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Washington State Biomass Data Book

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Disclaimer

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Who Will Benefit?

What Does It Contain?

Using This Book

This is the first edition of the *Washington State Biomass Data Book*. It was developed to be a resource for people who work with or are interested in biomass-to-energy projects in Washington. Energy planners and policy makers are encouraged to use the *Washington State Biomass Data Book* to gain a better understanding of the supply, current use, and possible use of biomass fuels.

This one document assesses sources and approximate costs of biomass fuels, presents a view of current users, identifies potential users in the public and private sectors, and lists prices of competing energy resources.

The **Summary** describes key data from the categories listed above.

Part I, Biomass Supply, presents data in increasing levels of detail on agricultural residues, biogas, municipal solid waste, and wood waste. The information includes type of resource, historical perspective (when available), variability in the quantity of biomass generated, its availability for energy consumption, and costs associated with collection and transportation. Some data are presented on costs of biomass fuels. Further information on agricultural residue pricing and logging residue pricing can be found in *Biomass Energy Project Development Guidebook* (U.S. Department of Energy/Bonneville Power, 1989); *Agricultural Residues* (Roy Taylor, 1987); and *Regional Logging Residue Supply Curve Project*, Vol. 1, Final Report, (U.S. Department of Energy and Bonneville Power Administration, 1986).

Part II, Current Industrial and Commercial Use, demonstrates how biomass is successfully being used in existing facilities as an alternative fuel source. Biomass annually contributes 64 trillion Btu and has a potential of contributing nearly 143 trillion (See Tables S-1 and S-2, page viii). (Washington State Energy Office, 1990). To put this into perspective, Washington's industrial sector consumes nearly 247 trillion Btu of fuels per year. Residential use is estimated to be 154 trillion Btu per year.

Part III, Potential Demand, describes potential energy-intensive public and private sector facilities. Biomass fuels offer a unique energy resource. They are produced on a continuous basis as a result of food, fiber, and materials needs. Using biomass to fuel the energy needs of these facilities could be one solution to reducing consumption of fossil fuels.

Part IV, Prices of Competing Energy Resources, shows current suppliers of electricity and natural gas and compares utility company rates. This section also includes coal and petroleum

consumption and pricing patterns in Washington State from 1960 to 1988.

The **Bibliography** lists the sources used to compile this document. References appear at the end of each section.

Appendix A contains a glossary with brief definitions of words and technical expressions used in this document.

Appendix B contains one sample of the 39 county profiles that have been prepared. Data shown for Spokane County are representative of biomass information available on a per county basis. Each profile gives a detailed look at biomass for a specific county. Information provided includes: climate, population, major cities, principal economic activities, highways, railroads, airports, power generating facilities, utilities, agricultural extension contacts, farms and cropland, landfills, colleges, state facilities, hospitals, schools, etc.. To keep printing costs down, only one county profile has been included in this document. Copies of the other county profiles can be obtained from the Washington State Energy Office.

Sources

Taylor, Roy. *Agricultural Residues*. July 1987.

U.S. Department of Energy and the Bonneville Power Administration. *Biomass Energy Project Development Guidebook*. Prepared for the Pacific Northwest and Alaska Bioenergy Program. 61195-1. 1989.

U.S. Department of Energy and the Bonneville Power Administration. *Regional Logging Residue Curve Project, Volume 1, Final Report*. August 1986.

Availability of Biomass Fuels

Summary

Biomass fuels offer a unique energy resource in Washington state. They are produced on a continuous basis as a result of our food, fiber, and material needs. Biomass fuels have a potential of contributing nearly 143 trillion Btu annually.

Major biomass fuels are agricultural field residues (barley and wheat), logging residues, mill residues, and municipal solid waste. Figure S-1 shows the contribution of these fuels to the total energy content of biomass generated. Figure S-2 shows the potential energy contribution of biomass assumed to be available for energy.

Although agriculture generates the largest percentage of residues, the majority must remain on the field for agronomic reasons. It is assumed that all logging residues generated are potentially available for energy. Mills generate a considerable amount of residue, but only a small portion goes unused. A portion of all municipal solid waste generated is recycled. Of the amount sent to landfills, only a portion is combustible and considered a fuel. As a result, the combustible portion generated is assumed to be the amount available for energy. Approximately 77 percent of municipal solid waste disposed is combustible and can be used for energy. Secondary wood processing facilities and sewage treatment plants each generate less than 1 percent of the total energy equivalent.

Currently, biomass contributes 64 trillion Btu per year to the industrial and commercial sectors (Washington State Energy Office, 1990).

The amount of fuels available at a competitive price is a critical question. Tables S-1 and S-2, page vii, compare the difference between the total amount of biomass generated and the potential amount available for energy. The cost of collecting logging residues and agricultural field residues is currently paid by the energy user. Mill residues and municipal solid waste are often available for free. In some cases the user is paid to haul the material away. Transportation costs are often a major part of the price paid.

1. Of the 8 million tons of barley and wheat field residues generated each year, 1.5 million (equivalent to 22.6 trillion Btu) are available for energy production. Nearly 81 percent of residues generated should be left on the ground for agronomic reasons.
2. Mills generate over 5.1 million dry tons of residues each year. Of that, 182.6 thousand tons are currently available for energy.
3. Nearly 4.2 million dry tons of logging residues equivalent to 75.4 trillion Btu are generated each year from logging

Table S-1

Biomass Generated

Type	Biomass Generated (Dry Tons)	Energy Equivalent (MBtu)
Agriculture	7,977,901	119,668,519
Mill Residues	5,141,690	92,550,416
Logging	4,190,605	75,430,886
MSW*	3,123,072	40,599,936
Sec. Wood Proc. Fac.	169,899	3,058,183
Biogas	NA	810,300
Total	20,603,167	332,118,239

* Figure represents only the combustible portion of disposed municipal solid waste and not the total generated.

Table S-2

Biomass Potentially Available for Energy

Type	Potential Available (Dry Tons)	Energy Equivalent (MBtu)
Logging	4,190,605	75,430,886
MSW*	3,123,072	40,599,936
Agriculture	1,506,311	22,594,666
Mill Residues	182,591	3,286,629
Sec. Wood Proc. Fac.	58,231	1,048,159
Biogas	NA	6,000
Total	9,060,810	142,966,276

* Figure represents only the combustible portion of disposed municipal solid waste and not the total generated.

Figure S-1

Figure S-2

Location of Biomass Fuels

activities in Washington forests. Over half of these residues are from private lands. Little is known as to how much of that is taken and consumed for energy. It is assumed that most of what is generated is available for energy.

4. Approximately 5.2 million tons of municipal solid wastes are generated in Washington state each year. Over 4 million tons of that are disposed and about 1.2 million tons are recycled. Of the amount disposed, a potential of 3.1 million tons (77 percent), or 40.6 trillion Btu, can be consumed for energy.
5. Close to 170 thousand tons of residues are generated by secondary wood processing facilities in Washington state. Over 58 thousand tons, slightly over 1 trillion Btu equivalent, can potentially be used for energy.
6. Sewage treatment facilities generate 1.3 billion cubic feet of biogas each year. Currently, approximately 10 million cubic feet, equivalent to 6 billion Btu, are available for energy. Biogas is used for space and process heat requirements of sewage treatment plants. Some larger facilities clean and scrub biogas to pipeline quality and sell it to utilities.

Almost all biomass fuels have one common characteristic: they are produced as a residue from some other primary process. Logging and wood product residues are generated because of our need for fiber and structural building materials; agricultural residues result from our need for food or fiber; and biogas and municipal solid waste come from our consumer habits. Whatever the primary purpose, biomass fuels will be used close to their point of generation.

1. For the most part, barley, spring wheat, and winter wheat field residues can be found on farms in eastern Washington. The southeast region generates approximately 58 percent of the total for both gross and net residues. Winter wheat dominates, generating 90 percent of the total for the state.
2. Mill residues are generated from sawmills, veneer and plywood mills, and shake and shingle mills. About 79 percent of available residues are from the shake and shingle mills found primarily in western Washington.
3. Logging residues on private forest lands represent 56 percent of the state total. On average, nearly 2.4 million tons of residues are generated annually. The southwest region dominates.
4. Since municipal solid waste and biogas generation is directly related to human activities, the largest population bases in Washington generate the greatest amount of wastes. The Puget Sound region in western Washington ranks number one in both categories.

A View of Current Users

Historically, the wood products industries and the residential sectors in Washington state have used wood residues to meet a significant portion of their fuel needs. Agricultural residues, biogas, and municipal solid waste have only recently been valued for their energy potential.

1. At this time, little if any data are available on agricultural residues used for energy.
2. Data on logging residues taken from forests are hard to document. Currently, it is not known how much is being taken from forests and used for energy consumption. The residential sector consumes most of the residues removed for energy.
3. Mill residues are being used for pulp and board, fuel, and for other purposes. Only a small percent of these residues go unused.
4. There are 59 wood combustion facilities generating 59 trillion Btu per year. Forest products industries often use residues in-house to produce energy for space and process heat. Some is sold to utility companies.
5. Currently, there are three municipal solid waste combustion facilities in Washington state, a fourth is under construction and is expected to be operational in 1992. They generate over 54 megawatts of electricity.
6. There are 39 sewage treatment plants that generate, on average, 810 billion Btu per year. Smaller plants use biogas in-house for space and process heat. Although larger plants use biogas for the same purposes, some scrub it and sell it to natural gas utilities or generate and sell electricity.
7. Secondary wood processors are generally smaller businesses and usually give residues away. These residues are used for soil improvement, animal bedding, and some are used as fuel. An accurate count of secondary wood processors is difficult to obtain and is not given in this report.

Potential Users in the Public and Private Sectors

Energy-intensive facilities in Washington state, such as state buildings, schools, hospitals, and industrial facilities could benefit from using biomass fuels.

1. The industrial sector consumes a total of 247 trillion Btu of energy per year. It follows the transportation sector, which consumes 527 trillion Btu. Approximately 255 industrial facilities were identified from this sector as potential biomass users.

Competing Energy Resources

2. The commercial sector consumes a total of 116 trillion Btu of energy each year. There are approximately 128 state agencies, 39 colleges and universities, 500 K-12 private and public schools, and 111 hospitals in this state whose energy consumption patterns can be analyzed to determine the feasibility of biomass fuel use.

As Washington state's population grows, so does energy demand. Because biomass fuels are produced on a continuous basis they offer a unique energy resource. More widely used energy resources are hydropower, petroleum, coal, and natural gas. In order to compete, biomass must be available at prices competitive with these resources.

1. Washington state currently relies heavily on hydropower to fuel the electrical energy demands in the state. Washington Water Power's Kettle Falls facility is the only investor owned utility utilizing biomass to generate electricity.
2. In 1991, energy demands increased taking Washington state from an era of electrical energy surplus to projected energy shortfall.
3. In 1986 (last year data available), the residential sector cut residential heating oil consumption by nearly 50 percent from 1960 (first year data available). Residual fuel consumption by the industrial sector remained approximately the same.
4. In 1986, coal consumed by the residential, commercial, and industrial sectors was reduced by approximately 50 percent from 1960. Coal consumed by electric utilities increased by approximately 30 percent from 1972 (first year coal was used to generate electricity).
5. Nearly all natural gas consumed in Washington state is imported from other states.

Sources

Washington State Energy Office. *1990 Washington State Directory of Biomass Energy Facilities*. 1990.

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Part I

Biomass Supply

Part I

Biomass Supply

The economy of Washington has traditionally been based on natural resources. The forest products and agricultural industries are dominant and they both generate large quantities of wastes that could be used for energy. The type and source of biomass fuel varies widely within the state both on a geographical and a time basis. In general, because these fuels have a low density they cannot be economically transported any great distance.

Agricultural field residues, biogas, municipal solid waste, logging residues, mill residues, and secondary wood processing residues are discussed in this section. Averages and ranges are presented by region and by county for agricultural, logging, and mill residues that were generated and available over an 8- to 10-year period for the state. Since data have not been available until recently, biogas, municipal solid waste, and secondary wood processing facility residue averages and ranges are not presented.

The data are presented in increasing levels of detail for each type of biomass. The first level presents an historical perspective and views the state as a whole. The next level defines geographic areas to represent potential supply zones. The final level gives details for each county. Figures, maps, and tables are presented for analysis under each type of biomass.

Also, other significant details, such as mill type and forest ownership, are presented in separate tables. Tables I-1 to I-3 show future availability and estimated prices of biomass fuels, factors determining costs, and transportation costs.

To represent the geographic areas in this book supply zones were borrowed from preestablished "Waste Generation Areas (WGA)" defined by the Washington State Department of Ecology (The Matrix Management Group et. al, 1988). These areas are:

Area	Counties
West	Clallam, Grays Harbor, Jefferson, Mason, Pacific
Northwest	Island, San Juan, Skagit, Whatcom
Puget Sound	King, Kitsap, Pierce, Snohomish, Thurston
Southwest	Clark, Cowlitz, Lewis, Skamania, Wahkiakum

Agricultural Field Residues

Methodology of Data Collected

North Central

Chelan, Douglas, Grant,
Okanogan

South Central

Kittitas, Klickitat, Yakima

Northeast

Ferry, Lincoln, Pend Oreille,
Spokane, Stevens

Southeast

Adams, Asotin, Benton,
Columbia, Franklin, Garfield,
Walla Walla, Whitman

The Department of Ecology used the following geographical factors as part of its criteria for selecting Waste Generation Areas: per-capita income, population, total employment in lumber and wood-products industries, total employment in nonlumber manufacturing, percent of area in harvested cropland, number of recycling centers, transportation costs to market for scrap paper, and average annual precipitation (The Matrix Management Group et.al, 1988).

Agricultural field residues are generated each year in Washington state as a result of the demand for food to feed the nation and the world. Demand for food is determined by population and the relative competitive position of the state in supplying needed crops.

Crops are the primary products; residues are what remain on the land after the harvest. Vines and culls from vegetable yields, stubble and straw from small grain and grass crops, stalks and cobs from corn production, and prunings from orchards and vineyards are all residues that can potentially be used for energy. Barley and wheat production predominate in Washington state; therefore, stubble and straw generated from the production of these grains are the only residues considered in this document.

The amount of residues generated each year and the quantity available for energy vary greatly. The quantity generated depends upon the yield of grain produced and the residue factors for that particular type of grain. The quantity available for energy depends upon the agronomic requirements for how much residues should be left on the ground to provide for erosion control and soil fertility.

Barley and wheat residues have a heating value of approximately 15 million British thermal units per dry ton.

Barley and wheat production figures were taken from the annual editions of *Washington Agricultural Statistics*, published by the Washington State Department of Agriculture, for the years 1982 through 1989. Residue factors of 1.5, 1.3, and 1.7 pounds of straw per pound of grain produced for barley, spring wheat, and winter wheat, respectively, were used.

The minimum amount of residue required to be left on a field for agronomic reasons depends on the individual site and the type of

farming. Dry land farming requires more surface mulch to maintain and protect the natural moisture from evaporation; irrigated farming requires less. For the purpose of this document, we made the following assumptions concerning soil improvement requirements: dry land farming requires 2.5 tons of residue per acre be left and irrigated farming requires 2.0 tons per acre be left.

All residues generated as a result of grain harvest were labeled gross residues. Residues available for energy after the percentage left for soil improvement were labeled net residues.

The gross quantity of residue generated was found by multiplying the grain yield data by the residue factor. To calculate net residues, the amount left for soil improvement was subtracted from the gross quantity generated.

Dry and irrigated land were calculated separately for both gross and net residues. (Results for Spokane county are given in Appendix B. Results for other counties are available upon request from the Washington State Energy Office). The values reported in this section of the document are combined for dry and irrigated lands.

Current Supply

Pages I-17 through I-36 show the current supply of barley, spring wheat, and winter wheat in increasing levels of detail. Figure I-1 shows the total amount of barley and wheat generated (gross) and available for energy (net) over an 8-year period from 1982 through 1989. Figures I-2 through I-4 give the amount per year by type of field residue (see Appendix B for actual figures by county). Tables I-4 through I-19 represent the average and range available for the state, regionally and by county. The net average for the state was over 1.5 million dry tons, which was 19 percent of the gross. The southeast region dominated, producing 58 percent of the net (see Table I-5). Counties having the greatest amount of residues available for energy were Whitman, Grant, Adams, Lincoln, and Walla Walla—all are located in Eastern Washington. Maps I-1 through I-8 show the gross and net annual average of agricultural field residues in dry tons by region and by type.

Approximately 90 percent (Figure I-5) of the 1.5 million dry tons of the total net residues were winter wheat. Winter wheat averaged 1.35 million dry tons, spring wheat averaged nearly 112 thousand dry tons, and barley averaged 45 thousand dry tons annually. The southeast region dominated for both types of wheat; the north central region dominated for barley. Adams and Grant counties ranked in the top five net generators for barley and wheat.

Future Availability and Cost

Barley and wheat residues generated and available for energy over the next two decades are assumed to be similar to the period between 1982 through 1989. The total net average being 1.5 million tons with an estimated range of 1 to 2.6 million tons. Eastern Washington is expected to produce the greatest percentage of agricultural field residues available for energy, with the southeast region predominating.

Biogas

Methodology of Data Collected

Current Supply

Municipal Solid Waste

Residue collection costs depend on the amount of residue per acre that can be removed with agronomic limits. The transportation costs can be high because of the low bulk density of the material. The trucks generally do not carry a full weight load and thus the cost per ton is higher than, for instance, logging residues. Table I-20 shows the estimated costs for collecting and transporting agricultural residues.

Biogas is the mixture of carbon dioxide and methane produced through the bacterial action of decomposing organic materials found in municipal solid wastes, sewage, and livestock manures. Gas is captured from these wastes through a process called anaerobic digestion. In this process, sludge is placed in a digester for a selected length of time and allowed to decompose. The gas released from this process is called biogas and has a heating value of approximately 600 British thermal units per standard cubic foot. Commercial natural gas, a combination of methane, propane, and butane, has a net heating value of approximately 1,050 Btu.

Although biogas can be generated from municipal solid wastes on landfills and manure on farms, in Washington state it is primarily captured from sewage treatment plants. For this reason, only biogas generated from these facilities is included in this document.

