

# APPENDIX D: ECONOMIC FORECAST

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## Contents

Role Of the Economic Forecast.....	4
Background.....	5
Economic Growth Assumptions .....	5
Economic Drivers of Residential Demand.....	5
Population.....	6
Housing Stock.....	8
Personal Income.....	16
Number of Energy-using Appliances in the Average Residence .....	17
Information Communication and Entertainment.....	17
Demand for Air Conditioning .....	21
Economic Drivers of the Commercial Sector .....	23
Methodology in Estimating Commercial Floor Space Requirements .....	23
Square Footage per Employee.....	25
Forecasting Commercial Floor Space Requirements .....	26
Changing Composition of Commercial Sector.....	27
Commercial Floor Space Additions .....	29
Patterns of Commercial Floor Space Additions .....	31
Commercial Floor Space Stock.....	34
Economic Drivers for Industrial Sector Demand .....	35
Projected Employment Growth .....	36
Industrial Output .....	37
Economic Drivers for other Sectors .....	40
Irrigation.....	40
Transportation.....	40
Alternative Economic Scenarios .....	41

## List of Figures and Tables

Figure D - 1: Population Forecast (000).....	7
Table D - 1: Population in the Region (000).....	8
Table D - 2: Composition of Regional Population (000) .....	8
Figure D - 2: Declining Household Size (People per Household).....	9
Figure D - 3: Growing Average Size of New Single Family Homes.....	9
Table D - 3: Average size of residential units (sqf).....	10
Figure D - 4: Historic and future composition of Housing Stock in the Northwest.....	11
Figure D - 5: Number of Single-Family Homes (000) Stock .....	11



Figure D - 6: Number of Multi-Family Homes (000) Stock.....	12
Figure D - 7: Number of Manufactured Homes (000) Stock .....	12
Figure D - 8: New Manufactured Homes per Year .....	13
Figure D - 9: New Multifamily Homes per Year .....	13
Figure D - 10: New Single Family additions per Year .....	14
Table D - 4: Market share by building type .....	14
Table D - 5: Regional Multifamily New Additions Market share.....	14
Table D - 6: Average Annual Number of New Homes by State.....	15
Table D - 7: Historic and forecast stock of residential units (1000s).....	16
Table D - 8: Growth Rate Personal Income (2000 constant dollars) .....	16
Figure D - 11: Personal Income.....	16
(Billions in 2005 constant dollars) .....	16
Figure D - 12: Count of Computers per household .....	18
Figure D - 13: Percent of Households with Computers .....	18
Figure D - 14: TV screen type by Vintage of TV .....	19
Figure D - 15: Number of TVs per home.....	19
Figure D - 16: Estimated consumption, in average MW, for select miscellaneous uses.....	20
Table D - 9: Estimated consumption, in average MW, for select miscellaneous uses .....	20
Table D - 10: Annual Shipment of Room Air Conditions to the Region (number) .....	21
Figure D - 17: Recent Trends in Nationwide Shipment of Room Air Conditioners (1000s) .....	22
Table D - 11: 2014 Commercial Building Stock (1,000,000 SQF) .....	25
Figure D - 18: Median square footage per employee.....	26
Figure D - 19: Commercial Employment Projection (thousands).....	27
Table D - 12: Number of employees in the commercial enterprises.....	28
Table D - 13: Percent Market Share of Employment.....	28
Figure D - 20: 2013 Stock of Commercial floor space by Business type (millions sqft) .....	29
Figure D - 21: Total Commercial Floor Space Additions (Millions of SQFT).....	30
Table D - 14: 2015-2035 New Commercial Floor Space Additions (millions of sqf).....	31
Figure D - 22: Pattern of Office Space Addition (millions of sqf) .....	32
Figure D - 23: Pattern of Retail Space Addition (millions sqf) .....	32
Figure D - 24: Pattern of Warehouse Floor Space Additions (millions of sqf).....	33
Figure D - 25: Pattern of Floor Space Addition for K-12 Schools (million sqf) .....	33
Figure D - 26: Pattern of Floor Space Addition for Elder Care Facilities (million sqf).....	34
Table D - 15: Regional Commercial Floor Space Stock (millions sqf) .....	35
Figure D - 27: Change in Regional Energy Intensity .....	36
Figure D - 28: Employment in Manufacturing Sectors (1000s).....	37
Figure D - 29: Average Annual Percent Change in non-farm Business sector (National Data) .....	38
Figure D - 30: Average Annual Percent Change in Manufacturing sector (National Data) .....	38
Figure D - 31: National improvement in Labor Productivity 1987 and 2012 indexed to 2000 .....	39
Table D - 16: Regional Industrial Output (billions of \$2012).....	40
Table D - 17: Forecast number of new vehicle additions and assumed market share of electric vehicles.....	41
Table D - 18: Historic and Forecast of Annual Growth Rate by Sector.....	43
Table D - 19: Forecast of Range of Annual Growth Rate by Sector.....	44



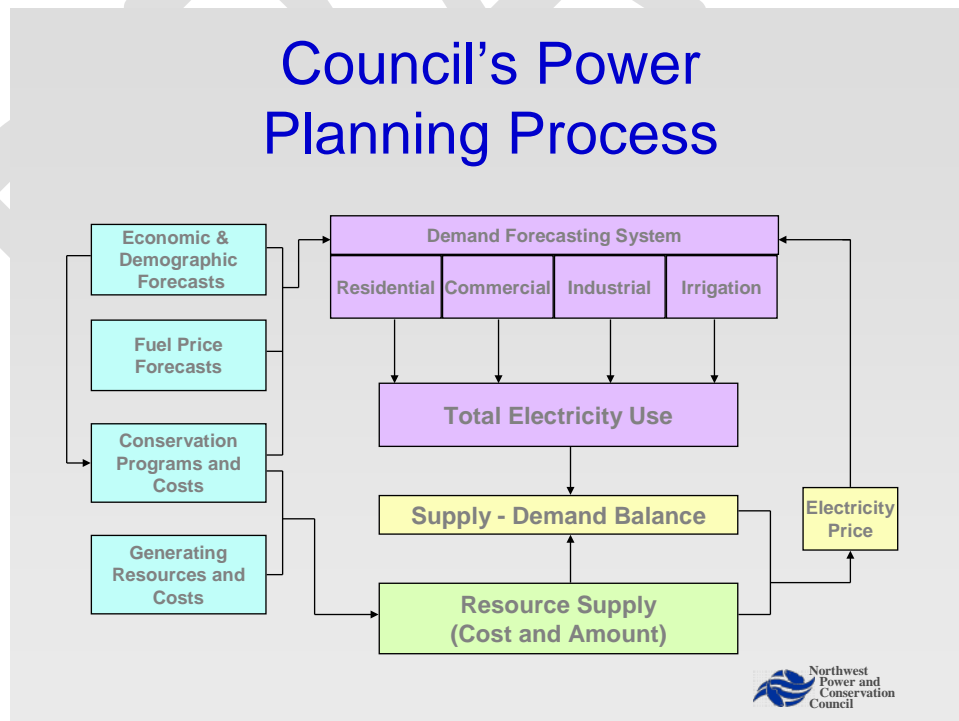
**In the bulk of this write-up we have presented the medium range of the forecast. At the last section we present the range of uncertainty on the drivers. This is done to reinforce the fact that future is uncertain. Council's planning process does not use a single deterministic future to drive the analysis. The stochastic variation introduced in the Regional Portfolio Model tests a wide range of future uncertainties in load, fuel prices etc.**

## ROLE OF THE ECONOMIC FORECAST

A 20-year forecast of demand for electricity is one of the requirements of the Northwest Power Act (Public Law 96-501, Sec. 4(e)(3)(D) ). A detailed demand forecast is used in planning future conservation potential, electricity market clearing price projections, as well as in the Council’s own resource risk assessments. To better capture the impact of future uncertainties, the Council develops a forecast of future demand for energy that identifies not just one trend but a range of trends. The demand forecast range is determined by a consistent set of assumptions about uncertainties in future economic and demographic activities in the region (focus of this chapter), the trajectory of fossil fuel and electricity prices, and legislative and market responses to climate change.

The figure below depicts the Council’s power planning process. The planning process starts with economic and demographic assessments and then adds fuel and electricity price forecasts to create a forecast for electricity demand. The demand forecast looks at energy use by sector to predict monthly load for electricity generators. The Northwest load forecast, along with the forecast for load outside the Northwest, is used in forecasting wholesale electricity prices. Northwest load is used in the Council’s Regional Portfolio Model (RPM), which is then used to seek least-cost, low-risk resource options for the region to meet that load.

The demand forecast is also used extensively to develop the conservation supply curves. The key economic drivers for the conservation supply curves are identical to the economic drivers of the demand forecast.



## BACKGROUND

### Economic Growth Assumptions

The national economic models driving the regional forecast of the Seventh Power Plan were updated as of the fourth quarter of 2014. Given the long-term nature of the Council's power plan, many factors determine the load forecast. Long-term variables may be economic circumstances, life-style choices, demographic changes, or socio-economic trends that take decades to develop and fade. Energy demand is also affected by short-term factors, such as weather conditions or changes in income. The combination of all these conditions determines the demand for energy.

### ECONOMIC DRIVERS OF RESIDENTIAL DEMAND

The number of dwellings is a key driver of energy demand in the residential sector. Residential demand begins with the number of units, including single family, multifamily, and manufactured homes. The "number of homes" category is driven by regional population, house size, and composition of the population. The region's population increased from about 8.9 million in 1985 to about 13 million by 2010, and is projected to grow to over 16 million by 2035 at an annual rate of 0.9 percent.

In the residential sector, electricity demand is driven by space and water heating, space cooling, refrigeration, cooking, washing and a new category called Information, Communication and Entertainment (ICE). This new category includes all portable devices that must be charged, such as laptop computers and cell phones, as well as larger, more energy-intensive televisions and gaming devices. As the regional population grows and with it the number of new homes, demand for these services and as well as other appliances will all increase. While this growth will be slower due to improvements in the energy efficiency of new appliances as a result of state and federal standards, energy demand, overall growth in the number of households will increase demand.

In addition to the number of devices and appliances in homes that consume electricity, another factor affecting residential demand for electricity changing life-styles. For example, the saturation rate for air-conditioning and other appliances and electronic equipment is increasing. Over 80 percent of all new homes in the region now have central air conditioning. This compares to 7 to 8 percent of housing stock with central air conditioning in the 1980s. The growth in high-speed Internet access has increased electricity demand from home electronics which grew at a rate of over 6 percent per year since 2000.



## Population

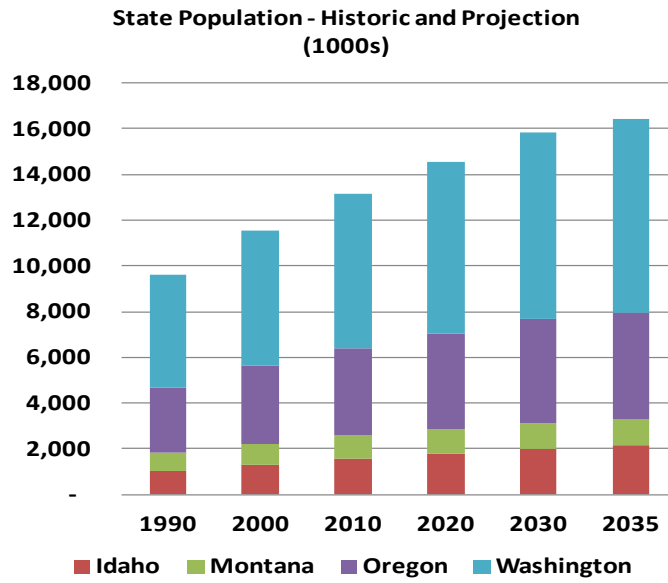
The region's population is changing and reflects demographic shifts seen throughout the United States. In 1985, 30 percent of the region's population was younger than 19. This age group has been growing at about 1 percent per year, but it is forecast to grow more slowly for the next two decades, at around 0.7 percent annually. As a percentage of the total population, it is projected to represent about 24 percent of the population by 2035. This generation represents consumers who have grown up with ICE technologies, the fastest-growing segment of residential electricity demand.

The 20 to 64 year-old age group, representing the working age population, has grown from about 5 million in 1985 to about 8 million in 2010, and is projected to grow to over 9 million by 2035. This age group has been growing at 1.6 percent per year, but its growth rate is expected to be significantly reduced as more and more baby boomers retire. This demographic category plays a critical role in regional employment, demand for homes, major capital equipment, and goods and services.

The fastest-growing population segment is people over 64, the "retirees." They represented about 12 percent of the population in 1985, and by 2035 they are expected to represent about 20 percent of the region's population. This segment is expected to grow almost 2.3 percent per year over the next 20 years, at almost two and half times the growth rate of the total population. This trend has affected the commercial sector in many ways, and the increase in the number of businesses catering to elders is one example. In 2005, the Bureau of Labor Statistics and county business patterns show there were over 3,200 businesses in the region offering elder care services. Such businesses had more than 100,000 employees and occupied about 178 million square feet of space by 2015. If the current trends continue, by 2035 an additional 54 million square feet of space would be needed for elder care. The demand from this business is tracked in the commercial section of the model.

The Figure D – 1 shows the expected population change in each of the four states. Table D – 1 shows the population forecast for each of the states in the region as well as the annual growth rates used in the Seventh Plan. Table D – 2 shows the age composition of the Northwest's population through time.

