Department of Commerce
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2015 Biennial Energy Report and State Energy Strategy Update

Issues, Analysis, and Updates

December 2014
Report to the Legislature
Brian Bonlender, Director

Acknowledgements

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Executive Summary

Washington continues to be rated in the top 10 states for energy policy by the American Council for an Energy Efficient Economy (ACEEE). Lately, historically low natural gas prices have provided a sense of opportunity and security. New analysis in this report recommends several cautions around this seemingly lucky turn of events. In particular, the state should be careful to protect its commitments to efficiency and renewable energy. Any support for natural gas should probably be directed toward displacement of coal-fired electric generation and away from light-duty vehicles.

Since the *2013 Biennial Energy Report*:

- The 2013 Legislature appropriated funding for creation of the Clean Energy Fund to expand clean energy projects and technologies statewide. (separate report available)
- Governor Inslee issued Executive Order 14-04,[1] Washington Carbon Pollution Reduction and Clean Energy Action.
- The Department of Commerce (Commerce) developed an advisory opinion process to help deploy conservation and renewable energy under the state's Energy Independence Act (I-937). The process is working well.
- Utilities continue to comply with both the renewable energy and energy efficiency requirements of the Energy Independence Act. Commerce has revised a number of the Energy Independence Act rules and will continue with the second phase of these revisions through 2014.
- Commerce has adopted rules regarding alternative fuel and vehicle use by state agencies, and is in the process of rulemaking for similar local government standards.
- Commerce, the Washington State University Extension Energy Program (WSU Energy Program), and the Department of Enterprise Services have worked together to develop a policy for state government purchase of electric vehicles.
- The Legislature has supported the development of clean energy by providing the means for clean energy grant funding.

[1] Executive Order 14-04

Introduction

Background

Every two years the Department of Commerce (Commerce) State Energy Office provides a status report and provides recommendations on recent trends in energy prices and expenditures, and updates a series of energy indicators.

The report begins with a brief summary of the state's utilities full compliance with conservation and renewable resource targets under the Energy Independence Act. Chapter 2 has a summary of ways to develop a sustained clean energy fund. Chapter 3 updates recommendations and provides new data on state energy efficiency. In Chapter 4 is the status of action items from the *2012 Washington State Energy Strategy*. The final chapter and appendices of this report provide a comprehensive treatment of energy system indicator data dating from 1970.

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. We follow and analyze key energy issues, policies, and programs related to natural gas, alternative fuels, energy efficiency, renewable energy development, greenhouse gas emissions, energy supply, prices, security, and reliability. We are a technical and policy resource to Washington members of the Northwest Power and Conservation Council, other state agencies, and state congressional officials on federal and regional energy policies and legislation. Our office produces reports on energy consumption, generation and other topics, and represents the states' policy interests in regional and national organizations. The State Energy Office developed the Washington State Energy Strategy in collaboration with an advisory committee, stakeholders, and the public.

We ensure statewide energy security and preparedness by protecting the states' energy infrastructure, especially electricity, petroleum, and natural gas. During energy supply or other energy emergencies, we provide assistance to the state emergency operations center, Governor's Office, energy companies, utilities, local governments, and others. We work to ensure energy shortages are controlled, reducing impacts on the health and safety of citizens, businesses, and our economy.

Over the next 20 years, being more energy efficient could save enough energy to meet 85 percent of new electric and gas loads. We are directed to develop and implement a strategic plan every three years that supports achievement of a 70 percent reduction in building energy use by 2030.

The State Energy Office's work and data includes:

- Appliance and equipment standards
- Applied research programs
- Biopower and biofuels
- Building efficiency
- Building energy codes
- Clean energy funding
- Clean energy incentives
- Climate change
- Critical energy infrastructure
- Electric and alternative fuel vehicles
- Electric utility data and fuel mix
- Emission performance standards
- Energy conservation
- Energy data
- Energy emergencies
- Energy Independence Act
- Energy resources and siting
- Federal energy and conservation programs
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- Petroleum and natural gas
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- Solar power development
- State energy strategy
- Technology transfer programs
- Transmission
- Utility resource plans
- Wind development

Chapter 1 – Energy Independence Act

The Energy Independence Act requires electric utilities with 25,000 or more retail customers in Washington to use renewable resources and conservation to help meet their customers' energy needs. The utilities must report annually to Commerce on their compliance.

The 2014 reports, summarized in Tables 1-1 and 1-2, show all utilities are meeting the 3 percent renewable target for 2014, and met or exceeded the conservation targets established in their conservation assessment work. All results are subject to review by the Utilities and Transportation Commission (for investor-owned utilities), the Washington State Auditor (for municipal utilities and public utility districts), or an independent auditor (for cooperative utilities).

The utilities are using wind power for about 80 percent of their renewable supplies and efficiency improvements at hydroelectric projects for about 15 percent. In 2016, the renewable energy target increases from 3 percent to 9 percent of customers' electricity load, and in 2020 the target will be 15 percent.

Utility reports are available on Commerce's Energy Independence Act reporting web page at www.commerce.wa.gov/Programs/Energy/Office/EIA/Pages/EnergyIndependence.aspx

Table 1-1: 2014 Renewable Energy for Washington Qualifying Utilities

Utility	Average Load 2012-2013 (MWh)	3% Renewable Target for 2014 (MWh)	Qualifying Renewables for 2014 (MWh)	Qualifying Renewables for 2014 (% of Load)
Avista	5,596,132	167,884	610,906	10.9%
Benton PUD	1,671,026	50,131	50,131	3.0%
Chelan PUD	1,582,314	47,469	47,469	3.0%
Clallam PUD	645,181	19,355	38,800	6.0%
Clark Public Utilities	4,397,977	131,939	183,209	4.2%
Cowlitz PUD	5,235,246	157,057	157,058	3.0%
Grant PUD	3,920,566	117,617	398,144	10.2%
Grays Harbor PUD	969,657	29,090	35,000	3.6%
Inland Power	844,433	25,333	26,000	3.1%
Lewis PUD	917,475	27,524	27,524	3.0%
Mason PUD #3	659,950	19,799	19,799	3.0%
Pacific Power	4,067,293	122,019	122,019	3.0%
Peninsula Light	580,137	17,404	17,405	3.0%
Puget Sound Energy	21,173,388	635,202	1,821,000	8.6%
Seattle City Light	9,461,917	283,857	283,858	3.0%
Snohomish PUD	6,540,146	196,204	754,394	11.5%
Tacoma Power	4,777,524	143,326	178,757	3.7%
Totals	**73,040,357**	**2,191,210**	**4,771,473**	**6.5%**

Notes: *Clark Public Utilities intends to comply under the no-growth provision.*
Snohomish PUD intends to comply under the 4 percent incremental cost cap provision.

Source: *Utility reports submitted June 1, 2014; available at www.commerce.wa.gov/EIA*

Table 1-2: Utility Conservation Targets and Acquisitions

Utility	2012-13 Conservation Target (MWh)	2012-13 Conservation Acquired (MWh)	2014-15 Conservation Target (MWh)
Avista	108,589	171,570	76,086
Benton PUD	26,981	32,984	23,740
Chelan PUD	29,609	35,887	18,221
Clallam PUD	18,151	19,061	12,054
Clark Public Utilities	99,338	116,360	87,863
Cowlitz PUD	73,584	158,224	56,940
Grant PUD	99,843	118,695	32,675
Grays Harbor PUD	14,980	21,096	12,702
Inland Power	6,912	15,582	9,110
Lewis PUD	15,155	17,160	11,563
Mason PUD #3	10,674	19,762	5,791
Pacific Power	76,291	111,924	74,703
Peninsula Light	8,234	13,146	5,729
Puget Sound Energy	666,000	782,591	621,120
Seattle City Light	210,328	257,268	207,437
Snohomish PUD	150,672	210,629	116,508
Tacoma Power	99,338	134,524	70,956
Totals	**1,714,678**	**2,236,463**	**1,443,197**

Note: Pacific Power reported a 2012-2013 target of 76,291 to 79,322 MWh.
Source: Utility reports available at www.commerce.wa.gov/EIA

Chapter 2 – Clean Energy Program

Executive Order 14-04[2] directed Commerce and appropriate stakeholders to:

> [D]evelop and make recommendations for a new state program to assist and support our research institutions, utilities, and businesses to develop, demonstrate, and deploy new renewable energy and energy efficiency technologies. The Department's recommendations must include specific proposals for dedicated and sustained funding for implementing and supporting programs.

Commerce is developing a program designed to support the state's research community in their work on renewable energy and energy efficiency during the research, development, demonstration, and deployment phases. We propose the creation of a Clean Energy Program to build on the existing Clean Energy Fund administered by the State Energy Office during the 2013-2015 biennium (Smart Grid Grants to Utilities and Matching Funds for Federal Clean Energy Grants), and to maintain the Clean Energy Revolving Loan Fund.

The program would expand in scope to allow applications for funding on a wider variety of renewable energy and energy efficiency research, development, and demonstration projects. It would be accessible to universities, research institutions, electric utilities, and private entities, and would strongly encourage collaborative partnerships. The overall structure and execution of the Clean Energy Fund would be aided by a high-level advisory and selection committee. The committee would help create standards for, and provide oversight of, the competitive application processes and project evaluation.

Commerce proposes to initially fund the program in FY 15-17 through the capital budget with long-term, sustained funding through one of the funding mechanism options outlined by Commerce. Clean Energy Program applicants would use these funds to match federal or other non-state funds with at least a one-to-one match. The revolving loan fund would be accessible to competitively selected lenders that would provide affordable loans to businesses and homeowners for projects such as energy retrofits, residential and community-scale solar installations, and combined heat and power projects. All projects will acquire assets with at least a 13-year useful life.

The Clean Energy Program will build on the success of the Clean Energy Fund, help improve job growth in clean energy business and technology, and increase energy efficiency investments that will benefit consumers.

The FY13-15 Clean Energy Fund report will be available in late 2014.[3]

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[2] Executive Order 14-04
[3] www.commerce.wa.gov/Programs/Energy/Office/Pages/Clean-Energy-Funds.aspx

Chapter 3 – Energy Efficiency

In previous publications, Commerce put forward recommendations for increasing the implementation rates of energy efficiency. The most recent publications include the *2012 Washington State Energy Strategy* and the *Energy Efficiency - Building Strategy Update 2014*. These are still valued references for our recommendations.

For this report, we are providing additional information on several subjects of interest. To increase consumer energy awareness, we detail our proposals for modifications to energy bills and provide new information on Seattle's commercial building energy benchmarking program. We have analyzed new survey data that gives detailed information on the residential energy retrofit potential for the state. We provide estimates of the potential for LED street lighting retrofits that can save our communities millions of dollars annually.

Washington State University Extension Energy Program (WSU Energy Program) contributed summaries of approaches to increase the adoption of energy efficiency measures in the industrial and agricultural sectors.

Providing One Year of Energy Consumption and Cost Information on Energy Bills

Building energy efficiency assessments require one year of energy consumption and cost information. With this information a preliminary efficiency assessment of the building can be completed. Commerce recommends this information be made readily available to building owners and operators as part of their energy utility billing statements.

Electric and gas utilities provide a variety of information on energy bills. In a recent review of 22 Washington State utility bills by Commerce, none provided a direct view of both annual energy consumption and cost.

Utility bills are frequently invisible to property owners. This includes multi-tenant commercial buildings, apartments, and single family rentals. To gather this information from utilities, property owners are frequently asked to gain authorizations from the tenant who pays the utility bill. This creates an obstacle to low-cost building performance assessments and optimization.

Commerce proposes that utility bills provide a table detailing the total periodic energy consumption and cost for the previous 12 months. We also recommend annual totals for each. The following Tables 3-1 and 3-2 provide an example of the information that would be required. We recommend that property owners have access to lease-holder bills to facilitate better energy management by the owner and operator of the building.

Table 3-1: Electric Utility Bill Proposal

Start Date	End Date	Electric kWh	Cost ($)
8/1/2013	8/31/2013	38589.72	$3,711.09
9/1/2013	9/30/2013	35900.62	$3,482.87
10/1/2013	10/31/2013	36204.38	$3,514.30
11/1/2013	11/30/2013	35775.00	$3,527.94
12/1/2013	12/31/2013	39642.76	$4,041.23
1/1/2014	1/31/2014	38646.53	$3,825.12
2/1/2014	2/28/2014	35950.72	$3,551.16
3/1/2014	3/31/2014	37680.00	$3,680.38
4/1/2014	4/30/2014	35795.72	$3,314.01
5/1/2014	5/31/2014	38244.28	$3,053.43
6/1/2014	6/30/2014	36360.00	$3,399.42
7/1/2014	7/30/2014	42960.00	$3,961.87
	Total	**451749.73**	**$43,062.82**

Table 3-2: Gas Utility Bill Proposal

Start Date	End Date	Gas Therms	Cost ($)
8/1/2013	8/31/2013	142.44	$162.89
9/1/2013	9/30/2013	305.49	$306.47
10/1/2013	10/31/2013	838.59	$783.42
11/1/2013	11/30/2013	1239.24	$1,146.48
12/1/2013	12/31/2013	2024.35	$1,856.86
1/1/2014	1/31/2014	1601.99	$1,476.28
2/1/2014	2/28/2014	1624.6	$1,493.30
3/1/2014	3/31/2014	1220.81	$1,132.08
4/1/2014	4/30/2014	711.53	$675.17
5/1/2014	5/31/2014	411.17	$416.07
6/1/2014	6/30/2014	307.64	$320.80
7/1/2014	7/31/2014	297.76	$312.60
	Total	**10725.61**	**$10,082.42**

Building energy assessment programs that require 12 months of energy use and cost data include Energy Star Portfolio Manager, for commercial buildings, and Energy Star Yardstick, for residential buildings. These web-based programs provide preliminary energy assessments at no cost. The information is required by energy professionals calibrating more detailed building energy assessments and a growing number of third party apps use it.

Commercial Building Energy Benchmarking and Disclosure

The goal of energy use disclosure is to create a market-based demand and competition for energy-efficient buildings. By making building energy performance information universally available, energy use can be considered during the sale or rental of properties. Tracking energy use also provides building owners with information they need to track and improve the performance of their properties.

Energy Star Portfolio Manager is the most commonly used benchmarking tool, tracking the total electricity, natural gas, steam, or other utilities used in a building. Portfolio Manager also creates comparisons to other similar buildings. A web-based tool can import utility data and easily share results with other users.

In 2012, the state commercial building sector spent over $3 billion on energy ($2.9 billion 2005 dollars).[4] The U.S. Environmental Protection Agency has reported good success for buildings that participate in their Portfolio Manager Benchmarking Program. From 2008 to 2011, an

[4] EIA SEDS www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_prices/com/pr_com_WA.html&sid=WA

evaluation of 35,000 participating buildings noted that annual savings was 2.4 percent, with a total savings of 7 percent over the three year analysis.[5]

Washington State adopted benchmarking as a requirement for commercial building transactions in 2009. RCW 19.27A.170 requires that building owners provide energy use disclosure when buildings are offered for sale, lease, or when being financed. Beginning in 2012, this rule applies to commercial buildings greater than 10,000 square feet in floor area.

We cannot assess compliance with Washington's energy disclosure law. Because the disclosure is limited to the two parties involved in the transaction, there is no way of tracking activity or impacts. The law does not specify reporting to a government agency, nor does it include fines.

In contrast to Washington's experience, jurisdictions with government reporting criteria have been able to create benchmarking reports on participation and building energy use. New York City, for example, has just published their third benchmarking report for the private sector. This year they added multi-family buildings to their report.[6] Approximately one million New York residents and building owners can now see how much energy and water their apartment buildings consumed in 2012.

Nine major cities and two states in the United States have passed policies requiring benchmarking and disclosure for large buildings, including Seattle's energy benchmarking and reporting ordinance. The jurisdictions have approached the concept of disclosure more broadly than the State of Washington, and also included penalties for non-participation.[7]

- Ten of the jurisdictions require reporting the benchmarking data to a government agency.
- Annual reporting is required by eight of the jurisdictions.
- Two jurisdictions, including Seattle, will aggregate benchmarking data and create public reports.
- Seven jurisdictions will post each building's energy use data on a public website.
- Nine of the benchmarking jurisdictions have enforcement provisions that include fines.

Seattle has implemented a comprehensive benchmarking program that has resulted in very high compliance rates. Seattle developed a proactive program that notifies property owners of their obligation, provides training resources, and includes penalties for non-compliance. They also worked with utilities to provide automated benchmarking services to property owners. This reduces the ongoing effort of compliance. This program has a 93 percent compliance rate that covers 87 percent of the applicable gross square footage of buildings. Table 3-3 provides a

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[5] U.S. Environmental Protection Agency, Energy Star Portfolio Manager Data Trends, Benchmarking and Energy Savings, October 2012, Washington D.C. www.energystar.gov/ia/business/downloads/datatrends/DataTrends_Savings_20121002.pdf

[6] New York City Local Law 84 Benchmarking Report, September 2013.

[7] Building Rating Organization, U.S. Policy Briefs www.buildingrating.org/content/us-policy-briefs

feature and program comparison between Washington RCW 19.27a.170 and Seattle Municipal Code Chapter 22.290.

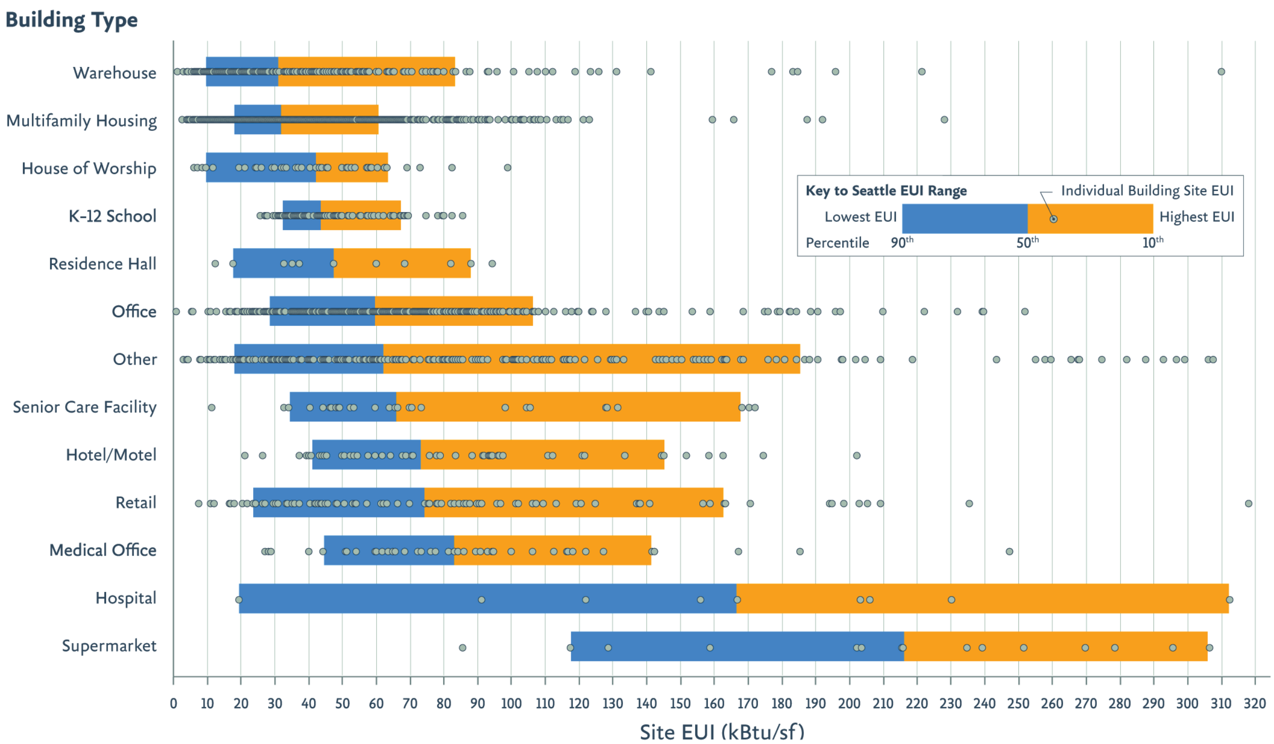
Table 3-3: Washington and Seattle Benchmarking Programs Compared

	WA RCW 19.27A.170	Seattle SMC 22.290
Energy benchmarking disclosure required at time of sale or lease, if requested by the prospective buyer or renter.	X	X
Annual reporting to the jurisdiction is required		X
Utilities are required to provide 12 months of billing data to building owners. Upon request, the qualifying utility shall upload the energy consumption data for the accounts specified by the owner or operator for a building to the U.S. environmental protection agency's energy star portfolio manager.	X Many utilities do not provide the specified data uploads.	X
Utilities provide updates to customer Portfolio Manager accounts.		X
The jurisdiction identifies regulated properties and informs owner of their obligations		X
The jurisdiction provides training and support for the program		X
Fines are imposed for non-compliance		X
Government provides aggregated reporting without disclosing individual building data.		X

In 2014, Seattle reported on their program.[8] Seattle's benchmarking program has been designed to open up the energy use and disclosure market without publicly revealing specific property information. Seattle accomplished this through consolidated reporting. By presenting data on all properties, people involved in transactions have good comparisons of energy use. It also supports building operators that want to know how they are doing compared to their peers. Figure 3-1 provides energy use distributions for major building categories in Seattle.

[8] 2011/2012 Seattle Energy Benchmarking Analysis Report, Seattle Office of Sustainability & Environment, January 2014

Figure 3-1: Seattle Energy Utilization Index (EUI) results provide building energy use comparisons by building type



Utility Role in Benchmarking

RCW 19.27A.170 requires utilities with more than 25,000 customers to support implementation of the law. Upon request, the utility "shall upload the energy consumption data for the accounts specified by the owner or operator for a building to the United States environmental protection agency's energy star portfolio manager."

Utilities in Washington will provide the historic utility billing data to their customers upon request. In many cases this is a paper report or simple spreadsheet with the customer energy use and cost data. Currently, automated uploads of utility data is only available to half of the commercial utility customers.

Automated data entry ensures that benchmarking accounts are kept up to date. It reduces participant cost by eliminating manual entry of monthly utility data. This approach has been demonstrated to increase continued participation in benchmarking programs.

The National Association of Regulatory Utility Commissioners has issued the "Resolution on Access to Whole-Building Energy Data and Automated Benchmarking".[9] In this document they

[9] National Association of Regulatory Utility Commissioners, Resolution on Access to Whole-Building Energy Data and Automated Benchmarking, July 2011.

recognize the need to make whole building energy use available to building owners and provide a framework for utility participation.

In the *2012 State Energy Strategy*, Commerce recommended modifications to RCW 19.27A.170, the state's commercial building energy benchmarking and disclosure law, to make the information more transparent and the law more enforceable. Based on Seattle's very successful implementation of a benchmarking and disclosure ordinance, Commerce recommends Washington State adopt legislation similar to the Seattle ordinance.