Figures were taken directly from the *1990 Washington State Directory of Biomass Energy Facilities*, published by the Washington State Energy Office (WSEO) in 1990.

Currently, Washington state generates approximately 1.4 trillion cubic feet of biogas annually. For the most part, it is produced at sewage plants from human waste. Pages I-37 through I-40 shows the amount of biogas generated in increasing levels of detail. The Puget Sound region generates the greatest percentage—71 percent of the total at 956 million cubic feet per year (573,600 M Btu), see Table I-21 and Map I-9. The most densely populated counties are the highest generators: King, Spokane, Pierce, Kitsap, and Thurston counties, see Table I-22.

Municipal solid waste (MSW) is generated by activities from the residential, industrial, manufacturing, construction, and governmental sectors of our economy. The quantity generated can be calculated based on the population and residue factor. It consists of newspaper, mixed waste paper, corrugated cardboard, glass, aluminum, tin cans, other metals, chemicals, textiles, leather, appliances, plastic, polystyrene, tires, other rubber products, wood waste, disposable diapers, oil, batteries, hazardous waste, construction and demolition debris, and other organic and inorganic wastes.

A certain percentage of the total waste generated is diverted from the landfills through recycling programs. The rest is either landfilled or incinerated.

Methodology of Data Collection

The figures in this document were based on the combustible fraction of disposed wastes and not from the total generated. Combustible wastes were defined as newsprint, corrugated containers, computer paper, office paper, mixed waste paper, nonrecyclable paper, PET bottles, HDPE bottles, other plastic packaging, expanded polystyrene, rubber products, tires, food, lawn and garden waste, wood waste, disposable diapers, textiles, and leather not currently recycled.

The figures given are based on the *Best Management Practices Analysis for Solid Waste, 1987 Recycling and Waste Stream Survey, Volume 1*, prepared by The Matrix Management Group, R.W. Beck and Associates and the Gilmore Research Group, for the Washington State Department of Ecology in 1988. These figures were for 1987 only. An annual average was not calculated.

Construction and demolition wood wastes are still being landfilled because the variation in their physical and chemical characteristics makes it challenging to find end-use markets. Therefore, construction and demolition wood wastes are included in this section of the document as opposed to the wood waste section.

Current Supply

Since municipal solid wastes are in essence "by-products" resulting from the activities of our society, those areas having the greatest population generate the most waste. Currently, the state of Washington generates over 5 million tons of municipal solid waste annually; approximately 22 percent of that is recycled. (This percentage is on the rise as municipalities are required by law to implement recycling programs in their communities.) Nearly 77 percent of what is currently sent to the landfills could potentially be recovered and burned to provide 39 trillion Btu of refuse derived fuel annually.

Pages I-41 through I-43 show the potential amount of combustible municipal solid waste generated in Washington state. The Puget Sound region has the densest population base and generates close to 60 percent of the total municipal solid waste disposed in the state, see Table I-23 and Map I-10. The top five counties generating the greatest percentages are: King, 35 percent; Pierce, 14 percent; Snohomish, 11 percent; Spokane, 9 percent; and Clark, 5 percent, see Table I-24.

Future Availability and Cost

Changing landfill regulations, public interest in recycling, consumer habits, and population growth all have an impact on the availability of municipal solid waste for energy.

As landfill regulations become more stringent the cost of land disposal increases. Thus for the many sectors of our economy, the cost of disposing their solid wastes becomes increasingly more expensive. Some industries cannot afford the disposal costs and are finding alternatives to landfilling, such as paying a lesser fee to users to dispose their wastes, using waste in-house to generate electricity, or recycling. In most cases, it is projected that recycling

programs will keep the level of solid waste requiring disposal from growing significantly over the next 20 years.

Municipal solid waste is a result of consumerism and thus is a function of population and economic activity within a supply zone. The quantity of solid waste that is generated can be calculated based on the population of an area and a residue factor. The Washington State Department of Ecology estimates 6.26 pounds of garbage per person per day.

When all other uses for municipal solid waste have been exhausted, it ends up being disposed in our landfills. As a result, it has zero value and often is available free. Often the user is paid to haul the material away.

Wood Wastes

The supply of wood wastes is determined by the market for wood and wood products. Forest residues are produced because timber is needed to produce lumber, pulp, and plywood. Mill residues are produced as a result of producing lumber, plywood, shakes, and shingles. Residues produced from secondary wood processing facilities result from manufacturing such items as kitchen cabinets, flooring, and pallets.

Washington has a large wood products industry that uses wood fuels extensively to produce energy for space and process heat. It is one of the leading timber industry states, producing 11 percent of the nation's softwood lumber, 7 percent of the nation's plywood, and 62 percent of the nation's softwood log exports (DNR, 1988).

Forest Residues

Forest residue is a general term that encompasses several sources of potential biomass fuels, all of which have a common aspect of being generated in a forest environment. The most common forest residues are called logging residues. Logging residues are a result of commercial logging operations in which trees are cut and merchantable material is removed from the forest. The residues, in general terms, consist of all down and dead woody material existing on an area after timber harvest is completed. Other categories of forest biomass that could be used for energy include stagnant and dying timber, hardwood stand conversions, and precommercial thinnings. The economics of recovery are currently such that only logging residues are considered as available for energy uses. The other categories of material often are in unroaded areas and/or the concentration of residues makes their recovery for fuel uneconomic. Furthermore, the data on resource availability and the cost of recovering these other categories of forest residues are not readily available. This section will therefore only assess the availability of logging residues.

Typically, forest residues are burned on-site or left to decompose in the forest, unless the landowner requires removal of the waste.

Methodology of Data Collection

Residues per acre harvested were calculated using residue factors developed by James O. Howard of U.S. Forest Service (USFS) and harvest data taken from annual Timber Harvest Reports from 1980 to 1988 published by the Washington State Department of Natural Resources (DNR). (Howard, 1981; DNR, 1980-1988) Using Howard's residue factors and DNR's Timber Harvest Reports, quantity of residue generated for each ownership, in each county, were calculated for the years 1981 through 1988. The average and range of values are reported in this section of the document.

Ratios used were the result of extensive field measurements of the volume of wood residues generated as a result of logging activities. The major elements found to influence residue volume were forest ownership, location (eastern and western Washington), and harvest type (clear cut or partial cut). Appendix B contains the values for each year by ownership for Spokane county; information on other counties can be obtained from the Washington State Energy Office.

The quantity available for energy depends on environmental and economic factors that are site specific and not quantified in this document. There is also competition for logging residues to be used as raw materials for pulp production or other fiber uses.

Current Supply

Washington state generates nearly 4.2 million dry tons of logging residues annually. Pages I-45 through I-61 show the amount of logging residues generated and potentially available for energy in increasing levels of detail.

All residue generated is assumed available for energy. Over 56 percent comes from private lands, 24 percent from national forests, 13 percent from state lands, 6 percent from Indian lands, and 1 percent from other federal and non-federal lands (see Figure I-5).

Figures I-6 through I-11 show the amount of logging residues generated in the state from 1981 to 1988. The total logging residues generated on all land ownerships is summarized in Figure I-6. Figures I-7 through I-11 show logging residues by type of land ownership.

Tables I-25 through I-30 show residues generated by region and land ownership. Maps I-11 through I-16 show the annual average of logging residues by region and by land ownership. The heavily forested areas of the West and Southwest regions generate more than half of the forest residues in this state. The majority of these forests are privately owned.

The counties generating the most residues are Lewis, Grays Harbor, Cowlitz, Jefferson, Skamania. Lewis and Grays Harbor generate 20 percent, which is the greatest percentage for any two counties in the state. Tables I-31 through I-36 show logging residues generated by county and by land ownership.

Future Availability and Costs

The quantity of logging residue generated in the next 20 years will depend upon the harvest levels and quantity of residue generated per volume of harvested materials. A decrease in the quantity of logging residues is expected as less and less old growth material is available to be harvested.

Calculating the amount of logging residue that can be delivered to a specific user at a specific cost is a difficult task. A report prepared for the Pacific Northwest and Alaska Bioenergy Program gives logging residue supply curves for Washington state. This study serves as the basis for the cost data derived in this section (U.S. Department of Energy, 1989).

When retrieving residues from the forests, the lowest cost materials are assumed to be removed first, and each additional volume costs more to recover. Firewood is considered to be a less expensive material to retrieve and is usually removed first.

The quantity of logging residue was calculated that could be recovered up to marginal cost of \$3.30/MBtu, chipped and delivered 50 miles to a potential energy site. Table I-37 shows the predicted quantity of material that may be available in Washington state for three different time periods in the future at a marginal cost of less than \$3.30/MBtu. The minimum cost of logging residues is \$2.60/MBtu and the average would depend upon the specific supply zone. Additional materials would be available at increased costs. The costs given are based on the residues removed paying their own way.

If slash burning is regulated more severely in this state, logging residues may have to be removed to meet environmental regulations. In that case, residue recovery costs may be partially paid for by the commercial timber product. If firewood use is restricted as a secondary source of heat in the residential sector, the quantity removed may decline. This would make more of the less expensive material available and thus reduce the average cost for forest residues.

The method of recovering timber from the forest may change in the future with more whole tree harvesting. This will also result in reduced costs because the cost of bringing the material to the loading point will be paid for by the commercial timber. The effect of future changes in logging practices and the environmental changes on costs of recovery is assumed to balance out resulting in no real change in recovery costs in future years.

Mill Residues

Sawmills, shake and shingle mills, and veneer and plywood mills are considered to be the primary wood processing industries. Residues are a combination of scraps, sawdust, and bark from processing whole logs into lumber, plywood, shakes, and shingles.

Methodology of Data Collection

The quantity of residues generated depends upon products produced by these mills and the residue factor for each product. The demand for lumber products from Washington state is driven by the world economy and our ability to competitively market our products.

The characteristics of the residues produced depend on the industry. For the most part, sawmills generate sawdust from harvested wood; furniture manufacturers and cabinetmakers primarily generate scraps of veneers, plywood, particle board, and laminates; and shake and shingle mills tend to generate a combination of bark, sawdust, and scraps.

Traditionally, mills have been effective at finding end uses for their waste—over 96 percent are used. Higher grade residues are sold to pulp and paper mills. Lower grade residues are burned on-site to meet the facility's heat and process steam needs or sold to other companies for fuel.

The annual average was based on data spanning the last 10 years and was taken directly from annual mill surveys published by DNR. Washington Mill Survey reports total residues by industry, current use, and how much goes unused. They also report information on industry characteristics and wood consumption by ownership, timber age, and species.

DNR's economic areas differed from the waste generation areas defined by the Department of Ecology. DNR based the economic areas on wood consumption and production of wood products. Since this report is interested in other sources of biomass as well as wood residues, other criteria were equally important. Per capita income, population, employment in lumber and non-lumber industries, agriculture, precipitation, and transportation costs are important aspects to consider in determining how much biomass is available for energy in any particular region. These criteria were already studied by the Department of Ecology when it selected its waste generation areas and are used throughout this report for the biomass regions. For comparison purposes, DNR's regions are listed below (DNR, 1988) and the Department of Ecology's areas are listed on page I-1.

DNR Economic Area	Counties
Olympic Peninsula	Clallam, Grays Harbor, Jefferson, Lewis, Mason, Pacific, and Thurston
Puget Sound	Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom
Lower Columbia	Cowlitz, Clark, Klickitat, Skamania, Wahkiakum

Central Washington

Adams, Benton, Chelan,
Douglas, Franklin, Grant,
Kittitas, Klickitat, Okanogan,
and Yakima

Inland Empire

Asotin, Columbia, Ferry,
Garfield, Pend Oreille,
Spokane, Stevens, Whitman,
Walla Walla

In order to avoid disclosure, DNR grouped counties having fewer than three operations with other counties. Counties were combined with those used in previous surveys to allow for some comparison. Residues were only reported by county for those counties having greater than three operations.

In order to determine veneer and plywood mill residues by region, a percentage of residues was calculated based on operating capacity of the facilities in the region. Facility operating capacity figures were taken from the *1988 Directory of the Forest Products Industry* (Miller Freeman Publications, 1988). *As disclosure may be an issue, the data in this report were calculated and presented by region. The data provided are WSEO's best estimate of mill residues for the region.*

Current Supply

Pages I-63 through I-73 show the supply of mill residues. Figures I-12 through I-15 show mill residues by type of mill during the last 10-year period for which data are available, 1978 through 1988. Historically, mills sold and used a relatively high percentage of residues generated, only a small percentage have gone unused. In 1988, for example, 47 percent was used for pulp and board, 41 percent was used as fuel, 9 percent was used for other purposes, and only 2 percent went unused.

From 1978 through 1988 the sawmill, veneer and plywood, and shake and shingle industries averaged over 5.1 million dry tons of wood and bark residues annually. Sawmills accounted for close to 82 percent, veneer and plywood mills generated 15 percent, and shake and shingle mills generated only 3 percent. (See Tables I-38 through I-45.)

Maps I-17 through I-24 clearly illustrate that Western Washington dominates the state in the amount of residues generated. Table I-38 shows the Southwest region generated 1.34 million dry tons and the Puget Sound region generated approximately 1.26 million dry tons. The West ranked third generating over 926 thousand dry tons annually. Table I-39 shows the unused portion of the amount generated.

Future Availability and Cost

The calculated quantity of available mill residues is highly dependent upon the accuracy of the data used. Since availability is calculated as the difference between two numbers (supply and demand) that are approximately equal, an error in estimating either supply or demand will result in a relatively large change in the calculated

Secondary Wood Processing

Methodology of Data Collection

amount available. The quantity of residue generated can be determined more precisely than demand because of accepted residue factors and records kept on primary production. The large use of residues by pulp and board industries for furnish and fuel is the major demand sector. Predicting their future demands for residues is difficult and has not been attempted for this report.

The cost of mill residues depends upon the balance between supply and demand. When supply is greater than demand, the material is generally available for the cost of transportation. The average cost of material at a particular energy site depends upon how far the material must be transported. Table I-3, page I-15 shows the transportation costs per ton at different haul distances.

Table I-46 shows the predicted quantity generated and available for the cost of transportation for each time period for the two demand assumptions. The quantities generated in the future were computed by using the Resource Information Systems, Inc. (RISI) projections for the quantity of lumber and plywood that would be produced between 1991 and 2010 (RSI, 1988). The demand for fuels was assumed to be the same as determined by the surveys conducted by the Washington State Energy Office. The quantity of material going to pulp and board was assumed to be either 1) the historical percentage of residues generated that go to pulp and board or 2) the use of all the course residues generated (Larson, 1986; Howard, 1988).

The quantities listed above as available for fuel may still have to compete with other residue uses, such as animal bedding or landscape. For example, landscaping bark in the Puget Sound was selling for \$44/ton in June 1989. The effect of future changes in the residue factor due to higher recovery rates and changing size and quality of timber was not considered. The quantity of material available with a reasonable supply radius will determine the quantity of material that can be used for electric generation.

Secondary wood processing industries use lumber produced from mills to manufacture their products. Residues are primarily made up of sawdust, shavings, fines, and chips. Manufacturers of structural wood members (trusses, arches, timbers), pallets, skids, boxes, shook, barrels, baskets, premanufactured housing, and furniture are considered secondary wood processing industries.

Information in this section came directly from WSEO's *1990 Wood Residue Survey and 1990 Directory of Secondary Wood Processing Facilities in Washington State*, 1990. For this assessment, WSEO surveyed eight secondary lumber and wood products manufacturing industries: hardwood dimension and flooring, millwork, wood kitchen cabinets, structural wood members (not classified elsewhere), nailed wood and shook boxes, wood pallets and skids, wood mobile homes, and prefabricated wood building facilities.

Many businesses did not keep accurate records of how much residue they generated in 1989 or how it was used. As a result, rough estimates were given and may not be accurate.

Attempts were made to estimate the total residue generated based on the figures given by the firms. Ratios computed for residue per board foot consumed and residues per employee varied considerably by both industry and employment size classifications. Rather than take the chance of significantly overestimating or underestimating the total, only the actual amount reported is given (WSEO, 1990b).

Current Supply

In 1989, 169,899 dry tons of residues were reported statewide by secondary wood processing facilities. Of that, 34 percent can potentially be used for energy. The Puget Sound region dominated for both residues generated and residues unused. Pierce, Snohomish, Cowlitz, King, and Spokane counties were among the top generators. (See Maps I-25 through I-26 and Tables I-47 through I-50, on pages I-75 through I-78).

Future Availability and Costs

Future residues available for energy will depend on demand for products and competition for residues.

