

Estimating the Contribution of Rural Energy Sources to Washington State's Energy Production and Consumption

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Executive Summary

Nearly 100 percent of Washington State's energy production originates in the state's rural areas. Additionally, 25.4 percent of the total energy *consumed* in the state is both renewable and rural in origin (includes hydropower). There is nuclear power production which occurs in rural Eastern Washington. When the nuclear power is added, the percentage rises to 31.2 percent. Only a small amount of solar is urban in origin. The vast hydropower, wind and bioenergy resources as well as the largest share of solar and geothermal capacity are both renewable and rural in origin. The difference between energy production and consumption is a reflection of the significant amount of imported natural gas and petroleum consumed in the state. The state of Washington has met the vision of 25x'25: *"By 2025, America's farms, forests and ranches will provide 25 percent of the total energy consumed in the United States, while continuing to produce safe, abundant, and affordable food, feed and fiber."* Washington should consider adopting a stretch vision.

Overview

This report documents an initial attempt to estimate the portion of energy produced and consumed in Washington State which originates in the state's rural communities. The report begins with an overview of the state's energy resources and energy use patterns and then introduces a methodology for estimating the contribution to the energy economy from rural areas. Detailed data are provided in the appendix.

Data Sources

Most of the data used in this report are from the Energy Information Administration State Energy Data System (EIA SEDS).¹ This report assumes the reader has a basic level of understanding of EIA SEDS data or can refer to SEDS Technical Notes for additional details related to the content or description of those data.² In some cases, unique state-level data have been substituted where those data are likely to be more accurate than data available from EIA. This report documents the use of substitute data, the overall methodology and necessary assumptions for conducting a rural energy analysis.

Overview of Washington's Energy Resources

Washington State has no currently developed indigenous natural gas or petroleum production. Washington has some limited coal resources but the one commercial coal mine, located in Centralia, recently closed. Washington has enormous hydropower potential. The capacity for large, conventional hydropower is fully developed yet significant remaining potential exists in small hydro and efficiency upgrades at existing hydro facilities. Washington has large bioenergy resources, including wood, which support the largest forest products industry in the U.S. Washington also is fifth in the nation for installed wind capacity and has significant solar and geothermal resources. The state is also a leader in agricultural production with over 300 different agricultural products sold around the world.

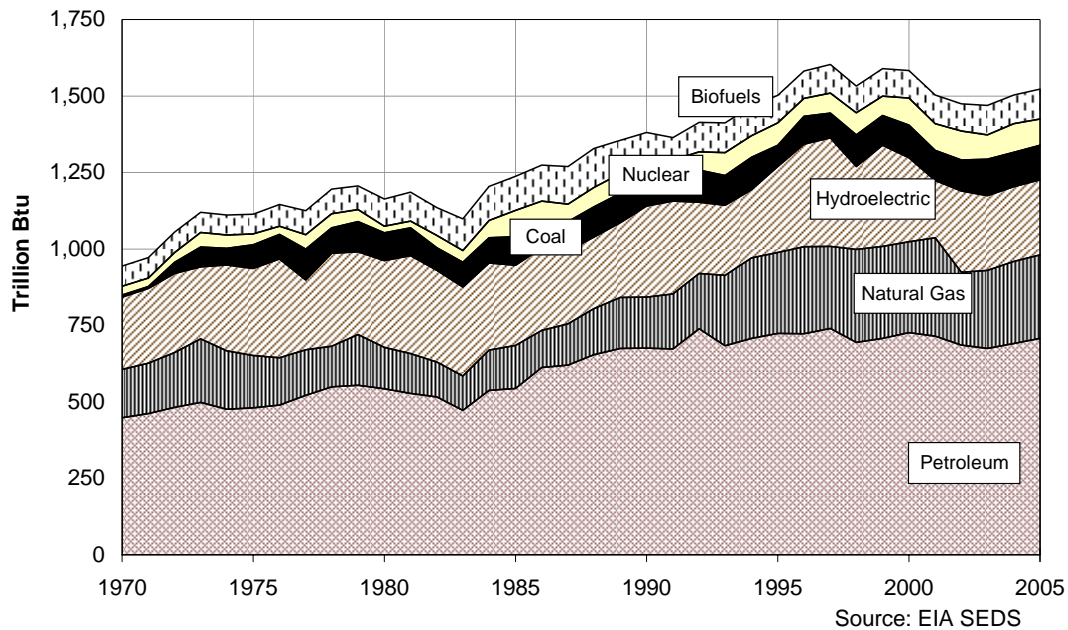
A Snapshot of Washington's Energy Consumption

