Department of Commerce
Innovation is in our nature.

2013 Biennial Energy Report

Issues, Analysis, and Updates

December 2012
Report to the Legislature
Rogers Weed, Director

Acknowledgements

Washington State Department of Commerce
Tony Usibelli, Director, Energy Office
Mark Anderson, Energy Policy Specialist, Energy Office
Glenn Blackmon, Energy Policy Specialist, Energy Office
Angela Burrell, Analyst, Energy Office
Roel Hammerschlag, Project Manager, Energy Office
Peter Moulton, Energy Policy Specialist, Energy Office
Greg Nothstein, Analyst, Energy Office

Washington State Department of Commerce
Energy Office
1011 Plum Street
P.O. Box 42525
Olympia, WA 98504-2525
commerce.wa.gov/energy/

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Abbreviations and Definitions

aMW average Megawatt
A unit of energy, meaning one megawatt delivered continuously for one year

ARRA American Recovery and Reinvestment Act
The federal "stimulus bill" passed in 2009, Public Law 111-5

Btu British thermal unit
A unit of energy. For scale: 1,000 Btu will bring a three-quart pot of water to boiling.

CAFE Corporate Average Fuel Economy
A standard requiring minimum average fuel efficiencies for the portfolio of vehicle models manufactured by any one corporation

CELC Clean Energy Leadership Council
Task force created by the Legislature to research and prioritize Washington's best clean energy development opportunities

CNG Compressed Natural Gas

CTR Commute Trip Reduction
A state program designed to reduce single-occupancy vehicle commuting

DE Distributed Energy
A combination of the concepts of distributed generation, combined heat and power, and district heating

EECBG Energy Efficiency Community Block Grants
A grant program created under ARRA

EIA Energy Information Administration
A division of the U.S. Department of Energy.

GSP Gross State Product
A measure of the size of a state's economy; the sum of all payments between all sectors

kWh kilowatt-hour
A unit of energy, meaning one kilowatt of power delivered continuously for one hour

mmBtu Million Btu
One million Btu (a unit of energy). For scale: an average household consumes about 30 mmBtu per year.

mpg Miles per gallon

MWh Megawatt-hour
1,000 kWh (a unit of energy)

RCW Revised Code of Washington
RCW is the document that continuously compiles all of Washington's state law as it is legislated (not to be confused with Washington Administrative Code, or WAC, which contains rules developed by state agencies in order to comply with the laws described in the RCW).

REC Renewable Energy Credit
A certificate indicating that one MWh of electricity was generated with renewable energy

RFS Renewable Fuels Standard
A standard requiring use of a minimum fraction of liquid fuels generated from renewable feedstocks

SEPA State Environmental Policy Act

Washington law that requires state and local agencies to consider the likely environmental consequences of a proposal before approving or denying the proposal

TBtu Trillion Btu

One trillion Btu (a unit of energy). For scale: the entire Washington energy budget is about 1,500 TBtu per year

Tcf Trillion cubic feet

A measure of volume, measuring natural gas reserves. One Tcf contains about 1,000 TBtu of energy

UTC Washington Utilities and Transportation Commission

WAC Washington Administrative Code

WSDOT Washington State Department of Transportation

WSU Washington State University

Boldface call numbers appear throughout the document, in the form of a letter **R**, **S** or **W** followed by four numeric digits, for example **R0234** or **W0018**. **R** or **S** call numbers follow reference citations, and allow the Energy Office to retrieve an archival copy of the cited reference when requested. **W** call numbers follow original tables, graphs, or other quantitative treatments and allow the Energy Office to retrieve an archival copy of the spreadsheet containing the relevant calculations.

Executive Summary

The close of 2012 finds Washington with a new incoming Governor and with a hopeful energy future. A year ago, Washington issued its first comprehensive *Washington State Energy Strategy* since 1993. This report offers the first look back at implementation of the new strategy, and finds that the Legislature, Governor, and state agencies have all taken steps along the path it outlines.

- Recent legislation created new laws supporting exploratory steps toward tying the cost of cars and highways to their use, including usage-based insurance, car sharing, and usage-based road pricing.
- The Department of Commerce (Commerce), the Governor's Office, the Washington State University Extension Energy Program (WSU Energy Program), and the Department of Enterprise Services are collaborating on a policy for state government purchase of electric vehicles.
- The Department of Ecology is encouraging efficiency in fossil-fueled vehicles with its Clean Diesel Program partners.
- The Legislature has supported the development of advanced aviation fuels by streamlining facility siting, enabling advanced aviation fuel refiners to qualify for Industrial Revenue Bonds, and establishing research support through Innovate Washington.
- Multiple efforts toward streamlined permitting for distributed energy are underway, led by a Utilities and Transportation Commission rulemaking to modernize and simplify interconnection standards.
- The Legislature established an advisory opinion process to facilitate the deployment of conservation and renewable energy under the state Energy Independence Act, and widened the definition of biomass energy to allow for a more diverse spectrum of alternative energy.
- The WSU Energy Program completed a study exploring the potential impacts of minimum efficiency standards for rental housing, and is working toward transitioning the federally funded Community Energy Efficiency Programs to a sustainable, state-funded model. The Legislature also provided capital funding for Commerce's Energy Matchmakers program to support weatherization of low-income households.

Lately, historically low natural gas prices provide a sense of opportunity and security. New analysis in this report recommends several cautions around this apparently lucky turn of events. In particular, the state should be careful to protect its commitments to efficiency and renewable energy. Generally speaking, any support for natural gas should probably be directed toward displacement of coal-fired electric generation and away from light-duty vehicles.

This report also features an inventory of energy-related tax breaks and their expiration dates, to assist policymakers with a comprehensive and holistic appraisal of support the state gives to progressive energy policy. Much of this support will expire in 2013, and legislators will want to consider carefully which incentives to renew.

As with previous biennial energy reports, the final chapter and appendices of this report provide a comprehensive treatment of energy system indicator data dating from 1970.

The Washington State Energy Office

The State Energy Office provides energy policy support, analysis, and information for the Governor, Legislature, Commerce, and other energy decision makers. It analyzes key energy issues, including natural gas, alternative fuels, energy efficiency, renewable energy development, greenhouse gas emissions, energy supply, and price. It provides technical and policy support on federal and regional energy policies and legislation to Washington members of the Northwest Power and Conservation Council, other state agencies, and state congressional officials.

Working with an advisory committee, stakeholders, and the public, the Energy Office develops the *Washington State Energy Strategy (Energy Strategy)*. It produces energy use, electricity, and other reports, and represents the state's policy interests in regional and national organizations.

The federal American Recovery and Reinvestment Act funding in 2009 supported a variety of projects over the past three years. These included development of advanced biofuels, wood-waste bioenergy, irrigation hydropower, wind turbine installation, water-cooling systems, improvements to existing and construction of new anaerobic digesters, and numerous energy efficiency upgrades around the state. Loan repayments will enable the Energy Office to offer new loans in the fall of 2014.

The Energy Office ensures statewide energy security and preparedness by protecting the state's energy infrastructure, especially electricity, petroleum, and natural gas. During energy supply or other energy emergencies, it provides assistance to the state emergency operations center, Governor's Office, energy companies, utilities, local governments, and others. It works to ensure energy shortages are controlled, thereby reducing impacts on the health and safety of citizens, businesses, and our economy.

The Energy Office also supports energy efficiency and renewable energy. For example, the Legislature has directed the Energy Office to develop and implement a strategic plan that will support achievement of a 70 percent reduction in building energy use by 2030. This plan is to be completed every three years. The first plan, produced in 2010, supports reducing energy use and greenhouse gas emissions from buildings.[a] In addition, Commerce, the Washington Department of Transportation, and a broad group of organizations formed the Plug-in Electric Vehicle Task Force to create a favorable environment for electric vehicle markets.

The full portfolio of policy development and data collection responsibilities includes:

- Appliance and equipment standards
- Biopower and biofuels
- Building efficiency
- Building energy codes
- Energy resources
- Federal energy programs
- Fuel mix
- Green jobs

[a] http://www.commerce.wa.gov/Documents/EO%202011%20Strategic%20Plan%20for%20Buildings.pdf

- Climate change
- Critical energy infrastructure
- Electric utility data
- Electric vehicles
- Energy emergencies
- Emission performance standards
- Energy efficiency and conservation
- Energy data
- Energy education
- Energy emergencies
- Energy facility siting
- Energy Independence Act
- Greenhouse gas emissions
- Hydropower
- Incentives
- Legislation
- Petroleum and natural gas
- Energy policy
- Renewable energy
- Renewable development
- *Washington State Energy Strategy*
- Technology transfer programs
- Transmission
- Electric utility resource plans
- Wind development

Chapter 1 – Emerging Energy Market Issues

Introduction

This *2013 Biennial Energy Report* marks the 13th report since the first one was delivered to the Legislature in January 1989. Every two years, the report provides the status of a number of fundamental energy indicators – quantities and costs of energy generated and consumed in Washington – augmented with analysis of a few emerging issues unique to the Pacific Northwest's energy economy. This year, Washington's citizens and businesses find themselves concerned about volatile petroleum prices that were recently pushed further upwards by outages at West Coast refineries; the implications of potentially large volumes of low-cost natural gas; and the collective expiration of a large number of tax incentives designed to promote progressive energy policy in Washington.

Petroleum Products Supply and Prices

Washington State's gasoline and diesel prices consistently are higher than the national average, and prices nationwide are exhibiting increased volatility – large price spikes over short time periods. Recently, Washington prices have been more volatile than usual because of contingencies at West Coast refineries. The increase in prices is a direct drain on the economy, and price volatility is an indirect drain because it makes it difficult to plan. Higher prices and higher price volatility are deep-rooted changes for transportation energy, and there are no easy or simple solutions.

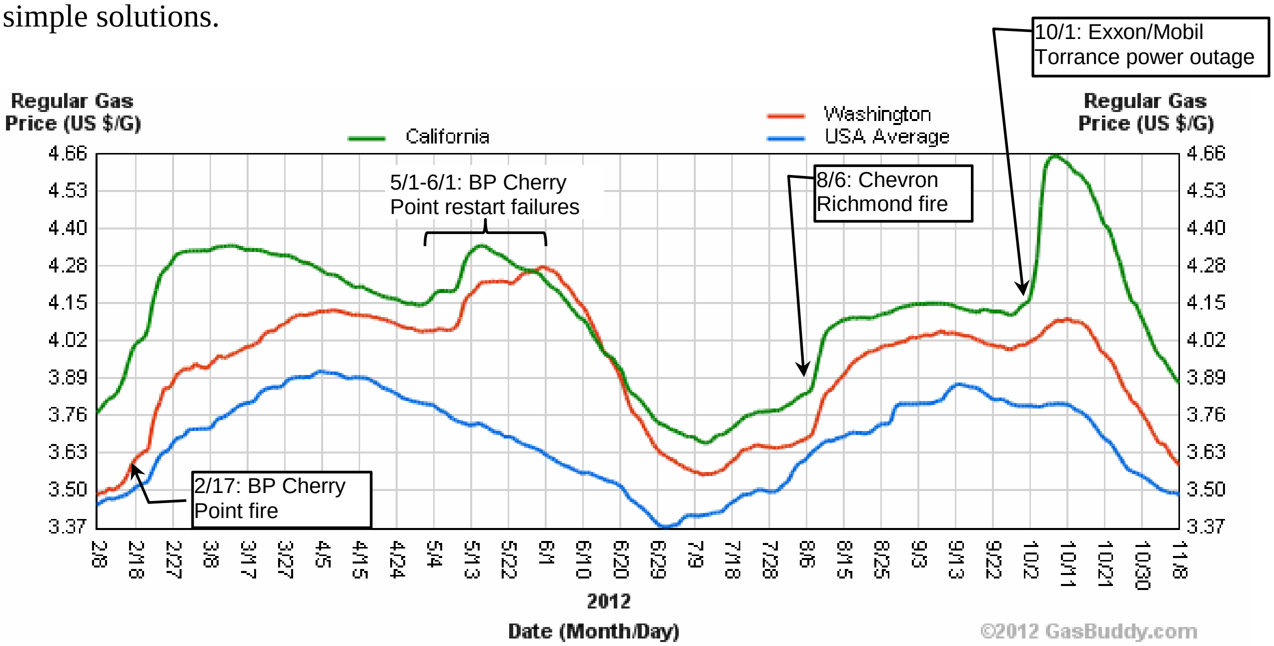

Figure 1-1: Retail, regular gasoline prices over the last nine months in Washington (red), California (green), and the U.S. average (blue). California gasoline prices are the highest due to air quality regulations that require reformulated gasoline. Because the West Coast gasoline market is isolated from the rest of the country, Washington prices are strongly influenced by its much larger West Coast neighbor. Price volatility in the West Coast market is tightly related to contingencies occurring at the refineries supplying the market. Data and graphics: gasbuddy.com.

During the 1990's, gasoline and diesel prices nationwide were generally flat, with a U.S. average regular gasoline price of $1.23/gallon.[2] In 2002, prices began a steady increase and peaked in 2008 at $4.11/gallon, a 334 percent increase or 17 percent per year on average.[3] Prices crashed in 2009 mainly because of a reduction in consumption induced by recession, but steadily climbed back to the 2008 peak by the summer of 2012, where they remain. Price volatility has increased as well, with price changes of $1.00/gallon over as little as six months.[4] In individual cities and counties even greater volatility has occurred.

Figure 1-2: U.S. average retail, regular gasoline price from 1990 to present. Data and graphics: U.S. Energy Information Administration.

In Washington and on the West Coast, prices have followed the national trend – only higher and, at least recently, more volatile. The reasons for this situation are well understood. The West Coast is isolated from the country's main refining centers and their prodigious supplies of petroleum products. There are no pipelines connecting the West to these resources and transport by tanker is not timely. This makes West Coast costs generally higher, particularly so when unscheduled supply problems occur. The region cannot quickly obtain alternate supplies like most of the rest of the country. Alaska and Hawaii are even more isolated and face higher and equally volatile prices. West Coast states also have higher fuel taxes. Requirements for reformulated gasoline in California also nudges prices up, because Washington refiners can make higher profits supplying California.

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2 Average U.S. Regular All Formulations Retail Gasoline Prices, USDOE/EIA, calculated from available weekly data from May 1992 through December 1999. The average price increase over the period was just over 2/10ths of one percent (.0023).

3 *Ibid*, calculated from available weekly data January 2000 through November 5, 2012.

4 Commerce compared the Relative Standard Deviation (RSD) of West Coast Regular All Formulations Retail Gasoline Prices, USDOE/EIA, from January 2000 to November 5, 2012. RSD for the previous decade is 14 percent, and for the 2000s is 28 percent. By this measure West Coast volatility has doubled over the last decade.

Citizens, businesses, and governments alike are affected by the high, unstable prices. While economists and energy policy analysts understand the reasons for the high prices and their instability, it is frustrating to have limited ability to control them.

The ability to affect prices is limited because of the fundamental nature of the market.

- In 2011, the cost of crude oil represented 68 percent of the retail price for gasoline.[5] Crude oil prices are set in a world market, affected by world supply and demand, and there is essentially nothing Washington, or any other state, can do to significantly affect the price. Cost recovery for all the remaining requirements to store, refine, distribute, and sell the product, plus taxes and profit on the product, is contained in the remaining 32 percent of the retail price.
- Gasoline and diesel wholesale prices are set in a multi-state, regional market, affected by regional supply and demand. Actions in Washington have some effect, but do not control prices.
- Retail prices are set by supply and demand in local markets. Consumer actions there can affect prices, but again, not by a large degree.

There are really only three ways to lower prices:

- Lower prices directly by mandate, increased competition, or cost reduction
- Increase supply (assuming no change in manufacturing costs)
- Decrease demand

An alternative is to mitigate consumers' costs, for example, by subsidizing transit alternatives or by providing educational programs that assist with more efficient use of transportation resources.

None of these are easy, simple options to implement; some are more feasible than others. Each has costs and impacts, sometimes significant and sometimes conflicting. A policy that helps deal with price spikes may lead to higher long-term costs.

Policy Options – Lowering Prices Directly

Washington law currently does not allow the state to mandate refined product price controls. In the only recent instance of a state effort to control gasoline prices, Hawaii implemented a price cap on regular, unleaded gasoline in September 2005. The state rescinded the law just eight months later in May 2006 because prices were deemed to be higher than without the cap.[6]

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5 Gasoline Explained, Factors Affecting Gasoline Prices, USDOE/EIA, http://www.eia.gov/energyexplained/index.cfm?page=gasoline_factors_affecting_prices, accessed 11/9/2012. (**R0259**)

6 Actual implementation of the wholesale gasoline price caps took effect on September 1, 2005. Governor Lingle suspended them with the signing of Act 78 (2006) on May 5, 2006. Gas Cap Information (historical), State of Hawaii, Public Utilities Commission, http://puc.hawaii.gov (**R0261**); and Letter of Notice of Gubernatorial Signature to Hawaii State Legislature, Linda Lingle, Governor, May 5, 2006. (**R0260**)

Since the 1980s, the U.S. has purposefully pursued market solutions, eschewing price controls and even letting fuel allocation legislation sunset. During a contingency, it is the price signals themselves that direct supply to where it is needed most.

One alternative is to lower the state gas tax during contingencies. In September 2005, after Hurricane Katrina, Georgia suspended the state gasoline tax for one month.[7] Retail prices decreased, but not as much as the value of the tax.

Perhaps the only way that policy makers in Washington could directly lower the price of gasoline and other petroleum products long term would be to reduce the taxes that are incorporated into fuel prices. Washington taxes gasoline and diesel fuel at 37.5 cents per gallon, and any reduction in the tax rate would likely be reflected in lower prices to the consumer. Oregon and Idaho tax these fuels at 30 cents and 26 cents, respectively.[8] However, fuel taxes are the primary source of funding for severely needed transportation projects for maintaining an effective and efficient transportation system in Washington. If those transportation projects are not completed, then congested roadways lead to greater fuel consumption (and therefore higher fuel costs) for individual vehicles – even if the price of the fuel is lower.

Another alternative would be to take actions to effectively lower refiners' fuel production costs, hoping that the savings would work through to consumers. The state could waive any number of regulations that create costs for refiners; these are generally safety-related or environmental in nature. The elimination of these regulations is not certain to reduce gasoline prices equal to implementation costs – plus the safety or environmental benefits are lost.

Hypermarket retailers (for example, Costco or Safeway) offer lower retail prices than conventional outlets.[9] Increasing their share of the retail fuel market in Washington likely would lower average prices, as long as sufficient competition remains. The state could choose to incentivize such expansion.

Policy Options – Increasing Supply

Long-term, refined-product supply is not at risk. The problem is the inability during contingencies to quickly obtain alternative supplies in sufficient amounts to keep prices from rising so high for so long. Solutions to this problem all require significant investments that cannot be done quickly.

The problem, essentially, is that insufficient inventory is retained. But there are significant costs to constructing infrastructure and maintaining inventory, all of which would raise long-term prices. There are several ways that inventory could be structured, all of which have benefits and

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7 Executive Order 09.02.05.01, suspending the collection of taxes on motor fuel taxes. (**R0262**)

8 http://www.taxadmin.org/fta/rate/mf.pdf. Local governments in Oregon add an additional one to three cents per gallon, over and above the 30-cent state-wide rate. (**R0263**)

9 P R Zimmerman, *The Competitive Impact of Hypermarket Retailers on Gasoline Prices*, U.S. Federal Trade Commission - Bureau of Economics, June 18, 2009, http://mpra.ub.uni-muenchen.de/20248/. (**R0258**)

costs. In 2003, the California Energy Commission (CEC) rejected a staff recommendation, based on a California attorney general study, to implement a state strategic fuel reserve, based mainly on concerns about the potential for unintended consequences that might negatively affect prices and supply.[10]

In addition to increased inventory, increases in regional refining capacity or petroleum product transportation capacity, such as pipelines, could help during contingencies. These would all require industry initiative and investment, though the state could support such projects with incentives, permitting assistance, and the like. The industry is looking for ways to expand the refining of crude oil and the distribution of refined products from the Bakken oil field in the Dakotas, and there may be initiatives in Montana and Utah for doing so. Both states supply Washington State via petroleum product pipelines.

Policy Options – Decreasing Demand

Alternatives that would decrease gasoline demand in Washington could improve our economic conditions by lowering costs to consumers and producers, but they are not likely to lower prices. Washington is a small market compared to the world, and our reduced demand would not affect the base price of crude oil, gasoline, or diesel fuel. An unexpected drop in demand could result in lower prices if it resulted in excess inventory at refineries, but the market would respond over time by reducing supply.

In the short term, when gasoline prices go up, demand goes down. Economists recognize the short-term price elasticity of gasoline demand to be very low, perhaps -0.10.[11] A price elasticity of -0.10 means that when the price doubles – a 100 percent increase – demand goes down only 10 percent. While some people can change their consumption practices quickly and significantly, large numbers of individuals and businesses cannot.

The reverse analysis is not as well understood: When supplies are tight, how much will the price go down with a 10 percent reduction in demand? It will have some effect on price, but to what degree? Achieving such a voluntary reduction also is difficult, especially if it comes on top of a reduction that was essentially already forced by the price increase. But whether or not demand reduction can reduce the price at the gas pump, what demand reduction *can* do is lower the energy bills of individuals and businesses.

Demand reduction alternatives that citizens, businesses, and agencies can take are discussed in detail in the *Energy Strategy*.[12]

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10 *Feasibility of a Strategic Fuel Reserve in California*, California Energy Commission, July 2003. (**R0264**)

11 J E Hughes, C R Knittel & D Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand*, National Bureau of Economic Research working paper #12530, September 2006, http://www.nber.org/papers/w12530. (**R0269**)

12 **S0102**. See especially sections 3.4.4, 3.4.5, 3.4.6, 3.4.7, 3.5.5 and 3.5.6.

Using substitute fuels, such as natural gas or electricity, is another way to reduce demand. Large fleets potentially could be converted to alternative fuels – Pierce County Transit is 100 percent natural gas powered. However, it would require conversion of a large fraction of the trucking industry to significantly affect oil consumption, an expensive proposition once changes to infrastructure are included. Migration to natural gas comes with uncertain climate impacts as well (see *Chapter 4 – Special Focus on Natural Gas* beginning on page 37).

Policy Options – Mitigating Costs

In the same way that demand reduction helps reduce gasoline costs, as opposed to lowering prices, steps could be taken to lower other costs for citizens to mitigate the impact of the high cost of gasoline. These could take many different forms, from a sales tax reduction to subsidies for transit services. Many of these types of subsidies are already in place, such as lower transit rates for seniors. Government agencies and businesses with more than 100 employees are required to have Commute Trip Reduction plans and incentives, which reduce consumption and lower the transportation costs of participants. These efforts could be expanded, but they are difficult to implement quickly and provide greater benefits to participants over the long run. They have essentially no impact on fuel prices, but help lower transportation costs for individuals and businesses.

Finally, citizens and businesses can mitigate the high price of fuel both long term and during price spikes by making informed choices about their transportation alternatives. Fuel prices are driven by crude oil prices, crude prices are driven by world supply and demand, and world demand will only increase. High petroleum prices are here to stay.

Natural Gas Supply

Since 2007, natural gas prices in the North American market have declined dramatically. The state has significant infrastructure, allowing it to take advantage of low-cost natural gas supply; a significantly changing price can have big impacts on the choices that Washington’s energy companies and consumers make. The future prospect for natural gas is clouded, however, by vigorous debates regarding its net impact on the climate system as well as collateral environmental impacts of accelerated extraction. This report provides an in-depth look at these debates and the outlook for natural gas in our state (*Chapter 4 – Special Focus on Natural Gas* begins on page 36).

Expiring Tax Breaks in Washington

The Legislature has used tax preferences[13] or exemptions as a tool to encourage development of alternative energy sources and, to a much smaller degree, energy efficiency. It enacted a broad

[13] The Legislature has defined a “tax preference” as an exemption, exclusion, or deduction from the base of a state tax; a credit against a state tax; a deferral of a state tax; or a preferential state tax rate. The Department of Revenue has on record about 600 such tax preferences, www.citizentaxpref.wa.gov/about.htm. (**S0103**)

package of renewable energy preferences in 2009, and many of these provisions are scheduled to expire on June 30, 2013.

Equipment and Installation for Renewable Energy Systems

The largest of the expiring tax breaks – worth about $43 million during the 2011-2013 Biennium[14] – applies to equipment and machinery installed for renewable electric generating projects, such as solar and biomass.[15] The biggest breaks go to smaller solar photovoltaic systems, but other renewable systems and larger solar projects also benefit:

- **Solar systems up to 10 kW**. Until June 30, 2013, purchases of machinery and equipment used directly in a facility that generates no more than 10 kilowatts of electricity using solar energy are exempt from sales and use tax. Also exempt are labor charges to install such equipment. The sales tax exemption is taken at the point of sale.
- **Solar systems greater than 10 kW and other qualified renewable energy systems 1 kW or greater**. Until June 30, 2013, taxpayers who install these systems qualify for a refund of 75 percent of the sales and use tax paid to the seller and installer. This refund program applies to:
    - Solar energy systems that produce more than 10 kW of electricity.
    - Qualified renewable energy systems that produce at least 1 kW of electricity. These systems generate electricity from wind, fuel cells, biomass energy, tidal or wave energy, geothermal resources, anaerobic digestion, and technology that converts otherwise lost thermal energy from exhaust or landfill gas.

The 75 percent refund is a step down built into the Legislature's 2009 action. These projects qualified for a full sales and use tax exemption until 2011.

The Joint Legislative Audit and Review Committee (JLARC) reviewed the renewable equipment and machinery preference in 2011.[16] It noted that the Legislature intended the break to be temporary and recommended that it be allowed to expire as scheduled (JLARC did not separately review the exemption for smaller solar projects). The 2009 law replaced a similar sales and use tax break, applying to projects with capacity greater than 200 watts, which was enacted in 2004 and expired in 2009.

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[14] Washington Department of Revenue, *2012 Tax Exemption Study: A Study of Tax Exemptions, Exclusions, Deductions, Deferrals, Differential Rates and Credits for Major Washington State and Local Taxes*, p. 215 http://dor.wa.gov/docs/reports/2012/Exemption_study_2012/2012%20Exemption%20Study%20-%20Entire%20Report.pdf (**S0099**).The amounts identified in this section are generally tax revenues at the state level; some of the provisions also have an impact on local government tax revenues.

[15] Revised Code of Washington (RCW) 82.08.962, RCW 82.12.962, RCW 82.08.963 and RCW 82.12.963.

[16] Citizens Commission for Performance Measurement of Tax Preferences (2012), www.citizentaxpref.wa.gov/reports.htm (**S0104**);

Joint Legislative Audit & Review Committee (JLARC), *2011 Expedited Light Tax Preferences*, May 20, 2011, p.4, www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/11-E.pdf (**S0100**);

Joint Legislative Audit & Review Committee (JLARC), *2011 Tax Preference Performance Reviews*, Washington State Legislature Report 12-2, January 11, 2012, p.19, www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/12-2.pdf. (**S0101**)

Fuel Inputs for Renewable Energy Systems

Once a renewable generating system is built or installed, it requires energy inputs or feedstocks to operate, and some tax preferences for these input fuels are also scheduled to expire on June 30, 2013. The 2009 legislation exempted forest-derived biomass – including hog fuel, but not firewood or pellets – from sales and use taxes when used as inputs to produce electricity, steam, heat, or biofuel, and this exemption is scheduled to expire in 2013.[17]

When the exemption expires, the state taxation of fuel inputs to electric production will vary significantly. Fuel used for natural gas-fired generating stations will be taxed at the public utility rate of 3.852 percent.[18] The coal used at the Centralia power plants will be exempt from any sales and use taxes,[19] a tax break estimated in 2010 to cost about $23 million per biennium.[20] Fuel for biomass generators will be taxed at the sales tax rate, which varies by location from 7.5 to 9.5 percent. The feedstocks for other renewable energy generation – sunlight, wind, and water – are not taxed by the state.

Looking a step further up the energy supply chain, the harvesters of biomass fuels for electric generation will continue to be eligible for a tax break on the business and occupation tax. This credit will actually be increasing in 2013 from $3 per ton of green harvested material to $5 per ton.[21] The business and occupation tax credit expires in 2015.

Electricity Outputs of Renewable Energy Systems

Washington provides tax breaks on the output of some renewable energy systems, and these are scheduled to continue through 2020. The production tax credits allow utilities to offset their public utility tax obligations with payments to customers for electricity using solar photovoltaic, wind, Stirling converter, or anaerobic digester systems.[22] The customer payments range from $0.12 per kilowatt-hour for customer-owned wind generation to $1.08 per kilowatt-hour for electricity produced by a community solar project whose solar modules and inverters are manufactured in Washington. The tax preference costs the state about $2.4 million in the 2011-2013 Biennium and is projected to double in cost by 2015.[23]

With a 2020 expiration date, the production tax credits do not qualify as expiring tax breaks, but there are several issues with this tax preference that have raised concern among stakeholders. The requirements for a community solar project are of particular concern, perhaps because a community solar project qualifies for twice the subsidy of an otherwise identical facility owned

[17] RCW 82.08.956, RCW 82.12.956, RCW 82.08.957, and RCW 82.12.957.

[18] RCW 82.12.022.

[19] RCW 82.08.811.

[20] Washington Department of Revenue legislative fiscal note for House Bill 3077 (2010), https://fortress.wa.gov/ofm/fnspublic/legsearch.asp?BillNumber=3077&SessionNumber=61. (**S0105**)

[21] RCW 82.04.4494.

[22] RCW 82.16.110, RCW 82.16.120, RCW 82.16.130. A Stirling converter generates electricity from solar heat.

[23] WA DOR (2012) *op. cit.*, p. 138.

by a single utility customer and because the ownership structure of community solar projects is often complex. Developers and equipment manufacturers would like to see an early extension of the 2020 expiration date.

Another question is whether the tax preference should be structured to encourage in-state manufacturing of components or to encourage installation of solar photovoltaic systems by Washington residents. The tax preference for in-state components encourages the state's solar manufacturing activity, but the money could be used to provide larger subsidies that would encourage more solar installations overall.

The Citizens Commission for Performance Measurement of Tax Preferences has scheduled this preference for review in 2016.[24]

Property Tax Exemptions on Anaerobic Digesters and Biofuel Manufacturing

Washington has provided property and leasehold tax breaks to firms that operate anaerobic digesters or manufacture biodiesel fuel, alcohol fuel, biodiesel feedstock, or wood biomass fuel, and those breaks are scheduled to end over the next three years. These facilities are eligible for a six-year exemption from property or leasehold taxes. New anaerobic digesters will be ineligible after December 31, 2012, and new biofuel manufacturing facilities become ineligible after December 31, 2015.[25] These tax preferences were renewed in 2009 after a favorable recommendation from JLARC, and JLARC is scheduled to conduct an expedited review again in 2013.[26]

Tax Breaks for Energy Efficiency

The tax breaks offered for energy efficiency projects are significantly smaller than those offered for renewable energy. The cost of materials, equipment, and installation labor for energy efficiency upgrades is subject to sales and use tax and, once installed, is subject to full property or leasehold taxation. However, energy efficiency benefits from an implicit tax break for the life of the equipment, since it displaces electricity or natural gas that would incur public utility tax of about 3.9 percent.

Until it expired in 2010, Washington provided a business and occupation tax credit for businesses that purchased energy efficiency equipment. The credit effectively offset the sales and use taxes on these purchases.[27] A sales and use tax exemption for solar hot water systems, which improve energy efficiency in water heating, expired in 2009.[28]

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[24] *2013-2022 10-Year Tax Preference Review Schedule*, http://www.citizentaxpref.wa.gov/documents/reviewschedules/2013-2022reviewSchedule.pdf. (**S0106**)

[25] RCW 84.36.635, RCW 84.36.640.

[26] *2013-2022 10-Year Tax Preference Review Schedule*. op. cit.

[27] RCW 82.04.4493, expired.

[28] RCW 82.08.835.

The state continues to provide a sales tax exemption for materials used in low-income weatherization projects, but the cost of labor for installation is taxed as a retail sale.[29] This tax break costs about $600,000 per biennium.[30] However, when public funds are used to pay for the weatherization, the tax effect is neutral. Another conservation-related tax break allows public utilities to avoid paying the public utility tax on revenues from the Bonneville Power Administration for energy efficiency programs.[31] The biennial cost of this tax break is about $650,000.[32] It is scheduled to expire in 2015.

[29] RCW 82.08.998.

[30] Washington Department of Revenue (2012) *op. cit.,* p. 216.

[31] RCW 82.04.310(4).

[32] Washington Department of Revenue (2012) *op. cit.,* p. 47.

Chapter 2 – Implementation Update, 2012 Energy Strategy

Introduction

The *Energy Strategy* included a combination of near-term recommendations and long-term policy options, distributed among three primary topic areas.

- Efficient transportation
- Buildings efficiency
- Distributed energy

The three corresponding tables below repeat the recommendations and policy options of the strategy, but also function as an index to the updates following them. After each recommendation or update in the table, the number in italics is the page in *this* document, in which the update is provided.

Efficient Transportation

Buildings Efficiency

Performance and Transparency	Funding and Financing	Low-income and Rental Housing
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Transportation

Near-Term Recommendations

3.4.1 Electric Vehicle Support

Since the adoption of the *Energy Strategy*, Washington continues to support the development of electric vehicles. In March 2012, Governor Chris Gregoire, together with the governors of Oregon and California and the premier of British Columbia, signed the Pacific Coast Collaborative's *2012 West Coat Action Plan on Jobs*.[33] Part of the agreement included

[33] http://www.pacificcoastcollaborative.org/Documents/Reports%20and%20Action%20Items/WestCoast_ActionPlanonJobs_MOU_WEB.pdf. (**S0107**)

commitments to fully energize the West Coast Green Highway from Whistler B.C. to Baja California, develop a West Coast "green fleets" initiative, and work on coordinated purchases of clean vehicles, especially electric vehicles. Commerce, in cooperation with the Governor's Office, WSU Energy Program, and the Department of Enterprise Services, is developing a policy for the state government purchase of electric vehicles. In addition, the Department of Enterprise Services has 45 level 2 charging stations available for public agencies to install. Both of these activities will help state agencies fulfill their statutory obligations to purchase alternative fueled vehicles.[34]

Using federal American Recovery and Reinvestment Act of 2009 (ARRA) funds, Washington State purchased and installed a dozen fast charging stations along the entire length of Interstate 5, and portions of Interstate 90 and State Highway 2.[35] Washington now has one of the largest electric vehicle charging networks in the U.S., exceeded only by California.[36]

The state's Plug-In Electric Vehicle Task Force[37] continued work to encourage and support electric vehicle deployment. The group is currently examining ways to build an expanded public/private organization that can maintain Washington's leading position on electric vehicles.