Sources

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Biomass

Tables

Table I-1

Future Availability and Price of Biomass Fuels

Residue Resource	Trillion Btu/year	Price, \$/MBtu
Logging Residue	36 - 48	2.60 - 3.30
Mill Residues	2 - 7	0.40 - 1.00
Agricultural Field Residue	15 - 38	2.20
Municipal Solid Waste	35 - 40	-5.00 to - 8.00

Table I-2

Factors Determining Cost of Residues

Resource	Price Determinants
Logging Residue	Collection cost; transportation
Agricultural	Collection cost; transportation
Wood Products	Alternative disposal cost; transportation
Municipal Solid Waste	Alternative disposal cost; transportation

Table I-3

Transportation Costs - UTC Rates

Miles	\$/Ton	\$/MBtu
10	2.62	0.31
20	3.66	0.43
30	4.72	0.55
40	5.64	0.66
50	6.60	0.77
75	9.06	1.07

Source: WA State Utilities and Transportation Tariff No. 4-A, 1989

Agricultural Residues

Figures, Maps, and Tables

Figure I-1

Figure I-2

Figure I-3

Figure I-4

Map I-1

Map I-2

Map I-3

Map I-4

Map I-5

Map I-6

Map I-7

Map I-8

Table I-4

Gross Barley, Spring Wheat, Winter Wheat Residues by Region

Ranked by Gross Annual Average (dry tons)

Rank	Region	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	4,661,360	69,920,395	3,564,105	6,103,917
2	Northeast	1,660,977	24,914,649	1,130,190	2,206,545
3	North Central	1,235,681	18,535,218	794,850	1,693,389
4	South Central	356,604	5,349,054	211,872	523,680
5	Northwest	35,798	536,963	12,789	65,955
6	Southwest	18,305	274,579	6,171	36,393
7	Puget Sound	7,758	116,376	1,383	17,790
8	West	1,419	21,285	0	5,961
	State	7,977,901	119,668,519	5,991,306	10,306,260

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-5

Net Barley, Spring Wheat, Winter Wheat Residues by Region

Ranked by Net Annual Average (dry tons)

Rank	Region	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	874,877	13,123,149	398,229	1,611,552
2	Northeast	227,582	3,413,724	36,080	518,080
3	North Central	287,022	4,317,035	210,830	445,538
4	South Central	160,296	1,507,436	39,951	181,290
5	Northwest	11,533	174,499	1,819	25,475
6	Southwest	2,828	42,413	569	9,312
7	Puget Sound	1,032	15,476	0	5,138
8	West	62	934	0	461
	State	1,506,311	22,594,666	1,003,240	2,554,574

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-6

Gross Barley Residues by Region

Ranked by Gross Annual Average (dry tons)

Rank	Region	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	811,115	12,166,725	504,147	1,116,360
2	Northeast	402,643	6,039,645	268,731	558,774
3	North Central	93,074	1,396,110	38,928	160,536
4	South Central	51,947	779,205	28,794	73,830
5	Northwest	9,102	136,530	5,010	14,988
6	Southwest	8,034	120,510	2,475	12,780
7	Puget Sound	1,049	15,735	630	1,488
8	West	727	10,905	0	1,710
	State	1,377,689	20,665,365	851,580	1,909,998

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-7

Net Barley Residues by Region

Ranked by Net Annual Average (dry tons)

Rank	Region	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	North Central	15,213	228,195	5,286	25,335
2	Southeast	12,929	193,935	6,088	28,630
3	Northeast	8,809	132,135	3,059	19,584
4	South Central	7,663	114,945	4,350	13,790
5	Northwest	573	8,595	260	805
6	West	26	390	0	210
7	Puget Sound	16	240	0	130
8	Southwest	8	120	0	50
	State	45,237	678,555	19,700	78,255

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-8

Gross Spring Wheat Residues by Region

Ranked by Gross Annual Average (dry tons)

Rank	Region	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	293,286	4,399,283	114,816	898,443
2	North Central	146,523	2,197,845	120,244	206,271
3	Northeast	120,632	1,809,480	34,593	438,750
4	South Central	66,831	1,002,465	30,348	137,046
5	Puget Sound	4,236	63,540	0	15,600
6	Northwest	1,087	16,305	0	3,081
7	West	692	10,380	0	4,251
8	Southwest	327	4,905	0	1,560
	State	633,614	9,504,203	392,496	1,625,520

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-9

Net Spring Wheat Residues by Region

Ranked by Net Annual Average (dry tons)

Rank	Region	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	41,907	628,605	22,760	117,026
2	North Central	39,526	592,890	33,007	52,600
3	South Central	22,264	333,960	9,965	43,635
4	Northeast	8,064	120,960	321	19,872
5	Northwest	77	1,155	0	331
6	Puget Sound	73	1,095	0	393
7	West	36	540	0	251
8	Southwest	0	0	0	0
	State	111,947	1,679,205	80,786	217,395

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-10

Gross Winter Wheat Residues by Region

Ranked by Gross Annual Average (dry tons)

Rank	Region	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	3,556,960	53,354,400	2,271,234	5,018,247
2	Northeast	1,137,702	17,065,530	514,845	1,547,850
3	North Central	996,084	14,941,260	549,729	1,409,538
4	South Central	237,826	3,567,390	0	420,495
5	Northwest	25,608	384,120	3,825	49,623
6	Southwest	9,945	149,175	3,060	23,613
7	Puget Sound	2,091	31,365	0	12,138
8	West	0	0	0	23,613
	State	5,966,216	89,493,240	3,511,146	8,284,032

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-11

Net Winter Wheat Residues by Region

Ranked by Net Annual Average (dry tons)

Rank	Region	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Southeast	820,040	12,300,600	431,054	1,542,633
2	North Central	233,064	3,495,960	150,280	370,816
3	Northeast	210,709	3,160,635	49,001	480,600
4	South Central	70,568	1,058,520	0	158,077
5	Northwest	10,983	164,745	1,075	24,373
6	Southwest	2,820	42,300	810	9,113
7	Fuget Sound	872	13,080	0	5,138
8	West	0	0	0	0
	State	1,349,056	20,233,840	765,585	2,420,285

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-12

Gross Barley, Spring Wheat, Winter Wheat Residues by County

Ranked by Quantity

Rank	County (Region)	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Whitman (SE)	1,715,315	25,729,723	1,421,235	2,174,043
2	Lincoln (NE)	1,127,815	16,917,227	757,416	1,453,512
3	Adams (SE)	923,055	13,845,832	651,849	1,256,592
4	Grant (NC)	751,011	11,265,164	546,576	995,202
5	Walla Walla (SE)	742,896	11,143,434	561,495	945,975
6	Spokane (NE)	474,198	7,112,976	339,522	662,301
7	Douglas (NC)	456,998	6,854,973	230,895	656,133
8	Franklin (NE)	371,342	5,570,124	247,317	512,418
9	Columbia (SE)	305,647	4,584,701	233,418	419,109
10	Garfield (SE)	258,862	3,882,932	198,054	327,618
11	Benton (SE)	256,360	3,845,402	189,843	344,202
12	Yakima (SC)	208,242	3,123,636	105,594	325,698
13	Klickitat (SC)	113,494	1,702,406	92,139	143,589
14	Asotin (SE)	87,883	1,318,247	60,894	123,960
15	Stevens (NE)	49,863	747,951	31,056	70,782
16	Kittitas (SC)	34,868	523,013	14,139	54,393
17	Skagit (NW)	26,748	401,226	8,871	50,712
18	Okanogan (NC)	21,860	327,898	14,184	33,360
19	Clark (SW)	11,712	175,686	3,582	25,233
20	Snohomish (PS)	7,671	115,059	1,383	17,088
21	Ferry (NE)	7,560	113,406	1,356	17,688
22	Lewis (SW)	6,593	98,893	2,589	11,160
23	Chelan (NC)	5,812	87,182	3,195	8,694
24	Whatcom (NW)	5,018	75,274	1,413	8,751
25	Island (NW)	3,487	52,307	2,505	5,148
26	Pend Oreille (NE)	1,539	23,091	840	2,262
27	Clallam (W)	1,419	21,285	0	5,961
28	San Juan (NW)	544	8,156	0	1,344
29	Pierce (PS)	88	1,316	0	702
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
State Total		7,977,901	119,668,519	5,721,360	10,653,630

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-13

Net Barley, Spring Wheat, Winter Wheat Residues by County

Ranked by Net Annual Average (dry tons)

Rank	County (Region)	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Whitman (SE)	348,616	5,229,240	171,686	704,802
2	Grant (NC)	281,431	4,221,461	210,034	419,324
3	Adams (SE)	151,309	2,269,629	107,197	262,636
4	Lincoln (NE)	149,085	2,236,279	33,029	330,451
5	Walla Walla (SE)	148,803	2,232,043	33,135	258,168
6	Franklin (NE)	107,371	1,610,558	58,354	137,731
7	Yakima (SC)	80,008	1,200,126	32,357	148,435
8	Spokane (NE)	72,517	1,087,753	2,160	169,579
9	Columbia (SE)	60,834	912,514	16,848	138,295
10	Benton (SE)	29,737	446,053	11,009	46,262
11	Garfield (SE)	26,581	398,711	0	56,393
12	Kittitas (SC)	14,115	211,727	4,920	23,535
13	Skagit (NW)	9,770	146,546	1,121	21,549
14	Klickitat (SC)	6,372	95,584	2,674	9,320
15	Douglas (NC)	5,408	81,118	768	22,930
16	Stevens (NE)	4,291	64,363	891	12,363
17	Ferry (NE)	1,630	24,454	0	5,427
18	Asotin (SE)	1,627	24,401	0	7,265
19	Clark (SW)	1,432	21,478	20	6,973
20	Lewis (SW)	1,396	20,934	549	2,339
21	Snohomish (PS)	1,032	15,476	0	5,138
22	Whatcom (NW)	979	14,683	163	2,528
23	Okanogan (NC)	931	13,971	28	3,025
24	Island (NW)	885	13,269	535	1,398
25	Clallam (W)	62	934	0	461
26	Pend Oreille (NE)	58	876	0	260
27	Chelan (NC)	32	486	0	259
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
State Total		1,506,311	22,594,666	687,478	2,796,846

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-14

Gross Barley Residues by County

Ranked by Gross Annual Average (dry tons)

Rank	County (Region)	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Whitman (SE)	440,617	6,609,251	314,940	684,600
2	Lincoln (NE)	258,666	3,879,984	153,531	373,260
3	Spokane (NE)	122,217	1,833,261	93,000	168,324
4	Adams (SE)	96,772	1,451,576	38,919	180,540
5	Walla Walla (SE)	85,032	1,275,480	45,780	131,100
6	Garfield (SE)	72,392	1,085,878	54,930	106,650
7	Grant (NC)	62,182	932,726	29,106	93,210
8	Franklin (SE)	36,152	542,278	11,484	73,110
9	Columbia (SE)	34,439	516,583	16,815	52,500
10	Douglas (NC)	28,586	428,794	8,580	63,480
11	Asotin (SE)	26,610	399,156	12,000	44,550
12	Yakima (SC)	25,081	376,217	16,437	43,950
13	Klickitat (SC)	20,846	312,688	9,846	34,485
14	Benton (SE)	19,101	286,515	4,524	34,590
15	Stevens (NE)	18,667	280,007	10,800	31,887
16	Chittitas (SC)	6,020	90,293	2,511	12,744
17	Clark (SW)	6,007	90,101	1,440	9,384
18	Skagit (NW)	5,599	83,987	3,510	9,555
19	Ferry (NE)	2,179	32,681	270	5,625
20	Lewis (SW)	2,027	30,403	600	4,020
21	Whatcom (NW)	1,633	24,497	750	2,832
22	Okanogan (NC)	1,538	23,063	690	2,769
23	Island (NW)	1,326	19,890	720	2,280
24	Snohomish (PS)	1,049	15,728	630	1,488
25	Pend Oreille (NE)	914	13,714	600	1,950
26	Chelan (NC)	769	11,531	180	2,025
27	Clallam (W)	727	10,901	0	1,710
28	San Juan (N)	544	8,156	0	1,344
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
State Total		1,377,689	20,665,339	832,593	2,173,962

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-15

Net Barley Residues by County

Ranked by Net Annual Average (dry tons)

Rank	County (Region)	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Grant (NC)	15,115	226,723	5,006	25,100
2	Lincoln (NE)	6,570	98,556	1,649	13,944
3	Yakima (SC)	5,470	82,054	3,373	9,152
4	Franklin (SE)	3,966	59,494	2,000	6,460
5	Adams (SE)	3,765	56,468	0	8,090
6	Benton (SE)	2,442	36,623	420	5,930
7	Walla Walla (SE)	2,421	36,311	0	7,590
8	Kittitas (SC)	1,798	26,966	580	3,420
9	Spokane (NE)	1,642	24,632	140	3,584
10	Skagit (NW)	537	8,049	260	805
11	Klickitat (SC)	395	5,927	0	1,218
12	Stevens (NE)	360	5,393	0	1,251
13	Whitman (SE)	287	4,307	0	1,110
14	Ferry (NE)	182	2,728	0	805
15	Douglas (NC)	91	1,369	0	280
16	Pend Oreille (NE)	55	829	0	260
17	Garfield (SE)	36	544	0	110
18	Island (NW)	36	540	0	200
19	Clallam (W)	26	394	0	210
20	Snohomish (PS)	16	244	0	130
21	Asotin (SE)	9	131	0	70
22	Clark (SW)	8	113	0	50
23	Okanogan (NC)	7	103	0	55
24	Columbia (SE)	4	56	0	30
NA	Chelan (NC)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Lewis (SW)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
NA	Whatcom (NW)	0	0	0	0
State Total		45,237	678,551	13,428	89,854

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-16

Gross Spring Wheat Residues by County

Ranked by Gross Annual Average (dry tons)

Rank	County (Region)	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Grant (NC)	113,602	1,704,032	88,491	159,705
2	Adams (SE)	104,003	1,560,049	51,636	326,820
3	Lincoln (NE)	86,912	1,303,673	17,004	347,100
4	Whitman (SE)	72,482	1,087,223	6,981	333,645
5	Yakima (SC)	46,717	700,757	20,085	113,529
6	Benton (SE)	45,123	676,845	10,335	81,471
7	Franklin (SE)	32,609	489,133	11,622	85,995
8	Douglas (NC)	26,808	402,114	10,920	42,978
9	Spokane (NE)	24,185	362,773	11,661	83,304
10	Walla Walla (SE)	22,308	334,620	8,697	58,500
11	Klickitat (SC)	10,525	157,877	2,691	20,475
12	Kittitas (SC)	9,589	143,837	7,956	11,739
13	Stevens (NE)	7,800	117,000	4,329	14,313
14	Garfield (SE)	7,122	106,836	3,861	13,143
15	Columbia (SE)	6,684	100,254	3,744	13,689
16	Okanogan (NC)	4,748	71,224	1,131	6,942
17	Snohomish (PS)	4,149	62,229	0	15,600
18	Asotin (SE)	2,954	44,314	1,092	5,304
19	Ferry (NE)	1,550	23,254	507	3,081
20	Chelan (NC)	1,365	20,475	702	1,950
21	Skagit (NW)	1,087	16,307	0	3,081
22	Clallam (W)	692	10,384	0	4,251
23	Lewis (SW)	327	4,899	0	1,560
24	Pend Oreille (NE)	185	2,779	0	312
25	Pierce (PS)	88	1,316	0	702
NA	Clark (SW)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Island (NW)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
NA	Whatcom (NW)	0	0	0	0
State Total		633,614	9,504,203	263,445	1,749,189

¹Average based on reports from 1982 through 1989.²Includes residues from both dry and irrigated lands.³Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-17

Net Spring Wheat Residues by County

Ranked by Net Annual Average (dry tons)

Rank	County (Region)	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Grant (NC)	38,976	584,634	32,223	52,600
2	Adams (SE)	22,474	337,114	9,553	74,046
3	Yakima (SC)	16,980	254,693	7,658	37,599
4	Franklin (SE)	11,464	171,964	3,876	28,584
5	Benton (SE)	6,752	101,286	393	14,515
6	Lincoln (NE)	6,539	98,078	0	17,720
7	Kittitas (SC)	3,278	49,163	2,020	5,027
8	Klickitat (SC)	2,007	30,107	287	5,728
9	Spokane (NE)	1,246	18,692	4	2,590
10	Walla Walla (SE)	1,023	15,345	184	2,856
11	Douglas (NC)	413	6,195	0	1,605
12	Whitman (SE)	194	2,903	0	872
13	Stevens (NE)	171	2,571	0	540
14	Okanogan (NC)	137	2,053	0	560
15	Ferry (NE)	108	1,613	0	389
16	Skagit (NW)	77	1,159	0	331
17	Snohomish (PS)	73	1,099	0	393
18	Clallam (W)	36	540	0	251
NA	Asotin (SE)	0	0	0	0
NA	Chelan (NC)	0	0	0	0
NA	Clark (SW)	0	0	0	0
NA	Columbia (SE)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Garfield (SE)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Island (NW)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Lewis (SW)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pend Oreille (NE)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
NA	Whatcom (NW)	0	0	0	0
State Total		111,947	1,679,205	56,198	246,206

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-18

Gross Winter Wheat Residues by County

Ranked by Gross Annual Average (dry tons)

Rank	County (Region)	-----Gross Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Whitman (SE)	1,202,217	18,033,249	772,650	1,712,988
2	Lincoln (NE)	782,238	11,733,570	256,785	1,034,382
3	Adams (SE)	722,280	10,834,207	286,110	1,094,664
4	Walla Walla (SE)	635,556	9,533,334	457,215	807,942
5	Grant (NC)	575,227	8,628,406	357,765	813,501
6	Douglas (NC)	401,604	6,024,065	181,560	569,058
7	Spokane (NE)	327,796	4,916,942	234,549	474,555
8	Franklin (SE)	302,581	4,538,712	149,838	450,789
9	Columbia (SE)	264,524	3,967,864	199,920	362,865
10	Benton (SE)	192,136	2,882,042	109,191	310,794
11	Garfield (SE)	179,348	2,690,218	125,307	217,107
12	Yakima (SC)	136,444	2,046,662	58,497	274,074
13	Klickitat (SC)	82,123	1,231,841	64,923	112,863
14	Asotin (SE)	58,319	874,778	34,272	77,265
15	Stevens (NE)	23,396	350,944	15,147	32,181
16	Skagit (NW)	20,062	300,932	1,530	40,494
17	Kittitas (SC)	19,259	288,883	3,213	34,272
18	Okanogan (NC)	15,574	233,612	8,415	25,092
19	Clark (SW)	5,706	85,584	1,020	16,473
20	Lewis (SW)	4,239	63,591	1,989	7,140
21	Ferry (NE)	3,831	57,471	459	9,333
22	Chelan (NC)	3,678	55,176	1,989	6,579
23	Whatcom (NW)	3,385	50,777	663	6,528
24	Island (NW)	2,161	32,417	1,632	3,060
25	Snohomish (PS)	2,091	31,365	0	12,138
26	Pend Oreille (NE)	440	6,598	0	1,275
NA	Clallam (W)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
State Total		5,966,216	89,493,240	3,324,639	8,507,412

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-19

Net Winter Wheat Residues by County

Ranked by Net Annual Average (dry tons)

Rank	County (Region)	-----Net Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(M Btu/Year) ³	Minimum	Maximum
1	Whitman (SE)	348,135	5,222,031	171,686	704,388
2	Grant (NC)	227,340	3,410,103	149,181	362,001
3	Walla Walla (SE)	145,359	2,180,387	28,720	249,936
4	Lincoln (NE)	135,976	2,039,646	13,660	316,360
5	Adams (SE)	125,070	1,876,048	68,666	244,814
6	Franklin (SE)	91,940	1,379,100	45,184	122,889
7	Spokane (NE)	69,629	1,044,429	1,409	163,405
8	Columbia (SE)	60,831	912,458	16,848	138,265
9	Yakima (SC)	57,559	863,379	15,347	134,988
10	Garfield (SE)	26,545	398,168	0	56,393
11	Benton (SE)	20,543	308,145	3,814	43,540
12	Skagit (NW)	9,156	137,336	280	20,744
13	Kittitas (SC)	9,040	135,598	828	17,045
14	Douglas (NC)	4,904	73,554	208	21,255
15	Klickitat (SC)	3,970	59,550	730	7,300
16	Stevens (NE)	3,760	56,400	891	11,931
17	Asotin (SE)	1,618	24,270	0	7,265
18	Clark (SW)	1,424	21,366	20	6,973
19	Lewis (SW)	1,396	20,934	549	2,339
20	Ferry (NE)	1,341	20,113	0	4,233
21	Whatcom (NW)	979	14,683	163	2,528
22	Snohomish (PS)	872	13,084	0	5,138
23	Island (NW)	849	12,729	535	1,310
24	Okanogan (NC)	788	11,815	4	2,845
25	Chelan (NC)	32	486	0	259
26	Pend Oreille (NE)	3	47	0	25
NA	Clallam (W)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Grays Harbor (W)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	King (PS)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Mason (W)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
State Total		1,349,057	20,235,860	518,723	2,648,169

¹ Average based on reports from 1982 through 1989.² Includes residues from both dry and irrigated lands.³ Energy equivalent, 15 million Btu/ton.Source: Washington State Dept. of Agriculture, *Washington Agricultural Statistics*, 1982-1989.