All of the petroleum, natural gas and coal consumed in the state are imported. Canada, Alaska and the U.S. Rocky Mountain region are the leading suppliers for fossil fuels consumed in Washington.³

Primary energy consumption is the fuel input into the energy system, before any conversions or losses occur.

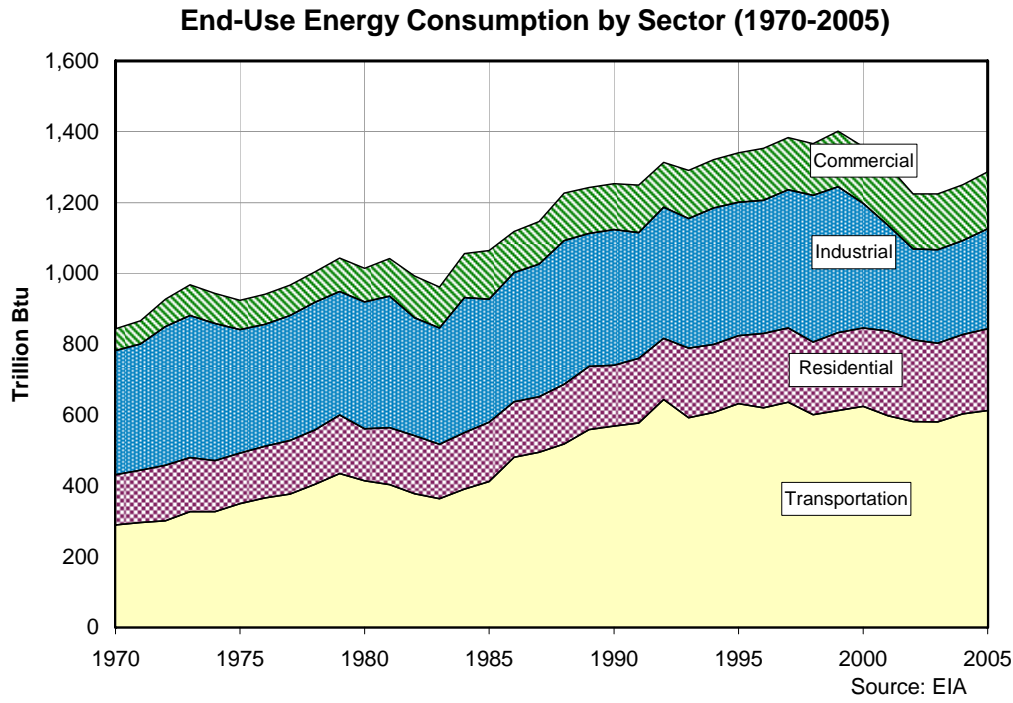
Figure 1

Total Primary Energy Consumption by Source (1970-2005)



End-use energy consumption is based on energy used after losses in power generation and transmission have occurred. Therefore end-use consumption is much smaller than primary energy consumption. The transportation sector consumes about half of the total energy used in the state.

