Study on Natural Gas Needs and Alternatives as they may be met by the Jordan Cove Energy Facility at Coos Bay

Revised Draft on Task 1 – Natural Gas and Electricity Supply/Demand Projections

Submitted to:
Jordan Cove Energy Project, L.P.
125 Central Avenues, Suite 380
Coos Bay, Oregon 97420

Submitted by:
ICF International
9300 Lee Highway
Fairfax, VA 22031 USA
Tel: 1.703.934.3000
Fax: 1.703.934.3968

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Chapter 1

Executive Summary for Task 1

I.1 Introduction

ICF was retained by the Jordan Cove Energy Project (JCEP) in February 2008 to provide an assessment of the outlook for natural gas consumption in the Pacific Northwest over the 2008 to 2030 period. This assessment is based on a review of publicly available information and forecasts, and is summarized in this report.

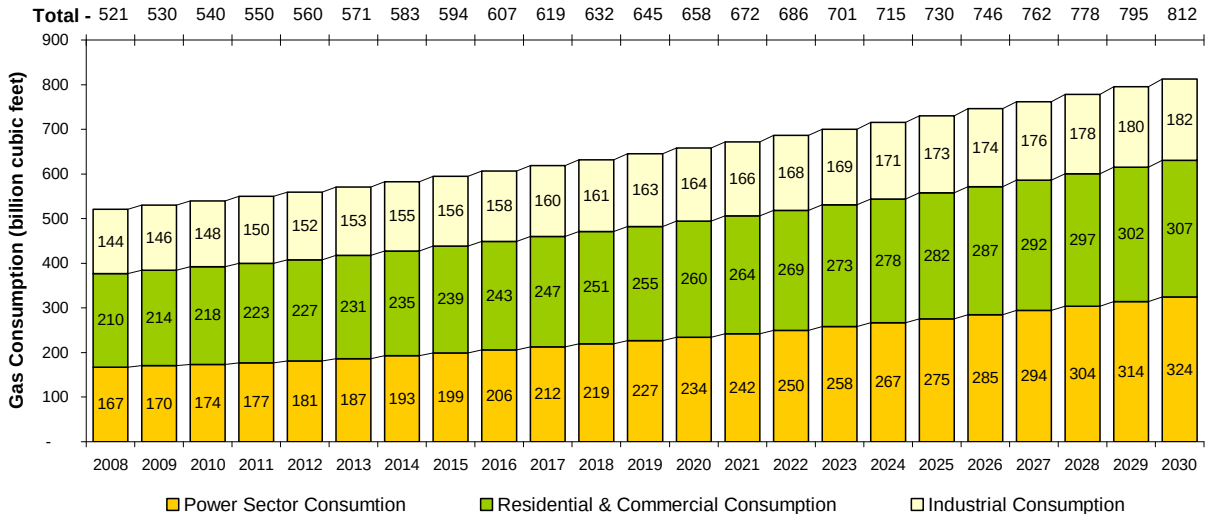
The Base Case projection will be used as a starting point for scenario analysis in a study of the potential impacts of Jordan Cove LNG imports into the Pacific Northwest. Task 2 of this study is a comprehensive analysis of LNG and the Pacific Northwest gas market.

I.2 Outlook for Natural Gas Consumption in the Pacific Northwest

Historically, i.e. in the 1990s, the industrial sector was the largest consumer of natural gas in Oregon and Washington. However, in recent years, the power sector is emerging as the increasingly dominant consumer class, and in Oregon, the power sector has now eclipsed the industrial sector as the largest natural gas end-user. This trend is expected to continue, with gas consumption from the power sector expected to increase at a more rapid pace than other sectors.

Exhibit 1-1 summarizes our Base Case projection for gas consumption for key sectors between 2008 and 2030. The overall growth rate is projected to be approximately 2 percent on average. This is nearly identical to the historical market growth rate from 1997 to 2006, although there are differences among individual sector growth rates. The growth rate is projected to be highest for the power sector at approximately 3.1 percent on average, and lowest for the industrial sector at 1.1 percent on average. Natural gas consumption in the commercial and residential sectors (referred to in this report as the "CORE" sector) is projected to grow at an annual average rate of 1.7 percent, consistent with recent historical trends. Modest industrial gas consumption is consistent with a growing economy.

Exhibit 1-1
Summary of Base Case Pacific Northwest (OR+WA) Gas Consumption Forecast



I.3 Gas Consumption from the Power Sector

Historically, hydroelectric generation has been the dominant form of electric generation in the Pacific Northwest; on average, hydro has contributed around 70 percent to the overall generation mix. Other generation requirements have been met through a combination of natural gas, coal, nuclear, and a small amount of renewable resources. Going forward, however, due to environmental constraints and limited resources, the region has limited potential to bring additional hydroelectric capacity into service and in fact, may be facing decreasing hydroelectric capacity and generation over time.

Amid growing concerns about climate change and associated opposition to coal-fired generation (particularly vocal in the Pacific Northwest and California), options for incremental sources of energy are thus limited to nuclear, natural gas and renewables. In the Pacific Northwest, there are currently no announced plans for development of nuclear facilities and hence the practical alternatives for the foreseeable future appear to be natural gas fired capacity and renewable capacity. While renewable sources have the potential to play an increasing role, especially in light of Renewable Portfolio Standard (RPS) requirements in both Oregon and Washington, they have clear constraints and limitations associated; intermittent availability, interconnection problems, and in some cases, prohibitively high cost (e.g. solar). The intermittent nature of renewable sources, such as wind, poses concern for system reliability, particularly when capacity of such sources in the overall system increases. While the hydro system has some capacity for providing the rapid response generation (i.e. operating reserves) in the event of sudden and unanticipated decreases in wind output, natural gas generation is normally the source of such generation in the US and is not likely to be impacted by tightening environmental controls. Furthermore, seasonal variations in renewable output may increase the overall variability of supply when combined with the large variability of the region's hydroelectric system.

As the region of the country most reliant on hydroelectric generation from legacy dams, the variability of hydroelectric supplies can greatly increase the importance of natural gas generation very rapidly. The range of hydroelectric output is plus or minus 12% when expressed on a capacity factor or generation basis,[1] which is the equivalent of 226,000 MMCf per year (approximately 45 percent of annual gas consumption) assuming natural gas generation makes up the entire difference.[2] This is of course an extreme example but illustrates the potential for a significant increase in natural gas consumption in order to backfill any shortfall in hydroelectric generation. Indeed, a contributing factor to the western energy crisis of 2000-2001 (and the increase in gas consumption from the power sector) was the Pacific Northwest's hydroelectric shortfall. Additionally, any increase in hydrological variability due to climatic changes further increases the importance of natural gas as a "swing fuel".

The key role of natural gas generation in meeting incremental demand has important implications due to the potential for significant electricity demand growth. The Pacific Northwest has seen a steady increase in electricity demand growth over the long-term on average, with the exception of the significant decrease in demand levels in Oregon and Washington in 2001 (associated with the western energy and economic crisis, the extremely high wholesale power prices that resulted in the closing of many industrial facilities in the northwest). Since then, peak and energy demand have been growing robustly at an average rate of 3.8% and 2.3%, respectively (over the 2001 to 2006 period). To the extent this recovery in demand growth is more indicative of the future of the Pacific Northwest, the potential for increased demand for natural gas is greater.

Thus, natural gas fired generation is expected to play a strong role going forward as it can not only provide reliable, continuous power to meet incremental demand needs, but can also act as a supplemental resource to address the variability and intermittent nature of generation from hydro and wind resources. Natural gas consumption from the power sector is accordingly expected to increase at a strong pace as well.

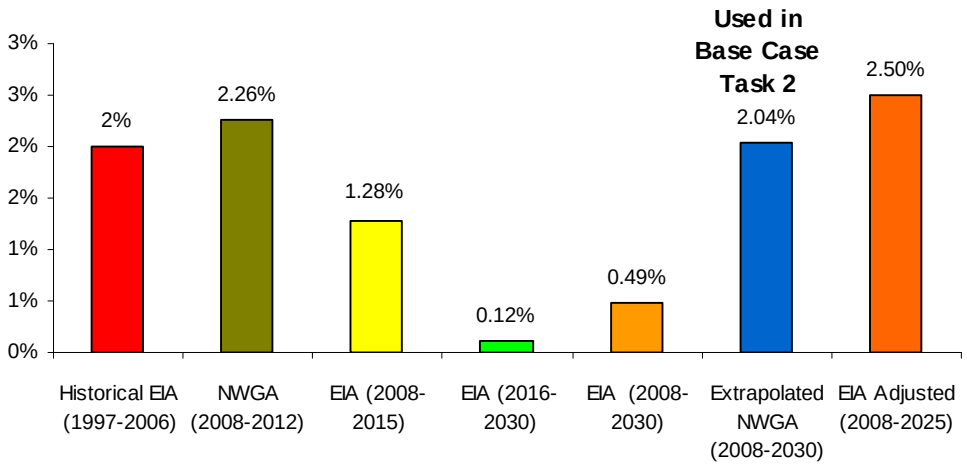
[1] The average capacity factor over the 1995 to 2006 period was 44.5%, the maximum was 56% and the lowest annual level was 31%.

[2] 31,000 GWh hydro generation variability substituted with 7500 Btu/kWh heat rate gas fired generation results in 233,000,000 equivalent MMBtu (226,00 MMCfd) of gas consumption

I.4 Comparison of Base Case Projections for Gas Use

As can be seen in Exhibit 1-2, our Base Case projection for natural gas consumption is similar to the historical experience in the region (on average across all sectors). As our Base Case projection is derived largely from an extrapolation of NWGA projections, it is also very similar to the 2008-2012 NWGA projections on average. The Base Case projection is considerably higher than the EIA projections, but as we discuss in this report, we believe the EIA projections for natural gas consumption are considerably understated as they are predicated on a view that incremental power generation in the Pacific Northwest (and California) are going to be predominantly met through increased coal-fired generation. We believe this to be an unreasonable assumption considering (i) present opposition to new coal plants in the Pacific Northwest, including recent decisions in Oregon rejecting new coal projects, (ii) the small share of existing coal power plant capacity in the region in the overall capacity mix, (iii) the paucity of local coal production, (iv) the history of remote coal generation in coal-producing regions in Utah, Wyoming and Montana being complicated by the need for new transmission, (v) likely forthcoming national green house gas (GHG) emissions cap regulations (not embedded in EIA's base case), and (vi) the significant increase in new coal plant construction costs. When the EIA projection is revised to assume that incremental coal-fired generation will be met by a combination of natural gas and renewables generation, the EIA adjusted projection exceeds our Base Case projection.

Exhibit 1-2
Pacific Northwest Annual Average Gas Consumption Growth Rates for All Sectors



Acronyms
EIA: Energy Information Administration (part of the Department of Energy)
NWGA: NorthWest Gas Association

Sources
EIA Annual Energy Outlook 2007 for forecasted information
EIA Natural Gas, US Data for historical information
NWGA Northwest Gas Outlook For Years 2007-2012, published fall 2007
EIA Adjusted reflects ICF's adjustment of the EIA 2008-2025 forecast as described previously and in chapter 4

Chapter 2

Background on the Power and Natural Gas Sectors in the Pacific Northwest

II.1 Introduction

This chapter provides an overview of the supply/demand profile for both the electric power and natural gas sectors in Oregon and the Pacific Northwest more broadly (including Washington). The first section focuses on the electric supply/demand profile, with discussion on the historical capacity and generation mix, followed by a discussion of historical peak and energy demand trends. The second section focuses on the natural gas sector, with discussion of historical gas consumption by sector (and in aggregate), supply sources and international/interstate gas imports and exports for Oregon and the Pacific Northwest.

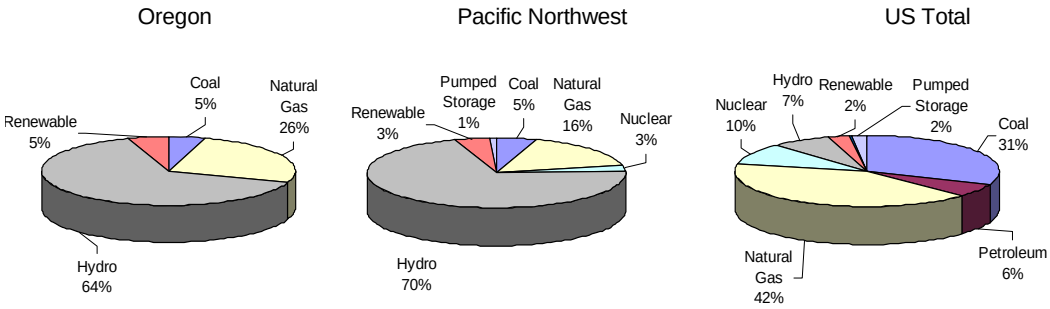
II.2 Electric Supply/Demand Profile

II.2.1 Capacity and Generation Mix

Historically, the capacity and generation mix in Oregon and the Pacific Northwest has been dominated by hydro generating units, considerably more so than almost all other regions across the US. In 2006, hydroelectric units accounted for about 64 percent of total installed capacity in Oregon and 70 percent in the Pacific Northwest more broadly (see Exhibit 2-1). This contrasts with 7 percent for the US as a whole. Generation levels are even higher, with hydro accounting for 71, 74, and 7 percent of the overall 2006 generation mix in Oregon, the Pacific Northwest, and the US, respectively (see Exhibit 2-2). Hydroelectric units have negligible variable costs (as there are no fuel costs) and hence they are always dispatched to the maximum extent available. Availability is in turn driven by the hydrological and weather conditions prevailing at the time, but is also a function of any environmental or other constraints limiting water flow and hydro generation.

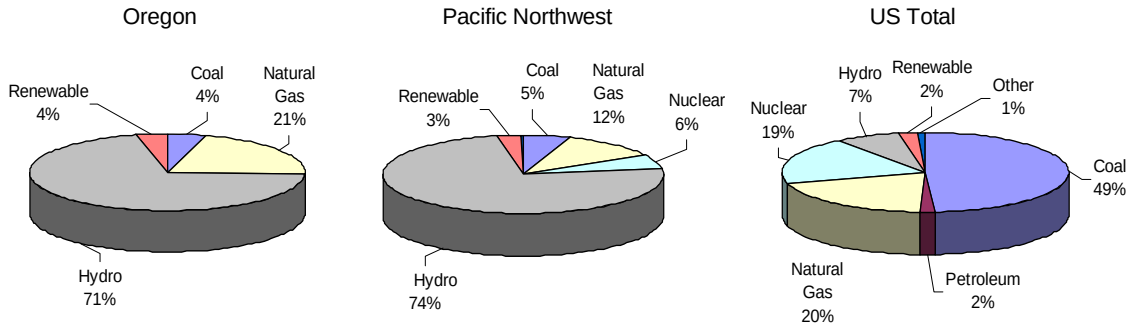
Natural gas capacity is the next most important resource in the Pacific Northwest capacity and generation mix, accounting for 16 and 12 percent of the capacity and generation mix, respectively. The remainder of generation comes from a combination of nuclear, coal, and renewable capacity.

