



THE ECONOMIC CONTRIBUTION OF WASHINGTON STATE'S PETROLEUM REFINING INDUSTRY IN 2015

ACKNOWLEDGEMENTS

Washington Research Council has produced this report with funding from the Western States Petroleum Association. Washington state's economy is simulated using the Washington Research Council-Regional Economic Models, Inc. (WRC-REMI) model, based on a detailed survey of the five oil refiners operating in Washington. The results of this analysis are the sole responsibility of the Washington Research Council, a nonprofit organization committed to objective analysis of economic and public policy issues in Washington state.

1. Report Overview

This report quantifies the impact of Washington's five major petroleum refiners on the state's economy in 2015.

In 2015, the refiners directly provided 2,097 full-time jobs, paying an annual average wage of \$126,960. In addition, the refiners employed, at high wages, 2,408 contract workers on an average day, doing maintenance, capital repair and capital replacement. The refiners indirectly created additional Washington state jobs in industries from which they purchased goods and services, including transportation, construction, utilities and business services. Spending of the income earned in these direct and indirect jobs created even more jobs.

The sum of all these effects was 25,012 jobs and \$1.86 billion in personal income for Washington state in 2015. From this activity, state and local governments received \$62.0 million in sales and use taxes and

\$84.6 million in business and occupation taxes.

Also, downstream industries, which distributed refined petroleum products, paid \$458 million in wages to 16,045 workers in 2015. Excise taxes collected by the state from these industries totaled \$206.4 million in 2015.

Because of Washington's unique tax structure, a Washington refinery's state and local tax burden in 2015 was almost three times higher than the state and local tax burden of a comparable refinery located in California.

The report updates the economic impact analyses of petroleum refining for 2003, 2005, 2007, 2009, 2011 and 2013 previously prepared by the Washington Research Council (WRC 2004, 2006, 2009, 2010, 2012 and 2014), drawing upon a survey of Washington refiners conducted by the Council in 2016 (Appendix A) and the WRC-REMI model of the Washington state economy (Appendix C).

Table 2.1: Summary of Multipliers and Economic Impacts

Refining Jobs	Multiplier	Indirect and Induced Economic Effect	Major Petroleum Refiners Total Economic Impact
2,097	11.93	22,915 jobs	25,012 jobs
	\$883,000	\$1,476,515,000 personal income	\$1,851,652,000 personal income
	\$29,560	\$52,111,000 sales and use taxes	\$61,987,000 sales and use taxes
	\$41,273	\$13,742, B&O taxes	\$84,551,000 B&O taxes

Source: 2016 Refiner Survey, WRC-REMI Model

2. Summary of Findings

Washington's five refineries provide 3.4 percent of the United States' refining capacity. In 2015 they processed 588,300 barrels of crude oil and other feedstocks per day. Gasoline, diesel oil, and jet fuel are the largest finished product categories, representing 44.6 percent, 25.7 percent, and 14.6 percent, respectively, of total production, with gasoline production averaging 267,900 barrels per day.

According to the refiners survey, the five major refineries employed 2,097 workers in 2015, paying them an average annual wage of \$126,960—more than twice the Washington state average.

As indicated in Table 2.1, these jobs have a total employment multiplier of 11.93, meaning that each direct refining job generates an additional 10.93 jobs in the state, for a total employment impact of 25,012 jobs resulting from the five refineries.

Petroleum refining's extraordinarily high capital intensity, high wages and extensive use of highly paid contract labor are the major reasons for its high jobs multiplier. The WRC-REMI model, which is used here to determine the economic impact of

the industry, calculates that each petroleum job adds \$883,000 of state personal income, a total income contribution of \$1.85 billion to the state economy.

The industry is highly taxed and regulated, producing a bounty of tax and fee revenues for state and local government.

The five refineries paid \$216.3 million in state and local taxes in 2015. This total included \$72.8 million in business and occupation (B&O) tax, \$90.3 million in hazardous substance tax, \$24.5 million in property tax and \$9.9 million in sales and use taxes (Table 7.2).

In addition, the refiners paid \$11.0 million in regulatory fees in 2015 (Table 7.3).

Including the indirect and induced effects, the refining industry generated \$62.0 million in sales and use and \$84.6 million in B&O taxes (Table 2.1)

Calculations of state and local taxes paid by hypothetical 160,000 barrels-per-day refineries located in Washington and California indicate that the tax burden on refineries in Washington was 37 percent greater than that in California in 2015 (Table 8.1).

Table 3.1: Washington Refineries

Firm	Year Constructed	Location	Major Products	Capacity (barrels/day)
BP Cherry Point (formerly ARCO)	1971	Whatcom County, northwest of Ferndale	Gasoline, diesel oil, jet fuel, calcinated coke	236,000
Phillips 66 Ferndale (formerly ConocoPhillips Tosco, BP Oil and Mobil Oil)	Mid-1950s by General Petroleum (subsidiary of Socony-Mobil)	Whatcom County, west of Ferndale	Gasoline, diesel oil, jet fuel, liquid petroleum, residual fuel oil	107,500
Shell Oil (formerly Equilon Enterprises and Texaco)	1957	Skagit County, five miles east of Anacortes	Gasoline, diesel oil, jet fuel, propane, coke, sulfur	149,000
Tesoro (formerly Tesoro Northwest and Shell Oil)	1955	Skagit County, on March Point	Gasoline, diesel oil, turbine & jet fuel, liquid petroleum gas, residual fuel oil	125,000
U.S. Oil	1957	Pierce County, Tacoma Tideflats	Gasoline, diesel oil, jet fuel, marine fuel, gas oils, emulsified & road asphalt	42,000

Finally, refiners contribute generously to the communities in which they are located. The five refiners and their employees contributed \$2.9 million to various community causes in 2015. The firms themselves contributed about 40 percent of this, with the balance provided by firm-sponsored employee giving (Appendix A, Table A.11).

3. Oil Refining in Washington State

Building and development of the industry. The oil refining industry in Washington state began in the mid-1950s with construction of refineries by Shell in Anacortes (Skagit County) and Mobil west of Ferndale on the

Strait of Georgia (Whatcom County). Following closely in 1957, Texaco built in Anacortes, and U.S. Oil constructed its refinery on the Tacoma Tideflats. In the early 1970s, in anticipation of the crude oil that would begin flowing from Alaska's North Slope, Atlantic Richfield (Arco) built its refinery at Cherry Point. Now owned by BP, this plant remains one of the nation's newest refineries. Ownership of all these facilities has been fluid over the years, but today Washington's refining activity is concentrated at the four major plants in Whatcom and Skagit counties and the U.S. Oil plant in Tacoma. (See Table 3.1.)

Federal restrictions. Oil companies invest tremendous sums in their facilities in order to maintain their assets, to increase refining capacities, and to remain viable in a highly competitive global industry. In the 1970s, Washington's older oil refineries embarked on major plant modifications in anticipation of the Alaskan crude. Plans for new port facilities on Puget Sound to receive supersized tankers and new pipelines to carry Alaskan oil on to the Midwest were debated. But in 1977, before these plans could be finalized, the Marine Mammal Protection Act came up for reauthorization in Congress. Washington's then-senior senator, Warren Magnuson, preempted these plans by attaching an amendment to the reauthorization bill prohibiting construction of new ports east of Port Angeles.

Geographic isolation. This decision sealed Washington's isolation from the rest of the country's petroleum supplies by preempting pipeline construction to the upper Midwest that would have provided the Northwest with easier access to Eastern and Midwestern distribution systems.