Figure 2



Methodology for Rural Energy Analysis

The first step is to make any necessary adjustments to EIA data. EIA collects data based on the units of measurements commonly used for each fuel type. For example, petroleum is reported in barrels, coal is reported in short tons and natural gas is reported in cubic feet. In order to compare the energy content of a variety of fuels, it is necessary to convert all fuels to British Thermal Units (BTUs). In the case of hydropower, EIA assigns a BTU conversion rate which assumes a heat-loss rate equivalent to a thermal generator. The rationale behind that method is that if the hydro were not operating, the replacement resources would likely be a thermal generator which would have a significant heat loss. In other words, in order to get the same kWh output from a thermal generator, significantly more fuel would need to be input to account for the losses that occur during generation. The resulting effect is that the kWh data for hydropower reported in SEDS are actual generation, but the same data converted to BTUs show a grossly inflated figure.⁴

For most states, this is not a significant concern. However, 60 percent of Washington's electricity is produced from hydropower so the issue is significantly magnified. To adjust for this, a Washington State analysis must recreate the BTU data for hydropower by using SEDS kWh data multiplied by 3.412, the factor for converting electricity to BTUs. This allows a direct BTU comparison across fuels without assuming heat losses are associated with hydropower generation. The primary energy consumption shown in Fig 1 includes this adjustment (without it, contributions from hydropower appear about three times larger.)

Non-Renewable Energy

Coal

Coal Production

The production data reported in EIA are collected from coal producers.⁵ The only producing coal mine in the state is located in Centralia and was closed in 2007. All of the coal produced from the mine was consumed at the adjacent electricity generation facility. The generator is still operating; however all of the coal consumed is imported from Wyoming and Montana.

Coal Consumption

Electric power generation is responsible for 97% of the coal consumption in Washington. All of that consumption occurs at the state's only coal generator located in Centralia.

The difference between coal production and coal consumption in the state represents the amount of imported coal. The historical coal production as well as the historical and current coal consumption occurs entirely in rural areas of the state.

Natural Gas

Washington has no commercially viable indigenous natural gas resources. All of the natural gas serving the state originates in Canada or the Rocky Mountains region.

The following table shows the proportion of natural gas consumed by sector.

Table 1

| | |
|--------------------|-----|
| Transportation | 3% |
| Commercial Sector | 20% |
| Electric Power | 21% |
| Industrial Sector | 27% |
| Residential Sector | 29% |

Petroleum

As with natural gas, Washington State has no indigenous petroleum supplies and therefore no production. All of the petroleum consumed in the state is imported, mostly from Canada or Alaska. The state is the refining center for the Pacific Northwest with several large refineries located in rural Whatcom County.

EIA SEDS data for motor gasoline consumption include the portion of fuel containing ethanol. The SEDS data contain an ethanol data series that can be subtracted from the gasoline consumption data in order to distinguish between the two.

Nuclear Power

EIA's data assume that electricity generated in the state is also consumed in the state, so the production and consumption figures are identical. In reality, the state is a net electricity exporter and many of the facilities located in the state serve the entire western power grid. However, for the purposes of this analysis, it is assumed that the electricity produced by nuclear generators located here is also consumed here.

All of the nuclear power production in the state occurs in the Tri-Cities region in the rural southeastern region of the state.

Renewable Energy

Ethanol

Ethanol is blended into all the gasoline sales in the state. EIA data for petroleum consumption include gasoline sales with ethanol already blended. However, a separate data series for ethanol is also available. Removal of the ethanol from the gasoline sales allows the ethanol to be shifted to the bioenergy category.

Washington State once produced ethanol from brewery byproducts, wood and pulp waste (1944-2003) however there is no production currently in operation. All ethanol production is considered rural in origin.

EIA assumes that the ethanol consumed in the state (as a portion of gasoline sales) is equal to the ethanol produced in the state. For this analysis, the ethanol production and consumption are based on EIA's data.

The following table shows the proportion of ethanol consumed by sector across the state:

Table 2

| | |
|-------------------|------|
| Transportation | 98% |
| Commercial Sector | 0.3% |
| Industrial Sector | 1.5% |

Wood

The EIA SEDS data assumptions related to wood energy use are:

- Production and consumption are the same
- The residential and commercial sectors primarily uses wood for space heating
- The commercial sector also uses wood, municipal waste and landfill gas for steam heat and electricity generation
- The industrial sector uses combustible by-products and wood chips for electricity generation and process steam.
- The electric power sector uses wood, industrial wood waste and waste gas and municipal waste as co-firing or primary fuels to produce electricity.