Exhibit 2-1
Capacity Mix of Oregon, Pacific Northwest and US total - 2006



Source: EIA

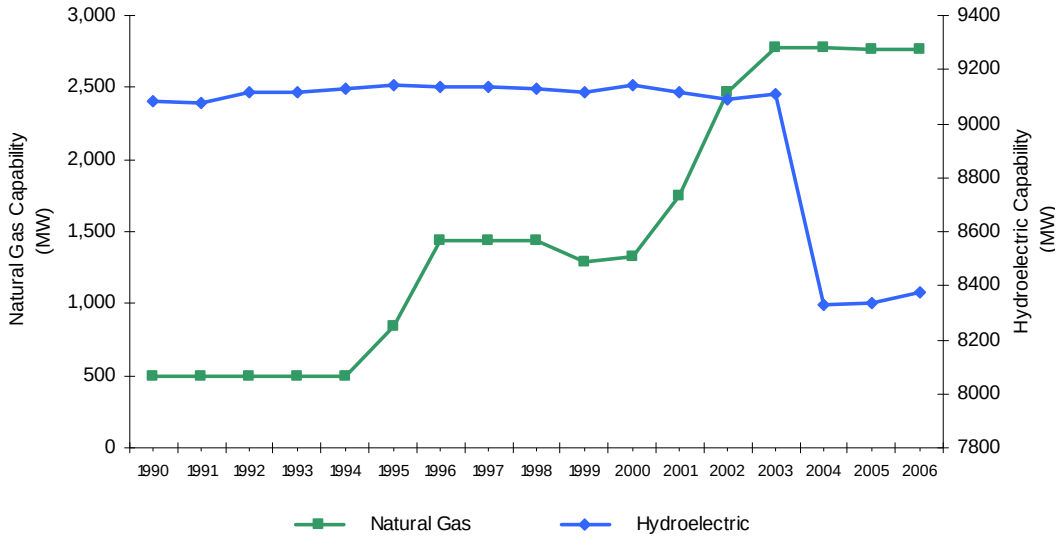
Exhibit 2-2
Generation Mix of Oregon, Pacific Northwest and US Total - 2006



Source: EIA

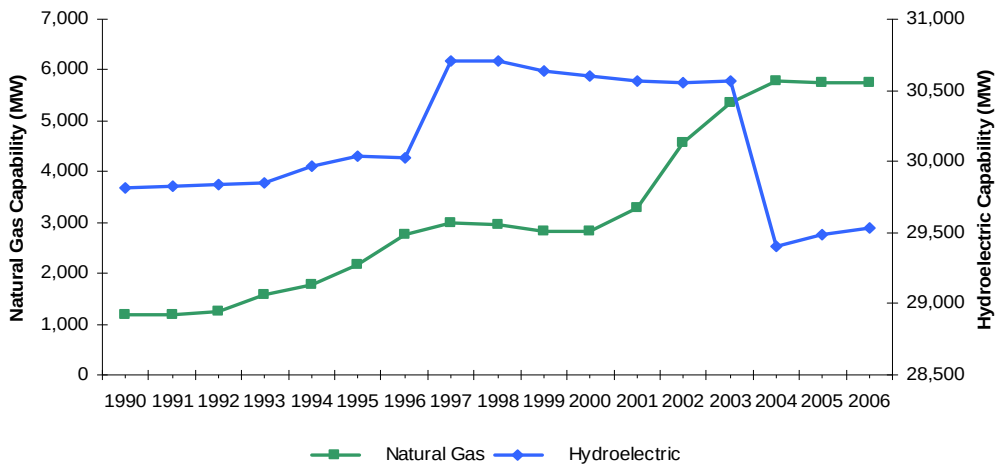
Natural gas capacity has been the most dynamic aspect of the capacity mix over the past two decades. Specifically, gas-fired capacity in Oregon has increased from 500 MW in 1990 to roughly 2,800 MW in 2006. In Washington, gas fired capacity has increased from 700 MW to roughly 3,000 MW in the same period and will further increase to approximately 3,900 MW by end of 2008. In contrast, in Oregon, hydro capacity has remained virtually static over the past 15 years except in 2004 when there was a decline from 9,100 MW to 8,300 MW, due to a revision in the operating norms for hydro units. In Washington, similarly, hydro capacity has remained largely static since 1997 except in 2004 when there was a small decline in capacity, from 21,450 MW to 21,100 MW. Exhibits 2-3 and 2-4 summarize Oregon and Pacific Northwest natural gas and hydro capacity over the 1990 to 2006 period.

Exhibit 2-3
Oregon Natural Gas and Hydroelectric Capability 1990-2006



Source: EIA

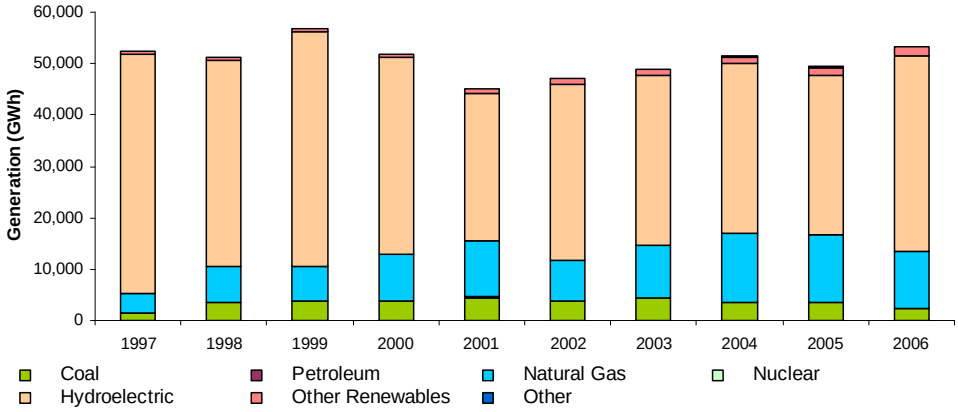
Exhibit 2-4
Pacific Northwest Natural Gas and Hydroelectric Capability 1990-2006



Source: EIA

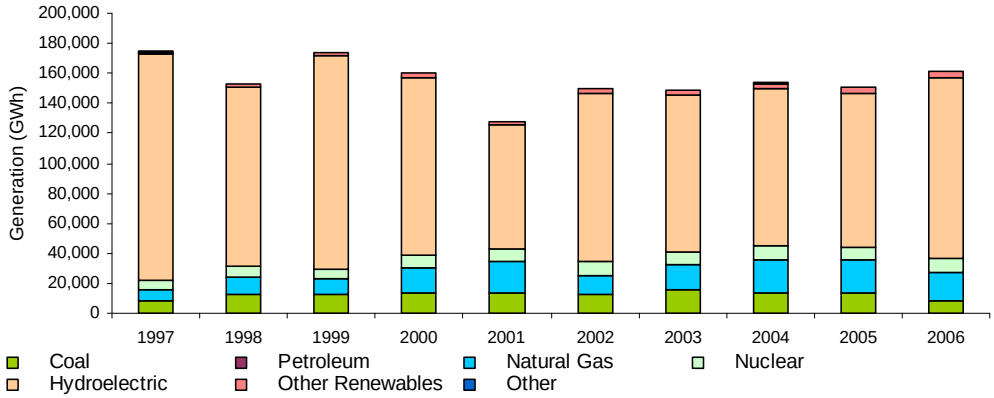
The multi-year trend of increasing reliance on natural gas to meet electricity demand growth rather than building new hydro-electric dams co-exists with year-by-year variation in hydroelectric conditions which can be quite significant. Since gas generation effectively fills in for hydroelectric shortfalls, gas-fired generation is inversely correlated with hydro generation, all else being equal (see chapter 3 for additional discussion). But, on a weather normal basis, since hydro capacity has not increased (and rather decreased slightly) in the past ten years, incremental energy requirements are being met largely through increased gas-fired generation (and secondarily, through increased renewable generation). For example, increasing energy requirements and poor hydro conditions increased gas-fired generation considerably in the 2000 to 2001 period, while increasing energy requirements over time and hydro capacity contraction has led to increased gas-fired generation on average over the 1997 to 2006 period. It should be noted that the 2000 and 2001 shortfalls in hydroelectric generation coincided with the California energy crisis.

Exhibit 2-5
Historical Oregon Generation Mix



Source: EIA

Exhibit 2-6
Historical Pacific Northwest (OR+WA) Generation Mix



Source: EIA

II.2.2 Peak and Energy Demand

Both Oregon and Washington are winter peaking, with 2006 peak demand of 9.3 GW and 16.5 GW respectively, for a total of 25.8 GW.[3] This represents approximately 3 percent of the total US peak demand of 790 GW in 2006. Total Oregon and Washington energy demand in 2006 was 148,541 GWh, reflecting a 66 percent load factor[4]. The Pacific Northwest is the only major US region in which the annual peak demand occurs during the winter; all other major regions peak during the summer air conditioning season. The Pacific Northwest has also had among the lowest average generation costs and the lowest retail electricity prices facilitating significant electric heating. This diversity has affected many aspects of the power industry, including diversity in power trading and extensive transmission interconnections with neighboring summer peaking regions.

The 10-year rolling average peak and energy demand growth is 0.5 and 0.9 percent, respectively, over the 1986-2006 period. For context, average peak and energy demand growth across the US was 2.5 and 2.6 percent over this period. These low peak and energy demand growth rates in the Pacific Northwest can be explained in part by one or two periods of contraction in demand, associated with the western energy and economic crisis, which in turn resulted in the closing of many industrial facilities in the northwest, significantly reducing electricity demand. For example, in 2001, peak and energy demand across both Oregon and Washington decreased by approximately 10 to 12 percent.

The significant decrease in electricity demand in this period and the associated western energy crisis reflects a relatively unique confluence of events and factors, both fundamental and structural. The period leading up to the 2001 crisis evidenced excess capacity in the west in the early 1990s followed by a period of deregulation, during which virtually no capacity was added while demand continued to grow. This resulted in eroding reserve margins[5], which when compounded with a period of very low hydro availability in 2000 and 2001 (the second driest hydro period in 73 years), resulted in a shortage of generation capacity, which in turn resulted in explosively high wholesale power prices. In addition to shortages, wholesale market structure issues and some degree of market manipulation also prevailed. This combination of factors including high wholesale power prices and retail price caps precipitated utility bankruptcies and financial distress, federal and state government intervention, and litigation. The resultant explosive power prices also had traumatic effects on the industrial sector, with practical annihilation of the aluminum industry.

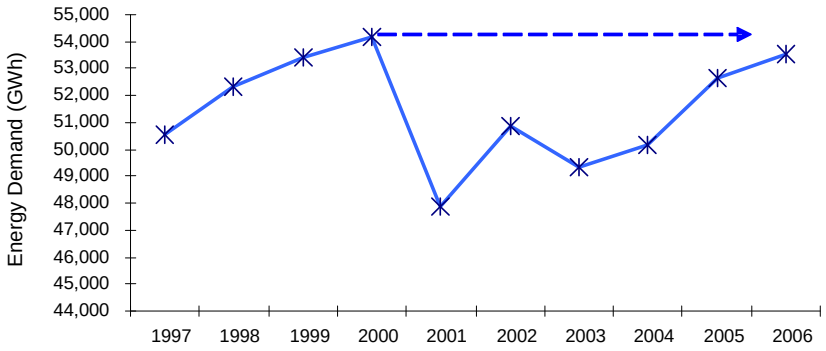
[3] Source: NERC ES&D 2007 for NWPP scaled to estimate Oregon and Washington demand based on historical information from EIA and information from GE MAPS; Oregon summer peak in 2006 was 8.7 GW and Washington summer peak was 15.5 GW

[4] Load factor is a ratio of annual energy demand and peak demand for 8760 hours

[5] Reserve margin is a measure of system reliability and expresses a ratio of available net capacity less peak demand, to peak demand. This is indicative of excess capacity available over peak demand. As reserve margins approach a 13-18% target level, high prices tend to result reflective of shortage or near-shortage conditions.

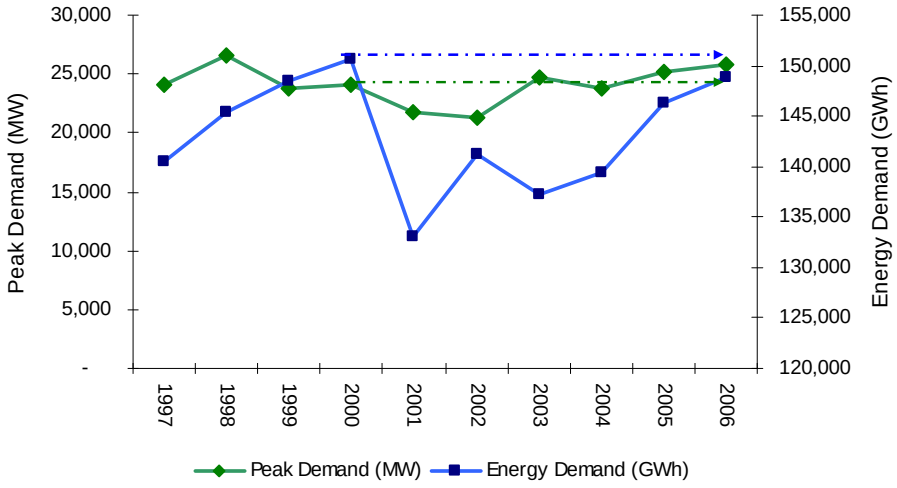
Since 2001, however, peak and energy demand have been growing robustly at an average rate of 3.8% and 2.3%, respectively (over the 2001 to 2006 period). 2006 peak demand has surpassed the 2000 peak demand, while 2006 energy demand is still below, but approaching 2000 levels (see Exhibits 2-7 through 2-9). With the dramatic reduction in industrial load in 2001, generation previously utilized for industrial purposes became available for residential and commercial sectors.

Exhibit 2-7
Oregon Historical Energy Demand 1997-2006



Source: NERC ES&D 2007 for NWPP scaled to estimate Oregon demand based on historical information from EIA and information from GE MAPS; specifically, Oregon demand is 22% of total NWPP demand

Exhibit 2-8
Pacific Northwest (OR+WA) Historical Peak and Energy Demand 1997-2006



Source: NERC ES&D 2007 for NWPP scaled to estimate Pacific Northwest (OR+WA) demand based on historical information from EIA and information from GE MAPS NWPP demand

Exhibit 2-9
Pacific Northwest Historical Electricity Demand Growth 1997-2006

Year	Energy Demand (GWh)	Peak Demand (MW)	%Growth in GWh	%Growth in MW
1997	140,491	24,078	-2.4%	1.6%
1998	145,440	26,617	3.5%	10.5%
1999	148,513	23,838	2.1%	-10.4%
2000	150,616	24,101	1.4%	1.1%
2001	133,057	21,705	-11.7%	-9.9%
2002	141,299	21,292	6.2%	-1.9%
2003	137,178	24,770	-3.0%	16.3%
2004	139,406	23,842	1.6%	-3.8%
2005	146,281	25,175	4.9%	5.6%
2006	148,825	25,806	1.7%	2.5%
Average (1997-2006)			0.8%	1.1%
Average (2001-2006)			2.3%	3.8%

Source: NERC ES&D 2007 for NWPP

II.2.3 Imports and Exports

Historically, the Pacific Northwest has been a net exporter of energy to California and Canada, largely due to the abundance of low variable cost hydroelectricity, but also due to varying seasonal requirements in the northern areas vs. the southern areas. Going forward, as excess capacity across the West diminishes, available capacity in the Pacific Northwest, notable gas-fired capacity may be called on to operate increasingly not only to meet local demand but potentially for exports as well.