Today, Washington's five refineries make up 3.4 percent of the nation's total refining capacity (EIA 2016a). With this state accounting for about 1.9 percent of national petroleum consumption, in-state refineries produce quantities more than sufficient for Washington's needs (EIA 2016b).

Dependence on in-state refining. Other areas of the country—the Midwest and the East—are connected to a larger distribution system that allows their short-term petroleum supply disruptions to be accommodated more easily than those in the West.

which are not connected to the Gulf Coast and Midwest pipeline systems. West Coast consumers are supplied primarily from refineries in California and Washington.

Geographically, the three most important sources of crude oil for Washington refineries are Alaska's North Slope, the Canadian province of Alberta and the Bakken oil field of North Dakota.

Nationally, plant obsolescence and federal and state regulations requiring cleaner products and production processes have resulted in a reduction in the number of operable U.S. petroleum refineries from 301 in 1982 to 141 at the beginning of 2016. Those refineries that remain, however, are more efficient, with slightly more refining capacity available today than in 1982.

Over the decade prior to the 2001–03 recession, the increased demands of a growing population and economy and an increasing array of “boutique” fuels required by federal and state regulations strained capacities, with price effects felt throughout the country. The 2001–03 recession provided a respite, but capacity constraints returned at mid-decade as the economy recovered. The situation was exacerbated by hurricane damage to refineries along the Gulf Coast. During 2008–09, high crude oil prices followed by financial crisis induced demand reductions severely squeezed refinery margins. During 2010–2012, margins for North American refineries rebounded as increased crude oil production in the U.S. lowered refinery costs, while global product prices remained high. More recently, the profitability of North American refineries trended

lower as global refining profits converged (EIA 2014, 2016c).

The constrained supply-demand relationship combines with the West Coast's isolation to produce an economy in Washington that is unusually dependent on its in-state refining capacity. It is this industry and its relationship with the larger Washington state economy that are described in the sections that follow.

4. Industry Impact Analysis

To quantify the impact of Washington State's refineries on its economy, we use the WRC-REMI model to simulate a permanent increase in refinery employment of roughly 8 percent and measure the resulting changes in total state employment, personal income, and gross product. Dividing these resulting changes by the change in refinery employment gives "multipliers" that are then applied to the industry's total employment to calculate total economic impact. For example, in 2015 the five refineries had 2,097 employees. With a multiplier of 11.93 the total impact of the refineries was 25,012 jobs. Similarly, the refinery activities resulted in \$883,000 of state personal income for every direct job, or a total statewide \$1.85 billion in personal income.

The economic impacts of petroleum refining in Washington, however, are broader than those of most other sectors of the economy. If petroleum prices go up, the effects are felt in the price of food and other essential consumer goods, the costs of commuting, and the cost of moving goods to market for businesses throughout the economy. And, unlike products from other sectors, alternative petroleum supplies or sub-

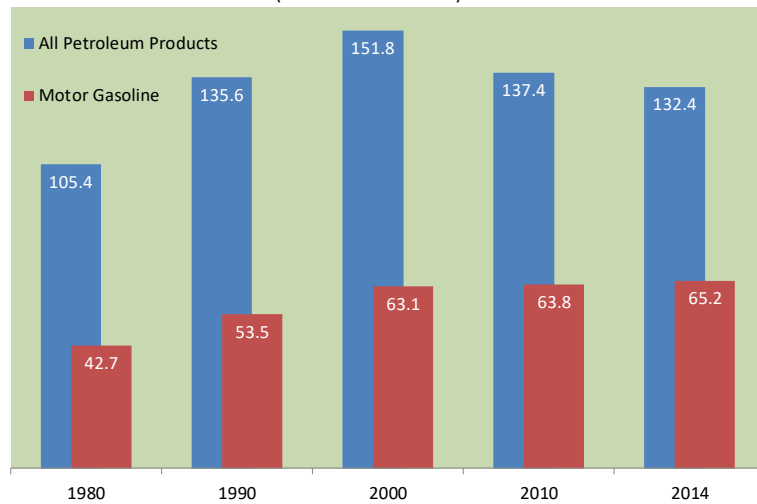
stitute products are not readily available in the case of an emergency. In order to fully appreciate the economic value of the petroleum refining industry in Washington, the dire economic consequences possible in a catastrophic scenario must be acknowledged. Foreign product would have to be imported, increased dock and terminal capability would be required, product prices would increase in response to diminished supply availability and stability, and these increases would be felt throughout the economy.

In the sections that follow, Washington's petroleum refining industry is described under equilibrium conditions by summarizing consumption (Section 5), production (Section 6), and the direct purchases of the five major industry refiners (Section 7). Based on these data, the WRC-REMI model calculates the effect of the five refineries on jobs, income, retail sales and use, and B&O taxes statewide (Section 9).

Section 8 presents a comparison of taxes paid by hypothetical 160,000 barrels-per-day refineries located in Washington and California.

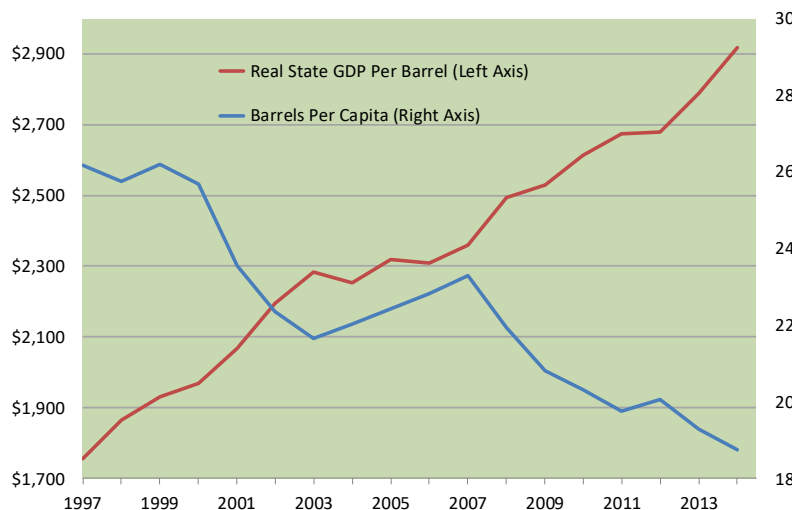
Finally, in Section 10 we provide employment, wage, and tax contribution information on the portions of the transportation, wholesaling, and retailing sectors that operate downstream of the refining process. These petroleum-related activities combine to assure that petroleum products get to their markets in Washington state and beyond. Although they would exist regardless of the presence of in-state refining, their inclusion here helps to give a complete picture of the petroleum industry in Washington state.