The following table shows the portion of wood consumption by sector:

Table 3

| | |
|--------------------|-----|
| Commercial Sector | 3% |
| Electric Power | 12% |
| Residential Sector | 17% |
| Industrial Sector | 68% |

This methodology assumes 100 percent of wood production is rural in origin. Some wood material may be gathered as a result of urban tree maintenance; however since no state-level data exist, this is assumed to be negligible.

Waste

EIA defines “waste” as containing wood waste as well as municipal solid waste from non-biogenic sources and tire-derived fuels.

The following table shows the portion of waste consumption by sector. Since most of the waste is consumed by the industrial and electric power sectors, it is assumed to be primarily wood, and therefore 75 percent rural in origin. There are some generators in the state that are fueled by municipal solid waste and tires; these are assumed to be urban in origin and represent the remaining 25 percent of waste production.

Table 4

| | |
|-------------------|-----|
| Commercial Sector | 0% |
| Electric Power | 41% |
| Industrial Sector | 59% |

Geothermal

EIA defines “geothermal” as the direct use of geothermal energy and geothermal heat pumps. The data for direct use and heat pumps in the residential, commercial and industrial sectors reported by EIA SEDS are based on data collected in a survey conducted by the Oregon Institute of Technology Geo-Heat Center. The electric power sector is collected from EIA Form 906.

Most of the commercial sector consumption is based in the rural Columbia Plateau region. Geothermal production is assumed to be 100 percent rural in origin.

SEDS assumes production and consumption are the same.

The following table shows the proportion of geothermal consumption by sector:

Table 5

| | |
|--------------------|-----|
| Commercial Sector | 92% |
| Residential Sector | 8% |

Solar

EIA assigns states solar production and consumption based on shipments of solar panels. For Washington State, these data were substituted by data provided by state solar industry specialists tracking applications for solar tax incentive rebates. These data were applied to the year 2005 and forward.

About one-third of the installed solar capacity in the state is residential and the remaining two-thirds is commercial. The largest commercial facilities are located in Hanford, Olympia, Chelan County, Orcas Island, White Bluffs and Wild Horse. There are urban solar facilities as well, but the total installed capacity is much less than in rural areas. Based on data for individual commercial solar projects reported by the Renewable Northwest Project and data collected from tax rebates for residential systems, it is estimated that 85 percent of installed solar capacity is in rural locations.⁶

This analysis assumes state production and consumption are the same.

Wind

All wind data are reported as electric power generation. The EIA SEDS data assume production and consumption are the same. Washington State has access to unique data allowing a substitution for wind consumption. Utilities in Washington are required to report the generation they own or purchase which is used by Washington State consumers. These data come from the Fuel Mix Disclosure report.⁷ The data represent wind consumption which is a part of the standard electricity product sold to all consumers (not above-market green power program sales) and does not include wind that has been stripped of environmental attributes (in other words, the wind electricity has not been separated from the RECs).

While it is possible that wind is being generated in urban areas, this amount is assumed to be statistically insignificant compared to the vast wind farms in the rural parts of the state.

Hydropower

EIA SEDS assumes hydropower production and consumption are the same. However, Washington State is a net exporter of electricity and consumes significantly less electricity than is generated here. The Fuel Mix Disclosure data are substituted for hydropower consumption from the year 2000 forward (see discussion on Fuel Mix Disclosure in Wind section above.) The production numbers are the same as those found in EIA SEDS, other than the adjustment which is necessary to eliminate the heat loss assigned by EIA to hydropower (see discussion on Adjustments to EIA data, page 2)

Nearly all of the hydropower occurs in rural areas of the state. The very small amount located within urban counties is still in the most rural parts of those counties.