Washington has consistently been a net exporter, with net exports totaling roughly 11 percent of local generation (see Exhibit 2-10). In contrast, Oregon has been a net importer in some years and a net exporter in other years and generally at lower levels. On average, over the 1997-2006 period, Oregon was a very small net importer, at a level less than 1 percent of total local generation (see Exhibit 2-11). As such, to some degree, Oregon can be considered a transit point for energy flowing between Washington and California. Additionally, as mentioned earlier, Oregon and Washington imports and exports are dictated in part by varying seasonal requirements. Western Canada and the Pacific Northwest are winter peaking while California and most of the rest of the US are summer peaking. Hence imports may flow north in the winter and south during the summer.

The large role of power imports and exports highlights the significant interaction that other regions have with the Pacific Northwest. Thus, the effects of relatively small shortfalls in supply can have a magnified effect if they are reinforced by trends elsewhere in the western US. In fact, as discussed earlier, one of the factors contributing to the western energy crisis was supply shortages in the Pacific Northwest due to low hydro generation combined with supply shortages elsewhere in the WECC. Note that Washington has consistently been a net interstate exporter of energy, with the notable exception of 2001 when the western energy crises occurred (see Exhibit 2-10).

Exhibit 2-10
Washington Historical Net Trades 1997-2006

Washington					
Year	Net International Trade (GWh)	Net Interstate Trade (GWh)	Net Trade (GWh)	Generation (GWh)	Net Trade as % of Local Generation
1997	-3,632	27,068	23,436	122126	19%
1998	-2,467	1,943	-524	102159	-1%
1999	-1,809	11,262	9,453	117084	8%
2000	1,133	2,365	3,498	108237	3%
2001	5,058	-8,627	-3,569	83049	-4%
2002	1,187	17,460	18,647	102765	18%
2003	1,957	12,786	14,743	100095	15%
2004	4,848	11,430	16,278	102165	16%
2005	3,004	8,996	12,000	101966	12%
2006	8,656	8,465	17,121	108203	16%
Average	1,794	9,315	11,108	104,785	11%

Note: Negative values indicate net imports and positive values indicate net exports

Exhibit 2-11
Oregon Historical Net Trades 1997-2006

Oregon					
Year	Net International Trade (GWh)	Net Interstate Trade (GWh)	Net Trade (GWh)	Generation (GWh)	Net Trade as % of Local Generation
1997	-773	486	-287	52413	-1%
1998	-591	1,029	438	51148	1%
1999	-310	5,498	5,188	56848	9%
2000	-153	-2,738	-2,891	51790	-6%
2001	-140	-3,955	-4,095	45052	-9%
2002	-1,468	-226	-1,694	47099	-4%
2003	-3,115	3,600	485	48966	1%
2004	-2,446	4,616	2,170	51381	4%
2005	-3,842	2,255	-1,587	49325	-3%
2006	14	269	283	53341	1%
Average	-1282	1083	-199	50736	-0.4%

Note: Negative values indicate net imports and positive values indicate net exports

II.3 Natural Gas Supply / Demand Profile

II.3.1 Gas Consumption Profile

Up until the 1990s, the industrial sector was the largest consumer of natural gas in Oregon and Washington. However, in recent years, the power sector has emerged as the increasingly dominant consumer class, and in Oregon, the power sector has now eclipsed the industrial sector as the largest natural gas end-user. This is consistent with the aforementioned lack of investment in new hydro-electric facilities and the heavy reliance on natural gas generation as the marginal power source.

Specifically, as can be seen in Exhibit 2-12, gas consumption in the industrial sector in Oregon declined at an average rate of -2% in the 1997-2007 period. However, much of this decline was concentrated in the two-year period from 1999 to 2001. Industrial demand, which had been rising steadily through the 1990s, subsequently decreased in response to increases in natural gas prices. The sharp drop in 2000

and 2001 corresponds to the California Energy crisis. Oregon's industrial gas consumers reduced their gas use by 35 percent from 108 Bcf in 1999 to less than 70 Bcf in 2001.

In contrast, natural gas use in the power sector in Oregon dramatically increased at an average growth rate of close to 20 percent annually over the 1997 to 2006 period. Of course, these large growth rates (particularly in the early part of this period) can be partially explained by increases from a low starting level of gas consumption in this sector.

Residential and commercial consumers (referred to as the "CORE" sector in aggregate) have also seen increased gas consumption over the past few years (albeit at a more moderate pace), with an average growth rate of 2.0 percent, over this same period. Year-to-year growth in the CORE gas consuming sector is not readily apparent from historical consumption levels. Since this sector consumes gas mainly for space and water heating, weather has a significant influence. Population growth is the dominant driver for this sector. During this time period, Oregon population grew at an average annual rate of 1.3 percent. Historically, technological efficiency gains balance increases in average square footage per person and the CORE sector gas consumption, when adjusted for weather, trends near population growth.

The trends are similar in Washington, with a decline in the industrial gas consumption levels and a rapid increase in power gas consumption levels. Exhibit 2-13 summarizes historical growth trends for the Pacific Northwest region in aggregate. Overall, gas consumption levels have grown at an average rate of 2.9 percent in Oregon, 1 percent in Washington, and 1.7 percent in the Pacific Northwest in aggregate over the 1997 to 2006 period. Growth rates would have been higher were it not for the large decrease experienced in 2002.

The power sector increase in gas consumption is primarily driven by increased gas-fired capacity installation and increasing electricity demand requirements largely being met by incremental generation from these natural gas power plants. As discussed earlier in section II.2, due to hydroelectric availability variations year-to-year and natural gas generation's role in supplementing hydro generation, gas consumption profiles for the power sector can also vary considerably year to year, despite a generally increasing trend. For example, gas consumption from the power sector was at its highest level in 2000 and 2001, corresponding to years of particularly low hydroelectric generation (see Chapter 3 for additional discussion on this topic).

Exhibits 2-14 through 2-17 provide additional graphical summaries of historical gas consumption by sector in Oregon and the Pacific Northwest.

Exhibit 2-12
Oregon and Washington Historical Gas Consumption Growth by Sector 1997-2006

	Oregon				Washington			
Year	Core sector	Industrial	Power Sector	All Sectors	Core sector	Industrial	Power Sector	All Sectors
1997								
1998	4.2%	13.7%	118.6%	25.2%	-0.9%	19.7%	45.6%	13.6%
1999	11.0%	5.1%	-6.0%	4.0%	13.9%	-6.6%	-19.2%	-0.5%
2000	0.3%	-29.4%	39.9%	-5.2%	-0.2%	-32.7%	127.9%	0.3%
2001	-1.7%	-8.4%	18.8%	2.6%	15.8%	-10.4%	15.8%	8.0%
2002	0.6%	0.9%	-32.3%	-11.7%	-15.4%	-9.7%	-54.1%	-25.0%
2003	-4.8%	-4.2%	33.2%	6.4%	-0.7%	-2.7%	46.3%	6.9%
2004	2.1%	6.2%	19.3%	9.7%	0.4%	2.9%	14.1%	4.3%
2005	4.2%	-2.8%	-0.8%	0.0%	3.3%	-1.4%	-0.4%	1.1%
2006	2.2%	0.6%	-14.6%	-4.8%	2.8%	5.8%	-10.7%	0.1%
Average	2.0%	-2.0%	19.6%	2.9%	2.1%	-3.9%	18.4%	1.0%

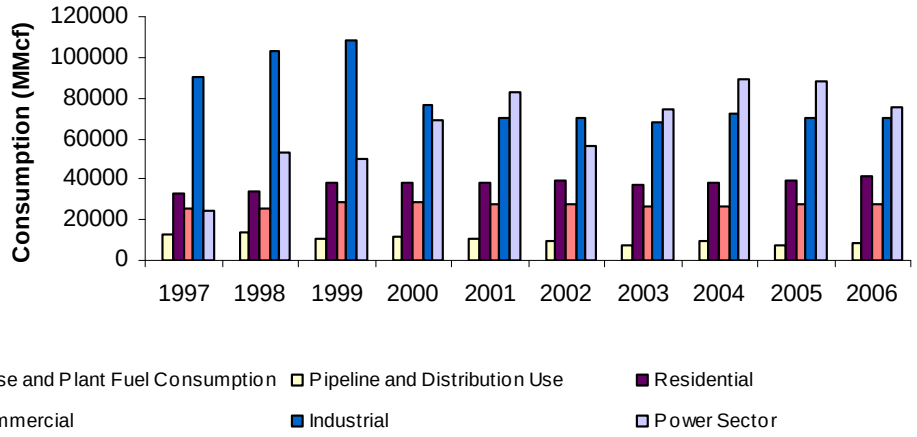
Source: EIA

Exhibit 2-13
Pacific Northwest Historical Gas Consumption Growth by Sector 1997-2006

Pacific Northwest (OR+WA)				
Year	Core Sector	Industrial	Power Sector	Total
1997				
1998	0.8%	17.0%	79.6%	18.3%
1999	12.9%	-1.5%	-11.7%	1.4%
2000	0.0%	-31.1%	74.8%	-2.1%
2001	9.6%	-9.5%	17.3%	5.7%
2002	-10.3%	-4.6%	-43.5%	-19.4%
2003	-2.2%	-3.5%	38.7%	6.7%
2004	1.0%	4.6%	17.0%	6.8%
2005	3.6%	-2.1%	-0.6%	0.6%
2006	2.5%	3.2%	-12.9%	-2.2%
Average	2.0%	-3.1%	17.6%	1.7%

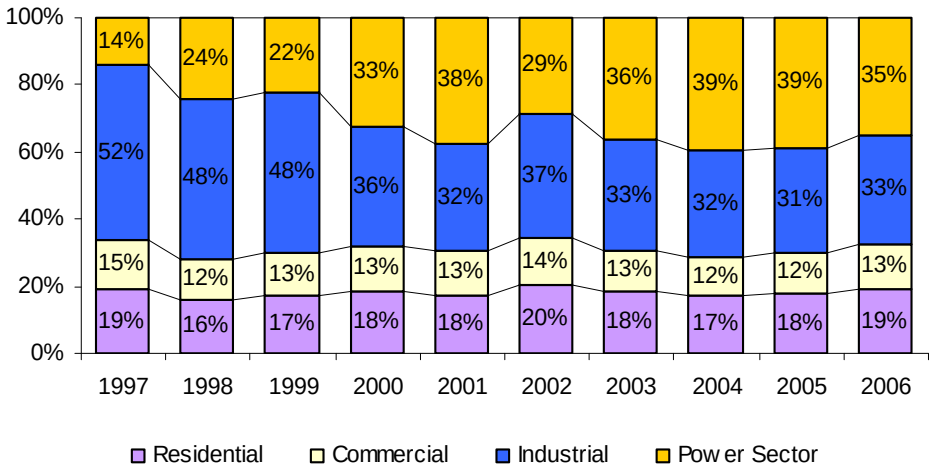
Source: EIA

Exhibit 2-14
Oregon Historical Gas Consumption by Sector 1997-2006



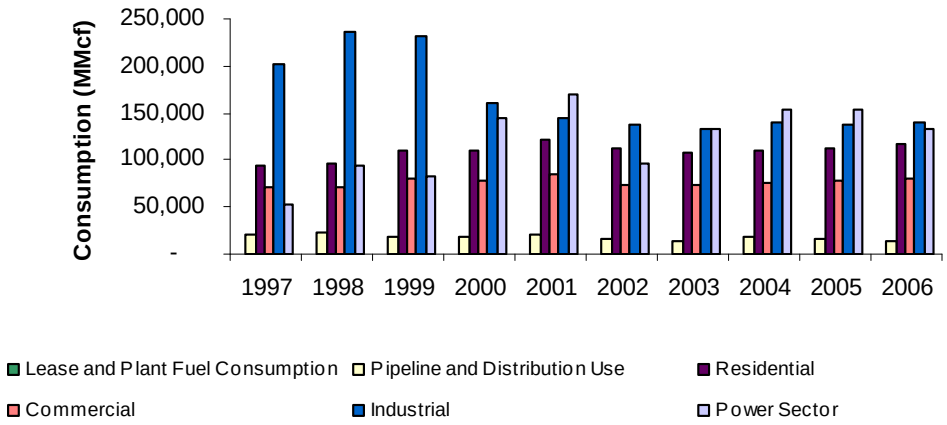
Source: EIA

Exhibit 2-15
Oregon Historical Gas Consumption by Sector 1997-2006



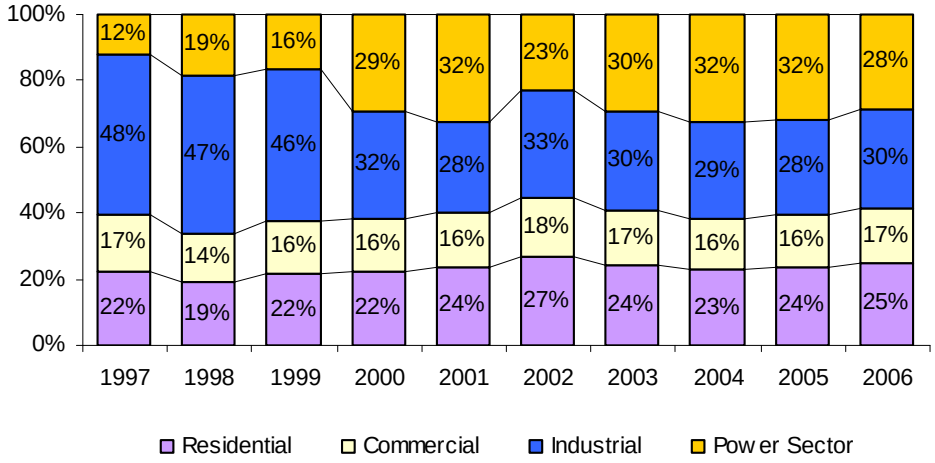
Source: EIA

Exhibit 2-16
Pacific Northwest (OR + WA) Historical Gas Consumption by Sector 1997-2006



Source: EIA

Exhibit 2-17
Pacific Northwest (OR + WA) Historical Gas Consumption by Sector 1997-2006