Efficiency Retrofit Potential in Single Family Homes

Commerce recommended an expanded program for weatherization in section 4.4.3 of the 2012 State Energy Strategy. The recommendation was for funding of the work to be part of the administrative services implemented through the Community Energy Efficiency Program[10] allocated through state capital funding. This fund would need to expand to continue to implement the existing community weatherization programs, as well as an expansion into a broader contractor network.

To ensure all homes are affordable, comfortable and healthy, they should include a minimum set of efficiency features. This includes adoption of minimum criteria for insulation, air leakage control, windows, and heating systems. The criteria that follow are not a complete list of potential energy efficiency measures, but are a set of basic features that ensures a home provides a minimum level of performance. Using these criteria, we can estimate that there are efficiency project potentials in hundreds of thousands of Washington State's single family homes.

Most of the following assessment is based on utility program protocols that have been used in Washington State for many years. These programs have worked off checklists that base work orders on the existing condition of the home and prescribe an efficiency upgrade. For the vast majority of homes, this results in projects that are cost effective to the homes occupant and provide benefits to all utility ratepayers. When implementation includes good contracting practices, professional energy services, and third party quality control, additional analysis of the cost and benefits should not be required.

This assessment also recommends the elimination of oil as a space and water heating fuel to advance a policy of moving residential customers to lower carbon fuels.

Table 3-4 provides criteria that is built on regional utility program specifications. There are some small variations in the recommendations provided by utilities, but programs are fairly uniform.

[10] The Community Energy Efficiency program is implemented by WSU Extension Energy Program. Information is at www.energy.wsu.edu/BuildingEfficiency/CommunityEEProgram.aspx

Table 3-4: Recommended Efficiency Upgrades for Single Family Homes

	Existing Condition	Recommended Upgrade
Attic	Attics < R-20 insulation	R-49, or maximum for available space
Frame Wall	No insulation	Fill the wall with insulation (R-13 or greater)
Floor	< R-15 Insulation	R-30
Basement Wall	No wall insulation	R-10 continuous or R-21 Frame wall
Windows	Single pane or metal frame	Replacements Meet Code (U-0.30)
Air Leakage Control	Very drafty (>10 ACH50)	Implement Blower Door Guided Air Sealing (>7 ACH50)
Duct Leakage Control	Very leaky (>10%/CFA)	Implement duct sealing, test to verify ducts are sealed (>6%/CFA)
Duct Insulation	Ducts in unconditioned space <R-4 insulation	Insulate to R-11
Primary Space Heating	Electric resistance space heating	Install a heat pump
Primary Space Heating	Oil space heating	Replace oil with gas furnace or heat pump

Potential for Energy Efficiency Upgrades

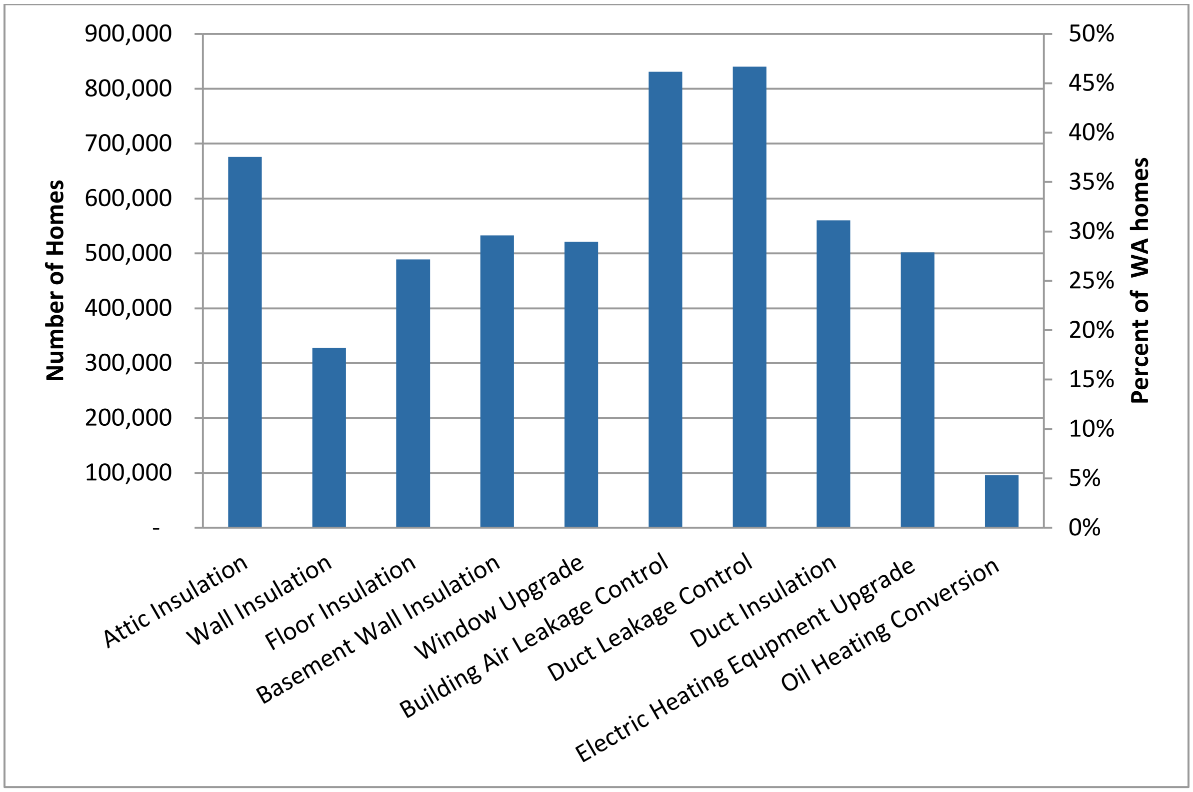
To assess the potential for additional home energy retrofit projects, an inspection of the existing building stock is required. This building stock is then compared to the Recommended Efficiency Upgrades for Single Family Homes noted above to evaluate the potential.

In 2011, the Northwest Energy Efficiency Council (NEEA) conducted the Residential Building Stock Assessment (RBSA). This study covered multi-family, mobile homes, and single family homes. The study conducted detailed energy surveys of 1,850 sites across the Northwest, including more than 1,400 single-family homes. It included 736 single family homes in Washington. The study sample was randomly selected and includes good geographic distribution. Detailed reporting from this study is provided by NEEA at http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment.

Commerce has used the Washington State RBSA data to examine the potential for energy efficiency upgrades in Washington's single family homes. By comparing the Recommended Efficiency Upgrades for Single Family Homes included in Table 3-1 with the RBSA survey data, we have developed an estimate showing the magnitude of the home improvement retrofit potential.

There are approximately 1.9 million single family homes in Washington State. We have estimated the available retrofit opportunities using the Recommended Efficiency Upgrades for Single Family Homes as the threshold for action. These results are presented in Graph 3-1.

Graph 3-1: Estimate of Energy Upgrade Potential for Single Family Homes in Washington State

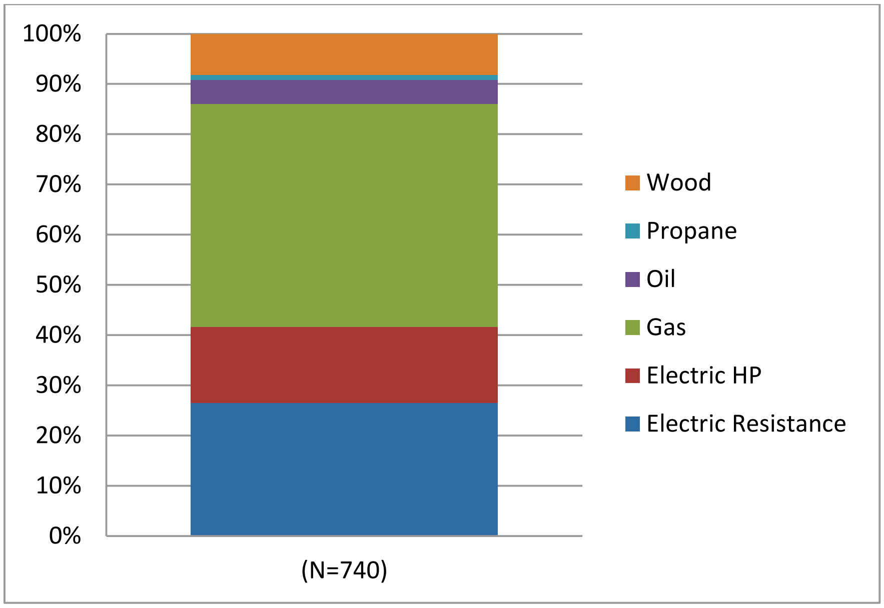


Primary Space Heating Type

Washington's single family homes use a diverse mix of space heating fuels and equipment. With respect to equipment, it is usually advisable to upgrade to high efficiency equipment when the old equipment fails. Two specific space heating types are identified for early conversion to alternatives; these are electric resistance heating and oil heating systems.

Figure 3-2 provides information on the primary heating fuel identified in the RBSA data set. For electric heating systems, we broke it out by electric heat pump and electric resistance heating. It is important to add, many homes use more than one space heating fuel, such as electric plus wood.

Figure 3-2: Space Heating Type



For electric resistance space heating we recommend an upgrade to heat pumps. The recent introduction of small ductless mini-split heat pumps has increased the efficiency and lowered the cost of heat pump retrofits. They are more easily incorporated into small existing homes than larger ducted heat pumps. This results in a universal recommendation for heat pump conversions that would not have been made a few years ago.

For oil heated homes we recommend conversion to a heat pump. Heating oil has the highest carbon content of any of the heating fuels used in Washington. Heating with an electric heat pump has the lowest. This recommendation is made to meet the state carbon emissions reduction goals.

We do not recommend changes in primary fuel and equipment for other space heating types. We simply recommend when equipment reaches the end of operation, it is replaced with the most efficient equipment available.

Efficiency Upgrade Potential of Rentals Compared to Owner Occupied Homes

The RBSA demonstrates that rentals are lagging with respect to energy efficiency. For example, 16 percent of owner occupied homes have no wall insulation. For the sample of rental homes, the fraction of homes with no wall insulation is 29 percent. The owner and rental upgrade for attic insulation potential is 33 and 41 percent. The owner and rental upgrade potential for floor insulation is 36 and 47 percent respectively.

Figures 3-3 through 3-5 provide comparisons of attic, wall, and floor insulation of owner occupied and rental homes.

Figure 3-3: Attic Insulation Owner/Renter

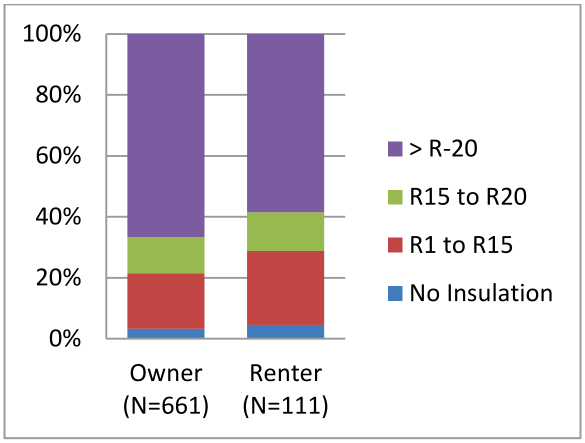


Figure 3-5: Floor Insulation Owner/Renter

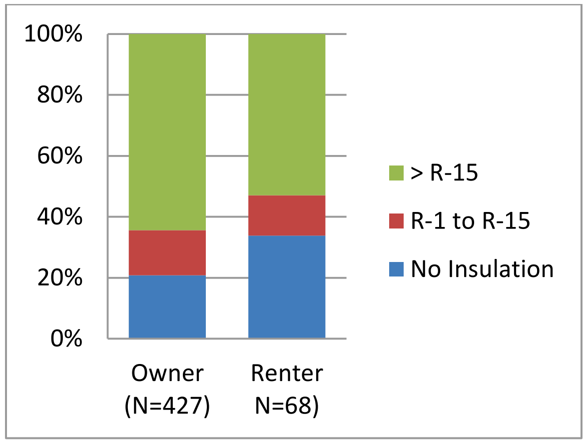
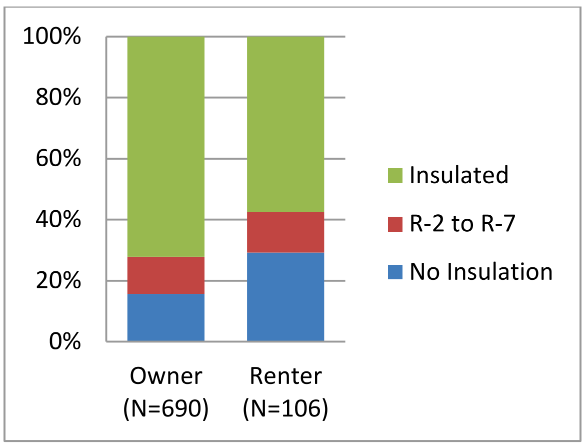


Figure 3-4: Wall Insulation Owner/Renter



Continuing to Implement Home Efficiency Upgrades

The estimate of residential efficiency retrofit potential presented in Graph 3-1 shows there are a large number of homes that could benefit from cost effective efficiency upgrades.

Electric heated homes still have significant remaining energy efficiency potential in both weatherization and heat pump conversions. Homes heated by other fuels have even greater need for basic weatherization measures.

Rental housing is less likely to have basic efficiency features than similar owner occupied homes. Policies should be developed that specifically motivate basic efficiency upgrades in rental housing.

Solid State Street and Area Lighting

Commerce estimates there are more than 500,000 municipal streetlights in Washington.[11]

The rapid evolution of solid state lighting is remarkable. A small industry several years ago now produces LED lighting products that fit most lighting applications. In July 2014, the U.S. Department of Energy certification program reported over 14,000 solid state lighting products designed for indoor applications and over 16,000 products designed for outdoor applications. U.S. Department of Energy also document improved color rendering, improved efficiency, and the availability of high output lighting that was not available in 2013.[12] This technology is ready for widespread market adoption.

For street lighting, LED lighting provides multiple benefits.

- LED's provide better color rendering, improving visibility and safety.
- 40-60 percent energy savings depending on incumbent lighting source. Savings of up to 80 percent have been demonstrated when LED street lights are combined with advanced controls.
- Better than 50 percent street lighting maintenance savings. LED service life is 15-20 years, two to three times that of incumbent light sources. Advanced controls may be used to maintain light output over time further extending the fixture life.

Several pilot projects conducted in Washington State have demonstrated the applicability, cost, and benefits of solid state street lighting. These studies have shown that early adoption of LED street lighting will provide financial benefits to municipal governments.

- The Washington State Transportation Improvement Board conducted a pilot project that replaced more than 1,900 high pressure sodium lights in six small cities throughout the state. Preliminary results show the project pay-back period is five years, which includes total cost and all benefits (both financial and environmental). For every $1 spent, the investment is expected to return $2.34 over a 15-year study period.[13]
- The City of Seattle street lighting upgrade program is approaching 50,000 units installed. They have estimated a simple payback of 7.6 years based on a 15-year study. Once completed, Seattle anticipates saving $2.4 million per year in energy and maintenance cost.[14]

The cost of LED street lighting retrofits include equipment, installation, design, and administration. The cost of design is low for programs that implement lamp for lamp

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[11] Estimate based on a voluntary survey of municipal street lights in Washington, conducted by the U.S. DOE Lighting Initiative, 2014.
[12] U.S. Department of Energy, CALiPER Snapshot Reports, July 2014.
[13] Washington State Transportation Improvement Board, *Spotlight on Small City Streetlight Projects*, 2014.
[14] Seattle City Light Power Lines, Seattle City Light LED Streetlight Conversions Ahead of Schedule, September 2012.

replacements. Programs that include highways with more critical safety issues may require more design and more expensive equipment.

For the large Seattle program, the 2014 cost for equipment has ranged from $202 to $468 per fixture. Smaller neighborhood lamps are covered by the low price fixtures, with higher cost for high light output fixtures needed for arterial roads. Seattle has contracted for installation at a cost of $130 per fixture. These costs do not include design or administration.[15]

The Washington State Transportation Improvement Board reports implementation cost ranging from $276 per fixture for one jurisdiction to $1,166 for the highest cost jurisdiction. This includes all costs. Projects were installed using a variety of contractors, including utility crews and private contractors. Even though some costs were higher than others, each project had positive returns on investment.[16]

Washington State Energy Efficiency and Solar Grants for Higher Education, Local Governments, and State Agencies administered by Commerce have funded a number of street lighting retrofit projects. 2013-2015 Energy Efficiency & Solar Round One - March 12, 2014 included four exclusive street lighting projects. Project cost ranged from $406 to $1186 per lamp. Three different types of contractors were used. This includes retrofit's executed in partnership with the serving public utility, municipal contracting with an engineering firm, and the energy service performance contracting method.

Agricultural Energy Efficiency

The Farm Energy Program pilot was conducted from 2011 to 2013. The pilot provided energy assessments for 31 dairy producers and continues the activity in targeted areas of the state. This work helps agricultural producers in the state reduce their energy use, operating costs, and carbon footprint. The program support was from the USDA Natural Resources Conservation Service and Rural Development, the WSU Energy Program, the WSU Center for Sustaining Agriculture and Natural Resources, Washington State Conservation Commission, Washington Association of Conservation Districts, Washington State Department of Agriculture, Washington State Dairy Federation, state agricultural associations and participating utilities.

Dairy farms participating in the pilot received energy-saving recommendations that could save about 25 percent on their energy bills. One farmer received a national award for his sustainable approach to dairy farming. The assessment identified some of the key measures that were installed to save energy and increase the efficiency of his business.

Governor Inslee, in Executive Order 14-04[1], directed the WSU Energy Program and the Department of Agriculture, along with other relevant partners, to create an expanded energy-

[15] Personal email from Carol Anderson, City of Seattle, October 1, 2014.
[16] HDR Decision Economics, SROI Analysis for TIB Low Energy Lighting Conversion in Small Cities in Washington State, June 2014.

efficiency program for the agricultural sector. The program should accelerate the assessment and funding of energy savings options for the state's agriculture sector, including preparing them to capitalize on the federal dollars available for efficiency improvements.

Industrial Energy Efficiency

The WSU Energy Program, in collaboration with Bonneville Power Administration and the Northwest Energy Efficiency Alliance, launched the Washington Industrial Energy Leaders (WIEL) statewide awards program in 2012. The program identifies and recognizes industrial businesses in Washington that demonstrate leadership in the pursuit of energy efficiency.

In Executive Order 14-04[1 above], the WSU Energy Program was directed to develop and launch an Industrial Energy Services Center. It is to provide a range of energy systems engineering, combined heat and power, and financial incentives to catalyze energy efficiency and carbon reduction investments. The program will build on previous experience providing financial incentives to help offset the costs of energy efficiency equipment, and it will be designed to leverage regional efforts made by the Northwest Combined Heat and Power Technical Assistance Partnership for Washington.

Chapter 4 – Status of State Energy Strategy Recommendations

The 2010 Legislature directed the State Energy Office to develop a new state energy strategy and established three primary goals for that strategy:

- Maintain competitive energy prices that are fair and reasonable for consumers and businesses and support our state's continued economic success.
- Increase competitiveness by fostering a clean energy economy and jobs through business and workforce development.
- Meet the state's obligations to reduce greenhouse gas emissions.[17]

To achieve the mandate, the *Washington State Energy Strategy* included long- and near-term recommendations in three major topic areas.

- Efficient transportation
- Buildings efficiency
- Distributed energy

Tables 4-1, 4-2, and 4-3 summarize the recommendations and policy options of the strategy. Full descriptions of each strategy and extensive background analyses are included in the *2012 State Energy Strategy*. In addition, Chapter 2 of the *2013 Biennial Energy Report* includes detailed updates on the recommendations though late 2012. This chapter briefly summarizes additional activities undertaken since the 2013 report.

[17] RCW 43.21F.010(4)

Transportation

Table 4-1: Efficient Transportation

Vehicles and Fuels	Travel Efficiency	Pricing
Near-term Recommendations		
3.4.1 Electric Vehicle Support 3.4.2 Renewable Fuels Standard 3.4.3 Diesel Engine Fuel Efficiency Improvements	3.4.4 Commute Trip Reduction Program Expansion 3.4.5 Smart Growth and Transportation Planning 3.4.6 Transportation Systems Management 3.4.7 Regional Mobility Grants	3.4.8 Electric Vehicle Mileage Pricing Pilot 3.4.9 Car Sharing and Mileage Based Insurance
Long-term Policy Options		
3.5.1 Revenue Neutral Feebate 3.5.2 Low Carbon Fuel Standard 3.5.3 Advanced Aviation Fuels 3.5.4 Improvements to Railroads	3.5.5 Comprehensive Trip Reduction Program 3.5.6 Energy Efficient Transportation Choices	3.5.7 Emerging Pricing Methods 6.0.0 Carbon Pricing

3.4.1 Electric Vehicle Support

In October 2013, Governor Inslee together with Oregon Governor Kitzhaber, California Governor Brown, and British Columbia Premier Clark committed to a new set of collective climate and energy actions as part of the Pacific Coast Collaborative (PCC). One of the major new commitments was "to expand the use of zero emissions vehicles, aiming for 10 percent of new vehicle purchases (in public and private fleets) by 2016."[18]

In 2014, Washington State reached the distinction of having the highest per capita percentage of electric vehicles with more than 10,000 on the road today.[19]

In May 2013, Commerce adopted rules for alternative fuel and vehicle use by state agencies and higher education. As part of the rulemaking process, Commerce formed the Alternative Fuels and Vehicles Technical Advisory Group (AFV-TAG) comprised of large state agencies and higher education that is helping promote greater deployment of alternative fuels and vehicles, especially electric vehicles, in public fleets. Commerce has instituted a companion rulemaking process for local governments.

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[18] Pacific Coast Action Plan on Climate and Energy, October 28, 2013
[19] Top Electric Car States – Which has the Highest Percentage of Electric Cars? February 3, 2014, Clean Technica

Commerce has developed analytical tools to allow agencies to determine the life-cycle costs of alternative and electric vehicles, including the social cost of carbon. The tool has demonstrated that electric vehicles are usually the least expensive option amongst the passenger vehicles available through the state procurement process.

Executive Order 14-04[1] (Washington Carbon Pollution Reduction and Clean Energy Action) directs the Washington Department of Transportation (WSDOT) to develop an "action plan to advance electric vehicle use, to include recommendations on targeted strategies and policies for financial and non-financial incentives for consumers and businesses, infrastructure funding mechanisms, signage, and building codes." WSDOT is expected to complete that report in late fall of 2014.

The 2014 Legislature appropriated $250,000 for the Joint Transportation Committee to evaluate the status of electric vehicle charging stations and make recommendations on potential business models to expand and sustain an electric vehicle charging network. [20]

3.4.2 Renewable Fuels Standard

There have been no legislative changes to Washington's Renewable Fuel since the completion of the 2012 State Energy Strategy. Work is underway through the direction of Executive Order 14-04[1] on clean fuels (see 3.5.2 Low Carbon Fuel Standard), and zero emissions vehicles represent current efforts in this area.