3.4.2 Renewable Fuels Standard

Efforts to modify the existing renewable fuels standard (RFS), which is considered unenforceable under current state law,[38] were unsuccessful during the 2012 legislative session. HB 2740 would have moved the current volumetric requirement for 2 percent biodiesel in the state diesel supply to a universal 5 percent biodiesel (B5) requirement, and removed the volumetric requirement for 2 percent ethanol in the gasoline supply. The ethanol provision has been effectively superseded by federal RFS requirements.

Moving to a universal B5 requirement would mirror Oregon's RFS, and provide a uniform regional policy framework that recognizes current fuel distribution channels and allows biodiesel to be more efficiently blended into the diesel supply. Oregon relies on Washington for the bulk of its fuel supply, and its experience with implementing a B5 requirement can provide valuable guidance to Washington. Tax incentives, such as a sales tax credit or business and occupation tax rate reduction, should be considered as a means of helping to offset necessary investments in blending infrastructure by fuel distributors.

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[34] RCW 43.19.648 *Publicly owned vehicles, vessels, and construction equipment – fuel usage – tires* http://apps.leg.wa.gov/RCW/default.aspx?cite=43.19.648

[35] See the West Coast Green Highway at http://www.westcoastgreenhighway.com/. (**S0068**)

[36] U.S. Department of Energy, *EV Project Overview Report*, August 2012 at http://avt.inel.gov/pdf/EVProj/EVProjOverviewQ22012.pdf. (**R0265**)

[37] http://www.electricdrive.wa.gov/taskforce.htm .**(S0108)**

[38] Washington State Department of Ecology, *Path to a Low-Carbon Economy: An Interim Plan to Address Washington's Greenhouse Gas Emissions*, Washington State Department of Ecology publication no. 10-01-011, December 2010, https://fortress.wa.gov/ecy/publications/publications/1001011.pdf, p.23. (**S0113**)

3.4.3 Diesel Engine Fuel Efficiency Improvements

In 2012, Thurston County fire districts and fire departments, and the Washington State Department of Ecology (Ecology) successfully installed idle reduction systems on nine fire engines and 33 medic units. This effort built upon a successful program with the Poulsbo Fire District initially reported in the *Energy Strategy*. The Thurston County districts and departments estimate an annual fuel savings of 18,000 gallons of fuel. Ecology spent $441,000 to purchase and install the idle reduction technologies.[39] The Districts and departments expect to annually save $117,000 in fuel and maintenance costs, for a payback time of a little less than four years.

Ecology has also expanded on the partnership with school and transit bus fleets described in the strategy. As of this writing, the department has partnered with 24 school districts and three transit authorities to install diesel-fueled engine pre-heaters and cabin heaters on 619 school buses and 82 transit buses. These heaters eliminate the need to idle the bus engine while de-icing and defrosting the windows on cold mornings. At an average cost of $2,500 each, the heaters annually save about 140 gallons of diesel for a school bus and about 240 gallons for a transit bus. These savings will equal the cost of the heaters in 2.5 to 4.5 years. For these 702 buses, Ecology estimates these technologies will conserve more than 1 million gallons of fuel over the expected 10-year life of the heaters.

In collaboration with other Clean Diesel Program partners, Ecology is developing several new projects that reduce the use of diesel fuel. Ecology expects to complete these projects in 2013:

1. **Idle reduction technologies for cargo handling equipment at the ports of Tacoma and Seattle.** Ecology and the Puget Sound Clean Air Agency are assisting marine terminal operators with the selection, purchase, and installation of idle reduction technologies on up to 245 pieces of cargo handling equipment.
2. **Idle reduction technologies for switch locomotives in Spokane and Pasco.** Ecology and the Spokane County Clean Air Agency are assisting Burlington Northern Santa Fe Railway with selection, purchase, and installation of idle reduction technologies on 10 switchyard locomotives.
3. **Idle reduction technologies for commuter locomotives at Lakewood.** Ecology is assisting Sound Transit with the selection, purchase, and installation of wayside power units at their Lakewood Layover facility. Wayside power units allow locomotives to plug in to the electrical grid for power needs rather than idle the main engine.
4. **Demonstrate feasibility of diesel/electric hybrid cargo handling equipment at the ports of Seattle and Tacoma.** Ecology is assisting the ports with purchase or lease of diesel/electric hybrid yard trucks to demonstrate their use to marine terminal operators.
5. **Repower tugboat.** Ecology, the Puget Sound Clean Air Agency, and the U.S. Environmental Protection Agency are assisting with the purchase and installation of new fuel-efficient, low-emission engines for a tug operating in Puget Sound.

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[39] Spending from the Local Toxics Control Account, created by the Model Toxics Control Act (MTCA), RCW 70.105D.

Ecology is also initiating a routine clean car update to ensure continued alignment with California's Low Emission Vehicle standards,[40] as required by Washington law.[41] Ecology expects to file a Proposed Rule Making (CR-102) with the Office of the Code Reviser in October of 2012 to align Washington administrative code[42] with California's August 2012 adoption of "LEV III" standards.[43]

In 2011, the federal government adopted the first national greenhouse gas and fuel consumption standards for medium-duty and heavy-duty vehicles.[44] These standards are phased in for model years 2014-2018. By 2018, vehicles must achieve greenhouse gas and fuel consumption reductions from a 2010 baseline:

- 20 percent for tractor-trailers.
- 15 percent for heavy-duty pick-ups, vans, and vocational vehicles (buses, garbage trucks, etc.).
- Vehicles built after 2018 must use more advanced technologies that will save even more fuel.

Meanwhile, the International Energy Agency has initiated a major effort toward inventorying technologies available for improving the fuel efficiency of light- and heavy-duty vehicles.[45]

3.4.4 Commute Trip Reduction (CTR) Program Expansion

No expansion has occurred, but the Washington State Department of Transportation (WSDOT) is developing the next phase of the CTR program and intends to propose changes to the CTR law in the 2013 legislative report. The CTR board is considering a range of changes to the program that could facilitate innovation and offer greater flexibility by allowing jurisdictions to adapt their programs to meet local transportation needs. Connecting to local objectives may improve performance. Despite constraints on existing funds, the CTR board is committed to moving the program forward through pilot rulemaking as authorized by law.[46] Pilot rulemaking is a tool that state agencies can use to test the feasibility of experimental approaches that differ from the current CTR program and rules in an effort to reduce greenhouse gas emissions, energy consumption, and traffic congestion. It would allow WSDOT to waive certain rules in WAC Chapter 468-63 during the pilot period so that research projects can be conducted. The pilots could lead to enhanced program performance and may result in the development of new or modified rules, as well as recommendations to the Legislature for changes to the program.

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[40] http://www.arb.ca.gov/msprog/levprog/levprog.htm. (**R0266**)

[41] RCW 70.120A.010, http://apps.leg.wa.gov/rcw/default.aspx?cite=70.120A.010

[42] WAC 173.423, http://apps.leg.wa.gov/wac/default.aspx?cite=173-423.

[43] http://www.arb.ca.gov/regact/2012/leviiighg2012/leviiighg2012.htm. (**R0267**)

[44] 76 FR 57106, https://www.federalregister.gov/articles/2011/09/15. (**R0268**)

[45] International Energy Agency, *Technology Roadmap: Fuel Economy of Road Vehicles*, OECD/IEA 2012. (**R0250**)

[46] RCW 34.05.313, http://apps.leg.wa.gov/rcw/default.aspx?cite=34.05.313

3.4.5 Smart Growth and Transportation Planning

State Energy Office and Growth Management Services staff have produced a series of discussion papers geared toward integrating energy into land use and transportation planning. The papers target land-use and transportation planners working in local government. Topics include compact communities, complete streets, improving transportation efficiency, parking, brownfields redevelopment, transfer of development rights, distributed energy, energy and growth, and transportation. The papers are posted on the agency's website.[47] The webpage also includes Commerce resources, resources from other agencies, and links to additional information.

Additionally, Growth Management staff moderated an energy and planning session at the Planning Association of Washington conference in May 2012. The session introduced the Energy Aware Communities webpage and discussion papers referenced above, and offered energy planning presentations from local government and municipal attorney perspectives.

3.4.6 Transportation Systems Management

WSDOT has estimated an annual economic savings of $72 million associated with the incident response program.[48] Three new ramp meters will be in operation this fall on I-5 though the Joint Base Lewis-McChord area.

WSDOT has not received any additional funding to expand the incident response program. There have been no new active traffic management systems installed, and no significant transportation management center operations expansions, due to funding constraints.

3.4.7 Regional Mobility Grants

WSDOT is in the process of proposing another round of investment to the Legislature in 2013 for funding in next biennium. These investments will help reduce energy use in transportation through shifts to transit, ridesharing, and walking and bicycling. As part of the evaluation of grants, WSDOT looked at the applicant's greenhouse gas emissions reductions policies and scored them. WSDOT also evaluated applications based on cost effectiveness, impacts on congested corridors, readiness to proceed, and system integration.

3.4.8 Electric Vehicle Mileage Pricing Pilot

The *Energy Strategy* recommended that the state pilot a mileage pricing system to explore alternative sources of roads funding. Specifically, the strategy recommended that the pilot focus on electric vehicles. In the 2012 Legislature, the transportation revenue bill included the

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[47] http://www.commerce.wa.gov/Services/localgovernment/GrowthManagement/Growth-Management-Planning-Topics/Climate-Change-and-Energy/Pages/Energy-Aware-Communities.aspx. (**S0094**)

[48] Washington State Department of Transportation, *The 2012 Congestion Report*, August 2012, http://www.wsdot.wa.gov/NR/rdonlyres/BB9EFB94-1117-4F15-8B4B-49453A77687C/0/2012CongestionReport2Final.pdf, p.69. (**S0096**)

requirement that electric vehicles be assessed an annual fee of $100,[49] the revenue from which is to be deposited primarily in the Motor Vehicle Fund. In the companion transportation appropriations bill,[50] WSDOT is authorized to "conduct a limited scope pilot project to test the feasibility of a road user assessment system to be applied to electric vehicles." A Road User Charge Steering Committee will be providing preliminary findings and recommendations to the Legislature in January, and completing a full report in June 2013. The June 2013 report may include a recommendation on whether future pilots should be pursued. Any state funding for pilot projects must be authorized by the Legislature.

3.4.9 Car Sharing and Mileage-Based Insurance

The *Energy Strategy* recommended car sharing programs and mileage-based insurance as additional mechanisms for better scaling the cost of driving to the amount of driving. Both mechanisms faced legal barriers in Washington State, and during the 2012 legislative session the Legislature corrected both barriers.

House Bill 2384, "Regulating personal vehicle sharing programs,"[51] addressed liability and insurance issues associated with personal vehicle sharing by creating a legal framework for personal vehicle sharing programs. Such programs are now defined in state law, and allowed to hold specialized insurance policies that protect vehicle owners from damages and liability incurred by vehicle borrowers.

House Bill 2361, "Concerning usage-based automobile insurance,"[52] provided support to usage-based automobile insurance programs in Washington by protecting proprietary data regarding the insurer's usage-based rate structures from public inspection. Commerce staff also testified in support of more aggressive support for mileage-based insurance in the form of House Bill 2445, which offered carefully crafted provisions supporting consumer disclosure, and required reporting and rulemaking around mileage-based insurance by the Office of the Insurance Commissioner. This more comprehensive bill failed to move forward.

Long-Term Policy Options

3.5.1 Revenue Neutral Feebate

No action since December 2011.

3.5.2 Low Carbon Fuel Standard

No action since December 2011.

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[49] EHB 2660 section 10, http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2660.

[50] ESHB 2190 paragraph 214(1)(b), http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2190.

[51] ESHB 2384, http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2384.

[52] ESHB 2361, http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2361.

3.5.3 Advanced Aviation Fuels

In 2012, HB 2422 established aviation biofuel production facilities as "projects of statewide significance" to facilitate siting and permitting assistance. The legislation enabled such facilities to qualify for Industrial Revenue Bonds, and established a work group under Innovate Washington. The work group will provide annual reports on the industry's status to the Legislature over the next three years. This effort will help support two major, USDA-funded regional research consortia coordinated by WSU and the University of Washington. The consortia are exploring two wood-based biorefining pathways based on forest harvest debris and agroforestry crops, respectively. Numerous opportunities exist for the state to encourage these efforts, including:

- **Support for ongoing research.** Washington State has become a global leader in many aspects of bioenergy research, thanks in large part to state support. A number of these efforts are on the cusp of commercialization. Continued funding for bioenergy research at WSU and the University of Washington is needed if the state is to maintain its position as a leader in advanced biofuels development.
- **Modify the state RFS.** "Renewable diesel," derived from cellulosic feedstocks such as wood waste, already qualifies for RFS compliance. Moving to B5 would provide a modest, fixed market for renewable diesel, one of the many co-products resulting from advanced biorefining. Healthy markets for biorefining co-products are needed for the aviation biofuels component to become cost-competitive.
- **Restore biodiesel incentives.** The state's existing biodiesel producers are developing the refining infrastructure that will support implementation of next-generation technologies. Wood-based biofuel producers receive a reduced business and occupation tax rate, but this same incentive for biodiesel producers has expired. Restoring this incentive would provide a consistent policy framework to support the industry's evolution.
- **Revise solid waste policies.** Funding for Ecology to revise solid waste policies was eliminated in the most recent state operating budget. Advanced biorefining pathways are looking for sustainable organic waste streams to process into biofuels and related products. Existing policies need to be revisited in order to facilitate such waste-to-energy opportunities.
- **Support co-product markets.** In collaboration with a broad cross-section of public and private partners, Ecology has prepared a six-year Green Chemistry Roadmap for the state. The roadmap identifies opportunities to integrate green chemistry into a greener and more sustainable economy, including value-added co-products resulting from biorefining. Implementing roadmap recommendations would advance the research and product development necessary to make aviation biofuels more cost-competitive.
- **Clarify definitions in code.** Numerous duplications, conflicts, and omissions in definitions for bioenergy feedstocks and process technologies have developed within state law. A thorough review is needed to modernize and standardize definitions that are hampering a variety of bioenergy development opportunities.
- **Encourage proactive state procurement.** The state is authorized to enter into long-term procurement contracts for biofuels, but has not acted to the extent allowed by law. A

concerted exploration of long-term contracting opportunities for biodiesel, renewable diesel and other distillate fuels, and biorefining co-products should be undertaken to assess the potential budgetary and economic development benefits.

3.5.4 Improvements to Railroads

No action since December 2011.

3.5.5 Comprehensive Trip Reduction Program

WSDOT, with the help of the State Smart Transportation Initiative (SSTI) began to develop a travel efficiency education and outreach program. However, after several meetings, WSDOT staff expressed concern that partners engaged in transportation energy efficiency (including WSDOT) have limited resources to explore a transportation energy efficiency campaign. WSDOT may be able to improve transportation energy efficiency more effectively by integrating the campaign concepts into the transportation planning process and focus on corridors. Therefore, WSDOT shifted the transportation energy efficiency education and outreach effort to a new phase focusing on further advancing demand management on key corridors identified by the Moving Washington program. This collaboration with SSTI is expected to be completed in early 2013.

One additional comprehensive trip reduction program to note is the Curb the Congestion Program, a partnership between Community Transit and Snohomish County to reduce traffic and encourage healthy travel options along three of the county's most congested arterials.[53] The program is funded by Snohomish County through development mitigation fees and federal grants, and operated by Community Transit. Curb the Congestion has been successfully removing vehicle trips since 2008. It is a proven program that reduces traffic congestion, parking demand, energy use, and greenhouse gases through the use of alternatives to driving alone. The program educates residents about choosing the best transportation option to save money and time, and improve their quality of life. More than 92,000 trips were removed from the three target corridors in 2011.

3.5.6 Energy Efficient Transportation Choices

No action since December 2011.

3.5.7 Emerging Pricing Methods

The 2012 transportation appropriations bill allocated $775,000 for the state Transportation Commission to study the feasibility of transitioning from a gas tax to a "road user assessment

[53] 164th St. SE/SW, 20th St. SE, and 128th St. SE.

system" for funding state transportation infrastructure.[54] A preliminary report on this work is due to the Legislature on January 1, 2013, with a final report due June 30, 2013.

The same bill also appropriated $225,000 for WSDOT to assess the operational feasibility of such a system,[55] in conjunction with the commission study.

Buildings Efficiency

Near-Term Recommendations

4.4.1 Non-Residential Disclosure

In October 2012, Commerce received a grant from the U.S. Department of Energy to increase energy efficiency in state-owned and leased facilities. Part of that grant included funding to improve the implementation of energy disclosure by these facilities using the Environmental Protection Agency's Energy Star Portfolio Manager software.[56] The city of Seattle has also implemented its mandatory non-residential energy disclosure requirements.[57] Commerce is monitoring the implementation of that requirement.

4.4.2 Residential Disclosure

In October 2012, Commerce received a grant from the U.S. Department of Energy to work with electric utilities and other stakeholders to enhance energy efficiency programs in the state. One element of this project will be to review the disclosure practices of the state's utilities and provide them with an opportunity to share successful approaches. Commerce will also be collecting information on the effect of disclosure mechanisms on consumer behavior.

4.4.3 Marketing and Quality Assurance

In 2010, Commerce and WSU created the Community Energy Efficiency Program (CEEP). Funding for that program will end in June 2013. Commerce, WSU Energy Program, and CEEP are developing a plan to transition CEEP to a more sustainable business model. As part of that transition effort, the partnership is trying to incorporate marketing and quality assurance policies presented in the *Energy Strategy* into any newly developed program. This work is just beginning and will be developed through 2013.

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[54] ESHB 2190 subsection 205(4), http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2190.

[55] ESHB 2190 paragraph 214(1)(a), http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2190.

[56] Information on energy use by state agencies and higher education is available at http://www.ga.wa.gov/energy/EnergyStar.htm.

[57] See http://www.seattle.gov/environment/benchmarking.htm.

4.4.4 Meter-Based Financing

No action since December 2011.

4.4.5 Energy Efficient Property Conversions

As of October 2012, the Energy Office has not conducted any addition analysis of this option. Some organizations in the city of Seattle are discussing ways that the existing tax incentives for low-income housing development might be modified to incorporate energy efficiency, but no specific proposals are currently available.

4.4.6 Minimum Standards for Rental Housing

The WSU Energy Program has published the *Rental Retrofit Assessment and Policy Study* [58] supporting this initiative of the *Energy Strategy*. The report assessed the potential energy savings and greenhouse gas emissions reductions possible from applying basic retrofits measures like attic, wall and floor insulation, windows, and duct sealing to rental housing. Only housing constructed prior to 1991, when the Washington State Energy Code went into effect, is included in the analysis. The report found a total potential energy savings of 4.5 million MWh/year, more than 12 percent of the residential sector's gross electricity consumption.[59] Additionally, the report surveyed rental housing energy efficiency programs in other states, finding examples in Maine, Minnesota, New Mexico, Wisconsin, and the city of Memphis. Wisconsin's program stands out for its longevity – it has been successful since 1985 and may provide a good model for future efforts in Washington State.

4.4.7 Sustaining Investment in Low-Income Weatherization Programs

In the Jobs Now Act (SB 6047), the 2012 Legislature provided $10 million in capital funding to Commerce's Energy Matchmakers program. Energy Matchmakers provides funding for low-income weatherization through Commerce to community action agencies statewide. The unprecedented allocation allows Washington to continue jobs and weatherization activities through the remainder of the current biennium at levels approaching those under the ARRA funded programs.

4.4.8 Prevailing Wage Class for Weatherization

The Commerce Weatherization program contracted with the WSU Energy Program to study the impacts of prevailing wage on cost and service to low-income households. The results of that analysis are expected to be available by the end of 2012.

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[58] K Eklund, *Rental Retrofit Assessment and Policy Study: A Report for the Washington State Department of Commerce, Energy Office*, Washington State University Extension Energy Program July 2012. (**S0097**)

[59] Under the assumption that all rental housing is heated electrically; in reality, a small fraction of the energy savings will be gas savings, not electric savings.

Distributed Energy

Near-Term Recommendations

5.3.1 Interconnection Standards

In December 2011, the Utilities and Transportation Commission (UTC) began a rulemaking process to update and revise its interconnection standards for smaller electricity generators.[60] Although the UTC's interconnection standards only apply to investor-owned utilities, the stakeholders in the process strongly supported updated standards that could also apply to the consumer-owned utilities not subject to UTC oversight. As a result, the Washington Public Utility Districts Association, Washington Rural Electric Cooperative Association, and the Association of Washington Cities agreed to convene a workgroup to develop proposed modifications. The goal of that process was to modify the standards so they could be adopted by both the UTC and the governing boards of consumer-owned utilities, thus creating some statewide uniformity. During this process, stakeholders considered all of the interconnection recommendations set forth in the *Energy Strategy*.[61] However, the stakeholder group did not adopt all of the recommendations. It did include simplification of standards of very small systems, some increased uniformity of project screening criteria, and other changes. The proposed changes do not remove the disconnect switch requirements or decrease insurance-related costs. As of November 2012, the UTC process was still underway.

5.3.2 Net Metering Policies

The 2012 Legislature did not modify the existing net metering statute. Stakeholders were not in agreement with either the need for changes to the law or what changes might be made.

5.3.3 Streamlined Permitting for Distributed Energy

The *Energy Strategy* recommended several implementation items related to streamlined permitting for distributed energy. Three major activities related to those recommendations include development of a number of energy planning guides, work on streamlining of solar system permitting, and efforts to better align the Washington State Environmental Policy Act (SEPA) and Growth Management Act.

Commerce's Growth Management Services unit created an Energy Aware Communities webpage.[62] The page includes new papers addressing brownfield redevelopment, compact

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[60] Interconnection with Electric Generators Rulemaking, UE-112133, http://www.utc.wa.gov/docs/Pages/InterconnectionRulemaking.aspx.

[61] *Energy Strategy*, http://www.commerce.wa.gov/Documents/EO%202012%20WA%20Energy%20Strategy.pdf, pgs. 128-130. (**S0102**)

[62] http://www.commerce.wa.gov/Services/localgovernment/GrowthManagement/Growth-Management-Planning Topics/Climate-Change-and-Energy/Pages/Energy-Aware-Communities.aspx. (**S0094**)

communities, complete streets, distributed energy, improving travel efficiency, mixed use, parking, sense of place, smart growth and energy, transfer of development rights, and transportation. Papers addressing economic development, historic preservation, and infrastructure will be added soon.

Growth Management staff also moderated a session about energy issues and planning, and introduced the Energy Aware Communities resources at the Planning Association of Washington's May 2012 conference. Staff developed an Energy Aware Communities brochure for planners for the American Planning Association, Washington Chapter's conference, and the four regional Planners Forums held in October 2012.

In late 2011, the Energy Office was awarded a grant from the U.S. Department of Energy's Sunshot program to streamline the permitting of small rooftop solar systems by local governments statewide to make installation faster and less expensive. The project includes participation from the cities of Seattle, Bellevue, Ellensburg, and Edmonds, together with their respective utilities, as well as several non-profit renewable energy organizations. The work is expected to be completed by early 2013.

The energy facility-related work on the SEPA and Growth Management Act focuses primarily on energy overlay zones. The biggest obstacle identified is the cost of upfront SEPA work. One of the recommendations was to provide funding to jurisdictions that were renewable energy resource-rich. No new funding is likely for this effort. One option available to local governments is to use a conditional use approach and defer SEPA to the applicants while still having specific criteria. Adams and other counties have used this approach.

Long-Term Policy Options

5.3.3 Streamlined Permitting for Distributed Energy

This long-term policy option is cross-indexed as a near-term recommendation – see the discussion immediately above.

5.4.1 DE-Compliant Power Purchase Agreements

No action since December 2011.

5.4.2 Distributed Energy in I-937

The 2012 Legislature passed two modifications to the Energy Independence Act[63] (I-937) – the Advisory Opinion Process and modifications to the definitions and eligibility of biomass-based renewables.

Senate Bill 6414[64] establishes a review process to determine whether a proposed electric generation project or conservation resource qualifies to meet a target in the Energy Independence Act. The law allows a consumer-owned utility or project developer to request an advisory opinion from Commerce. If Commerce determines that the project is qualified and the governing board of the consumer-owned utility builds or acquires the output of that project, it is then designated as a qualified resource. As of October 2012, Commerce has issued two affirmative advisory opinions through this process – one renewable energy project and one energy efficiency project.[65] For projects in investor-owned utility service territories, the UTC has declaratory order authority to make a comparable determination.[66]

Senate Bill 5575[67] expanded the eligibility of biomass-based renewable sources to include several biomass facilities constructed prior to 1999. The law also modified the biomass energy definition to include organic byproducts of pulping and the wood manufacturing process, animal manure, solid organic fuels from wood, forest or field residues, untreated wooden demolition or construction debris, food waste and food processing residuals, liquors derived from algae, dedicated energy crops, and yard waste. The modification to the definition implements the corresponding recommendation in the *Energy Strategy*.

The 2012 Legislature did not adopt any change in the Energy Independence Act related to definitions of cogeneration, distributed energy systems, or anaerobic digesters.

5.4.3 Rationalize DE Incentives

The Energy Office at Commerce has conducted some limited additional analysis of this topic.[68]

Carbon Pricing

Work by the Energy Office on assessing the economic and environmental impacts of a carbon tax deployed in Washington State were accepted for publication in the academic journal *Energy*

[63] The Energy Independence Act is encoded into law as RCW 19.285. However, it is often referred to by the initiative number it was given during the 2006 election, I-937.

[64] RCW 19.285.045, http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.045

[65] See the EIA Advisory Opinion Process at http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx. (**S0109**)

[66] Washington Utilities and Transportation Commission, Policy *Statement Regarding the Process for Determining Whether Projects are "Eligible Renewable Resources" under RCW 19.285 and WAC 480-109,* Docket UE-111016, June 7, 2012.

[67] http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/Session%20Laws/Senate/5575-S.SL.pdf . (**S0066**)

[68] http://www.commerce.wa.gov/Documents/EnergyTaxPreferences.pdf

Policy.[69] The study modeled a hypothetical carbon tax similar to that deployed in British Columbia, beginning at $10/t ($10 per metric ton of carbon dioxide equivalent) and increasing annually in $5/t steps until reaching a maximum of $30/t.[70] By 2035, the $30/t tax would generate roughly $2.1 billion in revenues for the state, sufficient to offset some 52 percent of state property tax revenues, 8 percent of state retail sales tax, or 68 percent of business and occupation tax revenues. Even when made revenue-neutral, such a tax can be expected to induce a significant reduction in Washington's greenhouse gas emissions. The research method varied several of the model's parameters in a Monte Carlo simulation, and observed a range of possible greenhouse gas reductions from 4.8 percent to 11.7 percent below a business-as-usual reference point.

British Columbia's carbon tax went into effect July 1, 2008. During 2012, two private research organizations published reviews of the tax's effects, and both report neutral to positive impacts on the province's economy and greenhouse gas emissions reductions.[71,72] The provincial government is expected to issue its own assessment of the carbon tax before December 31, 2012.[73]

It has long been a legal question whether a carbon tax in Washington State could be levied on motor vehicle fuels, as language in the 18th Amendment to the state constitution can be construed to prohibit use of taxes on motor vehicle fuels for non-highway purposes. However, on October 4, 2012, the Washington State Supreme Court ruled in a unanimous opinion[74] that this is not the case, hence removing a perceived legal barrier to carbon pricing in Washington.

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[69] K Mori, "Modeling the impact of a carbon tax: A trial analysis for Washington State," *Energy Policy* 48 (2012) pp.627-639. (**R0255**)

[70] In the model, aviation and marine fuels are exempted from the tax.

[71] Sustainable Prosperity, *British Columbia's Carbon Tax Shift: The First Four Years*, University of Ottawa 2012, http://www.sustainableprosperity.ca/article2864. (**R0235**)

[72] M Horne & E Petropavlova, *British Columbia's Carbon Tax: Exploring perspectives and seeking common ground*, The Pembina Institute 2012, http://www.pembina.org/pub/2352. (**R0236**)

[73] British Columbia Ministry of Finance, *Budget and Fiscal Plan* 2012/2013-2014/2015, p.66. (**R0270**)

[74] *Auto. United Trades Org. v. State*, No. 85971-0 slip op. (Wash. 2012), http://www.courts.wa.gov/opinions/index.cfm?fa=opinions.showOpinion&filename=859710MAJ viewed 17 Oct. 2012. (**S0110**)

Chapter 3 – Other Initiatives Since the 2011 Biennial Report

Adopting Rules Governing Alternative Fuel Use by State-Owned Vehicles

Commerce has initiated rulemaking regarding agency use of alternative fuels and vehicles "to the extent practicable" as directed by law.[75] An interagency committee comprised of the departments of Commerce, Agriculture, Enterprise Services, Ecology, and Transportation, along with the WSU Energy Program, is guiding rule development. A draft rule and public workshop is planned for late 2012, to be followed by rule adoption. A separate rulemaking addressing alternative fuel and vehicle requirements for local governments is due by June 1, 2015.

State use of alternative fuels and vehicles has been a priority since 1989. The Legislature has adopted 16 bills, resulting in 15 sections of code, while governors have issued five Executive Orders and three Governor's Directives. As a result, Washington has more hybrid vehicles in its motor pool than any other state.[76] Agencies are also subject to some of the most aggressive biodiesel use requirements in the country.

To date, the rulemaking process has clarified and integrated baseline reporting on agency fuel and vehicle use, quantified the contribution of various types of hybrid vehicles, and identified potential exemptions (e.g., aircraft, emergency response vehicles, stationary equipment). Other criteria under discussion include functional differences in equipment and fuels, technological trends, duty cycles, geographic availability, seasonality, and procurement and administrative costs. The resulting rule will likely propose a phased approach addressing different fuel applications, economics of scale, and infrastructure development thresholds.

Adopting Rules Revising an Emission Performance Standard

During 2012, Commerce worked with stakeholders to calculate the first adjustment of the state's greenhouse gas emissions performance standard, as required every five years by the law passed in 2007.[77] Commerce published a Preproposal Statement of Inquiry ("CR-101") on March 7, 2012, and during the ensuing seven months held two face-to-face meeting with stakeholders, and consulted with a stakeholder technical team to determine appropriate values for parameters in the calculation of the new standard. The Notice of Proposed Rulemaking ("CR-102") was published on November 7, 2012, and a public hearing held on November 28.

Deploying the Washington Energy Supply Disruption Tracking System

In 2009, all 50 states and territories received stimulus funding from the American Recovery and Reinvestment Act to conduct energy assurance planning. One of the requirements of the grant

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[75] RCW 43.325.080, http://apps.leg.wa.gov/rcw/default.aspx?cite=43.325.080

[76] Fletcher, Lauren, "Top 50 Commercial, Private Utility & Public Sector Hybrid Fleets," *Automotive Fleet* September 2010, http://www.automotive-fleet.com/magazine/issue/2010/09.aspx. (**R0276**)

[77] Chapter 80.80 RCW, http://apps.leg.wa.gov/rcw/default.aspx?cite=80.80

was to develop an energy supply disruption tracking process. A Commerce-led feasibility study supported the development of a geo-data based mapping system to track energy supply problems. Through a bid process, Commerce selected iMapData Inc. to design, develop, and host the Washington Energy Supply Disruption Tracking System (WAESDTS), which was inaugurated in January 2012. The system represents a fundamental improvement in the state's ability to monitor and respond to major energy emergencies.

The new system will allow Commerce to gather information about damaged energy infrastructure and its impacts, and report to state and federal responders more quickly with more accurate, graphic, and detailed information. All energy companies can be contacted and respond simultaneously, with hundreds of data layers (such as locations of hospitals) automatically stored and graphically visible through an integrated database. Reports can be automatically aggregated and distributed to preset service lists.

The tracking system is unique in the U.S., and represents the most sophisticated and capable state system for tracking electricity, natural gas, and oil supply disruptions.

Closure and Evaluation of ARRA Programs

The Energy Office received more than $80 million dollars in American Recovery and Reinvention Act funds in 2009. These funds included grants for appliance rebates, Energy Assurance Planning, Energy Efficiency Community Block Grants (EECBG), and the State Energy Program. The appliance rebate program was completed in February 2012 and the other programs will end in 2013. The appliance rebate program distributed 41,693 rebates to Washington consumers. EECBG funds have helped 43 local governments become more efficient. The Energy Assurance Planning program has enabled Washington to build a model electronic system for tracking and monitoring utility outages. Commerce has awarded 35 grants and loans to private entrepreneurs and public agencies to further energy efficiency, renewable energy, and the broader clean energy industry in Washington. An evaluation of EECBG and the State Energy Program will be completed in 2013.

Utility Resource Plans Report

The Utility Resource Planning Act, enacted into law in 2006, supports the state's ability to maintain a reliable electric system.[78] Utilities provide Commerce with information describing current and anticipated electricity demand, and detail on acquired or potential resources to meet this demand. Commerce analyzes the information and aggregates findings into a report to the Legislature. Utilities and Commerce are required to report every two years. Following are outcomes based on the 2012 reporting process and historical data.

Utilities review customer demand for electricity using factors such as population change, weather patterns, commercial, industrial activity, etc. Each utility has reported their estimate of

78 RCW 19.280, http://apps.leg.wa.gov/RCW/default.aspx?cite=19.280.

the anticipated electricity load for their particular customer base. While demand continues to climb upward, aggregately, utilities are forecasting that customers will need less electricity than was forecasted in the last two planning cycles (2008 and 2010). The base year consists of actual loads, resources and surplus. The five- and 10-year estimates are forecasted amounts.