Appendix – Data

Table 6
2006 Energy Consumption, Production and Status of Origin

| | Total Consumption (Trillion BTU) | Rural origin (Trillion BTU) | % rural | Total Production (Trillion BTU) | Rural origin (Trillion BTU) | % rural | Renewable energy production (Trillion BTU) | Rural origin (Trillion BTU) | % rural |
|---------------|-------------------------------------|-----------------------------------|------------|---------------------------------------|-----------------------------------|--------------|---|-----------------------------------|--------------|
| Coal | 69.2 | 69.2 | | 40.3 | 40.3 | | 0 | 0 | |
| Natural Gas | 271.6 | 0.0 | | 0.0 | 0.0 | | 0 | 0 | |
| Petroleum | 800.8 | 0.0 | | 0.0 | 0.0 | | 0 | 0 | |
| Nuclear Power | 97.3 | 97.3 | | 97.3 | 97.3 | | 0 | 0 | |
| Ethanol | 8.2 | 8.2 | | 0.0 | 0.0 | | 0.0 | 0 | |
| Wood | 101.3 | 101.3 | | 101.3 | 101.3 | | 101.3 | 101.3 | |
| Waste | 5.7 | 4.3 | | 5.7 | 4.3 | | 5.7 | 4.3 | |
| Geothermal | 0.7 | 0.7 | | 0.7 | 0.7 | | 0.7 | 0.7 | |
| Solar | 0.2 | 0.1 | | 0.2 | 0.1 | | 0.2 | 0.1 | |
| Wind | 3.0 | 3.0 | | 10.3 | 10.3 | | 10.3 | 10.3 | |
| Hydro | 203.4 | 203.4 | | 279.8 | 279.8 | | 279.8 | 279.8 | |
| TOTAL | 1561.2 | 487.4 | 31% | 535.5 | 534.1 | 99.7% | 397.9 | 396.5 | 99.6% |