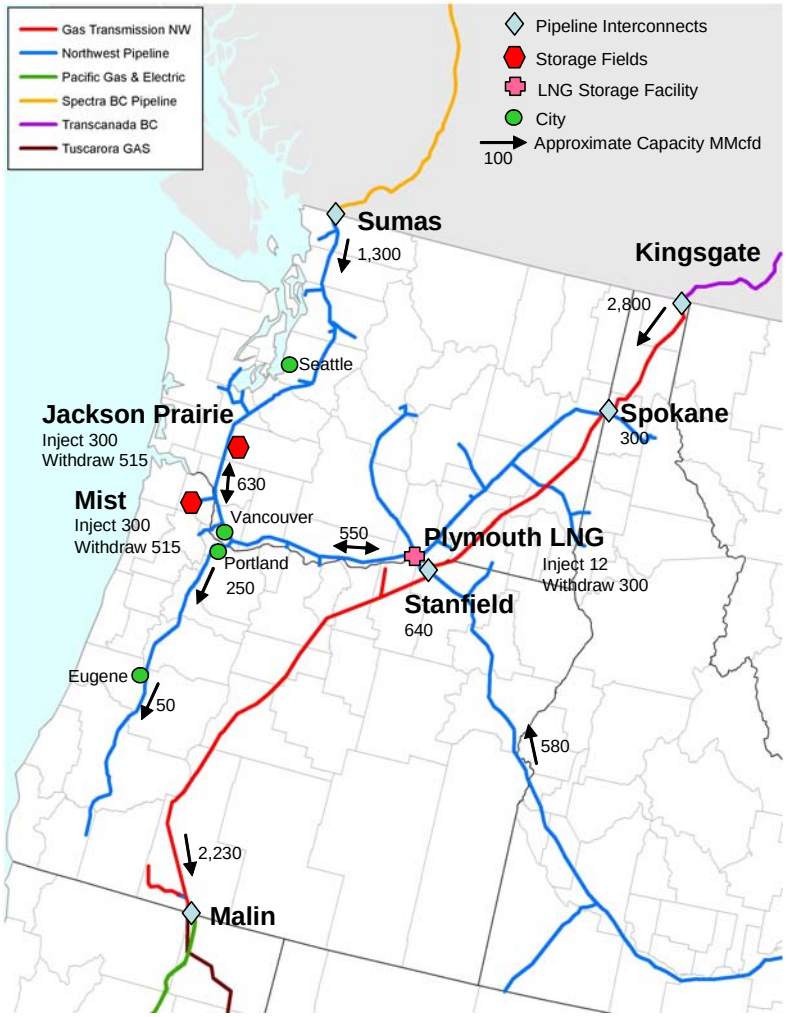
Source: EIA

II.3.2 Pacific Northwest Imports (Supply) and Exports

The Pacific Northwest has negligible gas production and must rely on natural gas produced outside the region. Historically, Oregon and Washington has depended on gas from the Western Canada Sedimentary Basin (WCSB) and the U.S. Rockies. The Pacific Northwest is also a transit point for gas supplies to California and Nevada.

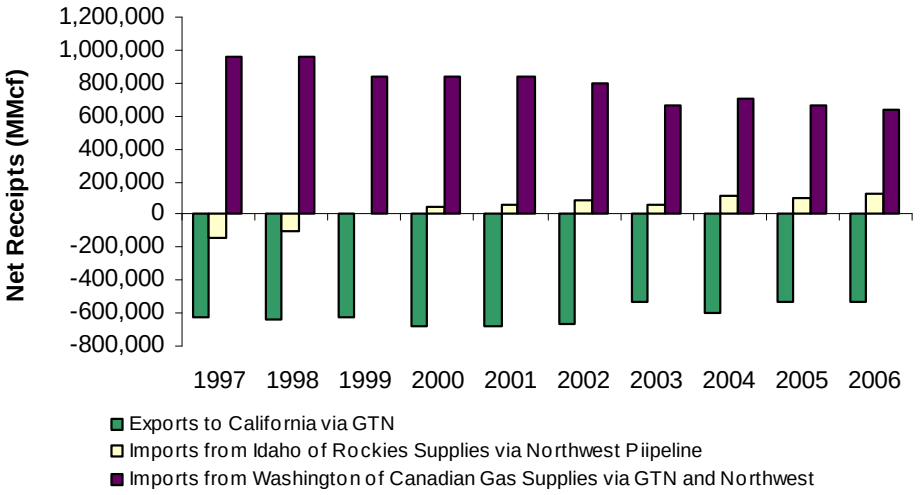
Washington imports natural gas from Canada via Gas Transmission Northwest (GTN) and Northwest Pipeline (Exhibit 2-18). Much of the gas imported into Washington on GTN flows through Oregon to serve markets in California and Nevada. Exhibits 2-19 through 2-21 are for summaries of gas import and export receipts for Oregon, the Pacific Northwest, and California.

Exhibit 2-18
Pacific Northwest Pipeline Infrastructure



In the last 10 years, annual imports of Canadian gas supplies entering Oregon from the state of Washington declined by roughly one-third from over 950 Bcf in 1997 to under 635 Bcf in 2006 (Exhibit 2-19). As mentioned earlier, increasing internal gas demand in Canada has resulted in reduced exports to the Pacific Northwest, impacting gas supplies for the whole region. During the same time period, exports to California from Oregon declined by only 100 Bcf. The natural gas shortfall was balanced by increasing supplies from the Rocky Mountains, a growing production area. Prior to 1999, Canadian gas supplies would be exported from Oregon to serve Idaho markets. However, after 2000, the net annual flow has reversed resulting in net imports from Idaho to Oregon. Currently, southern Idaho (and some Northern Nevada markets) is being served almost exclusively by Rockies supplies with the balance flowing to the Pacific Northwest. According to the Northwest Pipeline electronic bulletin board (EBB), in the past two years, flow out of Wyoming at the Kemmerer Compressor station (in southwestern Wyoming) is nearly always at the maximum pipeline capacity, limiting additional imports of Rockies gas supplies into the region. Additional Rocky Mountain gas supplies into Oregon cannot be achieved without incremental pipeline capacity.

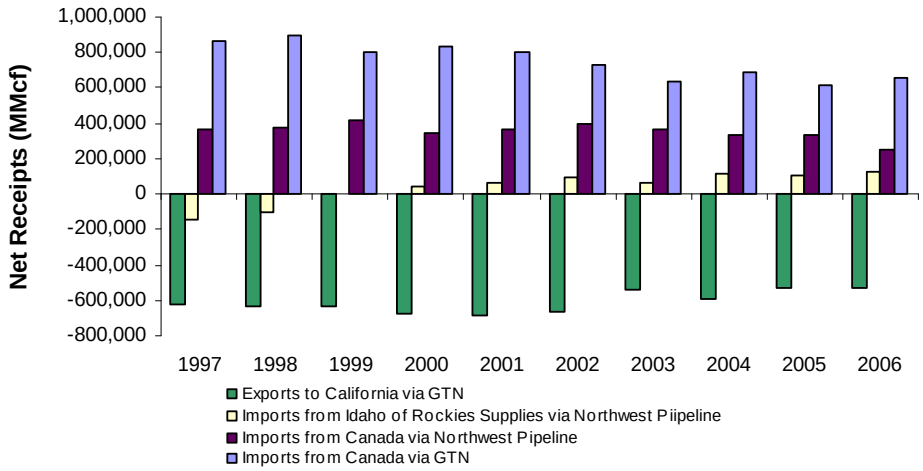
Exhibit 2-19
Oregon Historical Gas Import and Export Receipts



Source: EIA international and Interstate Movements of Natural Gas by State

The natural gas import and export picture for the Pacific Northwest as a whole is similar to Oregon's individual balance (see Exhibit 2-20). From 1997 to 2000, Canadian imports have declined by over 300 Bcf per year. Two thirds of the decline or 200 Bcf has been on GTN while the remaining third was reduced imports on Northwest Pipeline. Exports to California and imports from southern Idaho are the same as the Oregon balance since the entry and exit points are along the Oregon border. Rocky Mountain gas supplies that began entering the region after 2000 serve both Washington and Oregon markets, mainly via Northwest pipeline.

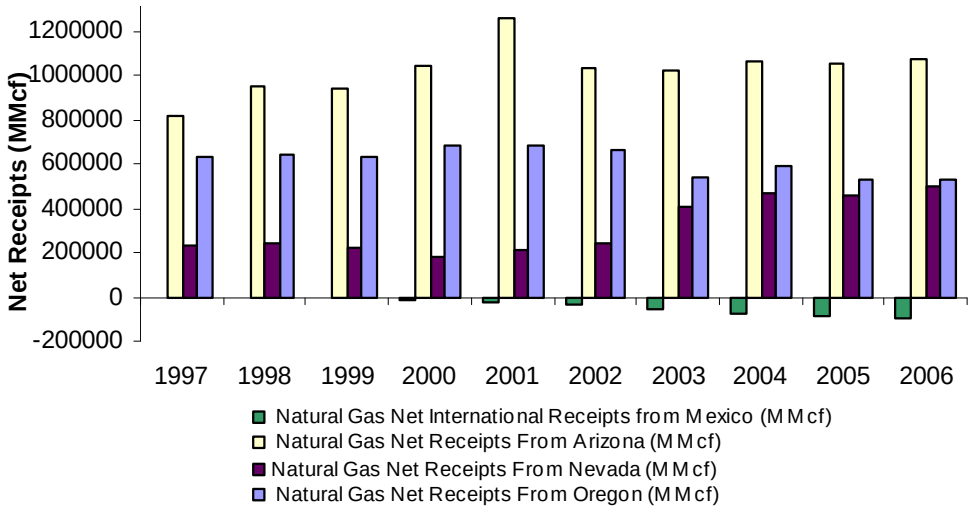
Exhibit 2-20
Pacific Northwest (OR+WA) Historical Gas Import and Export Receipts



Source: EIA international and Interstate Movements of Natural Gas by State

Historical California imports and exports are shown in Exhibit 2-21. With the decline of Canadian gas supply via the Pacific Northwest, California increased imports via other sources. Rocky Mountain gas supplies from Nevada increased in 2003 after a Kern River Gas Transmission pipeline expansion. But similar to the Pacific Northwest, additional Rocky Mountain gas supplies are limited by pipeline capacity. California gas consumption growth and the availability of other gas supplies will determine the California's demand for Canadian gas imports via Oregon.

Exhibit 2-21
California Historical Gas Import and Export Receipts



Source: EIA international and Interstate Movements of Natural Gas by State

Chapter 3

Role of Natural Gas in a Diversified Power Generation Mix

III.1 Introduction

This chapter provides an overview of the role of natural gas in the power sector in the Pacific Northwest. It begins with a brief discussion of terminology commonly used to describe power systems, namely capacity and generation. The following section provides a discussion of hydroelectricity's role in the Pacific Northwest as this is an important determinant of the role of natural gas. The next section provides an overview of historical hydro and natural gas generation in the region. The fifth section discusses projections of electricity demand growth, and the last section discusses the potential capacity and generation profile in the region going forward.

III.2 Power System Capacity vs. Generation

As an introduction to a discussion of power systems and generation requirements, it is useful to distinguish between a plant's capacity and generation. Each unit has a maximum power output measured in MW and this is referred to as the plant's capacity, and is equal to the energy delivered per second. A modification to the definition can be appropriate for hydroelectric and other plants limited by the available energy input (e.g. water flow or wind availability). In some cases, the capacity level is decreased (or "de-rated") to account for this limitation.[6] In considering availability to meet system reliability requirements, particularly during peak load periods, the level of total available capacity (or de-rated capacity for intermittent resources) is assessed relative to peak demand and reserve requirements.

Most power plants do not actually produce energy at the maximum potential in every hour of the year for a number of reasons including unexpected or forced outages, planned outages to permit maintenance, lack of demand[7], lack of storage, and competition from lower cost units. Generation is the sum of actual output across a period of time and is measured in units of energy or MWh, and capacity factor[8] is an expression of actual generation relative to maximum potential generation over a given period. Generation levels need to be sufficient to meet system energy requirements and transmission losses.

A region may have excess capacity in a given time period for purposes of meeting peak demand and reserve requirements, but would still require incremental generation (typically from existing facilities) to meet growing energy needs. As such, it is likely that gas generation or gas consumption will be growing even in the face of "excess capacity", particularly if other existing non-gas facilities are already being utilized close to their maximum potential level.

III.2 Role of Hydroelectricity in the Pacific Northwest

The Pacific Northwest is blessed with abundant hydroelectricity and relies heavily on hydroelectric power to meets its energy needs. However, due to environmental constraints and limited resources, the region (and the US as a whole) has limited potential to bring additional hydroelectric capacity into service and in fact, may be facing decreasing hydroelectric capacity and generation over time.

- The Biennial Monitoring Report on the Fifth Power Plan from NWPCC (January 5, 2007) states that new hydro sites may yield about 480 MW of additional hydropower

[6] For example, in contrast to a fossil unit's contribution to reserve margin of 100%, hydro units' or wind units' contribution to reserve requirements may be considerably less than 100%
[7] Demand and supply must always be in balance even as demand varies
[8] Capacity factor is sometimes expressed as capacity utilization

capacity with roughly 200 average MW[9] of generation by 2025. However, this report also states that new hydroelectric development would unlikely offset loss of capacity and energy associated with expected removal of several older "environmentally damaging" hydro projects. Specifically, damage to waterway and ecological systems is sometimes attributable to hydro dam projects. Hydro dams are also considered the drivers of near-extinction of Pacific Northwest salmon fish species and are also blamed for blocking water needed for healthy river systems.

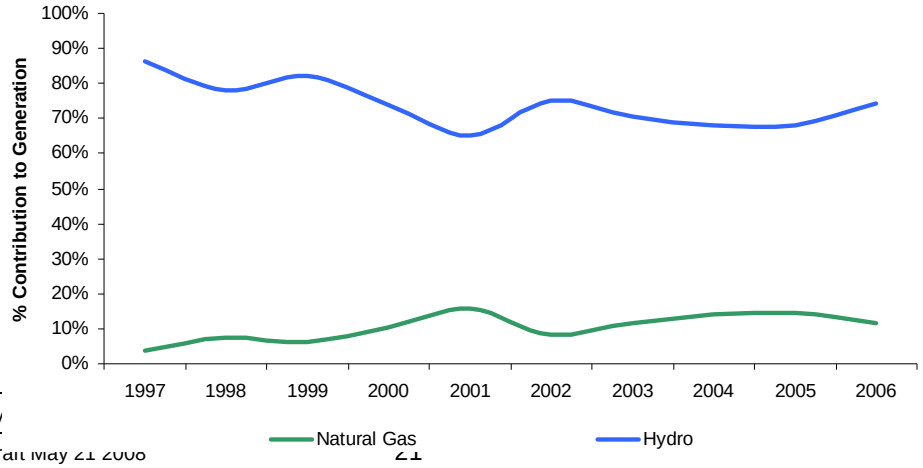
- Of the approximately 2,600 MW of new capacity that has come on-line or will come on-line in the 2006 to 2009 period (i.e. is recently operational or is currently under construction), only 15 MW (or less than 1 percent) is hydro capacity.
- Of the approximately 7,000 MW of new capacity that has been planned or proposed, less than 90 MW comprises hydro capacity, or approximately 1 percent.
- Moreover, the hydro regulations which specify project operations for fish, such as seasonal flow augmentations, minimum flow level for fish, spills for juvenile fish passage, reservoir drawdown limitations and turbine operations efficiency requirement, have greatly reduced the ability of hydro energy production to meet firm loads. Any future norms for fishery operations may further decrease the flexibility of the hydro system operations and hence may result in further lowering of hydro generation and capability.
- As an example of increasing pressure from environmental concerns, Portland General Electric recently started disassembling the 22 MW Bull Run Hydroelectric Project at Marmot Dam (one of the largest dams of Oregon). This will be followed by disassembly of the Little Sandy Dam on its namesake river in the summer of 2008. These removals will create unimpeded salmon and steelhead passage from the southwest slopes of Mt. Hood to the Pacific Ocean.