Figure D - 1: Population Forecast (000)



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Table D - 1: Population in the Region (000)

State	1990	2000	2010	2020	2030	2035	Annual Growth rates <sup>1</sup>	
							1985-2014	2015-2035
<b>ID</b>	1,017	1,302	1,572	1,770	2,015	2,136	1.7%	1.3%
<b>MT</b>	802	904	992	1,077	1,129	1,149	0.8%	0.5%
<b>OR</b>	2,869	3,435	3,841	4,192	4,527	4,678	1.4%	0.8%
<b>WA</b>	4,916	5,921	6,753	7,506	8,159	8,460	1.6%	0.9%
<b>Region</b>	9,603	11,561	13,158	14,546	15,830	16,423	1.5%	0.9%

Table D - 2: Composition of Regional Population (000)

Population Cohort	1990	2000	2010	2020	2030	2035	AAGR	AAGR
							1985-2014	2015-2035
<b>Age 0 thru 19</b>	2,824	3,301	3,463	3,571	3,800	3,925	0.9%	0.6%
<b>Age 20 thru 64</b>	5,580	6,886	7,973	8,467	8,971	9,245	1.6%	0.6%
<b>Age 65 &amp; over</b>	1,200	1,374	1,722	2,508	3,059	3,254	2.3%	2.2%

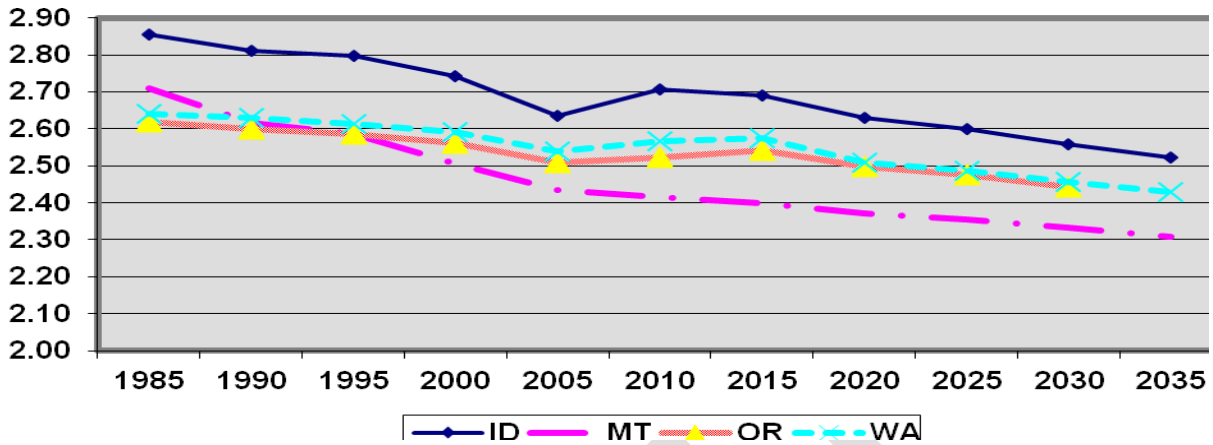
## Housing Stock

While the regional population has been increasing, the number of occupants per household has been declining. In 1985, the average household size was about 2.6 to 2.9 persons per household, and by 2035 it is expected to go down to 2.3 to 2.5 persons per household, resulting in the number of homes growing at a faster rate than the population. Figure D-2 shows the historical trend is household size from 1985 with projections through 2035.

<sup>1</sup> Important note: This appendix uses average annual growth rates as summary figures when comparing the historic and forecast periods for many economic drivers and fuel prices. The average annual growth rate is sensitive to the base year values used in calculating the annual growth rates. For a more accurate picture of the year-by-year growth in economic drivers and prices, additional information for each state is available from the companion Excel worksheet available from Council's website. This companion data can provide a more accurate picture of historic and future growth.

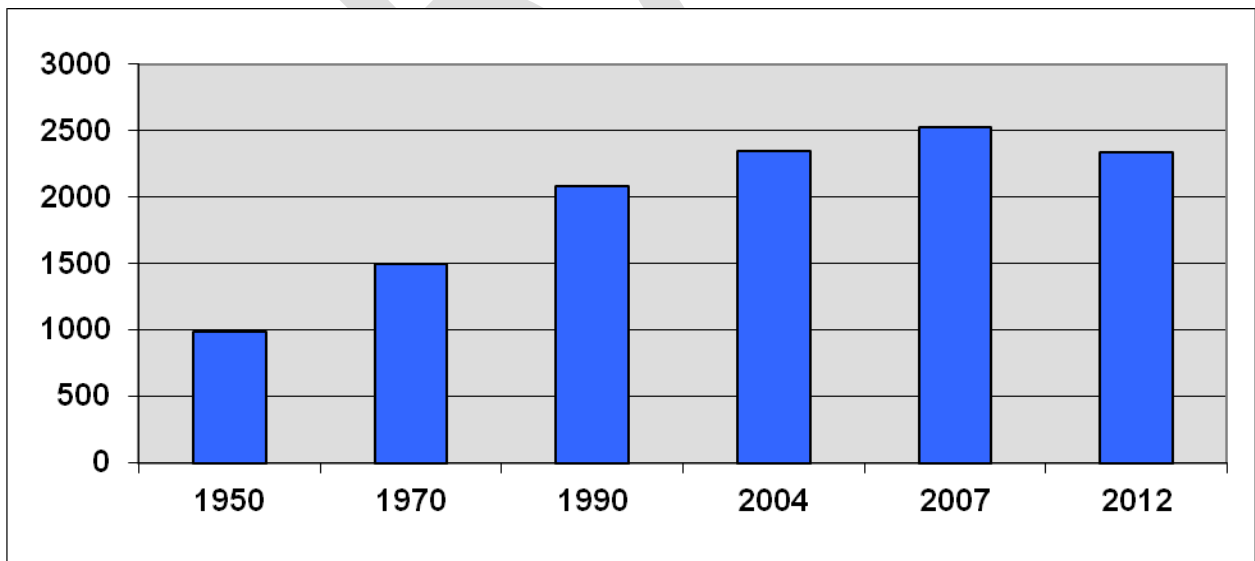


Figure D - 2: Declining Household Size (People per Household)



While the number of occupants per household has declined, the square footage of homes has been increasing. According to the U.S. Bureau of Census’s annual survey of new homes, the average single-family house, defined as a detached single-family home or a multi-plex unit of up to 4 units, completed in 2007 had 2,521 square feet, 801 more square feet than homes in 1977. Going back to the 1950s, the average square footage of a new single-family home was about 983 square feet. As can be seen from Figure D – 3, over the past five decades, the average home size has grown by more than 250 percent. As a result of economic recession starting in 2007, and slow-down in house construction by 2012, we see a drop in the average size of single family units and a shift to multifamily structures. Multifamily homes (defined as housing with greater than four units but less than 4 stories)

Figure D - 3: Growing Average Size of New Single Family Homes



The increase in the average size of homes has not been limited to single-family residences. It is difficult to predict the future trends in house size. For the Seventh Power Plan, the Council has assumed the dwelling sizes shown in Table D - 3. The data for 2014 comes from the recent Residential Building Stock Assessment.<sup>2</sup>

Table D - 3: Average size of residential units (sqf)

State	Building type	1985	2014	2035
ID	Single Family	2127	2174	2200
MT	Single Family	2225	2270	2229
OR	Single Family	1908	1973	1944
WA	Single Family	2051	2140	2150
ID	Multifamily	688	750	780
MT	Multifamily	688	737	771
OR	Multifamily	688	740	768
WA	Multifamily	688	741	768
ID	Other Family*	1160	1279	1288
MT	Other Family	1339	1478	1492
OR	Other Family	961	1203	1214
WA	Other Family	1160	1273	1257

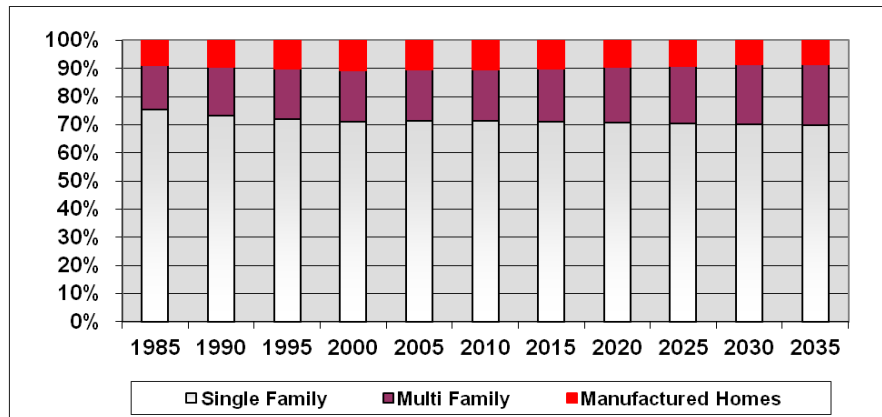
\*- other family structures are manufactured homes

In absolute terms, the number of housing units has been growing at a faster pace than the overall population. Between 1985 and 2012, the population grew at 1.5 percent per year and the number of single family homes grew at 1.5 percent per year, with multifamily and manufactured homes growing at 2.2 to 2.3 percent per year, respectively. The future outlook for growth in homes coincides with slower projection for growth in population.

Figure D – 4 shows the historic and forecast mix of housing types in the total Northwest stock from 1985 through 2035. This figures shows that the share of single family homes declines gradually between 1985 and 1995, then remains fairly constant over the remaining period.

<sup>2</sup> <http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment>

Figure D - 4: Historic and future composition of Housing Stock in the Northwest



Figures D – 5 through D – 7 show the historical and forecast number of new single family, multi-family and manufactured homes added to the stock each year by state and the regional total.

Figure D - 5: Number of Single-Family Homes (000) Stock

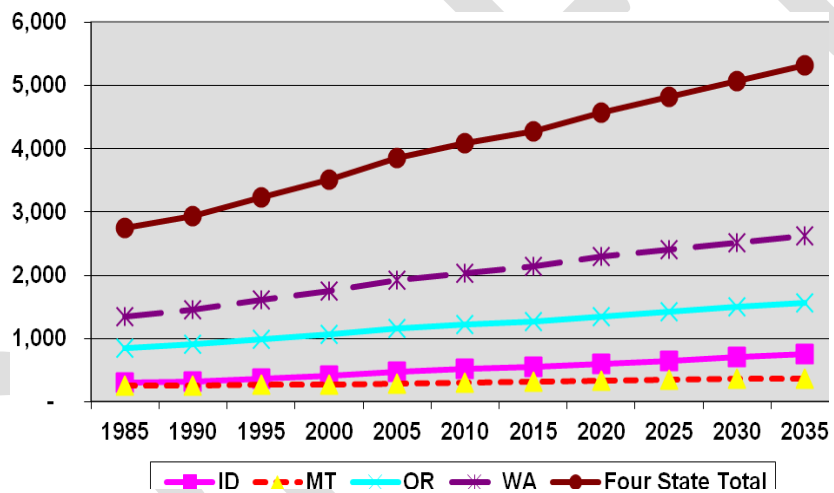
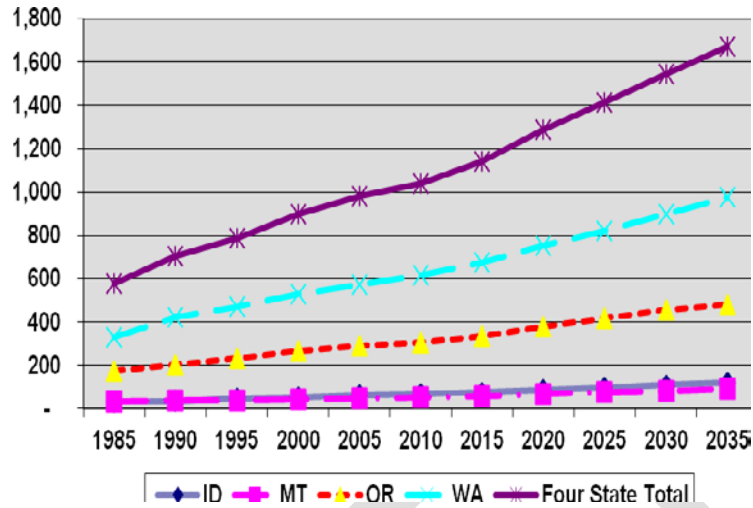
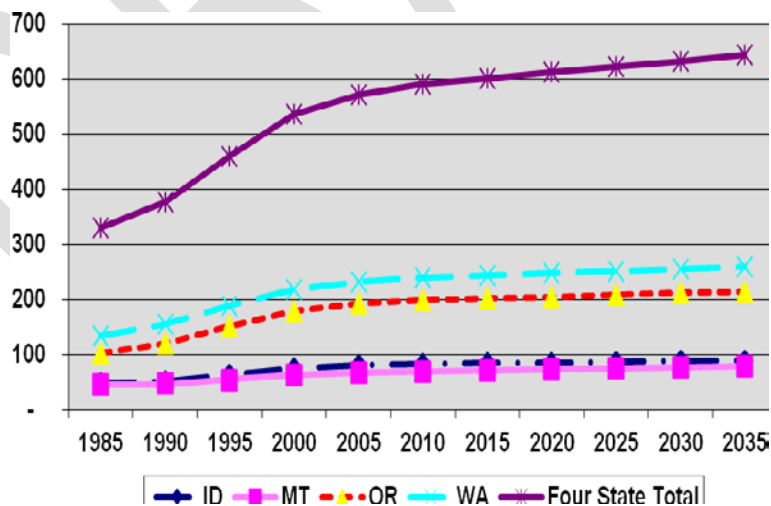


Figure D - 6: Number of Multi-Family Homes (000) Stock



As can be seen from a review of Figures D – 7 and D - 8, the housing sub-sector that has *not* been growing as fast as it had historically is manufactured housing. The factors determining demand for this type of housing are income, price of land, and the number of newlywed and low-income populations. Manufactured homes tend to be less-expensive housing options, so an increase in per capita income in the region has slowed demand for these homes. The price of manufactured housing has also increased, although significantly less than site-built homes.

Figure D - 7: Number of Manufactured Homes (000) Stock

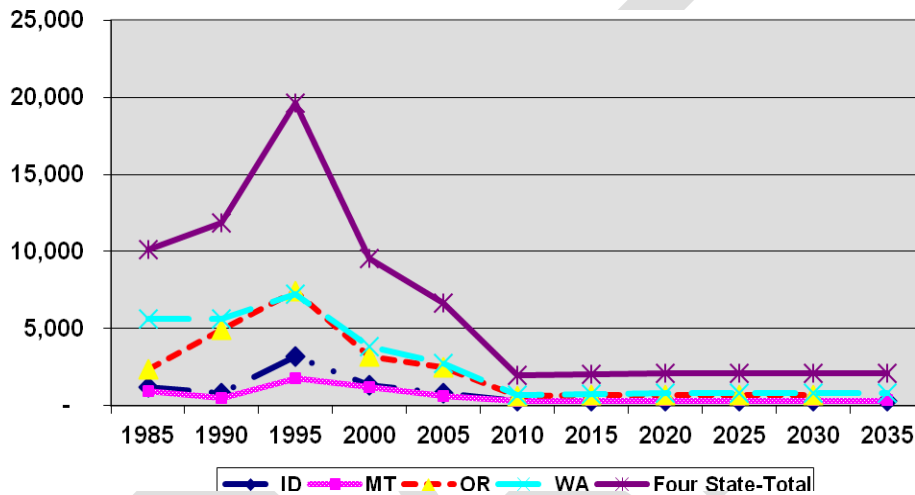


Although manufactured housing typically represents about 10 percent of new homes in the region, they represent about 30 percent of electrically heated new homes. Recognizing this high percentage of electrically heated homes, the Manufactured Housing Acquisition Program was established in 1992. The incentive program, supported by the Council, the Bonneville Power Administration, state

energy offices, electric utilities, and manufacturers, paid manufacturers the incremental cost to add efficiency measures to each new home. New manufactured homes peaked in 1995 after this program ended. For now, the stock of manufactured homes is projected to increase, although at a slower rate.

The recent Residential Building Stock Assessment (2012) shows that on a square footage basis, existing stock of manufactured housing consumes more electricity and natural gas than single family homes. This issue will be discussed further in the demand forecast Appendix E.

