. Figure 22 shows that from 1990-2016 demand for electricity for irrigation purposes has varied between 650 and 980 average megawatts. Taking 1990 level of electricity intensity, measured in kWh of electricity per dollar of output and keeping it constant for 1991-2016 indicate that by 2015 demand for electricity would have been higher by 11%.

Figure 22. Irrigation Sector Electricity Sales



Appendix A.

The data for Figure 5 and Figure 6 are provided in Table 6.

Table 6. Electricity Sales Per Million $2012 of Output

Year	Regional Average MW Sales	4 states GSP in constant 2012 dollars	aMW sales per Million $2012 GSP
1980	15,073	254,231	0.05929
1981	16,693	254,458	0.06560
1982	15,609	246,373	0.06335
1983	15,491	258,055	0.06003
1984	16,682	270,049	0.06178
1985	16,255	273,657	0.05940
1986	15,987	286,764	0.05575
1987	16,361	296,309	0.05522
1988	17,609	310,194	0.05677
1989	18,171	328,369	0.05534
1990	18,853	344,876	0.05467
1991	19,157	351,862	0.05445
1992	18,759	369,299	0.05080
1993	19,030	389,191	0.04890
1994	18,855	405,492	0.04650
1995	19,077	413,500	0.04614
1996	19,684	440,357	0.04470
1997	19,840	461,742	0.04297
1998	20,320	488,193	0.04162
1999	20,842	516,245	0.04037
2000	21,034	532,262	0.03952
2001	17,914	522,356	0.03429
2002	17,602	534,510	0.03293
2003	17,965	547,635	0.03280
2004	18,309	570,583	0.03209
2005	18,856	595,552	0.03166
2006	19,370	625,058	0.03099
2007	19,832	655,211	0.03027
2008	20,062	664,400	0.03020
2009	19,956	650,436	0.03068
2010	19,706	668,593	0.02947
2011	20,315	679,687	0.02989
2012	20,166	686,349	0.02938
2013	20,408	694,786	0.02937
2014	20,184	714,401	0.02825
2015	19,937	738,985	0.02698
1980-2015	0.8%	3.2%	-2.3%

Table 7 provides the tabular data shown in Figure 15. This table also provides data showing the impact on aggregate residential sector electricity use, if the use per person had remained constant at 1990 levels. Table 7 shows that in 2015, electrical sales would have been higher by about 1,600 average megawatts without lower electricity use per capita in the residential sectors.

Table 7. Weather-Normalized Total Residential Sector Electricity Use and Use Per Person 1990 - 2015

Year	Regional (Four State) Population (millions)	Weather Normalized Residential Loads (aMW)	Weather Normalized Residential Loads with 1990 Use/person (aMW)	Actual Residential Consumption of electricity (MWH/ person/ year)	1990 Residential Consumption of electricity (MWH/ person/ year)	Difference in Total Sector Use (aMW)
1990	9.604	5,855	5,855	5.34	5.34	0
1991	9.837	6,167	5,997	5.49	5.34	-170
1992	10.08	6,037	6,145	5.25	5.34	108
1993	10.317	6,246	6,290	5.30	5.34	44
1994	10.53	6,393	6,420	5.32	5.34	27
1995	10.741	6,717	6,548	5.48	5.34	-169
1996	10.93	6,895	6,663	5.53	5.34	-232
1997	11.117	6,907	6,777	5.44	5.34	-130
1998	11.283	6,505	6,879	5.05	5.34	374
1999	11.426	7,136	6,966	5.47	5.34	-170
2000	11.561	6,789	7,048	5.14	5.34	259
2001	11.698	6,646	7,132	4.98	5.34	486
2002	11.831	7,106	7,213	5.26	5.34	107
2003	11.953	6,929	7,287	5.08	5.34	358
2004	12.093	7,229	7,372	5.24	5.34	143
2005	12.27	7,267	7,480	5.19	5.34	213
2006	12.485	7,200	7,611	5.05	5.34	411
2007	12.677	7,459	7,728	5.15	5.34	269
2008	12.862	7,319	7,841	4.98	5.34	522
2009	13.028	7,446	7,942	5.01	5.34	496
2010	13.16	7,356	8,023	4.90	5.34	667
2011	13.287	7,297	8,100	4.81	5.34	803
2012	13.411	7,435	8,176	4.86	5.34	741
2013	13.542	7,469	8,256	4.83	5.34	787
2014	13.705	7,339	8,355	4.69	5.34	1,016
2015	13.902	7,404	8,475	4.67	5.34	1,071

Table 8 lists the business types included in the commercial sector analysis.