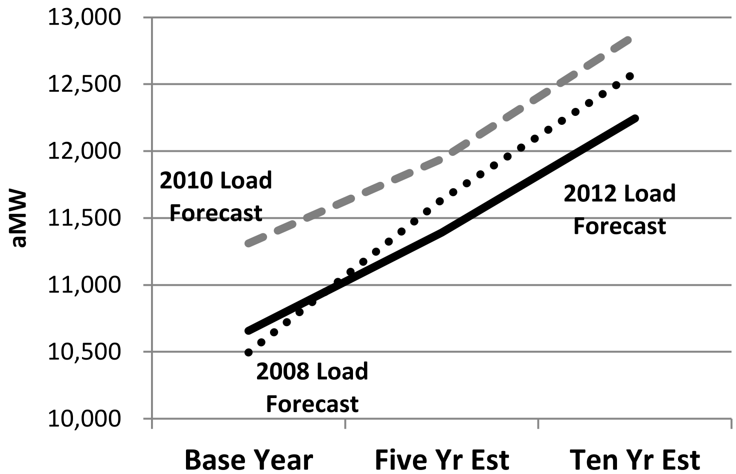

Figure 3-1: Combined electricity load forecasts of all Washington utilities, in reporting years 2008, 2010, and 2012. For each reporting year, the associated line shows the progression from estimated load during the base year, to the forecast load five years later, to the forecast load 10 years later. "aMW" means average megawatts. (Source: W0027)

Better understanding the demand for electricity makes it possible for utilities and the state to determine how much energy resource should be acquired or maintained. In aggregate, utilities have reported a surplus of electricity resources from approximately 2011 through 2022. The gap between forecasted load and planned resource narrows toward the end of the planning horizon (Figure 3-2).

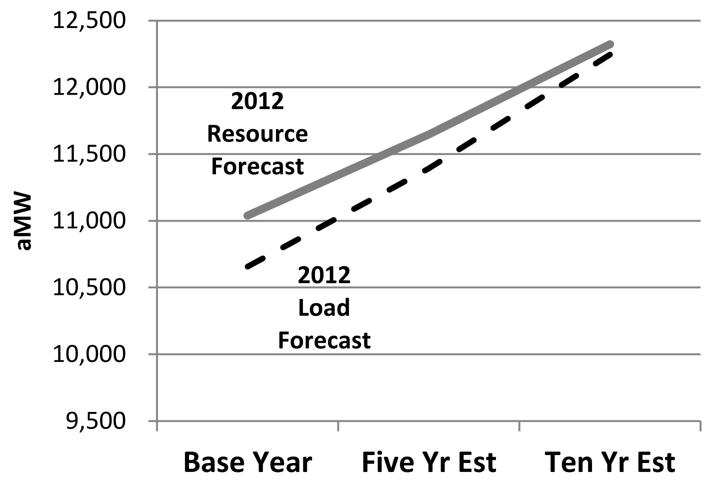

Figure 3-2: Comparison of load and resource forecasts.The dashed line shows the combined load forecasts of Washington's utilities, and the solid line shows the combined resource forecasts. Each line shows the progression from base year estimate, to forecast five years later, to forecast 10 years later. (Source W0027)

Rising demand coupled with a modest forecast for supply has resulted in a declining forecast for surplus compared with the surplus anticipated in the prior reported planning cycles. Further analysis of utility resource planning data and outcomes is available in a separate report to the Legislature.[79]

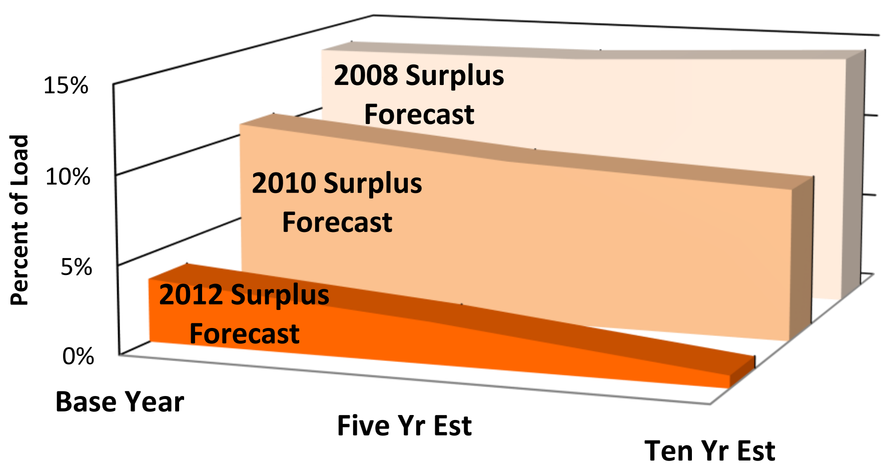

Figure 3-3: Declining forecast for energy resource surplus represented as a percentage of load. (Source W0027)

[79] *Washington State Electric Utility Resource Planning-2012* to be submitted to the Legislature by Commerce in November 2012.

I-937 Compliance

All Washington electric utilities with 25,000 or more customers are subject to the requirements of the Energy Independence Act. Those requirements include identifying and acquiring all cost-effective electricity efficiency resources and meeting progressively increasing targets for energy supplied from eligible renewable resources. The first compliance period for the utilities was 2010-2011 for conservation and 2012 for renewable resources. As part of the Energy Independence Act, each of the 17 utilities covered by the act was required to report its electricity efficiency and renewable energy achievements to Commerce by June 1, 2012. Commerce made the reports available on its website[80] and compiled the summary tables presented here.

All 17 utilities reported compliance with the 3 percent renewable target required for 2012 and had met or exceeded the conservation targets established in their conservation assessment work.

Utility	Load (MWh)	Target (MWh)	Qualifying Renewables (MWh)	Qualifying Renewables (% of Load)
Avista	5,534,889	166,047	215,654	4%
Benton PUD	1,620,582	48,617	102,638	6%
Chelan PUD	1,565,000	46,950	46,950	3%
Clallam PUD	644,504	19,335	19,335	3%
Clark PUD	4,573,173	137,195	196,697	4%
Cowlitz PUD	4,824,749	144,742	144,742	3%
Grant PUD	3,958,381	118,751	364,141	9%
Grays Harbor PUD	927,142	27,814	172,388	19%
Inland	817,137	24,514	36,641	4%
Lewis PUD	947,515	28,425	29,829	3%
Mason PUD #3	660,747	19,822	19,822	3%
PacificCorp	3,995,247	119,857	119,857	3%
Peninsula Light	578,506	17,355	17,355	3%
Puget Sound Energy (PSE)*	21,198,607	635,733	635,733	3%
Seattle City Light	10,056,873	301,706	301,706	3%
Snohomish PUD	6,801,463	204,044	452,666	7%
Tacoma City Light	4,778,049	143,341	165,352	3%
Total	**73,482,561**	**2,204,477**	**2,405,772**	**3%**

* PSE did not specify a total in their report to Commerce, but certified to the UTC that they have met the requirement.

Table 3-1: Renewable Electricity 2012 Compliance Report. "Load" is the total electric energy supplied to customers during the year. "Target" is 3 percent of Load, the renewable generation standard for 2012 in RCW 19.285.040(2)(a). "Qualifying Renewables" are renewable generation and renewable energy credits (RECs) expected to be available during calendar year 2012. (Source: Washington Department of Commerce, 2012 Energy Independence Reports, http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx).

80 2012 EIA reports, http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx.

Eligible Renewable Resource	Energy (MWh)	RECs (MWh)	Total (MWh)	% of Claims
Water	651,857	0	651,857	21%
Wind	615,824	935,131	1,550,955	51%
Solar	561	25	586	0%
Geothermal	0	0	0	0%
Landfill Gas	0	18,028	18,028	1%
Wave, Ocean, Tidal Energy	0	0	0	0%
Gas from Sewage Treatment Energy	0	0	0	0%
Biodiesel Energy	0	0	0	0%
Biomass Energy	66,515	56,000	122,515	4%
Apprentice Labor Energy	15,199	15,114	30,313	1%
Distributed Generation Energy	22,268	9,251	31,519	1%
Puget Sound Energy (not specified)*	635,733		635,733	21%
Total			**3,041,505**	

* PSE did not specify the sources of their renewable resources.

Table 3-2: Sources of renewable electricity claimed for I-937 Compliance. "REC" means Renewable Energy Credit. (Source: Washington Department of Commerce, 2012 Energy Independence Act reports, http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx).

Utility	2010-11 Load (MWh)	2010-11 Conservation Target (% of Load)	2010-11 Conservation Achieved (% of Load)	2012-13 Conservation Target (% of Load*)	2010-2011 Conservation Expenditures (% of Revenue Requirement**)
Avista	11,069,777	1.2%	1.5%	1.0%	3.6%
Benton PUD	3,241,164	0.9%	1.5%	0.7%	2.1%
Chelan PUD	3,130,000	0.9%	0.9%	0.9%	3.7%
Clallam PUD	1,289,008	0.8%	1.1%	0.9%	3.8%
Clark PUD	9,146,346	0.8%	1.4%	0.9%	3.0%
Cowlitz PUD	9,649,498	0.5%	1.1%	0.8%	2.5%
Grant PUD	7,916,762	0.7%	1.2%	0.6%	3.2%
Grays Harbor PUD	1,854,284	0.8%	1.3%	0.8%	2.5%
Inland	1,634,274	0.8%	2.6%	0.4%	4.4%
Lewis PUD	1,895,030	0.7%	1.3%	0.8%	2.5%
Mason PUD #3	1,321,493	0.5%	1.0%	0.3%	1.9%
PacificCorp	7,990,494	0.9%	1.2%	1.0%	2.7%
Peninsula Light	1,157,012	0.7%	1.4%	0.7%	3.5%
Puget Sound Energy (PSE)*	42,397,213	1.5%	1.5%	1.6%	3.6%
Seattle City Light	20,113,745	0.9%	1.3%	1.0%	5.0%
Snohomish PUD	13,602,926	0.9%	1.3%	1.1%	3.7%
Tacoma City Light	9,556,097	0.9%	1.4%	1.0%	4.9%
Totals	**146,965,123**	**1.0%**	**1.4%**	**1.1%**	**3.8%**

* % of 2010-2011 load

** % of retail revenue requirement. Grant PUD and Mason PUD #3 did not report retail revenue requirements; for these utilities actual revenues were used.

† PacifiCorp 2012-2013 conservation target is derived from a range, 76,291-79,322 MWh

Table 3-3: Utility electricity conservation during compliance period 2010-2011. All values are annual averages during the 2010-2011 two-year compliance period. (Source: Washington Department of Commerce, 2012 Energy Independence Act reports, http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx).

Other Reports

Energy Freedom Program

The Energy Freedom Program, established in 2006 through the Washington State Department of Agriculture (Agriculture), distributed grants and loans to bioenergy projects throughout the state. Agriculture continues to administer the original loan awards, and issues an annual report on their status. In 2007, responsibility for future awards was conveyed to Commerce. Subsequent loan repayments have been transferred to the state general fund, and no new awards have been issued. Commerce reports to the Legislature on program status during even-numbered years. The 2012 report will also encompass other bioenergy projects that have received state and federal pass-through funding since 2006.

Fuel Mix Disclosure

The Washington Fuel Mix Disclosure is a program coordinated by Commerce since 2001, following legislation passed in 1998.[81] The intent of the law is to provide electricity utility consumers with a description of the mix of energy sources powering the electricity they buy. Each spring, retail electric utilities must disclose the generating plant(s) and the associated amount of power for all purchases made on behalf of customers the previous year. Commerce combines these declared resources with additional data collected from Bonneville Power Administration, the U.S. Department of Energy, and the Oregon Department of Energy to calculate the "disclosure labels" for Washington's utilities.

All utilities must provide customers with a standard disclosure label once per year. In addition, utilities are required to publicly disclose the label via publication or the Internet twice per year for large utilities, or once per year for small utilities. Commerce must report the state aggregate fuel mix to the Legislature each year. Twelve such reports have been submitted and may be found on the Commerce website.[82]

Green Power Programs Reporting

Washington State law[83] directs utilities with more than 25,000 customers to offer customers a "green power" electricity product – electricity generated by environmentally preferable sources such as wind, solar, landfill gases, and other sources determined in the law. Utilities may offer green power generated by actual green power resources or as represented by renewable energy credits (RECs). RECs are a type of currency used in the electricity industry to represent the environmental and social benefits of clean electricity production. They are separated from the electricity produced and sold as a distinct product. A REC represents the environmental attributes equivalent to a specific amount of electricity produced by renewable resources. Utility customers voluntarily participate in the utility programs.

Commerce and the UTC share responsibility for implementing the green power program law. As originally legislated, the law required utilities to report annually to the joint state agencies, and the agencies to report to the Legislature, through December 2012. However, in 2011 the Legislature terminated the reporting requirement, leaving the programmatic requirement intact.[84] Utilities must continue to provide green power programs as defined in the statute and may be required to offer program details to Commerce and the Legislature upon request.

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81 RCW 19.29A, http://apps.leg.wa.gov/RCW/default.aspx?cite=19.29A.

82 Fuel Mix Disclosure reports and information are available at http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/FuelMix.aspx. The most recent Fuel Mix Disclosure report covers fuel mixes used to supply utility loads during calendar year 2011 and was published in 2012: http://www.commerce.wa.gov/Documents/Fuel%20Mix%202011%20compiled%20reports.pdf. (**S0111**)

83 RCW 19.29A.090, http://apps.leg.wa.gov/RCW/default.aspx?cite=19.29A.090.

84 http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bill%20Reports/House/2664-S.E%20HBR%20FBR%2012.pdf.

Green Power reports were produced for 11 years beginning in 2001 and ending in 2011, and are available upon request to Commerce or the UTC.[85] Year-to-year, a range of 16 to 18 utilities formally offered green power programs captured via this reporting effort. Several other utilities in Washington not affected by the green power law also offer similar programs.

Innovate Washington *Clean Energy Report*

Innovate Washington is a newly created state organization that is designed to encourage and support economic development and jobs. One of the primary functions of Innovate Washington is to implement recommendations of the Washington Clean Energy Leadership Council (CELC). Among the CELC recommendations was creation of one point of accountability and leverage for public and private sector investments in clean energy. Innovate Washington is designed to serve that function.

The CELC also identified three specific areas where Washington has a particularly strong competitive advantage in clean energy, and where state efforts should focus its efforts:[86]

1. **Energy Efficiency.** Implementation of leading-edge, large scale combined energy efficiency, green building, and smart grid solutions that leverage Washington's strong green building and software sectors with upgrades to the electrical grid.
2. **Renewable Energy Integration.** Integration of renewable energy resources into the electric grid and utility portfolios to better demonstrate combinations of renewable energy, energy storage, and smart grid solutions to cost-effectively deploy the rising percentage of wind energy and later, the expected future development of solar energy in ways that can applied to other regional utility systems.
3. **Bioenergy.** Demonstration of market-leading deployment of biomass power generation and development of transportation biofuels using Washington's extensive forest- and agriculture-based resources and in-state capabilities.

In implementing that charge, Innovate Washington has initiatives related to both the energy efficiency and bioenergy focus areas. The U.S. Department of Commerce awarded Innovate Washington an I6 grant to develop building energy efficiency testing facilities and services. Washington State also supported this work through a multimillion-dollar capital appropriation.[87] House Bill 2422, passed by the 2012 Legislature, directs Innovate Washington to develop a plan that will position Washington State as a national and international leader in aviation biofuels.

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[85] Reports online at the UTC, http://www.utc.wa.gov/regulatedIndustries/utilities/energy/Pages/greenPowerProgramsInWA.aspx. For more information, contact the State Energy Office at 360-725-3118.

[86] Washington Clean Energy Leadership Council, *Washington State Clean Energy Leadership Plan Report – Accelerating Washington Clean Energy Job Growth,* Navigant Consulting, October 2010, http://www.efsec.wa.gov/Whistling%20Ridge/Adjudication/Intervenor%27s%20pre-filed%20testimony/Ex%2034-05,%20CELC%20extract.pdf.

[87] http://www.innovatewashington.org/news/washington-clean-energy-partnership-celebrates-i6-grant. (**R0272**)

The Sustainable Aviation Biofuels Work Group is to produce a plan by the end of 2012 and update it annually through 2014.[88]

[88] http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/Session%20Laws/House/2422-S.SL.pdf.

Chapter 4 – Special Focus on Natural Gas

Introduction

Since 2007, natural gas prices in the North American market have been declining dramatically (see the discussion for Indicator 14, *Average Energy Prices by Fuel*, beginning on page 78). Washington State produces almost no natural gas, but is a significant consumer of gas extracted elsewhere in the western U.S. and in Canada.

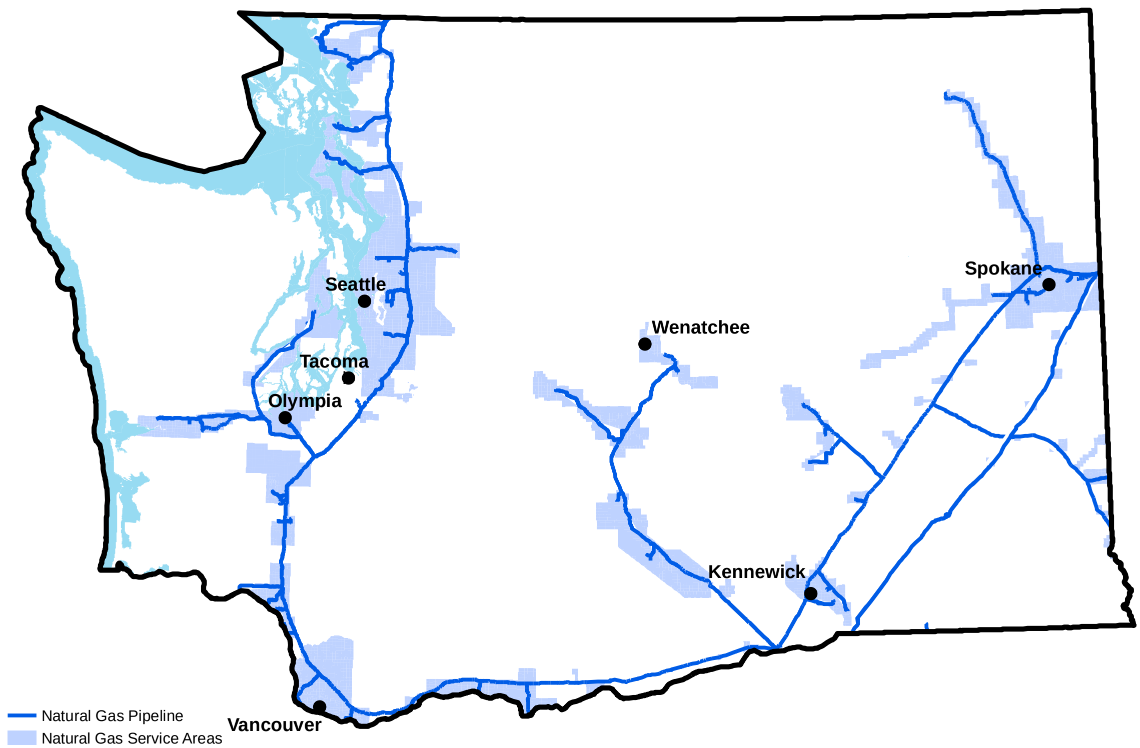

Figure 4-1: Natural gas transmission and distribution systems. (Source: UTC)

The state contains significant infrastructure (Figure 4-1) allowing it to take advantage of low-cost natural gas supply, so a significantly changing price can have big impacts on the choices that Washington's energy companies and consumers make. The pipelines shown in the figure make eventual connections to supplies in British Columbia, Alberta, and Wyoming.

Supply Forecast

Natural gas reserves are classified into two fundamental categories, conventional and unconventional.

Conventional reserves are pockets of natural gas trapped underground at high pressures by geological formations. Gas is extracted by tapping the geological formation with a well; the subsurface pressure pushes the gas up the well toward the lower pressure at the surface.[89] In the past, the vast majority of natural gas was extracted this way. By the end of the 20th century, the continent was clearly past its peak production of conventional gas. Some untapped reserves were still available north of the Arctic Circle, but only enough to supply the continent's needs for perhaps another decade.

Unconventional reserves are typically less concentrated than conventional reserves, trapped over large areas in sand, coal, or shale deposits.[90] They are more expensive to extract than conventional reserves. In the early- to mid-2000s, the dwindling North American conventional reserves increased natural gas prices, and natural gas operators were motivated to try unconventional extraction technologies. Two of these, horizontal drilling and hydraulic fracturing (fracking), opened access to a massive reserve of domestic shale gas previously considered economically untouchable.

Estimates in the recent Massachusetts Institute of Technology (MIT) study indicate between 605 trillion cubic feet (Tcf) and 1,272 Tcf of unconventional gas available in the U.S., and between 1,042 Tcf and 1,829 Tcf in the U.S. and Canada combined[91] (Table 4-1).

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[89] A minority of conventional gas is "associated" gas, meaning that it occurs together with an oil reserve in the same geological formation. The remainder is "non-associated" gas, where the gas is the only product extracted from the well. Almost all gas, whether associated or non-associated, comes out of the well "wet," meaning that it includes hydrocarbons like ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}) that are heavier than methane. The gas processor separates these heavier natural gas liquids (NGL) from the methane, and only the methane is shipped to power plants and consumers as pipeline gas. The NGL is further refined into other petroleum products, among them liquefied petroleum gas (LPG). In the United States, LPG is commonly referred to simply as "propane" even though it is actually a mixture of true propane with other hydrocarbons.

[90] Methane hydrates are another type of unconventional resource, but are not considered in this document because they are in a much earlier stage of development. Supplementary Paper 4 to E J Moniz, H D Jacoby & A J M Meggs, *The Future of Natural Gas, An Interdisciplinary MIT Study*, 2011, http://web.mit.edu/mitei/research/studies/natural-gas-2011.shtml (**R0231**) indicates that commercialization of this resource will not begin until roughly 2025 at the earliest.

[91] Op. cit., Appendix 2A. (**R0231)**

	Technically Recoverable Unconventional Gas (excluding Proved Reserves)		
	Mean	P90	P10
U.S.			
Tight	173	118	239
Shale	631	418	871
CBM	115	69	162
Total U.S.	**919**	**605**	**1,272**
Canada			
Tight	-	-	-
Shale	443	294	611
CBM	33	20	46
Total Canada	476	314	657
North America	**1,395**	**1,042**	**1,829**

Table 4-1: Technically recoverable unconventional gas in North America. "P90" and "P10" represent the 90 percent probability and 10 percent probability estimates of the resource, respectively. "CBM" means coal bed methane. The values are in trillion cubic feet (Tcf). (Source: R0231)

The majority of the unconventional gas resource is shale gas, with the balance consisting of tight gas and coal bed methane. When the North American unconventional resource estimates are combined with conventional resource estimates, the grand total covers a range from 1,994 Tcf to 4,138 Tcf.[92] In calendar year 2010, the U.S. and Canada together consumed less than 27 Tcf,[93] so the total resources available are sufficient to last 75 to 150 years at the current rate of consumption.

Magnitude and Permanence of Price Changes

The Northwest Power and Conservation Council's Sixth Plan[94] was published in 2010, when the shale gas revolution was already underway, and includes gas price forecasts out to 2030 that take the new resource into account. In July 2012, the council published updated price forecasts based on the emerging North American shale gas prospect.[95]

[92] Op. cit., **R0231**, Appendix 2A table 2A. The two figures cited here are the sums of the U.S. and Canadian values for P10 and P90 in the "Remaining Recoverable Resource" column.

[93] Energy Information Administration, U.S. Department of Energy, international energy statistics, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=26&aid=2 accessed 12 October 2012. (**R0273**)

[94] Northwest Power and Conservation Council, *Sixth Northwest Conservation and Electric Power Plan*, 2010, www.nwcouncil.org/energy/powerplan/. (**R0027**)

[95] Northwest Power and Conservation Council, *Update to the Council's Forecast of Fuel Prices*, Northwest Power and Conservation Council document 2012-07, July 20, 2012, http://www.nwcouncil.org/library/2012/2012-07.pdf. (**R0234**)

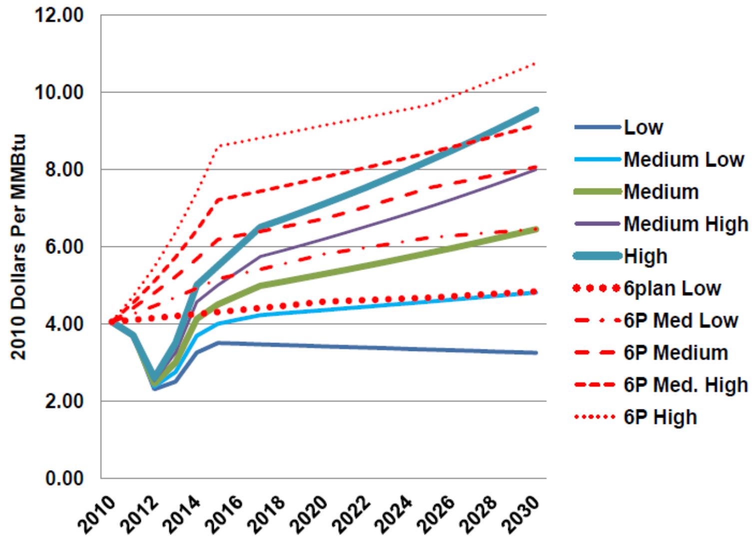


Figure 4-2: Northwest Power and Conservation Council forecasts of natural gas prices at Henry Hub, 2010-2030. 2012 updated forecasts are shown in comparison to Sixth Plan forecasts ("6P" shown in red) dating from 2010. (R0234 p.3)

All forecasts show at least some rebound from the current low prices associated with a glut of product from the new resources. In the long term, however, prices could follow any one of a wide range of trajectories, some of them climbing to values as high as were experienced in the mid-2000s. The council cites a number of factors that, in some scenarios of the future, would drive the Pacific Northwest's natural gas prices higher:

- A rapid economic recovery in the U.S. and worldwide would increase industrial and transportation activity and hence increase demand for all forms of energy, natural gas included.
- Environmental restrictions on shale gas development could be legislated and enforced, restricting the supply and/or adding mitigation costs.
- Aggressive regulation of greenhouse gases could stimulate high natural gas demand to replace coal.
- Increased use of natural gas vehicles could increase demand.
- Liquefied natural gas (LNG) could grow into a high volume export commodity for Canada and the United States.
- Increased demand from gas-to-liquid projects, in which natural gas is used as a feedstock to synthesize liquid fuels (gasoline or diesel substitutes) for transportation.

Whether prices head upward or stabilize at a level near their current low, it is important to appreciate that this commodity has a very high short-term volatility superimposed on the long-term trend.

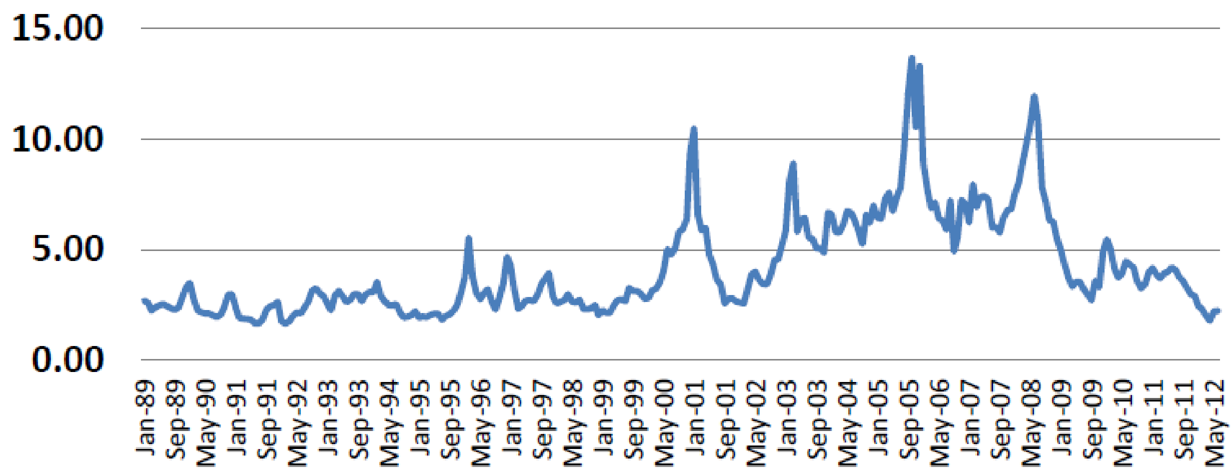


Figure 4-3: Gas price at Henry Hub in $/mmBtu, constant dollars (corrected for inflation). (R0234 p.1)

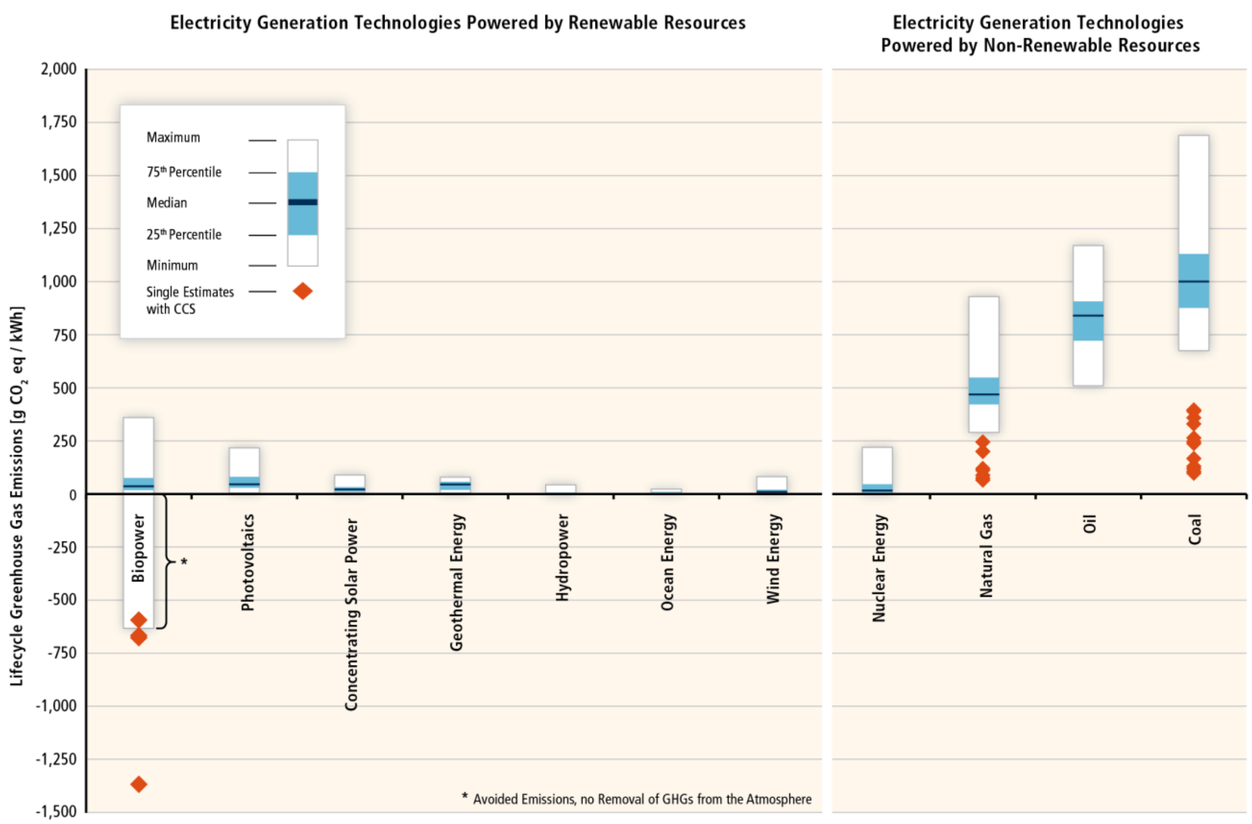
Figure 4-3 shows prices at Henry Hub in Louisiana, the generally accepted reference price for natural gas in the U.S. The long-term trend line is clear: a stable price in the $2/mmBtu (million British thermal units) to $3/mmBtu range during the 1990s followed by a slow hump peaking around $6 to $7 and declining through the end of the charted time period. Yet, superimposed on that general trend are some very tall peaks, many of them having widths of up to a year in duration. Those are caused by any number of market vagaries, chief among them being weather, and the delayed, unsmooth dynamics of exploration (or lack thereof) driven by price feedbacks. That means setting natural gas policy has to be done with a level head: it is critical not to overreact to an immediate price emergency, but to keep a focus on the long-term.

Life-Cycle Greenhouse Gas Emissions

When it is burned in order to produce energy, natural gas combusts to produce carbon dioxide and water. Carbon dioxide is a final combustion product for all fossil fuels, and the predominant greenhouse gas driving global warming. Natural gas has a very high energy density, and it generates the least amount of carbon dioxide per unit of heat released, when compared to any other fossil fuel. It releases approximately 25 percent less carbon per unit of energy when compared to gasoline and 44 percent less when compared to coal. For this reason natural gas is often perceived as an important “bridge fuel” between the more carbon-intensive fossil fuels and carbon-free renewable energy.

Because it is a gas, it can be combusted in turbines, a more efficient method for extracting mechanical energy from the fuel than any method available for converting a solid fuel (coal) to mechanical energy. Mechanical energy is a necessary prerequisite to spinning the generator that will ultimately create useful electric energy. Between its high energy density and mechanical advantage, natural gas can be used to generate electric energy at significantly lower carbon dioxide emissions per kilowatt-hour than coal.

Natural gas (methane) is itself a powerful greenhouse gas; over a 100-year period, one pound of natural gas will cause 25 times the amount of global warming caused by one pound of carbon dioxide.[96] During the process of extracting and shipping methane, some fraction of it escapes at the wellhead and along the pipelines. These "fugitive" emissions are unmeasured and perhaps relatively small, but because methane's global warming potential is so high, they can add significantly to the quantity of global warming associated with each kilowatt-hour of electricity ultimately produced (or each therm[97] of heat energy supplied to a home, or burned in a natural gas vehicle).