3.4.3 Diesel Engine Fuel Efficiency Improvements

The 2014 Legislature passed HB 2569, creating a low- or no-interest loan program to governments for diesel idle reduction projects.[21] Updated information is available at the Washington State Department of Ecology's diesel emission website.[22]

3.4.4 Commute Trip Reduction (CTR) Program Expansion

Information on the Commute Trip Reduction (CTR) program is available at WSDOT's program website.[23]

3.4.5 Smart Growth and Transportation Planning

Executive Order 14-04[1] includes seven major action items for the transportation sector.

- Electric Vehicle Action Plan Status: see 3.4.1, above.

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[20] Information on the Electric Vehicle Charging Station Networks Study is available at: www.leg.wa.gov/JTC/Pages/ElectricVehicleChargingStationNetworksStudy.aspx

[21] app.leg.wa.gov/documents/billdocs/2013-14/Pdf/Bills/House%20Passed%20Legislature/2569-S2.PL.pdf

[22] www.ecy.wa.gov/programs/air/cars/diesel_exhaust_information.htm

[23] www.wsdot.wa.gov/Transit/CTR/overview.htm

- WSDOT, Commerce, and Ecology work with regional transportation planning organizations, counties, and cities to develop a program of financial and technical assistance for improved transportation efficiency and comprehensive plan updates. Status: The agencies are engaged with local governments and will design a program during 2015 with implementation in 2016.
- WSDOT will review state transportation grant programs and identify ways to increase investment in multimodal transportation options for local governments. Status: Program review underway with a planning implementation in early 2016.
- WSDOT is to review multimodal transportation corridor policies and guidance, focusing new corridor studies on ways to increase transportation choices, foster innovative land use, and reduce emissions. Status: Draft document completed by December 2015 with final documents due in early 2016.
- WSDOT is to develop, adopt, and implement a statewide transportation plan that includes alternative revenue sources, least-cost planning, transit-oriented land use, and freight-corridor development. Status: The WSDOT state transportation plan is scheduled for adoption around December 2016.
- The Department of Ecology is to research zero emissions vehicle options. Status: Ecology is developing policy options for consideration by the end of 2014.
- OFM is to examine clean fuel standards. Status: see 3.5.2 below.

3.4.6 Transportation Systems Management

WSDOT has a variety of transportation system management activities and programs underway, including intelligent transportation systems (ITS) operations,[24] smarter highways[25], and freight mobility.[26]

3.4.7 Regional Mobility Grants

No additional funding was provided due to the lack of a new state transportation budget.

[24] WSDOT, Intelligent Transportation Systems (ITS) operations
[25] WSDOT, Smarter Highways
[26] WSDOT, Washington State Freight Mobility Plan

3.4.8 Electric Vehicle Mileage Pricing Pilot

WSDOT completed a study of road usage charges in May 2013. The report, *Road Usage Charge Pilot Project – Final Evaluation Report for Washington State Participants,* evaluated the results of road usage pilot programs in Washington, Oregon, and Nevada.[27]

3.4.9 Car Sharing and Mileage-Based Insurance – No updates since the 2013 report.

3.5.1 Revenue Neutral Feebate – No updates since the 2013 report.

3.5.2 Low Carbon Fuel Standard

The Office of Financial Management (OFM) was directed by Executive Order 14-041 to "evaluate the technical feasibility, costs and benefits, and job implications of requiring the use of clean transportation fuels through standard that reduce the carbon intensity of these fuels over time."[28] OFM will complete that analysis in late 2014.[29]

3.5.3 Advanced Aviation Fuels

There continues to be a significant amount of activity related to advanced aviation fuels development. The 2012 legislature established the Aviation Biofuels Work Group. The work group has aviation industry, state agency, public interest, port, national laboratory, and biofuels industry representatives. The group produced an Aviation Biofuels Update in late 2013.[30] In 2014, the Legislature conveyed responsibility for work group coordination from Innovate Washington to Washington State University. An update on work group activities and recommendations will be completed in late 2014.

3.5.4 Improvements to Railroads – No updates since the 2013 report.

3.5.5 Comprehensive Trip Reduction Program – See 3.3.5 Commute Trip Reduction.

3.5.6 Energy Efficient Transportation Choices – See 3.4.5, above.

3.5.7 Emerging Pricing Methods – See 3.4.5, above.

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[27] www.wsdot.wa.gov/research/reports/fullreports/807.1.pdf
[28] Executive Order 14-04 Washington Carbon Pollution Reduction and Clean Energy Action
[29] For additional information and the draft report see the OFM Clean Fuel Standard site
[30] Innovate Washington, Aviation Biofuels Update, December 2013

Buildings Efficiency

Table 4-2: Buildings Efficiency

Performance and Transparency	Funding and Financing	Low-income and Rental Housing
Near-term Recommendations		
4.4.1 Non-Residential Disclosure 4.4.2 Residential 4.4.3 Marketing and Quality Assurance	4.4.4 Meter-Based Financing 4.4.5 Energy Efficient Property Conversions	4.4.6 Minimum Standards for Rental Housing 4.4.7 Sustaining Investment in Low-Income Weatherization Programs 4.4.8 Prevailing Wage Class for Weatherization

4.4.1 Non-Residential Disclosure – See Chapter 1 for the update

4.4.2 Residential Disclosure – See Chapter 1 for the update

4.4.3 Marketing and Quality Assurance – See Chapter 1 for the update

4.4.4 Meter-Based Financing

The 2012 Washington State Energy Strategy identified meter-based financing, also known as on-bill financing, as a promising alternative to traditional ways of paying for energy efficiency and renewable energy projects. Meter-based financing reduces or eliminates the up-front investment for a consumer or business, and allows for repayment from the reduction in energy cost savings. Meter-based financing is especially promising in situations where tenants are responsible for utility bills, since the property owner is not required to make an investment.

Meter-based financing is not yet available to most Washington customers, but during 2014 there were two significant steps toward greater availability. Commerce provided almost $3 million from the Clean Energy Revolving Loan Fund to Craft3 to expand a residential loan program for energy efficiency projects. Craft3, a nonprofit community development financial institution, currently offers on-bill repayment to customers of Seattle City Light. The revolving loan fund grant will allow Craft3 to provide additional loans in the Seattle area, and they are actively soliciting other utilities across Washington as on-bill financing partners.

Commerce also supported the implementation of an on-bill financing mechanism by Inland Power & Light Company, an electric cooperative serving 37,000 members in eastern Washington. Inland used a grant from Commerce to develop the mechanism, and apply for federal Rural Utility Service loan funds.

4.4.5 Energy Efficient Property Conversions

The Legislature has not adopted any legislation related to energy efficient property conversions. Several interest groups continue to investigate different approaches, but no firm proposals are available at this time.

4.4.6 Minimum Standards for Rental Housing – No policy actions since the 2013 update

4.4.7 Sustaining Investment in Low-Income Weatherization Programs

Commerce received $10 million in the FY 2013-15 capital budget for the Energy Matchmakers program for low-income weatherization. Commerce will be requesting additional capital funding for low-income weatherization in the FY 2015-17 capital budget.

4.4.8 Prevailing Wage Class for Weatherization – No new activity since the 2013 update

Distributed Energy

Table 4-3: Distributed Energy

Facilitating Development of DE	Financial Incentives
Near-term Recommendations	
5.3.1 Interconnection Standards 5.3.2 Net Metering Policies 5.3.3 Streamlined Permitting for Distributed Energy	
Long-term Policy Options	
5.4.1 DE-Compliant Power Purchase Agreements 5.4.2 Distributed Energy in I-937	5.4.3 Rationalize DE Incentives 6.0.0 Carbon Pricing

5.3.1 Interconnection Standards

On July 18, 2013, the Washington State Utilities and Transportation Commission adopted revised interconnection standard for electric generators.[31] Although these rules are only directly applicable to investor-owned utilities subject to regulation by the UTC, consumer-owned utilities were extensively engaged in the process, and many of those utilities have adopted equivalent rules or regulations for their service territories.

The Northwest Solar Communities Program (see 5.3.3 Streamline Permitting for Distributed Generation) includes work on decreasing interconnection costs for rooftop solar systems. The program will produce a report on model interconnection standards for photovoltaic systems by the end of 2014.

5.3.2 Net Metering Policies

The 2013 and 2014 Legislatures considered modifications to the state's net metering statute (RCW 80.60), but none were adopted. As of January 1, 2014, the cumulative generating capacity available to net metering systems was increased from 0.25 percent of any electric utility's 1996 load to 0.5 percent. No utility has met or exceeded that limit.

5.3.3 Streamlined Permitting for Distributed Energy

Commerce and the Oregon Department of Energy received funding for the U.S. Department of Energy's Rooftop Solar Challenge program to help reduce the "soft costs" of installation of rooftop solar systems. The funding led to the creation of the Northwest Solar Communities

[31] Utilities and Transportation Commission, Interconnection with Electric Generators Rulemaking, UE-112133

coalition made up for local jurisdictions, utilities, industry partners, and citizens groups. One of the major focus areas of the group is the "streamlining and standardization of the permitting processes and interconnection standards."[32]

In March 2014, U.S. DOE funded six Wind Energy Regional Resource Centers. The Northwest Regional Center, operated by Renewable Northwest with involvement from Commerce, is working with the Distributed Wind Energy Association to develop model zoning and permitting practices for small-scale distributed wind systems. Those model standards will be available by the end of 2014.

5.4.1 DE-Compliant Power Purchase Agreements – No activities since the 2013 update

5.4.2 Distributed Energy in I-937

Commerce continues to provide advisory opinions on issues related to the eligibility of renewable and conservation projects under the Energy Independence Act. Final decision making authority on the opinion resides with the governing board of the public or cooperative utility that uses the resources for compliance. Commerce has issued more than two dozen opinions since the law was adopted.[33]

The 2013 and 2014 Legislatures did not adopt changes to the Energy Independence Act related to definitions of cogeneration, distributed energy systems, or anaerobic digesters. However, in January 2014, Commerce amended its administrative rules to address uncertainties in the law's formula for counting conservation savings from cogeneration projects. The Utilities and Transportation Commission applied the clarification in its proposed rules issued in late 2014.

Commerce worked to resolve uncertainty in the application of the double credit offered to distributed generation projects under the Energy Independence Act. The law sets a threshold for distributed generation at 5 megawatts and applies this limit to any "integrated cluster" of generating units. In 2014, Commerce worked with stakeholders to define "integrated cluster" based on physical interconnection, ownership, and operational characteristics. Final action on this rule amendment was pending at the end of 2014.

5.4.3 Rationalize DE Incentives

Since 2013, the Legislature has considered several bills that would modify the state's renewable energy stem cost recovery incentive.[34] No legislation was passed in either the 2013 or 2014 legislative sessions, but substantial stakeholder activity continues in preparation for possible 2015 legislation.

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[32] www.commerce.wa.gov/Programs/Energy/Office/Topics/Pages/Solar.aspx
[33] www.commerce.wa.gov/Programs/Energy/Office/EIA/Pages/EIA-Advisory-Opinions.aspx
[34] RCW 19.126.110

6.0.0 Carbon Pricing

Executive Order 14-04[1] created a Carbon Emissions Reduction Task Force (CERT) made up of 21 leaders from business, labor, health, and public interest organizations. The charter of CERT is to provide the Governor with recommendations on the design and implementation of a market-based carbon pollution program. The task force will produce its final recommendations by November 21, 2014.[35]

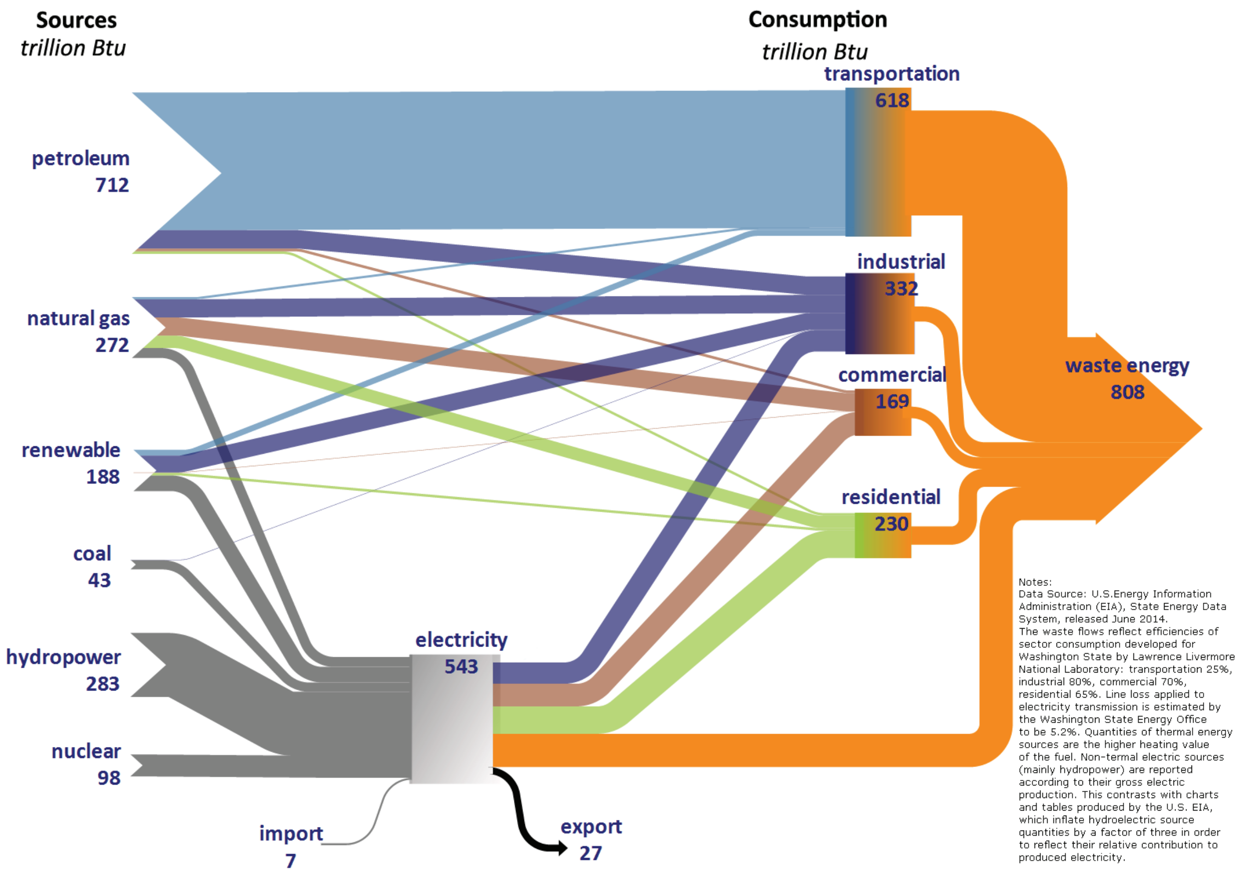
[35] www.governor.wa.gov/issues/climate/cert.aspx

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.

Figure 5-1: Sources and Consumers of Energy in Washington in Calendar Year 2012



Note: The state consumed 1,576 TBtu of energy. Sums may not equal totals due to rounding error. A larger version is attached after the Appendix.

Energy flows in Washington State have been mapped as shown in Figure 5-1. Data is for calendar year 2012, 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). The state consumed 1,576 TBtu of primary energy in 2012. Electric generators used 543 TBtu to produce 315 TBtu of electricity. The four end-use sectors, transportation, industrial, residential, and commercial, consumed 1,349 TBtu.[36] The transportation sector is the least efficient user of primary energy, delivering only 25 percent of the primary energy as useful energy services, and losing the remainder as waste heat.

In the early 1990s, Commerce developed 23 Energy Indicators, which we consolidated to 17, to illustrate important long-term energy trends in Washington. 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 U.S. Energy Information Administration's (EIA) 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. Consequently, the Energy Indicators are limited to analysis of long-term energy trends.

Data for most of the indicators runs from 1970 to 2012; a few are one-year snapshots. For each indicator there is a chart, figure, or table illustrating the trend, and narrative giving additional perspective or describing further aspects of the data. Data sources and links to related data are included for those indicators where the information is available.

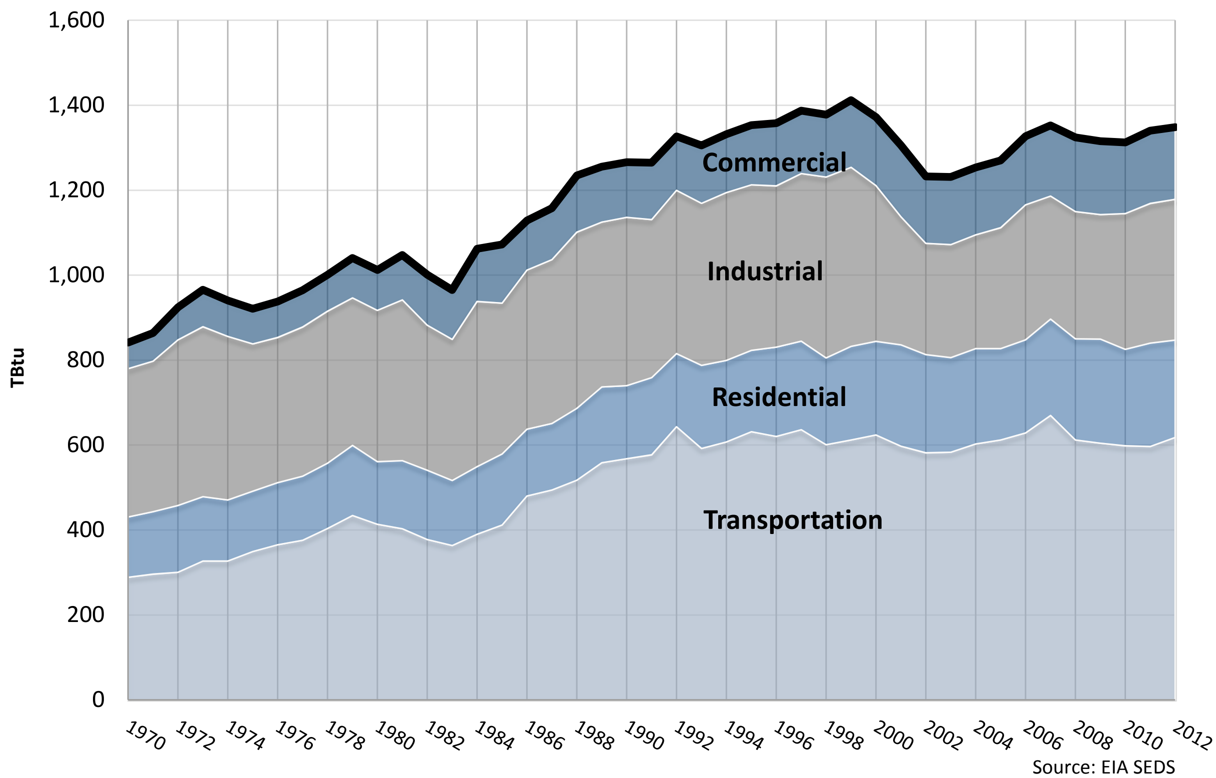
See Appendix A for more information on the methodology used to develop and update the indicators.

[36] The four sector total includes energy from the electric sector, which itself is not an end-use sector.

Indicator 1: End-Use Energy Consumption by Sector

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 1,412 trillion Btu (TBtu) in 1999, 67 percent higher than in 1970, 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 before declining about 2 percent during the recession of 2007-09. By 2012, as the economy recovered, state energy consumption has nearly returned to the level seen in 2007, but is still 4.5 percent less than the 1999 peak, despite a larger population.

Figure 5-2: End-use Energy Consumption by Sector 1970-2012



Source: EIA State Energy Data System www.eia.doe.gov/emeu/states/seds.html

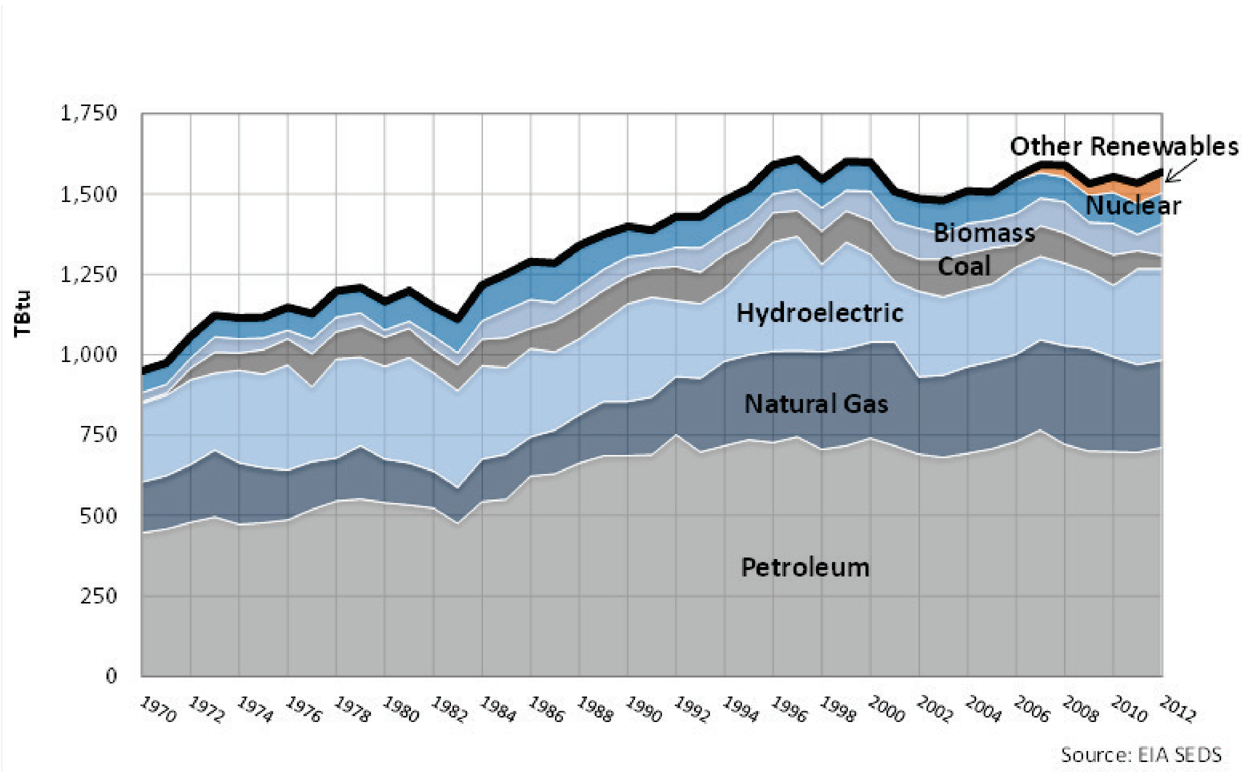
During the late 1970s and early 1980s, growth in energy consumption was dampened by higher energy prices and changes in the state's economy, but grew fairly steadily from 1984 to 1999, due to population growth and relatively modest energy prices. The transportation sector accounted for the largest share 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, grew at a 3.3 percent rate between 1970 and 2000, and has grown at a lower rate of about 0.6 percent since 2000. Residential sector energy use grew steadily at a 1.5 percent rate from 1970 to 2000, but is virtually unchanged over the past dozen years. Although there is some year-to-year variation due to economic activity, industrial sector energy consumption is actually lower in 2012 than it was in 1970. Some of this is due to energy efficiency improvements, but it also reflects structural changes in the state's economy, such as the decline of the aluminum industry. [37]

[37] During 1999-2002, high electricity prices shut much of the Northwest aluminum industry and consequently industrial sector energy consumption declined by 38 percent.