Figure 3

Washington State Energy Use by Rural Energy Production, 2006

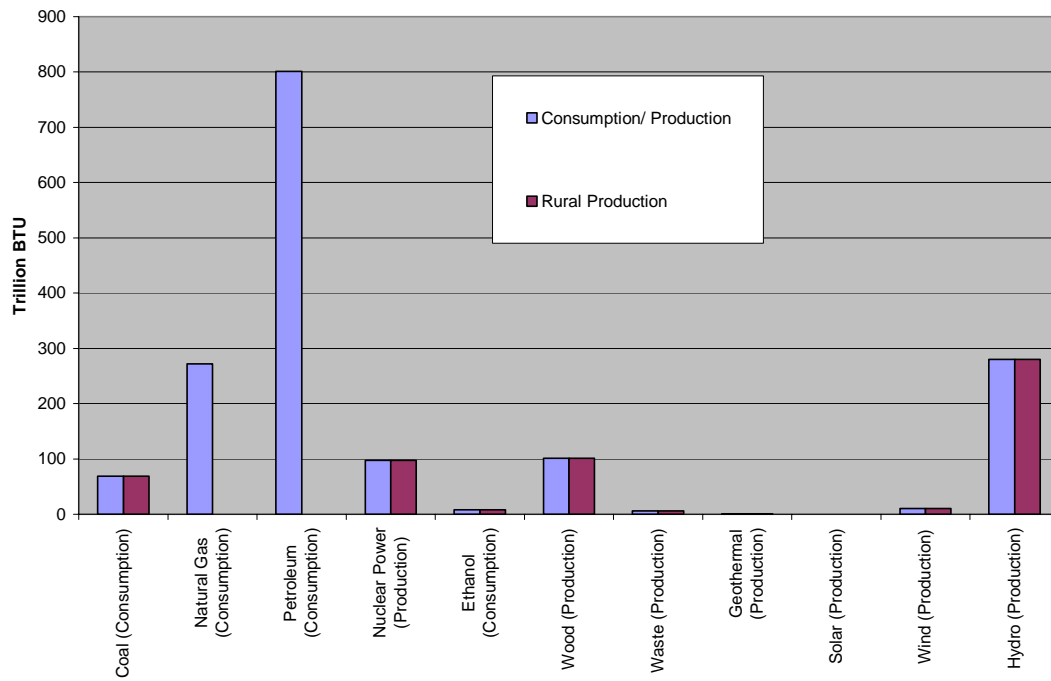


Figure 4

Washington State Non-hydro Renewable Energy Use by Rural Energy Production, 2006

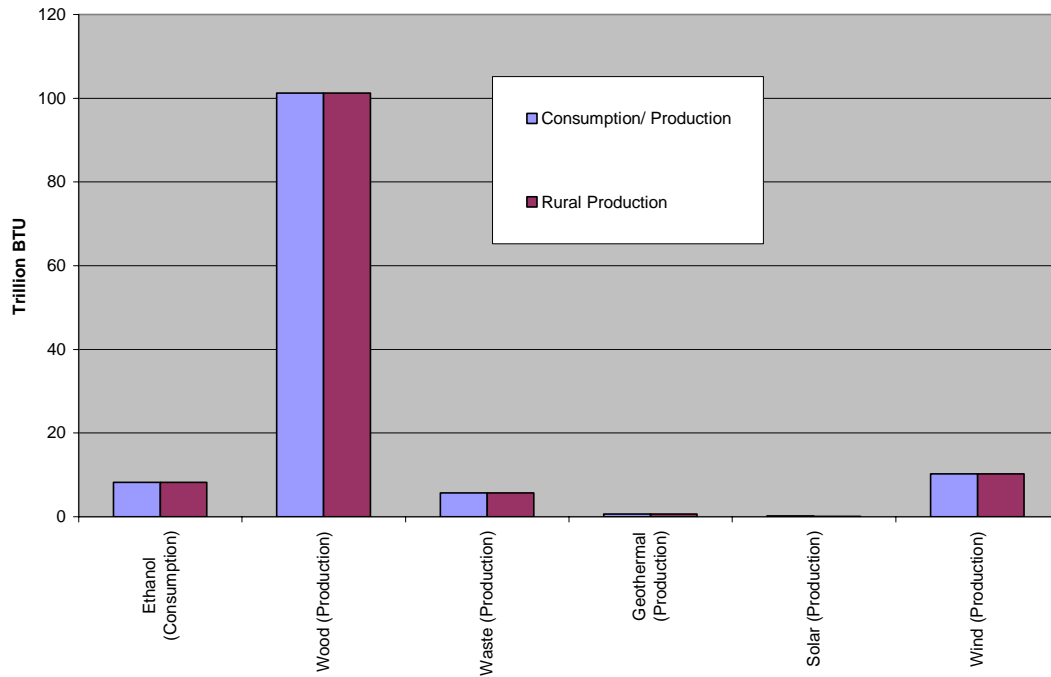


Table 7 Washington State Energy Production/Consumption and Rural Production (Trillion BTU)