Figure D - 8: New Manufactured Homes per Year



Figures D – 9 and D – 10 show the Seventh Plan’s medium forecast for new multifamily and single family homes. As can be seen from a review of these figures the number of new single family and multifamily homes added each years is anticipated to recover from pre-recession levels by 2015.

Figure D - 9: New Multifamily Homes per Year

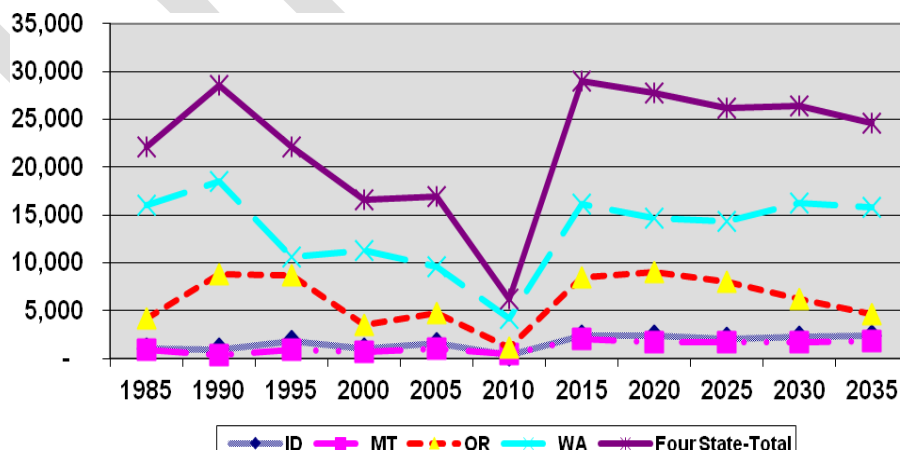
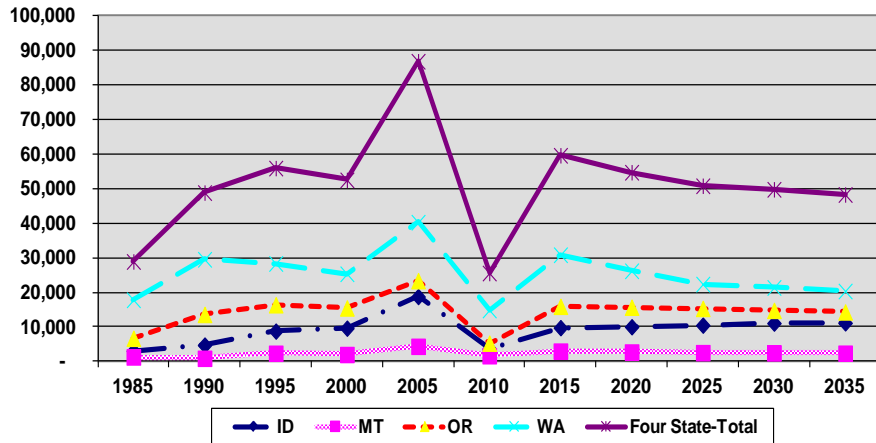


Figure D - 10: New Single Family additions per Year



As can be observed from Table D – 4, the overall composition of housing stock has recently been changing to favor multifamily homes. Although single-family homes had been increasing in market share in the late twentieth century, recent trends are that they are gradually losing market share. Single-family homes represented 47 percent of homes in the region in 1985. By 2015 they are expected to represent 66 percent of housing stock. However, by 2035, the forecast is for single-family homes to decline to about 64 percent. Multifamily homes represented 34 percent of residential housing stock in 1985, 18 percent by 2000, and are projected to be about 27 percent of the total housing stock by 2035. Within the multifamily building type, high rise structures have been and are projected to continue to represent a larger share. Table D – 5 shows that within high-rise buildings, those with four stories and above, are projected to constitute about 18 percent of multifamily housing stock by 2035, nearly doubling of their market share in from 1985-2000. Manufactured homes historically represented 12 to 17 percent of the housing stock, but this building type’s market share is projected to decrease to around 3 percent by 2035.

Table D - 4: Market share by building type

	1985	2000	2015	2030	2035
Single Family	47%	67%	66%	64%	64%
Multifamily - Low Rise	34%	18%	26%	28%	27%
MF - High Rise	2%	3%	6%	6%	6%
Manufactured Housing	17%	12%	2%	3%	3%

Table D - 5: Regional Multifamily New Additions Market share

	1985-2000	2001-2006	2007-2014	2015-2035
Low rise	90%	86%	84%	82%
High rise	10%	14%	16%	18%

Table D - 6 shows changing market share of various residential building types across different historic and forecast periods. On average, between 1985 and 2000, about 50,000 new single-family, 19,000 low-rise multifamily and 2,000 high-rise multifamily, and 14,000 new manufactured homes were added to the existing stock. Starting in year 2000 and lasting until 2006, each year has seen a dramatic increase in new single-family home additions. Rising income levels in the region and the increased availability of credit caused a shift from multifamily to single-family home ownership. In 2001-2006, more than 70,000 new single-family homes were added in the region. This increase in the number of single-family houses caused a substantial increase in the price of housing. A slow-down in new single-family home additions is evident in the 2007-2014 period with almost half as many built as during the previous 5 year period. For the forecast period 2015-2035, the Council predicts a return to more stable level of construction.

Table D - 6: Average Annual Number of New Homes by State

	1985-2000	2001-2006	2007-2014	2015-2035
Single-Family				
Idaho	6,987	13,743	5,828	10,518
Montana	1,706	3,547	2,344	2,650
Oregon	13,674	19,392	8,219	15,170
Washington	26,952	33,992	18,839	24,004
<b>Four State Total</b>	<b>49,319</b>	<b>70,674</b>	<b>35,230</b>	<b>52,342</b>
Multifamily- Low rise				
Idaho	1,144	1,559	828	1,844
Montana	547	855	760	1,410
Oregon	4,998	3,439	2,242	6,069
Washington	12,539	8,430	7,632	12,397
<b>Four State Total</b>	<b>19,228</b>	<b>14,283</b>	<b>11,462</b>	<b>21,721</b>
Multifamily- high rise				
Idaho	88	127	96	420
Montana	51	78	85	317
Oregon	1,157	1,336	1,179	1,330
Washington	895	826	800	2,827
<b>Four State Total</b>	<b>2,192</b>	<b>2,367</b>	<b>2,160</b>	<b>4,893</b>
Manufactured Housing				
Idaho	1,818	873	357	270
Montana	1,161	778	393	363
Oregon	4,983	2,424	870	670
Washington	5,609	2,809	1,037	795
<b>Four State Total</b>	<b>13,571</b>	<b>6,884</b>	<b>2,657</b>	<b>2,098</b>

In summary, the key driver for demand for electricity consumption in the residential sector is the number of residential units. Table D - 7 presents the existing residential units for select years.

Table D - 7: Historic and forecast stock of residential units (1000s)

Regional Summary	1985	2007	2015	2020	2030	2035
Single Family	2,753	3,997	4,279	4,573	5,077	5,318
Multi Family	578	1,016	1,141	1,286	1,546	1,673
Manufactured homes	329	583	601	611	632	643

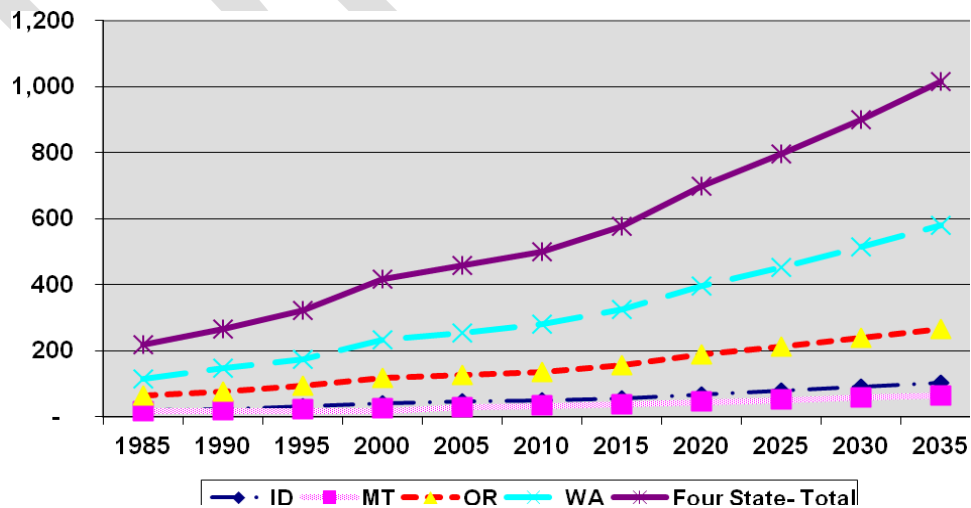
## Personal Income

Personal income is another economic driver of energy demand. Energy consumption is elastic, so a decline in personal income causes a short-term reduction in demand. Regional personal income, both in total and on a per-capita basis, has been on the upswing and is projected to continue, although at a slower rate. Table D - 8 shows the growth rate, in constant dollars, for personal income in the four states. Figure D – 11 shows the growth in personal income by state from 1985 to through the present and forecast to 2035.

Table D - 8: Growth Rate Personal Income (2000 constant dollars)

	1985-2009	2010-2030
<b>Idaho</b>	3.9%	3.1%
<b>Montana</b>	2.7%	2.4%
<b>Oregon</b>	3.3%	2.9%
<b>Washington</b>	3.8%	2.9%
<b>Four State- Total</b>	3.6%	2.9%

Figure D - 11: Personal Income  
(Billions in 2005 constant dollars)





## Number of Energy-using Appliances in the Average Residence

Energy-using appliances also affect energy demand in the residential sector, and the penetration rate of appliances is a key driver of demand. One group of devices that has experienced significant growth in the residential sector has been home electronics (ICE). Very few sources track the penetration rate of this end-use at the regional level, so the following analysis draws on national-level data.

### Information Communication and Entertainment

The explosive growth of these devices has been global, fueled in part by the rapid expansion of the Internet. In a not too distant past, the typical appliances in a typical home consisted of one or two refrigerators; a water heater; perhaps a freezer; some form of space-heating appliance; a cooking appliance; lighting fixtures; and, rarely, an air-conditioning unit. Entertainment appliances were usually limited to a color television and a stereo system.

An average home today has all these appliances, as well as a whole range of ICE devices. Some ICE devices provide services that were once performed outside the home, such as printing pictures or reports. Other ICE devices connect people to the outside world and social networks, and some provide entertainment. ICE devices, to a great extent, have removed the boundary between office work and home life as more and more people are able to conduct office work from home.

ICE end-uses are numerous and vary from household to household, depending on the life-style and demographic characteristics of the households. In 2012 Northwest Energy Efficiency Alliance conducted an extensive survey of inventory of ICE appliances in the residential units. In the following charts, the Council is presenting some of the highlights of the NEEA survey findings. Readers are encouraged to read the full NEEA Residential Building Stock Assessment available through NEEA website linked below.