Indicator 2: Primary Energy Consumption by Source

Figure 5-3 shows the extent of Washington's reliance on six major primary[38] energy sources: petroleum, hydroelectricity, natural gas, biomass, coal, and uranium (nuclear).[39]

Figure 5-3: Total Primary Energy Consumption by Source, 1970-2012



Sources: EIA State Energy Data System www.eia.doe.gov/emeu/states/_seds.html

Washington continues to rely on petroleum, much of which is delivered from Alaska, to meet 45 percent of its primary energy needs in 2012. The petroleum share of primary energy use has not changed appreciably – in 1970 it had a 47 percent share.

Natural gas is the next most frequently consumed primary energy source averaging an 18 percent share over the last five years, only a slight relative increase from 1970 when its share

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[38] 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, uranium, 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).

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

was just under 17 percent. Natural gas is used for heating, electricity generation, and industrial processes. Consumption is variable, depending in particular on the winter heating and electricity demand.

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 2.7 percent of Washington's primary energy consumption in 2012.

Total fossil fuel consumption (petroleum, coal, and natural gas) accounted for 64 percent of primary energy use in 2012, the same fraction as in 1970, but down from the peak of 76 percent in 2001. However, 2012 saw relatively mild temperatures, as well as a strong hydroelectricity generation, and consequently natural gas and coal consumption in the electricity sector were reduced.

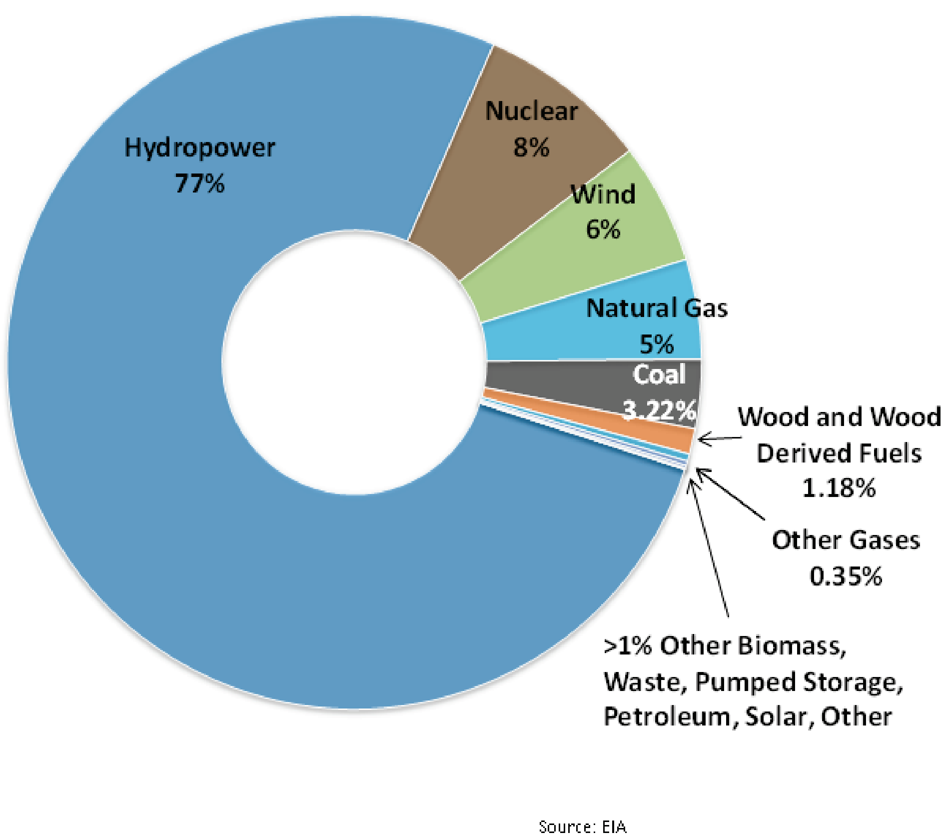
Hydroelectricity has been a key energy source in Washington for many years. It is important to recognize that total annual generation from hydroelectric dams varies widely depending on snowpack and river flows. Generation in 2001 dropped to its lowest level in 35 years, 32 percent lower than the average for the last 30 years. This compares to the peak year in 1997 when generation was 29 percent greater than the average. Hydropower generation in 2012 was about 7 percent above the 20-year average.

Biomass, mainly wood and wood waste products, accounted for about 7.7 percent of primary energy consumption in 2012. 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 at pulp and paper mills, but is also used for residential heating.

Indicator 3: Fuels Consumed for Electricity in Washington

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 5-4 and Table 5-1). Electricity generated from hydroelectric dams accounted for 77 percent of the electricity generated in the state in 2012. Wind, gas, coal, and nuclear represented nearly equal shares of the almost 20 percent of electricity production. The remaining few percent is a mix of fossil and renewable fuel sources. Renewable non-hydro fuel sources, including biomass, wind, waste, and landfill gas, were 7 percent of the total generation. Wind has grown from nearly zero share in 2000 to 5.6 percent in 2012 (ranking seventh in the nation in 2012 according to the American Wind Energy Association[40]). In 2012, power plants in Washington generated 29 percent more electricity than was consumed in the state.

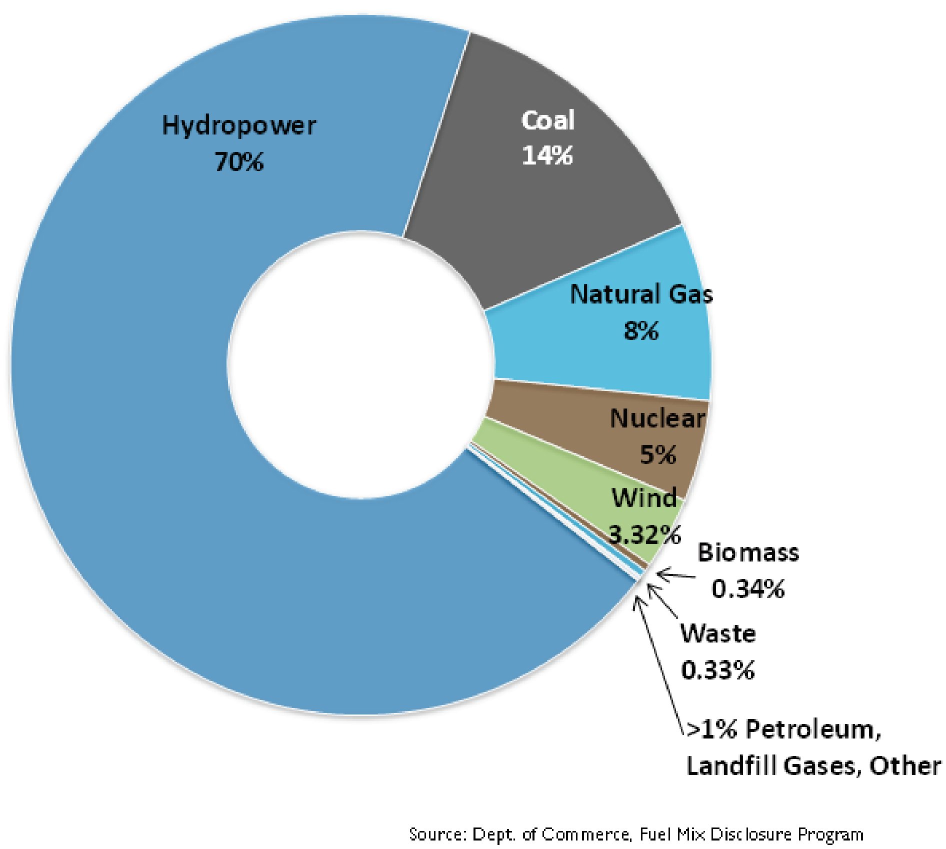
Figure 5-4: Fuels Consumed for Electricity Generated in Washington During Calendar Year 2012 (see Table 5-1).



[40] www.awea.org/learnabout/publications/reports/upload/3Q2012-Market-Reort_Public-Version.pdf

Another approach, and perhaps better estimate for the energy sources for electricity in Washington, is the mix of fuels used by utilities to serve customers in the state (Figure 5-5 and Table 5-2). Washington is part of an interconnected, multi-state, 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[41] and includes utility spot market purchases.

Figure 5-5: Fuels Consumed for Electricity Delivered in Washington During Calendar Year 2012 (see Table 5-2).



Hydroelectricity was still the dominant source, accounting for 70 percent of the electricity consumed in the state in 2012. 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 such as Montana and Wyoming. Renewable sources besides hydro accounted for approximately 4 percent of the electricity purchased by utilities for use by Washington

[41] 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.

consumers. This was less than the generation share, indicating that some of the renewable energy generated in Washington, notably wind, was sold to customers outside the state.

Table 5-1: Fuels Consumed for Electricity Generated in Washington, 2012

Fuel	Megawatt Hours	Mix
Hydropower	89,464,355	76.6%
Nuclear	9,333,709	8.0%
Wind	6,599,766	5.6%
Natural Gas	5,437,593	4.7%
Coal	3,762,957	3.2%
Wood and Wood Derived Fuels	1,374,801	1.2%
Other Gases	405,337	0.3%
Other Biomass	238,989	0.2%
Other	146,910	0.1%
Pumped Storage	43,551	0.04%
Petroleum	26,713	0.02%
Solar Thermal and Photovoltaic	794	0.0%
Total	**116,835,474**	**100%**

This table lists fuels used by electric generators physically located in the state.

Table 5-2: Fuels Consumed for Electricity Delivered in Washington, 2012

Fuel	Megawatt Hours	Mix
Hydropower	62,984,536	69.5%
Coal	12,149,258	13.4%
Natural Gas	7,439,486	8.2%
Nuclear	4,239,398	4.7%
Wind	3,011,137	3.3%
Biomass	310,812	0.3%
Waste	303,066	0.3%
Petroleum	83,665	0.1%
Landfill Gases	67,580	0.1%
Other	54,832	0.1%
Total	**90,643,771**	**100%**

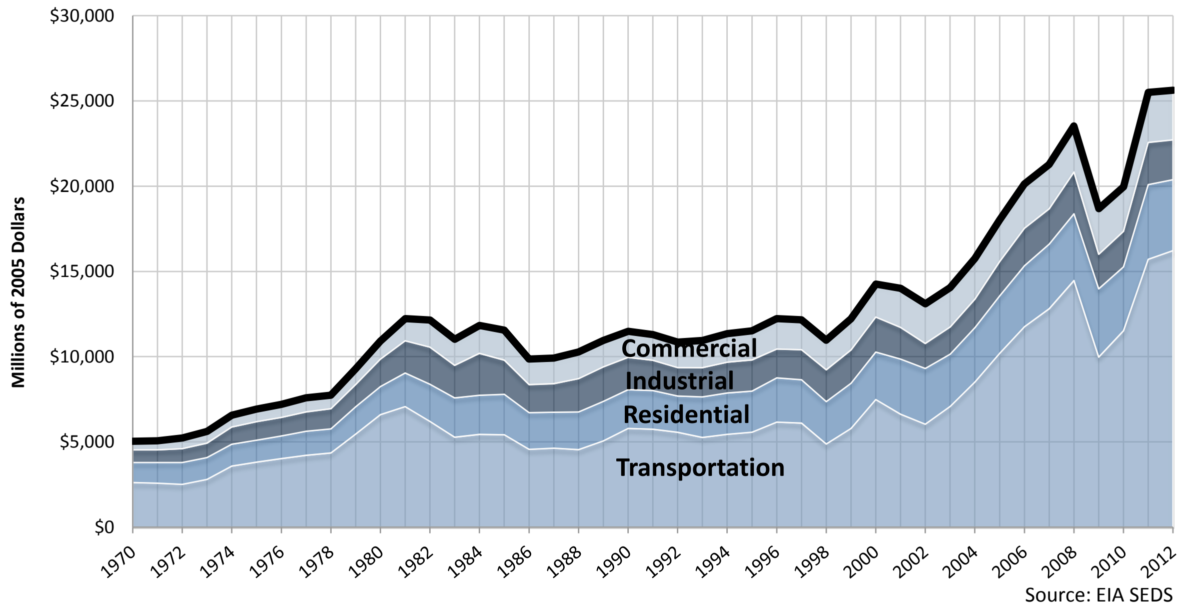
This table lists fuels used to generate the electricity purchased by Washington energy consumers, regardless of where the electricity was generated.

Source: Washington State Fuel Mix Disclosure Database

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[42] 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.

Figure 5-5: End-use Energy Expenditures by Sector, 1970-2012



Sources: EIA State Energy Data System, President's Council of Economic Advisors-2005 Annual Economic Report of the President www.eia.doe.gov/emeu/states/_seds.html

Washington's residents and institutions spent more than $26 billion on energy in 2012.[43] After peaking in the early 1980s, inflation-adjusted state energy expenditures declined and then increased modestly until 1998, primarily the result of steady population growth. During this period, energy prices generally did not keep pace with inflation. As a result, expenditures remained relatively stable despite significant growth in energy consumption.

Except for a brief respite during the 2001-02 recession, energy expenditures increased significantly from 1999 to 2008, growing at an average annual rate of 8 percent in real terms. Most of the increase was due to growing transportation sector energy expenditures. Energy expenditures also increased for the industrial, commercial, and residential sectors, but these sector increases were more modest.

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[42] 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.

[43] Expenditures are expressed in constant 2005 dollars so different years can be directly compared.

Expenditures decreased sharply during the 2007-09 recession due to a combination of less consumption and lower prices. State energy expenditures rose quickly during 2010-12 as energy prices and consumption rebounded with the economic recovery. During 2011 and 2012, the West Coast experienced higher gasoline and diesel prices due to several refinery accidents that interrupted regional fuel production.

The transportation sector accounts for the largest share of state energy expenditures: 63 percent in 2012. This proportion has grown in recent years, reflecting the increase in the real price of petroleum fuels. The industrial share of state energy expenditures has declined significantly in the last seven years, while the residential and commercial shares declined modestly.

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.[44] Key reasons are a shift in the state's economy from manufacturing to high-value businesses that are less energy-intensive and improved energy efficiency across all sectors.

Figure 5-6: Energy Consumption per Dollar of GSP, 1990-2012

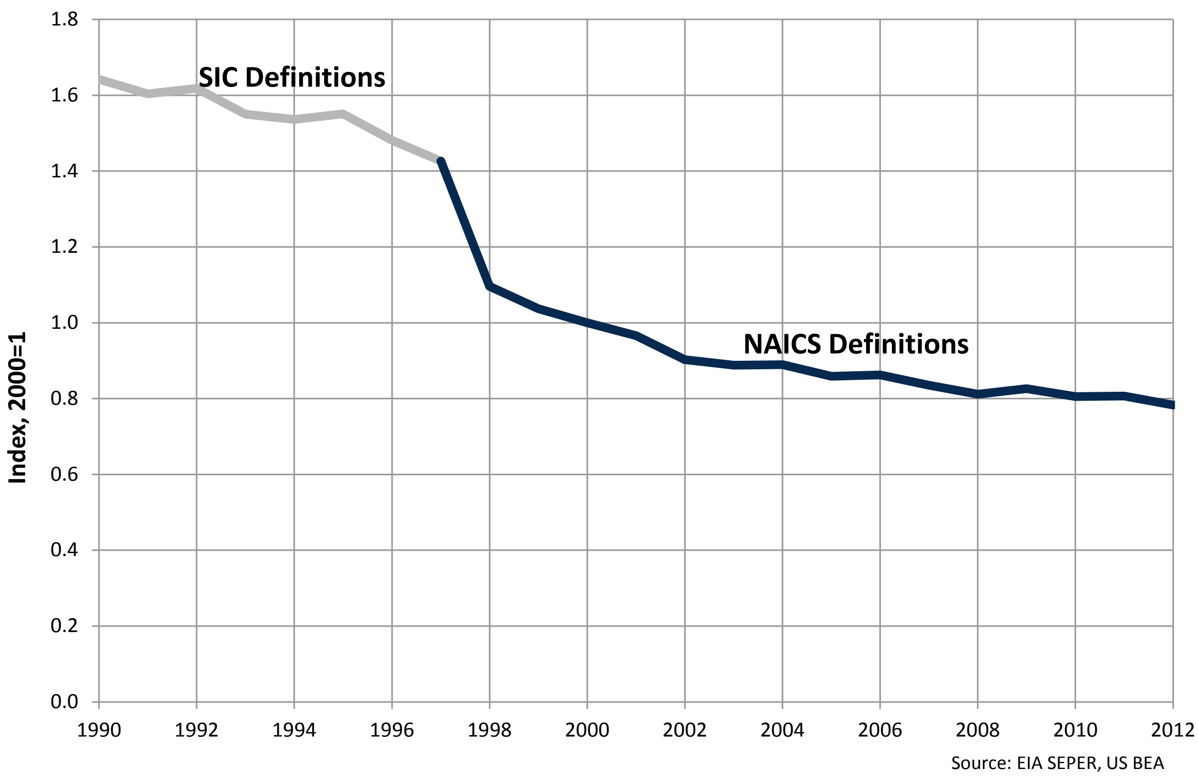


Figure 5-6 depicts this indicator of the overall energy intensity. In the last 20 years, energy consumption per dollar of GSP[45] declined approximately 51 percent.

The message from the chart is that 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 at the energy intensive industries. Gains in energy

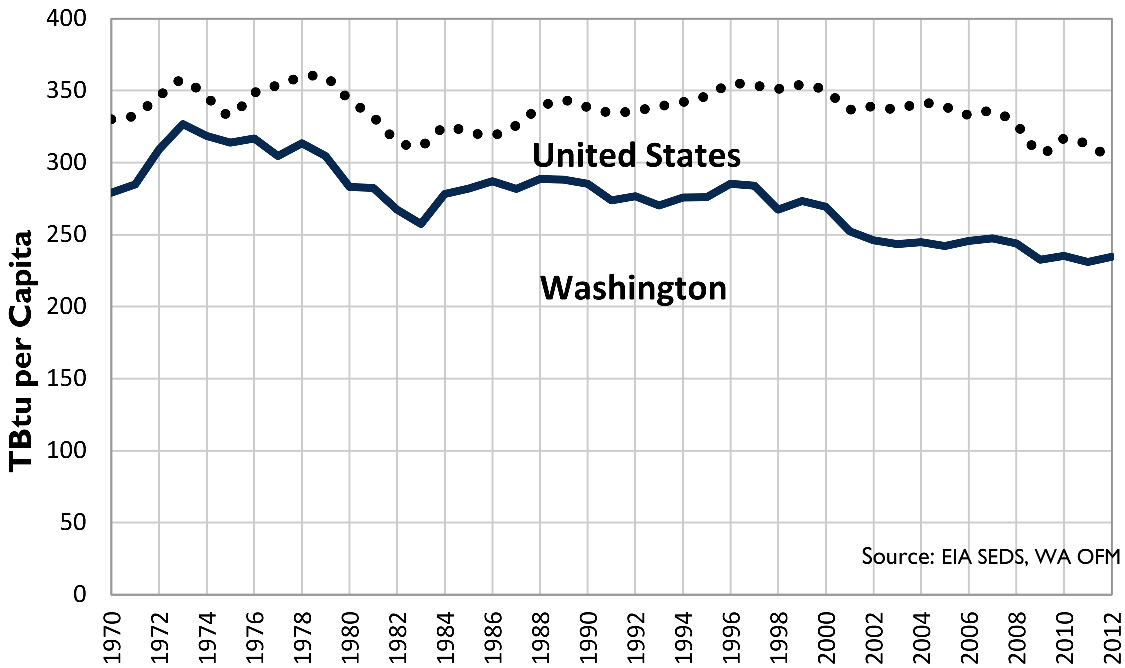
[44] Economic output (GSP) is in real dollars (millions of chained 2005 dollars). This adjusts for the effects of inflation and allows values for different years to be compared.

[45] 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.

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 state energy use being driven by growth in population. However, since 1999 energy consumption per capita has declined by 18 percent from historical levels to about 200 million Btu in 2012.

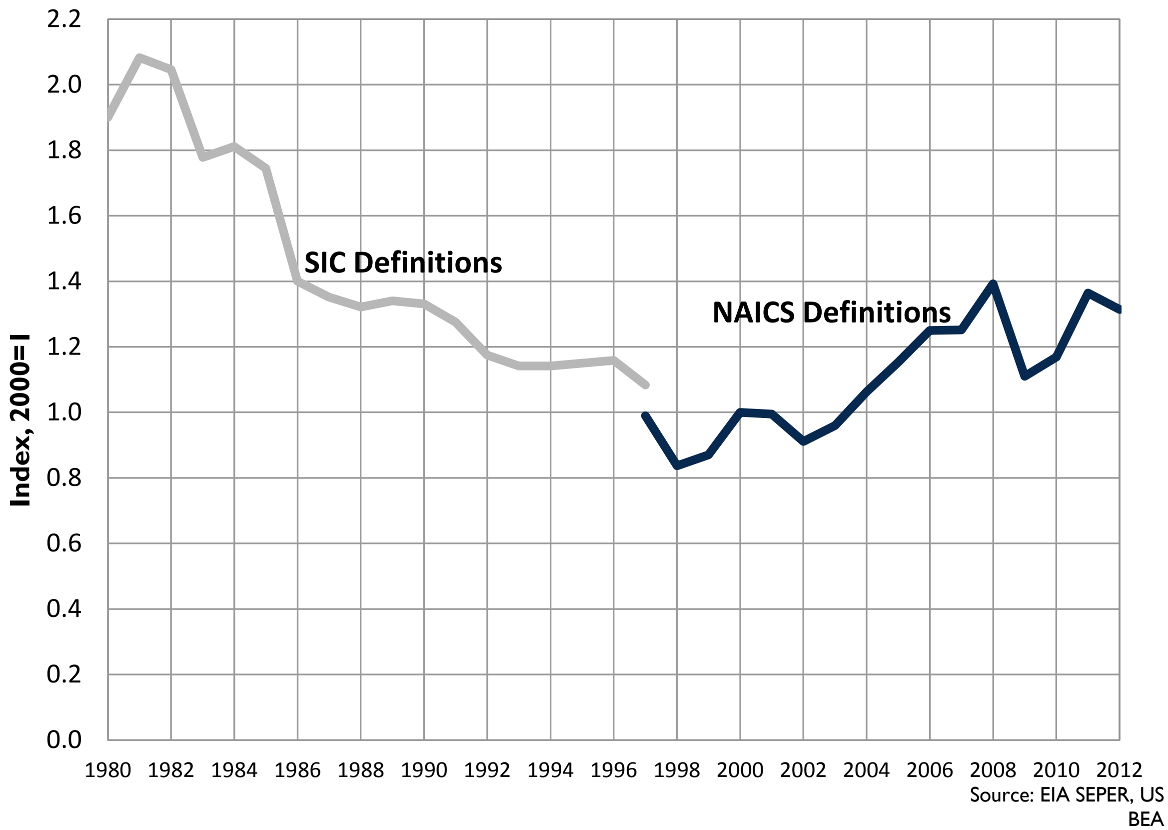
Figure 5-7: Energy Consumption per Capita, 1970-2012



Washington's annual per capita energy consumption averaged about 290 million Btu from 1970 to 1999, the energy equivalent of about 2,300 gallons of gasoline per person per year. Dips in per capita energy consumption during this period were usually 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 mainly due to increased transportation fuel use as Washingtonians drove more miles per year.