| Year | Fossil Fuels | | | | | | | | |
|------|--------------|-------------|------------------|-------------|-------------|------------------|------------|-------------|------------------|
| | Coal | | | Natural Gas | | | Petroleum | | |
| | Production | Consumption | Rural Production | Production | Consumption | Rural Production | Production | Consumption | Rural Production |
| | | | 100% | | | 0% | | | 0% |
| 1990 | 81.056 | 85.6 | 81.1 | 0 | 167.4 | 0.0 | 0 | 762.4 | 0.0 |
| 1991 | 82.32 | 89.1 | 82.3 | 0 | 179.2 | 0.0 | 0 | 768.2 | 0.0 |
| 1992 | 83.184 | 106.1 | 83.2 | 0 | 180.6 | 0.0 | 0 | 851.7 | 0.0 |
| 1993 | 74.933 | 97.8 | 74.9 | 0 | 229.6 | 0.0 | 0 | 770.7 | 0.0 |
| 1994 | 77.21 | 106.9 | 77.2 | 0 | 263.2 | 0.0 | 0 | 802.6 | 0.0 |
| 1995 | 78.433 | 69.8 | 78.4 | 0 | 264.5 | 0.0 | 0 | 823.0 | 0.0 |
| 1996 | 72.089 | 90.9 | 72.1 | 0 | 283.9 | 0.0 | 0 | 822.0 | 0.0 |
| 1997 | 71.253 | 80.5 | 71.3 | 0 | 268.1 | 0.0 | 0 | 825.4 | 0.0 |
| 1998 | 72.809 | 103.5 | 72.8 | 0 | 303.3 | 0.0 | 0 | 826.0 | 0.0 |
| 1999 | 63.997 | 96.9 | 64.0 | 0 | 302.3 | 0.0 | 0 | 853.1 | 0.0 |
| 2000 | 66.52 | 106.2 | 66.5 | 0 | 297.6 | 0.0 | 0 | 840.2 | 0.0 |
| 2001 | 72.134 | 99.4 | 72.1 | 0 | 322.4 | 0.0 | 0 | 778.0 | 0.0 |
| 2002 | 91.335 | 100.8 | 91.3 | 0 | 238.2 | 0.0 | 0 | 741.3 | 0.0 |
| 2003 | 97.712 | 118.2 | 97.7 | 0 | 255.1 | 0.0 | 0 | 731.0 | 0.0 |
| 2004 | 89.958 | 112.5 | 90.0 | 0 | 268.5 | 0.0 | 0 | 754.6 | 0.0 |
| 2005 | 82.685 | 112.3 | 82.7 | 0 | 272.7 | 0.0 | 0 | 774.3 | 0.0 |
| 2006 | 40.268 | 69.2 | 40.3 | 0 | 271.6 | 0.0 | 0 | 800.8 | 0.0 |
| 2007 | 0 | 95.7 | 0.0 | 0 | 279.7 | 0.0 | 0 | 836.5 | 0.0 |

Table 7, continued

| Year | Fossil Fuels (continued) | | | Renewables | | | | | |
|------|--------------------------|-------------|--------------------------|------------|-------------|--------------------------|------------|-------------|--------------------------|
| | Nuclear Power | | | Ethanol | | | Wood | | |
| | Production | Consumption | Rural Production 100% | Production | Consumption | Rural Production 100% | Production | Consumption | Rural Production 100% |
| 1990 | 60.8 | 60.8 | 60.8 | 0.7 | 0.7 | 0.7 | 92.6 | 92.6 | 92.6 |
| 1991 | 44.3 | 44.3 | 44.3 | 0.8 | 0.9 | 0.8 | 71.6 | 71.6 | 71.6 |
| 1992 | 59.6 | 59.6 | 59.6 | 3.9 | 4.0 | 3.9 | 91.9 | 91.9 | 91.9 |
| 1993 | 74.9 | 74.9 | 74.9 | 6.8 | 6.9 | 6.8 | 89.4 | 89.4 | 89.4 |
| 1994 | 70.4 | 70.4 | 70.4 | 7.9 | 7.9 | 7.9 | 88.1 | 88.1 | 88.1 |
| 1995 | 72.9 | 72.9 | 72.9 | 2.6 | 2.6 | 2.6 | 83.3 | 83.3 | 83.3 |
| 1996 | 58.7 | 58.7 | 58.7 | 1.1 | 1.2 | 1.1 | 82.7 | 82.7 | 82.7 |
| 1997 | 65.5 | 65.5 | 65.5 | 2.2 | 2.2 | 2.2 | 85.7 | 85.7 | 85.7 |
| 1998 | 72.6 | 72.6 | 72.6 | 2.9 | 3.0 | 2.9 | 80.4 | 80.4 | 80.4 |
| 1999 | 63.6 | 63.6 | 63.6 | 2.5 | 2.5 | 2.5 | 83.1 | 83.1 | 83.1 |
| 2000 | 89.7 | 89.7 | 89.7 | 2.8 | 2.8 | 2.8 | 82.4 | 82.4 | 82.4 |
| 2001 | 86.2 | 86.2 | 86.2 | 2.0 | 2.1 | 2.0 | 86.6 | 86.6 | 86.6 |
| 2002 | 94.5 | 94.5 | 94.5 | 5.9 | 6.0 | 5.9 | 82.0 | 82.0 | 82.0 |
| 2003 | 79.4 | 79.4 | 79.4 | 5.6 | 5.7 | 5.6 | 90.2 | 90.2 | 90.2 |
| 2004 | 93.7 | 93.7 | 93.7 | 1.9 | 1.9 | 1.9 | 86.7 | 86.7 | 86.7 |
| 2005 | 86.0 | 86.0 | 86.0 | 0.0 | 7.5 | 0.0 | 77.5 | 77.5 | 77.5 |
| 2006 | 97.3 | 97.3 | 97.3 | 0.0 | 8.2 | 0.0 | 101.3 | 101.3 | 101.3 |
| 2007 | 0.0 | 85.0 | 0.0 | 0.0 | 10.3 | 0.0 | 76.7 | 76.7 | 76.7 |