Figure 5.1: Washington State Petroleum Product Consumption (millions of barrels)



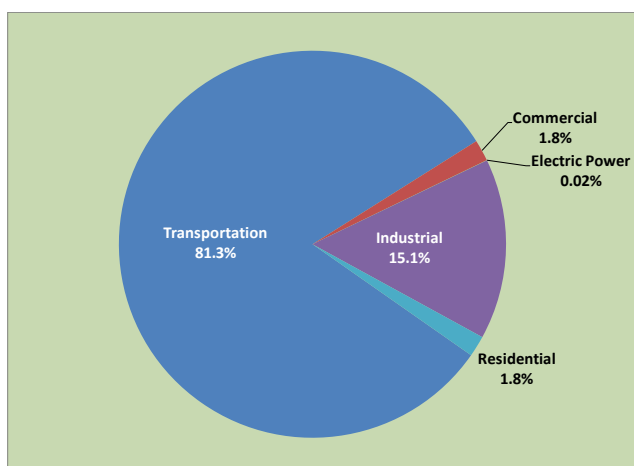
Source: EIA

Figure 5.2: Washington Petroleum Consumption Trends



Source: EIA

Figure 5.3: 2014 Consumption By Sector



Source: EIA

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5. Petroleum Product Consumption in Washington

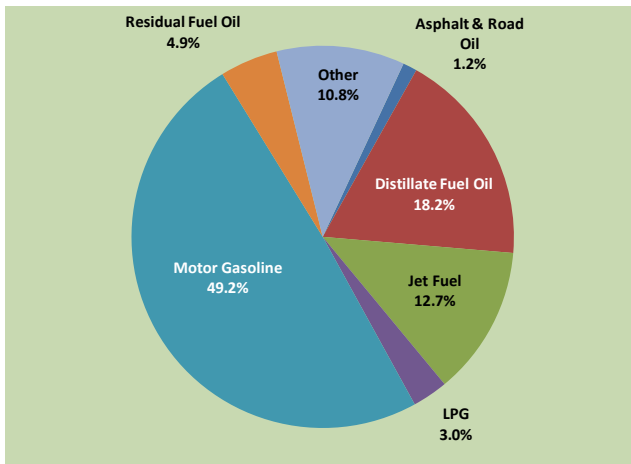
Washington households and businesses consumed a bit more than 132 million barrels of finished petroleum products in 2014, up 26 percent from 1980, according to the Energy Information Administration (EIA). (See Figure 5.1.) Washington's 2014 consumption was 1.9 percent of the U.S. total and about 15 percent of EIA's western Petroleum Administration for Defense (PAD) District V, which encompasses Washington, Oregon, California, Nevada, Alaska, and Hawaii. PAD District V represented 13 percent of total U.S. consumption in 2014 (EIA 2016b).

As a result of increasing fuel efficiency, petroleum product consumption in Washington declined by 11 percent from 1997 to 2014. Over the period the state's population grew by 24 percent and the output of the state economy (as measured by real gross state product) grew by 48 percent. As a result, per-capita consumption declined by 28 percent, while gross state product per barrel of petroleum increased by 66 percent. (See Figure 5.2)

The several broad classes of customers who purchase petroleum products help to explain the state's consumption patterns. Demand for petroleum products from transportation, industrial and residential customers decreased over the seventeen-year period by 6 percent, 28 percent and 45 percent, respectively. Commercial customer demand increased by 31 percent over the period (EIA 2016b).

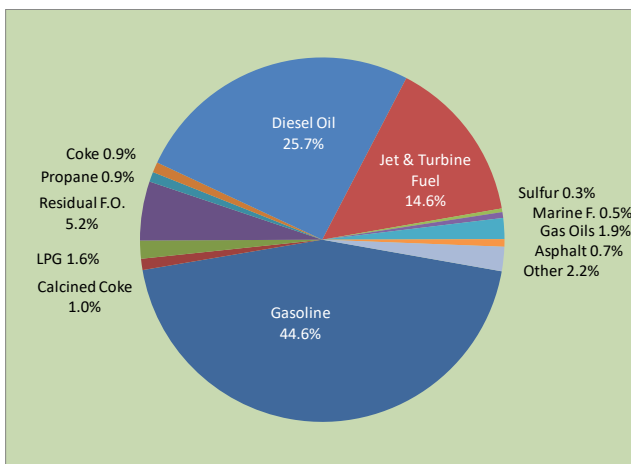
As shown in Figure 5.3, commercial customers accounted for less than 2 percent of Washington's total petro-

Figure 5.4: 2014 Consumption By Product (Volume in Barrels)



Source: EIA

Figure 6.1: 2015 Washington Production By Product (Volume in Barrels)



Source: 2016 Refiners Survey

leum product consumption; transportation and industrial customers together accounted for more than 96 percent.

By far, motor gasoline was the largest category of product consumed, at 49.2 percent of the total. (See Figure 5.4)

6. Refinery Production in Washington

The data that follow in Sections 6, 7, and 8, unless otherwise indicated, are the aggregated results of our survey of Washington's five major refiners (Appendix A).

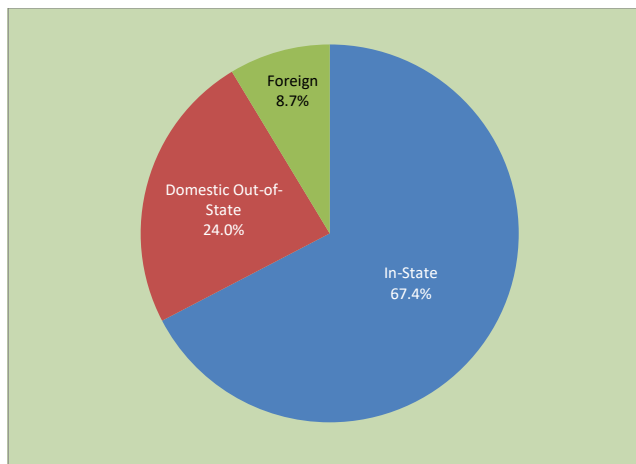
Finished products. Washington's refineries produced 601,200 barrels per day and more than a dozen different products in 2015. Gasoline, 267,900 barrels per day in 2015, is by far the largest product category, accounting for 44.6 percent of the total. Diesel oil and jet fuel are the next largest at 25.7 percent and 14.6 percent, respectively. (See Figure 6.1.)

Gasoline accounted for 45.8 percent of the refineries' total \$15.0 billion in output value in 2015. Again, diesel oil and jet fuel are next, accounting for 26.5 percent and 14.4 percent, respectively.

Markets. In 2015, 67.4 percent of Washington refined product was sold within the state; 24.0 percent of total product was sold domestically outside Washington; and the remaining 8.7 percent was delivered to foreign buyers. (See Figure 6.2.)

The World Institute for Strategic Economic Research (WISER) provides data on the destination of foreign exports of petroleum products from Washington. In 2015, the \$2.48 billion of petroleum products exported

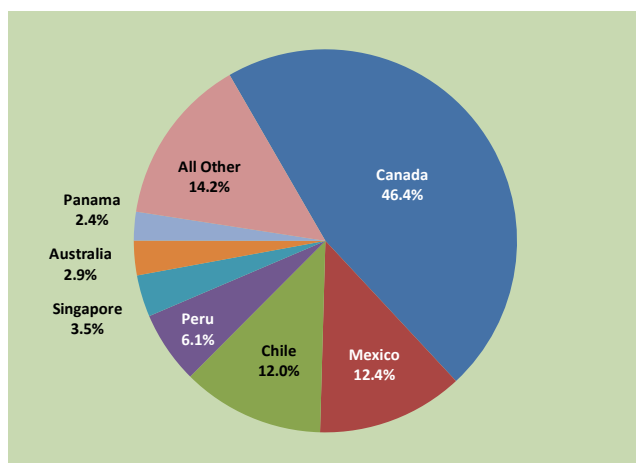
Figure 6.2: 2015 Washington Production By Destination (Volume in Barrels)



Source: 2016 Refiners Survey

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Figure 6.3: Top Export Markets in 2015



Source: WISER

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from the state amounted to 2.7 percent of Washington’s foreign exports. Almost 46 percent of the dollar value of petroleum product exports went to Canada. Mexico was the second most important export market, followed by Chile, Peru, Singapore, Australia and Panama. (See Figure 6.3; Appendix B provides more complete listings of export destinations for 2014 and 2015.)

Product transport. Finally, 50.3 percent of all products refined in Washington was shipped by pipeline in 2015, primarily to Seattle and Tacoma markets and on to Portland. Of the remaining product, 36.2 percent was shipped by water, to Portland and other destinations along the Columbia River as well as to foreign customers; 11.0 percent went by truck; and 2.5 percent went by rail.