Table I-20

Costs of Procuring Agricultural Field Residues

Cost Component	\$/Ton	\$/MBtu
Collection (fuel, labor, capital)	11	0.73
Fertilizer Value	3	0.20
Profit to Collector	5	0.33
Local Storage	4	0.27
Transportation up to 40 Miles	10	0.66
Total	33	2.20

Source: U.S. Department of Energy, "Biomass Energy Project Development Guidebook," 1989.

Biogas

Map and Tables

Map I-9

Table I-21

1989 Biogas Generated by RegionSorted by Biogas Output (MF³/Y)

Rank	Region	Biogas Output (MF ³ /Y)	Energy Equivalent ¹ (MBtu)
1	Puget Sound	956	573,600
2	Northeast	230	138,000
3	Southeast	70	42,000
4	North Central	24	14,400
5	South Central	24	14,400
6	Southwest	21	12,600
7	Northwest	20	12,000
8	West	5.5	3,300
	State Total	1,351	810,300

¹ Energy equivalent, 600 Mbtu per cubic foot.Source: Washington State Energy Office. *1990 Directory of Biomass Energy Facilities*. 1990

Table I-22

1989 Biogas Generated by CountySorted by Biogas Output (MF³/Y)

Rank	County (Region)	Biogas Output (MF ³ /Y)	Energy Equivalent ¹ (MBtu)
1	King (PS)	678	406,800
2	Spokane (NE)	200	120,000
3	Pierce (PS)	155	93,000
4	Kitsap (PS)	78	46,800
5	Thurston (PS)	45	27,000
6	Pend Oreille (NE)	30	18,000
7	Franklin (SE)	24	14,400
8	Lewis (SW)	21	12,600
9	Benton (SE)	16	9,600
10	Chelan (NC)	16	9,600
11	Yakima (SC)	16	9,600
12	Walla Walla (SE)	14	8,400
13	Skagit (NW)	12	7,200
14	Columbia (SE)	8	4,800
15	Douglas (NC)	8	4,800
16	Island (NW)	8	4,800
17	Kittitas (SC)	8	4,800
18	Whitman (SE)	8	4,800
19	Clallam (W)	5	3,000
20	Grays Harbor (W)	0.5	300
	State Total	1,351	810,300

¹ Energy equivalent, 600 MBtu per cubic foot.Source: Washington State Energy Office. *1990 Directory of Biomass Energy Facilities*. 1990

Municipal Solid Waste

Map and Tables

Map I-10

Table I-23

1987 Combustible Fraction of Municipal Solid Waste

Disposed in Washington State By Region

Rank	Region	Combustible Waste ¹ (Tons)	Energy Equivalent ² (M Btu)
1	Puget Sound	1,766,246	22,961,198
2	Northeast	306,426	3,983,538
3	Southeast	222,574	2,893,462
4	Southwest	203,434	2,644,642
5	West	166,345	2,162,485
6	Northwest	158,679	2,062,827
7	North Central	151,087	1,964,131
8	South Central	148,281	1,927,653
	Total	3,123,072	40,599,936

¹ Data available on a regional basis only.² Energy Equivalent, 13 MBtu/ton

Source: Washington State Department of Ecology, *Best Management Practices Analysis for Solid Waste 1987 Recycling and Waste Stream Survey*, 1988

Table I-24

Estimated Waste Generated in 1989 by County

Ranked by Estimated Annual Tons

Rank	County	1989 Population	Estimated Annual ¹ (Tons)
1	King	1,446,000	1,651,983
2	Pierce	560,900	640,800
3	Snohomish	430,400	491,710
4	Spokane	358,000	408,997
5	Clark	220,400	251,796
6	Yakima	187,800	214,552
7	Kitsap	181,500	207,355
8	Thurston	155,100	177,194
9	Whatcom	122,200	139,607
10	Benton	104,100	118,929
11	Cowlitz	82,100	93,795
12	Skagit	72,400	82,713
13	Grays Harbor	63,600	72,660
14	Lewis	58,000	66,262
15	Island	55,300	63,177
16	Clallam	55,200	63,063
17	Grant	51,900	59,293
18	Walla Walla	48,800	55,752
19	Chelan	48,600	55,523
20	Whitman	37,600	42,956
21	Mason	37,500	42,842
22	Franklin	34,200	39,072
23	Okanogan	31,700	36,216
24	Stevens	30,500	34,845
25	Douglas	25,400	29,018
26	Kittitas	25,400	29,018
27	Jefferson	19,200	21,935
28	Pacific	17,700	20,221
29	Asotin	17,600	20,107
30	Klickitat	16,700	19,079
31	Adams	13,400	15,309
32	San Juan	9,700	11,082
33	Pend Oreille	8,900	10,168
34	Lincoln	8,800	10,054
35	Skamania	8,100	9,254
36	Ferry	6,100	6,969
37	Columbia	4,100	4,684
38	Wahkiakum	3,500	3,999
39	Garfield	2,300	2,628
State Total		4,660,700	5,324,617

¹Based on Washington State Dept. of Ecology estimates of 6.26 pounds per person per day; 6.26 lbs/day x 365 days/yr x county population.

Source: Washington State Dept. of Ecology

Forest Residues

Figures, Maps, and Tables

Figure I-5

Percent of Logging Residues Generated by Land Ownership

Figure I-6

Total Annual Logging Residues on All Forest Land Ownerships, 1981-1988

Figure I-7

Figure I-8

Figure I-9

Figure I-10

Figure I-11

Map I-11

Map I-12

Map I-13

Map I-14

Map I-15

Logging Residues on Indian Lands

Annual Average
Dry Tons (Thousands)
By Region

— Regional Boundary
- - - County Boundary

State of Washington

Source: Washington State Dept. of Natural Resources

Map I-16

Logging Residues on Other Federal & Non-Federal Lands

Annual Average
Dry Tons (Hundreds)
By Region

— Regional Boundary
- - - County Boundary

State of Washington

Source: Washington State Dept. of Natural Resources

Table I-25

Logging Residues on All Forest Land Ownerships by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	West	1,192,089	21,457,598	907,879	1,403,925
2	Southwest	1,040,758	18,733,643	893,099	1,160,065
3	Puget Sound	606,596	10,918,721	443,487	767,619
4	South Central	494,378	8,898,811	328,164	578,855
5	Northeast	362,769	6,529,839	241,061	473,522
6	North Central	247,242	4,450,358	140,302	330,243
7	Northwest	223,924	4,030,631	164,202	263,525
8	Southeast	22,849	411,284	12,280	32,555
	State	4,190,605	75,430,886	3,370,809	4,847,3689

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-26

Logging Residues on Private Forest Lands by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	West	735,020	13,230,355	565,813	941,904
2	Southwest	665,134	11,972,419	534,578	734,003
3	Puget Sound	402,704	7,248,678	325,851	497,212
4	Northeast	190,054	3,420,966	146,473	228,743
5	South Central	185,434	3,337,815	132,290	218,734
6	Northwest	128,828	2,318,907	102,361	179,935
7	North Central	35,4446	37,988	21,458	49,519
8	Southeast	8,203	147,649	3,546	12,976
	State	2,350,821	42,314,776	2,051,948	2,652,232

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-27

Logging Residues on National Forest Lands by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Southwest	282,803	5,090,456	194,843	404,741
2	West	178,182	3,207,270	114,419	251,421
3	North Central	157,849	2,841,280	73,162	247,444
4	South Central	140,749	2,533,475	81,611	217,411
5	Puget Sound	104,123	1,874,212	46,920	154,163
6	Northeast	93,062	1,675,116	46,596	140,691
7	Northwest	42,010	756,176	25,180	62,251
8	Southeast	13,287	239,159	4,071	21,935
	State	1,012,064	18,217,145	607,262	1,012,064

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-28

Logging Residues on State Forest Lands by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	West	237,952	4,283,137	150,0223	47,646
2	Southwest	91,394	1,645,088	59,184	129,107
3	Puget Sound	68,368	1,230,623	30,737	113,506
4	South Central	55,315	995,670	4,162	95,206
5	Northwest	51,721	930,982	22,815	76,759
6	Northeast	26,535	477,625	9,615	36,167
7	North Central	21,927	394,686	6,087	34,811
8	Southeast	1,063	19,132	31	2,617
	State	554,275	9,976,944	302,071	752,587

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-29

Logging Residues on Indian Forest Lands by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	South Central	112,690	2,028,421	67,929	161,645
2	Northeast	49,439	889,909	27,209	73,878
3	West	33,761	607,705	13,134	52,240
4	North Central	31,067	559,208	24,132	40,556
5	Puget Sound	3,421	61,577	799	8,080
6	Northwest	1,061	19,106	527	1,856
7	Southeast	0	0	0	0
8	Southwest	0	0	0	0
	State	231,440	4,165,927	160,766	281,417

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-30

Logging Residues on Other Federal and Non-Federal Forest Lands by Region

Ranked by Annual Average (Dry Tons)

Rank	Region	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Puget Sound	27,980	503,631	7,081	93,885
2	West	7,174	129,130	0	22,117
3	Northeast	3,679	66,223	0	16,406
4	Southwest	1,427	25,680	0	4,669
5	North Central	955	17,195	0	5,722
6	Northwest	303	5,460	0	1,052
7	Southeast	297	5,345	0	1,289
8	South Central	191	3,429	0	699
	State	42,005	756,093	23,588	76,686

¹ Average based on report from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-31

Logging Residues - All Forest Land Ownerships by County

Ranked by Annual Average (Dry Tons)

Rank	County (Region)	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons) ²	(MBtu/Year)	Minimum	Maximum
1	Lewis (SW)	407,760	7,339,686	285,380	532,532
2	Grays Harbor (W)	402,872	7,251,695	212,317	522,958
3	Cowlitz (SW)	287,960	5,183,283	208,621	376,995
4	Jefferson (W)	280,852	5,055,341	207,000	347,464
5	Skamania (SW)	253,720	4,566,955	208,024	336,950
6	Clallam (W)	231,455	4,166,183	165,040	303,419
7	Yakima (SC)	213,075	3,835,358	139,796	253,263
8	Kittitas (SC)	190,044	3,420,797	118,228	244,799
9	Pierce (PS)	181,289	3,263,209	147,709	237,028
10	King (PS)	171,010	3,078,176	133,201	211,444
11	Okanogan (NC)	157,695	2,838,512	77,268	229,960
12	Mason (W)	157,284	2,831,120	79,643	243,503
13	Skagit (NW)	144,625	2,603,252	116,882	175,200
14	Snohomish (PS)	135,968	2,447,419	70,754	190,365
15	Stevens (NE)	131,620	2,369,153	94,668	162,461
16	Pacific (W)	119,625	2,153,259	64,939	163,213
17	Ferry (NE)	115,745	2,083,417	80,059	154,634
18	Klickitat (SC)	91,259	1,642,656	64,322	126,469
19	Chelan (NC)	89,393	1,609,073	62,735	117,305
20	Pend Oreille (NE)	86,711	1,560,791	49,233	129,691
21	Thurston (PS)	75,124	1,352,229	51,302	122,651
22	Whatcom (NW)	59,704	1,074,673	31,430	77,995
23	Wahkiakum (SW)	46,921	844,577	34,811	57,480
24	Clark (SW)	44,397	799,143	9,880	93,724
25	Kitsap (PS)	43,205	777,687	31,330	57,135
26	Spokane (NE)	25,398	457,162	13,367	30,732
27	Island (NW)	15,298	275,369	7,510	30,296
28	Columbia (SE)	11,342	204,149	3,475	21,400
29	Asotin (SE)	7,451	134,109	1,622	17,645
30	San Juan (NW)	4,297	77,337	1,955	8,728
31	Lincoln (NE)	3,295	59,316	1,594	4,217
32	Garfield (SE)	1,974	35,524	86	5,013
33	Walla Walla (SE)	1,423	25,608	67	3,756
34	Whitman (SE)	602	10,844	125	1,147
35	Douglas (NC)	154	2,774	0	935
36	Benton (SE)	58	1,050	0	467
NA	Adams (SE)	0	0	0	0
NA	Franklin (SE)	0	0	0	0
NA	Grant (NC)	0	0	0	0
State		4,190,605	75,430,886	3,370,809	4,847,689

¹ Average based on reports from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-32

Logging Residues on Private Forest Lands by County

Ranked by Annual Average (Dry Tons)

Rank	County (Region)	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Grays Harbor (W)	313,335	5,640,038	158,759	442,677
2	Lewis (SW)	278,970	5,021,458	205,424	304,508
3	Cowlitz (SW)	246,549	4,437,874	182,436	321,739
4	Pierce (PS)	123,654	2,225,765	96,442	186,771
5	King (PS)	118,510	2,133,171	94,618	160,871
6	Clallam (W)	114,497	2,060,947	98,151	128,031
7	Kittitas (SC)	107,363	1,932,532	68,668	142,817
8	Mason (W)	107,090	1,927,623	29,456	189,242
9	Pacific (W)	105,190	1,893,419	54,796	153,073
10	Jefferson (W)	94,907	1,708,327	53,610	131,566
11	Stevens (NE)	84,017	1,512,308	71,054	99,596
12	Skagit (NW)	81,948	1,475,071	67,569	106,186
13	Snohomish (PS)	69,765	1,255,773	45,840	109,961
14	Skamania (SW)	58,510	1,053,179	24,930	91,541
15	Klickitat (SC)	55,168	993,028	43,379	66,990
16	Thurston (PS)	53,538	963,688	33,380	95,393
17	Pend Oreille (NE)	47,284	851,114	32,963	71,343
18	Wahkiakum (SW)	42,199	759,576	31,201	57,013
19	Clark (SW)	38,907	700,332	8,814	81,587
20	Kitsap (PS)	37,238	670,281	28,004	50,261
21	Ferry (NE)	32,650	587,706	22,687	42,851
22	Whatcom (NW)	28,909	520,360	17,380	40,222
23	Spokane (NE)	23,175	417,149	12,302	28,821
24	Yakima (SC)	22,903	412,254	15,460	38,699
25	Okanogan (NC)	20,616	371,096	10,433	31,159
26	Chelan (NC)	14,673	264,118	3,548	23,920
27	Island (NW)	13,740	247,316	6,711	27,651
28	San Juan (NW)	4,231	76,161	1,955	8,537
29	Columbia (SE)	4,131	74,354	2,218	8,381
30	Lincoln (NE)	2,927	52,688	1,594	4,217
31	Asotin (SE)	1,202	21,643	651	3,239
32	Garfield (SE)	1,161	20,900	0	2,702
33	Walla Walla (SE)	1,048	18,859	19	3,756
34	Whitman (SE)	602	10,844	125	1,147
35	Douglas (NC)	154	2,774	0	935
36	Benton (SE)	58	1,050	0	467
NA	Adams (SE)	0	0	0	0
NA	Franklin (SE)	0	0	0	0
NA	Grant (NC)	0	0	0	0
State		2,350,821	42,314,776	2,051,948	2,652,232

¹ Average based on reports from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-33

Logging Residues on National Forest Lands By County

Ranked by Annual Average (Dry Tons)

Rank	County (Region)	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Skamania (SW)	182,570	3,286,254	133,553	274,396
2	Lewis (SW)	97,078	1,747,405	22,423	204,244
3	Okanogan (NC)	85,562	1,540,109	36,729	151,609
4	Kittitas (SC)	74,213	1,335,826	28,944	117,761
5	Chelan (NC)	72,287	1,301,171	36,433	104,827
6	Yakima (SC)	62,512	1,125,211	39,041	98,792
7	Clallam (W)	61,211	1,101,800	35,993	119,804
8	Jefferson (W)	42,127	758,283	23,264	75,420
9	King (PS)	40,456	728,201	17,971	68,296
10	Mason (W)	38,838	699,093	15,910	61,662
11	Grays Harbor (W)	36,005	648,095	13,468	58,552
12	Ferry (NE)	35,110	631,984	13,231	50,720
13	Pend Oreille (NE)	34,353	618,358	15,297	57,995
14	Snohomish (PS)	32,572	586,305	0	51,847
15	Pierce (PS)	31,095	559,706	9,705	62,099
16	Skagit (NW)	25,987	467,762	16,231	31,603
17	Stevens (NE)	23,556	424,005	9,942	42,111
18	Whatcom (NW)	16,023	288,414	3,322	30,794
19	Columbia (SE)	6,484	116,713	1,257	15,617
20	Asotin (SE)	5,990	107,822	485	16,394
21	Klickitat (SC)	4,024	72,439	0	12,483
22	Cowlitz (SW)	3,155	56,796	578	6,741
23	Garfield (SE)	812	14,624	0	3,601
24	Spokane (NE)	43	770	0	342
NA	Adams (SE)	0	0	0	0
NA	Benton (SE)	0	0	0	0
NA	Clark (SW)	0	0	0	0
NA	Douglas (NC)	0	0	0	0
NA	Franklin (SE)	0	0	0	0
NA	Grant (NC)	0	0	0	0
NA	Island (NW)	0	0	0	0
NA	Kitsap (PS)	0	0	0	0
NA	Lincoln (NE)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Thurston (PS)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
NA	Walla Walla (SE)	0	0	0	0
NA	Whitman (SE)	0	0	0	0
State		1,012,064	18,217,145	607,262	1,012,064