<http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment>



Figure D - 12: Count of Computers per household

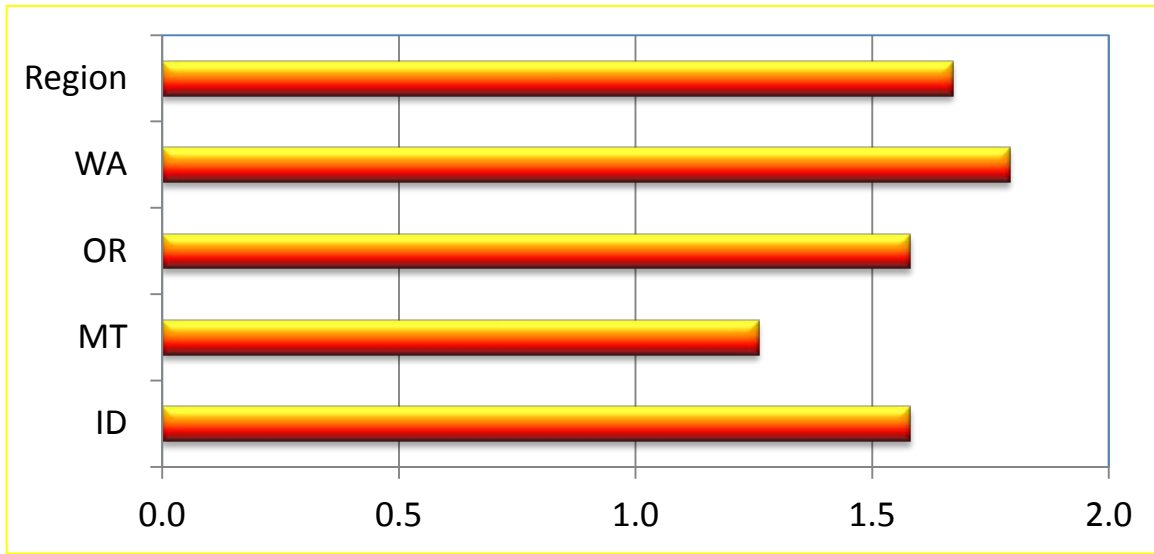


Figure D - 13: Percent of Households with Computers

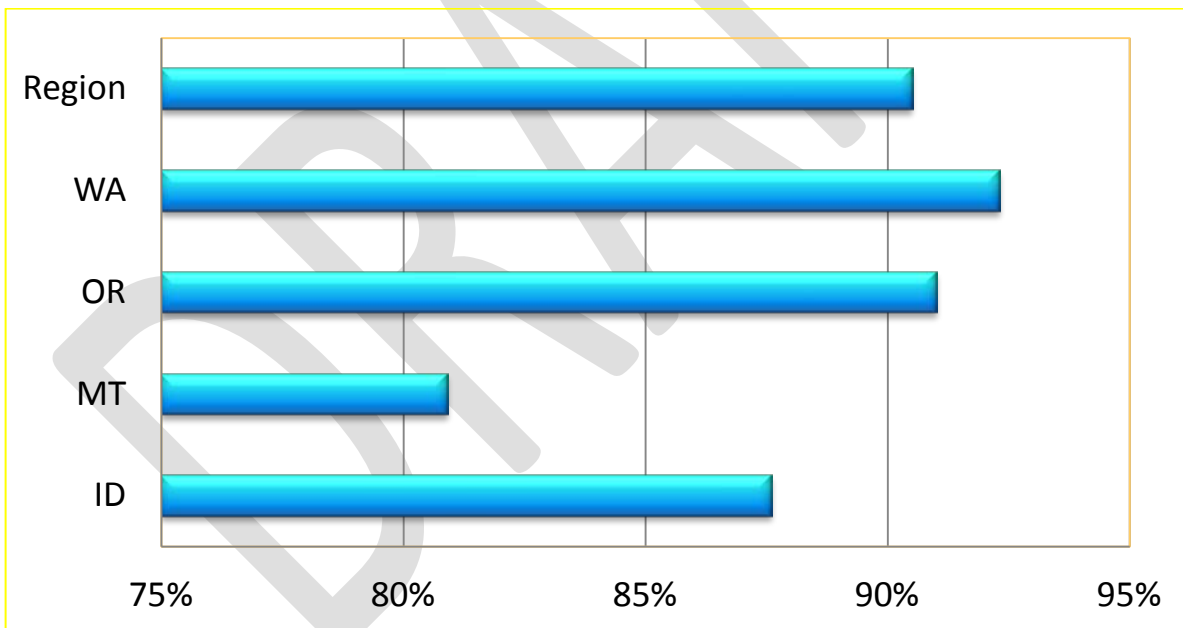


Figure D - 14: TV screen type by Vintage of TV

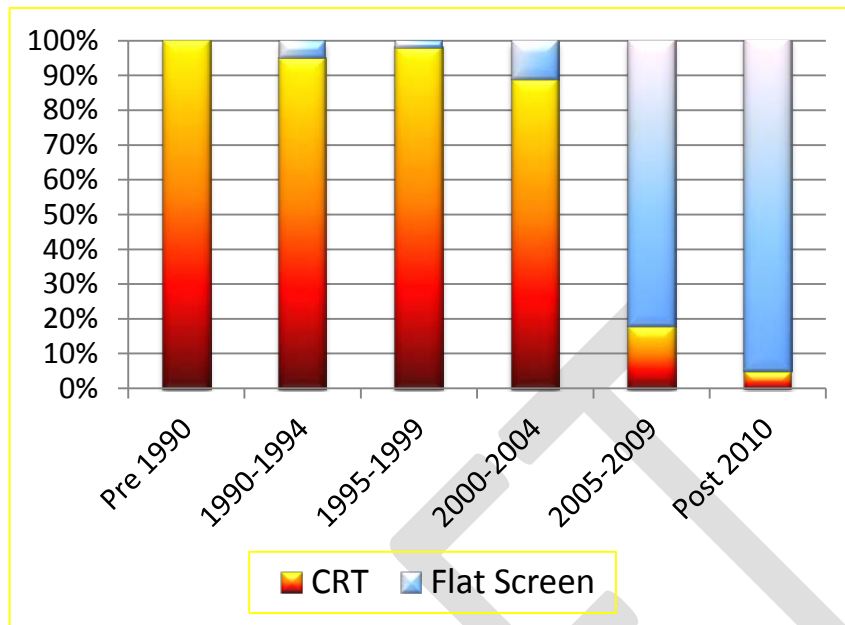
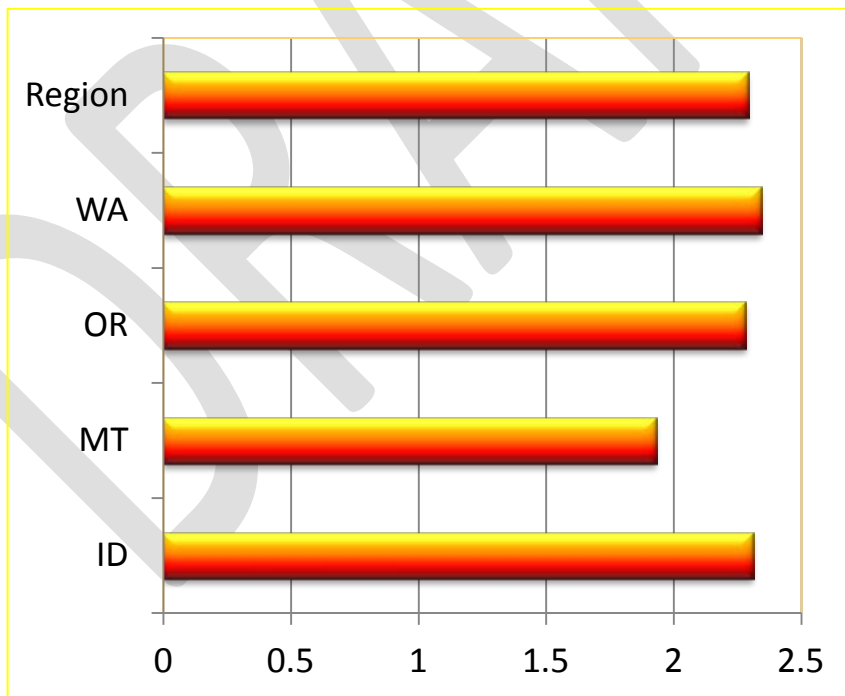


Figure D - 15: Number of TVs per home



Using RBSA findings along with national and regional projections on various ICE appliances, the Council has developed a more detail forecast for this category of end uses than in previous power plans. Table D – 9 and Figure D -16 shows the rapid increase in demand for electricity from ICE end-uses, as well as projected reduction in their rate of growth over the next two decades.

Figure D - 16: Estimated consumption, in average MW, for select miscellaneous uses

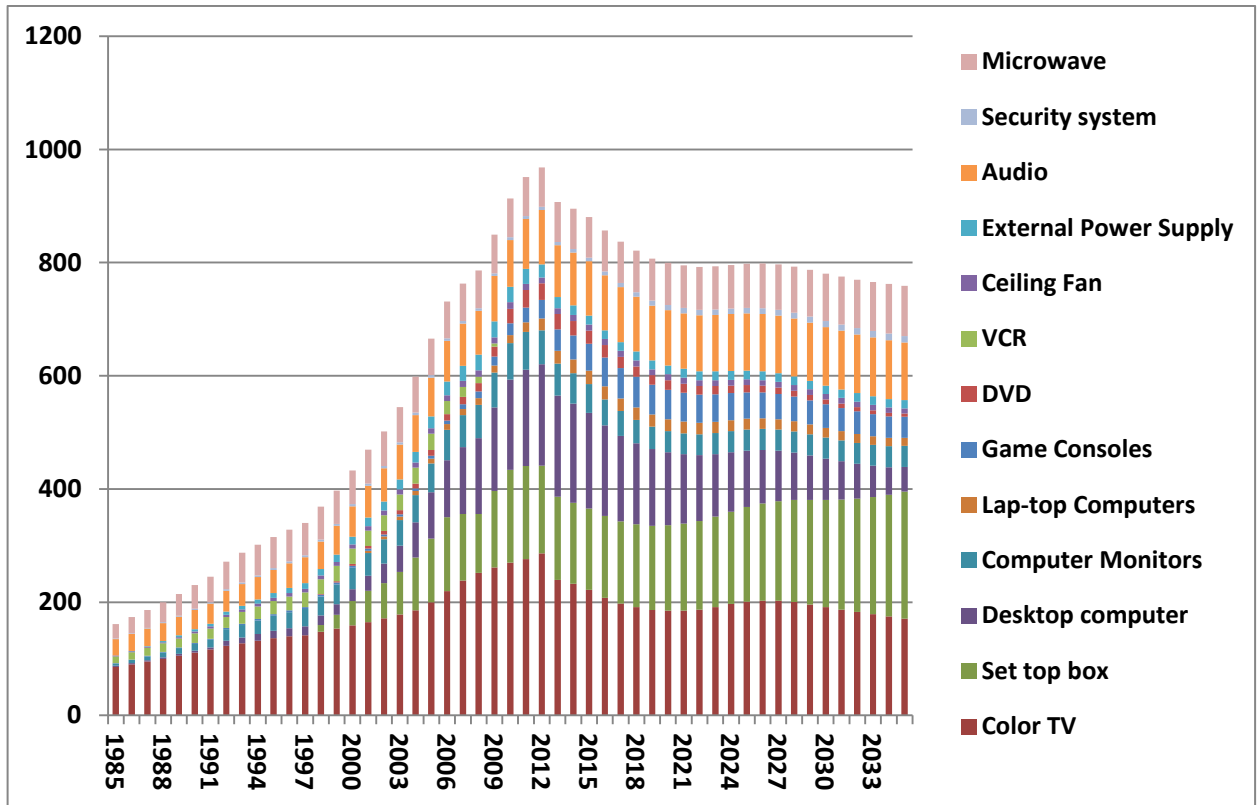


Table D - 9: Estimated consumption, in average MW, for select miscellaneous uses

	1985	1990	1995	2000	2005	2010	2015	2030	2035
Color TV	86	111	136	159	200	270	218	126	123
Set top box	-	-	-	43	112	164	144	189	224
Desktop computer	2	3	17	34	144	293	300	130	78
Computer Monitors	4	16	30	46	65	84	75	54	54
Lap-top Computers	-	-	-	-	8	17	36	26	22
Game Consoles	0	2	3	3	5	21	47	42	37
DVD	-	-	-	3	10	25	24	9	6
VCR	12	17	23	27	29	-	-	-	-
Ceiling Fan	1	4	6	8	10	12	11	10	9
External Power Supply	-	4	8	14	21	27	16	15	15
Audio	29	34	41	54	68	83	96	103	102
Security system	1	2	3	4	4	5	6	11	11
Microwave	26	42	55	60	64	68	72	84	89
<b>Total</b>	<b>161</b>	<b>234</b>	<b>322</b>	<b>454</b>	<b>741</b>	<b>1,070</b>	<b>1,045</b>	<b>798</b>	<b>770</b>

## Demand for Air Conditioning

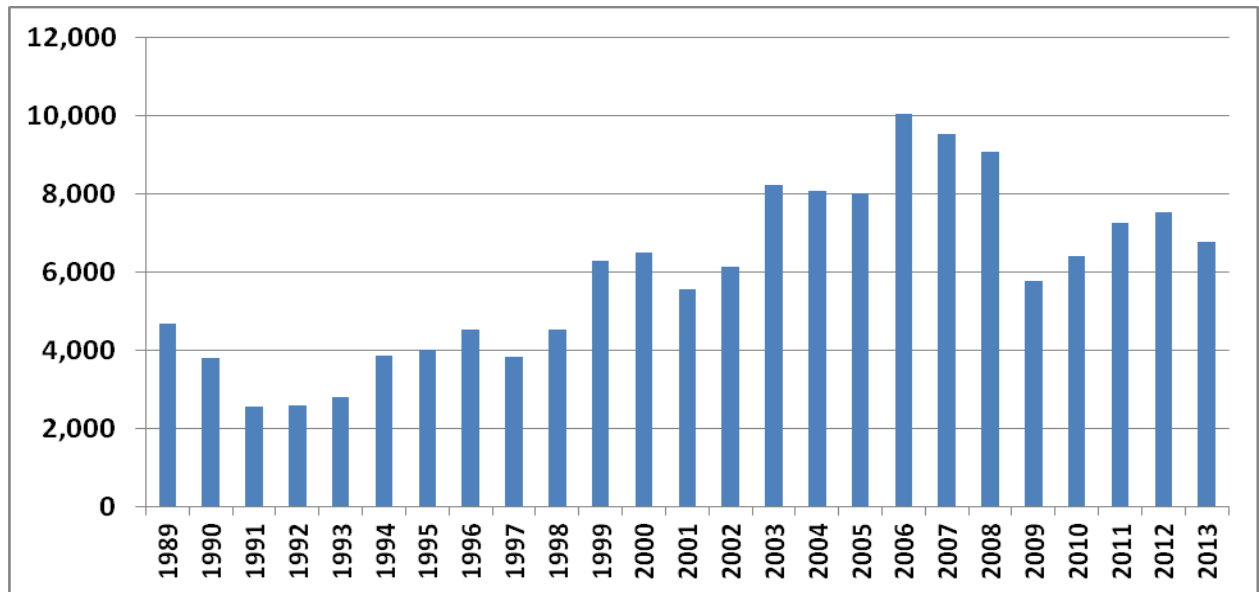
The market share of residential air conditioning has grown rapidly in the region. The market penetration of air conditioning by Northwest homeowners was relatively low, about 10 to 20 percent, during the 1980s and 1990s. Air conditioning use has been increasing significantly in recent years. This shift in demand can be attributed to warmer summer temperatures, reduced prices of air-conditioning units, and the number of new people moving into the region who are accustomed to using air-conditioning in their previous homes. Table D-10 shows that in 2000, about 40,000 room air conditioning units were shipped to the region. Five years later, the figure had increased to about 140,000.

Table D - 10: Annual Shipment of Room Air Conditions to the Region (number)

	2000	2001	2002	2003	2004	2005	2013
<b>Idaho</b>	5,300	5,400	7,500	13,000	13,600	9,998	4,400
<b>Montana</b>	4,200	4,900	8,000	12,400	15,300	7,926	3,600
<b>Oregon</b>	15,800	17,300	21,100	39,800	58,700	55,469	54,100
<b>Washington</b>	16,200	27,300	32,600	45,300	90,700	66,163	50,500

The increase in room air-conditioning has not been a regional phenomenon. Similar trends can be seen in national figures. Figure D – 17 shows that between 1997 and 2006, room air-conditioning sales grew at an annual rate of 11 percent, almost 10 times the population growth rate. Sales increased from about 4 million units in 1997 to about 10 million units in 2006. The sales volume for room air-conditioning depends on summer temperatures, which is evident from the high sales volume in 2006--one of the hottest years on record.

Figure D - 17: Recent Trends in Nationwide Shipment of Room Air Conditioners (1000s) <sup>3</sup>



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<sup>3</sup> Association of Home Appliance Manufacturers data.



# ECONOMIC DRIVERS OF THE COMMERCIAL SECTOR

The key economic driver for the commercial sector's energy demand is the square footage needed for commercial enterprises. In modeling this sector, the Council calculated the space requirement of thousands of business activities and aggregated these into 17 different building types.

## Methodology in Estimating Commercial Floor Space Requirements

The key driver for the commercial sector is the stock square footage required to conduct business activities in designated building types. To calculate this square footage, the Council developed a simple model that uses the number of employees per business activity and median square footage per building type with the following analytic steps:

1. The Bureau of Labor Statistics (Quarterly Census of Employment and Wages) provides the number of establishments<sup>4</sup> and employees at the end of 2013 (at 6-digit NAICS<sup>5</sup> code level) . This enabled a detailed investigation of the type of business activities and the number of employees for each business type. Each business activity was assigned one of the 17 commercial building types used in load forecasting and conservation assessment.
2. The median square footage per main-shift employees (the hours of 8 a.m.-5 p.m.) for various business activities are reported as part of Commercial Building Energy Consumption Surveys (CBECS 2012) from the U.S. Energy Information Administration.
3. CBECS micro data (individual site data) for 1992-2003 for more than 21,000 buildings are used to calculate the median square footage per employee and the number of hours of operation for various establishments.
4. The Bureau of Labor Statistics provides the percent of "major" occupation categories engaged in a business activity (at 4-digit NAICS). <http://stat.bls.gov/oes/home.htm>
5. An estimate of existing floor space stock and the demolition rate by building type from the 2014 Commercial Building Stock Assessment (CBSA).<sup>6</sup>
6. Floor space additions for each building type for 2002-2013 from F.W. Dodge are used to augment the 2001 building floor space stock to create an assessment of the existing floor space in 2013. This floor space stock was reduced by calculated demolitions during 2002-2013.