7. Washington Refiners: Inputs

Washington refiners spent \$23.5 billion on feedstocks and other inputs in 2015. This section describes their main areas of expenditure.

Feedstock. Washington’s petroleum refineries received 588,300 barrels per day of crude oil and other feedstock inputs (e.g., butane, isobutene, and cat feed) in 2015. The total volume of feedstock in 2015 was 1.8

Table 7.1: Quantity and Value of Feedstock Inputs

	2014	2015
Total Feedstock Inputs (thousands of barrels/day)	598.9	588.3
Crude Oil	578.3	565.5
Other	20.6	22.8
Total Value of Feedstock Inputs (millions of dollars)	20,513.5	11,430.1
Crude Oil	19,924.0	10,941.8
Other	589.5	488.3

Figure 7.1: Crude Oil Production, Alaska and North Dakota, (1,000 BBL/D)

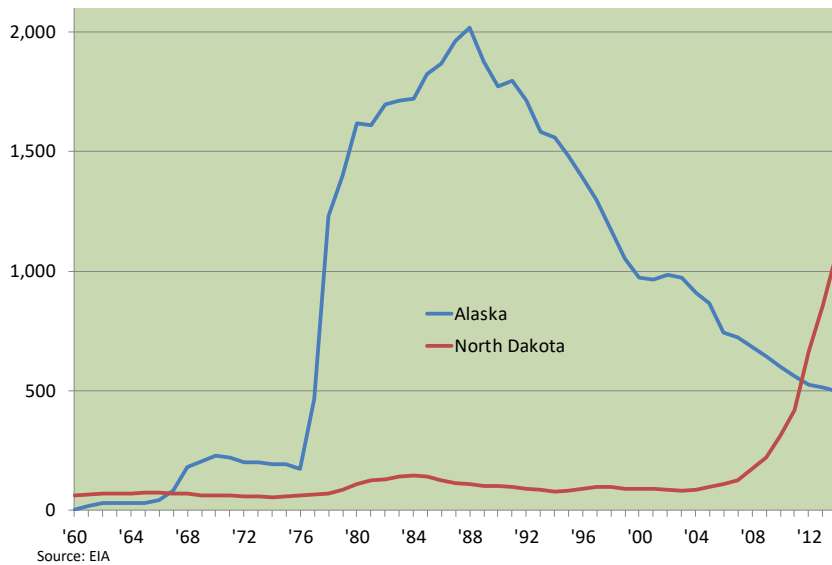
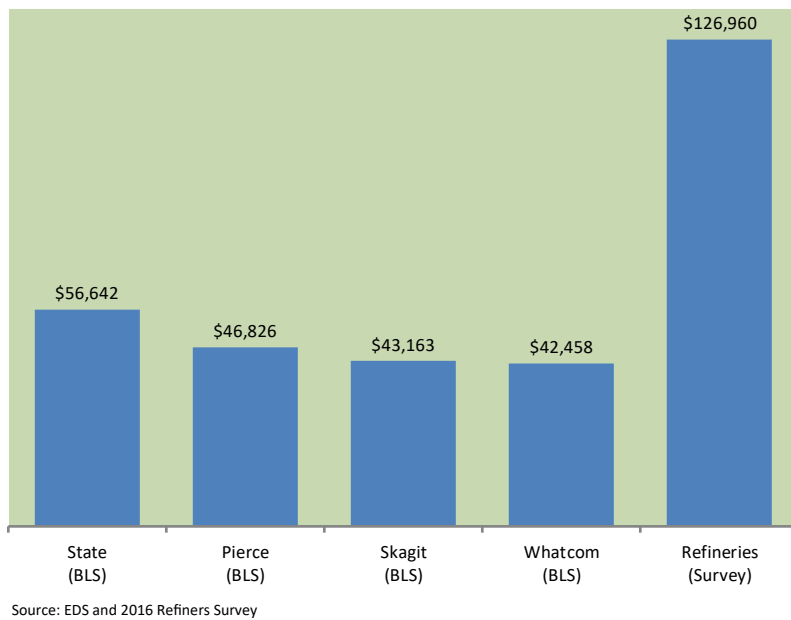


Figure 7.2: Average Annual wages



percent lower than 2014. The value of 2015 feedstocks was \$11.4 billion, down 44.3 percent from 2014. (See Table 7.1.)

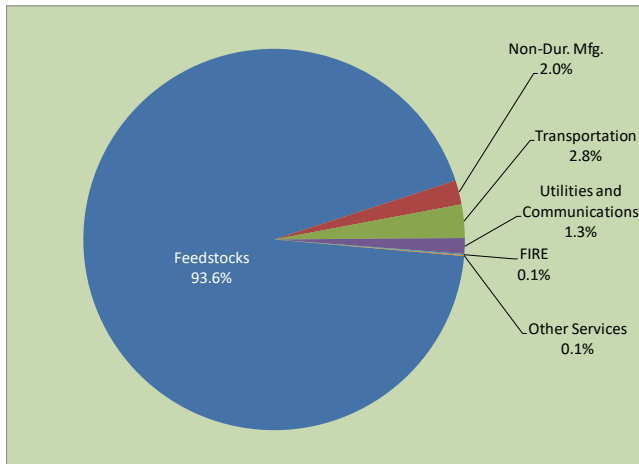
In 2015, 42.1 percent of crude oil came into the refineries by water, 31.4 percent came by pipeline; and 26.5 percent came by rail. Of the crude oil, 35.5 percent was Alaskan, 22.4 percent was Canadian from conventional sources, 10.9 percent was Canadian from oil sands and 24.9 percent was from North Dakota. The remaining 6.3 percent came from a number of other places.

This represents a noteworthy change from 2003 when 90.4 percent of crude came by water from Alaska and no crude came to Washington by rail from North Dakota. Driving this change was the precipitous decline of crude oil production in Alaska and growth of production in North Dakota, as shown in Figure 7.1.

Labor. Washington's five oil refiners employed 2,097 workers in 2015 and paid them extraordinarily well. The refiner survey puts the 2015 average annual refinery wage at \$126,960. According to the state Employment Security Department (ESD), the overall statewide average wage was \$56,642 in 2015, less than half of the refinery average wage. (See Figure 7.2.)

This contrast is even more pronounced when comparing refining wages with average annual wages in Whatcom and Skagit counties where the four largest refineries are located. The average annual wage in Whatcom County in 2015 was \$43,163 while in Skagit County it was \$42,458 (ESD 2014).

Figure 7.3: 2015 Non-Labor Operating Expenses



Source: 2014 Refiners Survey

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Refinery payrolls exceeded \$266 million in 2015. Worker benefits totaled nearly \$108 million, and average total compensation per employee was \$178,892.

Contract labor. Washington's petroleum refiners regularly rely on contract workers to clean and service various parts of their plant facilities and equipment, as well as to conduct scheduled major repairs and upgrades. The number of workers varies from year to year—1,656 in 2014 and 2,408 in 2015—and represents a significant part of the employment base, especially in Whatcom and Skagit counties.

In 2015 refiners paid \$370.4 million for contract workers, an average of \$153,841 per worker.

Thirty-five percent of contract workers in 2015 (846 workers) were engaged in capital repair and replacement, at a cost of \$188.9 million. In addition to this contract labor, the refiners made \$256.1 million in construction and other capital expenditures. Purposes included safety and

environmental compliance, efficiency improvements and clean fuels.