More recently our per capita energy consumption appears to have moved to a lower level, just under 240 million Btu per capita, nearly 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 2012, Washington's per capita energy consumption was about 25 percent less than the national average.

Figure 5-8: Energy Expenditures per Dollar of GSP, 1980-2012



Sources: EIA State Energy Data System, U.S. Department of Commerce, Bureau of Economic Analysis www.eia.doe.gov/emeu/states/_seds.html. GSP data at Bureau of Economic Analysis, www.bea.gov/regional/gsp/

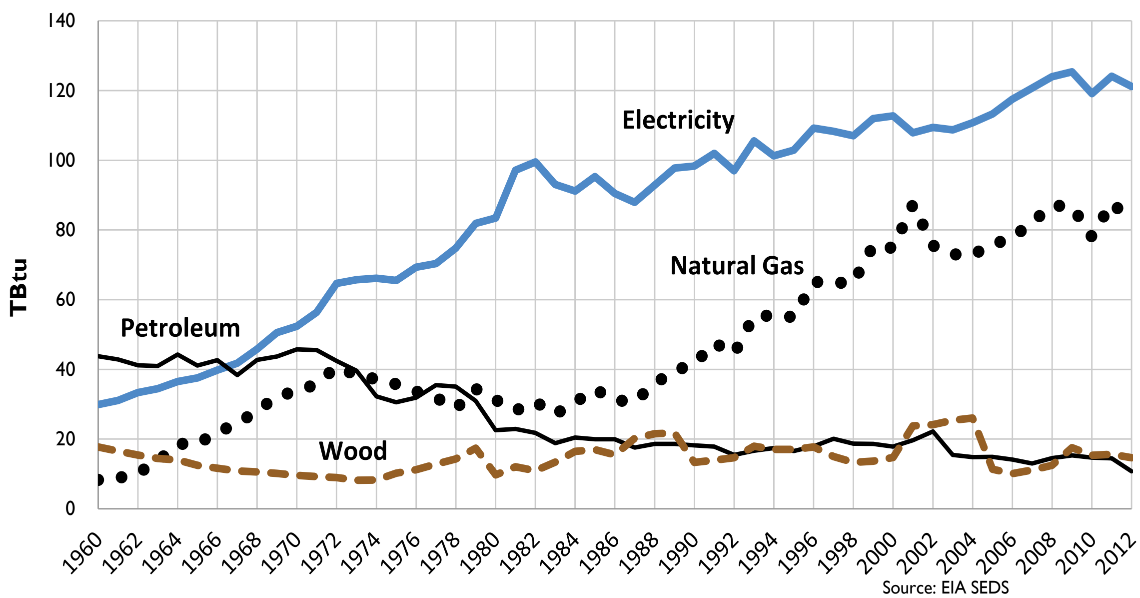
This indicator divides statewide energy expenditures by economic output, in the form of GSP (Figure 5-8). The result is an estimate of the significance of energy in Washington's economy. After peaking at more than 11 cents per dollar of GSP in 1981,[46] this value declined through the 1980s and 1990s. In 2000, approximately 5.3 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 4.4 cents in 1998 to 6.9 cents in 2012. The trend sharply reversed itself again in 2009 when energy prices and consumption plummeted during the recession in 2007-2009. The trend resumed its upward course as energy prices sharply rebounded during 2010-12.

[46] 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.

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 total household electricity consumption has slowed in the last 25 years, while growth in the use of natural gas for space and water heating rose rapidly 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, 1960-2012



Electricity share of residential energy consumption has grown steadily over the decades and accounted for a bit over half of residential energy consumption in 2012, even though 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 4.5 percent in 2012.[47]

Growth in natural gas consumption accelerated through 2001: the 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

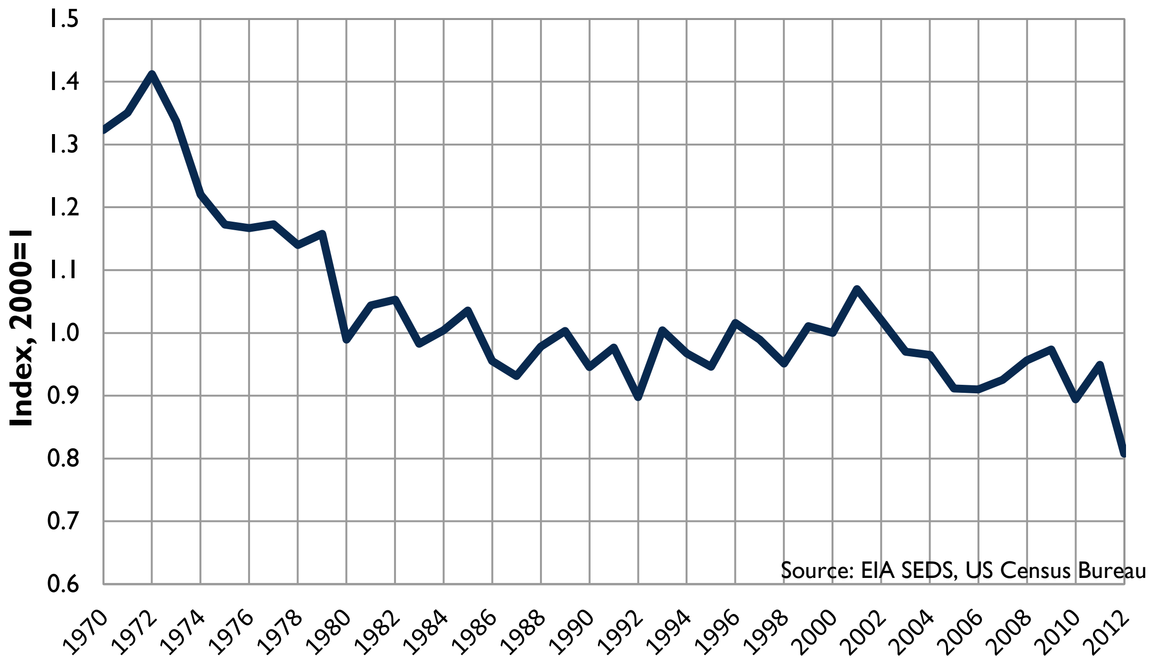
[47] The primary petroleum products consumed in households are heating oil (No. 2 distillate oil) and propane. Both are consumed mainly for space heating, although propane can also be used for cooking and water heating. Residential sector energy use does not include energy consumption for personal transportation.

both electricity and petroleum derived fuel, primarily heating oil. However, the natural gas share has declined slightly since 2002 in part due to higher gas prices, but also because electricity driven heat pumps have become competitive with natural gas.

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[48] 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. Over the last several years household energy intensity has begun a gradual decline.

Figure 5-10: Residential Energy Consumption per Household, 1970-2012



Sources: EIA State Energy Data System, U.S. Bureau of the Census www.eia.doe.gov/emeu/states/seds.html

The 1970s were characterized by higher energy prices and 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

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[48] Energy intensity is calculated by dividing total residential sector energy consumption by number of households (excludes transportation fuel unless otherwise noted).

and petroleum use were due to improvements in efficiency (e.g., adding insulation) and conservation[49] 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.

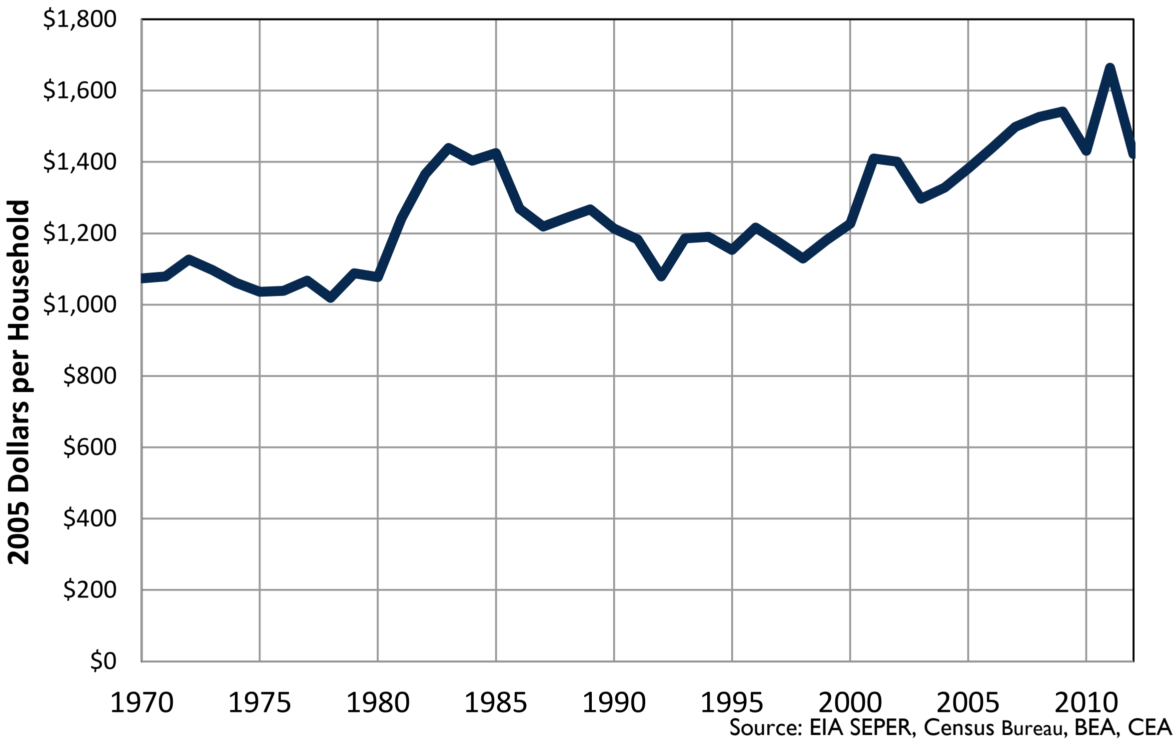
Concerted efforts to improve residential energy efficiency through building standards and codes began in the mid-1980s. However, there is little evidence of further declines in household energy use, until the last eight years. Some studies suggest that gains in energy efficiency due to building standards and codes are being mostly offset by construction of larger homes[50], more widespread use of air conditioning, and the proliferation of electricity-using appliances, computers, and entertainment systems. A higher level of household energy use may have been reinforced by relatively modest energy prices during the mid-1980s until the early 2000s. Without the building code and standard updates, household energy use would undoubtedly be higher. Note that this data does not include energy used for personal transportation, which increased during 1985-2004, and has subsequently declined.

[49] For example turning down thermostats or turning off lights.
[50] 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.

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 2012 than in 1998. Household expenditures peaked in 2011 due to a cold winter and relatively high natural gas prices (Figure 5-11).

Figure 5-11: Residential Energy Expenditures Without Transportation per Household, 1970-2012



In 2012, the average Washington household spent the inflation-adjusted sum of $1,422 (using constant 2005 dollars) for electricity, natural gas, heating oil, and propane delivered to the home. This is $293 more than households spent in 1998, but $242 less than was spent in 2011. 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 declining 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 increased during the previous decade, also contributing to higher overall residential energy expenditures. The recent trend towards lower natural gas prices and the state's emphasis on energy efficiency should help to lower household energy bills in the future.

Most presentations depicting residential energy expenditures do not include the major component of energy consumption and expenditure for most households – vehicles. The vehicle share has grown rapidly over the last decade, declined in 2009 during the 2007-09 recession, then rebounded in 2011 and 2012 as gasoline prices increased. Over the long-term increasing vehicle efficiency is forecast to slowly drive transportation costs down for consumers.

Adding energy used for personal transportation triples the annual energy bill for the average Washington household to $4,735 in 2012 (Figure 5-12 and Table 5-3).

Figure 5-12: Household Energy Bill by End Use, 2012 Dollars

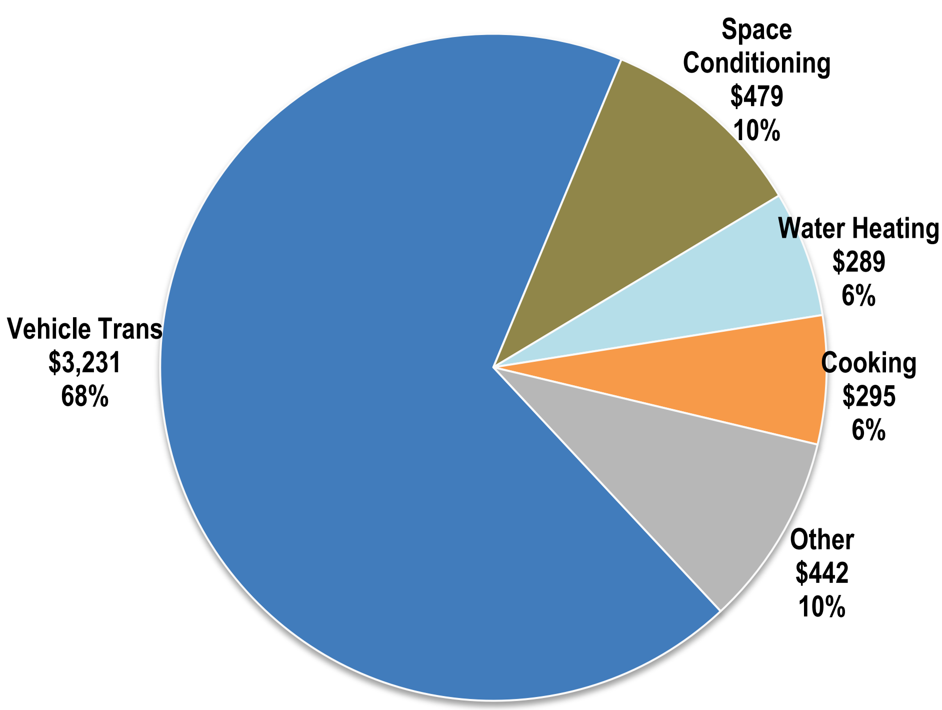


Table 5-3: Household Energy Bill With Transportation, 2012 Dollars

Average Gas price Methodology	
Space Conditioning	$479
Water Heating	$289
Cooking	$295
Other	$442
Vehicle Transportation	$3,231
Total	**$4,735**

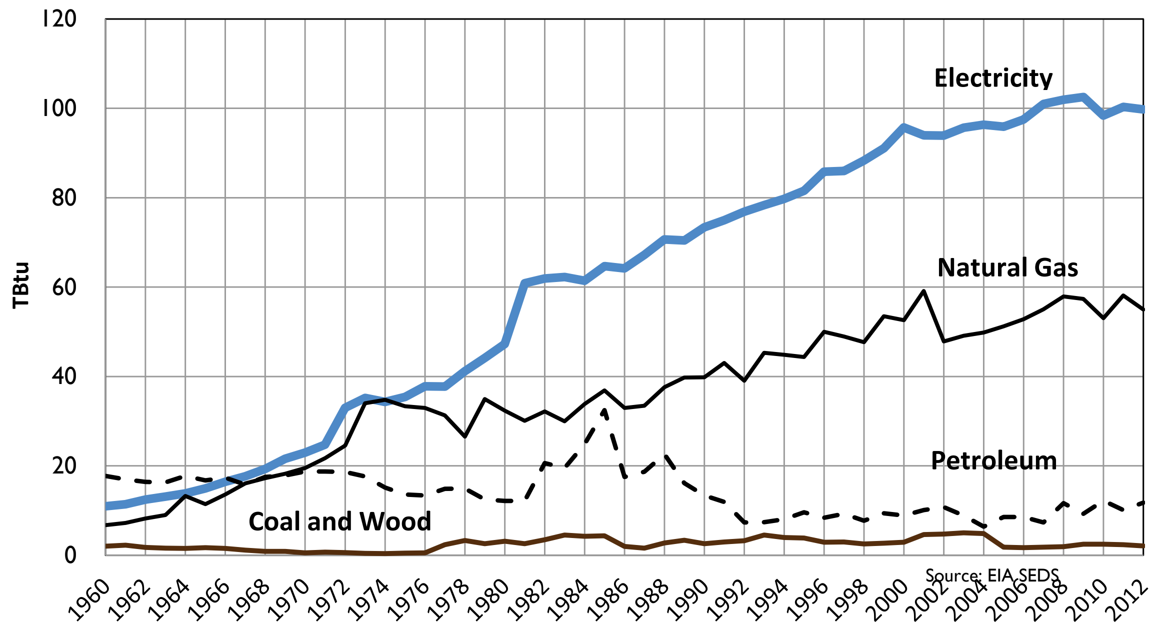
Sources: EIA State Energy Data System; Residential Energy Consumption Survey; Residential Transportation Energy Consumption Survey www.eia.doe.gov/emeu/states/seds.html

After personal transportation, the 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.

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). Their 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 after that. In 2012, electricity was 59 percent of end-use energy consumption in the commercial sector, while natural gas was 33 percent.

Figure 5-13: Commercial Energy Consumption by Fuel, 1960-2012



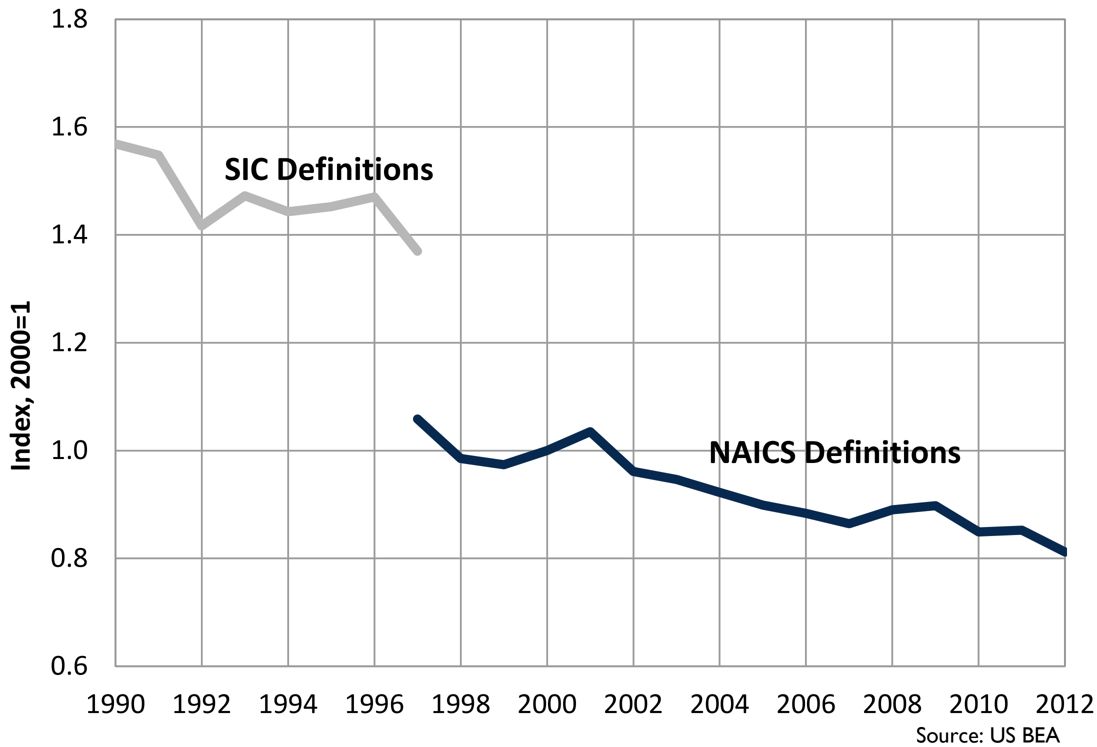
With rising use of electricity-consuming equipment, such as computers, printers, and copiers, the commercial sector became increasingly reliant on electricity during the 1970s and 1980s. Sector electricity consumption increased more than four times from 1970 to 2012.

Growth in commercial 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 commercial energy consumption in 2002, and has increased only slowly since. Petroleum consumption in 2012 was just over half of the 1970 level, declining from 30 percent share in 1970 to7 percent in 2012. Coal and wood represent under 2 percent of commercial energy use. After declining about 30 percent during the 1990s, commercial energy use relative to economic output increased in 2000 and 2001, before resuming a downward trend.

In 1997, federal economic reporting moved from the Standard Industrial Classification System (SIC) to the North American Industrial Classification System (NAICS). Energy intensities after

1997 should not be compared to intensities before it, or vice versa. A downward trend can be seen in both data sets.

Figure 5-14: Commercial Sector Energy Consumption per Real Dollar of Sector GSP, 1990-2012



Sources: EIA State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis
www.eia.doe.gov/emeu/states/seds.html

Washington's commercial sector has become less energy intensive (Figure 5-14) for the last 15 years.[51] From 1990 to 1997, commercial 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 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.

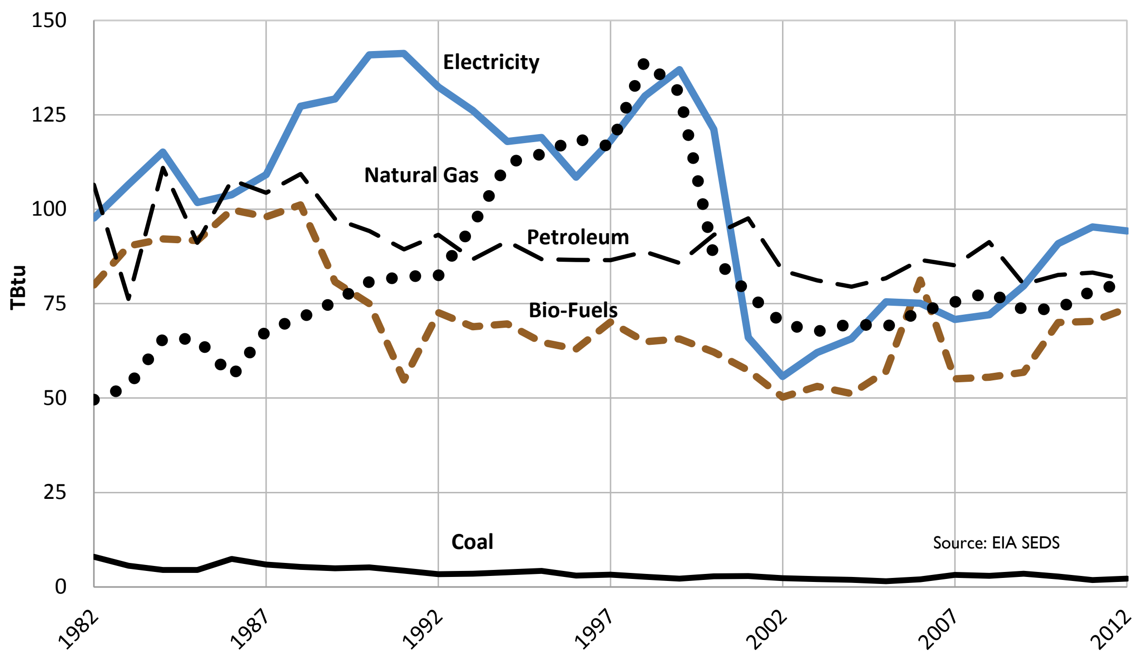
The trend appears to have briefly reversed in 2000, with growth in energy use exceeding growth in commercial sector GSP from 2000 to 2001. The change is likely due to an economic downturn at the time. However, the downward trend in energy intensity returned in 2002 as the economy picked up with little or no increase in commercial energy use. Commercial energy intensity ticked upward during the 2007-09 recession, but has since resumed its downward trend.