As such, hydroelectric generation is likely to remain, at best, at historical average levels, and increasing electricity demand will have to be met by other sources.

III.3 Historical Hydro and Natural Gas Generation Profile

Historically, natural gas generation has played an important role in the system to address hydro variability, particularly during periods of low hydroelectric generation. As such, it can be considered an important "swing" resource. This can be observed by the inverse correlation between hydroelectric generation and natural gas generation over the 1997 to 2006 period (see exhibits 3-1 and 3-2). There is also important seasonal variation in demand for natural gas. Hydroelectric generation is concentrated in the spring during the period of runoff associated with snow melt. As the storage capacity of the region's hydro-electric system does not allow water to be sufficiently stored, it is not possible to avoid hydro generation concentration in the spring. This results in lesser demand for fossil energy in this period. As the summer demand season begins, demand for natural gas increases as hydroelectric output decreases.

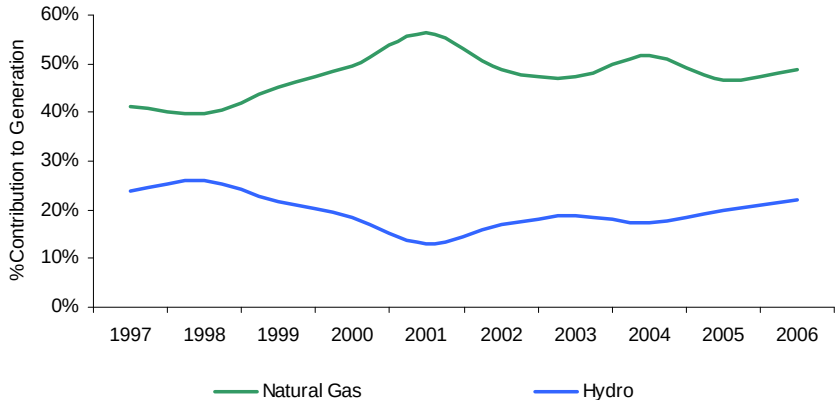
Exhibit 3-1
Historical Hydro and Gas Fired Generation in the Pacific Northwest (OR+WA)



[9] 1 average M

Source: EIA

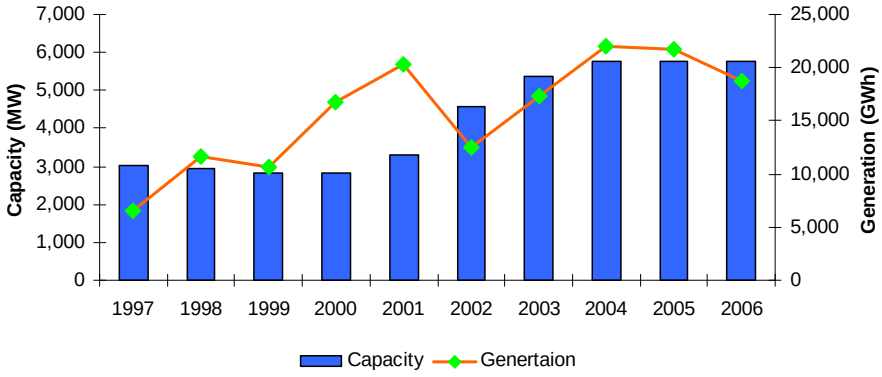
Exhibit 3-2
Historical Hydro and Gas Fired Generation in California



Source: EIA

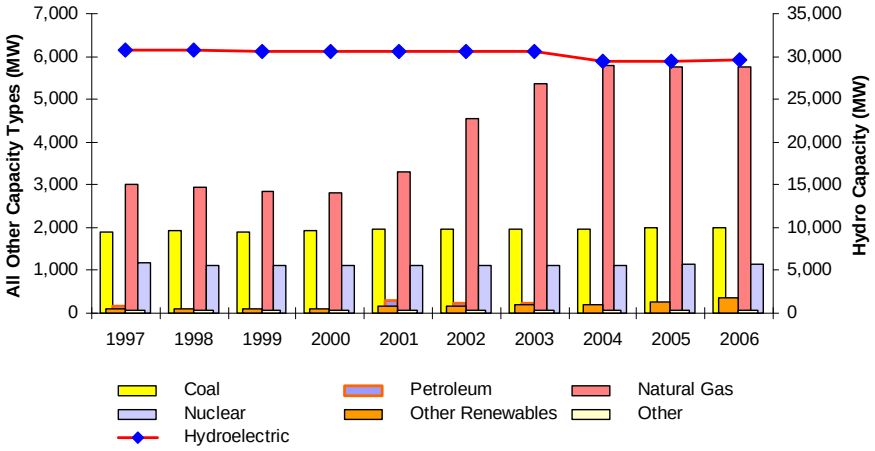
Furthermore, over the past several years, Oregon and Pacific Northwest incremental capacity and generation requirements have been mainly satisfied through natural gas based capacity and generation. Specifically, natural gas capacity in Oregon and Washington has nearly doubled from approximately 3000 MW in the 1997 to 2000 period to approximately 5800 MW in 2006. Other capacity types have either decreased or remained unchanged during this period, excluding a small incremental expansion of renewable capacity (see Exhibits 3-3 and 3-4).

Exhibit 3-3
Pacific Northwest Historical Gas-Fired Capacity and Generation Profile



Source: EIA

Exhibit 3-4
Pacific Northwest Historical Capacity Additions Compared to Hydro Capacity



Source: EIA

III.4 Electric Demand Growth Outlook

Electricity demand growth is the primary driver for increased generation and capacity expansion. Publicly available projections of electricity demand growth for the Pacific Northwest range from 1.2 to 1.5 percent for peak demand and 1.1 to 1.6 percent for energy demand. These forecasts are generally higher than long-term historical experience in the region, largely due to the significant decrease in demand in the early part of this decade, associated with the energy crisis and the closure of industrial plants, notably aluminum smelter plants (as discussed in greater detail in chapter 2). We do note, however, that all the official projections are lower than recent historical experience in the 2001 to 2006 period. Exhibits 3-5 and 3-6 summarize the projections from the various sources.

Exhibit 3-5
Electricity Demand Growth Projections from Various Sources

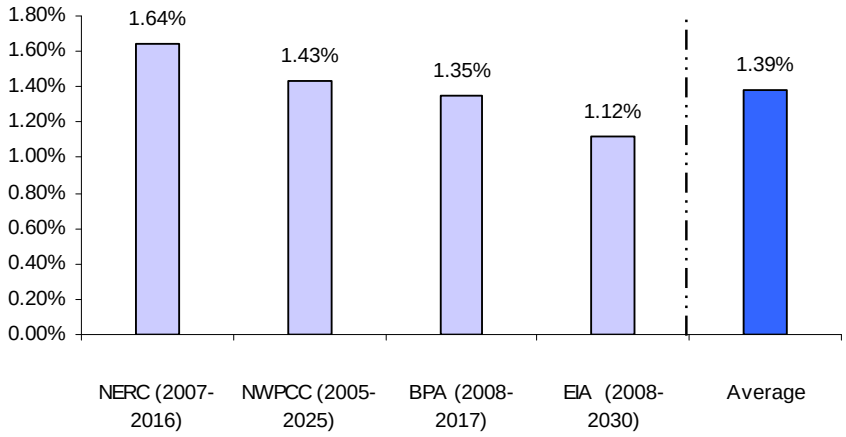
Source	Planning Study	Forecast Period	Regions Covered	Average Annual Peak Demand Growth	Average Annual Energy Demand Growth
NERC	2007 Long Term Reliability Assessment	2007-2016	NWPP (comprises of WA, OR, ID, WY, MT, and UT; a small portion of Northern California; and the Canadian provinces of BC and Alberta.)	1.54%	1.64%
NWPCC	Fifth Power Plan	2005-2025	Includes OR, WA, ID, and MT west of the continental divide, as well as the portions of NV, UT, and WY that lie within the U.S Columbia river basin; excludes Federal demand		1.43%
BPA	2007 Pacific Northwest Loads and Resources Study	2008-2017	Includes OR, WA, ID, and MT west of the continental divide, as well as the portions of NV, UT, and WY that lie within the U.S Columbia river basin	1.15%	1.35%
EIA	Energy Outlook 2007	2008-2030	NWPP (comprises of WA, OR, ID, WY, MT, and UT; a small portion of Northern California; and the Canadian provinces of BC and Alberta.)		1.12%
Average				1.35%	1.39%

BPA's projections include retail load consumption as well as long-term and multi-year import and export contracts. NWPCC projections reflect long-term forecasts of demand for individual consuming sectors such as residential, commercial, and industrial, but excludes demand associated with Federal load and firm exports to other regions. NWPCC projections reflect an assumption of recovery from economic recession of early 2000, although somewhat dampened by the permanent effects of higher electricity prices and lasting efficiency improvements achieved during the economic crisis.

In contrast to the BPA and NWPCC projections which are focused on the Pacific Northwest, the EIA projections and NERC projections are for a larger geographic region, namely all of the Northwest Power Pool. Sub-regional detail is not available from these sources. The EIA projections are provided by sector, with the commercial sector projected to experience the highest rate of growth.

Overall, as can be seen, NERC projects the highest level of demand growth at 1.5% and 1.6% annually on average for peak and energy, while EIA projects the lowest level of demand growth at 1.1% annually on average for energy. The average annual demand growth across sources is approximately 1.4% for both peak and energy.[10] For purposes of our analysis, we utilize this average growth rate, but do note that NERC and utility projections across most regions have consistently understated actual demand growth in most periods.

Exhibit 3-6
Electric Energy Demand Growth Projections from Various Sources



Sources:

NERC ES&D 2007: North American Electric Reliability Corporation Electric Supply & Demand 2007
NWPCC 5th Power Plan: Northwest Power and Conservation Council Fifth Power Plan
EIA AEO 2007: Energy Information Administration Annual Energy Outlook 2007

[10] Note that these projections for the Pacific Northwest are lower than US average historical growth rates which have been in the 2% to 2.5% range on average over the last two decades. They are also lower than US-wide projections from NERC. Additionally, EIA's Pacific Northwest forecast is lower than its US forecast as a whole. Additionally, we believe that both Washington and Oregon have already been active in pursuing demand side management and energy efficiency and that these may be reflected in recent historical levels and projections going forward. For example, based on EIA data for 2004, Washington was the 5th highest state in terms of energy efficiency spending and the 3rd best state in terms of energy efficiency savings in the US. Oregon ranks 8th for both metrics.

III.5 Electric Capacity and Generation Outlook

Incremental generation is required immediately to meet growing electrical energy demand. Assuming an annual average energy demand growth rate of 1.4 percent (the average across public forecasts referenced in the previous section), approximately 2000 to 2500 GWh of incremental generation would be required annually to meet incremental local energy requirements, with a cumulative increase in incremental generation requirements of approximately 54,000 GWh over the 2008-2030 period. This reflects a 36 percent increase over 2006 generation levels.[11]

The increase in generation requirements in some years could be greater even if the average growth trend does not change. One critical source of this variability is the region's dependence on its very large hydroelectric system. Fossil and nuclear generation can generally be controlled by system operators (i.e. with the exception of forced outages, they can determine if, when, and how much to run the facilities); in contrast hydroelectric generation is largely a function of hydrological conditions outside the control of system operators. Thus, the Pacific Northwest has the greatest variability in annual electric generation outside the control of system operators, and natural gas (as the key swing fuel) generation and consumption could vary greatly around a steady trend line. Furthermore, the upswings in gas generation have in some case coincided with grid-wide problems such as the 2000/2001 western energy crisis.

The potential for increased utilization of natural gas generation is further emphasized by observing historical capacity factor levels and their potential to increase over time. As mentioned earlier, capacity factor is a measure of actual generation relative to potential maximum generation. In Oregon, for example, capacity factors have been in the 36 to 56 percent range over the 2002 to 2006. They have been even lower in Washington in the 26 to 33 percent range. These plants can generally operate as high as 90 percent. In contrast, hydroelectric, nuclear and coal facilities already generally operate close to their maximum potential, and thus have very limited room to increase further.

Incremental generation requirements could be higher if net exports increased over time and would be lower if net exports decreased over time (or net imports increased over time). There is potential that buyers from outside the region might seek to access the generation capacity of the region's gas plants through upgrades in transmission, additional contracting, etc. This is related to temporary availability of capacity in the region as discussed below. Any sales from plants that would otherwise be operating to meet local demand would have to be made up by other plants, increasing total gas generation and consumption.

While the region will be relying on natural gas as the key marginal source of generation, there is some excess total generation capacity at the peak when one includes the most costly capacity. Most public sources indicate that no significant capacity expansion is required in the immediate future, even though increased generation is required. Indeed, when only local system coincident seasonal peak demand and maximum expected capacity are considered, Oregon and Washington combined have a summer reserve margin of approximately 40 percent in 2008 and a winter reserve margin of approximately 31.5 percent. This reflects a summer peak of approximately 25 GW, a winter peak of approximately 26.5 GW, and capacity of approximately 35 GW.[12]

Of course, the Pacific Northwest is part of the larger, highly interconnected Western Electric Coordinating Council (WECC) grid and hence capacity additions and generation levels are dictated not only by local requirements but the requirements of the larger grid as well. Other parts of the western grid are expected to require additional capacity as soon as 2009-2010. This can be expected to create demand for power from the Pacific Northwest. Historically, the Pacific Northwest has imported energy from western Canada and exported energy to California, with the region being a net exporter of energy overall (see Chapter 2 for more discussion on historical flows). However, as discussed earlier in chapter 2, import and export patterns vary during the course of the year, due to varying load profiles (with Western Canada and the Pacific Northwest peaking in the winter and the

[11] 2006 generation was around 162,000 GWh

[12] Source: Peak Demand from NERC ES&D 2007 for NWPP scaled to estimate Pacific Northwest (Oregon + Washington) demand based on historical information from EIA and information from GE MAPS; capacity information from ICF and assumes a hydro contribution to reserves at around 70 to 80 percent of total rated capacity.

rest of the US dominantly peaking in the summer) and due to varying hydro and other conditions year by year.
Assuming an annual average peak demand growth rate of 1.35 percent, approximately 500 to 600 MW of incremental capacity would be required annually once the system is in supply/demand balance or equilibrium (i.e. that peak demand and reserve requirements are at or above existing capacity levels). Assuming equilibrium in approximately 2015,[13] close to 7.5 GW of incremental capacity would be required between 2016 and 2030. However, the potential for retirement of older capacity including hydroelectric capacity, and an acceleration of peak demand growth bringing the region closer to the national average cannot be ruled out, and flexible planning is required to handle uncertainty in future conditions.