Non-labor operating expenditures. Non-labor operating expenditures are mostly for feedstocks—crude oil—and intermediate processed crude (which will be refined further into higher grade products) and chemicals and catalysts to be applied to the crude to produce various final products. These purchases show up in two categories: feedstocks and nondurable manufactured goods (primarily intermediate petroleum products and chemicals). Combined, these two categories account for more than 95 percent of all non-labor operating expenditures.

Significant amounts are also spent on utilities and transportation, which together accounted for \$508.4 million in 2015. Utilities expenditures, including electricity, gas and communications, totaled \$162.6 million in 2015, and transportation totaled \$345.8 million. Transportation expenditures were primarily for waterborne transport of inbound and outbound product (Appendix A, Table A.7).

Taxes. The five refiners paid \$216.3 million in state and local taxes in 2015 (See Table 7.2). The amount paid in 2014 was higher (\$298.3 million) due to the higher product prices in that year.

The state hazardous substance tax—\$90.3 million—comprised the largest share of total taxes paid in 2015, 41.7 percent of the total. The rate on this tax is 0.7 percent of wholesale value. Petroleum products constitute a large portion of the products subject to the tax.

Ranking a close second was the business and occupation tax, \$72.8 mil-

Table 7.2: Taxes Paid by Refiners in 2015

	(Millions)	% of Total
Retail sales and use tax	\$9.9	4.6%
Business and occupation tax	\$72.8	33.7%
Property tax	\$24.5	11.3%
Unemployment compensation tax (state only)	\$1.7	0.8%
Hazardous substance tax	\$90.3	41.7%
Oil spill tax	\$3.1	1.4%
Petroleum Products Tax	\$12.4	5.7%
Motor vehicle fuel tax	\$0.3	0.1%
Other	\$1.3	0.6%
Total	\$216.3	

Detail does not sum to 100% due to rounding

lion, 33.7 percent of the total. Refineries are subject to this tax under either the manufacturing or wholesaling categories, at the rate of 0.484 percent.

Next in line was the property tax, \$24.5 million and 11.3 percent of the total tax bill.

The fourth most costly tax in 2015 was the petroleum products tax, \$12.4 million. The current rate on this tax is 0.3 percent of product value. Revenues from this tax are dedicated to the pollution liability insurance program, which assists owners of underground storage tanks in obtaining insurance for upgrading and replacing tanks and preventing leaks. This tax is suspended when the pollution liability insurance program account balance exceeds a trigger value. The tax was last suspended from April 1, 2010 through June 30, 2015.

The oil spill tax is another tax unique to the petroleum industry. It is a tax of 5 cents per barrel on crude oil or petroleum products that are transported by ship, barge or railroad in Washington waters and offloaded at an in-state marine terminal. Of the proceeds, 4 cents are paid into the oil spill administration account and 1 cent into the oil spill response account. When the oil spill response account is fully funded, the 1 cent tax is suspended; when the account is short of funds, the tax is resumed. The 1 cent response tax was last suspended from April 1, 2013 to December 31, 2015. Through a credit, the tax is effectively eliminated for crude oil or petroleum products exported from the state.

The refineries reported paying \$9.9 million in sales and use taxes in 2015. Currently the sales and use tax

Table 7.3: Regulatory Fees Paid by Refiners in 2015 (dollars)

Air operating registration and permit fees	1,751,045	15.9%
Waste disposal fees	3,250,150	29.5%
Wastewater discharge fees	639,449	5.8%
Building Inspection Fees	-	0.0%
Building permit fees	50,000	0.5%
Other	\$5,318,600.0	48.3%
Total	11,009,244	

Source: 2016 Refiners Survey

rate paid by the two Skagit County refineries and the two Whatcom County refineries is 8.5 percent, while the rate paid by the Tacoma refinery is 9.5 percent.

Fees. In addition, the refiners paid \$11.0 million in regulatory fees in 2015. These included their air operating registration and permit fees (\$1.8 million, 15.9 percent) and waste disposal fees \$3.2 million. (See Table 7.3.)

8. Comparison with Taxation of a California Refinery

Table 8.1 compares the taxation of hypothetical refineries that processed 160,000 barrels of crude oil per-day in Washington and California in 2015.

We focus on seven major taxes. One of these taxes—the corporate income tax—is levied in California but not in Washington. Three of these taxes—the business and occupation tax, the hazardous substance tax, and the petroleum products tax—are levied in Washington but not in California. The remaining three taxes—the sales and use tax, the property tax and the oil spill tax—are levied in both states.

The overall 2015 tax burden in Washington, \$55.0 million, was 46 percent

greater than the burden in California, \$37.6 million. This is largely due to the fact that the Washington refinery pays more in B&O and hazardous substance taxes than the California refinery pays in corporate income tax.

Corporate income tax. California’s primary business tax is a corporate income tax. To avoid the complications inherent in state-level income taxation of multi-state businesses, we assume that the corporation owning the refinery does business only in California. California’s corporate income tax rate is 8.84 percent. Based on financial information from Tesoro Corporation’s 2015 Form 10-K filed with the U.S. Securities and Exchange Commission, we estimate the taxable income for a 160,000 barrels-per-day refinery to be \$161.7 million and the corporate income tax due to be \$25.3 million.

B&O tax. The B&O tax is Washington’s primary business tax. It is a tax on a business’s gross receipts. Our 160,000 barrel per day refinery has refined product sales of \$4.00 billion. This results in a B&O tax obligation of \$19.2 million at the manufacturing/wholesaling rate of 0.484 percent. B&O revenues for 2015 were unusually low because of low product prices. At 2014 prices, the B&O

Table 8.1: Taxes on a 160,000 Barrels per Day Refinery, 2015
(millions of dollars)

	Washington	California
Corporate Profits Tax		\$ 25.3
Business & Occupation Tax	\$ 19.2	
Hazardous Substance Tax	\$ 24.0	
Property Tax	\$ 5.0	\$ 5.9
Sales & Use Tax	\$ 2.6	\$ 2.6
Oil Spill Tax	\$ 0.8	\$ 3.8
Petroleum Products Tax	\$ 3.3	
	\$ 55.0	\$ 37.6

Source: WRC calculations

Detail does not sum to total due to rounding

obligation would have been \$30.4 million.

The B&O tax is a tax on gross income, without any deductions for the costs of making the goods or services sold, while the corporate income tax is a tax on net income, after deduction of these costs. The B&O tax tends to be more burdensome than a corporate income tax for low margin businesses such as refining.

Refinery margins as a percentage of revenue are particularly low when crude oil prices are high. In the long run, the prices refiners pay for crude oil passes directly through to the prices they receive for products, as Figure 8.1 illustrates. On the figure we have plotted the monthly average U.S. Gulf Coast spot price of conventional regular gasoline against the monthly average spot price of the benchmark European Brent crude oil (measured in dollars per gallon in both cases) from May 1987 to Sep-

tember 2016. The slope of the regression line through the data points is almost exactly equal to one.