¹ Average based on reports from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-34

Logging Residues on State Forest Lands by County

Ranked by Annual Average (Dry Tons)

Rank	County (Region)	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Jefferson (W)	143,035	2,574,627	105,896	203,938
2	Clallam (W)	49,526	891,468	15,577	94,146
3	Cowlitz (SW)	37,857	681,428	18,122	52,434
4	Skagit (NW)	36,293	653,280	12,548	54,366
5	Lewis (SW)	31,594	568,684	9,178	52,851
6	Snohomish (PS)	31,348	564,267	8,735	56,790
7	Klickitat (SC)	24,291	437,244	1,121	39,715
8	Yakima (SC)	22,555	405,993	1,275	39,349
9	Grays Harbor (W)	20,444	367,995	2,262	49,622
10	Okanogan (NC)	19,842	357,162	5,396	34,811
11	Stevens (NE)	19,259	346,662	7,163	26,376
12	Thurston (PS)	15,420	277,552	2,890	31,302
13	Whatcom (NW)	14,082	253,471	6,652	22,250
14	Pacific (W)	14,012	252,216	5,099	29,900
15	Skamania (SW)	12,251	220,517	762	25,442
16	Mason (W)	10,935	196,832	2,706	20,407
17	King (PS)	9,837	177,057	1,053	19,374
18	Pierce (PS)	8,982	161,676	2,566	21,137
19	Kittitas (SC)	8,468	152,433	1,766	17,952
20	Clark (SW)	5,066	91,185	1,057	12,090
21	Wahkiakum (SW)	4,626	83,274	467	12,646
22	Pend Oreille (NE)	4,292	77,252	878	8,976
23	Kitsap (PS)	2,782	50,070	1,642	4,659
24	Chelan (NC)	2,085	37,524	0	5,661
25	Spokane (NE)	1,434	25,809	131	2,870
26	Island (NW)	1,315	23,678	0	4,476
27	Ferry (NE)	1,182	21,275	0	2,569
28	Columbia (SE)	430	7,737	0	1,566
29	Walla Walla (SE)	375	6,750	0	2,617
30	Lincoln (NE)	368	6,628	0	1,074
31	Asotin (SE)	258	4,645	0	1,465
32	San Juan (NW)	31	552	0	245
NA	Adams (SE)	0	0	0	0
NA	Benton (SE)	0	0	0	0
NA	Douglas (NC)	0	0	0	0
NA	Franklin (SE)	0	0	0	0
NA	Garfield (SE)	0	0	0	0
NA	Grant (NC)	0	0	0	0
NA	Whitman (SE)	0	0	0	0
State		554,275	9,976,944	302,071	752,587

¹ Average based on reports from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-35

Logging Residues on Indian Forest Lands by County

Ranked by Annual Average (Dry Tons)

Rank	County (Region)	-----Annual Average ¹ -----		-----Range-----	
		(Dry Tons)	(MBtu/Year) ²	Minimum	Maximum
1	Yakima (SC)	105,106	1,891,901	66,829	138,321
2	Ferry (NE)	46,009	828,167	27,209	65,041
3	Okanogan (NC)	31,067	559,208	24,132	40,556
4	Grays Harbor (W)	27,286	491,143	12,180	42,046
5	Klickitat (SC)	7,584	136,521	1,100	23,325
6	Clallam (W)	6,087	109,567	954	9,210
7	Stevens (NE)	3,341	60,137	0	8,124
8	Snohomish (PS)	2,183	39,295	636	3,175
9	Kitsap (PS)	815	14,664	164	2,421
10	Whatcom (NW)	676	12,177	333	969
11	Mason (W)	389	6,995	0	984
12	Skagit (NW)	385	6,930	194	887
13	Thurston (PS)	367	6,612	0	2,050
14	Pend Oreille (NE)	89	1,604	0	713
15	King (PS)	56	1,005	0	434
NA	Adams (SE)	0	0	0	0
NA	Asotin (SE)	0	0	0	0
NA	Benton (SE)	0	0	0	0
NA	Chelan (NC)	0	0	0	0
NA	Clark (SW)	0	0	0	0
NA	Columbia (SE)	0	0	0	0
NA	Cowlitz (SW)	0	0	0	0
NA	Douglas (NC)	0	0	0	0
NA	Franklin (SE)	0	0	0	0
NA	Garfield (SE)	0	0	0	0
NA	Grant (NC)	0	0	0	0
NA	Island (NW)	0	0	0	0
NA	Jefferson (W)	0	0	0	0
NA	Kittitas (SC)	0	0	0	0
NA	Lewis (SW)	0	0	0	0
NA	Lincoln (NE)	0	0	0	0
NA	Pacific (W)	0	0	0	0
NA	Pierce (PS)	0	0	0	0
NA	San Juan (NW)	0	0	0	0
NA	Skamania (SW)	0	0	0	0
NA	Spokane (NE)	0	0	0	0
NA	Wahkiakum (SW)	0	0	0	0
NA	Walla Walla (SE)	0	0	0	0
NA	Whitman (SE)	0	0	0	0
State		231,440	4,165,927	160,766	281,417

¹ Average based on reports from 1981-1988² Energy Equivalent, 18 MBtu/ton

Source: Washington State Dept. of Natural Resources, and U.S. Dept. of Agriculture

Table I-37

**Logging Residues Generated and Amount Available
at a Marginal Cost of Less Than \$3.30/MBtu**

Type	Current	Time Period		2001-2010
		1991-1995	1996-2000	
		----- trillion Btu/year -----		
Generated	75.4	61.7	55.1	50.7
Available	19.2	15.3	13.6	12.75

Reference: Washington State Energy Office

Mill Residues

Figures, Maps, and Tables

Figure I-12

Figure I-13

Figure I-14

Figure I-15

Map I-17

Map I-18

Map I-19

Map I-20

Map I-21

Generated Shake and Shingle Mill Residues

State of Washington

Source: Washington State Dept. of Natural Resources

Map I-22

Unused Shake and Shingle Mill Residues

State of Washington

Source: Washington State Dept. of Natural Resources

Map I-23

Map I-24

Table I-38

Generated Mill Residues by Region

Sorted by Generated Annual Average (Dry Tons)

Rank	Region	--Generated Annual Average--		Range	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	Southwest	1,336,060	24,049,074	1,116,313	1,582,973
2	Puget Sound	1,259,242	22,666,347	1,015,229	1,499,588
3	West	926,388	16,674,990	828,141	1,085,014
4	South Central	556,316	10,013,696	403,111	690,173
5	Northeast	445,084	8,011,512	210,343	672,798
6	Northwest	294,881	5,307,861	127,522	429,696
7	North Central	229,102	4,123,830	172,377	269,686
8	Southeast	94,617	1,703,106	60,963	137,478
	State	5,141,690	92,550,416	4,053,010	5,953,643

Source: Washington State Department of Natural Resources, "Washington Mill Surveys," 1978-1988.

Table I-39

Unused Mill Residues by Region

Sorted by Unused Annual Average (Dry Tons)

Rank	Region	--Unused Annual Average--		Range	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	West	77,546	1,395,828	42,014	135,086
2	Northeast	27,337	492,066	590	102,658
3	Puget Sound	26,051	468,912	5,035	47,389
4	North Central	16,278	293,010	5,747	26,220
5	Northwest	15,212	273,810	3,607	29,243
6	Southwest	13,635	245,427	1,145	49,829
7	Southeast	3,701	66,618	0	22,162
8	South Central	2,831	50,958	0	7,759
	State	182,591	3,286,629	114,173	409,848

Source: Washington State Department of Natural Resources, "Washington Mill Surveys," 1978-1988.

Table I-40

Generated Sawmill Residues by Region

Sorted by Generated Annual Average (Dry Tons)

Rank	Region	—Generated Annual Average—		Range	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	Puget Sound	1,105,370	19,896,651	895,532	1,410,932
2	Southwest	1,069,104	19,243,866	848,528	1,383,397
3	West	766,600	13,798,800	696,762	851,833
4	Northeast	395,643	7,121,571	184,614	620,488
5	South Central	377,997	6,803,946	297,291	486,271
6	Northwest	209,219	3,765,936	56,838	353,951
7	North Central	191,387	3,444,960	152,993	224,322
8	Southeast	94,617	1,703,106	90,932	38,801
	State	4,209,935	75,778,836	3,358,266	5,247,504

Source: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988.

Table I-41

Unused Sawmill Residues by Region

Sorted by Unused Annual Average (Dry Tons)

Rank	Region	—Unused Annual Average—		Range	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	Northeast	26,468	476,424	590	100,212
2	West	25,332	455,970	8,184	59,833
3	Puget Sound	18,868	339,518	648	45,834
4	North Central	15,428	277,704	5,732	26,270
5	Southwest	9,083	163,500	660	34,825
6	Southeast	3,701	66,618	0	22,162
7	Northwest	1,951	35,121	129	3,451
8	South Central	533	9,597	0	1,367
	State	101,364	1,824,552	54,619	226,059

Source: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988.

Table I-42

Generated Shake and Shingle Mill Residues By Region

Sorted by Generated Annual Average (Dry Tons)

Rank	Region	--Generated Annual Average--		-----Range-----	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	West	90,104	1,621,878	55,148	180,614
2	Northwest	20,596	370,719	6,665	33,171
3	Southwest	17,576	316,365	1,703	37,472
4	Puget Sound	15,249	274,482	6,858	26,858
5	Northeast	363	6,537	0	1,562
6	North Central	322	0	1,710	1,710
7	Southeast	0	0	0	0
8	South Central	0	0	0	0
	State	144,210	2,589,981	88,480	281,387

Source: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988.

Table I-43

Unused Shake and Shingle Mill Residues By Region

Sorted by Unused Annual Average (Dry Tons)

Rank	Region	--Unused Annual Average--		-----Range-----	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	West	50,826	914,874	28,842	101,648
2	Northwest	12,789	230,193	3,478	25,073
3	Puget Sound	5,813	104,634	547	19,908
4	Southwest	2,708	48,735	485	7,219
5	North Central	271	4,884	0	1,563
6	Northeast	109	1,956	0	336
7	Southeast	0	0	0	0
8	South Central	0	0	0	0
	State	72,515	1,305,276	43,566	155,747

Source: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988.

Table I-44

Generated Veneer & Plywood Mill Residues By Region

Sorted by Generated Annual Average (Dry Tons)

Rank	Region	--Generated Annual Average--		-----Range-----	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	Southwest	251,707	4,530,728	180,606	489,416
2	South Central	178,319	105,820	235,084	277,453
3	Puget Sound	136,296	2,453,336	68,866	238,681
4	West	69,684	1,254,318	45,519	111,461
5	Northwest	65,067	1,171,214	26,335	116,747
6	Northeast	49,078	883,412	25,442	61,032
7	North Central	37,393	673,076	19,384	46,500
8	Southeast	0	0	0	0
	State	787,546	11,071,905	569,503	1,290,544

1 WSEO Estimate

Sources: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988; 1982 Directory of the Forest Products Industry

Table I-45

Unused Veneer & Plywood Mill Residues By Region

Sorted by Unused Annual Average (Dry Tons)

Rank	Region	--Unused Annual Average--		-----Range-----	
		(Dry Tons)	(MBtu)	Minimum	Maximum
1	South Central	2,297	41,341	0	6,422
2	Southwest	1,844	33,197	0	7,785
3	West	1,388	24,975	0	5,743
4	Puget Sound	1,370	24,653	0	3,656
5	Northeast	760	13,687	0	2,110
6	North Central	579	10,428	0	1,607
7	Northwest	472	8,491	0	1,073
8	Southeast	0	0	0	0
	State	8,710	156,771	0	28,042

1 WSEO Estimate

Sources: Washington State Department of Natural Resources, "Washington Mill Survey," 1978-1988; 1982 Directory of the Forest Products Industry

Table I-46

Mill Residues Generated and Amount Available for Cost of Transportation

Generated Available	1984-1985	1991-1995	1996-2000	2001-2010
Generated	100.10	104.4	107.1	128.5
Available High	8.80	11.6	13.3	26.2
Available Low	-0.51	1.5	3.1	13.9

Source: Washington State Energy Office

Secondary Wood Processing Residues

Maps and Tables

Map I-25

Map I-26

Table I-47

Generated Secondary Wood Processing Residues by Region

Ranked by Generated Dry Tons

Rank	Region	Generated ¹ (Dry Tons)	Energy Equivalent ² (MBtu)
1	Puget Sound	90,767	1,633,815
2	Southwest	32,198	579,573
3	Northeast	17,517	315,297
4	West	16,354	294,348
5	South Central	9,736	175,249
6	Southeast	3,291	59,218
7	Northwest	31	562
8	North Central	5	63
State Total		169,899	3,058,126

¹ Includes only the reported residues from 1989 Washington State Energy Office Survey² Energy equivalent, 18 MBtu/tonSource: Washington State Energy Office. *1990 Wood Residue Survey and Directory of Secondary - Wood Processing Facilities In Washington State. 1990*

Table I-48

Unused Secondary Wood Processing Residues by Region

Ranked by Unused Residues (Dry Tons)

	Region	Unused Residue ¹ (Dry Tons)	Energy Equivalent ² (M Btu)
1	Puget Sound	26,291	473,247
2	Southwest	15,435	277,828
3	South Central	9,589	172,595
4	Northeast	6,880	123,835
5	Northwest	22	403
6	Southeast	7	117
7	West	6	114
8	North Central	1	20
State Total		58,231	1,048,159

¹ Includes only the reported unused residues from the 1989 Washington State Energy Office Survey² Energy equivalent, 18 MBtu/tonSource: Washington State Energy Office. *1990 Wood Residue Survey and Directory of Secondary - Wood Processing Facilities In Washington State. 1990*

Table I-49

Generated Secondary Wood Processing Residues by County

Ranked by Generated Dry Tons

Rank	County (Region)	Generated* (Dry Tons)	Energy Equivalent** (M Btu)
1	Pierce (PS)	36,363	654,535
2	Snohomish (PS)	36,108	649,942
3	Cowlitz (SW)	25,003	450,059
4	King (PS)	18,115	326,069
5	Spokane (NE)	17,514	315,257
6	Grays Harbor (W)	16,332	293,977
7	Yakima (SC)	9,731	175,159
8	Lewis (SW)	4,001	72,016
9	Columbia (SE)	3,283	59,094
10	Clark (SW)	3,124	56,238
11	Thurston (PS)	169	3,035
12	Wahkiakum (SW)	70	1,260
13	Clallam (W)	20	359
14	San Juan (NW)	20	353
15	Kitsap (PS)	13	234
16	Whatcom (NW)	7	130
17	Benton (SE)	6	112
18	Kittitas (SC)	5	90
19	Island (NW)	4	66
20	Chelan (NC)	3	58
21	Stevens (NE)	2	41
22	Skagit (NW)	1	14
23	Jefferson (W)	1	10
24	Whitman (SE)	1	9
25	Grant (NC)	> 1	0
26	Adams (SE)	> 1	0
27	Mason (W)	> 1	0
28	Franklin (SE)	> 1	0
29	Okanogan (NC)	NR	NR
30	Douglas (NC)	NR	NR
31	Pend Oreille (NE)	NR	NR
32	Lincoln (NE)	NR	NR
33	Garfield (SE)	NR	NR
34	Skamania (SW)	NR	NR
35	Pacific (W)	NR	NR
36	Asotin (SE)	NR	NR
37	Ferry (NE)	NR	NR
38	Klickitat (SC)	NR	NR
39	Walla Walla (SE)	NR	NR
State Total		169,899	3,058,116

* Reported unused residues.

** Energy equivalent, 18 M Btu/ton.

NR - Not Reported.

Source: Washington State Energy Office. "1990 Wood Residue Survey and Directory of Secondary Wood Processing Facilities in Washington State."

Table I-50

Unused Secondary Wood Processing Residues by County

Ranked by Unused Dry Tons

Rank	County (Region)	Unused* (Dry Tons)	Energy Equivalent** (M Btu)
1	King (PS)	17,367	312,599
2	Cowlitz (SW)	12,503	225,053
3	Yakima (SC)	9,584	172,506
4	Spokane (NE)	6,879	123,830
5	Pierce (PS)	5,192	93,451
6	Snohomish (PS)	3,621	65,170
7	Lewis (SW)	2,001	36,012
8	Clark (SW)	861	15,503
9	Thurston (PS)	100	1,794
10	Wahkiakum (SW)	70	1,260
11	San Juan (NW)	19	350
12	Kitsap (PS)	13	233
13	Benton (SE)	6	112
14	Clallam (W)	6	104
15	Kittitas (SC)	5	90
16	Island (NW)	2	36
17	Whatcom (NW)	1	17
18	Chelan (NC)	1	15
19	Jefferson (W)	0.48	9
20	Grant (NC)	0.28	5
21	Stevens (NE)	0.25	5
22	Adams (SE)	0.13	2
23	Whitman (SE)	0.13	2
24	Mason (W)	0.10	2
25	Franklin (SE)	0.04	1
26	Columbia (SE)	0.00	0
27	Grays Harbor (W)	0.00	0
28	Skagit (NW)	0.00	0
NA	Asotin (SE)	NR	NR
NA	Douglas (NC)	NR	NR
NA	Ferry (NE)	NR	NR
NA	Garfield (SE)	NR	NR
NA	Klickitat (SC)	NR	NR
NA	Lincoln (NE)	NR	NR
NA	Okanogan (NC)	NR	NR
NA	Pacific (W)	NR	NR
NA	Pend Oreille (NE)	NR	NR
NA	Skamania (SW)	NR	NR
NA	Walla Walla (SE)	NR	NR
State Total		58,231	1,048,159

* Reported unused residues.

** Energy equivalent, 18 M Btu/ton.

NR - Not Reported.

