Economic Impacts of Recent Energy Price Increases: A Brief Summary.

Size of the energy sector: United States economy

According to the Energy Information Administration, a part of the U.S. Department of Energy, total energy expenditures in the early 1970's constituted 8 percent of the United States Gross Domestic Product (GDP), with petroleum expenditures at nearly 4.6 percent, natural gas at 1 percent, and electricity at 2.2 percent of GDP. The oil price shocks during the period of 1973 to 1981 drove up prices for all energy resources and energy's total share of U.S. GDP rose to nearly 14 percent, with the petroleum's share alone rising to 8.5 percent. The high-energy prices of the 1970's and early 1980's proved unsustainable, as high prices induced numerous efficiency efforts, and served to promote many new petroleum and natural gas supply side projects. As a consequence the energy share of U.S. GDP fell during the 1980's and 1990's dropping to 7.2 percent in 2000, with petroleum's share declining to only 3.5 percent, electricity at 2.4 percent and natural gas at 1.2 percent[1]. Table 1 below illustrates energy expenditures in 1970, 1981 (year of peak expenditures), 1990, and 2000 as a percent of U.S. GDP.

Table 1: U.S. Energy Expenditures as Percent of GDP

Year	Natural Gas	Petroleum	Electricity	Total Expenditures
1970	1.0%	4.6%	2.2%	8.0%
1981	1.9%	8.5%	3.7%	13.7%
1990	1.1%	4.1%	3.0%	8.1%
2000	1.2%	3.7%	2.4%	7.2%

Size of the energy sector: Washington state economy

Energy expenditures in Washington State follow the same pattern as the larger U.S. economy, rising rapidly during 1973-81, then declining through the 1980' and 1990's as prices eased and efficiency programs reduced per capita energy consumption. As Table 2 below reveals, energy expenditures as a percent of Washington Gross State Product (GSP) are a bit lower in Washington particularly expenditures for natural gas and electricity. This is primarily a result of our access to inexpensive hydropower, which results in a direct reduction in expenditures for electricity. Inexpensive hydropower power has also diminished the incentive for directly using natural gas for space and water heating.

Table 2: Washington State Energy Expenditures as Percent of GSP

Year	Natural Gas	Petroleum	Electricity	Total Expenditures
1970	0.5%	4.3%	1.7%	6.7%
1981	1.0%	8.1%	2.5%	11.7%
1990	0.5%	4.3%	2.6%	7.5%
2000	0.7%	3.5%	1.9%	6.0%

[1] Structural changes in the US economy also account for some of this decline: some manufacturing industries moving offshore, faster growth in the less energy intensive service sector of the economy.

Impacts of high-energy prices on the economy

During the period from 1970 to 2000, the effects of changes in energy prices on GDP growth, inflation, and unemployment were apparent. The two major run-ups in petroleum prices during 1973-74 and then 1979-80, helped to induce recessions within a year. In general terms as energy prices increased inflation increased (other factors also drove the 1970's inflationary spiral), in addition there is some evidence that decreasing energy prices reduce inflation to a small degree. The GDP growth rate also slowed markedly following the major price hikes during the 1973-81 period, and to a lesser degree during the price increases of 1991 and 2000. National unemployment rates also track with significant increases in energy prices during the 1970-2000 time frame. During the economic boom years of the 1990's energy prices were generally low.

Estimating price increases from 1998-99 to 2003-04

Over the last five years and particularly during the past two years, there have been sizable increases in the prices for all primary energy resources in the U.S and Washington State. How severe are these price increases and what are the potential economic impacts on the Washington State economy? The United States Energy Information Administration (EIA), a part of the Department of Energy, tracks energy prices and expenditures by fuel and sector for the U.S. and individual states. The most recent complete year of data that the EIA has compiled is for 2000, though most data for the year 2001 is available. However, the EIA has unit prices (dollars per gallon, cents per Kilowatt-hour, etc) for primary energy sources such as petroleum[2], natural gas and electricity through May or June of 2004. As an approximation we have used current and historical reported energy prices and the historical EIA expenditure data to estimate current expenditures on energy at the national and state level, and then expressed the historical and estimate energy expenditure results as percent of GDP. The steps involved in this process were as follows:

1. Establish 1998-99 as the base year period to which current 2003-04 energy prices and estimated energy expenditures are to be compared.
2. Create ratios from 1998-99 versus 2003-04 prices for individual energy resources based on EIA reported unit prices.
3. Collect EIA historical energy expenditure data for Washington State and the U.S.
4. Estimate 2003-04 energy expenditures by multiplying 1998-99 energy expenditures by individual energy price ratios[3]. Express as annual expenditures.
5. Estimate 2003 Washington state GSP using national GDP data. Compare historical and estimated energy expenditure data and compute energy expenditures as percent of historical and estimated GSP.

[2] The petroleum category encompasses a wide variety of refined products such as motor gasoline, diesel, jet fuel, residual fuel, etc…

[3] This approach serves to "lock in" the comparison at 1998-99 population levels. Estimates of GSP are scaled accordingly as if state population did not grow during 2000-2004.