Again, it is important to recognize that even with the assumption that no new capacity is required in the Pacific Northwest for several years (which may be optimistic in light of the potential for greater demand growth, exports, retirements, etc.), incremental generation is required immediately to meet growing energy requirements and to supplement intermittent hydro and renewable resources.

III.5.1 Limited Alternatives to Meet Incremental Capacity and Generation Requirements

As discussed in chapter 2, the current capacity and generation mix comprises hydro, coal, natural gas, nuclear, and renewable resources[14], with the vast majority coming from hydroelectric resources. While the potential universe of incremental capacity and generation could include all these resources, from a practical perspective, future capacity additions will likely be dominated by natural gas and renewables.

Incremental hydro capacity is extremely unlikely in any significant amount as most of the feasible sites have already been developed. The remaining opportunities are, for the most part, small-scale and relatively expensive. Additionally, environmental considerations may limit any significant new development and there may be potential for some level of hydro resource contraction. Hydro generation is thus likely to remain at historical average levels for the foreseeable future (or to decrease slightly over time).

Amid growing concerns about climate change and associated opposition to coal-fired generation (particularly vocal in the Pacific Northwest and California), options for alternative sources of energy are limited to nuclear, natural gas and renewable. In the Pacific Northwest, there are no announced plans for development of nuclear facilities and hence the practical alternatives for the foreseeable future appear to be natural gas fired capacity and renewable capacity. While renewable sources have the potential to play an increasing role, especially in light of Renewable Portfolio Standard requirements in both Oregon and Washington, they have clear constraints and limitations associated intermittent availability, interconnection problems, and in some cases, prohibitively high cost (e.g. solar). The effective “fuel” used by wind units for generation is wind flow and as the wind profile varies by time of day and season, with a significant degree of unpredictability, it is difficult for system operators to control and depend on this resource as it might fossil resources with respect to system reliability. This intermittent nature of renewable sources, such as wind, poses more concern for system reliability, particularly when capacity of such sources in the overall system increases, and this variability is combined with hydro variability. Additionally, wind resources are often located distantly from load, and hence interconnection with the grid can be a bottle neck in their expansion. Solar technology is still in early stages of development and as such, cost per MW of solar technology is very high and the capital cost recovery of solar plant through market based economic components is still very difficult to achieve. As such, natural gas fired generation is expected to play a strong role going forward as it can not only provide reliable, continuous power but can also act as a supplemental

[13] Note that public projections for when new capacity will be required for the Pacific Northwest region are limited. The NERC 2007 Long-Term Reliability Assessment indicates that the Northwest Power Pool (NWPP) as a whole may not need incremental capacity until after its forecast horizon which terminates in 2016. However, hydro availability during system peaks is a critical issue in making this determination and other factors such as the potential for retirements, higher demand growth, etc. could easily accelerate any stated need.
[14] For the context of this report, renewable resources are defined as including wind, biomass, solar and geothermal resources.

resource to address the variability and intermittent nature of generation from hydro and wind resources.

While there has been a tremendous resurgence in the interest of nuclear power plant development across the US over the last couple of years, none of this interest appears concentrated in the Pacific Northwest. Despite the announcement of potential licensing and development of 23 facilities with over 40 GW across the US, none of these are located in the Pacific Northwest. As such, it is extremely unlikely that any new nuclear capacity will be coming on-line in this region before 2020, and possibly 2025. Nuclear generation is thus likely to remain at historical average levels for the foreseeable future.

There are only two coal plants in the Pacific Northwest, namely Boardman and Centralia, totaling approximately 2 GW in capacity. As mentioned above, the region experiences considerable public opposition to development of new coal-fired facilities. Even in the absence of national CO_2 regulations, Oregon has promulgated a state law on carbon dioxide emission standards, reflective of strong anti-coal sentiments.[15] Washington has also promulgated a law that would make it difficult for new coal plants to get built.[16] Consistent with this, there are no announced conventional coal plants for either Oregon or Washington. There are, however, three IGCC coal plants announced with a combined capacity of approximately 1800 MW in Oregon and Washington. However, development of two of the three projects have been effectively stalled and/or ceased. Specifically:

- Energy Northwest's proposed 680 MW Pacific Mountain Energy Center in Kamala appears to violate the recent Washington law on CO_2 emissions and carbon sequestration.
- The Wallula Energy Resource Center IGCC power plant sponsors recently withdrew their request for the Potential Site Study[17] and indicated that they do not intend to re-apply for site certification anytime in the near future.

Hence, new coal or IGCC plant development appears to have very limited potential in the Pacific Northwest and coal generation is likely to remain at historical levels, which are generally close to maximum availability.[18]

III.5.2 Renewable and Natural Gas Generation Expected to Play Important Role in the Capacity and Generation Mix

In light of the limited potential for incremental hydro, nuclear, and coal development, incremental generation and capacity needs are likely to be fulfilled primarily through the increased utilization and development of gas-fired and renewables capacity.

There are explicit renewable portfolio standard (RPS) requirements for both Washington and Oregon that would dictate the addition of renewable capacity. RPS's require that a certain percentage of total electric energy consumed in a given region (usually a state) comes from eligible renewable generation technologies. Key aspects of RPSs differ from state to state, including percentage of energy required, eligibility of generators by technology, location (in-state vs. out-of-state), or vintage, usage of credit trading for compliance, and alternate compliance mechanisms, and affected load serving entities (LSE's). That said, most RPSs include wind, solar, biomass (closed-loop), geothermal, and landfill gas, and occasionally small hydro (<25 MW) as eligible technologies. At present, RPS goals are 15%

[15] In 1997, as part of HB 3283, the Oregon legislature gave the Energy Facility Siting Council the authority to set carbon dioxide emissions standards for new energy facilities. For base load gas plants and non-base load plants, the standard sets the net emissions rate at 0.675 lb/kWh CO_2. Additionally, the following Oregon greenhouse gas emission goals were put into state law in the 2007 session: (i) arrest growth of emissions by 2010; (ii) 10 percent below 1990 levels by 2020; and (iii) 75 percent below 1990 levels by 2050.

[16] The SB6001 Bill establishes a greenhouse gas performance standard for all new, long-term base load electric power generation. Under the standard, all base load generation for which utilities enter into long-term contracts must meet a greenhouse gas emissions standard of 1,100 pounds of less per megawatt-hour beginning in July 2008.

[17] Press release dated March 25, 2008

[18] Historical coal capacity factors have ranged from 70 to 85 percent for Boardman and 68 to 89 percent for Centralia over the 2001 to 2005 period. Capacity factors for both plants were lower in 2006 due to extended outage conditions. Maximum average availability is likely to be approximately 85 percent and hence there is some potential for increased generation to this level, unless environmental or other constraints prohibit this.

of demand by 2020 in Washington and 25% of demand by 2025 in Oregon. There remains some uncertainty as to whether these requirements need to be fulfilled within the states or can be fulfilled within the broader WECC. Nonetheless, it is anticipated that there will be significant renewable capacity development and generation to meet these requirements.[19]

Additionally, incremental generation requirements for the near-term are likely to be met by increased utilization of existing gas-fired facilities as existing non-gas resources have approached or will soon approach their availability limits. As mentioned earlier, coal capacity factors are approaching maximum availability with capacity factors for the Pacific Northwest as a whole in the 72 to 89 range between 2001 and 2005. Hydrological conditions are unlikely to change for the better and hence long-term average historical generation levels are likely to be repeated at best. Nuclear capacity factors have been in the 78 to 93 percent range over the 2002 to 2006 period, already close to maximum availability in the 90 to 93 percent range. In contrast, natural gas capacity factors[20] have been modest (in the 36 to 56 percent range for Oregon and in the 26 to 33 percent range for Washington over the 2002 to 2006 period), and these plants could be utilized at considerably greater levels (up to approximately 90 percent) to meet incremental needs. Furthermore, with the expectation of significant renewable resource additions, natural gas generation will be critical to supplement wind to address its intermittent and variable nature.

The projection that natural gas and renewable capacity and generation will dominate capacity expansion is consistent with the make-up of power plants recently added or currently under construction, as well as with the announced power plants for potential development. When looking at plants operational in 2006, 2007 and 2008 and under construction for operation in 2008 and 2009, gas capacity comprises 51 percent and renewable capacity comprises 48 percent. When looking at the combination of firm and announced builds for 2008 and onwards, gas capacity comprises 33 percent, wind capacity comprises 43 percent, other renewables comprise an additional 5 percent, and IGCC builds comprise 12 percent (still listed despite recent setbacks). Exhibit 3-7 summarizes firm and announced builds by type.

Exhibit 3-7
Firm and Announced builds in the Pacific Northwest (OR+WA)

Plant	Firm Capacity (MW)					Announced Capacity (MW)			Total Firm + Announced	
Type	2006	2007	2008	2009	Total	Planned	Proposed	Total	MW	% of Total
Wind	329	666	164	0	1159	32	2943	2975	4134	43%
Hydro	14	0	1	0	15	1	88	89	103	1%
IGCC	0	0	0	0	0	0	1126	1126	1126	12%
Coal	0	0	0	0	0	0	0	0	0	0%
Biomass	14	50	3	16	83	20	22	42	125	1%
Natural gas	0	685	650	0	1335	0	1833	1833	3168	33%
Tidal current	0	0	0	0	0	0	19	19	19	0%
Wave	0	0	3	0	3	3	202	205	208	2%
Geothermal	0	0	0	0	0	0	87	87	87	1%
Petroleum[2]	0	0	0	0	0	0	600	600	600	6%
Solar	0	0	0	0	0	1	0	1	1	0%
Total	357	1401	821	16	2595	57	6920	6977	9571	100%

Source: Power Plant Development Activity in the Pacific Northwest 2002-Present (dated Feb 2008)

[19] There are additional incentives for renewable generation. The Oregon Business Energy Tax Credit was established in 1979 to provide 35% tax credits to businesses that initiate projects to invest in energy conservation, renewable energy resources, recycling, and less polluting transportation fuels. This credit was recently increased to 50% for businesses that install renewable energy systems. In addition, manufacturers of renewable energy systems and components that construct new facilities in Oregon are eligible for the increased tax credit. The maximum eligible cost for renewable projects has also increased from $10 million to $20 million per project.

[20] Capacity factors express generation as a percentage of potential maximum generation

The NWPCC Fifth Plan projections also anticipate significant renewable and natural gas capacity expansion and generation. The Fifth plan assumes 6000 additional MW of wind potential and projects the need for even more gas fired capacity than identified prior to the Fifth plan, in part to maintain system reliability, and regulation and load following capability for the integration of wind power.[21] The Plan anticipates the potential for 480 MW of hydro expansion but this is expected to be offset (or more than offset) by contraction of existing hydro resource.

Additionally, the Northwest Wind Integration Action Plan (March 2007) report indicates that gas fired generation will play a role as flexibility augmentation technology to provide system reliability in an environment of increasing wind generation and capacity in the system.[22] It should also be noted that, in some cases, renewable resources cannot be located near load, especially in the western-most parts of the region. To the extent that transmission capacity is not forthcoming, natural gas will have the additional advantage of being located close to load.

III.5.3 Potential Natural Gas Generation Outlook

Pacific Northwest energy demand was approximately 149,000 GWh in 2006. Assuming 1.39% annual average growth (the average growth rate across four public projections as discussed in section III.3), incremental generation requirements would be approximately 54,000 GWh over the 2008 to 2030 period (see Exhibit 3-8). In the extreme, if all these incremental requirements were to be met through local gas-fired generation in the Pacific Northwest (existing and new capacity), incremental gas consumption from the power sector would be approximately 385,000 MMcf, representing a 5.65% annual average increase of gas consumption in the power sector between 2008 and 2030.[23] It is of course unlikely that all incremental needs would be met through gas-fired generation and more likely that they would be met primarily through a combination of gas-fired and renewable generation.

If half the incremental needs were met through gas-fired generation, then the resultant increase in gas consumption from the power sector would be approximately 192,000 MMcf or a 3.8% annual increase over the 2008-2030 period. For context, if one were to assume a 35% capacity factor level for all renewable projects (firm and proposed) and a conservative 50% average capacity factor level for all gas projects, the firm and announced build mix implies very similar levels of generation from both natural gas and renewables, each at around 32 percent of the overall total (or close to 40 percent if IGCC announcements were to be excluded). Exhibit 3-8 summarizes potential incremental gas consumption requirements from the power sector under varying scenarios of incremental gas generation. This assessment is provided for illustrative purposes only. Furthermore, generation requirements could be lower or higher if the net import / export profile were to change going forward.

Exhibit 3-8
Potential Power Sector Gas Consumption Scenarios 2008-2030

Sensitivity Cases of Power Sector Demand Growth for Pacific Northwest (OR + WA)			
Historical 2006 energy demand (GWh)	148,825		
Average annual energy demand growth 2007-2030 (%)	1.39%		
Expected energy demand 2008 (GWh)	152991		
Expected energy demand 2030 (GWh)	207,280		
Incremental energy demand and generation 2008-2030 (GWh)	54,289		
	Case-I	**Case-II**	**Case-III**
Incremental % generation from gas	25%	50%	100%
Historical gas consumption 2006 (MMCf)[1]	133,985		
Total gas demand 2030 (MMcf)	237,559	341,134	548,282
Incremental gas requirement[1] 2008-2030 (MMcf)	96,192	192,385	384,770

[21] Biennial Monitoring Report on the Fifth Power Plan, Jan 5, 2007, page G-4
[22] Northwest Wind Integration Action Plan March, 2007, pages D1 and D4
[23] This calculation assumes an average heat rate for gas-fired units of 7300 Btu/kWh, reflecting a mix of dominantly combined cycle capacity (which has heat rates in the 6900 to 7100 Btu/kWh range for recent technology) and some less efficient gas-fired capacity.

Average annual gas demand growth 2008-2030 (%)	2.39%	3.84%	5.65%

[1] Assumes 7300 btu/kWh heat rate (weighted average) for gas plants in the region during this period

III.6 EIA Projections for Capacity Expansion and Generation

The EIA 2007 Annual Energy Outlook (AEO) is the only publicly available forecast (that we are aware of) that provides long-term projections of capacity expansion and generation through 2030. As mentioned earlier, the projections are not provided by state but rather for aggregate regions. EIA's 2007 AEO projects significant new coal fired capacity and incremental coal-fired generation to meet future requirements (indeed almost all future requirements) of the Northwest Power Pool. EIA projects that coal-fired capacity would increase from 11 GW in 2008 to 20 GW by 2030 (with expansion commencing in 2016) and generation would increase from 9 average GW to 16 average GW over the same period. EIA projects natural gas capacity to increase from 9 GW to 13 GW in the same period (with expansion commencing in 2019), but projects gas-fired generation to decrease from 3 average GW to 1 average GW in this period. This results in a decrease in natural gas consumption between 2008 and 2030, or more specifically, between 2015 and 2030.