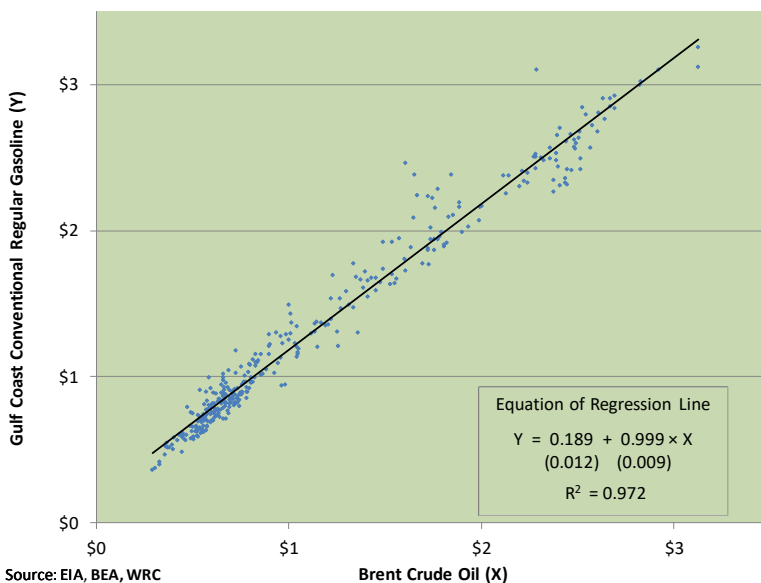
Hazardous substance tax. Returning to the taxes listed in Table 8.1, the hazardous substance tax is a second gross receipts tax levied by Washington state. Applying an effective rate of 0.6 percent to gross receipts of \$4.0 billion gives a \$24.0 million hazardous substance tax obligation for the 160,000 barrel per day Washington refinery. (Based on data from the state Department of Revenue, we use the 0.6 percent effective rate rather than the statutory 0.7 percent rate to account for various deductions and credits including the credit for product shipped out-of-state in vehicle fuel tanks.)

Property tax. We assume that the Washington refinery is in the city of Anacortes and that the California refinery is in the city of Martinez. (Shell and Tesoro have refineries in both cities.) Based on the taxes paid by the Shell and Tesoro refineries in Anacortes, we estimate that the taxes that would be paid by a 160,000 bbl./day refinery in Anacortes to be \$5.0 million. Based on the difference in property tax rates between Anacortes and Martinez, we estimate that such a refinery in Martinez would pay \$5.9 million in property taxes.

Sales and use tax. In 2015, the combined state and local sales tax rates was 8.5 percent in both Anacortes and Martinez. Based on the survey of Washington refineries, we estimate transactions subject to the sales and use tax to be \$30.9 million and the amount paid to be \$2.6 million.

Oil spill tax. Both states impose an oil spill tax. The rate in Washington is

Figure 8.1: Monthly Average Spot Prices May 1987 – September 2016
Gulf Coast Conventional Regular Gasoline vs. Brent Crude Oil
2009 Dollars Per Gallon



5 cents per barrel. As we noted above, in Washington, 1 cent of the 5 cents is sometimes suspended. The full 5 cents was collected in 2015, while only 4 cents was collected in 2014. Based on the amounts paid by Washington refineries in 2015, we estimate that the 160,00 barrel per day refinery would pay \$0.8 million in Washington. The oil spill tax rate in California is 6.5 cents per barrel, with no credit for exported product. The oil spill tax paid in California is then \$3.8 million.

9. Petroleum Refining Industry Direct, Indirect and Induced Economic Impacts

The economic impact of refineries on the state's economy can be divided into three primary categories: direct, indirect, and induced effects:

- The **direct** effects are those in the industry itself—the refinery jobs and payroll, and the taxes paid by the refiners.
- The **indirect** economic effects include the jobs, wages, and taxes of upstream suppliers of the refineries—not only the suppliers of crude oil, but also the construction companies and contract workers used for plant maintenance and repair and the office product and equipment suppliers, for example. These

figures were captured in the survey completed by the five refiners. The indirect economic effects also include the jobs, wages, and taxes of suppliers' suppliers; of the suppliers' suppliers' suppliers; and so on up the supply chain.

- Finally, the **induced** effects are the jobs, income, and taxes contributed by firms in industries that supply daily consumables and services—e.g., food, dry cleaning, banking—to workers holding the direct and indirect jobs.

The relationship between the direct jobs, income, and tax effects in an industry and their indirect and induced effects are captured by multipliers, which are calculated using the WRC-REMI model of the Washington state economy.

The employment multiplier for the petroleum refining industry is 11.93. Applying this multiplier to the 2,097 direct refinery jobs in 2015 gives a total state employment impact of 25,012 jobs.

This is large compared to employment multiplier typically seen in studies that use input-output models. For example, the 2007 Washington state Input-Output Study (2014) calculates that the employment multiplier for manufacturing/

Table 9.1: Impact of a 160,000 Barrel Per Day Refinery

558 Direct Jobs	
+6,999 Additional Jobs Elsewhere in the State Economy	
\$99.9 Million Direct Compensation	
+\$392.9 Million Additional Personal Income Elsewhere in the Economy	
\$51.7 Million Direct Taxes	
+\$17.5 Million Additional Sales, Use and B&O Taxes Elsewhere in the Economy	

Source: WRC

construction overall is 2.65. For the petroleum and coal products manufacturing sector (the “three-digit” sub-sector of manufacturing that contains the petroleum refining industry) the state study calculates an employment multiplier of 6.80.

The WRC-REMI model finds larger impacts because it is a more complete model of the state economy than the state Input-Output model. The REMI model incorporates many significant behavioral responses to changes in prices and costs that are not picked up by a simple input-output model: The wage rate depends on the supply and demand for labor, migration and labor force participation rates respond to changes in wage rates, and consumer purchases of specific goods and services respond to changes in relative prices and personal income. In addition, producers substitute among production factors in response to changes in relative factor costs, market shares respond to changes in regional production costs, and investment rises in response to increases in output.

Two channels of impact captured by the REMI model and absent from the Input-Output model are particularly important in explaining the high employment multiplier the WRC-REMI model finds for petroleum refining: government spending of the tax revenues paid by the refineries and investment spending by the refineries and their suppliers. When these two channels are turned off, the employment multiplier calculated for petroleum refining with the WRC-REMI model is just 4.13. Government spending of the tax revenue generated by refining adds 4.79 to the multiplier, while investment spending

adds 3.01. (Note that this spending is not investment to expand the capacities of factories and facilities, but rather the ongoing investments firms make year after year just to stay in place.)

Several additional factors contribute to the petroleum refining industry's large multiplier. First, petroleum refiners pay high wages. Thus, the employment induced by refinery employee spending is relatively great. Second, the petroleum industry ranks high in the ratio of in-state supplied intermediate inputs (including contract labor) to employee income. For this reason, indirect employment is relatively high. And some of these indirect jobs (e.g. contract labor) pay unusually high wages.

The WRC-REMI model calculates that each refining job results in an additional \$883,000 of state personal income. At 2015 employment levels, the industry adds \$1.85 billion to state personal income.

In 2015 state and local sales and use taxes averaged \$0.0335 for each dollar of state personal income. With the income multiplier of \$883,000 each petroleum refining job results in \$29,560 in state and local sales taxes or a total of \$62.0 million.

The refiners directly paid \$72.8 million in B&O taxes in 2015. In 2015 state B&O taxes averaged \$0.00931 for each dollar of personal income. Multiplying this rate into \$1,476.5 million—the increase in state personal income we ascribe to the 2,097 refinery jobs net of the wages and benefits of the refinery workers—gives \$13.7 million additional in-

duced and indirect B&O tax revenue, for a total of \$84.6 million, or \$41,273 per direct job.

These impacts can be expressed in terms of the hypothetical Washington refinery producing 160,000 barrels of product a day that was analyzed in Section 8. In 2015, this refinery would have provided 558 jobs, and these workers would have received \$70.9 million in wages and salaries and \$29.03 million in benefits. In addition to the direct jobs and income, the refinery would generate 6,999 jobs and \$392.9 million in personal income elsewhere in the state's economy. The refinery itself would pay \$51.7 million in state and local taxes. In addition to these direct taxes, the indirect and induced activities generated by the refinery would provide \$17.5 million in sales, use and B&O tax revenue. (See Table 9.1.)