Some examples of recent increases in energy prices:

1. Crude oil prices have increased from $16.75 per barrel in 1999 to a current range (2004) of $45 to $55 dollars per barrel: a nearly 300% increase. Since about half the price of gasoline and diesel is derived from the price of crude oil, and the rest from refining, transportation, marketing and taxes, the retail price has risen by a smaller percentage. Average regular gasoline price for the U.S. increased from $1.12 per gallon in 1999 to an average of $2.02 for during October 2004, expressed in nominal or current dollars. During October of 2004 Washington State gasoline prices averaged $2.07 per gallon. Our gasoline prices tend to be slightly higher[4] than the national average, in part due to the relative isolation of the West Coast petroleum markets and the limited number of refineries.
2. Price increases for diesel and home heating oil and jet fuel are similar in magnitude to the price increases for gasoline. In 1998-99 diesel averaged $1.18 per gallon. During October 2004, diesel prices have risen to a record high of $2.40 per gallon (in nominal dollars) as demand in Asia and the U.S. trucking industry remains high.
3. Natural gas price for delivery to major regional transmission hubs for 1999 was $2.28 per Mcf while 2004 prices through July have average $5.42 per Mcf: an increase of nearly 200%. Near term futures contracts for the winter months of 2004-05 are running in the $6 to $7 per Mcf range. Much of the customer cost for natural gas in the commercial and residential sector pays for infrastructure and transportation in addition to the price of the fuel. Industrial and electric power generators pay much lower transportation fees for natural gas. The average retail price for natural gas across all sectors has increased from $3.75 per Mcf in 1998-99 to $7.12 per Mcf during 2003-04: expressed in nominal dollars.
4. Electricity price increases for consumers in WA State vary by utility and are primarily dependent on the share of electricity obtained from the Bonneville Power Administration and the utility's market exposure during the 2000-01 energy crisis. On a statewide basis 2003 prices are 35 percent higher in nominal dollars. The increase in state electricity expenditures is less than the increase in prices in part because most of the aluminum smelters in Washington are either temporarily or permanently shutdown due to a combination of high operating and electricity prices and low aluminum prices[5].

Table 3 below lists the nominal prices from the EIA for primary energy resources for the two comparison periods and for 2004 based on year to date (Y.T.D.)[6] prices. Price factors were calculated by dividing 2003-04 or 2004 Y.T.D. prices by 1998-99 prices.

[4] Ranging from 5 to 15 cents per gallon more than the national average.
[5] Secondary costs or impacts, such as business closures, relocations, etc., due to high-energy prices are not assessed in this analysis.
[6] Coal and wood waste prices were estimated but are not included in Table 3.

Table 3: Primary Energy Prices in Washington for 1998-99, 2003-04 and 2004 Y.T.D.

Energy Source	1998-99	2003-04	2004 Y.T.D.	Price unit
Gasoline	1.26	1.81	1.95	$/gallon
Diesel	1.18	1.80	1.98	$/gallon
Jet	0.52	1.05	1.23	$/gallon
LPG	0.90	1.25	1.30	$/gallon
Residual	0.33	0.70	0.74	$/gallon
Natural Gas	3.75	7.12	7.71	$/Mcf
Electricity	4.1	5.6	5.4	Cents/KWh

Price factors derived from the energy price data in Table 3 above were used to estimate energy expenditures for 2003-04 and 2004 Y.T.D. Gross State Product values for 2003 and 2004 were estimated by assuming a 2 percent annual growth rate for each year[7]. Table 4 presents the historical 1998-99 energy expenditures and GSP as well as the estimated energy expenditures and GSP values for 2003-04 and 2004 Y.T.D. The increase in expenditures and fraction of state GSP devoted to energy expenditures is also shown.

Table 4: Historical and Estimated State Energy Expenditures

Time period	Total Energy Expenditures: Billions of dollars	Increase in Expenditures: Billions of dollars	State GSP: Billions of dollars	Energy Expend. as % GSP	Change in percent energy expend. (%GSP)
1998-99 (nominal $)	10.1	----	200	5.0	----
1998-99 (2003 $)	11.0	----	218	5.0	----
2003-04 (2003 $)	15.1	4.1	239	6.3	1.3
2004 Y.T.D. (2003 $)	15.6	5.6	244	6.4	1.4

As Table 4 illustrates there has been approximately a 40 percent increase in expenditures for energy in Washington State over the last five years. The higher energy prices, if maintained through 2004, will shift an estimated 5.6 billion dollars (1.4 percent) of state GSP from non-energy to energy purchases: an amount equivalent to about 890 dollars per resident of Washington State. Note that if one compares the values for 2003-04 energy expenditures as percent of GSP in Table 4 with the corresponding value for 2000 that can be found in Table 2, the percentage increase between the two periods is much smaller: only 0.3 percent. This is because after many years of low and stable energy prices, the year 2000 saw the first sizable increases in prices, particularly for gasoline, diesel, and natural gas. Overall energy expenditures in 2000 were up 25 percent over 1999 expenditures and served as an indictor that the energy markets were changing. Energy

[7] This is the more common GSP growth rate minus any projected growth from population increases, which is about 1.2 percent per year for Washington State.

prices, and probably expenditures, declined in late 2001 and 2002 as the economy worked its way through a mild recession.