Count of Estimates	222(+4)	124	42	8	28	10	126	125	83(+7)	24	169(+12)
Count of References	52(+0)	26	13	6	11	5	49	32	36(+4)	10	50(+10)

Figure 4-4: Life-cycle greenhouse gas emissions from renewable and fossil energy technologies. CCS means carbon capture and storage. (R0079 p.19)

Figure 4-4 shows the ranges of life-cycle emissions calculated for a variety of electric generating technologies, including natural gas. The emissions estimates were surveyed from academic

[96] S Solomon et al (eds.), Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press 2007. (**R0237** p.33)

[97] A "therm" is a common energy unit used to measure natural gas. One therm is 100,000 BTUs or approximately the energy content of 100 cubic feet of natural gas.

studies compiled by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) The range of potential lifecycle emissions for natural gas incorporates 83 estimates from 36 references.[98] The wide range of estimates, from 290 to 930 gCO_2eq/kWh, shows the high uncertainty surrounding upstream emissions of natural gas. The lifecycle emissions from coal are similarly uncertain, and when placed upon the higher direct emissions associated with coal combustion, they create a particularly wide range of possible emissions associated with the coal life cycle.

One team of scientists from Carnegie Mellon University methodically catalogued uncertainties around natural gas-related greenhouse gas emissions, and applied them to example policy choices to illuminate how those uncertainties should affect policymaking.[99] They modeled one each of gasoline and diesel cars displaced by a compressed natural gas (CNG) car, one diesel bus displaced by a CNG bus, and one coal power plant displaced by a natural gas combined cycle plant (Figure 4-5).

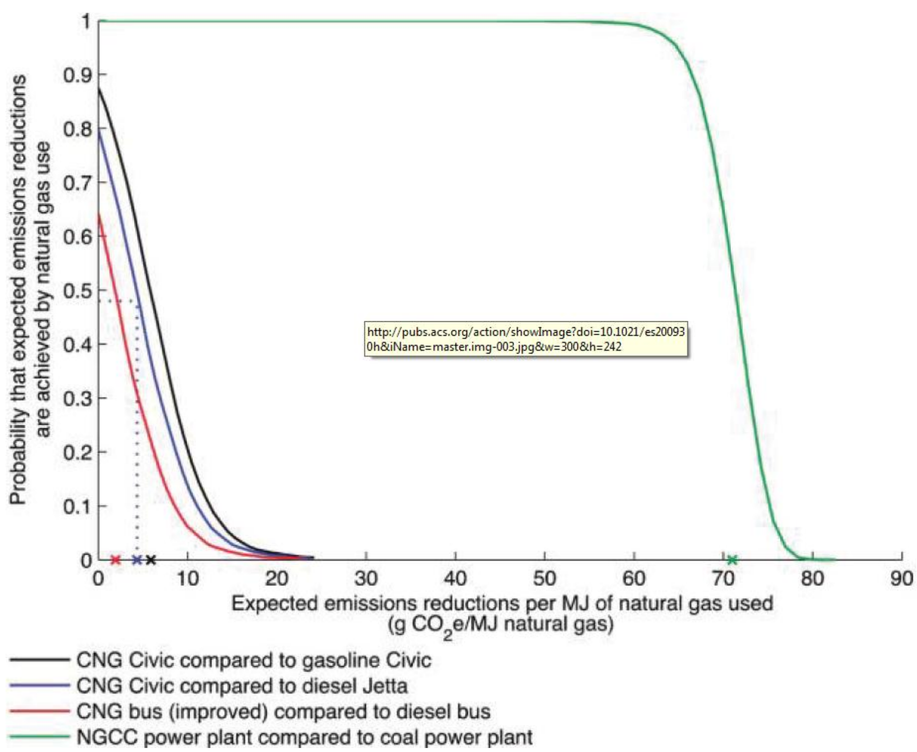


Figure 4-5: Probabilities of expected greenhouse gas emissions reductions from various technology substitutions. For example, substituting a CNG Civic for a diesel Jetta (blue solid line) shows a 48 percent probability of achieving at least 4 gCO_2e/MJ of greenhouse gas reduction (blue dotted line), and an 80percent probability of achieving some reduction over zero. (R0243)

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[98] NREL screened a pool of some 2,165 publications for quality and relevance before settling on a dataset drawn from 296 of those for the analysis published in the figure. Hence, the ranges shown exclude any unreasonable outliers. (**R0027 p.980**)

[99] A Venkatesh *et al.*, "Uncertainty in Life Cycle Greenhouse Gas Emissions from United States Natural Gas End-Uses and its Effects on Policy," *Environmental Science & Technology* 45 (2011) pp.8182–8189. (**R0243**)

The Carnegie Mellon team found sufficient greenhouse gas emissions uncertainties such that none of the transportation options are guaranteed to deliver a climate benefit. For example, replacing a diesel Jetta with a CNG Civic has an 80 percent probability of producing at least a marginal reduction in greenhouse gas emissions, but that means there's a 20 percent probability of producing an *increase* in greenhouse gas emissions. In contrast, displacing the coal plant offers a virtual guarantee of emission reductions, and certainly a much larger possible reduction than the vehicle technologies can offer.

Additional Environmental Impacts and Benefits

The technologies that have opened access to such a large quantity of natural gas, fracking in particular, have local environmental impacts additional to the contribution of fugitive or combusted methane to global warming. The interdisciplinary MIT study published this year[100] offers a well-structured typology:

1. **Leakage of natural gas or drilling fluids into shallow zones**. In many parts of the continent, shale gas lies much more deeply underground than the freshwater aquifers that supply drinking water. The fracture fluids must be pumped at high pressures through a well that passes through any aquifer that is present, and likewise the released natural gas is drawn upwards through the same well. If there is any failure in the lining of the well, it is possible for the fracture fluids, which can be toxic, or natural gas to intermingle with the drinking water supply.
2. **On-site surface spills**. Accidental spills of drilling mud have always been a risk of natural gas drilling, but fracking increases the risk because the quantity of liquids used at the drilling site are greatly increased by the use of fracture fluids.
3. **Off-site wastewater disposal**. In some locations, there is insufficient capacity in existing water disposal wells or sewage treatment plants to accept the volume of wastewater returned from the wells after fracking.
4. **Water withdrawal**. Some community and environmental advocates have expressed concern that the volumes of water required for shale gas extraction are sufficient to threaten the availability of water for other purposes.
5. **Road traffic and environmental disturbance**. Finally, drilling and operating the well comes with inherent increases to road traffic, ecological disturbance, and emissions of air pollutants that are unavoidable.

Because Washington is not the site of a major gas resource, our state is unlikely to experience the intense debates that surround these effects and policymaking around them. Though the Energy Office will not address the substance of those debates here, the outcomes of such debates taking place elsewhere in the U.S. and Canada may have significant impacts on the price and quantity of natural gas available in the future.

If the extent of collateral environmental impacts is shown to be large, and regulators elsewhere in the U.S. or Canada place tight controls on them, natural gas suppliers may be required to spend

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[100] *Op. cit.,* **R0231** pp.41-45.

sufficiently large amounts of money on those controls that future gas prices become elevated above current forecasts. The MIT study documented environmental incidents associated with about 20,000 shale gas wells drilled to date, and found that 80 percent of those incidents were associated with the first two types: well leakage into shallow zones or on-site surface spills. Hence, we can expect that future controls are most likely to focus on these two types.

Several organizations are developing guidelines for best practices in natural gas development.[101,102,103] If natural gas developers supplying Washington's gas are following best practices, collateral environmental impacts can be minimized, and even greenhouse gas emissions can be reduced by minimizing upstream leakage of methane.[104] Eventually, environmentally preferable gas certifications may become available, giving northwest gas utilities the option to offer certified gas to their customers.[105]

Natural gas yields fewer conventional air pollutants than almost any other combustible fuel when burned under similar conditions.[106] Some areas in Washington are coming closer to "non-attainment" of federal air quality standards for particulate matter and/or ozone. Natural gas might be an important tool in reducing the responsible air pollutants. The Tacoma area is in non-attainment status for particulate matter, due in large part to wood stoves used for home heating.[107] Clean-burning natural gas (or propane in more remote regions) could displace a significant portion of the wood heat and reduce particulate matter levels to meet federal standards.

Vehicle traffic in urban regions results in emissions of volatile organic compounds and oxides of nitrogen. Bothe classes of chemicals are precursors of ground-level ozone, which has reached non-attainment levels in the Puget Sound region and is threatening to do so in Spokane and Vancouver as well. Even though natural gas burns more cleanly, emissions control equipment on modern vehicles makes the conventional pollutants ultimately emerging from the tailpipe somewhat similar for gasoline, diesel, or natural gas.[108,109] When displacing diesel engines, the

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[101] Secretary of Energy Advisory Board, *Shale Gas Production Second Ninety Day Report*, U.S. Department of Energy, November 18, 2011, http://www.shalegas.energy.gov/index.html. (**R0277**)

[102] National Petroleum Council, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*, National Petroleum Council 2011, http://www.npc.org/reports/NARD-ExecSummVol.pdf. (**R0278**)

[103] U.S. EPA, *Natural Gas STAR Program*, http://www.epa.gov/gasstar/tools/recommended.html.

[104] S Harvey, *Leaking Profits: The U.S. Oil and Gas Industry Can Reduce Pollution, Conserve Resources, and Make Money by Preventing Methane Waste*, Natural Resources Defense Council, March 2012, http://www.nrdc.org/energy/leaking-profits.asp. (**R0279**)

[105] C Profita, "NW Natural CEO Proposes Certified Eco-Friendly Gas," *Ecotrope* (blog) November 9, 2012. http://ecotrope.opb.org/2012/11/nw-natural-ceo-proposes-certified-eco-friendly-gas/ viewed 12/6/12.

[106] U.S. Environmental Protection Agency, AP-42, *Compilation of Air Pollutant Emission Factors*, http://www.epa.gov/ttnchie1/ap42/.

[107] Puget Sound Clean Air Agency, *Fine Particulate Matter Non-Attainment Area Recommendation for the Tacoma Area*, Puget Sound Clean Air Agency 2007. (**R0275**)

[108] M I Jahirul *et al.*, "Comparative engine performance and emission analysis of CNG and gasoline in a retrofitted car engine," *Applied Thermal Engineering* 30 (2010) pp.2219-2226. (**R0281**)

emissions profile for natural gas experiences a per-mile penalty because natural gas engines are slightly less energy efficient than the diesel engines they would replace.[110] Commerce was unable to find any rigorous, scientific documentation of ozone reduction ascribable to the deployment of natural gas vehicles in the U.S.[111] Recent documentation of ground-level ozone formation in gas well fields[112,113] raises the additional need to balance urban ozone reduction against rural ozone intensification.

Until research can conclusively document a connection between CNG vehicles and significantly reduced ozone levels, natural gas can more reliably play an important role in improving air quality by displacing wood stoves in non-attainment areas for particulate matter.

Potential for Displacement of Renewable Energy and Energy Efficiency

The current, low price of natural gas, if sustained, will likely remain below the price (per unit of delivered energy) of most renewable resources. This is true both for electricity and for transportation fuels. Renewable electricity resources like wind and solar need to compete with natural gas burned in efficient, combined-cycle combustion turbine-generators. Renewable transportation fuels like ethanol and biodiesel need to compete with compressed or liquefied natural gas, or even with synthetic liquid fuels manufactured from natural gas. Without public policy direction, energy consumers are most likely to purchase the lowest-priced energy products, which will be those based on natural gas, so renewables will lose their market. Renewable energy advocates express concern that the natural gas boon will put a stop to renewable energy development that is critical to environmental protection, in particular to climate stabilization.[114,115,116]

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[109] G Karavalakis et al, "Air pollutant emissions of light-duty vehicles operating on various natural gas compositions," *Journal of Natural Gas Science and Engineering* 4 (2012) pp.8-16, http://www.sciencedirect.com/science/article/pii/S1875510011001302. (**R0282**)

[110] T Hesterberg, W Bunn & C Lapin, "An evaluation of criteria for selecting vehicles fueled with diesel or compressed natural gas," *Sustainability: Science, Practice, & Policy* 5 (2009) pp.20-30, http://sspp.proquest.com/archives/vol5iss1/0801-003.hesterberg.html. (**R0280**)

[111] There is at least one such study showing a benefit in a foreign country (see I Schifter et al, "Potential Impacts of Compressed Natural Gas in the Vehicular Fleet of Mexico City," Environmental Science & Technology 34 (2000) pp.2100-2104, **R0291**), but less effective emissions equipment on conventionally-fueled vehicles in other countries may be revealing the naturally clean burning advantage of natural gas more so than would be possible in the U.S.

[112] MA Rodriguez, MG Barna & T Moore, "Regional Impacts of Oil and Gas Development on Ozone Formation in the Western United States," Journal of the Air & Waste Management Association 59 (2009) pp.1111-1118. (**R0289**)

[113] RC Schnell et al, "Rapid photochemical production of ozone at high concentrations in a rural site during winter," Nature Geoscience 2 (2009) pp.120-122 (**R0290**)

[114] R Harris, *Could Cheap Gas Slow Growth Of Renewable Energy?* National Public Radio February 2, 2012, http://www.npr.org/2012/02/02/146297284/could-cheap-gas-slow-growth-of-renewable-energy viewed September 7, 2012. (**R0240**)

[115] K Schneider, *U.S. Fossil Fuel Boom Dims Glow of Clean Energy*, Yale Environment 360 (blog) March 29, 2012, http://e360.yale.edu/feature/us_fossil_fuel_boom_dims_glow_of_clean_energy/2511/ viewed September 7, 2012. (**R0241**)

[116] D P Schrag, "Is Shale Gas Good for Climate Change?" *Daedalus* 141 (2012) pp. 72-80. (**R0242**)

In the Pacific Northwest, utility funding of customer energy efficiency programs is at risk because of low wholesale natural gas prices. Utility and ultimately ratepayer benefits from energy efficiency programs must offset the cost of implementation. While individual participants would still benefit from efficiency programs, the benefits to the entire ratepayer population are low. Already, one of the state's four regulated gas utilities has filed with UTC a request to suspend their natural gas energy efficiency programs.[117] The UTC will likely rule on this request late in 2012. In addition, the UTC has initiated general rulemaking on natural gas utility energy efficiency programs.[118] This rulemaking will primarily examine the cost effectiveness tests applied to utility natural gas conservation programs.

Net Climatic Effect

Electricity, when generated with natural gas, produces significantly fewer greenhouse gas emissions than coal, as measured at the exhaust stack, for two separate reasons. First, the fundamental chemistry of combusting natural gas (CH_4) versus coal (a collection of much heavier carbon-based molecules) simply produces fewer greenhouse gases for the same quantity of heat energy released. Both fuels, if combusted completely, produce exhaust consisting primarily of water vapor and the greenhouse gas carbon dioxide (CO_2). However, burning amounts to produce the same amount of heat energy from each fuel will produce more than 1.7 times as much CO_2 from coal than from gas.

The second reason for the higher efficiency from natural gas is one of mechanics and engineering. Natural gas arrives at the power plant as a relatively clean gas, while coal arrives as a somewhat impure solid. The gas can be consumed directly in a high-efficiency combustion turbine. The gas turbine, in addition to combusting the gas to liberate heat, conveniently extracts mechanical energy at the same time to spin the electric generator. Coal, in contrast, needs to be pulverized and combusted in a significantly less efficient boiler that produces steam but no mechanical energy, so the coal plant has to rely on its steam turbine alone to rotate the generator.

When combined, the chemical and engineering differences between natural gas and coal mean that even a modern, pulverized coal plant emits nearly twice the carbon dioxide for the same amount of electric generation, between 736 and 811 kg CO_2/MWh compared to a range of 344 to 379 kg CO_2/MWh for natural gas combined cycle plants.[119]

In vehicles, gasoline has a chemical disadvantage relative to natural gas as well, though less so than coal: gasoline produces somewhat more than 1.3 times as much CO_2, relative to the energy-equivalent in natural gas. But natural gas holds no engineering advantage over gasoline the way

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[117] Avista Schedule 190 filing, June 29, 2012. http://www.avistautilities.com/services/energypricing/wa/Pages/default.aspx.(**R0274**)

[118] Washington State Utility and Transportation Commission, Natural Gas Conservation Rulemaking UG-121207. (**S0112**)

[119] E S Rubin, C Chen & A B Rao, "Cost and performance of fossil fuel power plants with CO_2 capture and storage," *Energy Policy* 35 (2007) pp.4444-4454. (**R0249**) Rubin, Chen & Rao survey the literature for representative values from three representative types of generating plants.

it does over coal, so as a result the climatic impacts of displacing gasoline with natural gas, though potentially positive, are far less dramatic.

The significantly lower emissions rate of natural-gas fired electric generation has been the basis of a broad and strong lobby to pursue natural gas as an important “bridge fuel” to an eventual, renewable energy future.[120] In this vision, natural gas-fired electric generators displace existing and/or future coal-fired electric generators to begin reducing projected greenhouse gas emissions while waiting for renewables, advanced nuclear power, carbon capture and storage, or other future technologies to herald a near zero-emissions energy system. One author goes a step further, suggesting that sufficient underutilized, gas-fired capacity exists on the grid to displace a substantive fraction of coal-fired electricity with little to no change in physical infrastructure.[121]

In recent years, however, a strong backlash argument has emerged characterizing natural gas as a “bridge to nowhere.”[122] Multiple concerns build on the well-documented uncertainty regarding fugitive methane emissions arising from exploration, extraction, and delivery as discussed in *Life-Cycle Greenhouse Gas Emissions* beginning on page 40, above. In particular, the specific extraction methods of shale gas may produce significantly more fugitive methane emissions than conventional gas extraction, so that the actual upstream emissions may be higher than typical ranges such as those behind Figure 4-4.[123]

A second theme in the “bridge to nowhere” argument is the permanence of the infrastructure created. While natural gas can offer greenhouse gas emissions reductions from zero to 50 percent relative to various existing fossil-fueled technologies, climate science shows that far deeper reductions will eventually be needed to stabilize the climate. Greenhouse gas emissions need to be reduced between 60 percent and 80 percent by 2050 to achieve scientists’ recommended goal of a maximum two degrees Celsius of global warming.[124] If we greatly expand natural gas consumption, energy companies, distributors and consumers will be investing in new infrastructure that they are unwilling to give up so soon.[125]

The infrastructure permanence issue is more significant for transportation than power generation. A new combined-cycle combustion turbine can be comfortably retired by a utility in as little as 25 years, and can be fueled through the existing pipeline infrastructure (Figure 4-1). In contrast,

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[120] *e.g.*, J D Podesta & T E Wirth, *Natural Gas: A Bridge Fuel for the 21st Century*, Center for American Progress 2009. (**R0246**)

[121] B A Lafrancois, “A lot left over: Reducing CO_2 emissions in the United States’ electric power sector through the use of natural gas,” *Energy Policy* in press as of August 2012. (**R0245**)

[122] *e.g.*, J Romm, “Natural Gas Is A Bridge To Nowhere Absent A Carbon Price AND Strong Standards To Reduce Methane Leakage,” *ThinkProgress* (blog) 9 April 2012. (**R0248**)

[123] R W Howarth, R Santoro & A Ingraffea, “Methane and the greenhouse-gas footprint of natural gas from shale formations,” *Climatic Change* 106 (2011) pp.679–690. (**R0247**)

[124] A Weaver *et al.*, “Long term climate implications of 2050 emission reduction targets,” *Geophysical Research Letters* 34 (2007) L19703, http://www.agu.org/pubs/crossref/2007/2007GL031018.shtml. (**R0283**)

[125] D L Greene, *Testimony to the United States Senate Committee on Energy and Natural Resources*, July 24, 2012, p.6, http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=96dc4c8c-4fbc-41f1-a33d-81201ad4f7cd. (**R0254**)

making natural gas-fueled cars commonplace would require building a sufficiently dense network of fueling stations, which would in turn require significant additions to the natural gas transmission and distribution system. Converting, for example, half of Washington's transportation energy consumption to natural gas would double the state's total demand for natural gas.[126]

The third theme in the "bridge to nowhere" argument is a call for more sophisticated treatment of global warming potentials from greenhouse gases. Climate policy has been governed by 100-year global warming potentials, which compare the relative effects of greenhouse gases over the period 100 years after they are released. On the 100-year basis, methane has a global warming potential 25 times that of CO_2. But unlike CO_2, which persists in the atmosphere nearly indefinitely, methane decays over a period of only about 12 years.[127] The vast bulk of its warming impact occurs during the first few years after release. For example, if one were to compare global warming potentials over only 20 years instead of 100 years, methane is 72 times as potent as CO_2.[128] Many climate scientists find short-term warming potential to weigh considerably more heavily than 100-year warming potential in reasonable scenarios for climate stabilization.[129]

A team of researchers recently proposed the concept of "technology warming potentials" (TWP) specifically to make climate policy decisions more consistent with the complex mathematics of climate forcing.[130] TWPs calculate the climate forcing year-by-year comparatively, showing the relative impact of one technology displacing another. TWPs reveal the time dependence of climate impacts, unhiding the temporal assumption behind the more simplistic 100-year global warming potentials used in the past. The authors applied TWPs to three cases in which natural gas is substituted for gasoline in cars, diesel in heavy-duty vehicles, and coal for electric generation (Figure 4-6).

[126] See the state's energy flow diagram on p.56. The transportation sector currently demands 661 TBtu of energy per year, while all sectors in the state combined consume just 295 TBtu of natural gas per year.

[127] Twelve years is the exponential decay constant, meaning that after 12 years, 63 percent of the methane has decayed.

[128] S Solomon et al (eds.), *Climate Change 2007: The Physical Science Basis*, *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press 2007, Table TS.2. (**R0237**)

[129] B Metz et al (eds.), *Climate Change 2007: Mitigation of Climate Change, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press 2007. (**R0284**)

[130] R A Alvarez et al, "Greater focus needed on methane leakage from natural gas infrastructure," *Proceedings of the National Academy of Sciences* 2012. (**R0233**)

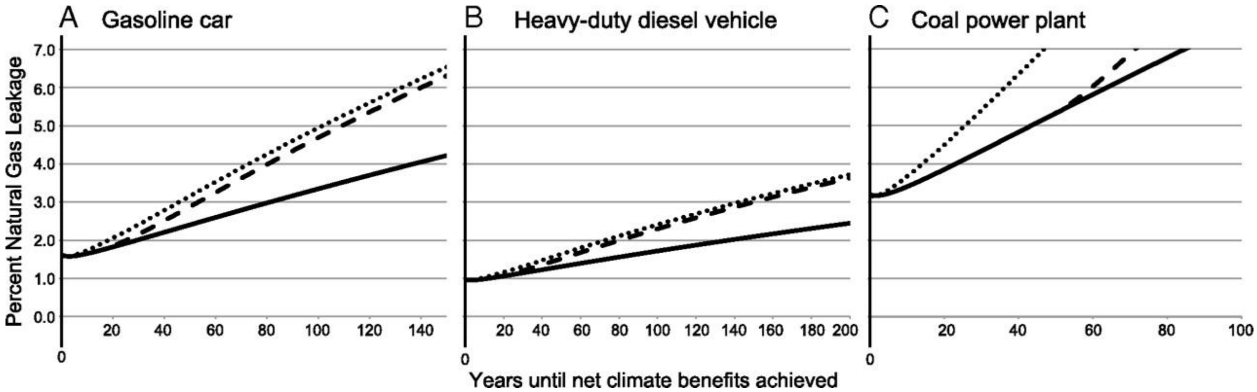

Figure 4-6: Climate benefit from using natural gas to displace (A) a gasoline car, (B) a heavy-duty diesel vehicle, or (C) a coal power plant. The solid line represents permanent conversion, the dashed line represents a temporary conversion (a single service life of 15 years for the vehicles or 50 years for the power plant), and the dotted line represents a single emissions event (for example, choosing to rent a CNG vehicle instead of a gasoline vehicle). The higher the upstream leakage of natural gas, the more years before the natural gas-fired technology "breaks even" with the older technology it replaced. For example, in the case of the gasoline car, if the upstream leakage is 3.0 percent then it will be 80 years before the greenhouse gas advantage of the CNG cars themselves make up for the increased climate forcing from methane leakage. (Source: R0233 Figure 2)

In all three cases, they found the climate benefit to be very heavily influenced by the quantity of upstream methane leakage in the system. For example, in the case of the gasoline car, if the upstream leakage is 3.0 percent,[131] it will be 80 years before the greenhouse gas advantage of the CNG cars themselves makes up for the more immediate impact of methane leakage, while at 1.0 percent the CNG car delivers climate benefits immediately.

Unsurprisingly, the authors of the TWP study find greater benefits and therefore less sensitivity to leakage rates for displacement of coal electric generation, than for displacement of gasoline or diesel fuel in vehicles. The actual methane leakage rate would have to exceed 3 percent to prevent a coal conversion from having immediate climate benefits.

Efficiency of Use

Natural gas has four major applications in Washington's energy system: (1) as a heat source for direct combustion in residential and commercial space heating, water heating, and cooking; (2) as a fuel for industrial processes; (3) when compressed to high pressures, as a fuel for transportation; and (4) as a fuel for generating electricity.[132]

In each of these applications, a new application of natural gas can be thought of displacing a new application of some other, competing fuel. In the case of residential and commercial combustion, the alternatives may be oil, propane, wood, or, most commonly, electricity. In the transportation sector, future natural gas could displace gasoline, diesel fuel, biofuels, or electricity. There is no

[131] Measured as a percentage of gas produced at the wellhead.

[132] See Chapter 5, Indicators 3, 6, 8, 9 and 10. Transportation sector applications may include liquefied (as well as compressed) natural gas in the near future. See, for example, Cedar River Group, *Evaluating the Use of Liquefied Natural Gas in Washington State Ferries*, Joint Transportation Committee, January 2012, http://www.leg.wa.gov/JTC/Pages/CompletedStudies.aspx. (**S0114**)

obvious alternative to natural gas for electric generation other than conservation; and industrial applications can resort to virtually any alternative fuel, making any hypothesis of the avoided fuel fairly arbitrary. A comprehensive assessment of the highest and best use of natural gas among the four categories, let alone among the many technologies available in each category, is an analytically complex exercise that, to the best of the Energy Office's knowledge, has never been undertaken. Even if it were done, the ultimate results will be different whether measured in terms of consumer cost, social cost, gross energy consumption, fossil energy consumption, or greenhouse gas emissions.

Generally speaking, applications of natural gas to transportation take a modest efficiency penalty because the natural gas first has to be pressurized to 3,600 pounds per square inch.[133] This is where the "C" in CNG (compressed natural gas) comes from. Without this compression step, the fuel would not physically fit in the vehicle. Compression to CNG exacts an energy penalty between 2 percent and 5 percent of the natural gas delivered to the compressor.[134] The other three categories of natural gas use do not suffer from this penalty.

There is one specific tradeoff that has attracted attention from analysts: space heating and water heating in the residential and commercial sectors can be fueled either with natural gas or electricity. In Washington, new electric load will be met with new electric generation fueled primarily by natural gas. Modern, high-efficiency space and water heating appliances typically deliver more than 90 percent of the combusted gas's heating value to the consumer.[135] In contrast, even the most modern and efficient electric generators deliver less than 60 percent of the fuel's heat energy to the end consumer as electric energy.[136]

In 2008, the American Gas Foundation released a study authored by the Black & Veatch Corporation modeling the effects on energy consumption, emissions, and prices if 7 percent of the United States' residential and commercial electric load is replaced with direct combustion of natural gas by 2030.[137] Black & Veatch tested the effects under five different scenarios of the future that varied the quantity of natural gas available on the market, improvements in energy technologies, and strength of greenhouse gas regulation. Figure 4-7 shows that direct combustion of the natural gas produced lower energy demand, on a national basis, in all of the modeled scenarios. They found similarly positive effects on greenhouse gas emissions and energy costs.

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[133] In modern U.S. equipment. Older U.S. equipment operated at 3,000 pounds per square inch, and many such systems are still in use.

[134] J E Sinor, *Comparison of CNG and LNG Technologies for Transportation Applications*, National Renewable Energy Laboratory 1992, www.afdc.energy.gov/pdfs/2451.pdf. (**R0256**)

[135] http://energy.gov/energysaver/articles/furnaces-and-boilers. (**R0285**)

[136] After line loss.

[137] American Gas Foundation, *Direct Use of Natural Gas Implications for Power Generation, Energy Efficiency, and Carbon Emissions*, 2008. (**R0244**)

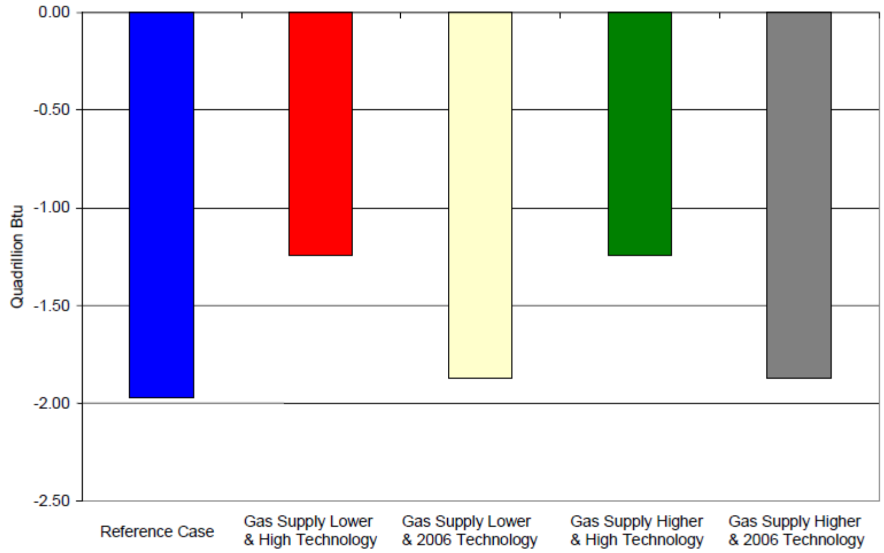

Figure 4-7: Change in U.S. energy consumption by 2030, when 7 percent of residential and commercial electric consumption is replaced by direct use of natural gas. An absolute reduction occurs under all five scenarios tested by Black & Veatch. (R0244 p.v)

The Black & Veatch study notably did not consider the effects of future penetration of heat pump technologies, which can use electricity at much higher coefficients of performance than traditional resistance heating, which dominates residential and commercial consumption in the Pacific Northwest. So the study would point to favoring on-site combustion of natural gas *when it is known that doing so displaces electric resistance heating.*

The Northwest Power and Conservation Council evaluated tradeoffs between on-site combustion of natural gas with electric heating appliances, focusing primarily on the economics of fuel conversion choices for existing residential consumers.[138] The Council's study did include heat pump alternatives, and found that, for the most part, Northwest consumers are likely to make conversion choices consistent with low regional energy costs. Even if all of those consumers fail to make the rational economic choice, the net, collective energy impact after 20 years would be just 1 percent increase in the total regional consumption of natural gas.[139] The Council study recommends no market intervention as a result.

[138] Northwest Power and Conservation Council, *Direct Use of Natural Gas: Economic Fuel Choices from the Regional Power System and Consumer's Perspective*, document 2012-01, NPCC 2012, http://www.nwcouncil.org/library/report.asp?d=654. (**R0257**)

[139] *Op. cit.* p.18.

Conclusions

Kevin Doran and Adam Reed, writing for *Yale Environment 360*, postulate that renewable energy and natural gas should not be seen as competitors, but rather as two parts of a coherent vision for our energy future.[140] Natural gas offers an easy path to displacing inefficient, high-greenhouse gas coal plants, simultaneously offering the capacity to firm up the intermittent generation of renewables that fluctuate with weather and time of day. Meanwhile renewable energy, with its zero (and therefore forecastable) fuel prices offers a hedge against the high volatility of natural gas prices.

The International Energy Agency (IEA) takes a similarly equivocal view in its *Golden Rules for a Golden Age of Gas*,[141] adding the observation that while lower gas prices might weaken the incentive to develop more expensive renewables, consumers' lower energy bills might allow more willingness to shoulder subsidies of renewables in the energy portfolio. Still the IEA offers an arresting bottom line: "Ultimately, the way that renewables retain their appeal, in a gas-abundant world, will depend on the resolve of governments."[142]

Washington's approach to the new abundance of natural gas can take a sound footing in the science and policy analysis available with a three-point foundation:

- **Protect and support renewable energy and energy efficiency**. Natural gas, if a meaningful bridge fuel, is a bridge *to* an efficient, renewable energy future. Low costs for natural gas must not be allowed to undermine the continued development of those critical, long-term resources.
- **Stay the course on electric vehicles and biofuels for transportation**. Greenhouse gas and conventional pollutant reductions from switching to natural gas in transportation are both uncertain. A massive deployment of natural gas for transportation would sink resources into permanent new infrastructure that might undermine the long-term goals of renewable energy. Supporting electric vehicles and biofuels, the paradigm for progressive transportation pursued by the state thus far, seems like the safer bet.[143]
- **Aim for displacement of coal**. The highest and best use of natural gas is almost certainly displacement of coal-fired electric generation. High efficiency, natural gas-fired generation should be encouraged in utility resource planning and other venues, *in those cases where it can be demonstrated to displace coal without displacing efficiency or renewable energy*.

[140] K Doran & A Reed, *Natural Gas and Its Role In the U.S. Energy Endgame*, Yale Environment 360 (blog) August 13, 2012, http://e360.yale.edu/feature/natural_gas_role_in_us_energy_endgame/2561/ viewed September 7, 2012. (**R0239**)

[141] International Energy Agency, *Golden Rules for a Golden Age of Gas: World Energy Outlook Special Report on Unconventional Gas*, 2012. (**R0232**)

[142] *Op. cit.*, p.80.

[143] Natural gas may be an appropriate option for institutional fleets, limiting investment to a small number of refueling points rather than an extensive infrastructure.

Chapter 5 – Energy Indicators

Washington's Energy System

When compared to other states, Washington's energy system is characterized by relatively clean and low-cost electricity dominated by hydroelectric generators, thermal energy with a larger-than-typical contribution from biomass, and fairly typical transportation energy. The state's greenhouse gas footprint is dominated by transportation energy, thanks to the relatively low greenhouse gas emissions related to the electric grid.

Energy flows in Washington State have been mapped as shown in Figure 5-1. Data is for calendar year 2010, the most recent year for which data are available on all sources and consumers of energy. In the figure, the thickness of each line is proportional to the quantity of energy being delivered or consumed; these quantities appear as numeric values on or adjacent to each line, in trillion British thermal units (TBtu). Of the 1,629 TBtu primary energy consumed in one year by the state, 557 TBtu was consumed by electric generators, and 1,071 TBtu went directly to the three consuming sectors (transportation, industrial, and residential/commercial). The transportation sector is the least efficient user of primary energy, delivering only 26 percent of the primary energy as useful energy services, and losing the remainder as waste heat.