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<sup>4</sup> Establishment - A single physical location where business is conducted or where services or industrial operations are performed.

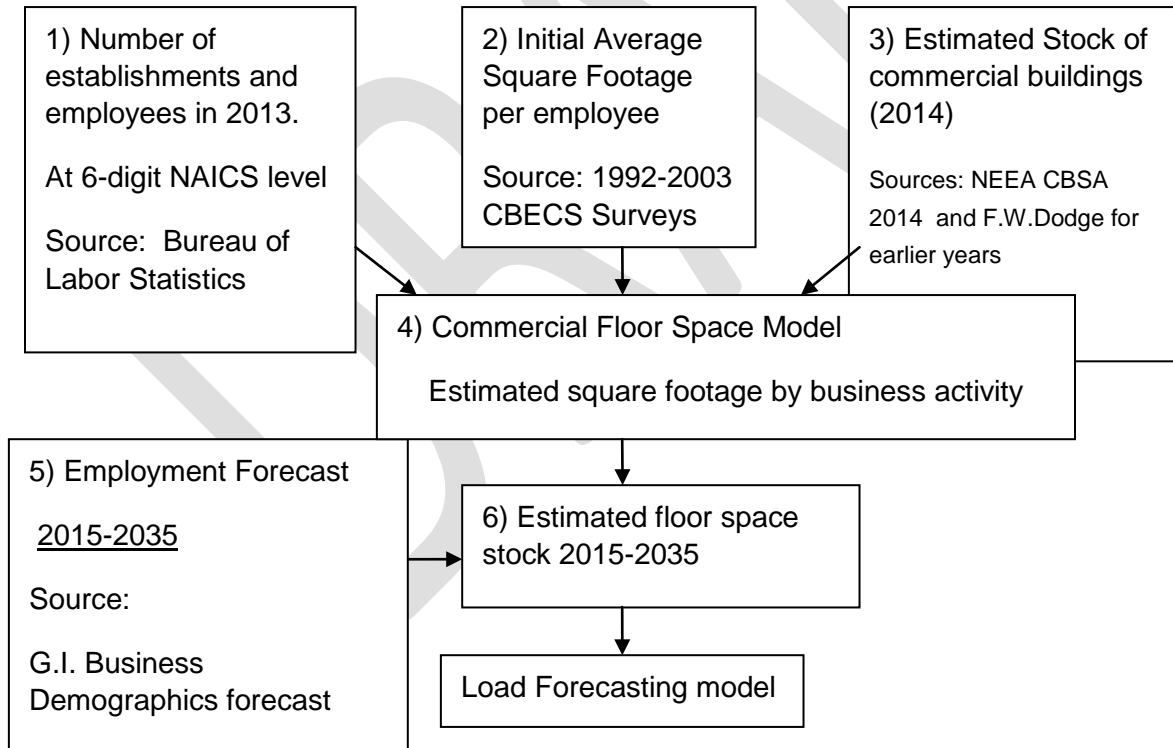
<sup>5</sup> NAICS - North American Industrial Classification System

<sup>6</sup> <http://neea.org/resource-center/regional-data-resources/commercial-building-stock-assessment>



7. An initial estimate of 2014 square footage requirements for each business activity was estimated using the following factors:
  - a. The assigned building type
  - b. Median square footage per employee
  - c. Number of employees
  - d. Percent of business activity engaged in an occupation
8. The estimated 2014 floor space stock for each business activity was adjusted so that the total square footage for that building type is close to the benchmark floor space stock in 2014.
9. Future floor space requirements were forecast by applying the annual growth rate in employment in each business activity to Global Insight’s forecast (at state, and 4-digit NAICS code level), and to the 2014 floor space requirements for that business activity.
10. For each year, the new floor space requirements across business activities were aggregated by building type, and for each building type, a portion of floor stock is estimated to be demolished.
11. For years 2015-2035, the estimated commercial floor space stock is fed into the demand forecasting model.

Analytic Steps in Forecasting Floor Space for Each State





The Northwest Energy Efficiency Alliance's (NEEA) market research report<sup>7</sup> estimated that for 2014 the total commercial floor space in the Pacific Northwest was 3.34 billion square feet. The estimated distribution of this floor space across states and building types is shown in Table D – 11.

Table D - 11: 2014 Commercial Building Stock (1,000,000 SQF)

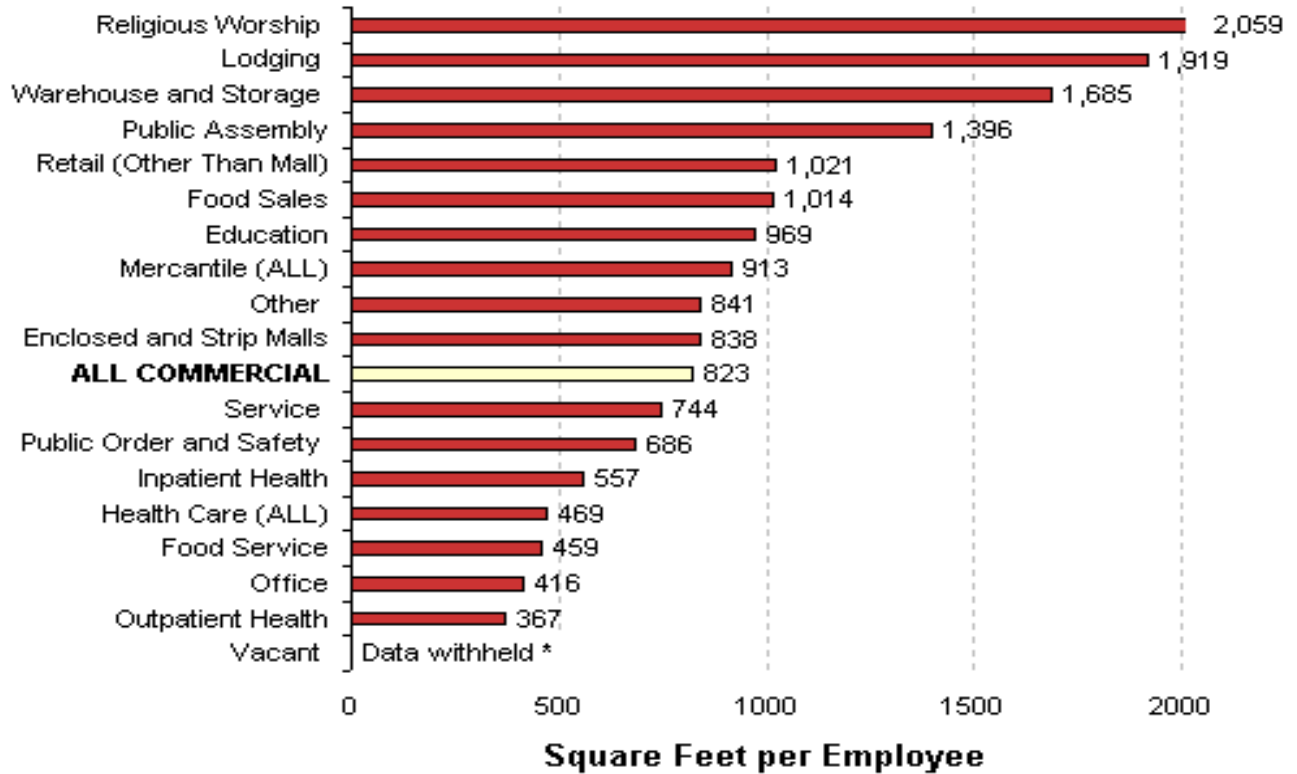
	Idaho	Montana	Oregon	Washington	Total
Office	57	45	185	447	734
Retail	57	65	142	307	571
Hospital	15	14	26	49	104
Elder Care facilities	7	7	44	68	125
Hotel	10	16	33	112	171
Restaurant	3	9	13	28	53
Grocery	4	6	19	38	66
Minimart	1	1	2	7	11
K-12	13	11	81	141	245
University	17	8	37	61	124
Warehouse	32	31	131	248	442
Assembly	25	26	122	196	369
Other	38	26	146	122	333
Grand Total	278	266	982	1,822	3,349

## Square Footage per Employee

Using the Department of Energy's Commercial Building Energy Consumption Survey data (micro-data from a national survey of over 21,000 commercial buildings surveyed between 1992 and 2003), the Council estimates the median square footage per employee for various business activities. A graphic example of the initial square footage per employee used in the model (from CBECS 1999) is shown in Figure D - 18.

<sup>7</sup> "Assessment of the Commercial Building Stock in the Pacific Northwest" March 2004,

Figure D - 18: Median square footage per employee



Note: "Mercantile (ALL)" includes both "Retail (Other Than Mall)" and "Enclosed and Strip Malls"; "Health Care (ALL)" includes both "Inpatient Health" and "Outpatient Health".

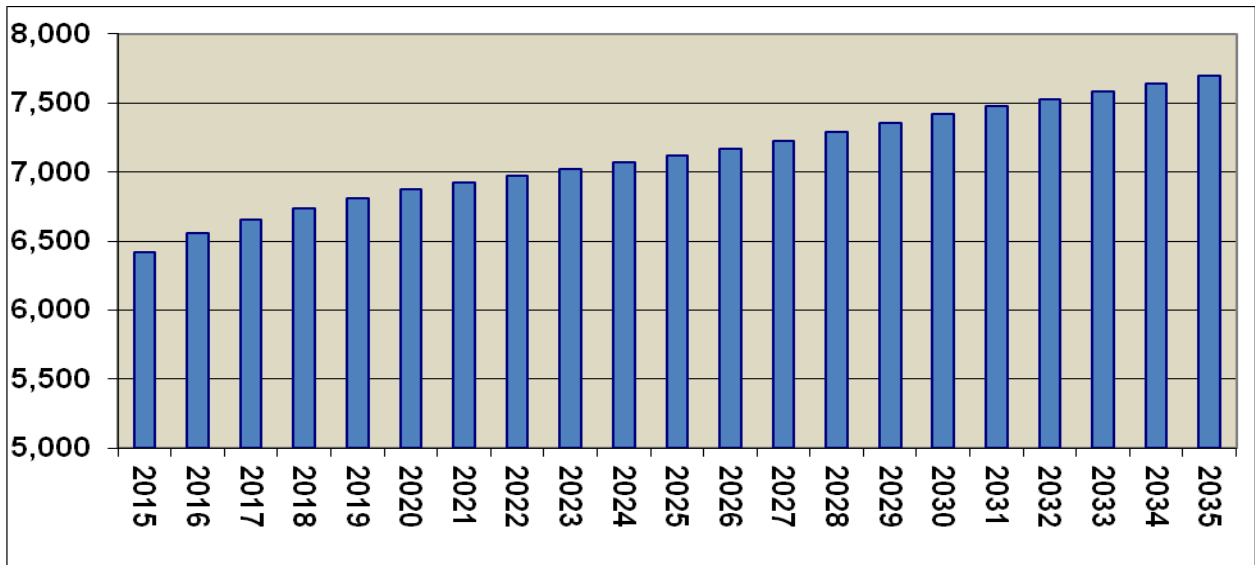
\* Relative Standard Error (RSE) greater than 50 percent or fewer than 20 buildings sampled.

Source: Energy Information Administration, 1999 Commercial Buildings Energy Consumption Survey.

## Forecasting Commercial Floor Space Requirements

As described above, the Council developed a model that forecast the square footage requirements of the commercial sector. This model's results were calibrated to the known square footage data from the 2014 CBSA. Then, using Global Insight's business demographic forecast of employment, the Council forecast the square footage requirement for commercial buildings. The following figures and tables show the historic and forecast commercial employment totals in the region, and then broken down by major business activity. Between 2015 and 2035, the overall commercial employment is expected to grow at an annual rate of 0.9 percent, with total employment growing from 6.4 million in 2015 to about 7.7 million by 2035.

Figure D - 19: Commercial Employment Projection (thousands)



## Changing Composition of Commercial Sector

The market share of business activity employment in the commercial sector has not been constant. Over the past 10 years, some business sectors have increased their share of total employment, while other sectors experienced a declining share employment. For example, businesses engaged in health care, information technologies, professional and technical services, and wholesale trade services have increased their share of total employment, while government and retail trade have reduced their share. The historic and forecast trends are presented in the Tables D – 12 and D – 13.

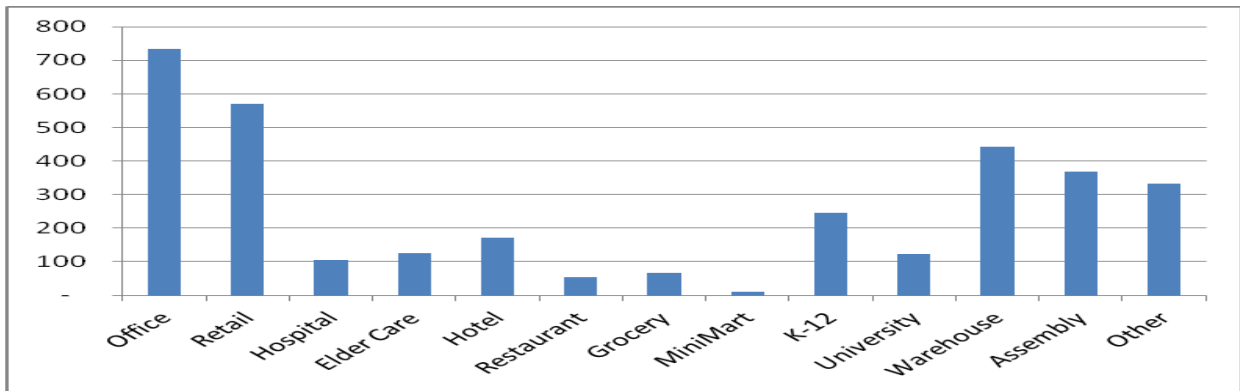
Table D - 12: Number of employees in the commercial enterprises

	1997	2007	2015	2035
Accommodation and Food Services	406	486	486	480
Administrative and Support Services	229	312	412	665
Arts, Entertainment, and Recreation	68	91	96	104
Educational Services	66	88	86	101
Federal Government	901	1,031	1,042	1,108
Finance and Insurance	169	207	210	209
Health Care and Social Assistance	457	606	660	807
Information	122	158	167	263
Management of Companies and Enterprises	60	74	73	84
Other Services (except Public Administration)	185	202	194	219
Professional, Scientific, and Technical Services	215	282	303	522
Real Estate and Rental and Leasing	94	110	111	120
Retail Trade	585	672	654	650
Transportation and Warehousing	164	179	185	224
Utilities	15	14	13	11
Wholesale Trade	231	255	259	361
<b>Total Commercial Employment</b>	<b>3,969</b>	<b>4,767</b>	<b>4,952</b>	<b>5,930</b>