From the state's perspective the impact of increased expenditures on energy is dependent on the location of the business that actually receives payments for selling the energy resource. Since petroleum and natural gas are produced and delivered from out of state, frequently by multinational corporations, an argument can be made that relative to the 1998-99 time period, several billion dollars have left the state. Because most of our electricity is generated within the state the increased expenditures for electricity may not represent as significant of a diversion of resources towards out of state entities[8].

Response to high-energy prices

Of course individuals and businesses will eventually respond to higher energy prices by altering behavior and consuming less energy. Some of the different ways they might consume less energy are by turning down thermostats, investing in energy conserving devices, reducing business activity and by driving fewer miles or using more efficient vehicles. Economists attempt to quantify consumer response to higher prices (energy or other purchases) in a term known as price demand elasticity. The term is often referred to as being elastic or inelastic. An energy price demand elasticity value of –1.0 is considered elastic, and implies that for a 50 percent increase in energy prices consumers will compensate by decreasing their consumption of energy by 50 percent. A value of 0.0 represents an inelastic energy price demand elasticity, where consumers are unable to reduce consumption following a price increase. Demand elasticity is also often expressed as a long or short run parameter. In the short run demand is more inelastic, that is consumers are not able to reduce energy consumption very much, so they primarily absorb the higher energy costs and reduce consumption in other areas. Over the long run, say 2 to 5 years, energy demand is more elastic and consumers are able to take steps to reduce consumption.

Most of the energy price demand elasticity estimates are for petroleum or refined petroleum products, and are typically derived form price and consumption data collected during the 1970's and 1980's. As an initial postulation economists often apply the petroleum elasticity estimates to other sources of energy, particularly natural gas. Short-term energy demand is inelastic with parameters averaging around –0.2, meaning a 50 percent increase in prices will only result in a 10 percent decrease in energy consumption[9]. Historically, long run energy elasticity estimates have ranged from –0.3 to –0.8, which translates into a 15 to 40 percent reduction in energy consumption for a 50

[8] Because some of our higher electricity rates can be attributed to long term contracts signed with energy-marketing companies during and after the 2000-01 west coast energy crisis a counter argument can be made that much of the revenue from higher prices is flowing out of state.

[9] See J. Bulow et. al. (2003) *US Midwest Gasoline Pricing and the Spring 2000 Price Spike*, The Energy Journal, p. 121-149.

percent price increase[10]. However, there are indications that such values, most derived from the 1970's and 1980's when energy prices soared, overstate current consumer responses and that long run price elasticity may now be closer to the lower end of the range given above[11]. To summarize, in the short run consumers in Washington State will not be able to significantly negate the impact of higher energy prices through changes in purchases or behavior. As a consequence, recent energy price increases will have a small but noticeable negative impact on the State's economy. Over the long-run consumers and businesses may be able to avoid a larger fraction of the increase in energy prices through improved energy efficiency or behavioral changes.

Consequences of higher energy prices

Predictions of reduced economic activity as a consequence of higher energy prices have appeared in the business press. A Deutsche Bank economic analyst[12] stated that, a prolonged $10 per barrel increase in the world price of oil (from $25 to $35) would decrease US economic activity (GDP) by 0.5 percent: this implies a GDP - petroleum price elasticity of –0.013. Recently, Alan Greenspan, chairman of the Federal Reserve Bank indicated that high-energy prices, while not likely to throw the U.S. or world economy into recession, have acted like a tax, equivalent to about 0.75 percent of GDP [13]. Stephen Brown, an economist at the Federal Reserve stated that based on research with petroleum price shocks, a 50 percent increase in natural gas prices could result in a 0.3 to 1 percent reduction in U.S. GDP.

Since petroleum expenditures represent just under half of our national energy budget (nationwide, $263 out of a total of $559 billion spent in 1999), we could, as a rough but conservative approximation[14], extend the Deutsche Bank elasticity presented above to the broader U.S. energy budget and impute that a 20 percent energy price increase reduces economic activity by 0.5 percent. Extending this relationship to Washington State, where our overall energy price increase over the past several years is approximately 40 percent, the above figure would allow us to (roughly) estimate a 1.0 percent decrease in state GSP due to the recent energy price increases if they are maintained for an extended period of time.

[10] D. Gately, (2004*), OPEC's Incentives for Faster Output Growth*, IAEE: The Energy Journal, p. 75-96.
[11] S. Brown, (2003), *U.S. Natural Gas Markets in Turmoil*, USAEE: Dialogue, July 2003, p.12.
[12] Deutsche Bank economic analyst Michael Rosenberg, Nov. 2002.
[13] This information is from a Federal Reserve Bank speech given by Alan Greenspan on Oct. 15, 2004. The reduction in GDP growth was estimated to be less than this amount.
[14] The Deutsche Bank GDP energy price elasticity value is lower than most.