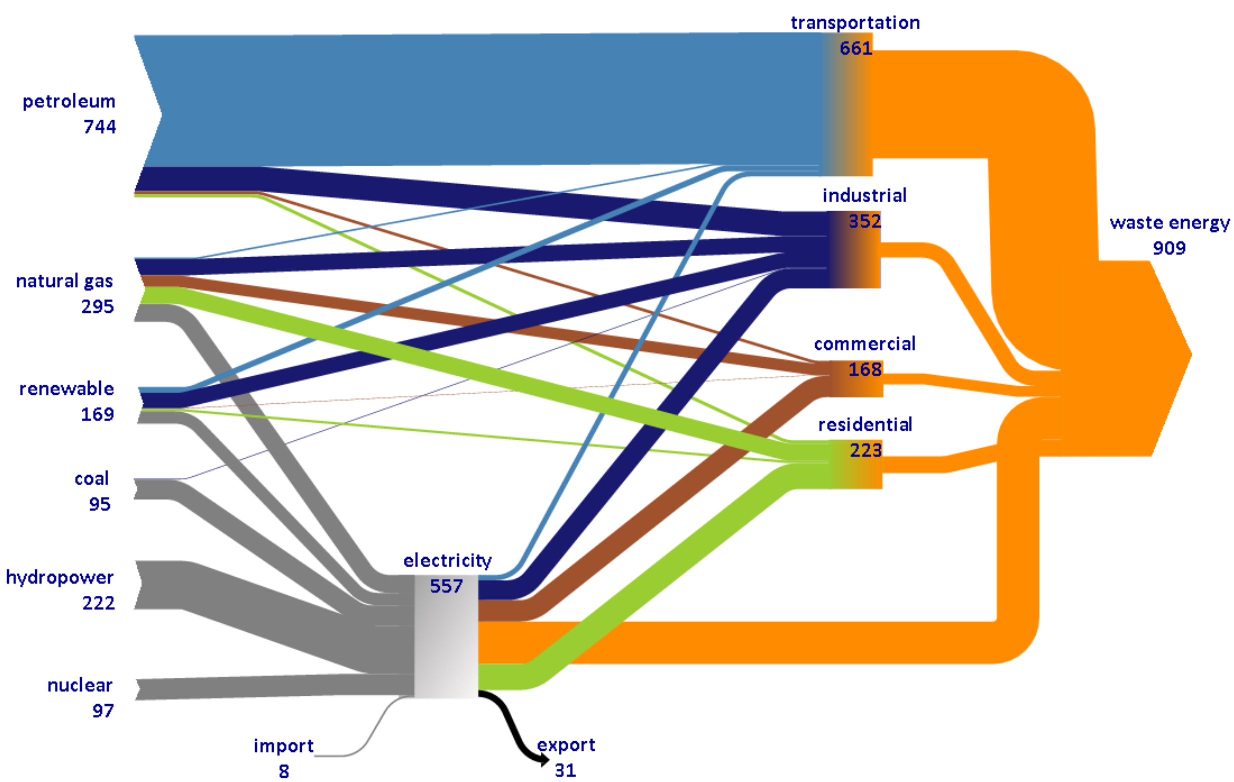

Figure 5-1: Sources and consumers of energy in Washington in calendar year 2010. The state consumed 1,629 TBtu of energy. Sums may not equal totals due to rounding error. (Source: W0026)

Energy Indicators

In the early 1990s, Commerce developed 23 Energy Indicators to illustrate important long-term energy trends in Washington. The indicators were first published in the *1999 Biennial Energy Report*. The concept of indicators was initially used in the *Washington State Energy Use Profile*, which was last published in June 1996.

Commerce does not collect a large amount of primary energy data, but rather depends on regional and national sources. The Energy Indicators are grounded in the best available information and can be updated on a regular basis. They are based as much as possible on regularly published data from sources in the public domain. The principal source for the indicators is the EIA's Combined State Energy Data System. Other sources include the U.S. Bureau of Economic Analysis the U.S. Census Bureau, the President's Council of Economic Advisors, the Washington State Office of Financial Management, Federal Highway Administration, Oak Ridge National Laboratory Center for Transportation Analysis, and the Washington State Fuel Mix Database.

Collecting and publishing detailed statistics on energy consumption, price, and expenditures for 50 states and the District of Columbia is a large task involving analysis and compilation of fuel- and sector-specific data. Thus, comprehensive state information from EIA lags by two to three years, and, consequently, the Energy Indicators are limited to analysis of long-term energy trends. Data for most of the Energy Indicators runs from 1970 to 2010; a few are one-year snapshots. Links to more current data are included for those indicators where this information is available.

For each indicator there is a chart illustrating the trend, a table with the energy data, narrative giving additional perspective or describing further aspects of the indicator, data sources for the indicator, and links to other related information.

See Appendix A for more information on the methodology used to develop and update the indicators.

Indicator 1: End-Use Energy Consumption by Sector

End-use energy consumption in Washington was 66 percent higher in 1999, at its peak, than in 1970 (Figure 5-2). Most of the increase occurred in the transportation sector, where energy use more than doubled. After 1999, end-use energy consumption declined due to a significant drop in industrial energy use and little growth in transportation, residential, and commercial energy use. In 2004 energy consumption began to rise again and peaked in 2007 before a combination of higher energy prices and a recession began to reduce consumption in 2008. Total energy consumption has continued to decline through 2010.

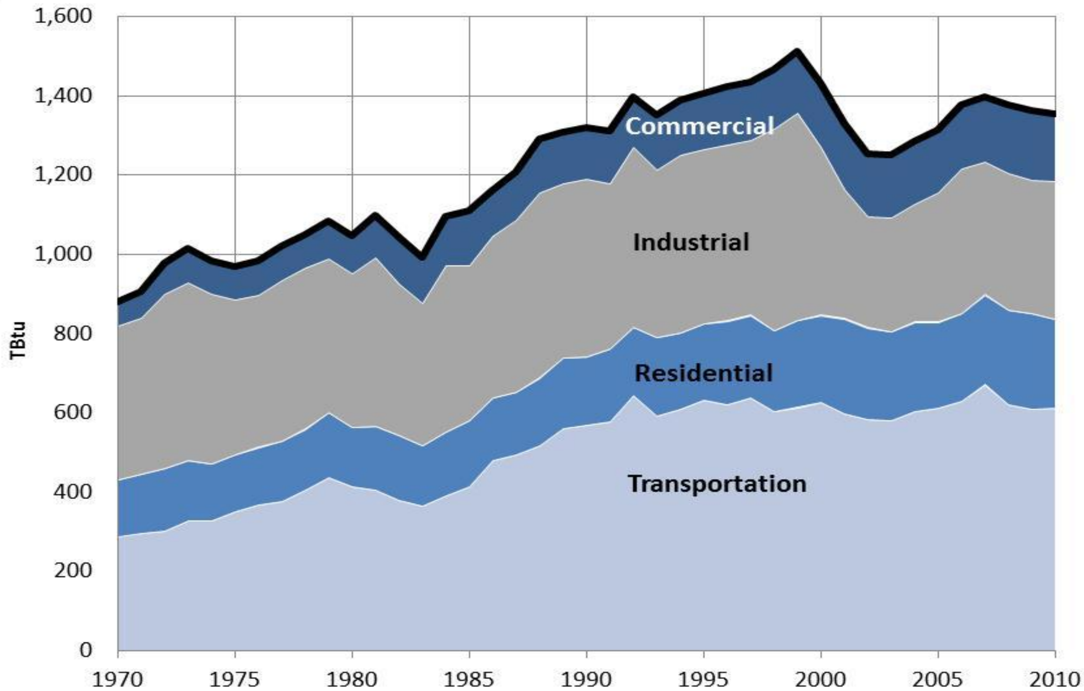

Figure 5-2: End-use energy consumption by sector 1970-2010. (Source: W0026, tab 1ch)

Washington's end-use energy consumption grew at an average rate of 1.8 percent per year between 1970 and 1999. Consumption reached an all-time high of 1.51 quadrillion Btu in 1999 before declining 13 percent by 2002 primarily due to a sharp drop in industrial energy consumption. Energy use began to climb again and reached another peak in 2007. Between 2007 and 2010, energy use declined at a 1 percent annual rate due to a combination of high energy prices and a deep recession.

During the 1970s and early 1980s, growth in energy consumption was dampened by higher energy prices and changes in the state's economy, but grew fairly steadily between 1983 and 1999, in part due to relatively modest energy prices. The transportation sector accounted for the largest share of growth in energy consumption during this period, growing at an annual rate of 3.3 percent. Energy consumption in the commercial sector, which includes service industries such as software, finances, and insurance, has grown steadily over the years. Between 1970 and 2000, commercial sector energy use grew at a 3.3 percent rate, but total consumption is smaller than the other sectors. Residential sector energy use has also grown steadily over the years, but at a more modest 1.5 percent from 1970 to 2000. Although there was some year-to-year variation, industrial sector energy consumption showed no net growth between 1970 and 2000.

In 2010, Washington's energy use was 10 percent less than the 1999 peak despite a larger population. Industrial sector consumption declined 38 percent from 1999 to 2002. This reflected structural changes in the state's economy and, in recent years, the decline of the aluminum industry. While there was a slight increase in industrial energy consumption since 2002, consumption in 2010 was still significantly lower than in 1999. Energy consumption in the transportation sectors in 2010 was similar to the 1999 level, and the residential and commercial sectors experienced modest growth. This suggests that the majority of the overall decline in Washington's energy use was due to the industrial sector decline.

The transportation sector accounted for 47 percent of the energy use in Washington in 2010. The industrial sector accounted for 26 percent of consumption, followed by the residential sector at 17 percent and commercial at 12 percent. The industrial share has declined since 1970, when it accounted for 42 percent of Washington's energy consumption.

Source: EIA State Energy Data System **(**see data table for **Indicator 1** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 2: Primary Energy Consumption by Source

Washington continues to rely on petroleum fuels for about half of its primary energy use. The relative contribution of hydroelectricity as an energy source has declined from about 25 percent of Washington's energy use for much of the 1970s to about 15 percent the last five years, largely due to somewhat lower hydroelectricity generation and the growth in use of other fuels such as natural gas, biomass, petroleum, and uranium.

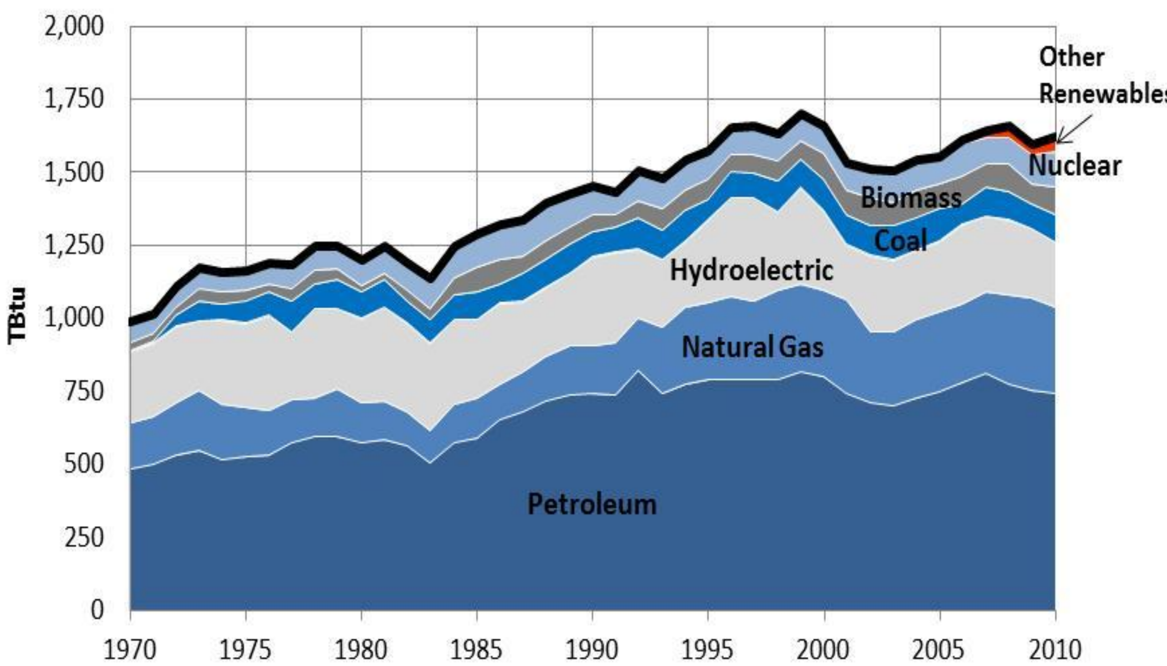

Figure 5-3: Total primary energy consumption by source, 1970-2010. (Source: W0026, tab 2ch)

Figure 5-3 shows the extent of Washington's reliance on six major primary[144] energy sources: petroleum, hydroelectricity, natural gas, biomass, coal, and uranium (nuclear).[145] Washington continues to rely on petroleum, much of which is from Alaska, to meet 48 percent (in 2010) of its primary energy needs. The petroleum share of primary energy use has not changed appreciably – in 1965 it was 50 percent. Fossil fuels (petroleum, coal, and natural gas) accounted for 71 percent of primary energy use in 2008. By 2001, consumption of natural gas had more than doubled, regaining the market share it lost during the 1970s. Natural gas consumption has declined a little since 2001, but accounted for nearly 19 percent of Washington's primary energy consumption in 2010.

Hydroelectricity has been a key energy source in Washington for many years. It is important to recognize that total generation from hydroelectric dams varies depending on river flows. Generation in 2001 dropped to its lowest level in 35 years, 32 percent lower than the average for the last 30 years. This compares to the peak year in 1997 when generation was 29 percent greater than the average.

Biomass, mainly wood and wood waste products, accounted for about 8 percent of primary energy consumption in 2010. This share has declined slightly from the 1980s, but is up significantly from the biomass share in the 1990s. Biomass is primarily burned for electricity and process steam, and at pulp and paper mills, but is also used for residential heating. Coal is consumed almost exclusively at the TransAlta Centralia Generation facility, while uranium is used at Energy Northwest's Columbia Generating Station in Richland. Together, fuel used for electricity generation at coal and nuclear generation plants accounted for 8 percent of Washington's primary energy consumption in 2010.

State-level energy consumption data for 2011 is not yet available, but national energy consumption for 2011 (97.3 quadrillion Btu) has been released and shows virtually no change from 2010 consumption, and a 4 percent decline from 2007, which also happened to be the peak year for US energy consumption (101.5 quadrillion Btu).

Sources: EIA State Energy Data System **(**see data table for **Indicator 2** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted to exclude non-energy petroleum products such as asphalt and road oil.

[144] The main difference between primary and end-use energy consumption is the treatment of electricity. Electricity must be generated using energy sources such as coal, natural gas, or falling water. These inputs to the power plant are counted as primary energy; the output of the power plant that is consumed by homes and businesses is end-use electricity. Since over half of the energy inputs to thermal power plants are typically lost as waste heat, primary energy consumption is larger than end-use. Note that some of the primary energy used to produce electricity in Washington may be for electricity used in other states. Washington typically generates more electricity than is consumed in the state (see Indicator #3).

[145] Several other renewable energy sources – geothermal, wind, and solar – account for less than 1 percent of primary energy consumption.

Indicator 3: Electricity Generation and Consumption by Fuel

There are two ways to look at the energy sources for electricity in Washington. One is to consider the sources for electricity generated in Washington (Figure 5-4a and Table 5-1a). Electricity generated from hydroelectric dams accounted for 80 percent of the electricity generated in the state in 2011 while coal, natural gas, and nuclear accounted for most of the remainder. Electricity generated from non-hydro, renewable sources has been growing. The total share for biomass, wind, waste, and landfill gas was 6.9 percent of the total generation. Wind has grown from nearly zero share in 2000 to 5.3 percent in 2011 (ranking seventh in the nation in 2012 according to the American Wind Energy Association[146]). In 2011, power plants in Washington generated 29 percent more electricity than was consumed in the state.

Another approach, and perhaps better estimate for the energy sources for electricity in Washington, is the mix of generation used by utilities to serve customers in the state (Figure 5-4b and Table 5-1b). Washington is part of an interconnected, regional bulk power system and utilities purchase electricity generated from a variety of sources throughout the region. The data for estimating the sources of electricity consumed in Washington is collected for the Washington State Fuel Mix Disclosure process[147] and includes utility spot market purchases.

Hydroelectricity was still the dominant source, accounting for 73 percent of the electricity consumed in the state in 2011. Electricity generated from coal accounted for 14 percent of the electricity used by Washington consumers, which is larger than the generation share. This reflects the electricity purchased by some utilities from coal-fired power plants located in other states like Montana and Wyoming. Renewable sources besides hydro accounted for 2 percent of the electricity purchased by utilities for use by Washington consumers. This was less than the generation share, indicating that some of the renewable energy generated in Washington was sold to customers outside the state.

[146] http://www.awea.org/learnabout/publications/reports/upload/3Q2012-Market-Report_Public-Version.pdf

[147] Fuel Mix Disclosure reporting is conducted annually and includes electricity consumption data reported by utility. Each utility reports resource category and fuel type for its electricity sales in Washington.

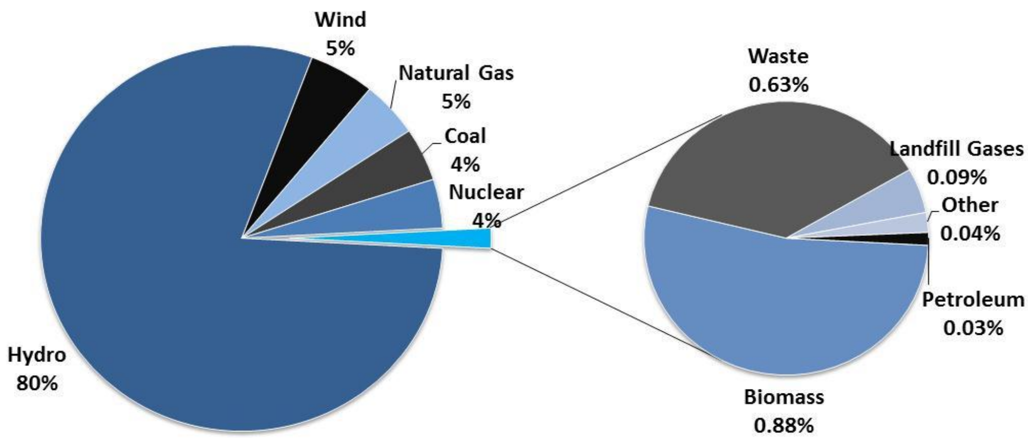

Figure 5-4a: Fuels consumed for electricity generated in Washington during calendar year 2011 (see also Table 5-1a).

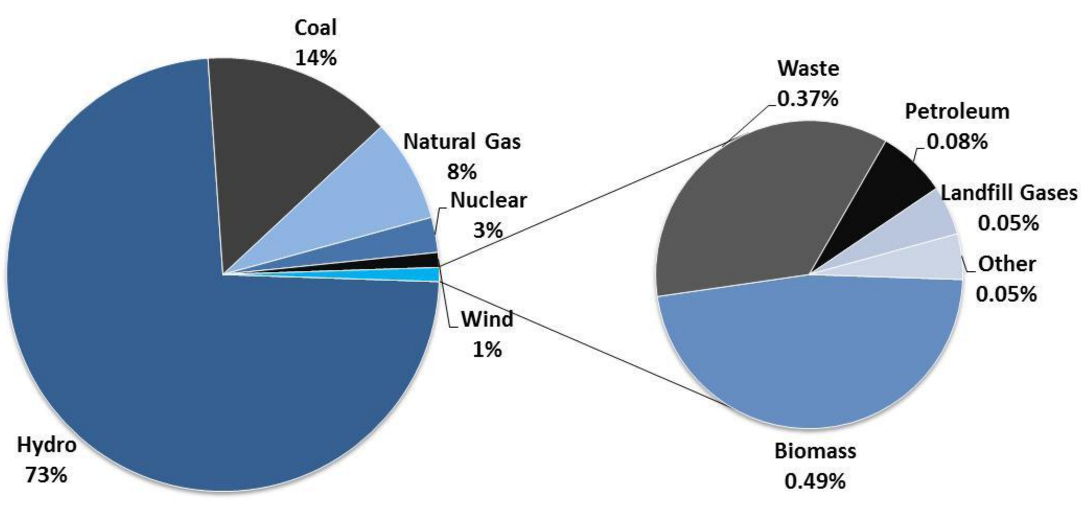

Figure 5-4b: Fuels consumed for electricity delivered in Washington during calendar year 2011 (see also Table 5-1b). (Source: W0026, tab 3ch)

Table 5-1a: Fuels Consumed for Electricity Generated in Washington

Fuel	Generation *MWh*	Share
Hydro	93,955,001	79.87%
Wind	6,208,588	5.28%
Natural Gas	5,479,974	4.66%
Coal	5,228,585	4.44%
Nuclear	4,806,278	4.09%
Biomass	1,039,315	0.88%
Waste	743,265	0.63%
Landfill Gases	104,588	0.09%
Other	45,961	0.04%
Petroleum	29,512	0.03%
Total	**117,641,067**	**100.00%**

Table 5-1b: Fuels Consumed for Electricity Delivered in Washington

Fuel	Generation *MWh*	Share
Hydro	66,847,397	73.37%
Coal	12,900,636	14.16%
Natural Gas	7,003,278	7.69%
Nuclear	2,390,245	2.62%
Wind	1,017,702	1.12%
Biomass	446,890	0.49%
Waste	336,948	0.37%
Petroleum	68,539	0.08%
Landfill Gases	49,209	0.05%
Other	45,429	0.03%
Total	**91,106,272**	**100.00%**

Table 5-1: Primary fuels used to generate electricity in and for Washington during calendar year 2011. Table 5-1a lists fuels used by electric generators physically located in the state. Table 5-1b lists fuels used to generate the electricity purchased by Washington energy consumers, regardless of where the electricity was generated.

Source: Washington State Fuel Mix Disclosure Database

Link: http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/FuelMix.aspx

Indicator 4: End-Use Energy Expenditures by Sector

While energy expenditures grew rapidly in the 1970s in Washington, during much of the 1980s and 1990s inflation-adjusted[148] expenditures declined or grew modestly despite significant growth in energy consumption. This trend changed in 1999 as inflation adjusted energy prices began to rise. By 2010, energy expenditures had grown by nearly 100 percent relative to 1998.

[148] Fuel prices throughout this document are referred to as "inflation-adjusted" or "real" dollars. This adjusts for the effects of inflation and allows prices for different years to be directly compared. See Appendix A: Methodology for details.

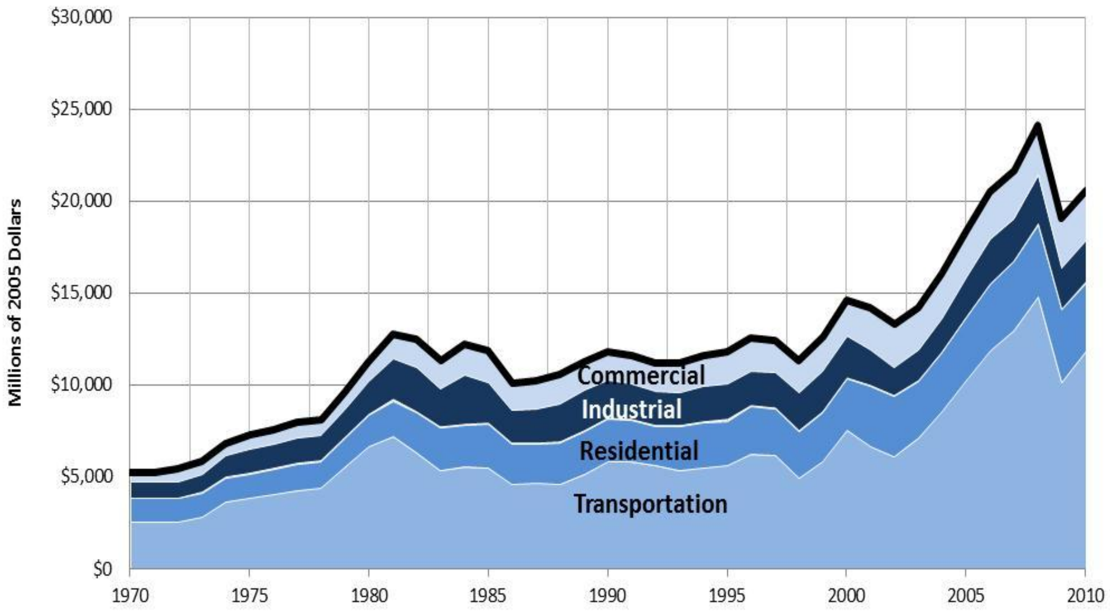

Figure 5-5: End-use energy expenditures by sector 1970-2010. (Source: W0026, tab 4ch)

Washington's residents and institutions spent more than $20 billion on energy in 2010. After peaking in the early 1980s, inflation-adjusted energy expenditures declined and then increased modestly until 1998. During this period, energy prices did not keep pace with inflation. As a result, expenditures remained relatively stable despite significant growth in energy consumption

Except for a brief respite in 2001 and 2002, energy expenditures increased significantly from 1999 to 2008, growing at an average annual rate of 8 percent. Expenditures decreased sharply in 2009 due to a combination of less consumption and lower prices. The increase from 1999 through 2008 was primarily due to higher unit energy prices, since energy consumption was relatively flat during this period. Most of the increase was due to growing transportation sector energy expenditures. Expenditures also increased for the commercial and residential sectors, but were more modest for the industrial sector.

The transportation sector accounts for the largest share of state energy expenditures: 58 percent in 2010. This proportion has grown in recent years, reflecting the increase in the real price of petroleum fuels. The industrial share of expenditures has declined significantly in the last seven years, while the residential and commercial shares declined modestly.

While energy expenditure numbers for 2011 from EIA are not yet available for the U.S. or Washington State, they are expected to be higher than 2010.

Sources: EIA State Energy Data System, President's Council of Economic Advisors-2005 Annual Economic Report of the President **(**see data table for **Indicator 4** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 5: Energy Consumption per Dollar of Gross State Product

Washington's economy is becoming less energy intensive – the amount of energy required per dollar of gross state product (GSP) is declining.[149] Key reasons are a shift in the state's economy to high-value businesses that are less energy-intensive and improved energy efficiency.

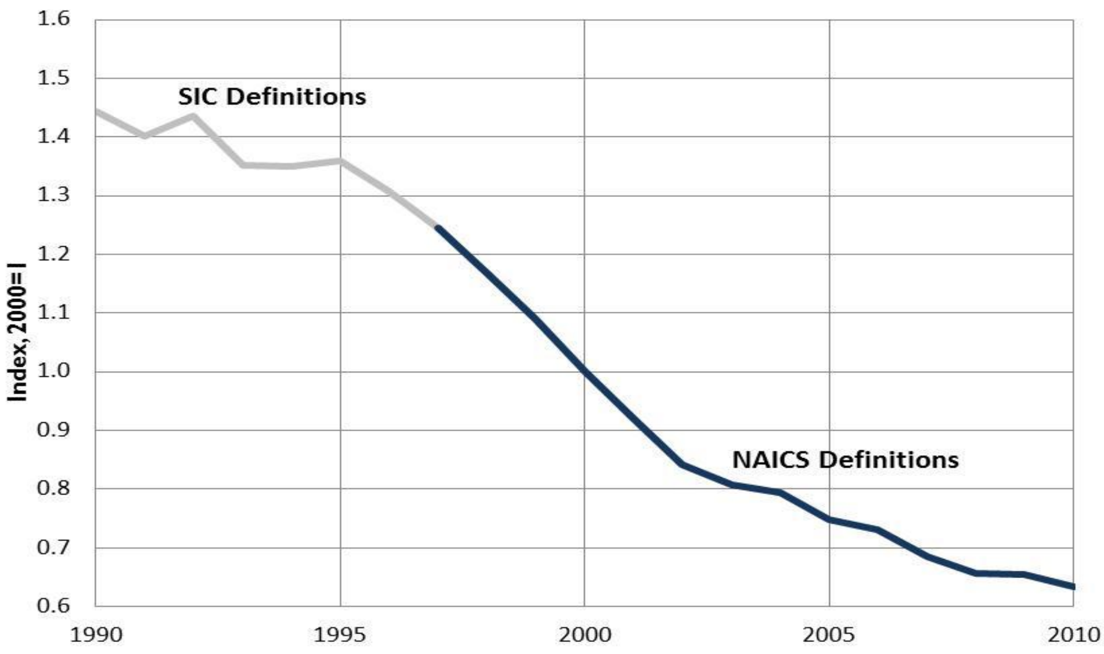

Figure 5-6: Energy consumption per dollar of GSP 1990-2010. (Source: W0026, tab 5ch)

Figure 5-6 depicts this indicator of the overall energy intensity. In the last 20 years, energy consumption per dollar of GSP[150] declined approximately 56 percent.

Washington's economy is growing faster than its energy consumption. This is due to a number of factors, chief among them is growth in the state's economic output and a shift from resource and manufacturing industries to commercial activity based on software, biotech, and other less energy intensive businesses. This trend will likely continue with the decline in production of the energy intensive aluminum industry. Gains in energy efficiency have also contributed to the reduction in Washington's energy intensity. We have not tried to determine the relative contribution of these various factors to the decline in energy use per unit of GSP.

Another way to look at Washington's energy intensity is energy consumption per capita (Figure 5-7). Energy consumption per capita in Washington was relatively constant between 1970 and 1999 with growth in overall energy use matching growth in population. However, since 1999

[149] Economic output (GSP) is in real dollars (millions of chained 2000 dollars). This adjusts for the effects of inflation and allows values for different years to be compared.

[150] Because there was a change in definitions for industry classifications used in the definition of GSP in 1997 (from SIC to NAICS), an exact comparison of energy intensity from 1990 to 2005 is not possible. However, at a state-level the change does not appear to have a significant impact.

energy consumption per capita has declined by 22 percent from historical levels to about 200 million Btu.

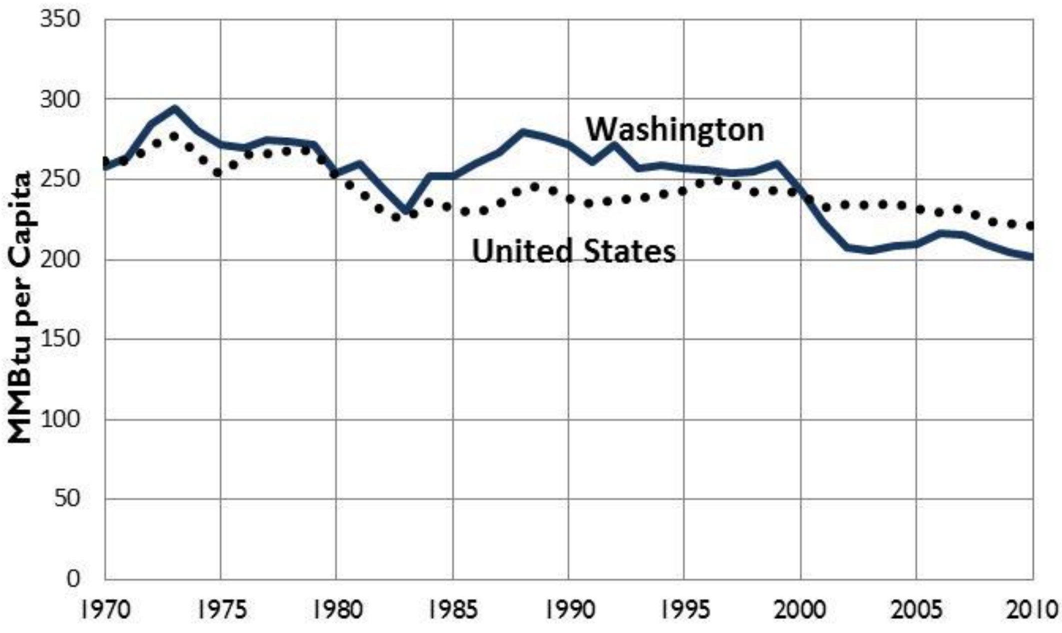

Figure 5-7: Energy consumption per capita 1970-2010. (Source: W0026, tab 5ch)

Washington's annual per capita energy consumption remained fairly close to 250 million Btu from 1970 to 1999: the energy equivalent of about 2,000 gallons of gasoline per person per year. This implies growth in overall energy use mirrors growth in population. Dips in per capita energy consumption during this period were generally the result of high energy prices or periodic economic downturns. Washington's trend was similar to the national average from 1970 through 1999. The growth in per capita energy use during the mid-1980s was largely due to increased transportation fuel use as Washingtonians drove more miles per year.

More recently, Washington's per capita energy consumption appears to have moved to a lower level of about 200 million Btu per capita, more than 20 percent below the historical trend. This was likely due to the decline in industrial energy use that occurred from 1999 to 2002, particularly in the energy-intensive aluminum industry, and because of generally higher energy prices during the last decade. In 2010, Washington's per capita energy consumption was about 10 percent less than the national average.