[51] 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, 1960-2012



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 25 percent of industrial consumption in 2012, much of which occurs at refineries, while electricity and natural gas accounted for 28 and 24 percent respectively. Biofuels[52] share is sensitive to activity in the timber industry and accounted for 22 percent in 2012; 19 percent during the recession year of 2008. Coal use accounted for less than 1 percent of industrial consumption in 2012, declining from a high of 14 TBtu in 1976 to 2.2 TBtu in 2012.

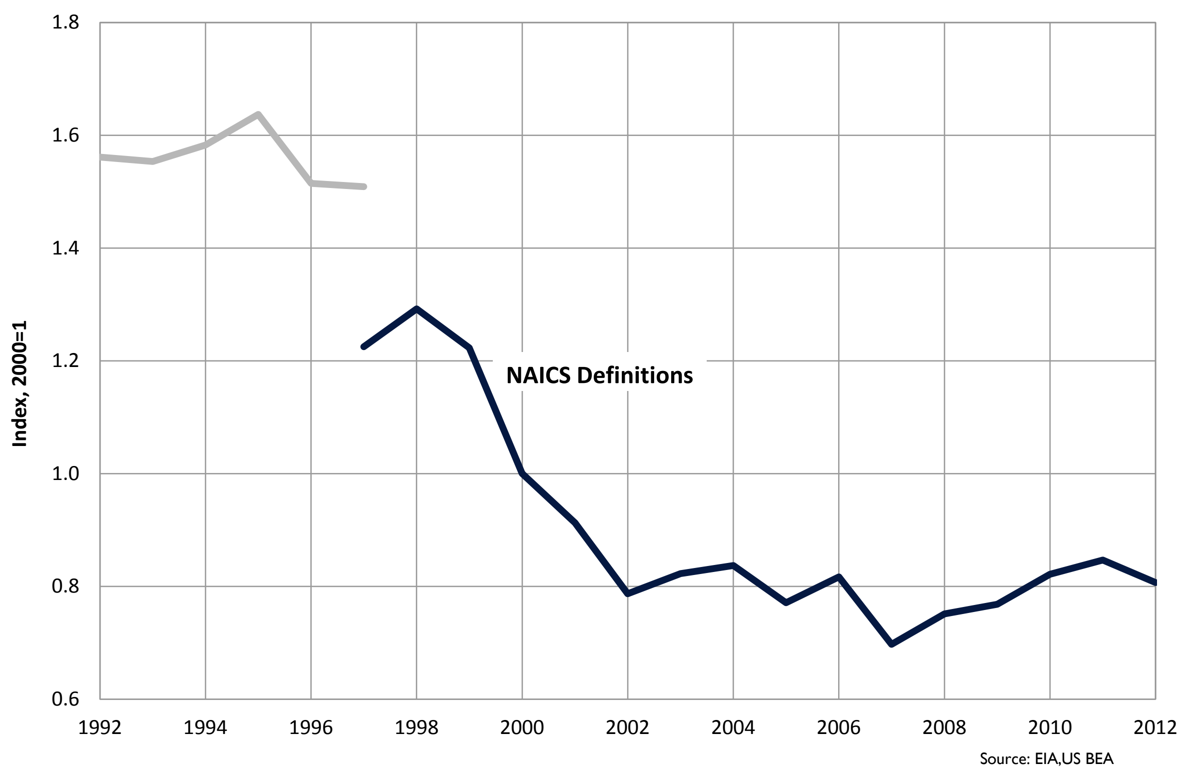
Energy consumption in the industrial sector varies more than the other sectors, with peaks and valleys that mirror economic activity. When industrial production declines, energy use declines. High energy prices can also contribute to lower production, particularly in energy intensive industries. Peaks in industrial energy use have occurred in 1973, 1988, and 1998. Between the

[52] 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.

1998 consumption peak and 2002 industrial 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 2012 it was 27 percent higher than in 2002.

Energy intensity in Washington's industrial sector was relatively constant during the 1990s, but declined significantly from 1998 to 2002 (Figure 5-16) and has remained relatively constant since.

Figure 5-16: Industrial Sector Energy Consumption per Real Dollar of Sector GSP, 1990-2012



Sources: EIA State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis [*www.eia.doe.gov/emeu/states/seds.html*](www.eia.doe.gov/emeu/states/seds.html)

Washington's industrial sector is less energy intensive than it was two decades ago when comparing industrial energy use to industrial GSP.[53] Energy intensity did not change much during the 1990s before dropping nearly 40 percent from 1998 to 2002. This reflected a decline in production by several energy intensive industries in Washington. This was true from 1998 to 2002 when industrial energy use dropped 38 percent, but industrial GSP increased 3 percent.

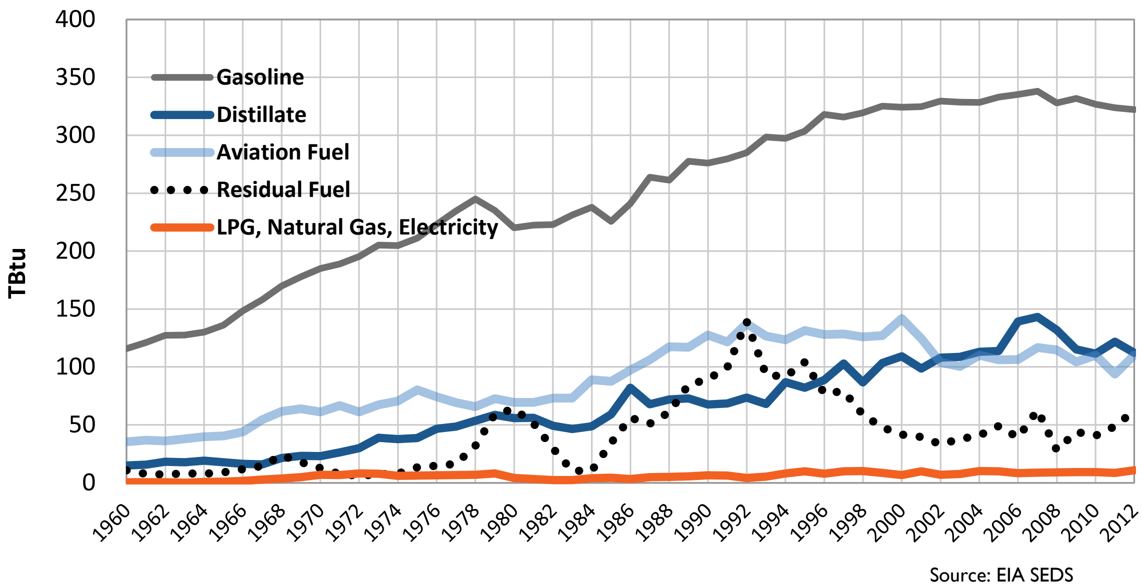
[53] Because there was a change in definitions for industry classifications used in the definition of GSP in 1997 (from SIC to NAICS), an exact comparison of values before and after 1997 is not possible.

Indicator 10: Transportation End-Use Energy Consumption by Fuel

Gasoline[54] accounts for just over half of transportation sector energy use in Washington. Petroleum fuels accounted for 98.2 percent of transportation energy use in 2012. Washington's status as a major seaport and aviation hub means significant consumption of aviation and marine fuels as well.

Except for the periods between 1978 and 1981, and after 2007-08 (when prices rose significantly), gasoline consumption has generally increased as population grew and demand for travel outstripped gains in vehicle fuel efficiency (Figure 5-17). Overall, gasoline consumption roughly tracked population growth until 2005. In 2012, consumption was 74 percent greater than in 1970, whereas the state population increased by 100 percent.

Figure 5-17: Transportation Sector Consumption by Fuel, 1960-2012



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

Consumption of distillate fuels in trucks, ships, and railroads grew at a much faster rate than other transportation fuels, reaching levels in 2012 that were four 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 two-thirds the increase for motor gasoline. Aviation fuel consumption more than doubled between 1970 and 2000, but has since dropped 20 percent due to fuller flights and more efficient aircraft.

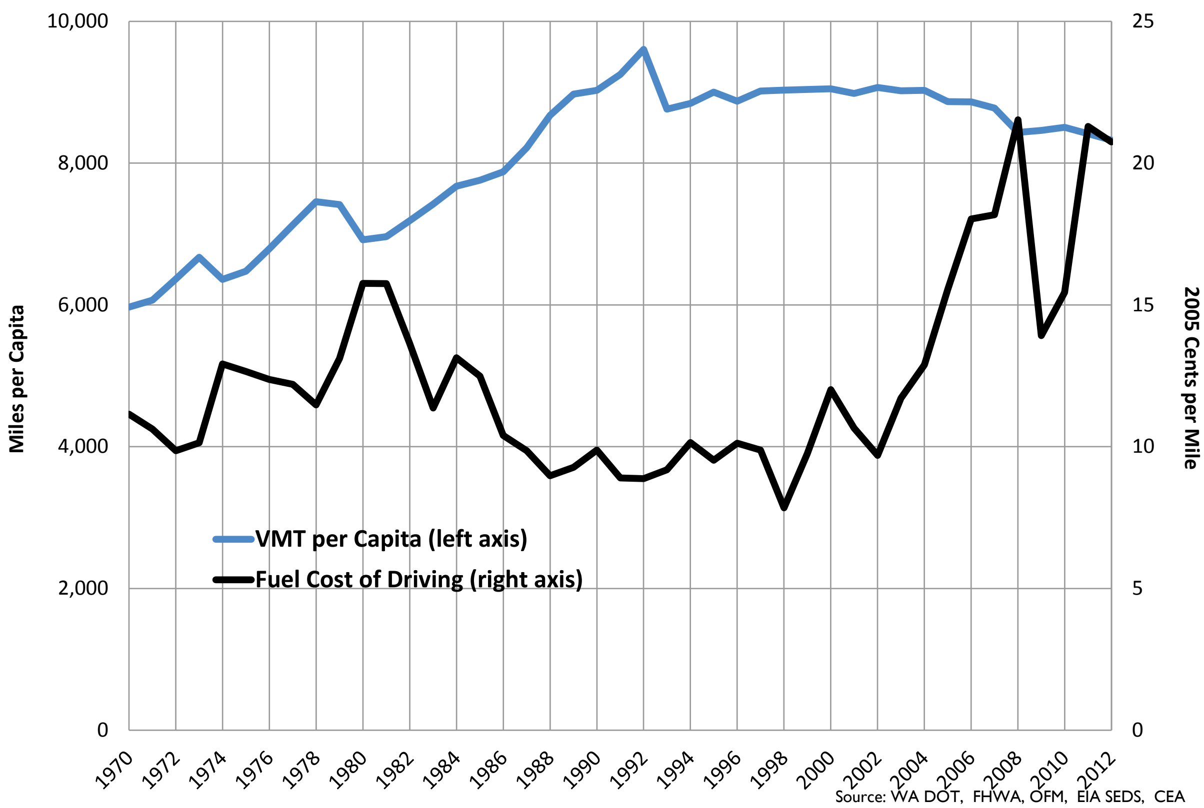
[54] Motor gasoline figures include some consumption for off-road uses such as recreational vehicles and agricultural uses. No. 2 distillate, also known as diesel fuel, is used by large trucks, ships, and railroads. The only transportation use for residual fuel is by very large ships. Aviation fuel includes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

Residual fuel consumption is subject to price-induced volatility because it can be stored for long periods of time without degrading. 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.

Indicator 11: Miles Driven and Transportation Fuel Cost of Driving

Vehicle miles per capita increased during the 1980s, stabilized during the mid-1990s, and began to decline around 2005. Washingtonians drove about 40 percent more miles per capita in 2012 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, 1970-2012



Sources: EIA State Energy Data System; President's Council of Economic Advisors; Federal Highway Administration, Washington State Department of Transportation, Washington State Office of Financial Management

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, increased in 1974, 1979-1980, and 2007-2008, and 2012-2013, as a result of oil price shocks or refinery mishaps. 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.

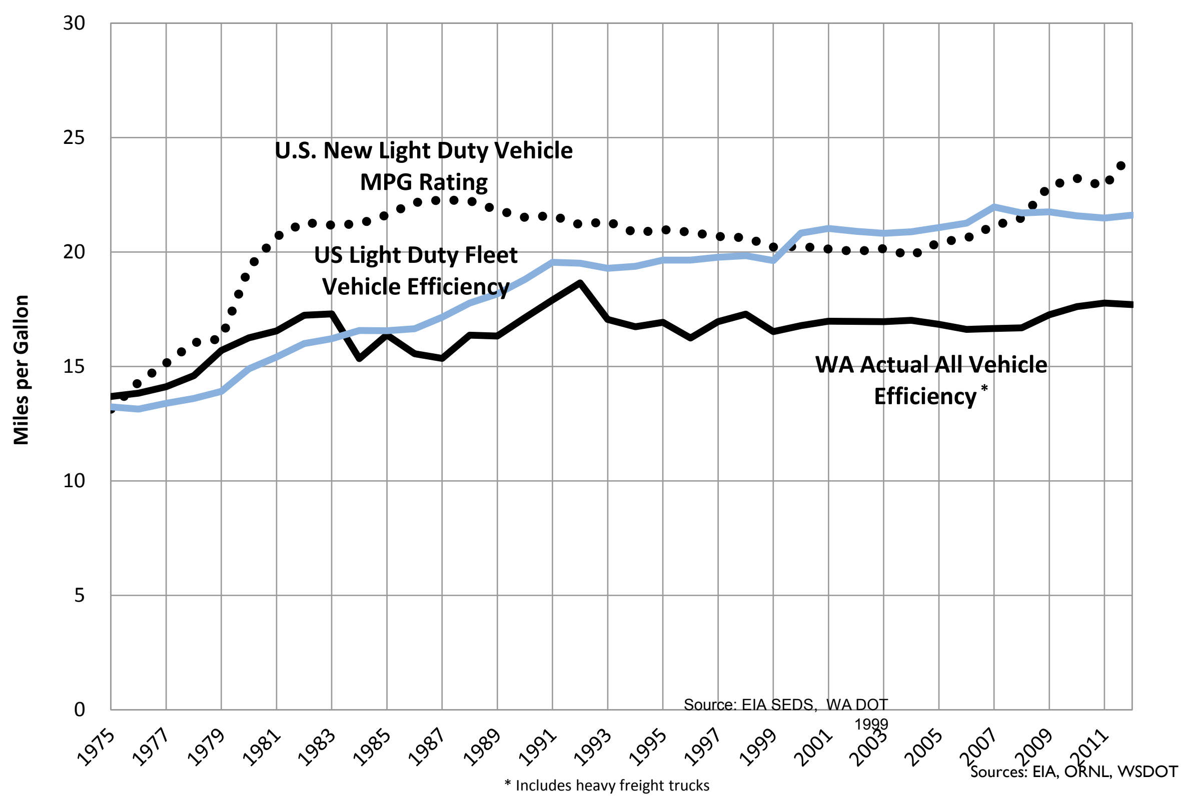
The spikes in fuel cost of driving generally coincided with the beginning of economic downturns that could also explain the small declines in per capita VMT. Long-term factors such as land-use patterns, commuting habits, and the long lifetimes of vehicles (limiting the ability to switch to fuel efficient 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). The real price of gasoline changed little over the next 12 years and, as a consequence, new vehicle fuel efficiency declined slightly. 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 and 2012, 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 during 2006-2008 with higher fuel prices and the onset of a recession. The fuel cost of driving reached a peak high of 21.5 cents per mile in 2008, with 2012 a close second at 21.3 cents per mile.

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, 1970-2012



Sources: EIA State Energy Data System; Federal Highway Administration; Washington State Department of Transportation; Oak Ridge National Laboratories Center for Transportation Analysis

Like other sectors, Washington's transportation sector has become more energy efficient over the years. The average efficiency of Washington's total vehicle fleet is in shown Figure 5-19. This metric includes both light and heavy-duty vehicles (freight), and is based on estimated total miles driven divided by total gasoline and road diesel fuel consumption. It is not directly comparable to the U.S. light-duty fleet efficiency line in Figure 5-19. Washington's total vehicle fleet efficiency increased from 12.6 miles per gallon (mpg) in 1975 to 18.7 mpg in 1992. However, this came to an end in the 1990s when Washington's vehicle fleet efficiency declined by 2.0 miles per gallon. Several factors 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 several years suggest that the total vehicle fleet fuel efficiency is improving again.

Gains in the efficiency of the U.S. and Washington light-duty vehicle fleets 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 it did not apply to the largest pickup trucks. As a result the increasing popularity of trucks and SUVs caused the fuel efficiency of the average new vehicle to drop by two mpg between 1988 and 2002. By 2005, the downward mpg trend reversed itself and the recent adoption of higher national CAFE standards (2007, 2010, and 2012 updates) has contributed to increasing new vehicle fuel efficiency over the past 6 years. This trend is expected to continue through the next decade.

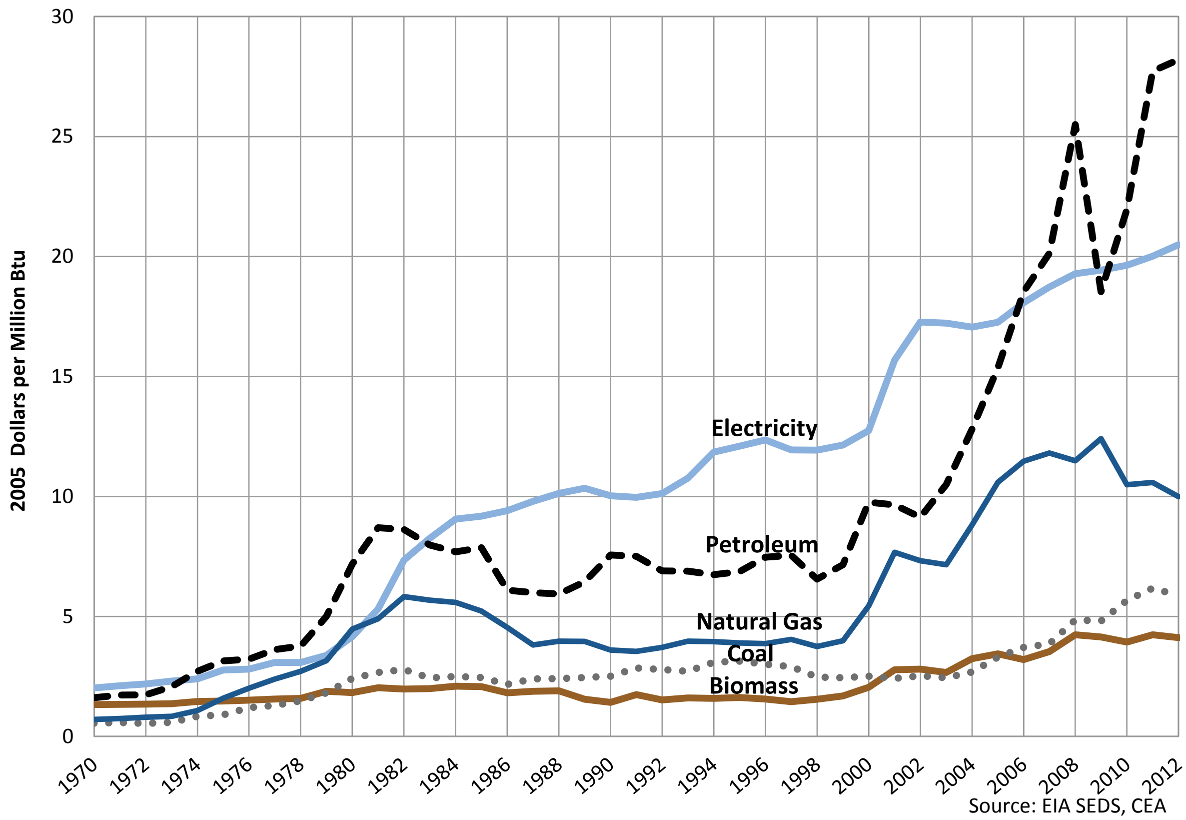
In 2012 the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration developed standards to improve the fuel economy of medium- and heavy-duty freight trucks. They will update these standards by 2016. These efforts will deliver significant and long-term fuel savings, as heavy trucks put on a large number of miles every year and have long service lifespans.

It is important to note 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. 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 1990s) 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.

Indicator 13: Average Energy Prices by Fuel

After a long period of stability from 1985 to 2000, Washington's real energy prices (constant 2005 dollars) began to rise during the previous decade, as shown in Figure 5-20.

Figure 5-20: Average Energy Prices by Fuel, 1970-2012



Sources: EIA State Energy Data System; President's Council of Economic Advisors
www.eia.doe.gov/emeu/states/_seds.html

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 relatively short-lived. Real petroleum prices more than doubled from 1972 to 1981, then returned close to pre-1974 levels by 1986, where they remained for almost 15 years. Real petroleum and natural gas prices began rising in 1999, reaching record levels by 2007-2008. Petroleum fuel prices declined during the 2007-09 recession, but continued their upward trend in 2010 as strong global demand for this source of fuel resumed. Petroleum prices reached new record levels in 2012.

Real natural gas prices followed a similar trend, rising steeply during the 1970s, falling during the 1980s, and staying relatively stable in the 1990s. Natural gas prices increased significantly during the previous decade and peaking in 2009. They declined as the shale gas boom delivered new supplies of gas, causing wholesale prices to drop sharply.