Source: Washington State Energy Office. "1990 Wood Residue Survey and Directory of Secondary Wood Processing Facilities In Washington State."

Part II

**Current Industrial and
Commercial Use**

Agricultural Residues

Biogas Use

Part II

Current Industrial and Commercial Use

Currently in Washington state agricultural field crop residues are left on the ground for soil improvement and erosion control or converted to animal feed. The remaining residues are burned on-site. It is not known how much, if any, is being consumed for energy.

Residues can be combusted in bale burners and pellet/cube/log burners. Under more controlled environments, agricultural wastes can be converted to energy in combustors equipped with state-of-the-art pollution control devices. Some problems associated with handling agricultural field residues are that residues tend to lose energy during storage, are only seasonally available, resist densification, and have a high ash content.

Residues can be processed into pellets, cubes, or straw logs through pulverizing and compressing them. Compressed or densified residues makes storage and handling easier. Agricultural field residues have an approximate heating value of 15 million Btu per ton.

In Washington state, biogas is primarily produced by sewage treatment facilities through a process known as anaerobic digestion. Sludge is placed in a digester for a selected length of time and allowed to convert to methane and carbon dioxide. Biogas has a heating value of approximately 600 British thermal units per standard cubic foot of gas. Commercial natural gas—a combination of methane, propane, and butane—has a net heating value of approximately 1,050 Btu.

The biogas is used in a variety of ways. For the most part, it is primarily burned in boilers to meet sewage treatment facilities' space and process heating needs. Larger biogas producers sell biogas as a boiler fuel; scrub and treat it to pipeline quality then sell it to the gas utility; or use it as vehicle fuel. Excess biogas is usually disposed of in a waste gas flare.

Table II-1, page II-4 shows sewage capacity of sewage treatment plants, average biogas output, and gross energy equivalent.

Municipal Solid Waste

Rapid reduction in existing landfill space, restrictive landfill regulations, and the political and technical difficulties of siting new landfills provide good incentives to develop waste-to-energy projects in Washington state. Currently, there are three municipal solid waste combustion facilities in Washington state and all are operating at capacity (see Table II-2, page II-5). A fourth facility will open in Spokane in the fall of 1991. The combustible fraction of municipal solid waste has an approximate heating value of 14 million Btu per ton.

The Clean Air Act tightened municipal solid waste incinerator emission laws. However, the 1991 national energy strategy includes provisions to encourage the development of waste-to-energy projects. Waste-to-energy will be more widely used once environmental concerns are addressed.

Although there is an interest in the energy recovery potential from our landfills, developing new solid waste combustion facilities will be determined by the political, environmental, and economic costs of the various disposal alternatives and will be decided on a case-by-case basis.

Wood Wastes

Wood wastes annually contribute a significant amount towards energy consumption in Washington state, see pages II-6 through II-8. Wood wastes are used for both steam generation and electric power cogeneration within the commercial and industrial sectors. Table II-3 shows energy consumption and gross energy equivalent of wood combustion facilities in the forest products industries. Wood consumption in the industrial sector accounts for approximately 30 percent of the total industrial energy use. Table II-4 shows state facilities that consume wood wastes and the gross energy equivalent of the amount consumed.

Washington Water Power operates the only private utility-owned, wood-fired electric power plant in Washington state that uses forest and mill residues to generate electricity. The 48 MW plant is located in Kettle Falls in Stevens County (see Table II-5).

Table II-6 shows the solid fuel processing facilities that use mill residues to produce fuel in the form of pellets and logs.

A certain percentage of forest residues left after commercial logging operations are normally available to woodcutters. These residues are primarily used by the residential sector as a primary or secondary source of heating fuel. The actual amount of wood taken from these forests is hard to document.

Mills and secondary wood industries have been effective at finding end uses for their waste. Mills use or sell over 96 percent of residues generated. Secondary wood processing facilities either sell or give away the majority of their sawdust and scraps.

Sources

Environmental laws have limited the amount of old growth timber available to be harvested. Because shake and shingle mills depend primarily on the use of old growth western red cedar, this industry is expected to decline in the future (DNR, 1990).

Washington State Department of Natural Resources. *Washington Mill Survey—1986*. Pages D-14 & 15. 1990.

Table II-1

Biogas Production Facilities

Sorted by Average Biogas Output

County (Region)	Facility	Sewage Capacity (M Gal/Day)	Avg. Biogas Output (M Cub.Ft./Yr)	Gross Energy Equivalent (MBtu/Yr)
King (PS)	Renton Treatment Plant*	72	339	203,400
King (PS)	West Point Treatment Plant**	125	256	153,600
Spokane (NE)	Spokane Wastewater Treatment Plant	44	200	120,000
Pierce (PS)	Tacoma STP-1*	28	80	48,000
Kitsap (PS)	Port Orchard/Kitsap County Sewer Dist. #5	2.8	55	33,000
Thurston (PS)	LOTT**	22	45	27,000
Pierce (PS)	Pierce County Chambers Creek Treatment	12	32	19,200
Pierce (PS)	Puyallup Wastewater Treatment Plant	10.7	30	18,000
Pend Oreille (NE)	Newport, City of	0.5	30	18,000
Franklin (SE)	Pasco, City of	4.25	24	14,400
King (PS)	Des Moines Creek Treatment Plant	6	21	12,600
King (PS)	SW Suburban Sewer District - Salmon Cre	5.8	15	9,000
King (PS)	SW Suburban Sewer District - Miller Creek	4.7	15	9,000
King (PS)	METRO/Alki Treatment Plant	15	14	9,000
Walla Walla (SE)	Walla Walla Wastewater Treatment Plant	15	14	8,400
Kitsap (PS)	Bremerton, City of**	15	14	8,400
Lewis (SW)	Chehalis, City of	2	13	7,800
Kitsap (PS)	Central Kitsap Treatment Plant	4.8	9	5,400
Kittitas (SC)	Ellensburg, City of	15	8	4,800
King (PS)	Federal Way Water & Sewer	13.8	8	4,800
Chelan (NC)	Wenatchee Water Pollution Control Plant	5	8	4,800
Lewis (SW)	Centralia, City of**	4.3	8	4,800
Skagit (NW)	Anacortes, City of	2.2	8	4,800
Yakima (SC)	Sunnyside Wastewater Treatment Plant	2.18	8	4,800
Douglas (NC)	Douglas County Sewer District	1.6	8	4,800
Benton (SE)	Prosser, City of	1.5	8	4,800
Yakima (SC)	Toppenish Wastewater Treatment Plant	1.35	8	4,800
Chelan (NC)	Chelan Treatment Plant	1.2	8	4,800
Island (NW)	Oak Harbor, City of	0.85	8	4,800
Columbia (SE)	Dayton, City of	0.6	8	4,800
Pierce (PS)	Rainier State School	NA	8	4,800
Whitman (SE)	Pullman Wastewater Treatment Plant	4.3	8	4,800
Benton (SE)	Richland Wastewater Treatment Plant**	8.9	8	4,800
Pierce (PS)	Tacoma STP-3, City of	10	5	3,000
Ciallam (W)	Port Angeles, City of	3.2	5	3,000
King (PS)	Richmond Beach Treatment Plant	3.2	5	3,000
King (PS)	Carkeek Park Treatment Plant	3.5	4	2,400
Skagit (NW)	Mount Vernon, City of	4.5	4	2,400
Grays Harbor (W)	McCleary Sewage Treatment Plant	0.75	<1	276
	Total	477	1,349	810,276

* Supplies Washington Natural Gas Pipeline ** Electrical Generation Capacity

Table II-2

Municipal Solid Waste Combustion Facilities

Sorted by Annual Consumption

County (Region)	Facility Name	Annual MSW Consumption (Tons/Year)	Gross Energy Equivalent* (MBtu/Yr)
Spokane (NE)**		292,000	3,796,000
Pierce (PS)	Tacoma Steam Plant #2	98,000	1,274,000
Skagit (NW)	Skagit Co. Resource Recycling Facil	50,000	650,000
Whatcom (NW)	Thermal Reduction Company	36,500	474,500
	Total	476,500	2,398,500

* Energy Equivalent, 13 MBtu/Ton Municipal Solid Waste

** Under construction, operational 1992

Source: Washington State Energy Office

Table II-3

Wood Combustion Facilities - Forest Products Industries

Sorted by Annual Wood Consumption

County (Region)	Facility Name	Biomass Type	Source	Annual Wood Consumption (BDT/Yr)	Gross Energy Equivalent (MBtu/Yr)
Cowlitz (SW)	Weyerhaeuser Company	Hog Fuel	In-house & Purch.	500,000	8,500,000
Cowlitz (SW)	Longview Fibre Company	Hog Fuel	Purchased	232,812	3,957,804
Grays Harbor (W)	ITT Rayonier, Inc. - Grays Harbor Di	Hog Fuel	Purchased	220,460	3,747,820
Okanogan (NC)	Omak Wood Products, Inc.	Hog Fuel	In-house	192,720	3,276,240
Pierce (PS)	Simpson Tacoma Kraft Company	Hog Fuel	Purchased	174,000	2,958,000
Whatcom (NW)	Georgia-Pacific Corporation	Hog Fuel	In-house & Purch.	157,000	2,669,000
Snohomish (PS)	Scott Paper	Hog Fuel	In-house & Purch.	154,000	2,618,000
Pierce (PS)	Boise Cascade Corporation	Hog Fuel	Purchased	153,973	2,617,541
Ferry (NE)	Boise Cascade Corporation	Hog Fuel	In-house	138,975	2,362,575
Yakima (SC)	Boise Cascade Corporation	Hog Fuel	In-house	118,000	2,006,000
Clallam (W)	ITT Rayonier, Inc.	Hog Fuel	In-house & Purch.	92,593	1,574,081
Walla Walla (SE)	Boise Cascade Corporation	Hog Fuel	Purchased	88,176	1,498,992
Mason (W)	Simpson Timber Company	Hog Fuel	In-house	83,772	1,424,124
Grays Harbor (W)	Weyerhaeuser Company	Hog Fuel	In-house & Purch.	80,000	1,360,000
King (PS)	Weyerhaeuser Company	Hog Fuel	In-house	78,939	1,341,963
Jefferson (W)	Port Townsend Paper	Hog Fuel	Purchased	77,713	1,321,121
Clallam (W)	Daishowa America	Hog Fuel	Purchased	63,600	1,081,200
Clark (SW)	James River	Hog Fuel	Purchased	51,552	876,384
Clark (SW)	Fort Vancouver Plywood	Hog Fuel	In-house	38,500	654,500
Snohomish (PS)	Summit Timber Power House	Hog Fuel	In-house	33,653	572,101
Clallam (W)	K-Ply, Inc.	Mill Residue	In-house	24,000	408,000
Pacific (W)	Weyerhaeuser Company	Hog Fuel	In-house	23,091	392,547
Grays Harbor (W)	Simpson Door Company	Hog Fuel	In-house	22,440	381,480
Okanogan (NC)	Colville Indian Precision Pine Co.	Hog Fuel	In-house	21,420	364,140
Whatcom (NW)	Mt. Baker Plywood	Hog Fuel	In-house	19,332	328,644
Spokane (NE)	W.I. Forest Products	Hog Fuel	In-house	19,332	328,644
Ferry (NE)	San Poil Lumber Company	Hog Fuel	In-house	18,795	319,515
Stevens (NE)	Vaagen Brothers Lumber, Inc.	Hog Fuel	In-house	17,885	304,045
Lewis (SW)	Co'mitz Stud Company	Hog Fuel	In-house	16,647	282,999
Pierce (PS)	Buffelen Woodworking	Mill Residue	In-house	15,573	264,741
Thurston (PS)	Hardel Mutual Plywood	Mill Residue	In-house	15,573	264,741
Clark (SW)	Pacific Wood Treating	Hog Fuel	In-house & Purch.	13,750	233,750
Lewis (SW)	Champion International	Hog Fuel	In-house	12,579	213,843
Skamania (SW)	Stevenson Co-Ply Inc.	Hog Fuel	In-house	12,485	212,245
Skagit (NW)	Goodyear Nelson Hardwood Co.	Hog Fuel	In-house	12,351	209,967
Pierce (PS)	Puget Sound Plywood	Mill Residue	In-house & Purch.	11,900	202,300
Snohomish (PS)	Northwest Hardwoods	Mill Residue	In-house	11,277	191,709
Clallam (W)	Allen Logging Company	Mill Residue	In-house	10,752	182,784
Lewis (SW)	Cowlitz Stud Company	Hog Fuel	In-house	10,740	182,580
Yakima (SC)	Jeld-Wen Fiber of WA	Hog Fuel	In-house	8,750	148,750
Walla Walla (SE)	Louisiana Pacific Company	Hog Fuel	In-house	8,400	142,800
Asotin (SE)	Bennett Lumber Products	Hog Fuel	In-house	8,030	136,510
Snohomish (PS)	E.A. Nord	Hog Fuel	In-house	7,000	119,000

Table II-3

Wood Combustion Facilities - Forest Products Industries (continued)

County (Region)	Facility Name	Biomass Type	Source	Annual Wood Consumption (BDT/Yr)	Gross Energy Equivalent (MBtu/Yr)
Pend Oreille (NE)	Vaagen Brothers Lumber, Inc.	Hog Fuel	In-house	6,643	112,931
Snohomish (PS)	West Coast Forest Products, Inc.	Mill Residue	In-house	4,720	80,240
Walla Walla (SE)	Strauser Manufacturing	Hog Fuel	In-house	3,000	51,000
Yakima (SC)	Layman's Lumber Company	Hog Fuel	In-house	2,100	35,700
Lewis (SW)	DeGoed Bulb Farms	Mill Residue	Purchased	1,625	27,625
Lewis (SW)	Kinnear of Washington	Hog Fuel	In-house	770	13,090
Whatcom (NW)	Oeser Company, The	Hog Fuel	In-house	280	4,760
Pierce (PS)	Fred Tebb & Sons, Inc.	Hog Fuel	In-house	153	2,601
Pierce (PS)	Coastcraft, Inc.	Mill Residue	In-house	NA	NA
Stevens (NE)	PlumCreek Manufacturing, Inc.	Hog Fuel	In-house	NA	NA
Snohomish (PS)	Smith Street Mill, Inc.	Hog Fuel	In-house	NA	NA
Total				3,091,831	52,561,127

Table II-4

Wood Combustion Facilities -- State

Sorted by Annual Wood Consumption

County (Region)	Facility Name	Biomass Type Used	Source	Annual Wood Consumption (BDT/YR)	Gross Energy Equivalent (MBtu)
Pierce (PS)	Western State Hospital	Wood pellet	Purchased	12,000	204,000
Walla Walla (SE)	Washington State Penitentiary	Wood pellet	Purchased	3,000	51,000
Lewis (SW)	Maple Lane School	Wood pellet	Purchased	2,043	34,731
Pierce (PS)	Washington Soldiers Home & Colon	Wood pellet	Purchased	1,930	32,810
Total				18,973	322,541

Table II-5

Wood Combustion Facilities -- Utility Companies

County (Region)	Facility Name	Biomass Type Used	Source	Biomass Wood Consumption (BDT/YR)	Gross Energy Equivalent (MBtu/Yr)
Ferry (NE)	Washington Water Power Co.	Hog Fuel	Purchased	350,000	5,950,000

Table II-6

Solid Fuel Processing Facilities

Sorted by Plant Capacity

County (Region)	Facility Name	Plant Capacity (Tons/Yr)	Average Plant Output (Tons/Yr)	Gross Energy Equivalent (M Btu)
Pierce (PS)	Manke Lumber Company	74,880	74,880	1,272,960
Spokane (NE)	Spokane Pres-To-Logs	69,000	52,000	884,000
Grays Harbor (W)	Wood Pellet Company	36,500	3,650	62,050
Okanogan (NC)	CD Pellet Company	6,000	6,000	102,000
	Total	186,380	136,530	2,321,010

Part III

Potential Demand

Part III

Potential Demand

Major savings can be realized by a number of energy-intensive facilities in both the public and private sectors of Washington state. There are approximately 128 state agencies, 39 colleges and universities, 500 K-12 public and private schools, 111 hospitals, and hundreds of industrial facilities statewide. Although all these facilities may not find biomass fuels an economically feasible alternative to electricity, natural gas, coal, or oil, larger facilities may find it advantageous to consider their use. A rough estimate of potential markets for biomass fuels is derived from the information provided in this section.

The commercial sector (which includes state buildings, hospitals, schools) and industrial sector require vast amounts of hot water, heat, and air-conditioning, as well as electricity. Some facilities require round-the-clock services. If their energy needs can be met more efficiently, appreciable reductions in operating costs could result in saving taxpayers and businesses thousands of dollars each year. Large facilities may benefit from installing cogeneration capability using biomass to supplement their energy requirements. These facilities would have the added advantage of selling electricity to utilities. Medium-sized facilities may find switching to natural gas to be the answer. Small facilities may want to increase the energy efficiency of the building structure. Facility managers must select and develop the best energy options to meet their needs.

Table III-1, page III-3 shows the total energy consumption in Washington state by sector.

A list of facilities and other pertinent data on a county-by-county basis can be obtained from the Washington State Energy Office (WSEO).

State Facilities and Schools

Table III-2, page III-4 shows the average square footage of state buildings by county. Data were obtained from WSEO's Energy Partnerships program. The average square feet of state buildings by county may not include all state facilities in the county; rather, it is an average of the major ones.

Table III-3, page III-5 shows the average square footage of school buildings by county. Data presented were obtained from Superintendent of Public Instruction. Square footage by county was for all schools—large, medium, and small—for that particular county.

Hospitals

Information on the total number of beds came from the Department of Health, Directory of Licensed Hospitals. The average number of hospital beds by region and by county were calculated from these data. The average was based on the total number of beds listed per county (see Tables III-5 through III-6, pages III-6 through III-10).

Industrial Users

Biomass fuels can be used to generate both steam and electricity at industrial facilities. *The Industrial Wood Fuel Market Assessment in Washington State, 1986*, was an assessment performed by James D. Kerstetter of the facilities that had characteristics conducive to the use of biomass fuels. These characteristics included relatively large energy users, 12-month operations, and operations with over 20 employees. Using a variety of data bases, facilities were identified that could potentially use biomass fuels. Three hundred facilities were surveyed to determine their interest and knowledge of biomass energy. The survey results were published in 1986.