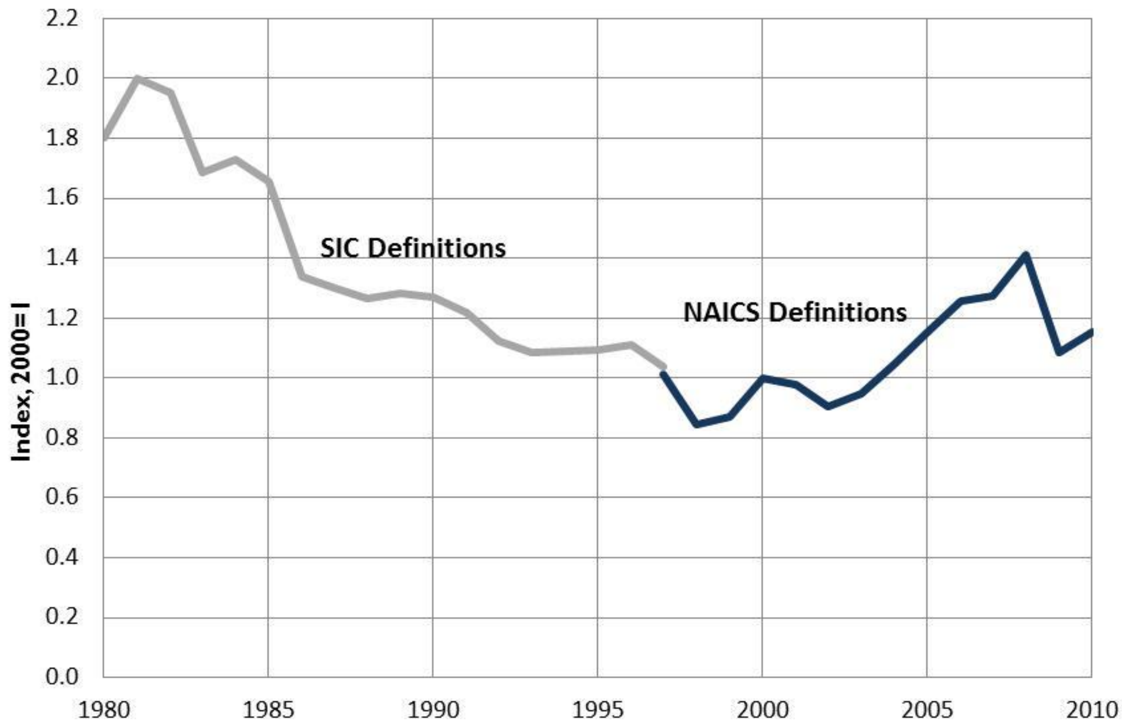

Figure 5-8: Energy expenditures per dollar of GSP 1980-2010. (Source: W0026, tab 5ch)

This indicator divides statewide energy expenditures by economic output, in the form of GSP (Figure 5-8). The result is an estimate of the significance of energy in Washington's economy. After peaking at more than 11 cents per dollar of GSP in 1981,[151] this value declined through the 1980s and 1990s. In 2000, approximately 5.8 cents was spent on energy in Washington for every dollar of GSP. Two trends contributed to this decline: Washington's economy was becoming less energy-intensive and real energy prices were declining. However, energy prices began to rise in 1999, increasing Washington's energy expenditures per dollar of GSP from the low of 4.9 cents in 1998 to 8.1 cents in 2008. The trend sharply reversed itself again in 2009 when energy prices plummeted during the recession, but show signs of a re-establishing an upward trend in 2010.

Sources: EIA State Energy Data System, U.S. Department of Commerce, Bureau of Economic Analysis **(**see data table for **Indicator 5** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the SEDS system will not match the numbers in this report that are adjusted. GSP data at Bureau of Economic Analysis, http://www.bea.gov/regional/gsp/.

[151] Because there was a change in definitions for industry classifications used in the definition of GSP in 1997 (from Standard Industrial Code (SIC) to North American Industrial Classification System (NAICS), an exact comparison of expenditures/GSP from 1980 to 2005 is not possible. However, at a state level the change does not appear to have a significant impact.

Indicator 6: Residential End-Use Energy Consumption by Fuel and Household Energy Intensity – Excluding Transportation

Electricity and natural gas account for the majority of household energy use (Figure 5-9). Growth in household electricity consumption has slowed in the last 25 years, while growth in the use of natural gas for space and water heating accelerated through 2001. Oil consumption has declined significantly since the early 1970s, while wood use increased from 2000 to 2004 to its highest levels, and then declined.

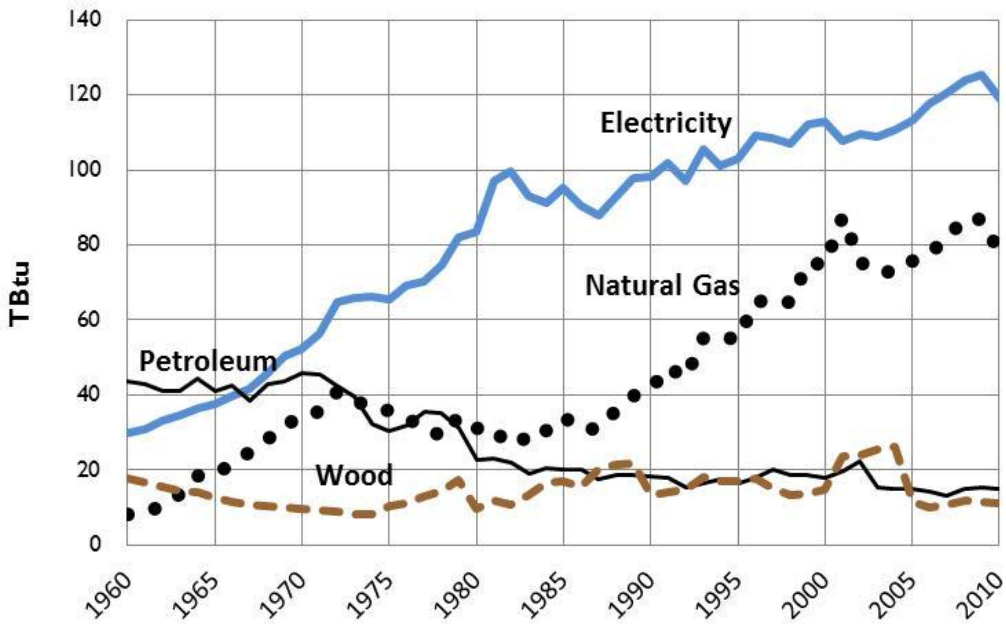

Figure 5-9: Residential end-use energy consumption by fuel 1960-2010. (Source: W0026, tab 6ch)

Electricity accounted for just over half of residential energy consumption in 2010, but average electricity use per household has declined 25 percent since 1982. Petroleum use (mostly heating oil) fell from more than 43 percent of household consumption in 1960 to 6.6 percent in 2010.[152]

Growth in natural gas consumption accelerated through 2001: residential sector gas use grew at 1.9 percent per year between 1980 and 1985, 3.9 percent per year between 1985 and 1990, 5.8 percent per year between 1990 and 1995, and 8.0 percent from 1995 to 2001. From 1980 to 2001, the natural gas share of residential energy consumption rose from 21 percent to 36 percent. This reflects increased use of natural gas for space and water heating as well as increased overall availability of natural gas as a residential fuel source. Natural gas displaced both electricity and petroleum derived fuel, primarily heating oil. However, natural gas use declined in 2002 in part due to high prices and has remained at roughly the same consumption level since then.

[152] The primary petroleum products consumed in households are heating oil (No. 2 distillate oil) and propane. Both are consumed mainly for space heating, although propane can also be used for cooking and water heating. Residential sector energy use does not include energy consumption for personal transportation.

Consumption of firewood has varied in response to higher heating fuel prices. It increased in the late 1970s due to high heating oil prices, while it remained stable and declined during much of the 1990s, when energy prices were relatively low. However, when energy prices jumped in 2001, so did wood use as people cut back on their use of natural gas, electricity, and petroleum for heating. Since 2005, wood use has declined, possibly due to higher prices for this fuel.

Energy intensity[153] in Washington households declined by one-third between 1972 and 1987 (Figure 5-10). From the late 1980s through the early 2000s household energy intensity remained essentially the same. There are signs that over the last six years household energy intensity has begun a gradual decline.

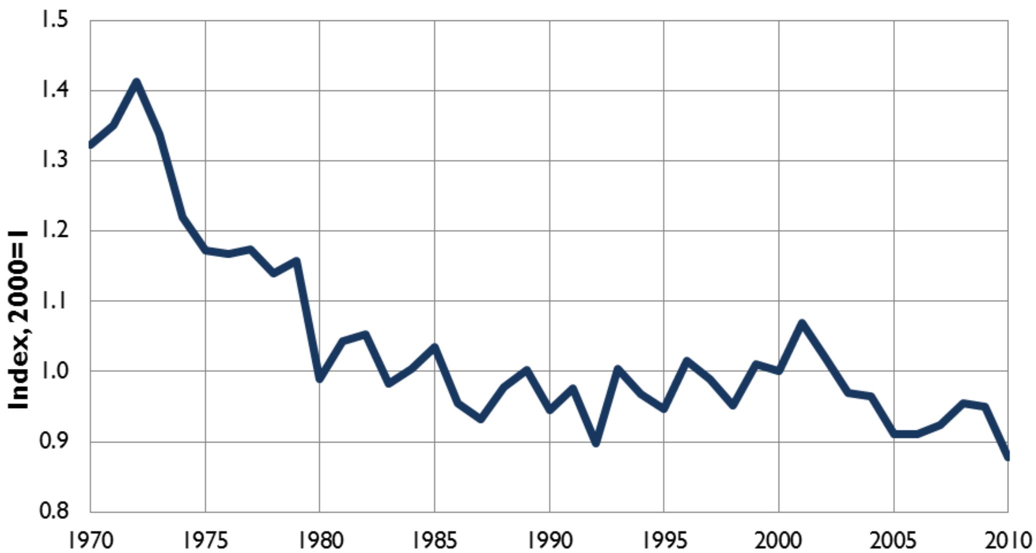

Figure 5-10: Residential energy consumption per household 1970-2010. (Source: W0026, tab 6ch)

The 1970s were characterized by diminished oil and natural gas consumption, with natural gas use per household falling by 33 percent between 1970 and 1980. Oil consumption dropped from 300 gallons per household in 1970 to 85 gallons in 1983, with half the decline occurring after the second oil shock in 1978-79. These declines in natural gas and petroleum use were likely due to improvements in efficiency (e.g., adding insulation) and conservation[154] in response to higher prices, and fuel switching. The data indicate an increased reliance on wood and electricity as space heating fuels during the late 1970s and early 1980s.

Concerted efforts to improve residential efficiency through building standards and codes began in the mid-1980s. However, there is little evidence of further declines in household energy use, until the last six years. Some studies suggest that gains in efficiency due to building standards

[153] Energy intensity is calculated by dividing total residential sector energy consumption by number of households. Excludes transportation fuel unless otherwise noted.

[154] For example turning down thermostats, or turning off lights.

and codes are being offset by construction of larger homes[155], more widespread use of air conditioning, and the proliferation of electricity-using appliances, computers, and entertainment systems. A higher level of household energy may have been reinforced by relatively modest energy prices during this period. Without the building code and standard updates, household energy use would probably be higher. Note that these data do not include energy used for personal transportation, which has increased markedly during the last 25 years.

Sources: EIA State Energy Data System, U.S. Bureau of the Census **(**see data table for **Indicator 6** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 7: Residential Household Energy Bill With and Without Transportation

Adjusted for inflation, the average Washington household spent 26 percent more for home energy in 2010 than in 1998. Household expenditures peaked during 2008-09 and in 2010 were about the same as the previous expenditure peak in 1983 (Figure 5-11).

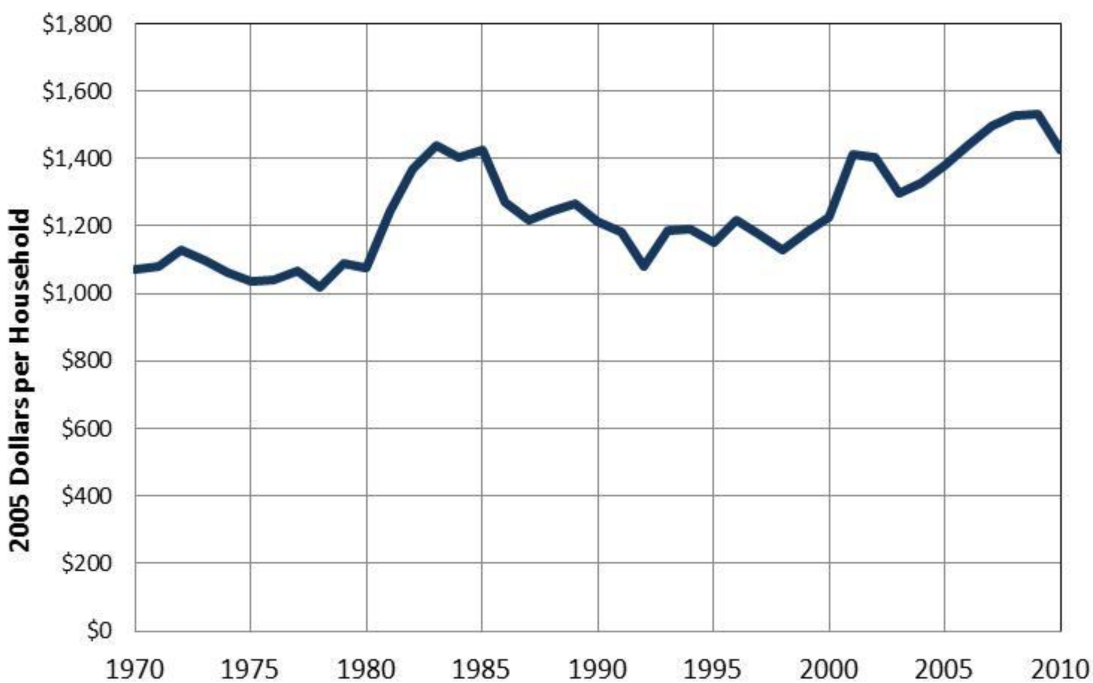

Figure 5-11: Residential energy expenditures without transportation per household 1970-2010. (Source: W0026, tab 7ch)

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155 See tables 43 and 44 of the September 2012 report by the Northwest Energy Efficiency Alliance, which indicates newer homes have half the heat loss of older vintage homes: http://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=8.

In 2010, the average Washington household spent the inflation-adjusted sum of $1,425 (using constant 2005 dollars) for electricity, natural gas, heating oil, and propane delivered to the home. This is $295 more than households spent in 1998, but $103 less than was spent in 2008. When household energy bills spiked in the mid-1980s, increased emphasis on energy conservation and fuel switching from heating oil to natural gas and wood helped mitigate the impact of the oil price shocks. However, there was no immediate substitute for electricity, so when average residential electricity prices increased by 65 percent between 1979 and 1983, due largely to the inclusion in rates of the Washington Public Power Supply System (WPPSS) bond default, the average household electricity bill increased by a similar amount.

During the mid-1980s and most of the 1990s household energy bills declined due to lower energy prices and fuel switching from expensive electricity and oil to natural gas for heating. Most new homes were being built with natural gas space heat and water heating (78 percent in 1998) and numerous existing households switched to natural gas as well. Electricity usage per household fell 18 percent between 1985 and 2001, while natural gas usage increased 83 percent.

The 2000-2001 West Coast electricity crisis led to another increase in residential electricity prices. Independently natural gas and petroleum prices have increased, also contributing to higher overall residential energy expenditures.

Adding energy used for personal transportation more than doubles the annual energy bill for the average Washington household to $4,027 in 2009 (Figure 5-12 and Table 5-2).

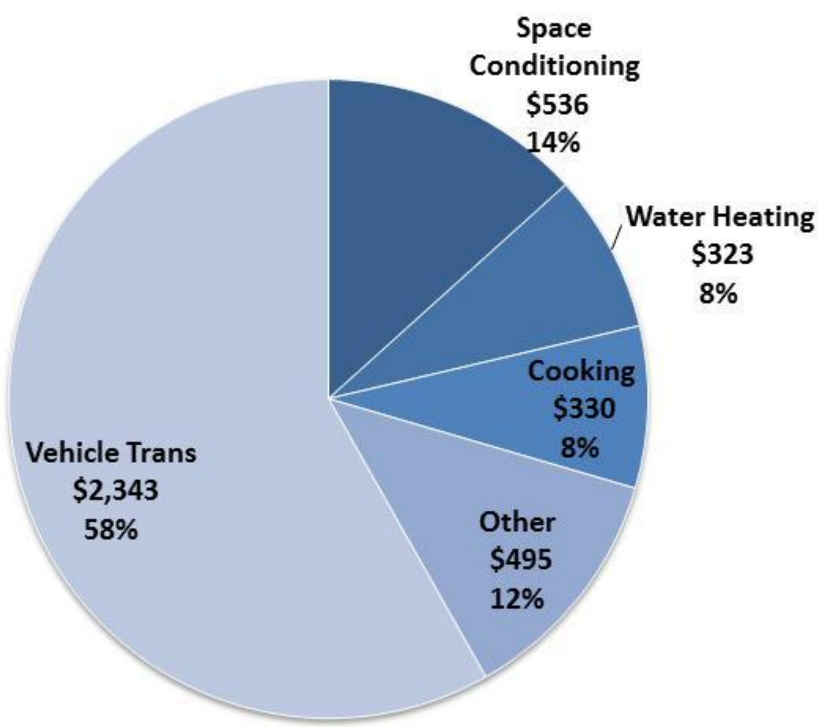

Figure 5-12: Household energy bill by end use 2009. (Source: W0026, tab 7ch)

Table 5-2: Household Energy Bill with Transportation

End Use	Annual Bill $	Share
Space Conditioning	536	14%
Water Heating	323	8%
Cooking	330	8%
Other	495	12%
Vehicle	2,343	58%
Total	4,720	100%

Most views depicting residential energy data do not include the major component of energy consumption and expenditure for most households – vehicles. The average household[156] in Washington spent well over half of its energy budget fueling vehicles for transportation in 2009. This share has grown rapidly over the last several years, but declined in 2009 due the collapse of fuel prices following the 2007-09 recession. Higher gasoline and diesel prices observed during 2011 and 2012 have pushed up transportation expenditures in the near-term, but increasing vehicle efficiency is forecast to slowly drive transportation costs down for consumers.

After personal transportation, major categories of household energy expenditures include other uses (lighting, household appliances, and electronic equipment), space conditioning (heating, cooling, and ventilation), water heating, and refrigeration. The "other" uses category has been growing, largely due to the proliferation of computers and electronic equipment. It is now roughly equivalent to space conditioning expenditures.

Sources: EIA State Energy Data System; Residential Energy Consumption Survey; Residential Transportation Energy Consumption Survey **(**see data table for **Indicator 7** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. In some cases, values downloaded from the SEDS system will not match the numbers in this report that are adjusted.

Indicator 8: Commercial End-Use Energy Consumption by Fuel

Electricity and natural gas are the dominant fuels in Washington's commercial sector (Figure 5-13). Electricity and natural gas use in the commercial sector grew at an average annual rate of more than 5 percent from 1960 to 2000, and at a slower annual rate of about 1 percent since then. Electricity accounted for 58 percent of end-use energy consumption in the commercial sector in 2010 while natural gas made up 31 percent.

[156] Actual household energy costs by end-use can vary significantly depending on the size and efficiency of the home, the efficiency of their vehicles, how much they drive, and their personal habits. A family living in an apartment in the city close to work and schools may have much lower expenditures than a family living in a large home in the suburbs far from work and other destinations.

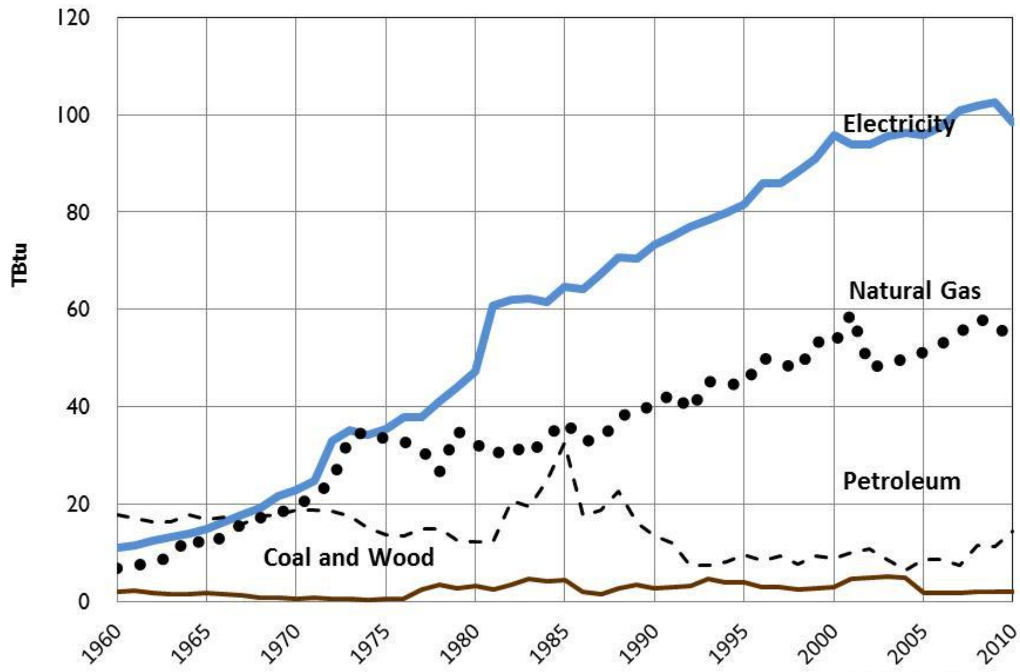

Figure 5-13: Commercial energy consumption by fuel 1960-2010 (Source: W0026, tab 8ch)

With escalating use of electricity-consuming equipment, such as computers, printers, and photocopiers, the commercial sector became increasingly reliant on electricity during the 1970s and 1980s. Sector electricity consumption increased more than fivefold from 1970 to 2008.

Growth in commercial sector natural gas use stagnated in the late 1970s and early 1980s, but has grown since. Natural gas use in 2001 was three times the amount in 1970, but dropped to a 20 percent share of total energy in 2002, and has increased only slowly since. Petroleum consumption in 2010 was just over half of the 1970 level, declining from 30 percent of commercial sector energy consumption in 1970 to 8.6 percent in 2010. Coal and wood accounted for less than 2 percent of commercial sector energy use.

After declining about 30 percent during the 1990s, commercial sector energy consumption relative to economic output increased in 2000 and 2001, before resuming a downward trend.

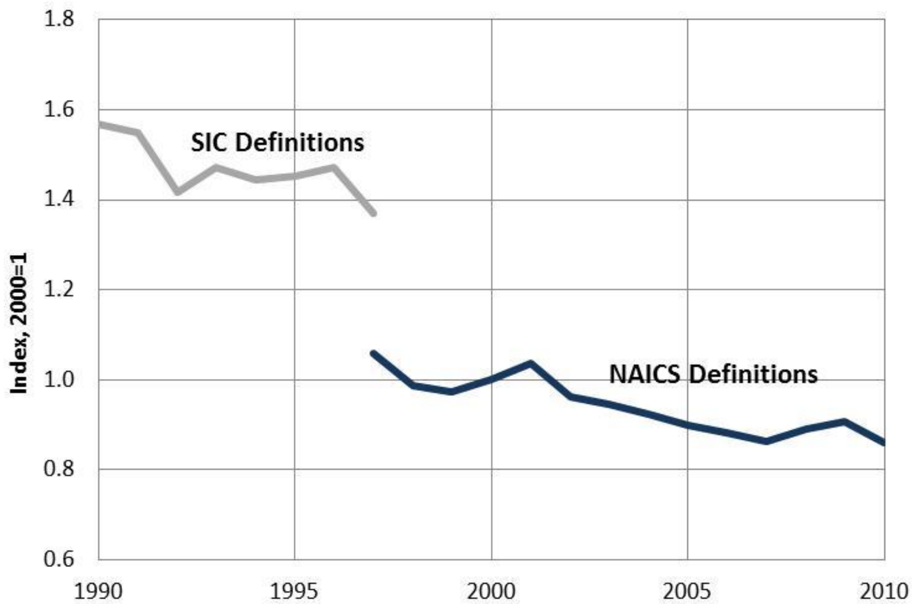

Figure 5-14: Commercial sector energy consumption per real dollar of sector GSP 1990-2010. In 1997, federal economic reporting moved from the Standard Industrial Classification System (SIC) to the North American Industrial Classification System (NAICS), so energy intensities after that year should not be compared to intensities before it, or visa versa. A downward trend can be seen in both data sets. (Source: W0026, tab 8ch)

Washington's commercial sector has become less energy intensive (Figure 5-14) for most of the last 15 years.[157] From 1990 to 1997, commercial sector energy consumption in dollars grew only 13 percent while the value of all goods and services produced by the commercial sector grew 30 percent. This decline in commercial sector energy intensity can be attributed to growth in the economy, shifts to less energy intensive businesses, increased productivity, and improvements in the efficiency of buildings, lighting, and equipment.

This trend appears to have briefly reversed in 1998, with growth in energy use exceeding growth in commercial sector GSP from 1998 to 2001. The change in trend is likely due to an economic downturn during this period. However, the downward trend in energy intensity returned in 2002 as the economy picked up with little or no increase in commercial sector energy use. We do not have sufficient detailed information after 2008 to determine the impacts of most recent recession on commercial energy use and intensity.

Sources: EIA State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis **(**see data table for **Indicator 8** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. In some cases, values downloaded from the SEDS system will not match the numbers in this report that are adjusted.

[157] Because there was a change in definitions for industry classifications used in the definition of GSP in 1997 (from SIC to NAICS), an exact comparison of values before and after 1997 is not possible.

Indicator 9: Industrial End-Use Energy Consumption by Fuel

Industrial energy consumption in Washington is more diversified among the different fuels than the other sectors and has varied more over time. Total industrial consumption declined 38 percent between 1998 and 2002 – natural gas and electricity use declined sharply before stabilizing over the last several years.

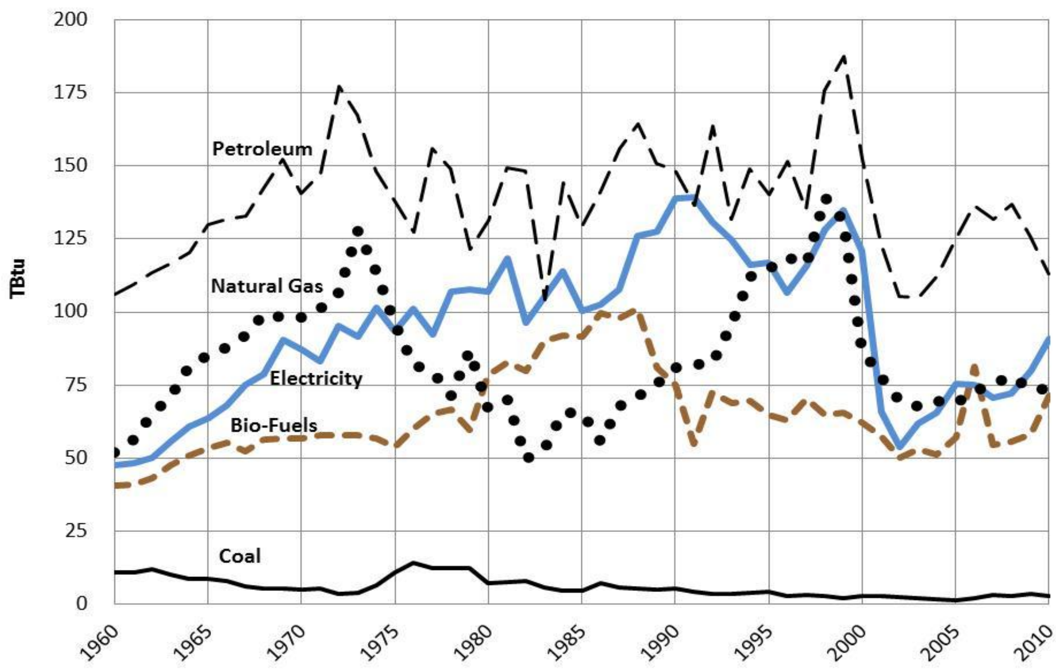

Figure 5-15: Industrial energy consumption by fuel 1960-2010. (Source: W0026, tab 9ch)

Energy consumption in Washington's industrial sector is quite diversified (Figure 5-15), unlike the residential and commercial sectors, which rely primarily on electricity and natural gas, or the transportation sector that consumes almost exclusively petroleum fuels. Petroleum accounted for 32 percent of industrial consumption in 2010, much of which occurs at refineries, while electricity and natural gas accounted for 26 and 21 percent respectively. Biofuels[158] share is sensitive to activity in the timber industry and accounted for 20 percent in 2010; 16 percent during the recession year of 2008. Coal use accounted for less than 1 percent of industrial consumption in 2010, declining from a high of 14 trillion Btu in 1976 to 2.7 trillion Btu in 2010.

Energy consumption in the industrial sector varies more than the other sectors, with peaks and valleys that mirror economic activity. When industrial production declines, energy use declines. High energy prices can also contribute to lower production, particularly in energy intensive industries. Peaks in industrial energy use have occurred in 1973, 1988, and 1999.

[158] Biofuels consumed in the industrial sector comprise mainly wood and wood waste products such as black liquor or hog fuel. These fuels are primarily burned in industrial boilers to make steam, which can be used directly for industrial processes or to generate electricity for on-site use.

Between 1999 and 2002 industrial energy use declined 38 percent. During this period, electricity use declined almost 60 percent and natural gas use declined 50 percent. This reflected the decline in aluminum production due to high electricity prices (and low aluminum prices) during 2000-02 and cuts in production for industries relying on natural gas due to high natural gas prices. Industrial energy use has since rebounded – in 2010 it was 25 percent higher than in 2002.

Energy intensity in Washington's industrial sector was relatively constant during the 1990s, but declined significantly from 1997 to 2002 (Figure 5-16). This reflected a decline in production for energy intensive industries such as aluminum smelting that resulted from high energy prices.

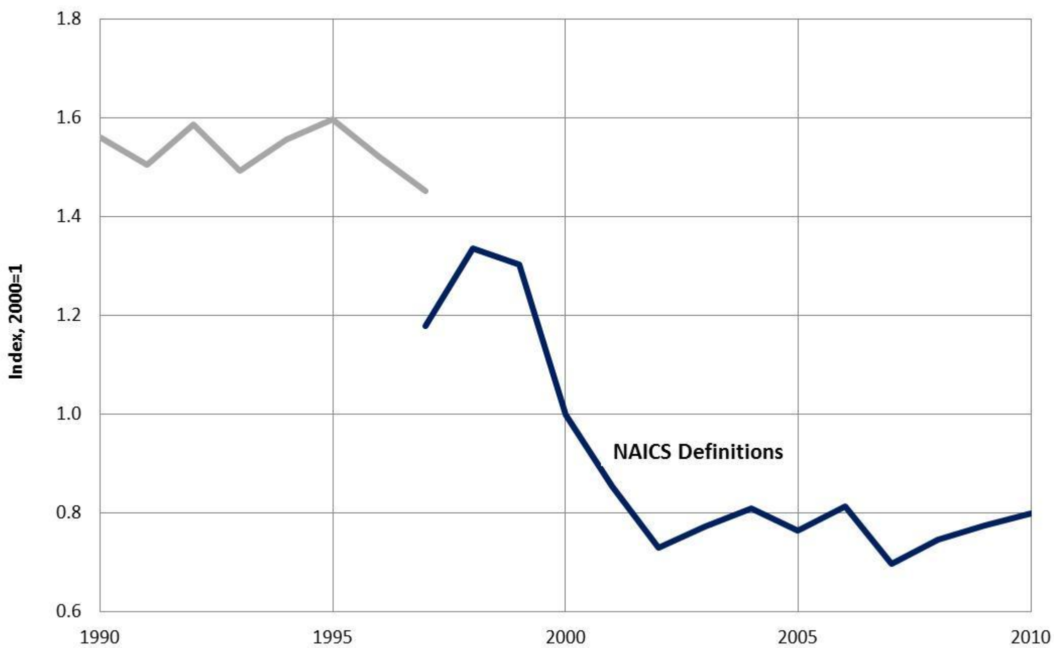

Figure 5-16: Industrial sector energy consumption per real dollar of sector GSP 1990-2010. (Source: W0026, tab 9ch)

Washington's industrial sector is less energy intensive than it was two decades ago when comparing industrial energy use to industrial GSP.[159] Energy intensity did not change much during the 1990s before dropping more than 40 percent from 1997 to 2002. This reflected a decline in energy intensive industries in Washington. This was particularly true from 1998 to 2002 when industrial energy use dropped 38 percent, but industrial GSP increased 3 percent. High electricity prices along with low aluminum prices contributed to a significant decline in Washington's aluminum production. Aluminum production is energy intensive (high energy use relative to product value) and relies on low-cost electricity in the production process. At the same time, natural gas prices rose significantly. High energy prices impact energy intensive industries the most and can contribute to cuts in production, particularly when it is not possible to switch to a less expensive fuel source.

[159] Because there was a change in definitions for industry classifications used in the definition of GSP in 1997 (from SIC to NAICS), an exact comparison of values before and after 1997 is not possible.

Sources: EIA State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis **(**see data table for **Indicator 9** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. In some cases, values downloaded from the SEDS system will not match the numbers in this report that are adjusted.

Indicator 10: Transportation End-Use Energy Consumption by Fuel

Gasoline[160] accounts for just over half of transportation sector energy use in Washington. Petroleum fuels accounted for 98.5 percent of transportation energy use in 2010. Washington's status as a major seaport and aviation hub means significant consumption of aviation and marine fuels as well.

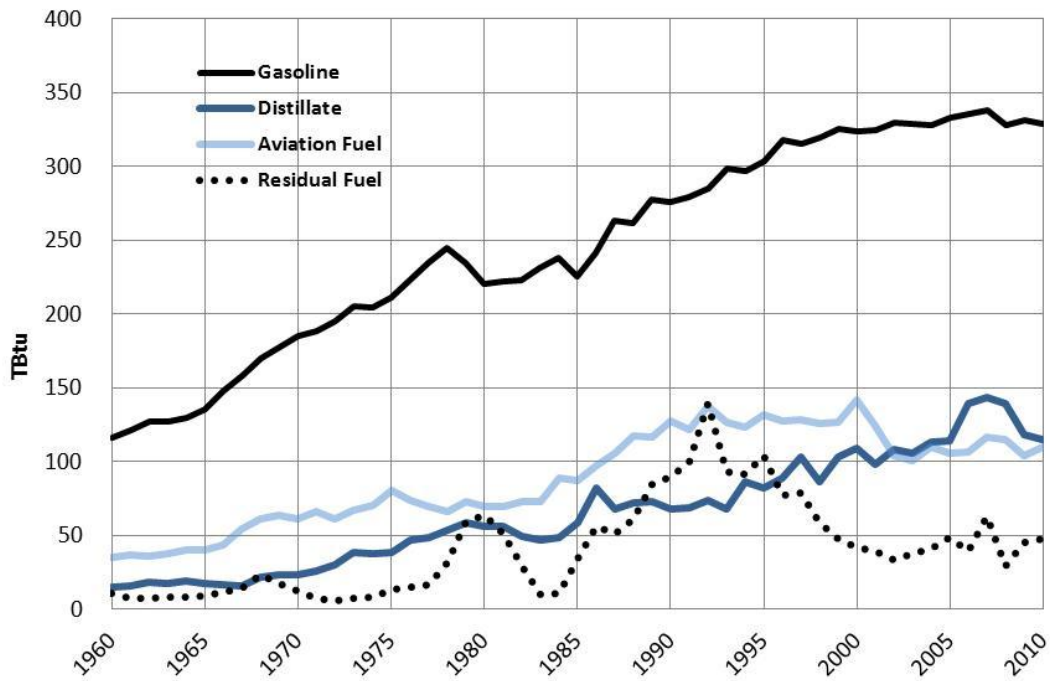

Figure 5-17: Transportation sector consumption by fuel 1960-2010. (Source: W0026, tab 10ch)

Except for the periods between 1978 and 1981 and after 2007-08 (when prices rose significantly), gasoline consumption has generally increased as population growth and demand for travel has largely outstripped gains in vehicle fuel efficiency (Figure 5-17). Overall, gasoline consumption roughly tracked population growth until 2007, and in 2010 was 78 percent greater than in 1970.