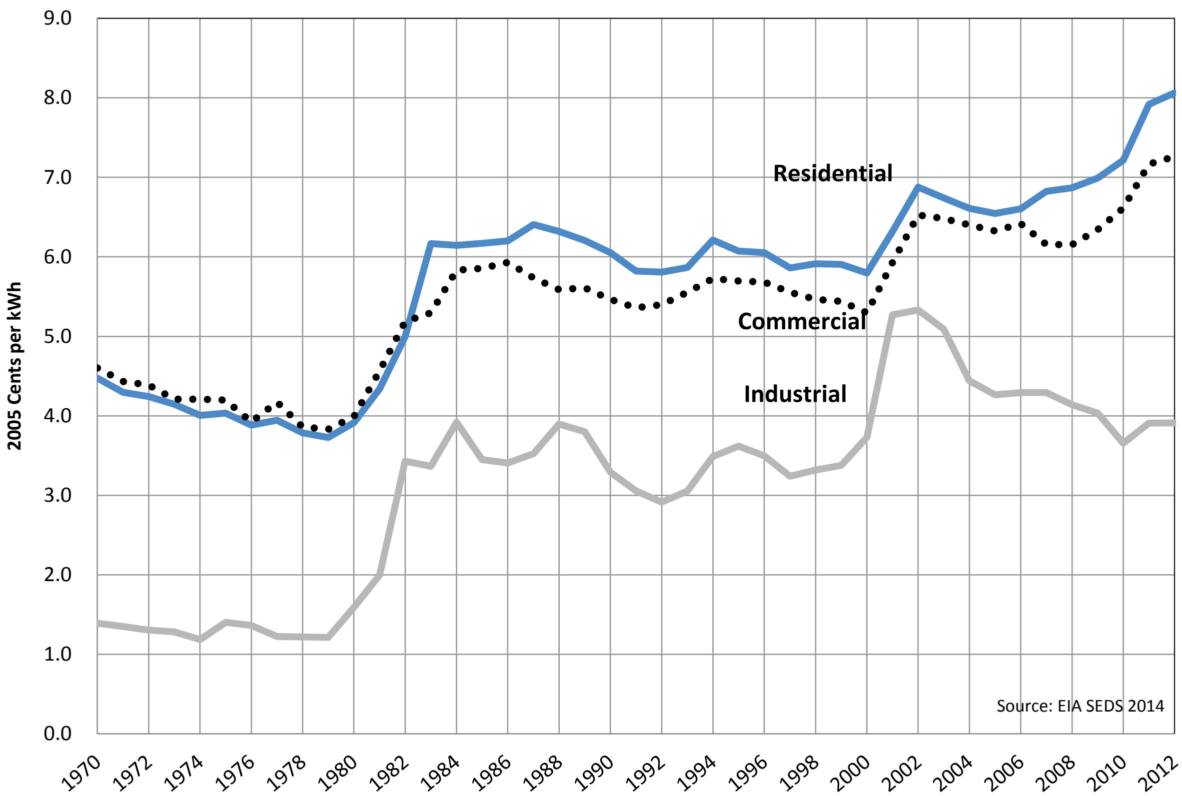
The average price of electricity, which had been low and stable for years, almost doubled between 1978 and 1984 as the costs of new nuclear power plant projects in Washington, most of which were never completed, were incorporated into electric utility rates. In contrast to oil and natural gas prices, real electricity prices did not decline from the level they reached during the early 1980s. Even though electricity prices in Washington tend to be lower than in other parts of the country, until 2005 electricity was the most expensive primary energy source in Washington (on a Btu basis). Real electricity prices rose in 2000 and 2001 after 15 years of relative stability, and have continued to rise at a slower rate over the past decade.

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.

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, 1970-2012



Sources: EIA State Energy Data System; President's Council of Economic Advisors. EIA Electric Sales, Revenue, and Average Price report.www.eia.gov/electricity/sales_revenue_price/. EIA State Energy Data System www.eia.doe.gov/emeu/states/_seds.html

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 when prices began to go up again, particularly for the residential and commercial sectors. In contrast, industrial sector electricity prices peaked in 2002, declined for several years, then stabilized near 4 cents per kWh. 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 2012 were nearly identical. Industrial sector prices have been more volatile than residential and commercial prices. Industrial electricity prices in 2012 were more than 250 percent greater than 1970, versus 80 and 58 percent increases for the residential and commercial sectors.[55] On a per unit basis, the average price increase from 1970 through 2012 also varied: 3.5 cents per kWh for residential, 2.7 cents per kWh for commercial, and 2.5 cents per kWh for industrial. Washington exhibits significant variation in price from utility to utility.

[55] 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.

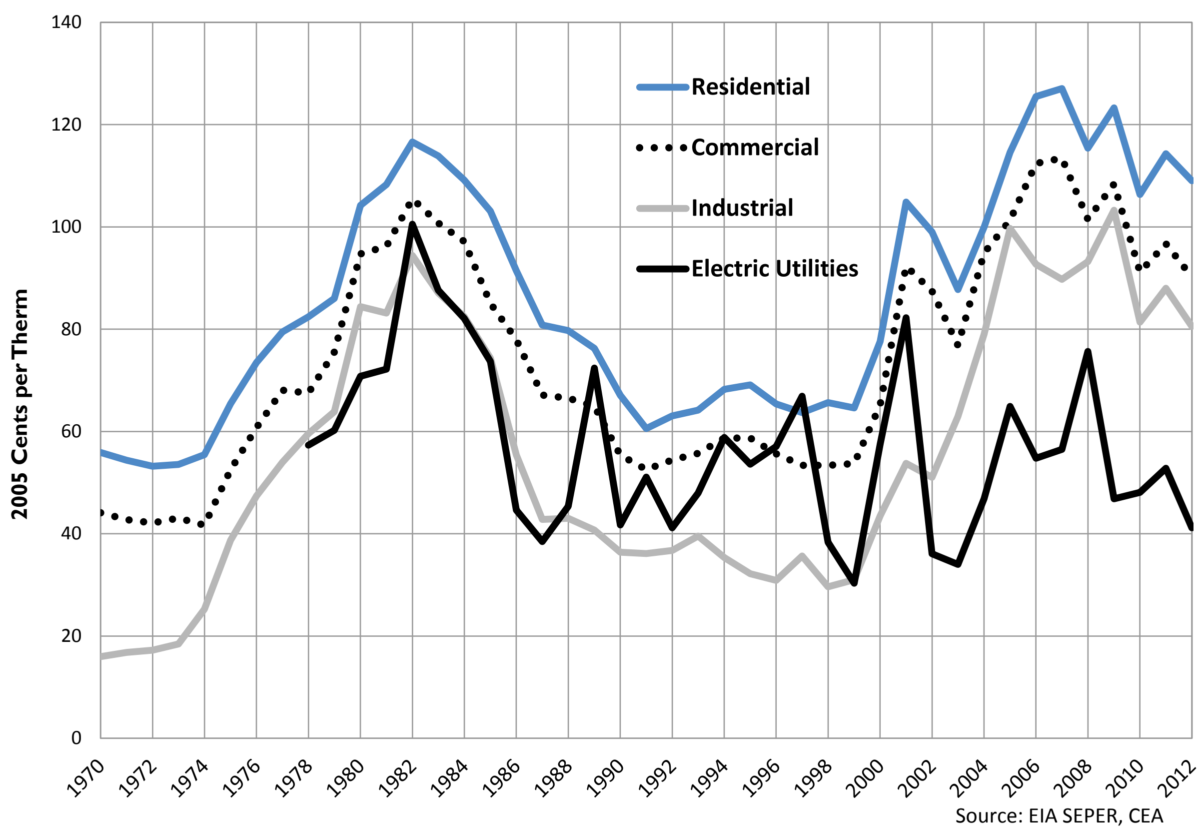
Indicator 15: Natural Gas Prices by Sector

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. The trend towards lower natural gas prices has continued through 2012.

Figure 5-22: Natural Gas Prices by Sector, 1970-2012



Sources: EIA State Energy Data System; President's Council of Economic Advisors www.eia.doe.gov/emeu/states/_seds.html.

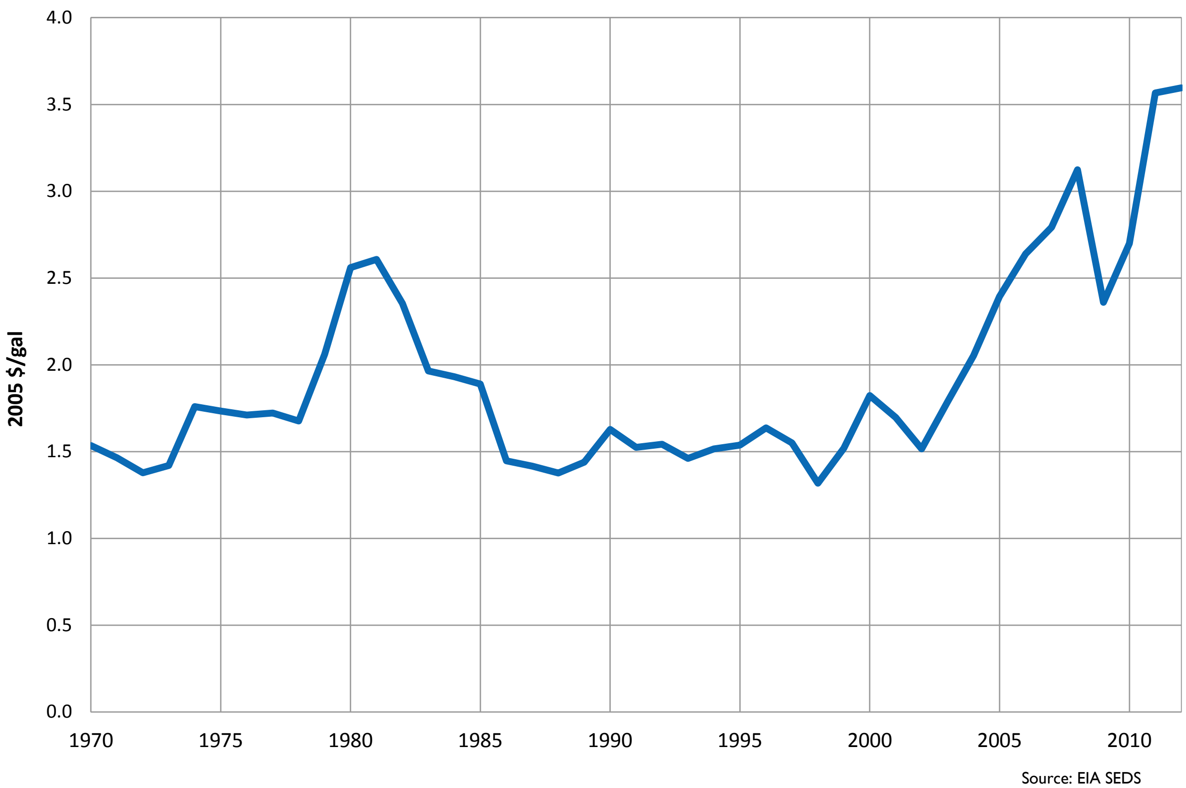
On a percentage basis, average industrial natural gas prices have been significantly lower than the other sectors, but by 2012 that relative difference had narrowed. Many large industrial customers began to make bulk purchases of commodity gas from suppliers other than their local utilities during the 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 fifteen years. 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.

Indicator 16: Gasoline Prices

Adjusted for inflation, gasoline prices[56] 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 2012.

Figure 5-23: Washington State Gasoline Prices, 1970-2012



Sources: EIA State Energy Data System; President's Council of Economic Advisors. For fuel-price trends see EIA's weekly Gasoline and Diesel Fuel price update, www.eia.gov/petroleum/gasdiesel/.

For more than 30 years, except from 1979 to 1982 when prices spiked due to the Middle East conflict, inflation-adjusted gasoline prices in Washington were relatively stable. Since 2003 gasoline prices have generally increased. 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 in 2001 briefly interrupted this climb in prices, but by 2006 the price of a gallon of gasoline in Washington exceeded the peak price observed in 1981. Gasoline reached at $3.12 per gallon in 2008 but fell

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

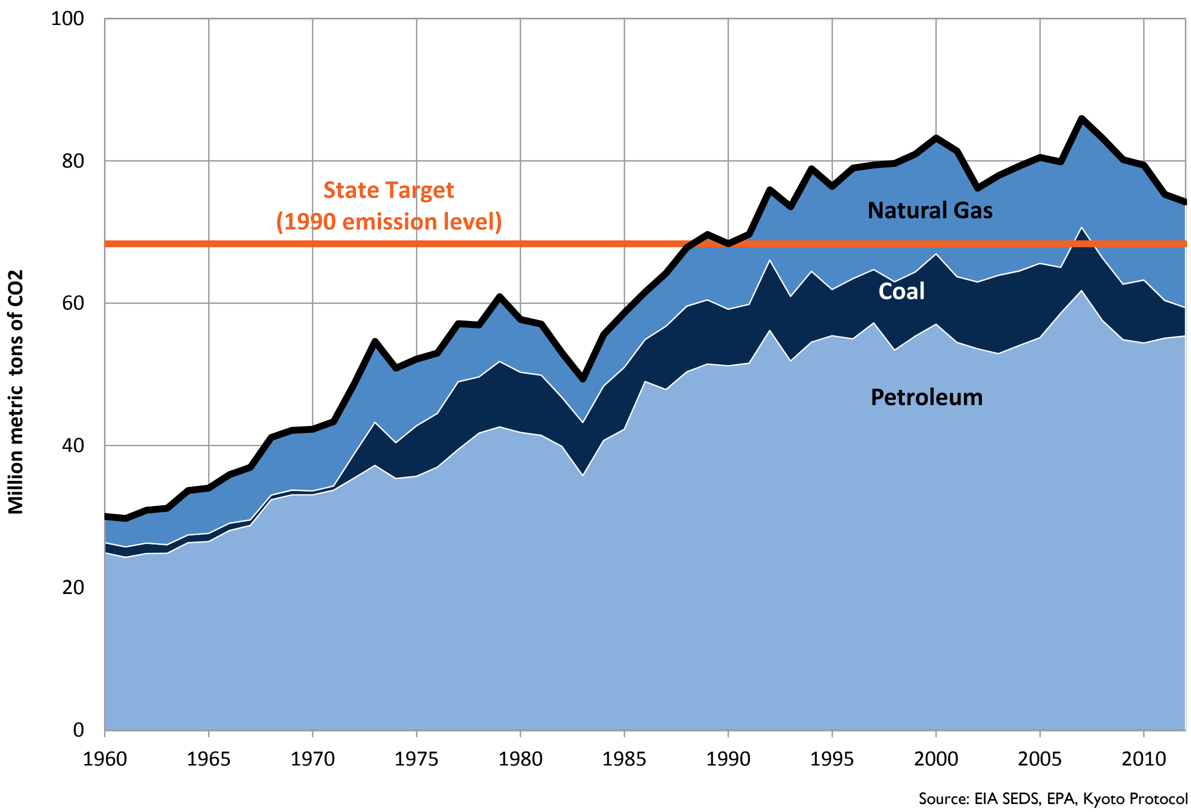
dramatically during the recent recession. With economic recovery in the U.S. and the world, gasoline prices began increasing in 2010 and reached a new peak in 2012 of $3.60 per gallon.

The majority of petroleum for Washington comes from Alaska, but increasing amounts are arriving from the Canadian oil sands and the Bakken region of North Dakota. Gasoline prices in Washington, even excluding taxes, tend to be a little bit higher than the national average.

Indicator 17: Energy-Related Carbon Dioxide Emissions

Statewide energy-related carbon dioxide emissions from 1980 through 2012 are determined and posted by the EIA, and are shown below for Washington State.[57] 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 75 percent of CO2 emissions from energy use in Washington in 2012.[58] In 1970, the share for petroleum related CO2 emissions was 78 percent.

Figure 5-24: Carbon Dioxide Emissions from Energy Use by Fuel Source, 1960-2012



Sources: EIA, CO2 Energy Emissions by State. For more information on CO2 emissions see EIA State Level Energy Related Carbon Dioxide Emissions, www.eia.gov/environment/emissions/state/analysis/.

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-

[57] 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.

[58] 2012 was a strong hydropower year and a relatively mild winter. Natural gas and coal consumption were much lower in 2012, which boosted the petroleum share of energy related emissions.

24 presents the trend in state energy-related CO_2 emissions. The orange line illustrates the 1990 level of energy-related CO_2 emissions. This not the same as the state target of 1990 level of GHG emissions, which includes CO_2, methane and other gases. However, the figure is indicative of the size of the reduction that must be realized for the state to meet the 2020 GHG emission target.

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 five years due to the recession, reduced demand due to higher energy prices, and increases in energy efficiency standards.

Consumption of petroleum products, the vast majority for transportation, accounted for most of the growth in Washington's energy-related CO_2 emissions since 1970. Emissions from coal exhibit the largest relative increase since 1970 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 now accounts for a larger share of Washington's CO_2 emissions than coal.

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 U.S. 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.

In the last biennial report, we indicated that we would evaluate the items included in the SEDS petroleum category in order to remove petroleum products not related to the production or consumption of energy. We identified and removed the following products, and this exclusion has been made through all of the indicators: asphalt and road oil, petrochemical feedstock, lubricants, petroleum coke, special naphtha, unfinished oils, unfractionated stream, waxes, and aggregated items in 'miscellaneous petroleum'. These petroleum items are primarily used in the industrial sector, 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 that 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: Energy Indicator Data

Appendix B - Energy Indicator Data

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.	renew. oth.	year
1970	142	61.7	349	289	841	66.5	5.9	243	28.7	158	447	0	1970
1971	147	65.9	355	296	864	67.2	6.4	250	27.7	165	459	0	1971
1972	157	76.7	390	300	924	67.0	36.6	262	31.5	180	480	0	1972
1973	152	87.2	400	327	966	66.2	65.0	239	48.3	208	496	0	1973
1974	144	84.6	385	327	940	65.2	54.2	287	43.4	191	474	0	1974
1975	142	82.8	347	349	921	64.3	76.2	290	36.4	171	478	0	1975
1976	146	84.6	342	365	938	71.4	81.2	326	26.6	155	487	0	1976
1977	151	86.3	351	375	964	78.3	102.4	231	46.5	149	520	0	1977
1978	154	85.9	358	403	1,001	81.0	84.7	307	45.3	133	546	0	1978
1979	165	94.1	347	434	1,041	77.5	99.0	274	39.3	166	552	0	1979
1980	148	94.9	356	413	1,012	88.3	91.0	287	22.3	135	541	0	1980
1981	161	105.6	378	403	1,048	95.1	90.9	326	22.5	131	534	0	1981
1982	164	118.2	342	377	1,001	91.3	74.1	305	40.2	114	524	0	1982
1983	153	116.2	332	363	965	104.8	80.2	300	38.1	112	476	0	1983
1984	160	124.3	389	390	1,062	110.7	82.3	290	57.6	132	544	0	1984
1985	168	138.4	355	411	1,073	112.4	93.7	268	85.4	140	552	0	1985
1986	157	116.6	375	480	1,129	118.3	63.3	275	89.3	122	623	0	1986
1987	157	120.9	386	494	1,157	123.3	95.7	242	57.7	136	630	0	1987
1988	169	133.6	415	517	1,235	128.2	99.1	236	63.6	151	663	0	1988
1989	179	130.3	388	558	1,255	109.2	96.7	248	64.7	168	686	0	1989
1990	172	130.1	396	568	1,266	94.4	85.6	303	60.8	168	688	0	1990
1991	182	133.7	372	577	1,265	75.1	89.1	310	44.3	179	690	0	1991
1992	172	127.3	384	643	1,327	99.6	106.1	235	59.6	181	752	0	1992
1993	196	136.3	381	592	1,305	103.5	97.8	231	74.9	230	698	1	1993
1994	192	137.3	395	607	1,332	104.4	106.9	225	70.4	263	718	1	1994
1995	192	140.5	390	631	1,353	93.0	69.8	283	72.9	264	736	1	1995
1996	210	148.1	380	620	1,358	90.9	90.9	339	58.7	284	728	1	1996
1997	209	148.2	395	636	1,387	96.5	80.5	354	65.5	268	745	1	1997
1998	204	147.3	426	601	1,378	90.2	103.5	271	72.6	303	707	1	1998
1999	220	157.7	422	612	1,412	91.6	96.9	330	63.6	302	718	1	1999
2000	221	161.2	367	624	1,372	92.1	106.2	273	89.7	298	742	1	2000
2001	239	168.7	302	597	1,306	94.8	99.4	188	86.2	322	718	1	2001
2002	232	157.6	262	581	1,232	93.6	100.8	265	94.5	240	692	5	2002
2003	223	159.6	266	583	1,232	101.4	118.2	242	79.4	256	681	7	2003
2004	225	158.6	268	602	1,254	94.5	112.5	239	93.7	270	694	8	2004
2005	216	158.6	284	612	1,270	88.6	112.3	240	86.0	272	708	6	2005
2006	220	161.9	318	628	1,327	111.8	69.2	271	97.3	271	730	11	2006
2007	227	166.3	289	670	1,353	89.2	95.7	259	85.1	279	767	25	2007
2008	238	174.5	300	612	1,324	94.9	94.6	255	96.9	307	722	37	2008
2009	245	172.9	293	604	1,316	104.8	84.0	237	69.4	320	701	36	2009
2010	228	167.5	319	598	1,312	124.6	94.9	222	96.6	295	699	48	2010
2011	243	171.3	329	597	1,340	124.3	57.0	297	50.3	272	697	63	2011
2012	230	169.4	332	618	1,348	123.2	42.8	283	97.8	272	712	64	2012