Table 8. Business Types included in Commercial Sector Gross State Product

Trade, Transp.& Utilities,
Wholesale Trade,

Retail Trade
Transportation & Warehousing
Utilities
Information
Financial Activities
Finance and Insurance
Real Estate and Rental and Leasing
Professional & Business Services
Professional, Scientific, and Technical Services
Management of Companies and Enterprises
Admin., Support, Waste Management and Remediation Services
Educational & Health Services
Educational Services
Health Care and Social Assistance
Leisure & Hospitality
Arts, Entertainment, and Recreation
Accommodation and Food Services
Other Services

EIA reports industrial sector's energy consumption as demand for energy from following sectors, manufacturing, construction, mining, irrigation, fishing, and forestry establishments. EIA does not provide separate measures of energy consumption for each one of these segments. Council tracks demand for electricity from manufacturing, and irrigation market segments. Construction, mining, fishing and forestry establishments were not included in this analysis we correlated manufacturing output to total demand for energy for industrial sectors.

Table 9 and Table 10 provide the tabular data presented in Figure 20 and Figure 21, respectively.

Table 9. Regional Commercial Sector Economic Output and Total Energy Consumption 1990 - 2015

Year	Commercial Output Four states (millions $2012)	Total Commercial Energy Use(Billions BTU)	Total Energy Use per Unit of Economic Output (million BTU/2012$)	Total Energy Use @ 1990 Energy Use/2012$ (Billion BTU)	Ratio of Simulated to Actual
1990	403,644	588,635	1.46	588,635	1.00
1991	415,933	598,744	1.44	606,556	1.01
1992	436,300	592,452	1.36	636,258	1.07
1993	465,734	619,427	1.33	679,181	1.10
1994	482,021	629,151	1.31	702,932	1.12
1995	490,749	638,791	1.30	715,660	1.12
1996	521,111	660,303	1.27	759,938	1.15
1997	544,440	662,615	1.22	793,958	1.20
1998	576,077	670,745	1.16	840,094	1.25
1999	605,383	702,515	1.16	882,832	1.26
2000	623,338	747,934	1.20	909,016	1.22
2001	628,221	746,334	1.19	916,135	1.23
2002	641,042	723,895	1.13	934,832	1.29
2003	659,721	706,378	1.07	962,072	1.36
2004	677,828	702,974	1.04	988,478	1.41
2005	708,922	705,175	0.99	1,033,823	1.47
2006	740,613	736,311	0.99	1,080,038	1.47
2007	773,360	737,647	0.95	1,127,793	1.53
2008	783,945	757,185	0.97	1,143,229	1.51
2009	753,130	751,151	1.00	1,098,291	1.46
2010	771,125	725,211	0.94	1,124,534	1.55
2011	786,123	745,326	0.95	1,146,404	1.54
2012	804,132	721,213	0.90	1,172,668	1.63
2013	821,856	738,977	0.90	1,198,515	1.62
2014	850,272	731,680	0.86	1,239,953	1.69
2015	884,349	714,733	0.81	1,289,648	1.80

Table 10. Trends in Commercial Sector Electricity Demand and Economic Output 1990 - 2015

Year	Regional (Four State) Commercial Economic Output (millions 2012$)	Commercial Sector electricity demand (aMW)	Electricity use/ dollar economic output (aMW/ million 2012$)	Demand for Electricity with 1990 ratio of electricity use/economic output	Difference Between Demand with 1990 ratio and Actual Demand (aMW)	Ratio of 1990 electricity use/million$ Demand to Actual Demand
1990	403,644	3,858	0.010	3,858	0	1.00
1991	415,933	4,053	0.010	3,975	-78	0.98
1992	436,300	4,166	0.010	4,170	4	1.00
1993	465,734	4,265	0.009	4,451	186	1.04
1994	482,021	4,417	0.009	4,607	190	1.04
1995	490,749	4,913	0.010	4,690	-222	0.95
1996	521,111	4,813	0.009	4,981	168	1.03
1997	544,440	5,090	0.009	5,203	113	1.02
1998	576,077	4,829	0.008	5,506	677	1.14
1999	605,383	5,250	0.009	5,786	536	1.10
2000	623,338	5,334	0.009	5,958	623	1.12
2001	628,221	5,181	0.008	6,004	823	1.16
2002	641,042	5,424	0.008	6,127	703	1.13
2003	659,721	5,550	0.008	6,305	755	1.14
2004	677,828	5,928	0.009	6,478	550	1.09
2005	708,922	6,034	0.009	6,776	741	1.12
2006	740,613	5,916	0.008	7,078	1,162	1.20
2007	773,360	6,131	0.008	7,391	1,260	1.21
2008	783,945	5,912	0.008	7,493	1,580	1.27
2009	753,130	5,954	0.008	7,198	1,244	1.21
2010	771,125	5,961	0.008	7,370	1,409	1.24
2011	786,123	5,817	0.007	7,513	1,696	1.29
2012	804,132	6,047	0.008	7,686	1,639	1.27
2013	821,856	6,051	0.007	7,855	1,804	1.30
2014	850,272	6,044	0.007	8,126	2,083	1.34
2015	884,349	6,077	0.007	8,452	2,375	1.39