10. Washington Petroleum Industry: Downstream Activities

Washington's petroleum refiners rely on a number of industries to distribute their product to consumers. These include transportation (pipelines, barges, trucks, and rail) and transportation support facilities (terminals, stockyards, and bulk stations), wholesalers, and retailers

(gasoline stations and fuel oil dealers).

These downstream industries exist due to petroleum product consumption in our economy, not as a result of petroleum refining. Presumably, if the refineries were gone or if they had never existed in Washington, finished petroleum products would be imported to terminal and stockyard facilities, transported to retail destinations within the state, and sold to consumers through systems much like those that currently exist, together with similar job, wage, and tax effects. Even so, their direct economic contribution is substantial and their role in the larger petroleum industry is crucial. This section describes the employment, wages, and taxes associated with these industries.

Of the total finished products produced by Washington's refineries, 50 percent leaves through pipeline to markets in Seattle and Tacoma and beyond. Another 36 percent goes by water to Seattle, Portland, or elsewhere with the remaining 14 percent of product shipped by rail or truck. About 50 percent of product is delivered to retailers for consumer sales within the state of Washington (Appendix A, Tables A.4 and A.5).

Table 10.1: Employment and Wages by Industry, 2015

Industry (NAICS Code)	Firms	Total Wages Paid	Average Employment	Average Annual Wage
Petroleum Bulk Stations and Terminals (424710)	24	\$61,735,162	848	\$72,801
Other Petroleum Merchant Wholesalers (424720)	76	\$70,075,243	1,149	\$60,988
Gasoline Stations With Convenience Store (447110)	1,373	\$232,551,997	11,923	\$19,504
Other Gasoline Stations (447190)	82	\$27,205,520	986	\$27,592
Fuel Dealers (45431)	58	\$49,956,180	993	\$50,308
Refined petroleum product pipelines (48691)*	7	\$16,446,000	146	\$112,775
Crude Oil Pipelines (48611)	D	D	D	D

*2014

Source: BLS

D: Value not disclosed

Table 10.2: Taxable Income and Taxes Due by Industry, 2015 (millions of dollars)

Industry (NAICS Code)	Gross	Taxable	B&O Tax	Other Excise	Total
Petroleum Products Wholesaling (4247)	5,445.4	4,191.4	21.3	24.2	45.5
Gasoline Stations (4471)	9,454.7	7,558.8	36.8	111.2	148.0
Fuel Dealers (45431)	375.2	336.1	1.7	11.2	12.9
Refined petroleum product pipelines (48691)	D	D	D	D	D
Crude Oil Pipelines (48611)	D	D	D	D	D

Source: DOR

D: Value not disclosed by DOR

Jobs and wages. According to detailed data reported to the BLS for 2015, the most recent year for which such data are available, there were about 1,600 employers in these downstream industries. Together, they paid \$458 million in wages to 16,045 workers. These are all workers covered by unemployment insurance in these industries, so the number includes both full-time and part-time workers. Table 10.1 shows these data for each industrial classification with its corresponding North American Industrial Classification System (NAICS) code.

Among the downstream industries there are three broad tiers of employment and pay:

- Refined petroleum product pipelines employ a few highly paid workers—146 workers made \$112,775 (plus benefits) on average in 2015.

- Bulk stations and terminals, wholesalers, and fuel oil dealers employ about 2,990 workers who earned on average \$60,792 in 2015.
- Gasoline stations generate a large wage bill with a lot of lower-wage and part-time jobs. In 2015, this industry's 1,455 employers paid total wages of \$259.8 million to 12,909 workers.

Taxes. The state Department of Revenue (DOR) reports excise tax data on these same industries (DOR 2016a, 2016b).

As shown in Table 10.2, total excise taxes due from the downstream industries equaled \$206.4 million in 2015. Gasoline stations paid \$148.0 million in excise taxes. Wholesalers paid \$45.5 million; fuel dealers, \$12.9 million.

Appendix A

A.1: Quantity and Value of Feedstock Input	2014	2015
Feedstock Quantity (KBBL/Day)		
Crude Oil	578.3	565.5
Other	20.6	22.8
Total	598.9	588.3
Feedstock Value (\$K)		
Crude Oil	19,924,033	10,941,790
Other	589,487	488,343
Total	20,513,520	11,430,133
A.2: Quantity and Value of Output	2014	2015
Output Quantity (KBBL/Day)		
Gasoline	263.0	267.9
Diesel Oil	162.1	154.4
Jet and Turbine Fuel	82.3	87.9
Calcined Coke	6.1	6.0
LPG	11.6	9.6
Residual Fuel Oil	41.4	31.5
Propane	6.7	5.3
Coke	4.0	5.5
Sulfur	1.9	1.9
Marine Fuels	3.3	3.1
Gas Oils	11.3	11.2
Emulsified and Road Asphalt	3.0	4.0
Other	9.8	13.0
Total	606.5	601.2
Output Value (\$K)		
Gasoline	10,736,328	7,259,375
Diesel Oil	6,936,923	3,989,601
Jet and Turbine Fuel	3,476,813	2,173,008
Calcined Coke	245,140	213,589
LPG	265,947	121,189
Residual Fuel Oil	1,397,092	582,340
Propane	109,957	29,602
Coke	48,635	36,571
Sulfur	5,097	5,277
Marine Fuels	111,355	74,679
Gas Oils	337,165	216,534
Emulsified and Road Asphalt	94,271	105,234
Other	223,295	236,043
Total	23,988,016	15,043,042

A.3: Origin of Inputs 2015	Crude Oil	Other
(KBBLs/Day)		
Alaska	201.0	6.1
Canada (Conventional)	126.4	-
Canada (Oil Sands)	61.4	-
Bakken	141.0	-
All Other Origins	35.7	22.6

A.4: Destination of Output 2015	Washington	Other U.S.	Foreign	Total
(KBBLs/Day)				
Gasoline	180.5	73.5	17.0	271.1
Diesel Oil	115.5	25.9	14.3	155.7
Jet and Turbine Fuel	68.0	11.3	10.1	89.4
Calcined Coke	5.9	-	-	5.9
LPG	7.8	-	-	7.8
Residual Fuel Oil	21.1	0.9	5.5	27.5
Propane	7.4	0.2	0.0	7.6
Coke	-	-	6.0	6.0
Sulfur	1.8	-	-	1.8
Marine Fuels	3.5	0.0	0.1	3.7
Gas Oils	3.5	11.2	-	14.7
Emulsified and Road Asphal	3.0	1.0	-	4.0
Other	3.1	26.0	1.0	30.1

A.5: Mode of Transport 2015	Pipeline	Water	Truck	Rail
Feedstocks (KBBLs/Day)				
Crude Oil	177.7	237.9	-	150.0
Other	2.2	20.1	0.2	4.6
Outputs (KBBLs/Day)				
Gasoline	167.7	81.6	21.7	-
Diesel Oil	80.2	53.4	21.5	-
Jet and Turbine Fuel	46.5	29.1	14.6	-
Calcined Coke	-	-	0.1	5.9
LPG	6.3	-	-	1.5
Residual Fuel Oil	-	27.5	-	-
Propane	0.9	-	5.4	1.3
Coke	-	6.0	-	-
Sulfur	-	-	1.4	0.4
Marine Fuels	0.1	3.6	-	-
Gas Oils	-	14.7	-	-
Emulsified and Road Asphal	-	-	2.0	2.0
Other	2.6	3.3	-	4.3