Indicators 4 end use energy expenditures by sector, 5 energy consumption per GSP (index) 6 energy consumption per capita, 7 energy expenditures per GSP (index)

year	indicator 4, billion 2005$ res.	comm.	ind.	trans.	ind. 5 2000=1	indicator 6 mmBtu/person WA	US	ind. 7 2000=1	year
1970	1,187	492	740	2,612		25	27		1970
1971	1,215	512	751	2,585		25	27		1971
1972	1,293	617	809	2,512		27	28		1972
1973	1,287	677	844	2,803		28	29		1973
1974	1,291	683	1,006	3,581		27	28		1974
1975	1,297	728	1,084	3,813		26	27		1975
1976	1,343	755	1,083	4,019		26	28		1976
1977	1,422	812	1,136	4,212		26	28		1977
1978	1,418	784	1,181	4,354		26	28		1978
1979	1,602	908	1,308	5,462		26	28		1979
1980	1,660	1,042	1,603	6,598		24	27	1.90	1980
1981	1,974	1,296	1,892	7,073		25	26	2.08	1981
1982	2,189	1,588	2,174	6,202		23	24	2.05	1982
1983	2,313	1,523	1,908	5,274		22	24	1.78	1983
1984	2,301	1,637	2,455	5,442		24	25	1.81	1984
1985	2,381	1,760	2,001	5,416		24	25	1.74	1985
1986	2,157	1,486	1,648	4,563		25	24	1.40	1986
1987	2,115	1,495	1,675	4,630		26	25	1.35	1987
1988	2,224	1,563	1,949	4,544		27	26	1.32	1988
1989	2,323	1,545	2,019	5,065		27	26	1.34	1989
1990	2,273	1,515	1,897	5,796	1.64	26	25	1.33	1990
1991	2,271	1,502	1,780	5,745	1.60	25	25	1.28	1991
1992	2,132	1,494	1,668	5,564	1.62	26	25	1.17	1992
1993	2,388	1,593	1,710	5,260	1.55	25	25	1.14	1993
1994	2,430	1,665	1,808	5,444	1.54	25	26	1.14	1994
1995	2,410	1,699	1,827	5,575	1.55	25	26	1.15	1995
1996	2,594	1,780	1,694	6,167	1.48	24	26	1.16	1996
1997	2,550	1,746	1,761	6,100	1.43 [a]	24	26	0.99 [b]	1997
1998	2,498	1,727	1,863	4,876	1.10	24	26	0.84	1998
1999	2,650	1,822	1,955	5,795	1.04	24	26	0.87	1999
2000	2,786	1,932	2,052	7,487	1.00	23	26	1.00	2000
2001	3,246	2,286	1,855	6,624	0.97	22	25	1.00	2001
2002	3,277	2,324	1,457	6,042	0.90	20	25	0.91	2002
2003	3,072	2,295	1,589	7,089	0.89	20	25	0.96	2003
2004	3,189	2,372	1,673	8,524	0.89	20	25	1.06	2004
2005	3,370	2,434	2,014	10,203	0.86	20	25	1.15	2005
2006	3,581	2,585	2,203	11,757	0.86	21	24	1.25	2006
2007	3,792	2,591	2,072	12,812	0.84	21	24	1.25	2007
2008	3,918	2,698	2,446	14,469	0.81	20	24	1.39	2008
2009	4,002	2,672	2,031	9,977	0.83	20	22	1.11	2009
2010	3,751	2,614	2,083	11,519	0.81	20	23	1.17	2010
2011	4,380	2,925	2,477	15,714	0.81	20	23	1.36	2011
2012	4,157	2,902	2,339	16,228	0.78	20	22	1.31	2012

a Based on NAICS 1997 & after, SIC 1996 & before; SIC-based index in 1997 (the transition year) is 1.2[illegible]

b Based on NAICS 1997 & after, SIC 1996 & before; SIC-based index in 1997 (the transition year) is 1.0[illegible]

Indicators 8 residential end use by fuel, 9 residential energy intensity (index), 10 residential energy bill excl. transportation

	indicator 8, trillion Btu				ind. 9 2000=1	ind. 10 $/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	15.5	25.42	0.97	1,297	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	11.12	0.93	1,498	2007
2008	124.0	87.1	14.5	12.44	0.96	1,526	2008
2009	125.4	86.7	15.3	17.55	0.97	1,542	2009
2010	119.1	78.0	14.7	15.32	0.89	1,431	2010
2011	124.1	87.9	14.5	15.67	0.95	1,664	2011
2012	121.2	82.2	10.7	14.62	0.81	1,422	2012

Indicators 12 commercial end use by fuel, 13 commercial energy intensity (index), 14 industrial end use by fuel, 15 industrial energy intensity (index)

	indicator 12, trillion Btu				ind. 13 2000=1	indicator 14, trillion Btu					ind. 15 2000=1	
year	elec.	NG	petrol.	coal,wd		elec.	NG	petrol.	biomass	coal	(2005 $)	year
1970	22.9	19.5	18.75	0.52		88.5	98.3	100.5	56.8	5.09		1970
1971	24.7	21.7	18.74	0.71		84.7	101.3	105.4	57.8	5.33		1971
1972	33.0	24.5	18.61	0.57		97.1	106.7	124.7	57.9	3.44		1972
1973	35.2	34.0	17.65	0.40		93.1	127.9	117.2	57.9	3.92		1973
1974	34.3	34.8	15.16	0.35		103.3	113.6	105.0	56.7	6.48		1974
1975	35.4	33.3	13.58	0.47		95.4	96.0	90.5	53.9	10.91		1975
1976	37.8	33.0	13.39	0.52		102.8	82.0	82.9	59.9	14.24		1976
1977	37.7	31.3	14.88	2.38		94.0	79.4	99.9	65.2	12.41		1977
1978	41.2	26.5	14.90	3.33		108.5	71.4	99.4	66.5	12.18		1978
1979	44.1	34.9	12.46	2.60		109.2	86.8	79.0	59.8	12.48		1979
1980	47.2	32.4	12.14	3.14		108.4	67.0	95.8	78.3	7.09		1980
1981	60.9	30.1	12.14	2.57		119.8	70.0	98.3	82.6	7.67		1981
1982	61.9	32.2	20.62	3.44		97.7	49.6	106.5	79.9	7.95		1982
1983	62.3	30.0	19.52	4.51		106.5	53.1	76.2	90.3	5.58		1983
1984	61.4	33.8	24.86	4.23		115.1	65.6	111.0	92.1	4.52		1984
1985	64.7	36.9	32.47	4.35		101.8	65.7	91.1	91.7	4.49		1985
1986	64.2	33.0	17.51	1.97		103.8	55.6	107.7	99.8	7.38		1986
1987	67.2	33.4	18.70	1.59		109.2	67.9	104.3	98.0	5.89		1987
1988	70.7	37.6	22.61	2.75		127.3	71.2	109.3	101.1	5.27		1988
1989	70.4	39.7	16.14	3.34		129.2	75.6	97.5	80.8	4.95		1989
1990	73.4	39.8	13.38	2.60	1.57	140.9	80.8	94.2	75.0	5.20	1.60	1990
1991	75.0	43.0	11.91	2.99	1.55	141.3	82.2	89.4	54.7	4.28	1.56	1991
1992	76.9	39.0	7.36	3.26	1.42	132.4	82.4	93.2	72.6	3.37	1.56	1992
1993	78.3	45.3	7.41	4.52	1.47	126.2	95.8	86.8	68.9	3.51	1.55	1993
1994	79.8	44.8	8.04	3.96	1.44	117.9	112.2	91.5	69.6	3.88	1.58	1994
1995	81.6	44.4	9.62	3.88	1.45	119.0	114.6	86.7	64.8	4.23	1.64	1995
1996	85.8	50.0	8.37	2.91	1.47	108.5	118.6	86.6	63.0	2.98	1.51	1996
1997	86.0	49.0	9.29	2.94	1.06 [a]	118.1	116.6	86.5	70.1	3.22	1.23 [b]	1997
1998	88.3	47.7	7.74	2.51	0.99	130.0	139.3	88.7	64.9	2.69	1.29	1998
1999	91.1	53.5	9.36	2.68	0.97	137.0	131.0	85.7	65.7	2.18	1.22	1999
2000	95.7	52.6	8.89	2.92	1.00	121.1	87.3	93.2	62.2	2.82	1.00	2000
2001	93.9	59.1	10.09	4.65	1.04	66.0	77.6	97.6	57.3	2.89	0.91	2001
2002	93.9	47.8	10.79	4.76	0.96	55.7	69.7	83.7	50.2	2.28	0.79	2002
2003	95.7	49.1	8.87	5.00	0.95	62.0	67.6	81.2	53.1	2.09	0.82	2003
2004	96.3	49.8	6.38	4.85	0.92	65.7	69.7	79.5	51.2	1.85	0.84	2004
2005	95.9	51.2	8.57	1.82	0.90	75.5	68.9	81.7	57.1	1.48	0.77	2005
2006	97.5	52.8	8.58	1.69	0.88	75.1	72.9	86.6	81.3	2.01	0.82	2006
2007	101.0	55.1	7.32	1.80	0.86	70.8	75.4	85.1	55.1	3.19	0.70	2007
2008	101.9	57.9	11.63	1.89	0.89	72.1	78.0	91.3	55.5	2.95	0.75	2008
2009	102.5	57.4	9.28	2.48	0.90	79.7	73.4	80.1	56.8	3.51	0.77	2009
2010	98.4	53.0	12.20	2.45	0.85	90.9	73.6	82.6	70.0	2.73	0.82	2010
2011	100.3	58.1	10.08	2.36	0.85	95.3	78.5	83.2	70.4	1.83	0.85	2011
2012	99.8	55.0	11.76	2.06	0.81	94.2	80.5	81.3	73.7	2.19	0.81	2012

[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 16 transportation end use by fuel, 17a travel per capita, 17b fuel cost of driving, 18 transportation energy intensity

	indicator 16, trillion Btu				ind.17a mi/person	ind.17b ¢/mi	indicator 18, 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	11.14	13.8		13.0	1970
1971	189	26.2	66.6	7.5	6,066	10.62	13.8		13.0	1971
1972	195	29.9	61.1	6.1	6,365	9.85	14.0		12.9	1972
1973	205	38.9	67.4	7.3	6,671	10.14	14.0		12.8	1973
1974	205	37.6	70.5	7.9	6,360	12.92	13.6		13.1	1974
1975	211	38.5	80.1	13.3	6,476	12.65	13.7	13.1	13.2	1975
1976	223	46.6	74.2	14.7	6,791	12.37	13.8	14.3	13.1	1976
1977	235	48.5	69.2	16.4	7,128	12.20	14.1	15.1	13.4	1977
1978	245	53.6	65.8	31.8	7,457	11.47	14.6	16.0	13.6	1978
1979	235	58.7	72.7	59.4	7,416	13.11	15.7	16.2	13.9	1979
1980	220	55.9	69.3	63.6	6,920	15.76	16.3	19.3	14.9	1980
1981	222	56.2	69.4	51.3	6,962	15.75	16.6	20.7	15.4	1981
1982	223	49.1	73.0	29.6	7,189	13.65	17.2	21.3	16.0	1982
1983	231	46.5	73.1	10.3	7,421	11.36	17.3	21.2	16.2	1983
1984	238	48.7	88.8	10.4	7,674	13.13	15.3	21.2	16.6	1984
1985	226	59.1	87.6	34.5	7,759	12.49	16.4	21.6	16.6	1985
1986	241	82.0	97.2	56.2	7,878	10.39	15.6	22.2	16.7	1986
1987	264	67.9	106.1	51.1	8,219	9.85	15.4	22.3	17.2	1987
1988	261	71.9	117.4	60.9	8,674	8.97	16.4	22.2	17.8	1988
1989	278	72.9	117.0	84.5	8,975	9.27	16.3	21.8	18.2	1989
1990	276	67.6	127.6	89.5	9,028	9.88	17.1	21.5	18.8	1990
1991	280	68.5	121.6	99.7	9,250	8.90	17.9	21.6	19.5	1991
1992	285	73.6	137.4	139.2	9,606	8.87	18.7	21.2	19.5	1992
1993	298	68.0	126.6	93.1	8,761	9.18	17.1	21.3	19.3	1993
1994	297	86.8	123.3	91.7	8,841	10.15	16.7	20.8	19.4	1994
1995	304	82.0	131.5	104.1	9,003	9.52	16.9	21.0	19.6	1995
1996	318	88.7	128.0	77.2	8,873	10.12	16.2	20.9	19.6	1996
1997	316	102.9	128.4	79.1	9,017	9.88	17.0	20.7	19.8	1997
1998	319	86.6	125.9	58.8	9,031	7.84	17.3	20.6	19.8	1998
1999	325	103.5	127.1	47.8	9,041	9.76	16.5	20.2	19.6	1999
2000	324	109.2	141.9	41.7	9,048	12.01	16.8	20.2	20.8	2000
2001	325	98.6	124.4	39.4	8,982	10.65	17.0	20.1	21.0	2001
2002	329	108.0	103.8	33.2	9,066	9.69	17.0	20.0	20.9	2002
2003	329	108.7	100.3	37.6	9,021	11.71	17.0	20.1	20.8	2003
2004	328	113.1	110.0	41.0	9,026	12.88	17.0	19.8	20.9	2004
2005	333	113.8	106.1	48.9	8,867	15.54	16.8	20.4	21.1	2005
2006	335	139.4	106.3	39.0	8,865	18.03	16.6	20.6	21.3	2006
2007	338	143.2	116.8	62.7	8,776	18.18	16.7	21.2	22.0	2007
2008	328	131.9	114.7	28.3	8,434	21.53	16.7	21.5	21.7	2008
2009	332	115.1	104.3	43.9	8,461	13.92	17.3	22.9	21.8	2009
2010	327	111.4	110.0	40.6	8,505	15.44	17.6	23.2	21.6	2010
2011	324	121.9	93.8	48.8	8,415	21.30	17.8	22.9	21.5	2011
2012	322	112.2	110.2	62.2	8,326	20.75	17.7	24.4	21.6	2012

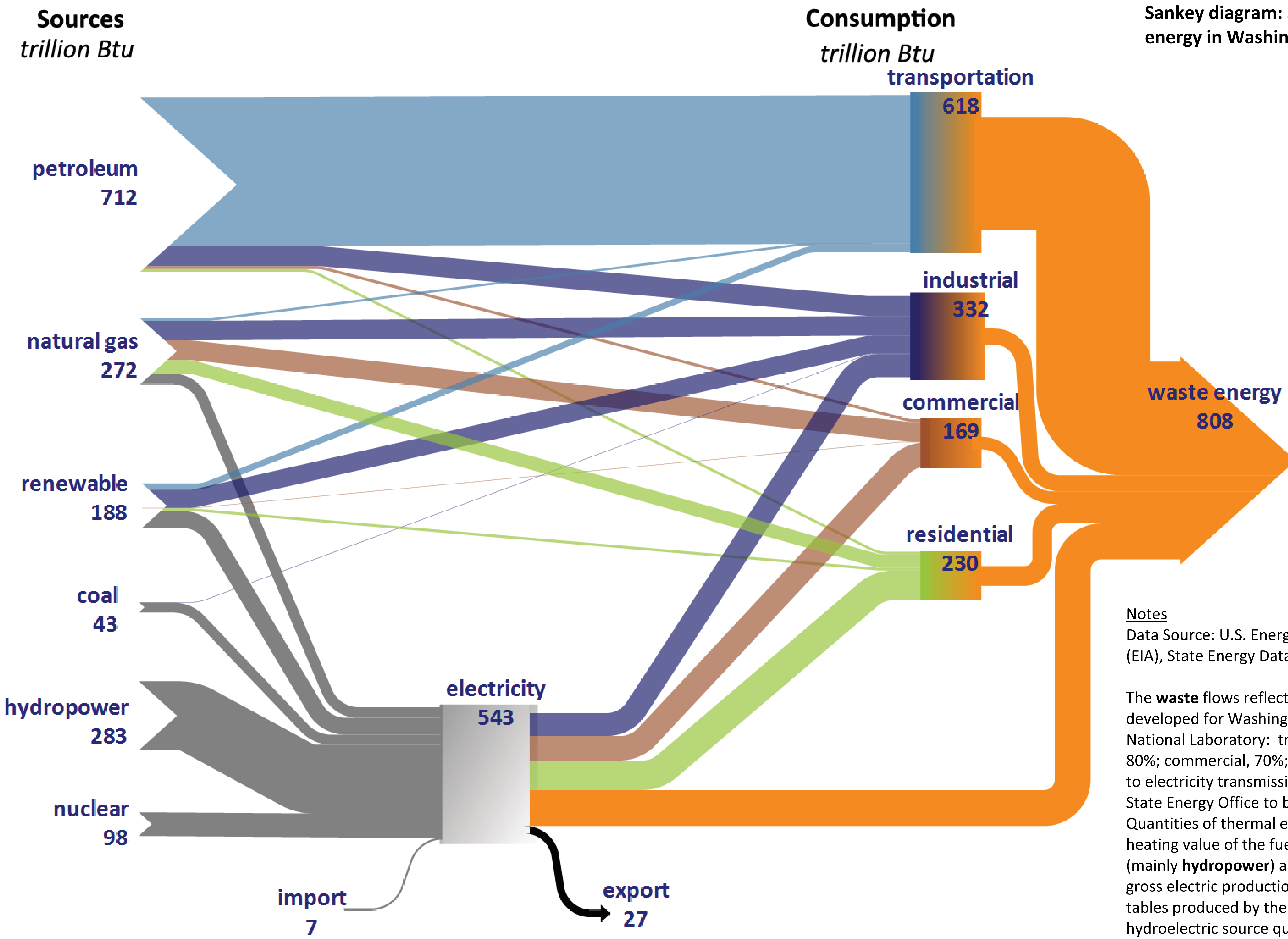
a All Washington on-road vehicles, regardless of class
b (for reference) Registered U.S. light duty vehicles
c (for reference) U.S. new light duty vehicle fuel efficiency rating

Indicators 20 energy prices by fuel, 21 electricity prices by sector, 22 natural gas prices by sector

	indicator 20, 2005$/mmBtu					indicator 21, ¢/kWh			indicator 22, ¢/therm[a]				
year	petrol.	elec.	NG	biomass	coal	res.	comm.	ind'l.	res.	comm.	ind'l	utility	year
1970	6.80	8.49	2.98	5.59	2.31	4.47	4.60	1.39	55.9	44.1	16.0	0.0	1970
1971	6.89	8.43	3.00	5.36	2.32	4.30	4.43	1.35	54.4	42.8	16.8	0.0	1971
1972	6.65	8.38	3.06	5.17	2.07	4.24	4.39	1.31	53.2	42.1	17.2	0.0	1972
1973	7.50	8.36	3.04	4.96	2.13	4.15	4.21	1.28	53.5	43.0	18.4	0.0	1973
1974	8.92	7.87	3.54	4.79	2.76	4.01	4.21	1.19	55.4	41.7	25.3	0.0	1974
1975	9.43	8.31	4.80	4.44	2.70	4.03	4.20	1.40	65.4	52.5	38.7	0.0	1975
1976	9.15	7.97	5.70	4.29	3.41	3.88	3.92	1.37	73.5	60.7	47.4	0.0	1976
1977	9.62	8.19	6.35	4.15	3.43	3.95	4.17	1.22	79.5	68.1	54.0	0.0	1977
1978	9.35	7.65	6.73	3.95	3.70	3.79	3.86	1.22	82.4	67.5	59.6	57.3	1978
1979	11.41	7.71	7.21	4.29	4.15	3.73	3.83	1.21	86.0	75.5	63.9	60.2	1979
1980	14.83	8.59	9.25	3.78	5.00	3.92	3.99	1.59	104.2	94.7	84.4	70.8	1980
1981	16.44	10.04	9.26	3.84	5.05	4.34	4.57	2.00	108.3	96.2	83.2	72.2	1981
1982	15.42	13.15	10.43	3.54	4.99	5.00	5.19	3.43	116.6	105.5	94.4	100.5	1982
1983	13.79	14.27	9.82	3.44	4.22	6.17	5.30	3.37	113.9	100.8	87.1	87.6	1983
1984	12.84	15.12	9.33	3.51	4.17	6.15	5.83	3.92	109.2	97.2	82.5	82.1	1984
1985	12.77	14.90	8.49	3.38	3.99	6.17	5.85	3.45	103.1	85.1	74.3	73.7	1985
1986	9.67	14.94	7.21	2.89	3.44	6.20	5.93	3.41	91.4	77.9	55.4	44.6	1986
1987	9.23	15.08	5.86	2.89	3.69	6.41	5.73	3.52	80.8	67.1	42.8	38.5	1987
1988	8.84	15.07	5.91	2.83	3.59	6.32	5.59	3.90	79.7	66.5	43.0	45.4	1988
1989	9.24	14.82	5.68	2.22	3.53	6.21	5.61	3.80	76.3	64.9	40.7	72.4	1989
1990	10.42	13.82	4.96	1.96	3.46	6.05	5.47	3.29	67.1	55.4	36.4	41.7	1990
1991	10.02	13.28	4.73	2.32	3.80	5.82	5.36	3.06	60.5	52.5	36.1	51.1	1991
1992	8.99	13.18	4.83	1.98	3.63	5.81	5.40	2.91	63.0	54.4	36.7	41.2	1992
1993	8.78	13.74	5.06	2.05	3.46	5.87	5.55	3.06	64.2	55.7	39.5	48.0	1993
1994	8.42	14.81	4.94	1.99	3.86	6.21	5.73	3.49	68.2	58.7	35.4	58.9	1994
1995	8.40	14.80	4.77	1.98	3.84	6.07	5.70	3.62	69.1	58.7	32.2	53.6	1995
1996	8.98	14.85	4.65	1.87	3.62	6.05	5.68	3.50	65.4	55.6	30.9	57.1	1996
1997	8.93	14.14	4.78	1.72	3.45	5.86	5.55	3.24	63.7	53.4	35.6	66.9	1997
1998	7.71	14.03	4.41	1.82	2.90	5.91	5.47	3.32	65.6	53.4	29.6	38.3	1998
1999	8.28	14.05	4.62	1.96	2.84	5.91	5.44	3.38	64.6	53.7	31.0	30.3	1999
2000	11.03	14.39	6.14	2.32	2.83	5.80	5.30	3.73	77.6	65.2	43.5	57.5	2000
2001	10.69	17.38	8.50	3.08	2.68	6.32	5.93	5.27	104.9	92.4	53.8	82.3	2001
2002	9.98	18.87	8.00	3.07	2.77	6.88	6.53	5.33	99.0	87.4	51.0	36.1	2002
2003	11.22	18.40	7.65	2.85	2.62	6.74	6.48	5.09	87.7	76.8	62.9	34.0	2003
2004	13.27	17.69	9.14	3.36	2.79	6.61	6.40	4.44	100.0	94.9	79.0	46.9	2004
2005	15.37	17.26	10.59	3.44	3.31	6.54	6.33	4.27	114.6	101.3	99.7	64.9	2005
2006	17.93	17.48	11.10	3.10	3.59	6.60	6.42	4.29	125.5	112.4	92.7	54.8	2006
2007	18.92	17.60	11.10	3.33	3.63	6.82	6.16	4.29	127.1	113.4	89.8	56.5	2007
2008	23.21	17.55	10.46	3.86	4.42	6.87	6.15	4.14	115.4	101.5	93.2	75.6	2008
2009	16.88	17.70	11.30	3.78	4.38	6.99	6.34	4.03	123.3	108.4	103.3	46.8	2009
2010	19.71	17.62	9.41	3.53	5.09	7.21	6.61	3.66	106.3	91.2	81.4	48.1	2010
2011	26.52	19.14	10.12	4.06	5.91	7.92	7.17	3.91	114.3	96.7	88.0	52.8	2011
2012	26.68	19.38	9.45	3.90	5.55	8.06	7.26	3.91	109.0	90.2	80.6	41.1	2012

[a] 1 therm = 100,000 Btu

Sankey diagram: Sources and consumers of energy in Washington in 2012



Notes

Data Source: U.S. Energy Information Administration (EIA), State Energy Data System, released June 2014.

The **waste** flows reflect efficiencies of sector consumption developed for Washington State by Lawrence Livermore National Laboratory: transportation, 25%; industrial, 80%; commercial, 70%; residential, 65%. Line loss applied to electricity transmission is estimated by the Washington State Energy Office to be 5.2%.

Quantities of thermal energy sources are the higher heating value of the fuel. Non-thermal electric sources (mainly **hydropower**) are reported according to their gross electric production. This contrasts with charts and tables produced by the U.S. EIA, which inflate hydroelectric source quantities by a factor of three in order to reflect their relative contribution to produced electricity.