The list of potential users and the information from the survey was used to develop information contained in this section. The energy used at each facility was estimated based on typical energy use for that particular industry type and the number of employees at the facility. This serves as a rough estimate of potential energy use and market for biomass fuels (see Table III-7, page III-11).

Sources

Kerstetter, James. *Industrial Wood Fuel Market Assessment in Washington State*. 1986.

Washington State Department of Health. *Directory of Licensed Hospitals*. 1989.

Washington State Energy Office. Data Collected by the Energy Partnerships Program. 1991.

Table III-1

Washinton State Total Energy Consumption by Sector*

Billion Btu

Year	Residential	Commercial	Industrial	Transportation	Other**	Total***
1960	83,290	36,696	195,477	170,076	4,913	490,451
1961	84,793	38,188	189,537	174,326	5,415	492,258
1962	86,319	38,834	203,666	181,503	5,589	515,911
1963	91,112	39,397	211,443	183,881	6,224	532,056
1964	101,202	45,989	234,303	189,346	6,735	577,576
1965	99,374	45,149	242,963	196,940	7,097	591,523
1966	106,326	48,947	250,981	214,031	8,100	628,384
1967	107,615	50,332	258,039	235,981	8,424	660,390
1968	120,053	54,439	271,388	268,404	8,765	723,049
1969	131,261	58,051	282,854	275,837	9,032	757,034
1970	136,441	61,331	281,154	276,092	9,543	764,562
1971	143,407	65,711	276,372	283,242	10,284	779,017
1972	148,724	70,066	306,563	286,951	11,075	823,381
1973	144,210	79,613	320,587	313,710	13,815	871,944
1974	136,866	77,628	305,064	315,595	13,201	848,355
1975	139,898	77,423	269,524	338,260	13,993	839,099
1976	143,385	79,571	262,705	359,640	15,112	860,412
1977	148,593	81,891	268,486	369,752	16,115	884,837
1978	150,566	80,682	270,573	397,293	15,016	914,130
1979	159,223	89,246	272,166	426,916	17,927	965,477
1980	148,001	87,755	262,909	409,940	15,040	923,656
1981	141,918	86,215	277,369	400,504	17,531	923,536
1982	146,844	99,284	244,151	375,950	16,555	882,784
1983	134,416	97,336	219,042	362,326	15,791	828,912
1984	143,195	104,293	244,239	393,292	16,330	901,349
1985	151,417	121,527	224,354	415,601	18,220	931,119
1986	142,290	103,011	236,002	494,934	13,946	990,184
1987	139,809	105,432	238,029	497,756	14,338	995,364
1988	153,642	115,854	246,794	526,933	10,162	1,053,385

* Does not include consumption of wood.

** Consists primarily of electricity expenditures for irrigation.

*** Does not include consumption for generation of electricity.

Source: U.S. Department of Energy

Table III-2

Average Square Feet of State Buildings By County

Sorted by Number of Square Feet

County (Region)	Number of Facilities	Average Sq. Feet	-----Range-----	
			Mnimum	Maximum
Thurston (PS)	21	186,573	1,864	1,885,930
King (PS)	19	758,451	4,500	10,344,000
Spokane (NE)	11	413,333	14,654	2,017,730
Pierce (PS)	10	395,187	7,360	1,208,629
Clark (SW)	7	147,113	13,452	422,800
Yakima (SC)	6	101,320	6,348	343,508
Lewis (SW)	6	103,229	5,600	206,092
Snohomish (PS)	6	270,704	11,652	801,012
Chelan (NC)	5	83,082	6,252	221,550
Clallam (W)	4	126,158	42,677	266,552
Kitsap (PS)	4	328,342	12,000	713,440
Whatcom (NW)	3	861,543	62,525	2,319,314
Skagit (NW)	3	104,015	34,014	232,241
Mason (W)	3	260,114	49,829	673,589
Kittitas (SC)	2	1,203,212	9,505	2,396,918
Walla Walla (SE)	2	689,534	315,011	1,064,056
Grant (NC)	2	196,061	5,832	386,289
Whitman (SE)	2	4,179,397	17,194	8,341,600
Benton (SE)	2	123,236	5,684	240,787
Cowlitz (SW)	1	272,711	272,711	272,711
Franklin (SE)	1	302,650	302,650	302,650
Pacific (W)	1	143,065	143,065	143,065
Okanogan (NC)	1	18,352	18,352	18,352
Grays Harbor (W)	1	188,218	188,218	188,218
San Juan (NW)	1	79,934	79,934	79,934

Table III-3

Average Square Feet of School Buildings By County

Ranked by Average Building Size (Sq.Ft.)

Rank	County (Region)	Average Building Size (Sq.Ft.)	Minimum Building Size (Sq.Ft.)	Maximum Building Size (Sq.Ft.)
1	Kitsap (PS)	71,111	19,616	337,482
2	King (PS)	66,548	3,600	323,937
3	Benton (SE)	65,234	800	271,553
4	Snohomish (PS)	64,707	3,010	285,674
5	Pierce (PS)	63,398	1,720	325,706
6	Clark (SW)	63,143	3,496	228,550
7	Spokane (NE)	61,587	1,717	260,025
8	Island (NW)	60,222	35,502	137,191
9	Thurston (PS)	59,148	17,214	171,670
10	Yakima (SC)	58,876	15,395	248,428
11	Cowlitz (SW)	58,638	4,960	181,653
12	Whatcom (NW)	57,583	8,170	188,466
13	Franklin (SE)	56,882	8,860	242,092
14	Walla Walla (SE)	55,885	11,576	171,146
15	Chelan (NC)	51,400	770	259,409
16	Clallam (W)	50,746	8,066	200,904
17	Mason (W)	50,399	12,700	177,624
18	Garfield (SE)	49,206	36,848	61,563
19	Grays Harbor (W)	48,943	3,635	265,857
20	Skagit (NW)	47,437	1,716	186,145
21	Skamania (SW)	45,804	8,815	122,127
22	Lewis (SW)	45,148	5,425	142,794
23	Douglas (NC)	43,902	3,440	146,847
24	Kittitas (SC)	42,596	4,725	147,466
25	Okanogan (NC)	42,237	4,955	139,063
26	Jefferson (W)	41,936	9,664	99,913
27	Whitman (SE)	41,293	1,000	154,085
28	Grant (NC)	41,290	7,185	124,638
29	Asotin (SE)	41,087	1,800	133,984
30	Adams (SE)	40,553	5,347	109,767
31	Lincoln (NE)	37,334	9,695	87,641
32	Pend Oreille (NE)	37,086	10,894	77,581
33	Stevens (NE)	36,961	2,324	62,625
34	Klickitat (SC)	36,528	6,523	73,920
35	Wahkiakum (SW)	34,779	30,239	39,319
36	Pacific (W)	33,595	14,260	89,249
37	Ferry (NE)	28,054	897	58,116
38	Columbia (SE)	27,181	12,018	49,247
39	San Juan (NW)	25,453	900	71,272

Source: Office of State Superintendent of Public Instruction

Table III-4

Washington State Hospitals

Sorted by Total Number of Beds

County (Region)	Hospital Name	Total Beds
King (PS)	Swedish Hospital Medical Center	697
Spokane (NE)	Sacred Heart Medical Center	615
King (PS)	University Hospital	450
Pierce (PS)	Tacoma General Hospital	415
King (PS)	Harborview Medical Center	413
Spokane (NE)	Deaconess Medical Center	388
King (PS)	Providence Medical Center	376
Cowlitz (SW)	St. John's Medical Center	346
King (PS)	Group Health Cooperative Central Hospital	346
Thurston (PS)	St. Peter Hospital	340
Pierce (PS)	St. Joseph Hospital & Health Care Center	340
King (PS)	Virginia Mason Hospital	336
King (PS)	Valley Medical Center	303
Kitsap (PS)	Harrison Memorial Hospital	297
King (PS)	Northwest Hospital	281
Spokane (NE)	Holy Family Hospital	272
Grays Harbor (W)	Grays Harbor Community Hospital	259
Snohomish (PS)	General Hospital Medical Center	257
Clark (SW)	St. Joseph Community Hospital	243
Pierce (PS)	Good Samaritan Hospital and Rehabilitation Center	225
Yakima (SC)	Yakima Valley Memorial Hospital	225
King (PS)	Overlake Hospital Medical Center	218
Snohomish (PS)	Providence Hospital	218
Snohomish (PS)	Stevens Memorial Hospital	217
Yakima (SC)	St. Elizabeth Medical Center	214
King (PS)	Children's Hospital and Medical Center	208
King (PS)	West Seattle Community Hospital	198
Clark (SW)	Vancouver Memorial Hospital	192
Lewis (SW)	Providence Hospital-Centralia	191
King (PS)	St. Frances Xavier Cabrini Hospital	189
King (PS)	Group Health Eastside Hospital	179
Chelan (NC)	Central Washington Hospital	176
King (PS)	Ballard Community Hospital	163
Pierce (PS)	Puget Sound Hospital	160
Pierce (PS)	Humana Hospital Tacoma	155
Benton (SE)	Kadlec Hospital	153
King (PS)	Auburn General Hospital	149
Walla Walla (SE)	St. Mary Medical Center	146
Spokane (NE)	St. Luke's Memorial Hospital	146
King (PS)	Riverton General Hospital	142
Skagit (NW)	Skagit Valley Hospital & Health Center	137
Whatcom (NW)	St. Joseph Hospital	136
King (PS)	Highline Community Hospital	135

Table III-4

Washington State Hospitals (Continued)

Sorted by Total Number of Beds

County (Region)	Hospital Name	Total Beds
King (PS)	Evergreen Hospital Medical Center	134
King (PS)	Fairfax Hospital	133
Clallam (W)	Olympic Memorial Hospital	126
Spokane (NE)	Valley Hospital and Medical Center	123
Franklin (SE)	Our Lady of Lourdes Hospital	119
Whatcom (NW)	St. Luke's General Hospital	117
Thurston (PS)	Black Hills Community Hospital	110
King (PS)	St. Frances Community Hospital	110
Pierce (PS)	Lakewood Hospital	105
Okanogan (NC)	North Valley Hospital	97
Skagit (NW)	United General Hospital	97
Lincoln (NE)	Lincoln Hospital	93
King (PS)	Careunit Hospital of Kirkland	83
King (PS)	Fifth Avenue Medical Center	80
Benton (SE)	Prosser Memorial Hospital	75
Walla Walla (SE)	Walla Walla General Hospital	72
Snohomish (PS)	Valley General Hospital	72
Benton (SE)	Kennewick General Hospital	71
Mason (W)	Mason General Hospital	68
Yakima (SC)	Providence Central Memorial Hospital	63
King (PS)	Schick-Shadel Hospital	63
Asotin (SE)	Tri-State Memorial Hospital, Inc.	62
Grant (NC)	Columbia Basin Hospital	58
Pierce (PS)	Mary Bridge Children's Health Center	56
Stevens (NE)	Mount Carmel Hospital	55
Garfield (SE)	Garfield County Memorial Hospital	54
Island (NW)	Whidbey General Hospital	51
Grant (NC)	Samaritan Hospital	50
Kittitas (SC)	Kittitas Valley Community Hospital	50
Adams (SE)	Othello Community Hospital	49
Snohomish (PS)	Cascade Valley Hospital	48
Whitman (SE)	Whitman Community Hospital	48
Grant (NC)	Coulee Community Hospital	48
Okanogan (NC)	Mid-Valley Hospital	44
Lincoln (NE)	Odessa Memorial Hospital	44
Okanogan (NC)	Okanogan-Douglas County Hospital	43
Skagit (NW)	Island Hospital	43
Jefferson (W)	Jefferson General Hospital	42
Whitman (SE)	Pullman Memorial Hospital	42
Thurston (PS)	Cascade Oaks	40
Yakima (SC)	Sunnyside Community Hospital	38
King (PS)	Community Memorial Hospital	38
Clallam (W)	Forks Community Hospital	37
Pacific (W)	Willapa Harbor Hospital	36
Spokane (NE)	Mountainview Hospital	34

Table III-4

Washington State Hospitals (Continued)

Sorted by Total Number of Beds

County (Region)	Hospital Name	Total Beds
Chelan (NC)	Lake Chelan Community Hospital	34
Chelan (NC)	Cascade General Hospital	33
Benton (SE)	Carondelet Psychiatric Care Center	32
Klickitat (SC)	Skyline Hospital	32
Klickitat (SC)	Klickitat Valley Hospital	31
Yakima (SC)	New Valley Osteopathic Hospital	30
Spokane (NE)	Shriners Hospitals for Crippled Children	30
King (PS)	Snoqualmie Valley Hospital	28
Columbia (SE)	Dayton General Hospital	28
King (PS)	Medical Dental Building Hospital	26
Pierce (PS)	Lakewood Hospital-New Beginnings	26
Spokane (NE)	Deer Park Health Center and Hospital	26
Stevens (NE)	St. Joseph's Hospital of Chewelah	25
Ferry (NE)	Ferry County Memorial Hospital	25
Pacific (W)	Ocean Beach Hospital	25
Pend Oreille (NE)	Newport Community Hospital	24
Grays Harbor (W)	Mark Reed Hospital	24
Lewis (SW)	Morton General Hospital	20
Adams (SE)	Ritzville Memorial Hospital	20
Pend Oreille (NE)	Mount Linton Hospital	19
Grant (NC)	Quincy Valley Hospital	16
Cowlitz (SW)	Hospice Care Center Hospital	4

Note: There are many variables associated with the amount of natural gas, oil and propane consumed per hospital bed. Not all hospitals use these energy resources in addition to electricity. Where electricity is unusually inexpensive it is the only source of energy. Two examples of the therms per hospital bed are given to demonstrate how energy consumption can vary per hospital bed. Evergreen Hospital Medical Center in King Co. used 399,859.5 therms from 1987-1988 they have 134 beds, $399,859 \text{ therms} / 134 \text{ beds} = 2,984 \text{ therms per hospital bed}$; St. Mary's Hospital in Walla Walla Co. used 611,235 therms from 1987-1988 they have 146 beds, $611,235 \text{ therms} / 146 \text{ beds} = 4,186.54 \text{ therms per hospital bed}$.

Table III-5

Average Number of Hospital Beds By Region

Sorted by Number of Hospitals

Region	Number of Hospitals	Average Number of Beds	-----Range-----	
			Minimum	Maximum
Puget Sound	43	199	26	697
Southeast	20	98	4	346
Northeast	15	128	19	615
North Central	10	60	16	176
South Central	8	85	30	225
West	8	77	24	259
Northwest	6	97	43	137

Table III-6

Average Number of Hospital Beds per County

Ranked by Number of Hospitals

Rank	County	# of Hospitals	Average # of Beds	Minimum # of Beds	Maximum # of Beds
1	King (PS)	27	211	26	697
2	Spokane (NE)	10	204	26	615
3	Pierce (PS)	8	185	26	415
4	Snohomish (PS)	5	162	48	257
5	Yakima (SC)	5	114	30	225
6	Benton (SE)	4	83	32	153
7	Grant (NC)	4	43	16	58
8	Okanogan (NC)	3	61	43	97
9	Skagit (NW)	3	92	43	137
10	Chelan (NC)	3	81	33	176
11	Thurston (PS)	3	163	40	340
12	Pacific (W)	2	31	25	36
13	Lincoln (NE)	2	69	44	93
14	Clark (SW)	2	218	192	243
15	Whitman (SE)	2	45	42	48
16	Stevens (NE)	2	40	25	55
17	Klickitat (SC)	2	32	31	32
18	Adams (SE)	2	35	20	49
19	Walla Walla (SE)	2	109	72	146
20	Lewis (SW)	2	106	20	191
21	Pend Oreille (NE)	2	22	19	24
22	Whatcom (NW)	2	127	117	136
23	Grays Harbor (W)	2	142	24	259
24	Cowlitz (SW)	2	175	4	346
25	Clallam (W)	2	82	37	126
26	Ferry (NE)	1	25	25	25
27	Columbia (SE)	1	28	28	28
28	Jefferson (W)	1	42	42	42
29	Asotin (SE)	1	62	62	62
30	Mason (W)	1	68	68	68
31	Franklin (SE)	1	119	119	119
32	Garfield (SE)	1	54	54	54
33	Kitsap (PS)	1	297	297	297
34	Kittitas (SC)	1	50	50	50
35	Island (NW)	1	51	51	51

Table III-7

Fuel Consumed by Potential Industrial Biomass Users by County

Sorted by Number of Business per County

County (Region)	# of Businesses	Average Billion Btu	-----Range-----	
			Minimum	Maximum
King (PS)	65	157	4	3,334
Pierce (PS)	40	209	11	1,802
Yakima (SC)	19	119	17	519
Snohomish (PS)	17	639	4	6,876
Clark (SW)	14	880	11	7,782
Whatcom (NW)	13	894	20	3,816
Spokane (NE)	13	162	19	1,478
Lewis (SW)	10	45	15	148
Grays Harbor (W)	9	247	23	996
Cowlitz (SW)	9	1,354	23	8,190
Thurston (PS)	7	175	44	849
Chelan (NC)	6	298	56	946
Walla Walla (SE)	6	836	26	4,467
Skagit (NW)	4	1,054	19	2,143
Clallam (W)	4	700	30	1,493
Grant (NC)	4	274	39	532
Klickitat (SC)	3	367	46	1,001
Pacific (W)	2	69	45	93
Kitsap (PS)	2	35	20	49
Franklin (SE)	2	340	325	355
Jefferson (W)	1	1,480	1,480	1,480
Pend Oreille (NE)	1	1,166	1,166	1,166
Okanogan (NC)	1	122	122	122
Kittitas (SC)	1	23	23	23
Columbia (SE)	1	1,037	1,037	1,037
Adams (SE)	1	158	158	158

Part IV

**Prices of Competing
Energy Resources**

Part IV

Prices Of Competing Energy Resources

Information contained in this section will be useful in setting biomass prices.