A.6: Employment and Contract Labor	2014	2015
On-Site Employment		
Number of FTE Employees	2,087	2,097
Total Payroll (\$K)	262,003	266,235
Total Employee Benefits (\$K)	97,873	108,902
Contract Labor		
Expenditure (\$K)		
Service and Maintenance	138,887	188,913
Capital Repair and Replacement	151,518	181,501
Total	290,405	370,414
Number of Contract Workers (FTE)		
Service and Maintenance	992	1,562
Capital Repair and Replacement	664	846
Total	1,656	2,408
% of Contract Labor from Outside WA State		
Service and Maintenance	13%	12%
Capital Repair and Replacement	35%	48%

A.7: Operating Expenditures Other than Labor or Feedstock (\$K)	2014	2015
Non-Durable Manufactured Goods		
Petroleum Products	241,476	210,923
Other Non-Durable Goods	39,051	39,204
Total	280,527	250,127
Durable Manufacturing	6,721	7,383
Construction	2,646	3,276
Transportation		
Rail	91,182	99,993
Trucking	5,213	3,512
Automobiles	4,403	4,196
Waterborne	268,026	224,955
Air	-	-
Other	14,376	13,149
Total Transportation	383,200	345,805
Utilities and Communications		
Electricity	68,673	53,211
Gas	178,581	89,482
Other	20,443	19,946
Total U&C	267,697	162,639
Finance, Insurance and Real Estate	12,129	12,446
Business Services	4,342	7,975
Other Services	1,640	1,584

A.8: Non-Labor Capital Expenditures	2014	2015
Equipment (\$K)	68,391	111,630
Materials and Supplies (\$K)	189,171	108,540
Construction (\$K)	724	1,383
Other (\$K)	9,764	34,424
Total	268,051	255,977
A.9: Taxes and Fees (State and Local)	2014	2015
Taxes (\$K)		
Retail Sales and Use tax	8,299	9,876
Business and Occupation Tax	116,102	72,808
Property Tax	24,034	24,456
Unemployment Insurance Tax	759	1,710
Industrial Insurance Premium	5,598	5,389
Hazardous Substance Tax	143,928	90,258
Oil Spill Tax	3,637	3,124
Petroleum Products Tax	-	12,424
Motor Vehicle Fuel Tax	269	294
Special Fuel Tax	-	-
Other	1,261	1,325
Regulatory Fees (\$K)		
Air Operating Registration and Permit Fees	1,468	1,751
Waste Disposal Fees	3,177	3,250
Wastewater Discharge Fees	741	639
Building Inspection Fees	-	-
Building Permit Fees	50	50
Other	5,581	5,319
A.10: Estimated Services and Retail Trade	2014	2015
Food Services (\$K)		
Associated with Contract Labor	377	477
Associated with Business Visitors	596	644
Total	973	1,121
Hotel and Motels (\$K)		
Associated with Contract Labor	660	756
Associated with Business Visitors	807	835
Total	1,467	1,591
Other Trade and Services (\$K)		
Associated with Contract Labor	30	30
Associated with Business Visitors	61	54
Total	91	84
A.11: Contributions	2014	2015
Corporate	939,010	1,785,820
Firm-Sponsored Employee Giving	1,099,089	1,145,150
A.12: Other	2014	2015
Estimated Business Visitors from Outside Washington	2,575	2,425

Appendix B: Petroleum Product Exports from Washington State

	2015		2014	
Canada	\$1,096,331,882	1	\$1,613,532,698	1
Mexico	\$292,532,432	2	\$958,332,751	2
Chile	\$284,089,046	3	\$417,879,572	4
Peru	\$144,277,411	4	\$368,499,744	5
Singapore	\$83,465,125	5	\$419,668,955	3
Australia	\$68,949,595	6	\$69,389,490	6
Panama	\$57,104,128	7	\$16,941,332	15
Philippines	\$49,474,979	8	\$409,111	27
Brazil	\$46,894,550	9	\$48,214,592	9
China	\$45,643,731	10	\$12,011,286	18
New Zealand	\$34,571,004	11	\$42,435,796	12
Saudi Arabia	\$24,801,000	12	\$20,551,706	13
Oman	\$22,770,000	13	\$1,820,650	24
Taiwan	\$22,289,826	14	\$55,840,584	8
Belgium	\$19,374,215	15	\$13,614,400	16
Ecuador	\$15,582,070	16	\$20,524,004	14
India	\$10,602,252	17	\$12,292,706	17
Japan	\$7,819,360	18	\$46,530,678	11
El Salvador	\$7,665,684	19	\$8,071,240	21
Malaysia	\$7,304,667	20	\$698,033	26
Korea, Republic of	\$5,063,328	21	\$64,812,293	7
Qatar	\$4,725,000	22	\$0	50
Mozambique	\$4,200,000	23	\$0	50
South Africa	\$3,150,000	24	\$0	50
Russia	\$1,573,301	25	\$3,632,230	23
Thailand	\$845,553	26	\$747,908	25
Indonesia	\$617,338	27	\$8,209,136	20
Guatemala	\$319,261	28	\$7,628,892	22
Vietnam	\$162,035	29	\$32,758	35
Colombia	\$136,219	30	\$46,982,878	10
Turkey	\$122,640	31	\$0	50
Dominican Republic	\$116,063	32	\$181,067	29
Nicaragua	\$72,950	33	\$96,067	30
Costa Rica	\$32,177	34	\$80,695	31
Israel	\$27,296	35	\$0	50
Switzerland	\$24,979	36	\$9,324	40
United Kingdom	\$22,935	37	\$0	50
Maldiv e Islands	\$20,445	38	\$0	50
Bahamas	\$19,244	39	\$52,790	33
Netherlands	\$17,448	40	\$2,740	48
Uruguay	\$14,915	41	\$0	50
United Arab Emirates	\$14,585	42	\$10,006,400	19
Marshall Islands	\$10,731	43	\$2,875	47
Palau	\$7,692	44	\$0	50
Trinidad and Tobago	\$6,833	45	\$53,463	32
Bolivia	\$6,300	46	\$0	50
Nigeria	\$4,540	47	\$0	50
Hong Kong	\$3,360	48	\$8,100	41
Venezuela	\$2,981	49	\$33,819	34
Argentina	\$2,708	50	\$2,708	49
Other	\$5,152		\$264,289	50
Total	\$2,362,890,966		\$4,290,099,760	

Source: WISERTrade

Appendix C

The Washington Research Council uses a model of the Washington state economy constructed especially for WRC by Regional Economic Models, Inc. Because it allows supply and demand to respond to changes in prices and wages, and permits substitution among factors of production, the WRC-REMI model is more elaborate than the standard input-output models commonly employed to estimate regional economic impacts (Treyz 1993).

The standard input-output model fails to model the numerous capacity constraints within the economy, the processes that set prices for goods and services and the responses of consumers and producers to changes in these prices. In the input-output model, industry and labor supply are perfectly elastic—so prices and wage rates do not matter.

Prices and wages do matter in the WRC-REMI model. The model divides the state into two sub-regions: The Seattle Metropolitan District (King and Snohomish Counties) and the balance of the state. There are 66 private industrial sectors within each sub-region, as well as four governmental sectors. Within each sub-region the model tracks inter-industry transactions, much as an input-output model would.

Unlike an input-output model, however, the WRC-REMI model incorporates a number of significant behavioral responses to changes in prices and costs: The wage rate depends on the supply and demand for labor, migration and labor force participation rates respond to changes in wage rates, and consumer purchases of specific goods and services respond to changes in relative prices and personal income. In addition, producers substitute among production factors in response to changes in relative factor costs, market shares respond to changes in regional production costs, and investment rises in response to increases in output.

This report uses version PI+ 1.7.2 of the WRC-REMI model.

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