Table D - 13: Percent Market Share of Employment

<b>Market share Commercial Establishments</b>	1997	2007	2015	2035
Accommodation and Food Services	10%	10%	10%	8%
Administrative and Support Services	6%	7%	8%	11%
Arts, Entertainment, and Recreation	2%	2%	2%	2%
Educational Services	2%	2%	2%	2%
Federal Government	23%	22%	21%	19%
Finance and Insurance	4%	4%	4%	4%
Health Care and Social Assistance	12%	13%	13%	14%
Information	3%	3%	3%	4%
Management of Companies and Enterprises	2%	2%	1%	1%
Other Services (except Public Administration)	5%	4%	4%	4%
Professional, Scientific, and Technical Services	5%	6%	6%	9%
Real Estate and Rental and Leasing	2%	2%	2%	2%
Retail Trade	15%	14%	13%	11%
Transportation and Warehousing	4%	4%	4%	4%
Utilities	0%	0%	0%	0%
Wholesale Trade	6%	5%	5%	6%

Figure D - 20: 2013 Stock of Commercial floor space by Business type (millions sqft)



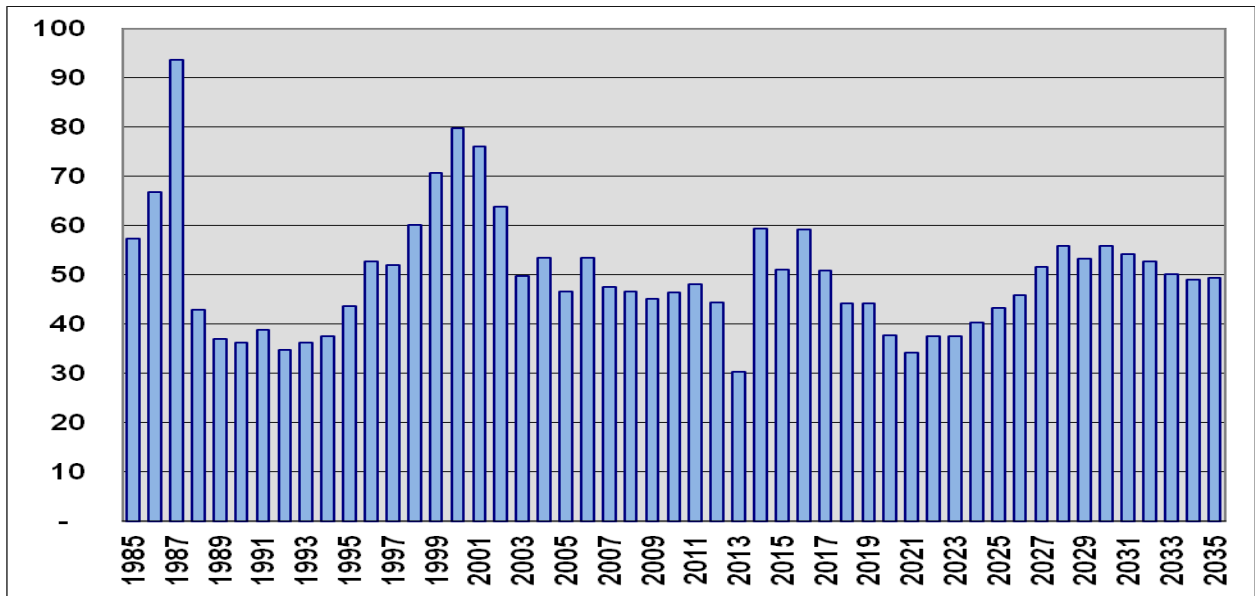
## Commercial Floor Space Additions

Figure D – 20 shows the 2013 floor space by building activity type. The floor space stock in each year is the sum of new floor space additions and retirements from the floor space in that year.

The overall pattern of floor space additions for the commercial sector is presented in the Figure D - 21. A quick review of the historic data shows the cyclical nature of commercial floor space additions. The sharp increase in late 1980s is followed by a significant slowdown in the early 1990s. The late 1990s indicate a sharp increase in new construction activities. The 2000-2002 recession slowed construction activities. In 2005, another wave of commercial construction took place. Due to the long construction time for commercial activities, it would typically take a year or two for construction activities to reflect the economy.

The long-term forecast projects a slowdown in floor space additions, from 60 million square feet per year to about 40 to 50 million square feet. The forecast for future floor space additions do show a wide swing in construction activities in this sector. However, these swings in construction activity are not due to business cycles but rather due to changing demographics and changing in commercial trends.

Figure D - 21: Total Commercial Floor Space Additions (Millions of SQFT)



The forecast for floor space additions for each state and the region is shown in the Table D - 14. The Council's Seventh Power Plan forecasts about 950 million square feet of new floor space. A large portion of this will be in warehouse space, office space, hospitals, and elder care facilities.

Table D - 14: 2015-2035 New Commercial Floor Space Additions (millions of sqf)

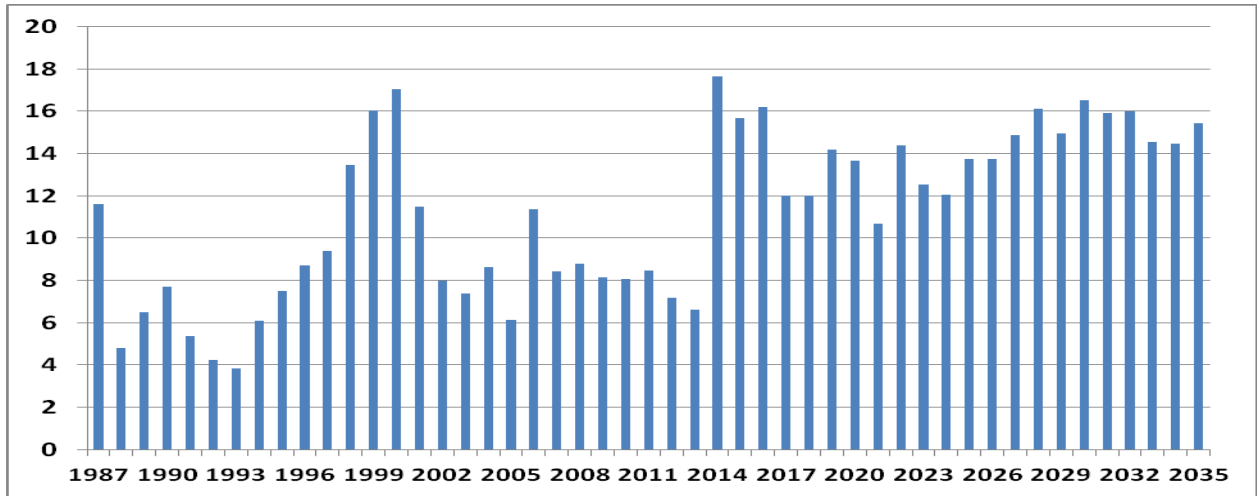
	Idaho	Montana	Oregon	Washington	Region
Large Office	13.0	3.5	33.1	90.0	139.6
Medium Office	16.3	10.2	31.7	56.2	114.4
Small Office	4.0	2.8	8.8	14.5	30.1
Extra large Retail	2.5	2.4	8.6	12.1	25.6
Large Retail	1.2	1.2	3.7	4.4	10.4
Medium Retail	4.0	7.3	13.5	15.8	40.6
Small Retail	1.3	2.4	4.9	4.4	12.9
K-12	6.5	0.4	16.6	5.0	28.5
University	5.1	0.4	1.9	13.2	20.6
Warehouse	9.8	7.6	48.7	29.6	95.7
Supermarket	0.3	0.5	1.9	3.2	5.9
Mini Mart	0.1	0.2	1.1	1.1	2.4
Restaurant	0.8	1.8	3.1	5.7	11.5
Lodging	0.9	3.0	7.0	12.3	23.2
Hospital	9.7	4.0	5.6	23.5	42.9
Elder care facilities	2.6	3.6	21.7	27.0	54.9
Assembly	14.5	8.1	30.0	34.3	86.8
Other	33.2	15.6	103.4	49.9	202.2
Total	125.8	74.8	345.3	402.2	948.2

## Patterns of Commercial Floor Space Additions

Commercial floor space additions typically show a cyclical pattern of overbuilding followed by high occupancy and demand for more space. This is especially true for the more speculative building types such as office or retail. A brief review of commercial floor space additions for 1987-2035 shows the different patterns of floor space additions for office, retail, warehouse, K-12 schools, and elder care facilities. An increase in office space additions, declining retail space requirements, substantial increases in new warehouse space, and declining additional K-12 school floor space requirements are forecast. Figures D – 22 through D-26 show the historical and Seventh Plan’s forecast for floor space additions for five major business types.

Office space requirements, shown in Figure D – 22, suggest a decline in new office space additions for 2012-2014, followed by a stable period from 2015-2019. Starting with 2020, the Council forecasts an escalation of commercial office construction activities.

Figure D - 22: Pattern of Office Space Addition (millions of sqf)



As shown in Figure D – 23, the Seventh Plan forecast a decrease in retail floor space requirements. This results in a decline in new retail space additions over the forecast period. This decrease reflects slower population growth and the move to e-commerce. Retail space additions peaked in 2005-2006. In the 2015-2035 period, retail commercial floor space is forecast to average around 3 to 4 million square feet per year.

A decrease in retail space requirement is off-set by an increase in demand for warehouse space. This is shown in Figure D – 24. The increase in warehouse space reflects the expanding market for e-commerce. Available data from F.W.Dodge indicates that in 2012 there were no new warehouse additions.

Figure D - 23: Pattern of Retail Space Addition (millions sqf)

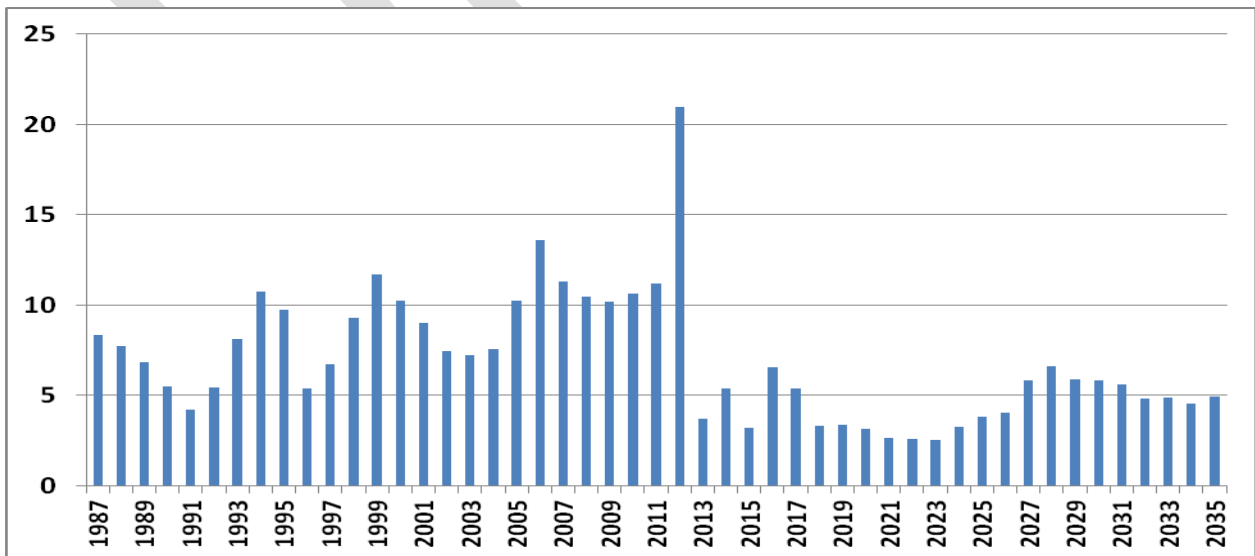
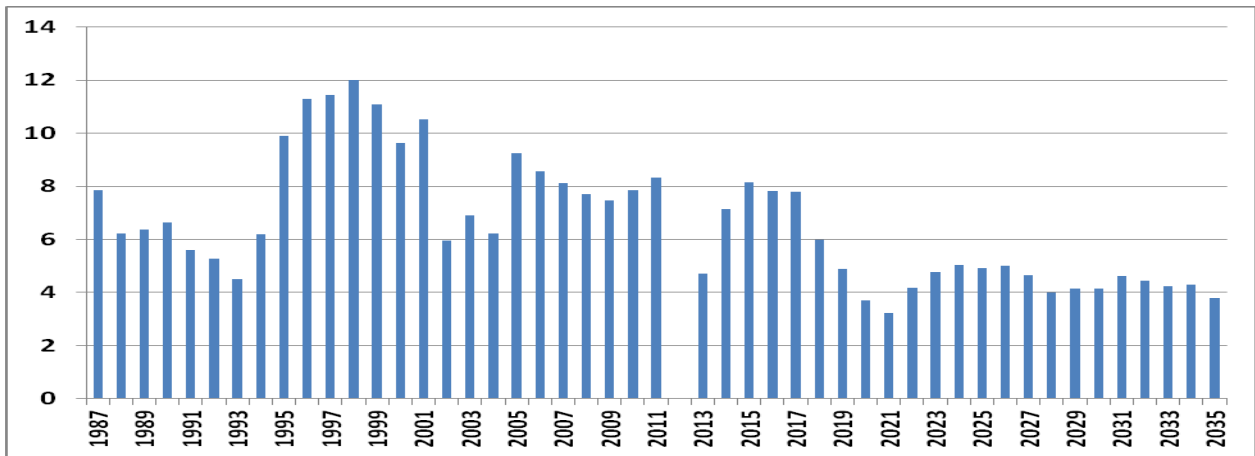


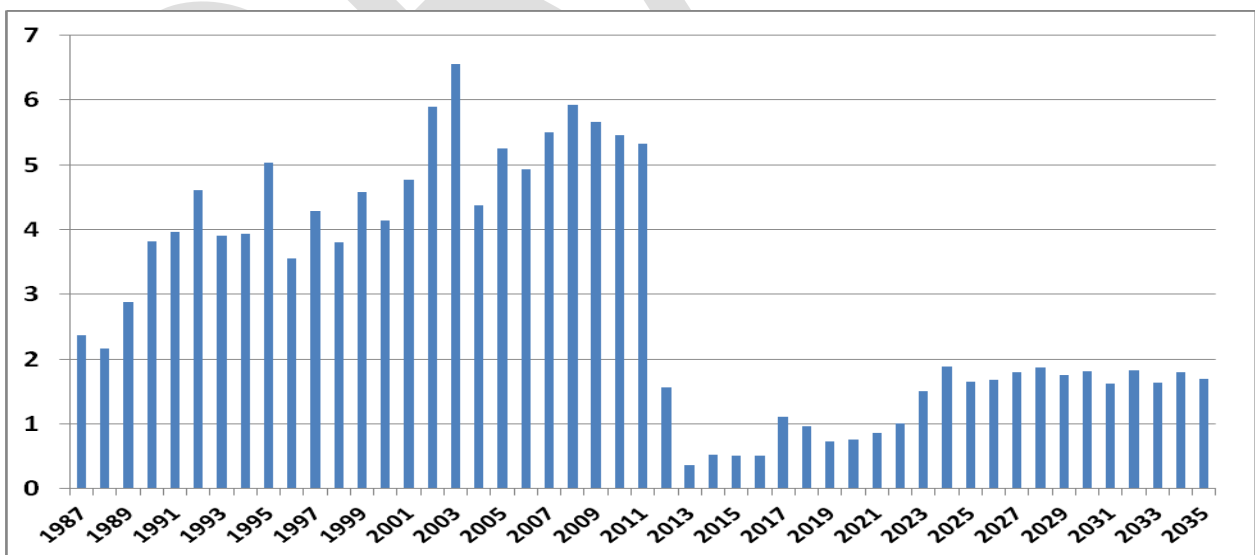


Figure D - 24: Pattern of Warehouse Floor Space Additions (millions of sqf)



The demand for the schools and elder care are driven by the demographic changes facing the region. Population in the region is growing at a slower rate and a larger population is at retirement age. The pattern of floor space additions for K-12 schools shown in Figure D - 25 reflects the declining share of the population under 19 years old. Between 1985 and 2015, the regional population of this age group increased by about 800,000. But between 2015 and 2035, this population group is forecast to grow by about 450,000 people. Expected increase in this population cohort calls for increase in K-12 floors pace additions in post 2020 period. For period 2025 to 2035 floor space additions are stable at just below 2 million square feet per year, significantly below their historic levels.