These EIA projections appear extremely unlikely considering (i) present opposition to new coal plants in the Pacific Northwest, including recent decisions in Oregon rejecting new coal projects, (ii) the small share of existing coal power plant capacity in the region in the overall capacity mix, (iii) the paucity of local coal production, (iv) the history of remote coal generation in coal-producing regions in Utah, Wyoming and Montana being complicated by the need for new transmission, (v) likely forthcoming national GHG emissions cap regulations (not embedded in EIA's base case), and (vi) the significant increase in new coal plant construction costs.[24]

If EIA projections were to be adjusted to assume (i) limited incremental coal-fired generation (keeping generation for the 2016 to 2025 period at 2015 levels) due to CO_2 regulations and other factors as mentioned above, (ii) incremental energy demand during the 2016-2025 period would be met through renewable generation sufficient to meet a hybrid RPS standard (20% of energy demand by 2025), and (iii) gas-fired generation to meet residual incremental energy needs, projected gas consumption levels would be considerably higher. Specifically, the annual average growth rate would be 4.9% rather than a negative growth rate. Note that beyond 2025, there is the potential that new nuclear capacity in the region may be viable and hence the gas consumption growth rate for the 2025 to 2030 period may be lesser in this scenario. This adjustment reflects a simplistic analysis and is provided only to illustrate the potentially significant implications on natural gas consumption projections.

[24] EIA's AEO 2007 assumes an all-in coal construction cost of approximately $1290/kW (2005$). However, costs have escalated significantly in the past 2 years with increases in commodity costs, labor costs, etc., and these increases have not been reflected in EIA's projections. At present, coal construction costs are generally estimated in excess of $2,500/kW. As an example, in April 2008, Midland City Council in Michigan approved a plan for a $2530/kW coal plant and Consumers Energy announced a plan for $2,875/kW coal plant. Other plants have been announced including Turk in Arkansas, Edwardsport in Indiana, Cliffside in North Carolina, and Little Gypsy in Louisiana. All these plants' estimated costs range from $2000/kW to $2900/kW. It is important to note that construction cost increases are not limited to coal plants, but extend to natural gas plants and wind plants as well. However, on a $/kW basis, the increase in coal plant costs are generally the highest.

Chapter 4

Natural Gas Demand Projections

IV.1 Introduction

This chapter provides a discussion on the outlook for natural gas consumption in the region. This assessment is based on publicly available information.

IV.2 Summary of Publicly Available Forecasts

There are limited public forecasts available for natural gas consumption going forward. As can be seen in Exhibit 4-1, the Northwest Gas Association (NWGA)[25] has a region-specific forecast for the Pacific Northwest, but the 2007 outlook only goes out to 2012. EIA provides projections for natural gas consumption through 2030, but the smallest relevant region is the "Pacific", which includes not only Oregon and Washington, but also California, Alaska, and Hawaii. Hence, Pacific Northwest specific projections are not directly available from EIA and are limited to NWGA.

Exhibit 4-1
Natural Gas Consumption Projections from Various Sources

Source	Forecast Period	Region	Gas Consumption Annual Average Growth Rate by Sector (%)			
			Power	Core	Industrial	All Sectors
NWGA 2007 Gas Outlook	2008-2012	OR, WA, and North ID	3.5	2.0	1.3	2.3
EIA AEO 2007	2008-2015	Pacific (OR, WA, CA, HI, and Alaska)	2.8	1.4	-0.6	1.3
	2016-2030		-3.1	1.0	1.6	0.1
	2008-2030		-12.1	1.1	0.9	0.5

Exhibit 4-2 provides additional detail on the NWGA 2007 Outlook projections for natural gas consumption by state and by sector within the Pacific Northwest. In this report, the Pacific Northwest is defined as Oregon and Washington. NWGA defines the Pacific Northwest more broadly to also include British Columbia and Idaho but provides information into sub-regions and therefore allows Oregon and Washington gas consumption to be broken out separately In the NWGA report, Washington gas consumption values also include some limited gas consumption in the Northern Idaho panhandle[26].

As can be seen, Washington has slightly higher gas consumption levels as compared with Oregon. Over the NWGA forecast horizon, Washington accounts for approximately 58% of the total Pacific Northwest gas consumption, with Oregon representing the remaining 42%. Washington is also projected to increase its gas consumption at a higher rate of approximately 2.6 percent as compared with Oregon at an annual average growth rate of 1.8 percent. Core sector gas consumption growth rates, which are driven by population growth, are similar between the two states. However, gas

[25] The NWGA consists of six major natural gas distribution and three pipeline companies that operate in the region.
[26] Avista Utilities serves both the Spokane, Washington area and localities across the state line in Idaho. Historical data and forecasts are provided by individual distribution companies and therefore the northern Idaho gas consumption numbers was grouped into the western Washington subregion.

consumption for the Washington industrial and power sectors are 1.5 and 2.5 times higher respectively.

Exhibit 4-2
Natural Gas Consumption Projections from NWGA 2007 Outlook (Bcf per year)

	Core (Residential and Commercial)	Industrial	Power	All Sectors
Oregon Annual Gas Consumption				
2008-2009	73.7	76.9	84.0	234.6
2009-2010	74.5	79.5	85.7	239.6
2010-2011	75.9	80.0	87.9	243.8
2011-2012	78.1	79.1	90.3	247.5
Average	79.0	79.1	93.4	251.5
Washington Annual Gas Consumption (Includes portions of northern Idaho)				
2008-2009	145.4	81.2	85.4	312.0
2009-2010	147.8	85.6	96.6	330.0
2010-2011	151.4	87.2	96.8	335.4
2011-2012	156.9	87.4	99.8	344.1
Average	158.3	87.3	100.4	346.0
Total Pacific Northwest Annual Gas Consumption				
2008-2009	219.1	158.1	169.4	546.6
2009-2010	222.3	165.1	182.3	569.7
2010-2011	227.3	167.2	184.7	579.2
2011-2012	235.0	166.5	190.1	591.6
Average	237.3	166.4	193.8	597.5

Exhibit 4-3
Natural Gas Consumption Growth Rate Projections from NWGA 2007 Outlook

	Core (Residential and Commercial)	Industrial	Power	All Sectors
Oregon Annual Gas Consumption Growth Rates				
2008-2009	2.1%	3.4%	2.1%	2.1%
2009-2010	3.1%	0.7%	2.6%	1.7%
2010-2011	3.9%	-1.1%	2.7%	1.5%
2011-2012	2.3%	0.0%	3.5%	1.6%
Average	2.9%	0.7%	2.7%	1.8%
Washington Annual Gas Consumption Growth Rates				
2008-2009	2.3%	5.4%	13.1%	5.8%
2009-2010	3.2%	1.8%	0.2%	1.6%
2010-2011	4.2%	0.2%	3.1%	2.6%
2011-2012	1.5%	-0.1%	0.6%	0.5%
Average	2.8%	1.8%	4.2%	2.6%
Total Pacific Northwest Annual Gas Consumption Growth Rates				
2008-2009	2.3%	4.4%	7.6%	4.2%
2009-2010	3.2%	1.3%	1.3%	1.7%
2010-2011	4.1%	-0.4%	2.9%	2.1%
2011-2012	1.7%	-0.1%	2.0%	1.0%

Average	2.8%	1.3%	3.5%	2.3%

The NWGA forecasts are generally consistent, on an average basis and an all-sector basis with historical growth in the 1997 to 2006 period. As discussed in chapter 2, historical gas consumption grew at an annual average rate of 1.7 percent in the 1997-2006 period, but at a higher annual average rate of 3.0 percent in the 2002 to 2006 period. The lower growth rate of gas consumption for the longer historical period can be explained by destruction of demand during the energy crisis from the industrial sector.

When comparing projections to historical experience by sector, a number of observations can be made. The NWGA projections are considerably lower for the power sector. The robust growth averaging over 18.5% per year is not expected to continue at the same rapid pace. However, power sector gas consumption growth is still expected to be the fastest growing sector at an average annual growth rate of 3.5%. NWGA gas consumption projections for heating load in the core sector are projected to increase at 2.0 percent essentially equaling historical trends.

The NWGA does not expect gas consumption to decrease in the industrial sector. The industrial sector experienced negative growth in the 2000-2003 period, contributing to average negative growth of the 1997-2006 period. NWGA projections do not anticipate a repeat of this experience; however, the projected growth is modest, at 1.3% annually. Most likely, the most gas sensitive industries have ceased operations in the region (as well as other parts of the U.S.), and the NWGA projects modest growth from the remaining industrial gas consumers consistent with a growing regional economy.

Total gas consumption growth in the EIA forecast is lower than the NWGA forecast for the near-term (2008-2015), at an annual average rate of 1.3 percent across all sectors as compared to NWGA's forecast of 2.3% for all sectors over the 2008-2012 period. Sector specific growth is also lower for all sectors. ICF does not believe that the EIA forecast should be given significant weight for a number of reasons:

(1) The applicable geographic region is much broader including the states of California, Hawaii, and Alaska. This biases the forecast to events projected to occur in California.

(2) EIA has significantly reduced their natural gas consumption projections in recent years. For example, total U.S. 2015 gas consumption in the reference 2008 AEO forecast is 17 percent below the vintage 2005 AEO forecast.

(3) EIA projections for demand growth for the power sector and gas consumption associated with the power sector have been understated in recent years.

(4) EIA's reference case (for which the greatest detail is available), does not consider existing or potential future national CO_2 regulations. With CO_2 regulations, natural gas generation and gas consumption more broadly is likely to increase considerably.

(5) Not only does EIA's reference case project a significant increase in coal capacity and generation in the Northwest Power Pool, but also in California. EIA's reference case projects increase in coal capacity of roughly 20 GW and an increased in coal- fired generation of approximately 150,000 GWh from 2004 to 2030 with an average annual growth of approximately 7.3% for both coal capacity and generation for California. This significant increase in California seems to be unrealistic considering the region's dearth of existing coal capacity, its opposition to coal capacity, its early adoption of aggressive RPS targets of 20% by 2010, and its announced plans to adopt state specific GHG emissions regulations in the event national regulations are not enforced by 2012.

(5) EIA reference case modeling is based on 2005 assumptions and data inputs, which may be dated when considering changed market dynamics since than, most notably, an almost-certain GHG emissions cap regime, which would replace much of envisaged coal capacity with renewable, gas and other lesser carbon emitting technologies, but also other factors such as dramatic increases in the costs of new power plant construction.

IV.3 Approach to the Assessment of Gas Consumption for the 2008-2030 Period

In order to provide a base projection of gas consumption levels for the 2008 to 2030 period, ICF utilized:

(1) EIA data for actual gas consumption for the most recent year available for Oregon and Washington as a base year starting point of consumption by sector;
(2) NWGA forecasted growth rates for gas consumption for 2008 to 2012 for Oregon and Washington; and
(3) Extrapolations of NWGA forecasted growth rates for 2008 to 2012 for the Pacific Northwest, applied to the 2013 to 2030 period.

NWGA defines the Pacific Northwest as including Oregon, Washington, British Columbia, and Idaho, i.e. broader that our definition for purposes of this assessment as including Oregon and Washington alone. However, NWGA provides additional detail for the following sub-regions:

- West Oregon
- East Oregon
- West Washington
- East Washington & North Idaho
- BC Lower Mainland & Vancouver Island
- BC Interior
- South Idaho

As mentioned earlier and summarized in Exhibit 4-2, we compiled gas consumption growth rate information for Oregon and for Washington, with Washington including portions of northern Idaho. However, since the base year of 2006 was normalized to EIA's gas consumption levels of Washington alone, the impact of including portions of northern Idaho was reduced.

IV.3.1 Gas Consumption Outlook for the Power Sector

The methodology, as applied to Oregon, is as follows, resulting in an annual average 3.2 percent growth rate in gas consumption for the power sector from 2008 to 2030:

(1) Oregon gas consumption of 75,180 MMcf in 2006 (data from EIA)
(2) Power sector average growth rate of 2.7 percent from 2006 to 2012 (based on the average NWGA projection for Oregon for the 2008-2012 period)
(3) Power sector average growth rate of 3.3 percent from 2013 to 2030 (based on the base case NWGA projection for the Pacific Northwest for the 2008-2012 period)

The methodology, as applied to Washington, is as follows, resulting in an annual average 2.9 percent growth rate from 2008 to 2030:

(1) Washington gas consumption of 58,800 MMcf in 2006 (data from EIA)
(2) Power sector average growth rate of 8.3 percent from 2006-2012 based on several factors:
    a. NWGA projects a significant increase in gas consumption in 2008 and 2009, presumably due to the addition of new gas plants; ICF factors this in by adjusting 2007 and 2008 gas consumption to reflect the Mint Farm 286 MW power plant coming on-line in 2007 and the Grays Harbor 650 MW power plant coming on-line in 2008; this results in a 15.3 percent growth rate from 2006 to 2007 and a 29.4 percent growth rate from 2007 to 2008; by way of reference, the NWGA average growth rate for 2008-2009 is 13.1 percent.
    b. Power sector average growth rate of 1.3 percent from 2009 to 2012 (based on the average NWGA projection for Washington for the 2009-2012 period)
(3) Power sector average growth rate of 3.3 percent from 2013-2030 (based on the base case NWGA projection for the Pacific Northwest for the 2008-2012 period)

These average growth rates of 2.9 and 3.2 percent are generally consistent with EIA's forecast for gas consumption for the power sector for 2008-2015 (at 2.8 percent), but as discussed earlier, considerably higher than EIA's longer term forecast. These growth rates are, however, considerably lower than the historical power sector gas consumption growth rate in the Pacific Northwest of the past decade.

For context, the projected growth rate of 3.1 percent on average for natural gas consumption in the Pacific Northwest implies that approximately 30 to 35 percent of incremental generation requirements will be met through local natural gas-fired generation. This is roughly consistent with the percentage of gas-fired capacity announced as a fraction of overall capacity expansion, and may be considered conservative in light of the fact that gas-fired power plant capacity factors are likely to be higher than renewable plant capacity factors on average.

IV.3.2 Gas Consumption Outlook for Other Sectors and in Aggregate

We applied a similar methodology for determining gas consumption from the other sectors, namely the CORE (commercial and residential) and industrial sectors. The projection assumes that CORE sector gas consumption will follow recent trends. This implies that population growth, space and water heating equipment efficiency increases, and changes in square footage per household and commercial space continue to follow current trends. Industrial sector gas consumption growth at 1.3% is less than half of the projected GDP growth of 3.0%.