[160] Motor gasoline figures include some consumption for off-road uses such as recreational vehicles and agricultural uses. No. 2 distillate, also known as diesel fuel, is used by large trucks, ships, and railroads. The only transportation use for residual fuel is by very large ships. Aviation fuel includes kerosene-based jet fuel used by major airlines, aviation gasoline consumed by smaller airplanes, and military jet fuel.

Consumption of distillate fuels in trucks, ships, and railroads grew at a much faster rate than other transportation fuels, reaching levels in 2010 that were five times greater than 1970. However, due to a low base level of diesel use in 1970, the magnitude of this consumption increase (in Btu) was only half the increase for motor gasoline. Aviation fuel consumption more than doubled between 1970 and 2000, but has dropped 20 percent since then due to fuller flights and more efficient aircraft.

Residual fuel consumption is subject to price-induced volatility because it can be stored for long periods of time without degrading. Thus purchases of this fuel dropped when prices were high, but grew when prices were relatively low. It also varies due to marine traffic at Washington ports and where large ocean going ships choose to purchase their fuel. The volatility of residual fuel use in Washington may indicate tracking and accounting problems with this fuel.

Sources: EIA State Energy Data System **(**see data table for **Indicator 10** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/seds.html. For price trends see the EIA weekly Gasoline and Diesel Fuel price update at http://www.eia.gov/petroleum/gasdiesel/.

Indicator 11: Miles Driven and Transportation Fuel Cost of Driving

Washingtonians drove about 40 percent more miles per capita in 2010 than in 1970 (Figure 5-18). During the same period the fuel cost of driving rose, declined, and then rose again.

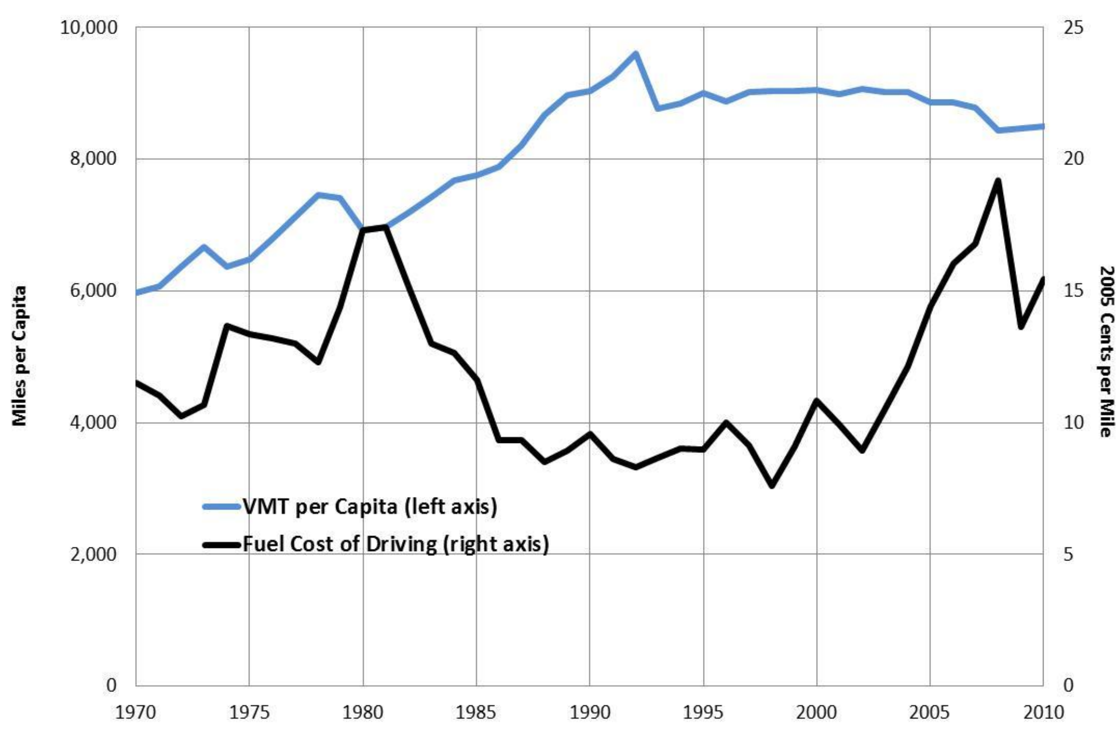

Figure 5-18: Fuel cost of driving and miles driven per capita 1970-2010. (Source: W0026, tab 11ch)

This indicator contrasts the fuel cost of driving with miles driven per capita in Washington. These two series exhibit a weak inverse relationship. The fuel cost of driving, calculated as real dollar highway energy expenditures divided by vehicle-miles traveled, spiked upward in 1974, 1979-1980, and 2007-2008 as a result of oil price shocks. Each time vehicle miles traveled per capita dropped slightly in response to higher prices, discretionary driving was temporarily curtailed. Other factors, such as congestion, the availability of transit options and an ageing population influence per capita VMT as well. The spikes in fuel cost of driving generally coincided with the beginning of economic downturns that could also explain the small declines in per capita VMT. Long-term factors such as land-use patterns, commuting habits, and the long lifetimes of vehicles (limiting the ability to switch to fuel efficient vehicles) mean that large swings in fuel prices lead to only small changes in miles driven and fuel consumed.

Increasing sales of more fuel-efficient vehicles in the early 1980s combined with declines in the price of highway fuels caused a rapid drop in the fuel cost of driving, from a high of 17.6 cents per mile in 1981 to 8.5 cents in 1988 (in 2005 dollars). Real gasoline prices changed little over the next 10 years, and new vehicle fuel efficiency declined slightly, resulting in little change in the fuel cost of driving. Low gasoline prices helped push the fuel cost of driving to an historic low in 1998, but higher fuel prices since then reversed this trend. By 2008, the fuel cost of driving had risen almost 150 percent. Per capita vehicle travel increased steadily during the 1980s, then remained relatively stable from 1993 through 2006, declining noticeably in 2008 with higher fuel prices and the onset of a recession. The fuel cost of driving reached a new peak high of 19.2 cents per mile in 2008, before declining to 15.5 cents per mile in 2010 following the recession of 2007-09.

Sources: EIAState Energy Data System; President's Council of Economic Advisors; Federal Highway Administration, Washington State Department of Transportation, Washington State Office of Financial Management **(**see data table for **Indicators 11** in Appendix B).

Indicator 12: Ground Transportation Sector Fuel Efficiency

Spurred by high gasoline prices and new vehicle efficiency standards, the fuel efficiency of Washington's existing vehicle fleet increased by more than 45 percent between 1975 and 1992. The increasing popularity of less fuel-efficient vehicles in the 1990s, such as vans, trucks, and sport utility vehicles, temporarily put an end to this upward trend.

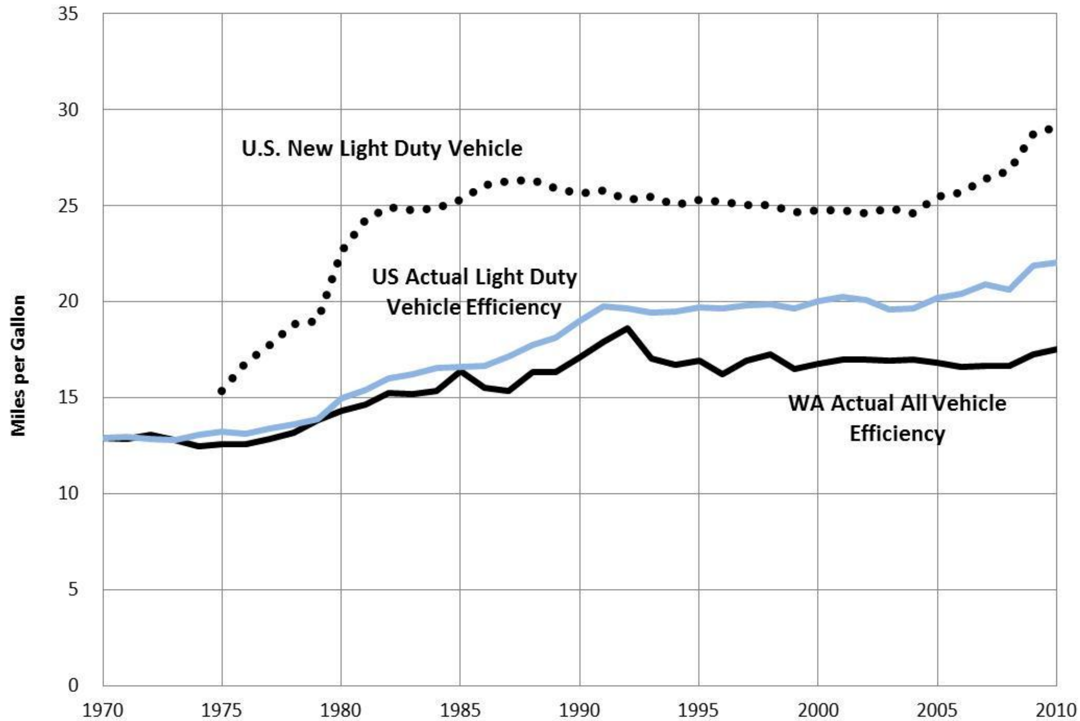

Figure 5-19: New vehicle miles per gallon and Washington State existing vehicle miles per gallon 1970-2010. (Source: W0026, tab 12ch)

Like other sectors, Washington's transportation sector has become more energy efficient over the years. The average efficiency of Washington's total vehicle fleet in Figure 5-19, which includes both light and heavy-duty vehicles (freight), and is based on estimated total miles driven divided by fuel use, increased from 12.6 miles per gallon (mpg) in 1975 to 18.7 mpg in 1992. However, this improvement came to an end in the early 1990s. Since 1992, Washington's vehicle fleet efficiency declined by 2.0 miles per gallon. Several factors have likely contributed to this decline, including a shift to heavier and performance vehicles in the light duty fleet, a rapid increase in freight being moved through the state by heavy-duty trucks, and increasing congestion on our roadways. The last couple of years suggest that the total vehicle fleet fuel efficiency may be improving again.

Gains in the efficiency of Washington's light-duty vehicle fleet through the 1980s were due to the replacement of old vehicles with more efficient models. However, new light-duty vehicle fuel efficiency standards did not change after the mid-1980s. The Corporate Average Fuel Economy (CAFE) standards required automakers to maintain the average fuel efficiency of new vehicles at 27.5 mpg for cars and 20.5 mpg for light trucks (which includes minivans, pickups, and sport-utility vehicles). CAFE had no mandates about how many vehicles could be sold in each category, and did not apply to the largest pickup trucks, and as a result the increasing popularity of trucks and SUVs caused the fuel efficiency of the average new vehicle to drop by almost two mpg between 1988 and 1999. By 2005, the downward trend reversed itself and recent adoption of higher CAFE standards (2007, 2010, and 2012 updates) should lead to higher new vehicle fuel efficiency through the next decade. An executive order directing the Environmental

Protection Agency (EPA) and the National Highway Traffic Safety Administration to improve the fuel economy of medium- and heavy-duty trucks should also contribute to higher vehicle efficiency.

It is important to note that the actual on-road fuel efficiency of existing vehicles is less than the new vehicle EPA-rated fuel efficiency shown by the top line in Figure 5-19.[161] There are two reasons for this difference. First, on-road fuel economy tends to be lower than the EPA composite fuel economy value. Second, vehicles have useful lifespans of 12 to 15 years so the existing light duty vehicle fleet is only slowly replaced by new vehicles with superior (inferior during the 1990's) fuel economy. As a result, the actual on-road efficiency of cars and trucks is lower and trails the new vehicle efficiency trend by a few years. This is reflected in Figure 5-19.

Sources: EIA State Energy Data System; Federal Highway Administration; Washington State Department. of Transportation; Oak Ridge National Laboratories Center for Transportation Analysis **(**see data table for **Indicator 12** in Appendix B).

Indicator 13: Average Energy Prices by Fuel

Even though electricity prices in Washington tend to be lower than in other parts of the country, electricity, until recently, was the most expensive primary energy source in Washington (Btu basis) as shown in Figure 5-20. Real electricity prices rose in 2000 and 2001 after 15 years of relative stability. Real petroleum and natural gas prices declined significantly from highs in the early 1980s, but began rising in the late 1990s and reached record levels by 2007-2008.

While the effect of the first oil shocks of the 1970s and early 1980s on Washington petroleum and natural gas prices was dramatic, it was short-lived. Real petroleum prices more than doubled from 1972 to 1981 and then returned close to pre-1974 levels by 1986, where they remained for almost 15 years. Real natural gas prices followed a similar trend, rising steeply during the 1970s, falling during the 1980s, and staying relatively stable in the 1990s. The average price of electricity, which had been low and stable for years, almost doubled between 1978 and 1984 as the costs of new nuclear power plants in Washington, most of which were never completed, were incorporated into electric utility rates. In contrast to oil and natural gas prices, real electricity prices did not decline from the level they reached during the early 1980s.

[161] The Energy Information Administration estimates actual, on-road performance to be 25.5 percent worse than the EPA rating for cars, and 18.7 percent worse for light trucks for models in 2000. (EIA, *National Energy Modeling System*, Fuel Economy Degradation Factor).

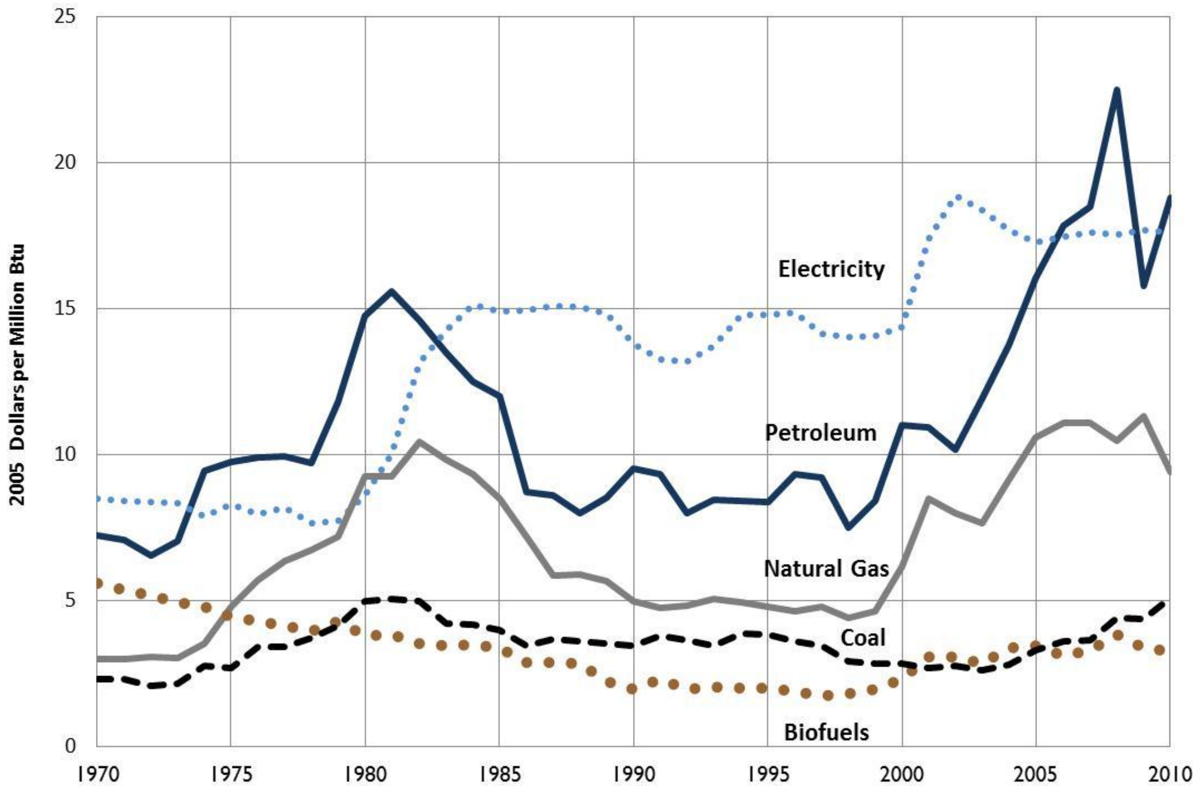

Figure 5-20: Average energy prices by fuel 1970-2010. (Source: W0026, tab 13ch)

Prices for electricity, petroleum, and natural gas began rising in 1999 and 2000. While electricity prices have not continued to rise, natural gas and petroleum prices increased significantly through 2008. The deep recession of 2007-09 caused prices of petroleum products to fall sharply, but they began to increase again in 2010. Natural gas prices fell in-part due to the recession, but have remained low as abundant supply from new shale gas fields has come on line.

Average price trends for coal are similar to the other fossil fuels, but the price swings have been less dramatic and the difference between coal and the more expensive energy sources has grown. Biofuel prices have been slowly rising since 1988, but are still less expensive than the other resources.

Sources: EIA State Energy Data System; President's Council of Economic Advisors **(**see data table for **Indicator 13** in Appendix B).

Links: See the EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 14: Electricity Prices by Sector

Real electricity prices increased dramatically between 1979 and 1984 then stayed relatively constant through 1999 before rising again in 2000 and 2001. While industrial electricity prices are significantly lower than the residential and commercial sectors, the relative price increases around 1979 and 2001 were much higher for the industrial sector (Figure 5-21).

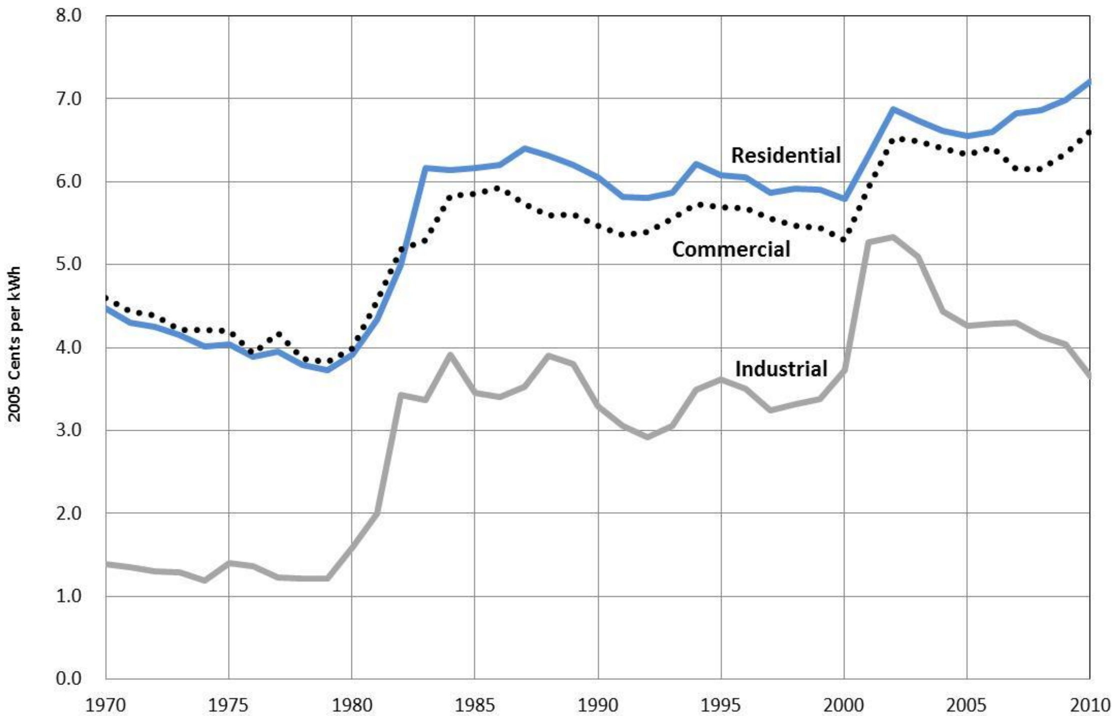

Figure 5-21: Electricity prices by sector 1970-2010. (Source: W0026, tab 14ch)

The most notable phases in real electricity prices were the steady or declining prices in the 1970s, the rapid increase between 1979 and 1984, and the period starting in 1984 when prices stayed relatively constant (with some up and down variation). This period of stable prices ended in 2001 and 2002 when prices trended upward again. However, electricity prices have declined some since 2002, particularly in the industrial sector. Price increases in the early 1980s were due to the costs associated with the default of partially constructed nuclear power plants, while increases in 2001 and 2002 reflect the impacts of the West Coast electricity crisis.

Electricity price trends for the residential and commercial sectors from 1970 to 2008 were nearly identical. Industrial sector prices have been more volatile than residential and commercial prices. Industrial electricity prices in 2010 were more than 250 percent greater than 1970, versus a 61 percent increase for the residential and commercial sectors.[162] On a per unit basis, the average increase also varied: 2.7 cents per kWh for residential, 2.0 cents per kWh for commercial, and 2.3 cents per kWh for industrial. Washington exhibits significant variation in price from utility to utility.

Sources: EIA State Energy Data System; President's Council of Economic Advisors **(**see data table for **Indicator 14** in Appendix B).

Links: EIA Electric Sales, Revenue, and Average Price report (issued annually in September) http://www.eia.gov/electricity/sales_revenue_price/.

EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 15: Natural Gas Prices by Sector

Real natural gas prices have followed a cyclical pattern over the last 35 years. Prices increased rapidly for all sectors between 1974 and 1982, as U.S. supplier struggled to meet demand and declined just as rapidly from 1982 to 1991, as new gas supplies were developed. After remaining relatively stable during the 1990s, natural gas prices began to rise in 2000, again reflecting supply constraints and increasing demand.

By 2006 and 2007, prices had exceeded the historic highs of 1982 for the residential, commercial and industrial sectors. This reflects supply constraints and growing demand, in part due to the increasing use of natural gas by the utility sector for electricity generation. Figure 5-22 also shows a decline for 2008, which not only was a recession year, but reflects the first year that natural gas from shale resources began to enter the market in large quantities. This new natural gas resource is expected to keep natural gas price lower for at least a decade.

[162] Industrial electricity prices include the aluminum industry and other Direct Service Industries (DSI) that have historically had access to relatively low-cost electricity from the Bonneville Power Administration. As production in these electricity price sensitive industries (such as aluminum smelters) varies, it can have an impact on average industrial electricity prices. For example, in 2001 when aluminum smelters curtailed production, non-DSI industries paying higher electricity prices made up a larger share of industrial electricity consumption, contributing to the increase in average industrial electricity prices.

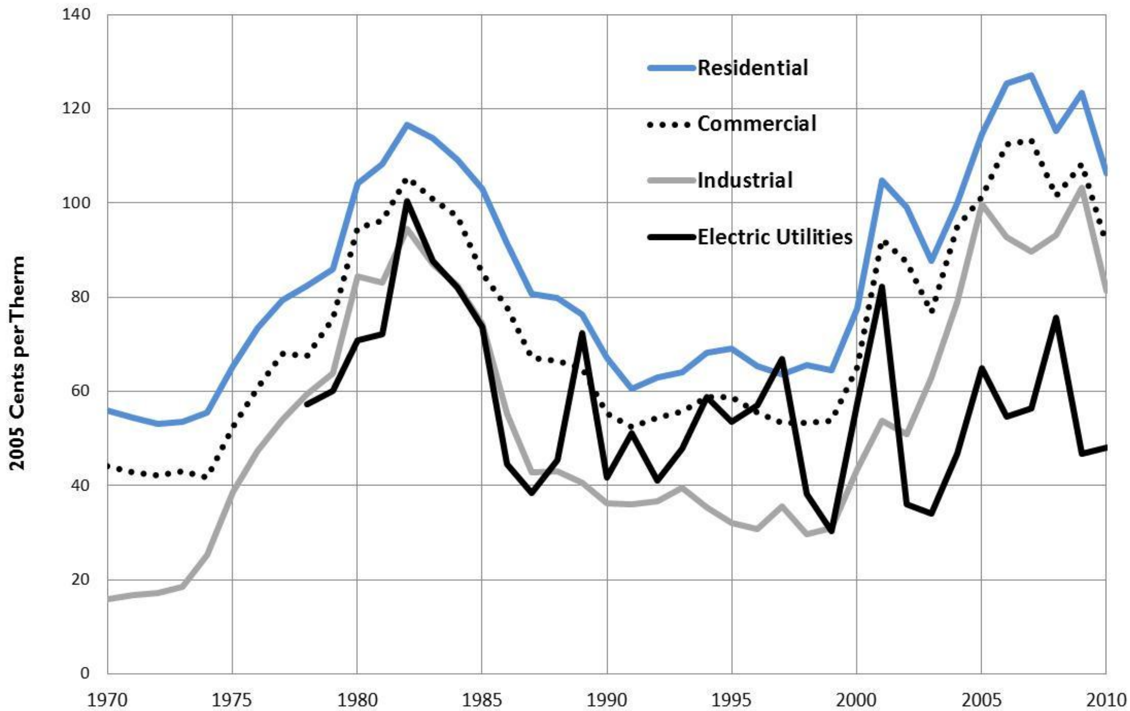

Figure 5-22: Natural gas prices by sector 1970-2010. (Source: W0026, tab 15ch)

On a percentage basis, average industrial natural gas prices have been significantly lower than the other sectors, but by 2010 that relative difference had declined. Many large industrial customers began to make bulk purchases of commodity gas from suppliers other than their local utilities during the 1990s, helping to keep industrial prices down. However, when prices began to climb in late 1999, the increase was more dramatic for the industrial sector than the other sectors.

The utility sector has historically used natural gas to fire relatively small power plants used for "peaking," which at least partially explains the price volatility experienced in that sector. Consumption was historically low and seasonal, with gas often being purchased on the spot market when needed. But the use of natural gas for electricity generation has been growing over the past decade. Regional utility natural gas prices spiked during 2001 due to shortages in hydroelectricity, which created a need to operate natural gas power plants, and resulted in high demand for natural gas.

Sources: EIA State Energy Data System; President's Council of Economic Advisors **(**see data table for **Indicator 15** in Appendix B).

Links: EIA State Energy Data System, http://www.eia.doe.gov/emeu/states/_seds.html. In some cases, values downloaded from the system will not match the numbers in this report that are adjusted.

Indicator 16: Gasoline Prices

Adjusted for inflation, gasoline prices[163] in Washington first peaked in 1981, and then declined to an historic low in 1998, before exceeding the 1981 peak in 2006 and reaching an all-time high in 2008.

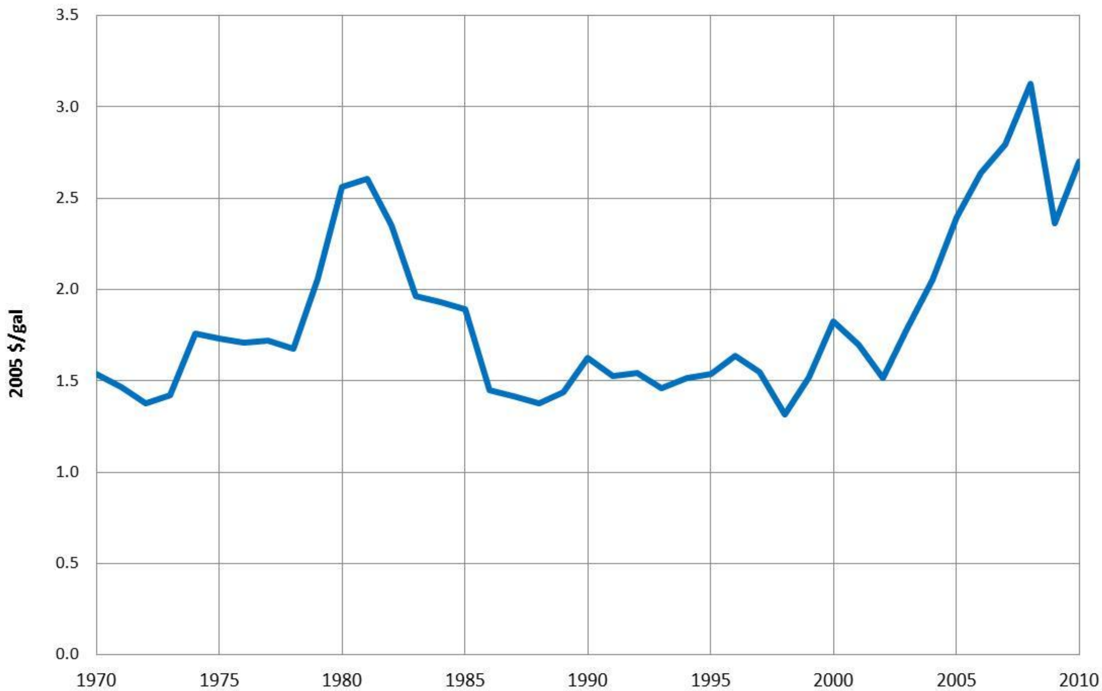

Figure 5-23: Washington State gasoline prices 1970-2010. (Source: W0026, tab 16ch)

For nearly 40 years, inflation-adjusted gasoline prices in Washington have been relatively stable except for two periods: from 1979 to 1982 when prices spiked due to the Middle East conflict, and since 2004 when growing world petroleum demand approached supply constraints. After peaking in 1981 at $2.61 per gallon (2005 dollars), prices dropped to pre-oil crisis levels by 1986. In 1998, following the Asian financial crisis, gasoline prices fell to their lowest level in nearly 30 years, but rose again beginning in 1999, reflecting increasing world oil prices. A downturn in the world economy briefly interrupted this climb in prices, but by 2006 the price of a gallon of gasoline in Washington exceeded the peak price in 1981. Gasoline peaked at $3.12 per gallon in but fell dramatically during the recent recession of 2008-09. With economic recovery in the U.S. and the world, gasoline prices increased in 2010.

The majority of petroleum for Washington comes from Alaska and most of this is refined into gasoline in Washington, but the price we pay for gasoline is influenced by world oil prices. Gasoline prices in Washington, even excluding taxes, tend to be a little bit higher than the national average (see Chapter 1 for discussion of prices).

[163] Gasoline prices from EIA include state and federal gasoline taxes but they do not include local sales tax.

Sources: EIA State Energy Data System; President's Council of Economic Advisors **(**see data table for **Indicator 16** in Appendix B).

Links: For fuel-price trends see the EIA's weekly Gasoline and Diesel Fuel price update, http://www.eia.gov/petroleum/gasdiesel/.

Indicator 17: Energy-Related Carbon Dioxide Emissions

Statewide energy-related carbon dioxide emissions from 1980 through 2010 are determined and posted by the EIA, and are shown below for Washington State.[164] Washington's reliance on fossil fuels has led to steady growth in emissions of carbon dioxide, the principal human-caused greenhouse gas. Petroleum use, primarily for transportation, accounted for 66 percent of CO_2 emissions from energy use in Washington in 2010. In 1960, the share for petroleum related CO_2 emissions was 83 percent.

To address climate change, Washington State has set several greenhouse gas (GHG) targets for the next several decades. The 2020 target is to return to the 1990 GHG emission level. Figure 5-24 presents the trend in state energy-related CO_2 emissions. The orange line illustrates the 1990 level of energy-related CO_2 emissions, which is not the same as the 1990 state level of GHG emissions. Nonetheless, it is indicative of the size of reduction that must be realized for the state to meet the 2020 GHG emission target.

[164] Independently the state also produces a GHG emission inventory that differs from the EIA estimates shown below in the following ways: the state inventory includes gases other than carbon dioxide, the state inventory goes beyond energy related carbon dioxide emissions and includes process emissions, and the state inventory includes other sectors of the economy such as agriculture and forestry.

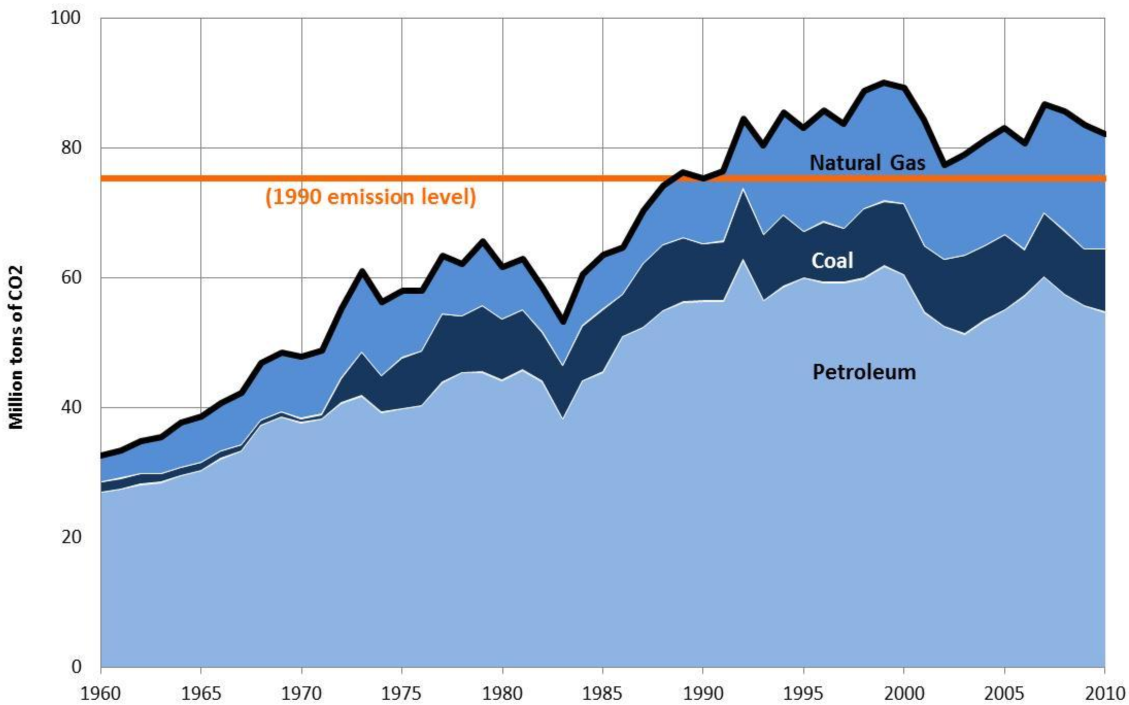

Figure 5-24: Carbon dioxide emissions from energy use by fuel source 1960-2010. (Source: W0026, tab 17ch)

Washington's continued dependence on fossil fuels, particularly petroleum, for energy has led to growth in emissions of CO_2, for much of the last 25 years. After dipping in the early 1980s, growth in CO_2 emissions accelerated after 1983 as the economy recovered from a protracted recession and oil prices plummeted. Washington's CO_2 emissions from energy use grew more than 70 percent between 1983 and 2001. Emissions dropped in 2002 as a result of lower energy use due to a recession, the partial shutdown of the Northwest aluminum industry, and higher energy prices. In addition, the 911 terrorist attacks sharply curtailed emissions from airlines. Emissions returned to a slow growth pattern from 2002 through 2007, but have declined over the past several years due to the recession.