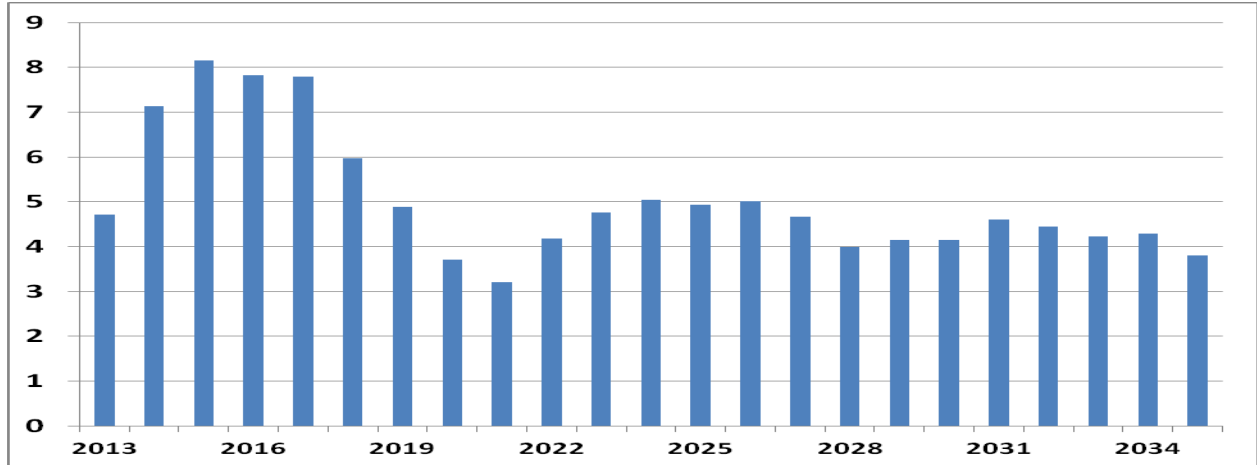
Figure D - 25: Pattern of Floor Space Addition for K-12 Schools (million sqf)



The elderly population, 65 and older, is increasing from about one million in 1985 to about 2.6 million by 2015, and to over 3.8 million by 2035. As shown in Figure D – 26, this more than doubling of population is forecast to increase the demand for special elder care facilities. In the 2011 to 2018

period, new floor space for these facilities is forecast to increase significantly to about 7 to 8 million square feet per year. After 2020, the forecast for new floor space drops is to drop to 4 to 5 million square feet per year.

Figure D - 26: Pattern of Floor Space Addition for Elder Care Facilities (million sqf)



## Commercial Floor Space Stock

Commercial floor space stock is projected to increase from 3.4 billion square feet in 2014 to about 4.3 billion square feet over the 2015 to 2035 period. The detailed projections by business activity type are shown in Table D – 15. As discussed above, sectors showing the greatest increase in floor space additions are large office, warehouse, and other health (elder care) facilities. Note that the warehouse floor space shown in Figure D-24 does not include self-storage facilities or warehouses associated with manufacturing facilities.

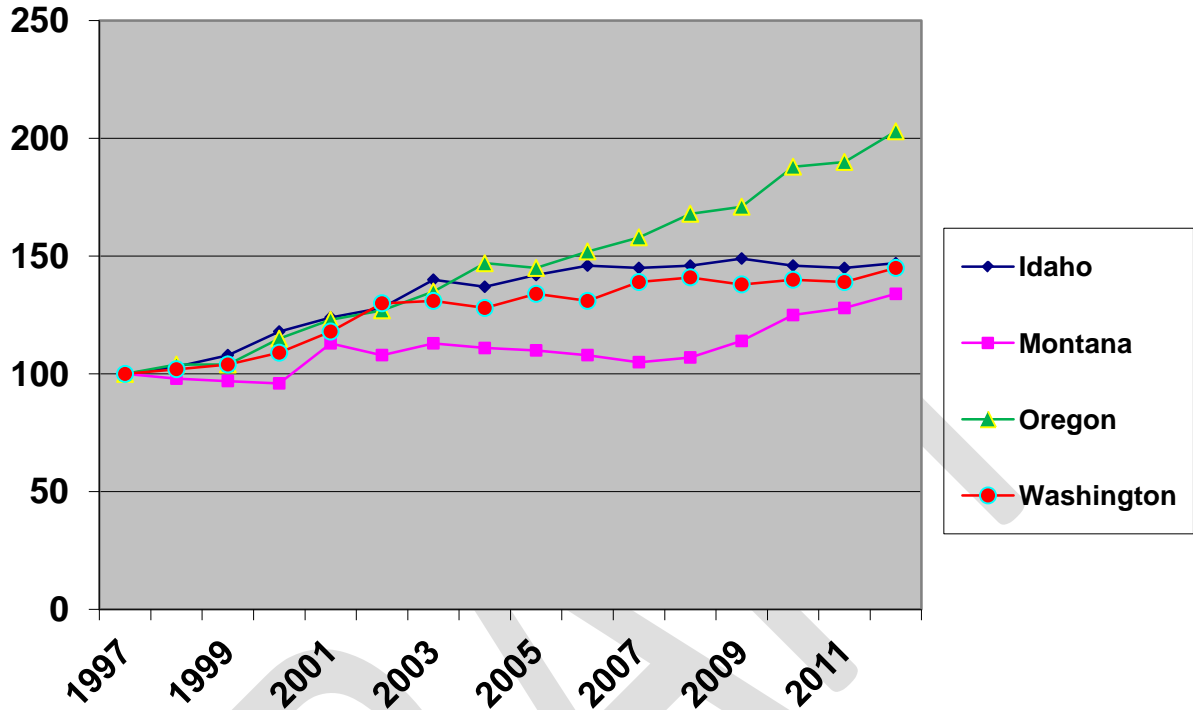
Table D - 15: Regional Commercial Floor Space Stock (millions sqf)

Regional Summary	1985	2015	2035	2015-2035 Addition
<b>Large Office</b>	189.911	305.491	445.049	146
<b>Medium Office</b>	49.259	158.054	272.482	116
<b>Small Office</b>	89.857	144.699	174.792	30
<b>Big Box-Retail</b>	19.572	149.706	175.298	25
<b>Small Box-Retail</b>	177.439	228.833	239.274	10
<b>High End-Retail</b>	44.359	103.924	144.514	39
<b>Anchor-Retail</b>	98.396	119.516	132.465	12
<b>K-12</b>	154.927	273.148	301.617	29
<b>University</b>	77.102	136.314	156.932	21
<b>Warehouse</b>	170.346	401.449	497.119	100
<b>Supermarket</b>	45.303	62.833	68.689	6
<b>Mini Marts</b>	5.438	26.267	28.676	2
<b>Restaurant</b>	35.746	128.135	139.609	11
<b>Lodging</b>	115.54	186.938	210.178	23
<b>Hospital</b>	38.939	106.338	149.243	44
<b>Other Health ( Elder Care)</b>	84.526	178.798	233.711	56
<b>Assembly</b>	123.494	250.185	336.99	88
<b>Other</b>	239.726	448.864	651.017	205
<b>Total</b>	1759.88	3409.49	4357.66	963

## ECONOMIC DRIVERS FOR INDUSTRIAL SECTOR DEMAND

Demand for energy in the industrial sector is driven by the demand for goods and products produced in the region. Historically, demand for electricity in the industrial sector was dominated by a few large energy-intensive industries. However, the regional mix of industries has been changing toward less electricity and energy-intensive industries, and the region's industry mix now resemble the rest of the country. Figure D – 27 shows the total energy use per dollar of Gross State Product (GSP in constant dollars) for the Northwest since 1997. Since 1960 there has been a trend toward less energy use in the Northwest's industrial sector. During the 1980s and 1990s, industries in the Northwest used significantly more energy for every dollar of output they produced.

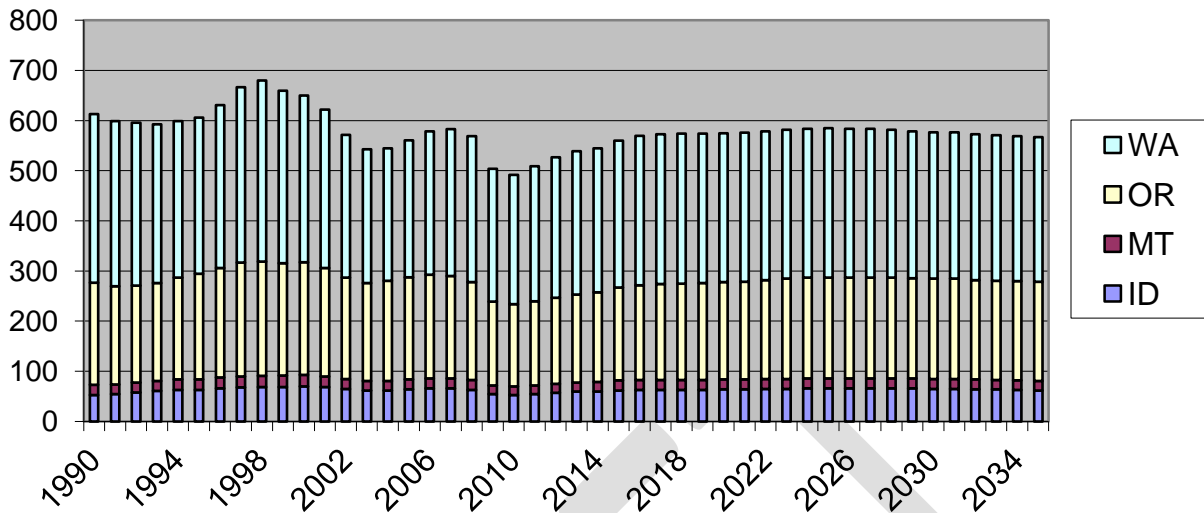
Figure D - 27: Change in Regional Energy Intensity  
 2012 \$GSP/Energy consumption Indexed to 1997 levels



## Projected Employment Growth

The demand forecast model tracks distinct industries. In the Seventh Plan, the Council used the growth in employment and changes in productivity for each industry to forecast future electricity demand. Productivity was measured in terms of dollars of output per employee times hours worked. Industrial employment has been on the decline, but the Seventh Plan forecast is for a projected slight increase in the 2015-2020 period, stable in the 2020-2030 period, followed by a slight decrease from 2030-2035. Figure D - 28 shows the number of industrial employees for selected historic and forecast periods. Industrial employment peaked at about 650,000 in 2000, but it declined significantly during the 2000-2010 period. By 2010 it was down to about 500,000 employees. By 2035 employment in manufacturing is expected to reach to about 570,000 employees.

Figure D - 28: Employment in Manufacturing Sectors (1000s)



The demand for energy consumed in each industry is forecast using the estimated growth in the product output in that industry. Output in each industry is forecast starting with the projected output from Global Insight. The output level projections are then modified, based on input from Demand Forecast Advisory Committee.

## Industrial Output

State level industrial output is forecasted using Global Insight's product Business Markets Insight. The 4 to 6 digit NAICS code forecasts were used to identify fast growing industries. Growth in output of major industries in the Northwest and nation reflect changes in productivity observed over the past few decades. The following three figures show the change in labor productivity in the United States. Decline in productivity since the start of the recession has been significant, the growth rate dropping by a full percentage point. Drop in manufacturing sector has been even more pronounced, dropping by 2 full percentage points since start of the 2007 recession.