Table 7, continued

| Year | Renewables (continued) | | | | | | | | |
|------|------------------------|-------------|------------------|------------|-------------|------------------|------------|-------------|------------------|
| | Waste | | | Geothermal | | | Solar | | |
| | Production | Consumption | Rural Production | Production | Consumption | Rural Production | Production | Consumption | Rural Production |
| | | | 75% | | | 100% | | | 85% |
| 1990 | 0.8 | 0.8 | 0.6 | 0.1 | 0.1 | 0.1 | 0.4 | 0.4 | 0.3 |
| 1991 | 2.3 | 2.3 | 1.8 | 0.1 | 0.1 | 0.1 | 0.4 | 0.4 | 0.3 |
| 1992 | 3.4 | 3.4 | 2.6 | 0.1 | 0.1 | 0.1 | 0.4 | 0.4 | 0.3 |
| 1993 | 7.1 | 7.1 | 5.3 | 0.1 | 0.1 | 0.1 | 0.4 | 0.4 | 0.3 |
| 1994 | 8.1 | 8.1 | 6.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 |
| 1995 | 6.9 | 6.9 | 5.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 |
| 1996 | 6.9 | 6.9 | 5.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 |
| 1997 | 8.5 | 8.5 | 6.3 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 |
| 1998 | 6.8 | 6.8 | 5.1 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 |
| 1999 | 6.3 | 6.3 | 4.7 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 2000 | 7.2 | 7.2 | 5.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 2001 | 6.1 | 6.1 | 4.6 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| 2002 | 5.6 | 5.6 | 4.2 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 |
| 2003 | 5.5 | 5.5 | 4.1 | 0.5 | 0.5 | 0.5 | 0.2 | 0.2 | 0.2 |
| 2004 | 5.8 | 5.8 | 4.4 | 0.6 | 0.6 | 0.6 | 0.2 | 0.2 | 0.2 |
| 2005 | 5.9 | 5.9 | 4.4 | 0.6 | 0.6 | 0.6 | 0.2 | 0.2 | 0.1 |
| 2006 | 5.7 | 5.7 | 4.3 | 0.7 | 0.7 | 0.7 | 0.2 | 0.2 | 0.1 |
| 2007 | 5.8 | 5.8 | 4.3 | 0.7 | 0.7 | 0.7 | 0.2 | 0.2 | 0.2 |

¹ Energy Information Administration State Energy Data System (EIA SEDS):
http://www.eia.doe.gov/emeu/states/_seds.html

² EIA SEDS Technical Notes: http://www.eia.doe.gov/emeu/states/_seds_tech_notes.html

³ Washington State Energy Use Indicators: <http://www.commerce.wa.gov/site/531/default.aspx>

⁴ To see this difference, see the SEDS state data for WA:
http://www.eia.doe.gov/emeu/states/hf.jsp?incfile=sep_use/total/use_tot_wa.html&mstate=WASHINGTON

⁵ EIA's survey Form EIA-7A, <http://www.eia.doe.gov/cneaf/coal/page/surveys/coal7a.html>

⁶ Renewable Northwest Project: <http://www.rnp.org/Projects/default.html>

⁷ Washington State Fuel Mix Disclosure: <http://www.commerce.wa.gov/site/539/default.aspx>

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