Consumption of petroleum products, the vast majority for transportation, accounted for most of the growth in Washington's energy-related CO_2 emissions since 1960. Emissions from coal exhibit the largest relative increase since 1960 and are almost entirely from one source, the Centralia steam plant, which burns coal to produce electricity. Natural gas contains less carbon per unit of energy than other fossil fuels, but because of higher levels of consumption accounts for a larger share of Washington's CO_2 emissions than coal.

Sources: EIA, CO_2 Energy Emissions by State **(**see data table for **Indicator 17** in Appendix B).

Links: For more information on CO_2 emissions see EIA State Level Energy Related Carbon Dioxide Emissions, http://www.eia.gov/environment/emissions/state/analysis/.

Appendix A: Methodology

Introduction

Most publicly available comprehensive energy data at the state level originate with surveys and estimates developed by the Energy Information Administration (EIA), an independent branch of the federal Department of Energy. We rely heavily on the EIA's State Energy Data System (SEDS) to produce Energy Indicators and other products. However we modify data from the EIA, based on years of experience with their components, to more accurately portray energy use in Washington. This includes the exclusion of non-energy uses of petroleum and the calculation of primary energy use for hydroelectricity generation.

Excluded Petroleum Products

We exclude the consumption of petroleum products for non-energy purposes. This includes asphalt, road oil, waxes, and lubricants from the transportation and industrial sectors. These are easily removed series that are clearly not used as energy sources.

For this biennial report, we have included petroleum coke reported in the industrial sector energy consumption by SEDS, while in previous reports it has been excluded. There is some uncertainty as to whether this fuel should be totally included or excluded from industrial energy consumption. In the near future, the Energy Office will evaluate whether all or some of the industrial petroleum coke consumption should remain in the reported industrial sector energy consumption.

We have also excluded other non-energy consumption, such as petroleum used as feedstock for paints and solvents, or to make waxes to coat packaging. The focus of this analysis is energy consumption in Washington, rather than the supply of, and demand for, petroleum products or other fossil fuels. Excluding these non-energy uses provides the most accurate picture of the consumption of energy in the state.

Hydroelectric Conversion

One last methodological note regarding the differences readers may notice here compared to other tallies of state primary energy use. In a steam-powered generator, as much as two-thirds of the energy in the fuel that is consumed is not converted to electricity, but is lost as waste heat due to thermal inefficiencies. Hydroelectric power generation does not experience thermal losses, but the EIA assigns losses to it equivalent to an average loss rate for fossil fuel powered generation, in an effort to enable comparison of primary energy consumption between individual states. We remove those imputed losses from our primary energy totals. This difference does not affect depictions of sector end-use consumption of energy, as these do not show primary consumption.

Methodology Summary

In summary, non-energy petroleum products used in the industrial sector and the calculation of primary energy use for hydroelectricity generation require modifications to standard views of energy consumption to accurately portray the trends depicted in these Indicators.

Fuel Prices

Fuel prices are shown in real dollars and are also referred to as inflation-adjusted dollars. The actual (or nominal) prices in each year have been adjusted to real or constant dollars reflecting the value of a dollar in the year 2005 (the constant year). This is done by multiplying the nominal prices by a gross domestic purchases index for the U.S. for each year (where the value in 2005 equals 1). This adjusts for the effects of inflation and allows prices for different years to be compared.

Sector Definitions

Residential sector: An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters. Note: Various EIA programs differ in sectoral coverage.

Commercial sector: An energy-consuming sector that consists of service-providing facilities and equipment of businesses; federal, state, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters and sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments.

Industrial sector: An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity manufacturing (NAICS codes 31-33); agriculture, forestry, fishing and hunting (NAICS code 11); mining, including oil and gas extraction (NAICS code 21); and construction (NAICS code 23). Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products. Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the above-mentioned industrial activities.

Transportation sector: An energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles; trucks; buses; motorcycles; trains, subways, and other rail vehicles; aircraft; and ships, barges, and other waterborne vehicles. Vehicles whose primary purpose is not transportation (e.g., construction cranes and bulldozers, farming vehicles, and warehouse tractors and forklifts) are classified in the sector of their primary use.

Electric power sector: An energy-consuming sector that consists of electricity generators and combined heat and power plants whose primary business is to sell electricity, or electricity and heat, to the public, i.e., NAICS code 22 plants.

Appendix B: Data Tables

- Data tables for indicators 3 and 7 appear in the body of the document, not in this Appendix.
- Indicators have been re-numbered for this *2013 Biennial Energy Report*.
- See discussion in body of document for explanations of indicators.
- Data prior to 1970 is available by request; contact the Energy Office.
- Data displayed to approximately three significant digits.
- Abbreviations used in table headings:

av. fuel	aviation fuel	NAICS	North American Industry Classification System
Btu	British thermal unit	NG	natural gas
comm.	commercial	pers	person
elec.	electricity	petrol.	petroleum products
gal	gallon	res.	residential
GSP	gross state product	resid.	residual fuel
ind.	indicator	SIC	Standard Industrial Classifications
ind'l	industrial	trans.	transportation
mi	mile	wd	wood
mmBtu	million Btu		

Indicators **1** end use energy consumption by sector, **2** primary energy consumption by source.

	indicator 1, trillion Btu					indicator 2, trillion Btu						
year	**res.**	**comm.**	**ind.**	**trans.**	**total**	**biomass**	**coal**	**hydro**	**nuclear**	**NG**	**petrol.**	**year**
1970	142	61.7	389	289	881	66.5	5.9	243	28.7	158	487	**1970**
1971	147	65.9	397	296	906	67.2	6.4	250	27.7	165	501	**1971**
1972	157	76.7	442	300	977	67.0	36.6	262	31.5	180	532	**1972**
1973	152	87.2	450	327	1,016	66.2	65.0	239	48.3	208	546	**1973**
1974	144	84.6	428	327	983	65.2	54.2	287	43.4	191	517	**1974**
1975	142	82.8	394	349	968	64.3	76.2	290	36.4	171	525	**1975**
1976	146	84.6	386	365	982	71.4	81.2	326	26.6	155	532	**1976**
1977	151	86.3	407	375	1,020	78.3	102.4	231	46.5	149	576	**1977**
1978	154	85.9	408	403	1,051	81.0	84.7	307	45.3	133	596	**1978**
1979	165	94.1	390	434	1,083	77.5	99.0	274	39.3	166	595	**1979**
1980	148	94.9	392	413	1,048	88.3	91.0	287	22.3	135	577	**1980**
1981	161	105.6	429	403	1,099	95.1	90.9	326	22.5	131	585	**1981**
1982	164	118.2	384	377	1,043	91.3	74.1	305	40.2	114	566	**1982**
1983	153	116.2	360	363	993	104.8	80.2	300	38.1	112	505	**1983**
1984	160	124.3	422	390	1,096	110.7	82.3	290	57.6	132	577	**1984**
1985	168	138.4	393	411	1,111	112.4	93.7	268	85.4	140	590	**1985**
1986	157	116.6	408	480	1,162	118.3	63.3	275	89.3	122	656	**1986**
1987	157	120.9	437	494	1,209	123.3	95.7	242	57.7	136	682	**1987**
1988	169	133.6	470	517	1,290	128.2	99.1	236	63.6	151	718	**1988**
1989	179	130.3	442	558	1,309	109.2	96.7	248	64.7	168	740	**1989**
1990	172	130.1	451	568	1,321	94.4	85.6	303	60.8	168	742	**1990**
1991	182	133.7	419	577	1,312	75.1	89.1	310	44.3	179	737	**1991**
1992	172	127.3	455	643	1,397	99.6	106.1	235	59.6	181	823	**1992**
1993	196	136.3	426	592	1,351	103.5	97.8	231	74.9	230	743	**1993**
1994	192	137.3	453	607	1,389	104.4	106.9	225	70.4	263	775	**1994**
1995	192	140.5	443	631	1,407	93.0	69.8	283	72.9	264	790	**1995**
1996	210	148.1	445	620	1,423	90.9	90.9	339	58.7	284	793	**1996**
1997	209	148.2	443	636	1,436	96.5	80.5	354	65.5	268	794	**1997**
1998	204	147.3	513	601	1,465	90.2	103.5	271	72.6	303	794	**1998**
1999	220	157.7	523	612	1,513	91.6	96.9	330	63.6	302	819	**1999**
2000	221	161.2	426	624	1,431	92.1	106.2	273	89.7	298	801	**2000**
2001	239	168.7	328	597	1,332	94.8	99.4	188	86.2	322	744	**2001**
2002	232	157.6	283	581	1,254	93.6	100.8	265	94.5	240	713	**2002**
2003	223	159.4	290	580	1,252	101.4	118.2	245	79.4	256	702	**2003**
2004	225	158.6	301	602	1,286	94.5	112.5	239	93.7	270	727	**2004**
2005	216	158.6	328	612	1,313	88.6	112.3	240	86.0	272	751	**2005**
2006	220	161.9	368	628	1,377	111.8	69.2	271	97.4	271	780	**2006**
2007	227	166.3	336	670	1,399	88.5	95.7	259	85.0	279	814	**2007**
2008	238	174.4	345	621	1,378	94.5	94.6	255	96.9	307	777	**2008**
2009	239	174.2	341	609	1,363	99.5	84.0	237	69.4	320	753	**2009**
2010	223	169.1	351	610	1,354	121.2	94.9	222	96.6	295	744	**2010**

Indicators **4** end use energy expenditures by sector, **5a** energy consumption per GSP (index) **5b** energy consumption per capita, **5c** energy expenditures per GSP (index)

	indicator 4, billion 2005$				**ind. 5a** 2000=1	**indicator 5b** mmBtu/person		**ind. 5c** 2000=1	
year	**res.**	**comm.**	**ind.**	**trans.**		**WA**	**US**		**year**
1970	1,187	492	908	2,664		258	262		**1970**
1971	1,215	512	928	2,633		264	262		**1971**
1972	1,293	617	1,007	2,564		285	271		**1972**
1973	1,287	677	1,032	2,853		295	277		**1973**
1974	1,291	683	1,231	3,639		280	266		**1974**
1975	1,297	728	1,386	3,872		271	254		**1975**
1976	1,343	755	1,384	4,077		270	265		**1976**
1977	1,422	812	1,490	4,268		275	266		**1977**
1978	1,418	784	1,485	4,415		274	268		**1978**
1979	1,602	908	1,589	5,541		272	267		**1979**
1980	1,660	1,042	1,907	6,688		254	252	1.80	**1980**
1981	1,974	1,296	2,321	7,173		260	243	2.00	**1981**
1982	2,189	1,588	2,477	6,284		244	230	1.95	**1982**
1983	2,313	1,523	2,147	5,356		231	226	1.69	**1983**
1984	2,301	1,637	2,743	5,529		252	236	1.73	**1984**
1985	2,381	1,760	2,264	5,495		252	232	1.66	**1985**
1986	2,157	1,486	1,870	4,630		260	230	1.34	**1986**
1987	2,115	1,495	1,913	4,694		267	235	1.30	**1987**
1988	2,224	1,563	2,168	4,608		279	244	1.27	**1988**
1989	2,323	1,545	2,276	5,128		277	245	1.28	**1989**
1990	2,273	1,515	2,159	5,858	1.44	271	238	1.27	**1990**
1991	2,271	1,502	2,030	5,807	1.40	261	235	1.22	**1991**
1992	2,132	1,494	1,917	5,631	1.44	272	237	1.12	**1992**
1993	2,388	1,593	1,902	5,330	1.35	256	238	1.09	**1993**
1994	2,430	1,665	2,033	5,517	1.35	259	241	1.09	**1994**
1995	2,410	1,699	2,055	5,645	1.36	257	243	1.09	**1995**
1996	2,594	1,780	1,968	6,237	1.31	256	250	1.11	**1996**
1997	2,550	1,746	2,004	6,165	1.24 [a]	254	248	1.01 [b]	**1997**
1998	2,498	1,727	2,163	4,948	1.17	255	242	0.84	**1998**
1999	2,650	1,822	2,286	5,858	1.09	260	243	0.87	**1999**
2000	2,786	1,932	2,341	7,551	1.00	243	241	1.00	**2000**
2001	3,246	2,286	2,022	6,685	0.92	223	233	0.98	**2001**
2002	3,277	2,324	1,626	6,110	0.84	208	235	0.90	**2002**
2003	3,068	2,293	1,736	7,122	0.81	205	234	0.95	**2003**
2004	3,189	2,372	1,866	8,606	0.79	209	235	1.05	**2004**
2005	3,370	2,434	2,247	10,305	0.75	210	232	1.15	**2005**
2006	3,581	2,585	2,469	11,873	0.73	216	230	1.26	**2006**
2007	3,791	2,591	2,331	12,933	0.68	216	231	1.27	**2007**
2008	3,922	2,696	2,723	14,805	0.66	209	225	1.41	**2008**
2009	3,979	2,686	2,284	10,143	0.65	204	222	1.08	**2009**
2010	3,734	2,638	2,329	11,841	0.63	201	221	1.15	**2010**

a Based on NAICS 1997 & after, SIC 1996 & before; SIC-based index in 1997 (the transition year) is 1.23

b Based on NAICS 1997 & after, SIC 1996 & before; SIC-based index in 1997 (the transition year) is 1.04

Indicator 6: **6a** residential end use by fuel, **6b** residential energy intensity (index), **6c** residential energy bill excl. transportation

	indicator 6c, trillion Btu				**ind. 6b** 2000=1	**ind. 6c** $/hhld	
year	**elec.**	**NG**	**petrol.**	**wood**		(2005 $)	**year**
1970	52.4	33.7	45.7	9.58	1.32	1,073	**1970**
1971	56.4	35.8	45.5	9.22	1.35	1,079	**1971**
1972	64.6	40.8	42.5	8.94	1.41	1,127	**1972**
1973	65.7	38.3	39.6	8.20	1.34	1,097	**1973**
1974	66.2	37.2	32.2	8.27	1.22	1,061	**1974**
1975	65.5	35.8	30.6	10.25	1.17	1,036	**1975**
1976	69.3	33.7	31.9	11.23	1.17	1,039	**1976**
1977	70.4	31.9	35.5	12.85	1.17	1,068	**1977**
1978	74.8	28.7	35.1	14.28	1.14	1,019	**1978**
1979	81.9	34.4	31.0	17.37	1.16	1,088	**1979**
1980	83.4	31.3	22.5	9.74	0.99	1,078	**1980**
1981	97.2	28.2	22.9	12.02	1.04	1,242	**1981**
1982	99.5	30.7	21.8	10.93	1.05	1,366	**1982**
1983	93.0	27.1	18.9	13.35	0.98	1,439	**1983**
1984	91.2	30.6	20.5	16.48	1.00	1,404	**1984**
1985	95.3	34.3	20.0	16.98	1.04	1,425	**1985**
1986	90.4	31.1	20.0	15.46	0.96	1,269	**1986**
1987	87.9	30.8	17.6	20.19	0.93	1,219	**1987**
1988	92.8	35.9	18.6	21.54	0.98	1,244	**1988**
1989	97.8	39.6	18.6	21.78	1.00	1,267	**1989**
1990	98.3	41.6	18.2	13.30	0.95	1,214	**1990**
1991	102.0	47.7	17.8	13.94	0.98	1,183	**1991**
1992	97.0	44.5	15.4	14.63	0.90	1,079	**1992**
1993	105.5	55.3	16.6	17.99	1.00	1,186	**1993**
1994	101.2	55.4	17.5	17.07	0.97	1,190	**1994**
1995	102.9	55.0	16.6	17.07	0.95	1,153	**1995**
1996	109.2	65.1	17.9	17.73	1.02	1,216	**1996**
1997	108.3	64.8	20.1	14.99	0.99	1,174	**1997**
1998	107.0	64.8	18.7	13.32	0.95	1,130	**1998**
1999	112.0	75.6	18.6	13.67	1.01	1,181	**1999**
2000	112.7	74.8	17.9	14.72	1.00	1,227	**2000**
2001	107.8	87.4	19.6	23.79	1.07	1,410	**2001**
2002	109.4	75.5	22.2	24.15	1.02	1,401	**2002**
2003	108.7	73.0	15.2	25.42	0.97	1,296	**2003**
2004	110.7	72.9	14.8	26.05	0.96	1,328	**2004**
2005	113.3	75.8	14.9	11.34	0.91	1,382	**2005**
2006	117.5	77.8	14.1	10.06	0.91	1,440	**2006**
2007	120.7	82.2	13.0	10.86	0.92	1,498	**2007**
2008	124.0	87.1	14.8	11.91	0.96	1,528	**2008**
2009	125.4	86.7	15.5	11.38	0.95	1,533	**2009**
2010	119.1	78.0	14.8	11.12	0.88	1,425	**2010**

Indicators **8a** commercial end use by fuel, **8b** commercial energy intensity (index), **9a** industrial end use by fuel, **9b** industrial energy intensity (index)

	indicator 8a, trillion Btu				**ind. 8b** 2000=1	**indicator 9a**, trillion Btu					**ind. 9b** 2000=1	
year	**elec.**	**NG**	**petrol.**	**coal,wd**		**elec.**	**NG**	**petrol.**	**biomass**	**coal**	(2005 $)	**year**
1970	22.9	19.5	18.75	0.52		87.1	98.3	140.6	56.8	5.09		**1970**
1971	24.7	21.7	18.74	0.71		83.1	101.3	147.6	57.8	5.33		**1971**
1972	33.0	24.5	18.61	0.57		95.4	106.7	177.4	57.9	3.44		**1972**
1973	35.2	34.0	17.65	0.40		91.4	127.9	167.2	57.9	3.92		**1973**
1974	34.3	34.8	15.16	0.35		101.5	113.6	148.2	56.7	6.48		**1974**
1975	35.4	33.3	13.58	0.47		93.5	96.0	137.5	53.9	10.91		**1975**
1976	37.8	33.0	13.39	0.52		101.1	82.0	127.4	59.9	14.24		**1976**
1977	37.7	31.3	14.88	2.38		92.5	79.4	156.0	65.2	12.41		**1977**
1978	41.2	26.5	14.90	3.33		107.0	71.4	149.1	66.5	12.18		**1978**
1979	44.1	34.9	12.46	2.60		107.8	86.8	121.5	59.8	12.48		**1979**
1980	47.2	32.4	12.14	3.14		107.0	67.0	131.2	78.3	7.09		**1980**
1981	60.9	30.1	12.14	2.57		118.5	70.0	149.2	82.6	7.67		**1981**
1982	61.9	32.2	20.62	3.44		96.3	49.6	148.4	79.9	7.95		**1982**
1983	62.3	30.0	19.52	4.51		105.2	53.1	104.4	90.3	5.58		**1983**
1984	61.4	33.8	24.86	4.23		113.8	65.6	144.2	92.1	4.52		**1984**
1985	64.7	36.9	32.47	4.35		100.4	65.7	129.2	91.7	4.49		**1985**
1986	64.2	33.0	17.51	1.97		102.5	55.6	141.0	99.8	7.38		**1986**
1987	67.2	33.4	18.70	1.59		107.8	67.9	155.9	98.0	5.89		**1987**
1988	70.7	37.6	22.61	2.75		125.9	71.2	164.6	101.1	5.27		**1988**
1989	70.4	39.7	16.14	3.34		127.5	75.6	150.9	80.8	4.95		**1989**
1990	73.4	39.8	13.38	2.60	1.57	138.9	80.8	148.8	75.0	5.20	1.56	**1990**
1991	75.0	43.0	11.91	2.99	1.55	139.3	82.2	136.4	54.7	4.28	1.51	**1991**
1992	76.9	39.0	7.36	3.26	1.42	130.8	82.4	163.8	72.6	3.37	1.59	**1992**
1993	78.3	45.3	7.41	4.52	1.47	124.8	95.8	131.9	68.9	3.51	1.49	**1993**
1994	79.8	44.8	8.04	3.96	1.44	116.2	112.2	148.9	69.6	3.88	1.56	**1994**
1995	81.6	44.4	9.62	3.88	1.45	117.0	114.6	140.2	64.8	4.23	1.60	**1995**
1996	85.8	50.0	8.37	2.91	1.47	106.6	118.6	151.5	63.0	2.98	1.52	**1996**
1997	86.0	49.0	9.29	2.94	1.06 [a]	115.9	116.6	134.9	70.1	3.22	1.18 [b]	**1997**
1998	88.3	47.7	7.74	2.51	0.99	128.3	139.3	175.8	64.9	2.69	1.34	**1998**
1999	91.1	53.5	9.36	2.68	0.97	134.8	131.0	187.4	65.7	2.18	1.30	**1999**
2000	95.7	52.6	8.89	2.92	1.00	120.8	87.3	152.4	62.2	2.82	1.00	**2000**
2001	93.9	59.1	10.09	4.65	1.04	66.0	77.6	123.8	57.3	2.89	0.85	**2001**
2002	93.9	47.8	10.79	4.76	0.96	53.9	69.7	105.3	50.2	2.28	0.73	**2002**
2003	95.7	49.1	8.68	5.00	0.95	62.0	67.6	105.1	53.1	2.09	0.77	**2003**
2004	96.3	49.8	6.38	4.85	0.92	65.7	69.7	112.3	51.2	1.85	0.81	**2004**
2005	95.9	51.2	8.57	1.82	0.90	75.4	68.9	124.9	57.1	1.48	0.76	**2005**
2006	97.5	52.8	8.58	1.69	0.88	75.1	72.9	136.5	81.3	2.01	0.81	**2006**
2007	101.0	55.1	7.32	1.80	0.86	70.8	75.4	131.8	54.7	3.19	0.70	**2007**
2008	101.9	57.9	11.51	1.89	0.89	72.1	78.0	137.0	55.6	2.95	0.75	**2008**
2009	102.5	57.4	11.17	1.88	0.91	79.7	73.4	125.9	58.3	3.51	0.77	**2009**
2010	98.4	53.0	14.45	1.86	0.86	90.9	73.6	113.1	71.3	2.73	0.80	**2010**

a Based on NAICS definitions from 1997 forward; SIC definitions 1996 and earlier. SIC-based index in 1997 is 1.19.

b Based on NAICS definitions from 1997 forward; SIC definitions 1996 and earlier. SIC-based index in 1997 is 1.21.

Indicators **10** transportation end use by fuel, **11a** travel per capita, **11b** fuel cost of driving, **12** transportation energy intensity

	indicator 10, trillion Btu				**ind.11a** mi/person	**ind.11b** ¢/mi	**indicator 12**, mi/gal			
year	**gasoline**	**distillate**	**av. fuel**	**resid.**		(2005 $)	**WA**[a]	**US**[b]	**US**[c]	**year**
1970	185	23.0	61.1	12.7	5,968	11.51	12.9		12.9	**1970**
1971	189	26.2	66.6	7.5	6,066	11.03	12.9		13.0	**1971**
1972	195	29.9	61.1	6.1	6,365	10.23	13.1		12.9	**1972**
1973	205	38.9	67.4	7.3	6,671	10.67	12.8		12.8	**1973**
1974	205	37.6	70.5	7.9	6,360	13.68	12.5		13.1	**1974**
1975	211	38.5	80.1	13.3	6,476	13.35	12.6	15.4	13.2	**1975**
1976	223	46.6	74.2	14.7	6,791	13.20	12.6	16.8	13.1	**1976**
1977	235	48.5	69.2	16.4	7,128	13.00	12.9	17.8	13.4	**1977**
1978	245	53.6	65.8	31.8	7,457	12.27	13.2	18.8	13.6	**1978**
1979	235	58.7	72.7	59.4	7,416	14.37	13.9	19.0	13.9	**1979**
1980	220	55.9	69.3	63.6	6,920	17.32	14.4	22.7	15.0	**1980**
1981	222	56.2	69.4	51.3	6,962	17.42	14.7	24.3	15.4	**1981**
1982	223	49.1	73.0	29.6	7,189	15.17	15.2	24.9	16.0	**1982**
1983	231	46.5	73.1	10.3	7,421	12.98	15.2	24.8	16.2	**1983**
1984	238	48.7	88.8	10.4	7,674	12.65	15.3	24.9	16.6	**1984**
1985	226	59.1	87.6	34.5	7,759	11.61	16.4	25.3	16.6	**1985**
1986	241	82.0	97.2	56.2	7,878	9.33	15.6	26.1	16.7	**1986**
1987	264	67.9	106.1	51.1	8,219	9.34	15.4	26.3	17.2	**1987**
1988	261	71.9	117.4	60.9	8,674	8.52	16.4	26.4	17.8	**1988**
1989	278	72.9	117.0	84.5	8,975	8.93	16.3	25.9	18.2	**1989**
1990	276	67.6	127.6	89.5	9,028	9.59	17.1	25.6	19.0	**1990**
1991	280	68.5	121.6	99.7	9,250	8.62	17.9	25.8	19.7	**1991**
1992	285	73.6	137.4	139.2	9,606	8.29	18.7	25.3	19.7	**1992**
1993	298	68.0	126.6	93.1	8,761	8.67	17.1	25.5	19.4	**1993**
1994	297	86.8	123.3	91.7	8,841	9.03	16.7	25.1	19.5	**1994**
1995	304	82.0	131.5	104.1	9,003	8.98	16.9	25.3	19.7	**1995**
1996	318	88.7	128.0	77.2	8,873	9.99	16.2	25.2	19.7	**1996**
1997	316	102.9	128.4	79.1	9,017	9.13	17.0	25.0	19.8	**1997**
1998	319	86.6	125.9	58.8	9,031	7.61	17.3	25.0	19.9	**1998**
1999	325	103.5	127.1	47.8	9,041	9.09	16.5	24.6	19.6	**1999**
2000	324	109.2	141.9	41.7	9,048	10.81	16.8	24.8	20.1	**2000**
2001	325	98.6	124.4	39.4	8,982	9.91	17.0	24.8	20.2	**2001**
2002	329	108.0	103.8	33.2	9,066	8.93	17.0	24.6	20.1	**2002**
2003	329	105.5	100.3	37.6	9,021	10.52	17.0	24.9	19.6	**2003**
2004	328	113.1	110.0	41.0	9,026	12.14	17.0	24.6	19.7	**2004**
2005	333	113.8	106.1	48.9	8,867	14.41	16.8	25.5	20.2	**2005**
2006	335	139.4	106.3	39.0	8,865	16.03	16.6	25.7	20.4	**2006**
2007	338	143.2	116.8	62.7	8,776	16.80	16.7	26.4	20.9	**2007**
2008	328	139.8	114.7	29.2	8,434	19.20	16.7	26.8	20.6	**2008**
2009	332	118.0	104.3	45.5	8,461	13.63	17.3	28.8	21.9	**2009**
2010	329	114.6	110.0	47.7	8,505	15.45	17.5	29.1	22.1	**2010**

a All Washington on-road vehicles, regardless of class
b (for reference) Registered U.S. light duty vehicles
c (for reference) U.S. new light duty vehicle fuel efficiency rating

Indicators **13** energy prices by fuel, **14** electricity prices by sector, **15** natural gas prices by sector

	indicator 13, 2005$/mmBtu					**indicator 14**, ¢/kWh			**indicator 15**, ¢/therm[a]				
year	**petrol.**	**elec.**	**NG**	**biomass**	**coal**	**res.**	**comm.**	**ind'l.**	**res.**	**comm.**	**ind'l**	**utility**	**year**
1970	7.23	8.49	2.98	5.59	2.31	4.47	4.60	1.39	55.9	44.1	16.0	0.0	**1970**
1971	7.07	8.43	3.00	5.36	2.32	4.30	4.43	1.35	54.4	42.8	16.8	0.0	**1971**
1972	6.54	8.38	3.06	5.17	2.07	4.24	4.39	1.31	53.2	42.1	17.2	0.0	**1972**
1973	7.05	8.36	3.04	4.96	2.13	4.15	4.21	1.28	53.5	43.0	18.4	0.0	**1973**
1974	9.45	7.87	3.54	4.79	2.76	4.01	4.21	1.19	55.4	41.7	25.3	0.0	**1974**
1975	9.75	8.31	4.80	4.44	2.70	4.03	4.20	1.40	65.4	52.5	38.7	0.0	**1975**
1976	9.90	7.97	5.70	4.29	3.41	3.88	3.92	1.37	73.5	60.7	47.4	0.0	**1976**
1977	9.94	8.19	6.35	4.15	3.43	3.95	4.17	1.22	79.5	68.1	54.0	0.0	**1977**
1978	9.71	7.65	6.73	3.95	3.70	3.79	3.86	1.22	82.4	67.5	59.6	57.3	**1978**
1979	11.79	7.71	7.21	4.29	4.15	3.73	3.83	1.21	86.0	75.5	63.9	60.2	**1979**
1980	14.74	8.59	9.25	3.78	5.00	3.92	3.99	1.59	104.2	94.7	84.4	70.8	**1980**
1981	15.59	10.04	9.26	3.84	5.05	4.34	4.57	2.00	108.3	96.2	83.2	72.2	**1981**
1982	14.60	13.15	10.43	3.54	4.99	5.00	5.19	3.43	116.6	105.5	94.4	100.5	**1982**
1983	13.48	14.27	9.82	3.44	4.22	6.17	5.30	3.37	113.9	100.8	87.1	87.6	**1983**
1984	12.50	15.12	9.33	3.51	4.17	6.15	5.83	3.92	109.2	97.2	82.5	82.1	**1984**
1985	12.00	14.90	8.49	3.38	3.99	6.17	5.85	3.45	103.1	85.1	74.3	73.7	**1985**
1986	8.73	14.94	7.21	2.89	3.44	6.20	5.93	3.41	91.4	77.9	55.4	44.6	**1986**
1987	8.59	15.08	5.86	2.89	3.69	6.41	5.73	3.52	80.8	67.1	42.8	38.5	**1987**
1988	8.00	15.07	5.91	2.83	3.59	6.32	5.59	3.90	79.7	66.5	43.0	45.4	**1988**
1989	8.53	14.82	5.68	2.22	3.53	6.21	5.61	3.80	76.3	64.9	40.7	72.4	**1989**
1990	9.52	13.82	4.96	1.96	3.46	6.05	5.47	3.29	67.1	55.4	36.4	41.7	**1990**
1991	9.32	13.28	4.73	2.32	3.80	5.82	5.36	3.06	60.5	52.5	36.1	51.1	**1991**
1992	8.01	13.18	4.83	1.98	3.63	5.81	5.40	2.91	63.0	54.4	36.7	41.2	**1992**
1993	8.46	13.74	5.06	2.05	3.46	5.87	5.55	3.06	64.2	55.7	39.5	48.0	**1993**
1994	8.40	14.81	4.94	1.99	3.86	6.21	5.73	3.49	68.2	58.7	35.4	58.9	**1994**
1995	8.39	14.80	4.77	1.98	3.84	6.07	5.70	3.62	69.1	58.7	32.2	53.6	**1995**
1996	9.32	14.85	4.65	1.87	3.62	6.05	5.68	3.50	65.4	55.6	30.9	57.1	**1996**
1997	9.22	14.14	4.78	1.72	3.45	5.86	5.55	3.24	63.7	53.4	35.6	66.9	**1997**
1998	7.48	14.03	4.41	1.82	2.90	5.91	5.47	3.32	65.6	53.4	29.6	38.3	**1998**
1999	8.43	14.05	4.62	1.96	2.84	5.91	5.44	3.38	64.6	53.7	31.0	30.3	**1999**
2000	11.02	14.39	6.14	2.32	2.83	5.80	5.30	3.73	77.6	65.2	43.5	57.5	**2000**
2001	10.94	17.38	8.50	3.08	2.68	6.32	5.93	5.27	104.9	92.4	53.8	82.3	**2001**
2002	10.18	18.87	8.00	3.07	2.77	6.88	6.53	5.33	99.0	87.4	51.0	36.1	**2002**
2003	11.91	18.40	7.65	2.85	2.62	6.74	6.48	5.09	87.7	76.8	62.9	34.0	**2003**
2004	13.77	17.69	9.14	3.36	2.79	6.61	6.40	4.44	100.0	94.9	79.0	46.9	**2004**
2005	16.05	17.26	10.59	3.44	3.31	6.54	6.33	4.27	114.6	101.3	99.7	64.9	**2005**
2006	17.86	17.48	11.10	3.10	3.59	6.60	6.42	4.29	125.5	112.4	92.7	54.8	**2006**
2007	18.49	17.60	11.10	3.31	3.63	6.82	6.16	4.29	127.1	113.4	89.8	56.5	**2007**
2008	22.50	17.55	10.46	3.82	4.42	6.87	6.15	4.14	115.4	101.5	93.2	75.6	**2008**
2009	15.77	17.70	11.30	3.37	4.38	6.99	6.34	4.03	123.3	108.4	103.3	46.8	**2009**
2010	18.80	17.62	9.41	3.28	5.09	7.21	6.61	3.66	106.3	91.2	81.4	48.1	**2010**

a 1 therm = 100,000 Btu