Figure D - 29: Average Annual Percent Change in non-farm Business sector (National Data)

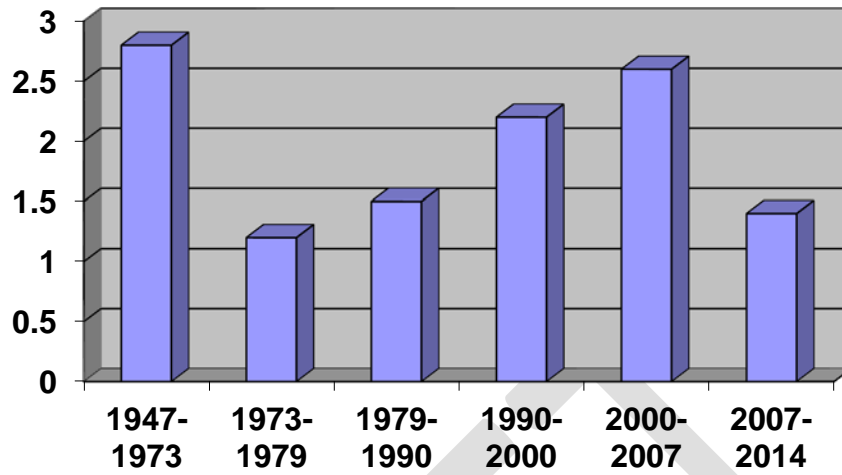


Figure D - 30: Average Annual Percent Change in Manufacturing sector (National Data)

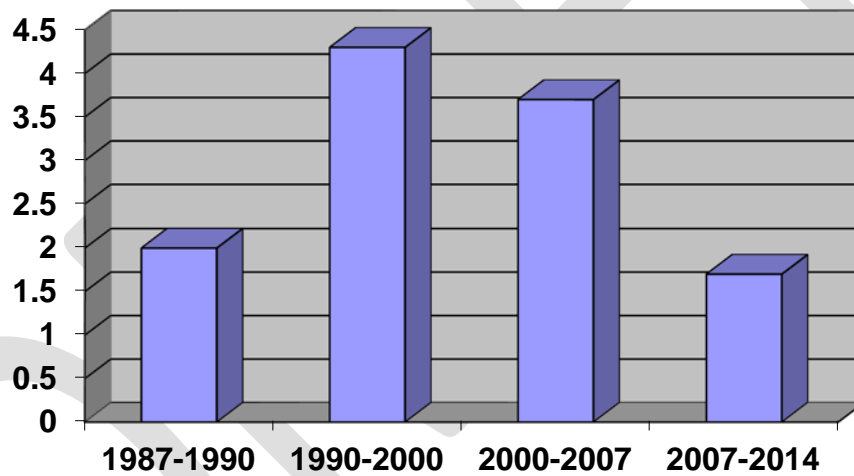
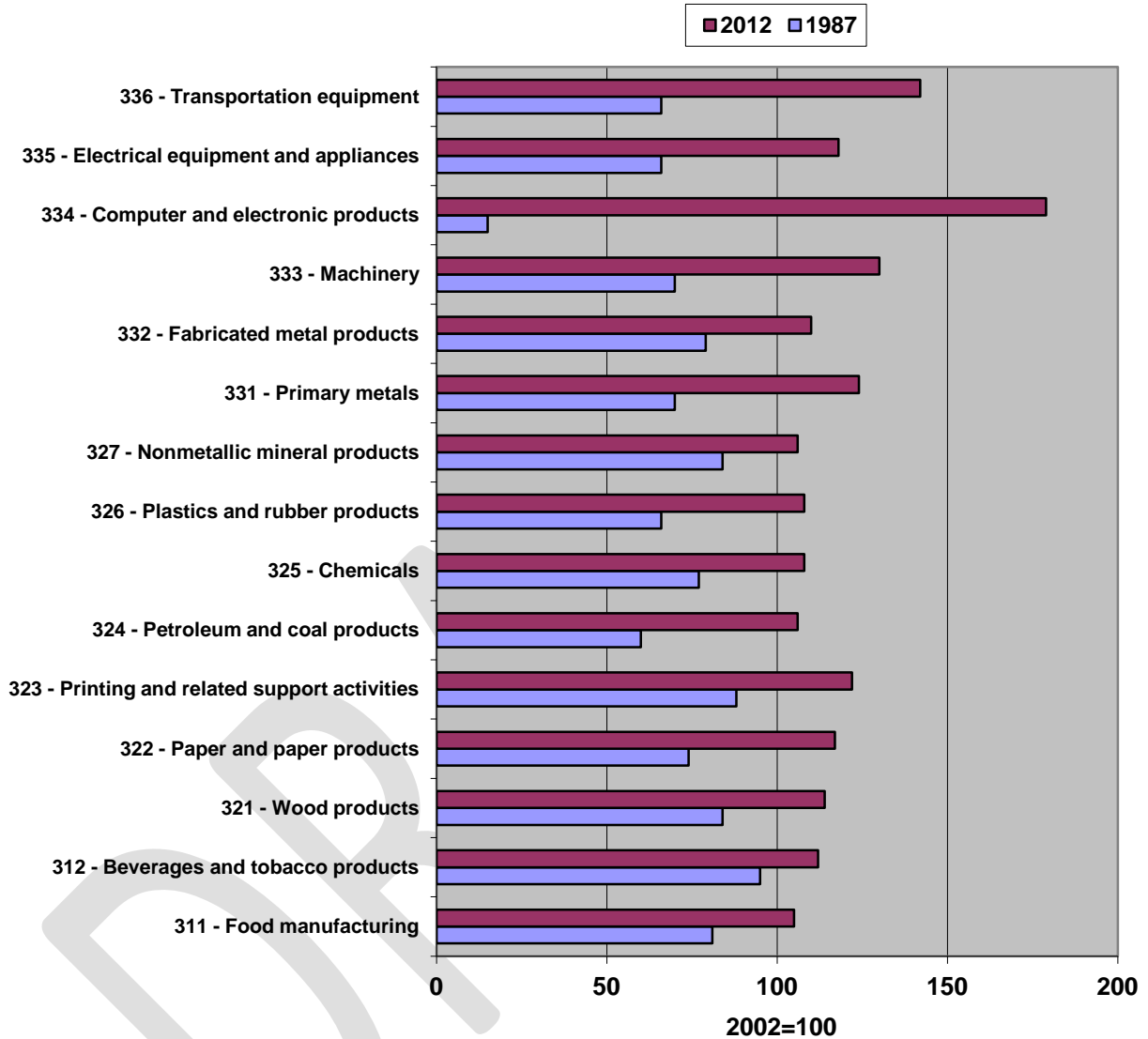


Figure D - 31: National improvement in Labor Productivity 1987 and 2012 indexed to 2000



Labor productivity is measured as dollar value of output per one hour of labor.

The composition of industrial output is also forecast to change. Manufacturing facilities producing food, rubber, paper, transportation, and chemicals are forecasted to grow while machines and computer (hardware) and lumber are projected to decline further.

Table D – 16 shows the dollar value of industrial output, which drives demand for this sector.

Table D - 16: Regional Industrial Output (billions of \$2012)

	1985	2007	2015	2035	1985-2015 AAGR	2015-2035 AAGR
Food & Tobacco	8.5908	13.7142	15.9948	27.4651	2%	3%
Textiles	0.2022	0.5799	0.7792	0.8842	5%	1%
Apparel	0.6289	0.3308	0.2227	0.1838	-3%	-1%
Lumber	19.0112	9.5444	9.2299	5.2684	-2%	-3%
Furniture	0.5779	2.7812	1.5556	3.1815	3%	4%
Paper	5.4951	6.2486	4.8832	8.697	0%	3%
Printing	3.7553	1.6765	1.128	1.4294	-4%	1%
Chemicals	0.9843	3.7532	4.8415	12.9812	5%	5%
Petroleum Products	3.2162	5.3746	6.1474	9.3096	2%	2%
Rubber	0.9495	2.5096	2.4278	4.9968	3%	4%
Leather	0.0796	0.0796	0.0971	0.0796	1%	-1%
Stone, Clay, etc.	1.409	3.4592	3.0906	6.1438	3%	3%
Fabricated Metals	1.9297	3.2182	3.6902	3.1243	2%	-1%
Machines & Computer	3.0018	7.1634	7.7106	6.851	3%	-1%
Electric Equipment	8.8317	8.9195	9.8285	9.671	0%	0%
Transport Equipment	2.7853	1.2824	1.2669	1.4886	-3%	1%
Other Manufacturing	23.2831	28.9599	29.0039	36.1335	1%	1%
Agriculture	0.9822	3.2713	4.0204	8.9499	5%	4%

Two other sectors are included in the industrial demand for electricity: custom data centers and Direct Service Industries. The demand for electricity from direct service industries is based on projections provided in the BPA White Book 2012 and data from the Chelan Public Utility District. Detailed discussions on the methodology and forecast for both custom data centers and direct service industries are in the demand forecast Appendix E.

## ECONOMIC DRIVERS FOR OTHER SECTORS

### Irrigation

Demand for electricity for irrigation is linked to agricultural output. A forecast of agricultural output in constant dollars is provided in the Table D -16. Agricultural output in the region is forecast to increase from about \$4 billion in 2015 to about \$9 billion by 2035.

### Transportation

In the current analysis, demand for electricity in the transportation sector is not limited to public transportation, such as the electric rail and bus transportation systems in Portland and Seattle; it also includes electric demand for powering plug-in hybrid and fully electric vehicles. The key



economic driver for the demand for PHEV is the forecast demand for new vehicles, a percentage of which is assumed to be plug-in hybrids/electric vehicles. A forecast of new vehicles is provided by Global Insight’s Q3 2014 for each state in the Northwest. The market share of PHEVs will depend on consumer consideration of the purchase price, available incentives, cost of gasoline, and the price of alternative vehicles. Using the data from 2010-2013 indicated that penetration rate of electric vehicles are significantly less in Idaho and Montana compared to the Oregon and Washington. Using this information the Council has assumed that future penetration rates to vary significantly by state. Table D – 17 shows the market share for electric vehicles by state for 2010, 2015 and 2035. As can be seen from this table, the market share of electric vehicles in Idaho and Montana is assumed to be half of Oregon and Washington. Further details are provided in Appendix E.

Table D - 17: Forecast number of new vehicle additions and assumed market share of electric vehicles

Year	Idaho	Montana	Oregon	Washington	Region	Market share for Idaho and Montana	Market share for Oregon and Washington
2010	32	40	99	174	345	0.07%	0.20%
2015	48	60	160	249	517	1.60%	3.00%
2035	58	55	161	287	561	14.50%	29.00%

## ALTERNATIVE ECONOMIC SCENARIOS

Because future economic conditions are highly uncertain, the forecasts encompass a wide range of possibilities for future economic growth. The demand forecast includes three alternative sets of economic drivers. In the base case scenario, discussed earlier, the key economic drivers project a healthy regional economy (albeit with a slower growth path than in the recent past). In addition to the base case, two alternative scenarios are considered, one representing a low-economic-growth scenario and the other a high-growth projection of the future.

The low-growth scenario reflects a future with slow economic growth, weak demand for fossil fuel, declining fuel prices, a slowdown in labor productivity, and a low inflation rate. On the other hand, the high-case scenario assumes faster economic growth, stronger demand for energy, higher prices for fossil fuel, sustained growth in labor productivity, and a higher inflation rate.

To estimate the low and high range for each key variable for each year, the base value for the driver was multiplied by an annual factor that increases the value (for the high case) or reduces it (for the low case). For example, if the base case value for new floor space additions for warehouses were 100,000 square feet, for the low-growth scenario the 100,000 square feet is lowered by 9 percent, and for the high-growth scenario it is increased by 20 percent. The 9 percent and 20 percent figures are averages; the actual percentage values used in the model vary by year. Tables D – 18 and D – 19 show the range of percent change from the base case scenario for each commercial building type and each industry. Similar methodology is used in developing each key economic driver.

The average annual growth rates presented above are summary values. The demand forecasting system, however, uses the year-by-year values rather than the annual average values. The source

of the range forecast used in the Seventh Plan, is Global Insight's long-term national forecast, Q4 2014.

Tables D – 18 and D – 19 also show the annual growth rate for the historic and forecast period for the region. In general, the key economic drivers reflect a slowdown in economic growth for 2015-2035 compared to historic growth rates.

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Table D - 18: Historic and Forecast of Annual Growth Rate by Sector

	Actual	Base	Low	High
	1985-2012	2013-2035	2013-2035	2013-2035
Single Family - Million Sq Ft	1.8%	1.10%	0.72%	1.52%
Multi Family - Million Sq Ft	2.8%	2.15%	1.82%	2.76%
Other Family - Million Sq Ft	2.7%	0.34%	0.23%	0.57%
Large Office - Million Sq Ft	1.8%	1.99%	1.81%	2.22%
Medium Office - Million Sq Ft	4.4%	2.91%	2.74%	3.15%
Small Office - Million Sq Ft	1.8%	0.97%	0.80%	1.21%
Big Box-Retail - Million Sq Ft	7.8%	0.80%	0.61%	1.03%
Small Box-Retail - Million Sq Ft	0.9%	0.22%	0.03%	0.45%
High End-Retail - Million Sq Ft	3.2%	1.68%	1.49%	1.92%
Anchor-Retail - Million Sq Ft	0.7%	0.51%	0.32%	0.75%
K-12 - Million Sq Ft	2.1%	0.47%	0.20%	0.72%
University - Million Sq Ft	2.1%	0.69%	0.42%	0.94%
Warehouse - Million Sq Ft	3.2%	1.15%	0.78%	1.38%
Supermarket - Million Sq Ft	1.2%	0.50%	0.30%	0.73%
Mini Mart - Million Sq Ft	6.0%	0.47%	0.27%	0.70%
Restaurant - Million Sq Ft	4.8%	0.46%	0.24%	0.69%
Lodging - Million Sq Ft	1.8%	0.65%	0.43%	0.87%
Hospital - Million Sq Ft	3.8%	1.83%	1.57%	2.07%
Other Health - Million Sq Ft	2.8%	1.37%	1.12%	1.62%
Assembly - Million Sq Ft	2.6%	1.62%	1.38%	1.85%
Other - Million Sq Ft	2.4%	1.89%	1.51%	2.12%
Food & Tobacco - 2012 B\$	2.3%	2.66%	2.35%	2.79%
Textiles - 2012 B\$	5.1%	0.77%	0.31%	0.86%
Apparel - 2012 B\$	-3.8%	-0.99%	-1.35%	-0.85%
Lumber - 2012 B\$	-2.6%	-1.93%	-2.19%	-1.79%
Furniture - 2012 B\$	3.7%	3.48%	3.37%	3.67%
Paper - 2012 B\$	-0.4%	2.83%	2.59%	2.97%
Printing - 2012 B\$	-4.4%	1.07%	0.84%	1.20%
Chemicals - 2012 B\$	6.1%	5.11%	4.91%	5.28%
Petroleum Products - 2012 B\$	2.4%	2.11%	1.91%	2.26%
Rubber - 2012 B\$	3.5%	3.62%	3.45%	3.79%
Leather - 2012 B\$	0.7%	-1.21%	-1.58%	-1.07%
Stone, Clay, etc. - 2012 B\$	3.0%	3.75%	3.47%	3.90%
Other Primary Metals - 2012 B\$	2.4%	-0.50%	-0.73%	-0.35%
Fabricated Metals - 2012 B\$	3.6%	-0.40%	-0.57%	-0.25%
Machines & Computer - 2012 B\$	0.4%	0.21%	-0.16%	0.37%
Electric Equipment - 2012 B\$	-2.9%	0.90%	0.75%	1.06%
Transport Equipment - 2012 B\$	0.8%	0.96%	0.85%	1.14%
Other Manufacturing - 2012 B\$	5.4%	3.95%	3.82%	4.14%
Agriculture - 2012 B\$	0.4%	1.15%	0.63%	1.88%

Summary range of annual average growth rates by sector are in the table below.

Table D - 19: Forecast of Range of Annual Growth Rate by Sector

	Base case	High case	Low case
Residential Units	1.18%	2.0%	0.08%
Commercial Floor space	1.11%	2.1%	0.67%
Industrial output	1.56%	2.4%	0.95%
Agricultural output	0.81%	2.0%	0.26%

Additional Details: A companion Excel workbook containing details on the economic drivers is available from Council's website: <http://www.nwcouncil.org/energy/powerplan/7/technical>