Specifically, CORE sector growth projections are derived by summing up the commercial and residential sector gas consumptions. The methodology for Oregon and Washington CORE sector growth, resulting in an annual average 1.7 percent growth from 2008 to 2030, is as follows:

(1) EIA total commercial and residential gas consumption of 71,882 MMcf and 133,844 MMcf for Oregon and Washington in 2007[27]
(2) CORE sector annual average growth rate of 1.7 percent for Oregon and 2.2 percent for Washington from 2007 to 2012 (based on NWGA average growth rates for the commercial and residential sectors from 2008 to 2012)
(3) CORE sector annual average growth of 1.7 percent from 2013 – 2030 (based on NWGA base case weighted average growth from 2008-2012 for the Pacific Northwest)

The industrial sector growth rate averages 1.0 percent and 1.2 percent for Oregon and Washington, respectively, from 2008 to 2030:

(1) EIA industrial gas consumption of 68,836 MMcf and 73,387 MMcf for Oregon and Washington, respectively, in 2007
(2) Industrial sector annual average growth of 0.9 percent for Oregon and 1.8 percent for Washington from 2007 to 2012 (based on NWGA average growth rates from 2008 to 2012 for the industrial sector)
(3) Industrial sector annual average growth of 1.0 percent from 2013 to 2030 (based on NWGA base case average growth from 2008 to 2012 for the Pacific Northwest)

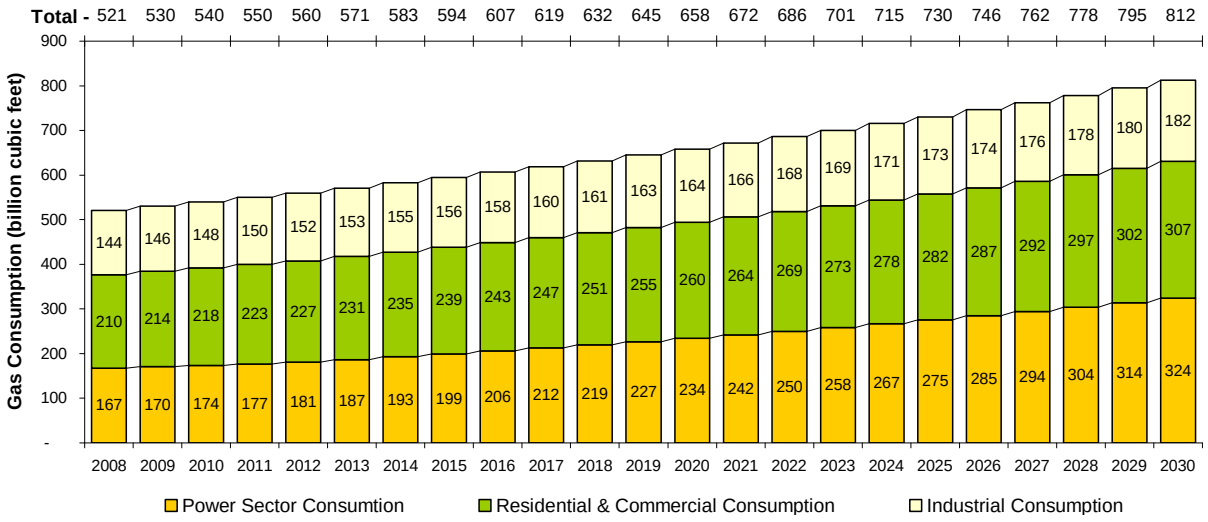
The resultant projections for 2008 to 2030 are summarized in Exhibits 4-3 and 4-4.

[27] Note 2007 data from EIA was available for all sectors except the power sector at the beginning of this study; hence 2006 actual values were used as the basis for power sector projections and 2007 actual values were used as the basis for all other sector projections.

Exhibit 4-4
Natural Gas Consumption Projections for the Power Sector with Adjusted and Extrapolated NWGA Growth Rates

	Power	CORE	Industrial	All Sectors
OR				
2006-2012[28]	2.7%	1.7%	0.9%	1.8%
2013-2030	3.3%	1.7%	1.0%	2.2%
2008-2030	3.2%	1.7%	1.0%	2.1%
WA				
2006-2012[28]	8.3%	2.2%	1.8%	3.9%
2013-2030	3.3%	1.7%	1.0%	2.0%
2008-2030	2.9%	1.8%	1.2%	2.0%
Pacific Northwest				
2006-2012[28]	5.2%	2.0%	1.3%	2.9%
2013-2030	3.3%	1.7%	1.0%	2.1%
2008-2030	3.1%	1.7%	1.1%	2.0%

Exhibit 4-5
Natural Gas Consumption Projections for All Sectors



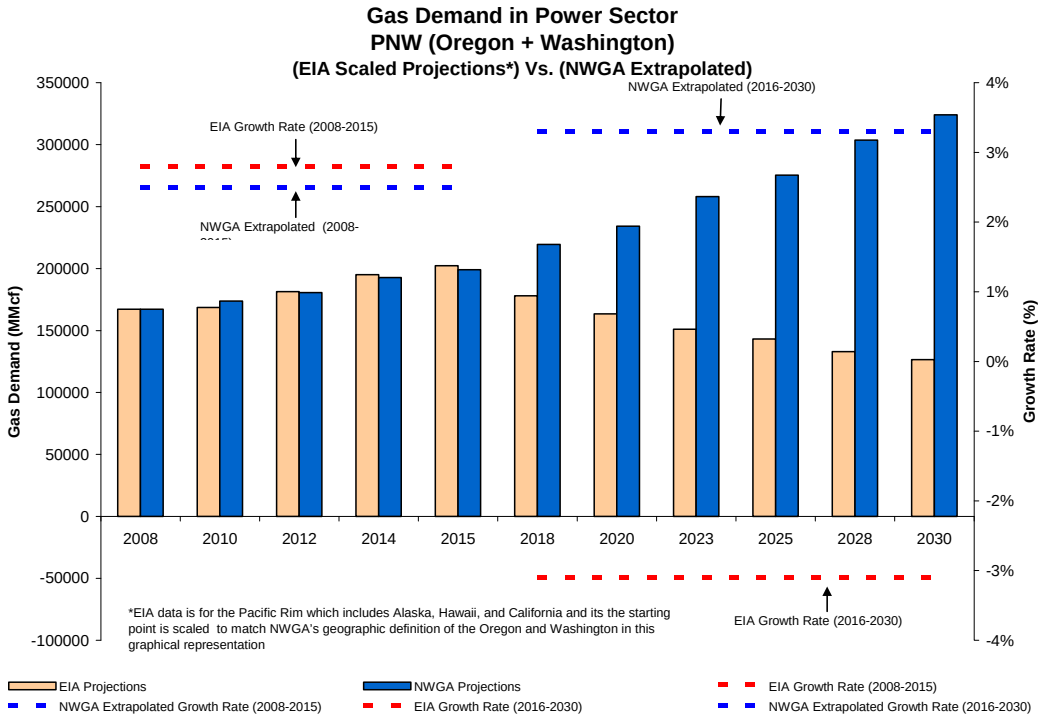
Source: ICF base projection based on publicly available information

IV.3.2 EIA Gas Consumption Outlook

As discussed earlier, the EIA Energy Outlook 2007 projects gas demand for power, residential, commercial and industrial sectors from 2008 to 2030 but for a larger Pacific region which includes California, Alaska and Hawaii. Ignoring the mismatch in regional focus, the EIA projects a similar (albeit slightly lower) rate of growth in gas consumption in the power sector for 2008 to 2015, but a decrease in gas consumption in the power sector from 2016 to 2030, in turn a function of an assumption of decreasing gas fired generation from 2016 onwards (see Exhibit 4-6).

[28] CORE and Industrial sector growth are average from 2007-2012

Exhibit 4-6
EIA vs. NWGA Projections for Gas Demand from the Power Sector



EIA projects that from 2016 onwards, all increasing energy demand requirements will be met by bringing on new coal capacity and increasing coal-fired generation. As noted earlier, this assumption of meeting all increasing energy demand for the Pacific region (including California) from coal-fired generation seems extremely unlikely and impractical considering the present opposition to coal plants, the focus on controlling GHG emissions and the promotion of renewable generation. Therefore, we believe a significant adjustment to the EIA projections is warranted. For illustrative purposes, we constructed a scenario whereby we made an adjustment to the projections by replacing incremental coal-fired generation from 2016 to 2025 with renewable and gas-fired generation, sufficient to meet a hybrid RPS standard. The resultant gas consumption growth rates are summarized in Exhibit 4-7. As can be seen, this scenario results in increasing the gas consumption annual average growth rate from 0.5% to 2.5%, exceeding the growth rate implied by NWGA projections. Alternative scenarios are of course possible, but we believe this scenario illustrates the significant impact of changing a single key assumption (coal generation growth) to one that is more reasonable and likely.

Exhibit 4-7
EIA Annual Gas Consumption Growth Rates – Reference Case and Adjusted

	Power Sector	Core Sector	Industrial Sector	All Sectors
EIA 2007 Outlook Base Case (2008-2030)	-1.21%	1.12%	0.88%	0.49%
EIA Outlook Adjusted (2008-2025)	4.88%	1.20%	0.77%	2.50%
ICF / NWGA Base Case (2008-2030)	3.10%	1.70%	1.10%	2.00%

Exhibits 4-8 to 4-10 compare projected sector growth rates among: the historical period 1997 to 2006, the NWGA forecast, the EIA forecast for different time periods, the NWGA extrapolated forecast, and the EIA adjusted forecast which makes adjustments for coal capacity in the power sector. Exhibit 4-11 is a comparison of projected growth rates for all end-use sectors combined. ICF used extrapolated growth rates from the NWGA report to create a Base Case forecast to 2030 of Pacific Northwest gas consumption. This Base Case was used as a starting point for scenario analysis in a study of the

potential impacts of Jordan Cove LNG imports into the Pacific Northwest; Task 2 in a comprehensive analysis of LNG and the Pacific Northwest gas market.

ICF believes that the Base Case projection is reasonable. Gas consumption in the power sector although robust, is well below recent historical growth rates and below the EIA projection when adjusted for coal-fired capacity additions. Since the power sector is the highest growth rate sector, it has the highest impact of the growth in the market as a whole. CORE consumption of space and water heating load customers are projected near historical trends. Industrial gas consumption is projected to increase modestly although consumption levels had decreased in recent years. ICF believes that industries most susceptible to higher gas prices have adjusted or shut-down. Modest gas consumption growth in the industrial sector is consistent with a growing economy. For all sectors in the Base Case, the projected average annual natural gas growth rate to 2030 in the Pacific Northwest is 2%, almost identical to the overall market growth rate from 1997 to 2006.

Exhibit 4-8
Pacific Northwest Annual Average Growth Rates for the Power Sector

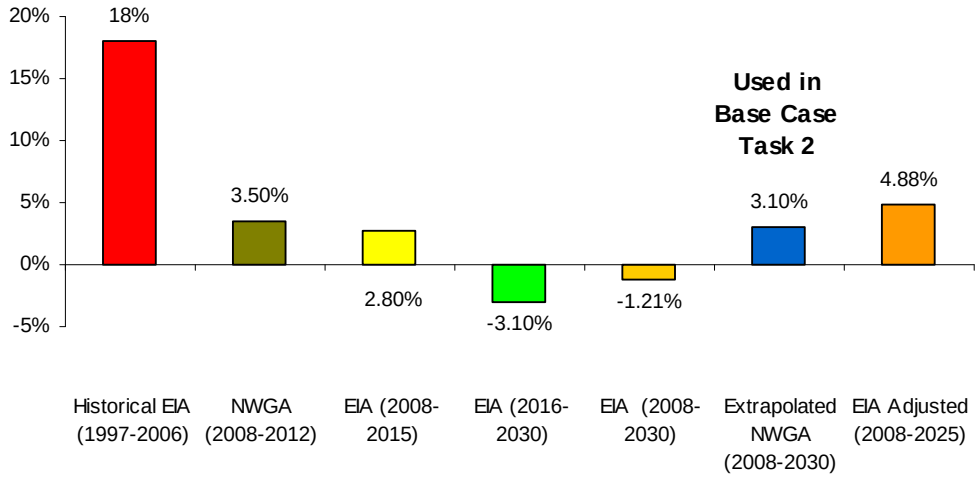
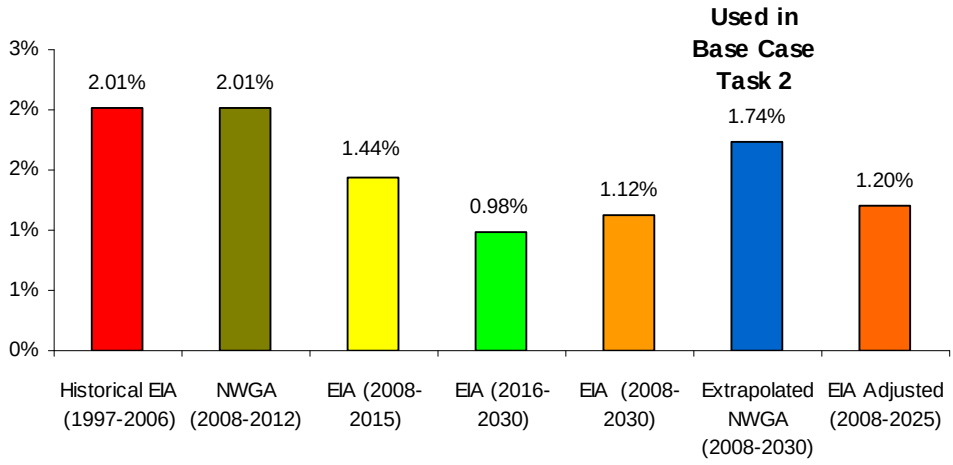


Exhibit 4-9
Pacific Northwest Annual Average Growth Rates for Core Sector[29]



[29] Note: the EIA Adjusted case only went to 2025 due to data availability. Gas consumption in the EIA case and the EIA Adjusted case are identical for all sectors except the power sector.

Exhibit 4-10
Pacific Northwest Annual Average Growth Rates for Industrial Sector

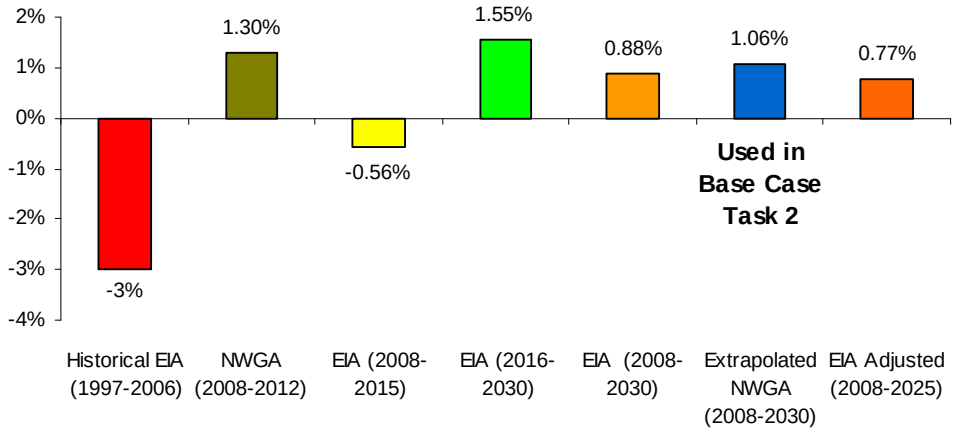


Exhibit 4-11
Pacific Northwest Annual Average Growth Rates for All Sectors