Electric Companies

Until recently, electricity generated from our rivers and streams afforded Washington's industrial, commercial, residential, and governmental sectors the benefits of abundant electricity and the lowest electrical energy rates in the country. Continued growth in our state, however, has moved Washington from an era of electrical surplus to one of projected shortfall. Changes in environmental laws may also have an enormous impact on future electric utility rates. Facilities with cogeneration potential may find greater opportunities in the 1990s and beyond to profitably produce electricity for resale to electric utilities.

Tables IV-1 through IV-2 (pages IV-3 through IV-13) compare Washington state average electric utility rates per kilowatt hour for the state as a whole and by region. Table IV-3 (pages IV-14 through IV-16) shows net generation, fuel consumption, and fuel stock by company and plant.

Natural Gas Companies

There are two major natural gas pipelines in Washington state (see Table IV-4, page IV-17). Pipeline companies primarily purchase their supplies from another state or import it from Canada. Although the natural gas utilities purchase their supplies from Northwest Pipeline Corporation, FERC Order 436, "allows suppliers and end-users to purchase gas directly from producers instead of from pipelines" (WSEO, 1988).

Table IV-5 (page IV-8) compares Washington state natural gas utility rates and to natural and other gases produced and purchased by natural gas pipeline companies.

Coal

A large percentage of Washington industrial and commercial coal is transported by rail from Utah and Wyoming. The consumption and prices of coal by sector are reported in this section. Table IV-6 (page IV-19) compares historical data from 1960 through 1988 for the residential, commercial, industrial, and electric utilities, giving consumption and prices for both Btu and short tons.

Petroleum

An historical perspective of consumption and pricing of residential heating oil and residual fuels from 1960 through 1988, the last year of available data, is reported on Table IV-7, page IV-20. The information presented compares consumption and prices on a Btu basis while also comparing quantity of barrels consumed and prices per gallon.

Sources

Washington State Energy Office. *Washington State Energy Use Profile 1960-1986*. January 1988.

Table IV-1

Washington State Average Electric Utilities Rates per Kilowatthour

Ranked by Unit Cost (Cents per kWh)

Rank	Agencies/Cooperatives Service Area (Region)	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
1	Clearwater Power Co..... Asotin (SE) Whitman (SE)	Cooperative	1990	0.0631	--	--
2	Orcas Power and Light Co..... San Juan (NW)	Cooperative	1988	0.0610	--	--
3	Tanner Electric Cooperative..... King (PS)	Cooperative	1988	0.0546	--	--
4	Mason County PUD No. 1..... Jefferson (W) Mason (W)	Public Utility	1988	0.0540	--	--
5	Kootenai Electric Cooperative..... Spokane (NE)	Cooperative	1990	0.0512	--	--
6	Northern Lights, Inc..... Pend Oreille (NE)	Cooperative	1990	0.0486	--	--
7	Inland Power & Light Co..... Garfield (SE) Pend Oreille (NE) Spokane (NE) Whitman (SE)	Cooperative	1989	0.0482	--	--
8	Ferry County PUD..... Ferry (NE)	Public Utility	1989	0.0479	--	--
9	Wahkiakum County PUD..... Wahkiakum (SW)	Public Utility	1988	0.0477	--	--
10	Peninsula Light Co..... Pierce (PS)	Cooperative	1989	0.0471	--	--
11	Okanogan County Electric Co-op, Inc..... Okanogan (NC)	Cooperative	1988	0.0470	--	--
12	Puget Sound Power and Light Co..... Island (NW) Jefferson (W) King (PS) Kitsap (PS) Kittitas (SC) Pierce (PS) Skagit (NW) Thurston (PS) Whatcom (NW)	Investor Owned	1989	0.0467	0.0529	0.0344
13	Kittitas County PUD..... Kittitas (SC)	Public Utility	1988	0.0466	--	--

-- = Not Available

Table IV-1

Washington State Average Electric Utilities Rates per Kilowatthour (Continued)

Rank	Agencies/Cooperatives Service Area (Region)	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
14	OHOP Mutual Light Co..... Pierce (PS)	Cooperative	1988	0.0449	--	--
15	Mason County PUD No. 3..... Mason (W)	Public Utility	1989	0.0447	--	--
16	Nespelem Valley Electric Co-op, Inc..... Ferry (NE) Okanogan (NC)	Cooperative	1988	0.0443	--	--
17	Alder Mutual Light Co..... Pierce (PS)	Cooperative	1988	0.0440	--	--
18	Clallam County PUD..... Jefferson (W)	Public Utility	1989	0.0439	--	--
19	Sumas, City of..... Whatcom (NW)	Municipality	1989	0.0436	--	--
20	Clallam County PUD..... Clallam (W)	Public Utility	1989	0.0431	--	--
21	Benton Rural Electric Assoc., Inc..... Benton (SE) Yakima (SC)	Cooperative	1988	0.0428	--	--
22	Pacific County PUD No. 2..... Pacific (W)	Public Utility	1988	0.0424	--	--
23	Eatonville Power & Light Co..... Pierce (PS)	Municipality	1988	0.0423	--	--
24	Klickitat County PUD..... Klickitat (SC)	Public Utility	1989	0.0417	--	--
25	Steilacoom, Town of..... Pierce (PS)	Other	1988	0.0417	--	--
26	Modern Electric Co..... Spokane (NE)	Cooperative	1988	0.0411	--	--
27	Milton, City of..... Pierce (PS)	Municipality	1988	0.0411	--	--
28	Blaine City Light..... Whatcom (NW)	Municipality	1988	0.0404	--	--
29	Ellensburg, City of..... Kittitas (SC)	Municipality	1988	0.0402	--	--
30	Snohomish County PUD..... Island (NW) Snohomish (PS)	Public Utility	1988	0.0402	0.0342	0.0272
31	Washington Water Power Co., The..... Spokane (NE)	Investor Owned	1988	0.0399	0.0520	0.0347
32	Ruston Electric Utilities..... King (PS)	Cooperative	1989	0.0398	--	--

-- = Not Available

Table IV-1

Washington State Average Electric Utilities Rates per Kilowatthour (Continued)

Rank	Agencies/Cooperatives Service Area (Region)	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
33	Cheney Light Department, City of..... Spokane (NE)	Municipality	1987	0.0393	--	--
34	Chewelah Light Dept., City of..... Stevens (NE)	Municipality	1988	0.0390	--	--
35	Fircrest, Town of..... Pierce (PS)	Other	1988	0.0385	--	--
36	Lewis County PUD..... Lewis (SW)	Public Utility	1989	0.0377	--	--
37	Skamania County PUD..... Skamania (SW)	Public Utility	1988	0.0376	--	--
38	Clark Public Utilities..... Clark (SW)	Public Utility	1989	0.0364	0.0350	0.0235
39	McCleary Light and Power..... Grays Harbor (W)	Municipality	1988	0.0361	--	--
40	Benton County PUD..... Benton (SE)	Public Utility	1989	0.0356	--	--
41	Grays Harbor County PUD..... Grays Harbor (W) Jefferson (W)	Public Utility	1989	0.0353	--	--
42	Richland Energy Svc. Dept., City of..... Benton (SE)	Other	1988	0.0353	--	--
43	Elmhurst Mutual Power & Light Co..... Pierce (PS)	Cooperative	1989	0.0350	--	--
44	Franklin County PUD..... Franklin (SE)	Public Utility	1989	0.0344	--	--
45	Vera Water and Power..... Spokane (NE)	Cooperative	1989	0.0343	--	--
46	Columbia Rural Electric Assoc., Inc..... Columbia (SE) Walla Walla (SE)	Cooperative	1989	0.0340	--	--
47	Parkland Light and Water Co..... Pierce (PS)	Cooperative	1988	0.0328	--	--
48	Lakeview Light and Power Co..... Pierce (PS)	Other	1989	0.0326	--	--
49	Lincoln Electric Cooperative, Inc..... Lincoln (NE)	Cooperative	1989	0.0326	--	--
50	Seattle City Light Dept., City of..... King (PS)	Other	1988	0.0312	0.0346	0.0254

-- = Not Available

Table IV-1

Washington State Average Electric Utilities Rates per Kilowatthour (Continued)

Rank	Agencies/Cooperatives Service Area (Region)	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
51	Coulee Dam Light Dept., City of..... Douglas (NC)	Municipality	1988	0.0306	--	--
52	Centralia Electric Light Dept., City of..... Lewis (SW)	Municipality	1989	0.0305	--	--
53	Big Bend Electric Cooperative, Inc..... Adams (SE) Franklin (SE)	Cooperative	1989	0.0301	--	--
54	Port Angeles Light & Power Dept., City of Clallam (W)	Municipality	1988	0.0291	--	--
55	Pacific Power and Light..... Columbia (SE) Garfield (SE) Walla Walla (SE) Yakima (SC)	Investor Owned	1989	0.0287	0.0501	0.0349
56	Okanogan County PUD..... Okanogan (NC)	Public Utility	1988	0.0269	--	--
57	Cowlitz County PUD..... Cowlitz (SW)	Public Utility	1989	0.0245	--	--
58	Tacoma DPU..... Pierce (PS) Whatcom County PUD..... Whatcom (NW)	Municipality Public Utility	1988 1988	0.0240 0.0239	0.0372 --	0.0224 --
59	Pend Oreille County PUD..... Pend Oreille (NE)	Public Utility	1989	0.0225	--	--
60	Cashmere Light Department..... Chelan (NC)	Municipality	1989	0.0169	--	--
61	Chelan County PUD..... Chelan (NC)	Public Utility	1988	0.0156	--	--
62	Douglas County PUD..... Douglas (NC)	Public Utility	1989	0.0132	--	--
63	Grant County PUD..... Grant (NC)	Public Utility	1989	0.0064	--	--
64	Skagit County PUD..... Skagit (NW)	Public Utility	1989	--	--	--
65	Waterville, Town of..... Douglas (NC)	Municipality		--	--	--

-- = Not Available

* Unit costs were calculated by dividing dollar sales by kwh sales of the particular utility company.

Source: 1990 Northwest Electric Utility Directory, Northwest Public Power Association and Energy User News, The

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region

Sorted by Unit Costs (Cents per kWh)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost*	Commercial	Industrial
				(Cts/kwh)	(Cts/kwh) 9/90	(Cts/kwh) 8/90
West	Mason County PUD No. 1.....	Public Utility	1988	0.0540	--	--
	Jefferson County Mason County					
	Puget Sound Power and Light Co.....	Investor Owned	1989	0.0467	0.0529	0.0344
	Jefferson County					
	Mason County PUD No. 3.....	Public Utility	1989	0.0447	--	--
	Mason County					
	*Clallam County PUD.....	Public Utility	1989	0.0439	--	--
	Clallam County Jefferson County					
Northwest	Pacific County PUD No. 2.....	Public Utility	1988	0.0424	--	--
	Pacific County					
	McCleary Light and Power.....	Municipality	1988	0.0361	--	--
	Grays Harbor County					
	Grays Harbor County PUD.....	Public Utility	1989	0.0353	--	--
	Grays Harbor County Jefferson County					
	Port Angeles Light & Power Dept., City of	Municipality	1988	0.0291	--	--
	Clallam County					
Northwest	Orcas Power and Light Co.....	Cooperative	1988	0.0610	--	--
	San Jaun County					
Northwest	Puget Sound Power and Light Co.....	Investor Owned	1989	0.0467	0.0529	0.0344
	Island County					
	Skagit County					
	Whatcom County					

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
Northwest (continued)	Sumas, City of.....	Municipality	1989	0.0436	--	--
	Whatcom County					
	Blaine City Light.....	Municipality	1988	0.0404	--	--
	Whatcom County					
	Snohomish County PUD.....	Public Utility	1988	0.0402	--	--
	Island County					
	Whatcom County PUD.....	Public Utility	1988	0.0239	--	--
	Whatcom County					
	Skagit County PUD.....	Public Utility	1989	--	--	--
	Skagit County					
Puget Sound	Tanner Electric Cooperative.....	Cooperative	1988	0.0546	--	--
	King County					
	Peninsula Light Co.....	Cooperative	1989	0.0471	--	--
	Pierce County					
	Puget Sound Power & Light Co.....	Investor Owned	1989	0.0467	0.0529	0.0344
	Kitsap County					
	Pierce County					
	Thurston County					
	King County					
	OHOP Mutual Light Co.....	Cooperative	1988	0.0449	--	--
	Pierce County					
	Alder Mutual Light Co.....	Cooperative	1988	0.0440	--	--
	Pierce County					
	Eatonville Power & Light Co.....	Municipality	1988	0.0423	--	--
	Pierce County					
	Steilacoom, Town of.....	Other	1988	0.0417	--	--
	Pierce County					

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
Puget Sound (continued)	Milton, City of.....	Municipality	1988	0.0411	--	--
	Pierce County					
	Snohomish County PUD.....	Public Utility	1988	0.0402	0.0342	0.0272
	Snohomish County					
	Ruston Electric Utilities.....	Cooperative	1989	0.0398	--	--
	King County					
	Fircrest, Town of.....	Other	1988	0.0385	--	--
	Pierce County					
Southwest	Elmhurst Mutual Power & Light Co.....	Cooperative	1989	0.0350	--	--
	Pierce County					
	Parkland Light and Water Co.....	Cooperative	1988	0.0328	--	--
	Pierce County					
	Lakeview Light and Power Co.....	Other	1989	0.0326	--	--
	Pierce County					
	Seattle City Light Dept., City of.....	Other	1988	0.0312	0.0346	0.0254
	King County					
Southwest	Tacoma DPU.....	Municipality	1988	0.0240	0.0372	0.0224
	Pierce County					
	Wahkiakum County PUD.....	Public Utility	1988	0.0477	--	--
Southwest	Wahkiakum County					
	Lewis County PUD.....	Public Utility	1989	0.0377	--	--
	Lewis County					
Southwest	Skamania County PUD.....	Public Utility	1988	0.0376	--	--
	Skamania County					

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
Southwest (continued)	Clark Public Utilities..... Clark County	Public Utility	1989	0.0364	0.0350	0.0235
	Centralia Electric Light Dept., City of..... Lewis County	Municipality	1989	0.0305	--	--
	Cowlitz County PUD..... Cowlitz County	Public Utility	1989	0.0245	--	--
North Central	Okanogan County Electric Co-op, Inc..... Okanogan County	Cooperative	1988	0.0470	--	--
	Nespelem Valley Electric Co-op, Inc..... Okanogan County	Cooperative	1988	0.0443	--	--
	Coulee Dam Light Dept., City of..... Douglas County	Municipality	1988	0.0306	--	--
	Okanogan County PUD..... Okanogan County	Public Utility	1988	0.0269	--	--
	Cashmere Light Department..... Chelan County	Municipality	1989	0.0169	--	--
	Chelan County PUD..... Chelan County	Public Utility	1988	0.0156	--	--
	Douglas County PUD..... Douglas County	Public Utility	1989	0.0132	--	--
	Grant County PUD..... Grant County	Public Utility	1989	0.0064	--	--
	Waterville, Town of..... Douglas County	Municipality		--	--	--

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
South Central	Puget Sound Power and Light Co.....	Investor Owned	1989	0.0467	0.0529	0.0344
	Kittitas County					
	Kittitas County PUD.....	Public Utility	1988	0.0466	--	--
	Kittitas County					
	Benton Rural Electric Assoc., Inc.....	Cooperative	1988	0.0428	--	--
	Yakima County					
Northeast	Klickitat County PUD.....	Public Utility	1989	0.0417	--	--
	Klickitat County					
	Ellensburg, City of.....	Municipality	1988	0.0402	--	--
	Kittitas County					
	Pacific Power and Light.....	Investor Owned	1988	0.0287	0.0501	0.0349
	Yakima County					
Northeast	Kootenai Electric Cooperative.....	Cooperative		0.0512	--	--
	Spokane County					
	Northern Lights, Inc.....	Cooperative		0.0486	--	--
	Pend Oreille County					
	Inland Power & Light Company.....	Cooperative	1989	0.0482	--	--
Northeast	Pend Oreille County					
	Spokane County					
	Ferry County PUD.....	Public Utility	1989	0.0479	--	--
	Ferry County					
Northeast	Nespelem Valley Electric Co-op, Inc.....	Cooperative	1988	0.0443	--	--
	Ferry County					

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
Northeast (continued)	Modern Electric Co.....	Cooperative	1988	0.0411	--	--
	Spokane County					
	Washington Water Power Co., The.....	Investor Owned	1988	0.0399	0.0520	0.0347
	Spokane County					
	Cheney Light Department, City of.....	Municipality	1987	0.0393	--	--
	Spokane County					
	Chewelah Light Dept., City of.....	Municipality	1988	0.0390	--	--
	Stevens County					
	Vera Water and Power.....	Cooperative	1989	0.0343	--	--
	Spokane County					
	Lincoln Electric Cooperative, Inc.....	Cooperative	1989	0.0326	--	--
	Lincoln County					
	Pend Oreille County PUD.....	Public Utility	1989	0.0225	--	--
	Pend Oreille County					
Southeast	Clearwater Power Co.....	Cooperative		0.0630	--	--
	Asotin County					
	Whitman County					
	Inland Power & Light Co.....	Cooperative	1989	0.0482	--	--
	Garfield County					
	Whitman County					
	Benton Rural Electric Assoc., Inc.....	Cooperative	1988	0.0428	--	--
	Benton County					
	Benton County PUD.....	Public Utility	1989	0.0356	--	--
	Benton County					

-- = Not Available

Table IV-2

Washington State Average Electric Utility Rates per Kilowatthour by Region (Continued)

Region	Agencies/Cooperatives Service Area	Type of Ownership	Year	Unit Cost* (Cts/kwh)	Commercial (Cts/kwh) 9/90	Industrial (Cts/kwh) 8/90
Southeast (continued)	Richland Energy Service Dept., City of..... Benton County	Other	1988	0.0353	--	--
	Franklin County PUD..... Franklin County	Public Utility	1989	0.0344	--	--
	Columbia Rural Electric Assoc., Inc..... Columbia County Walla Walla County	Cooperative	1989	0.0340	--	--
	Big Bend Electric Cooperative, Inc..... Adams County Franklin County	Cooperative	1989	0.0301	--	--
	Pacific Power and Light..... Columbia County Garfield County Walla Walla County	Investor Owned	1989	0.0287	0.0501	0.0349

-- = Not Available

* Unit costs were calculated by dividing dollar sales by kwh sales of the particular utility company.

Source: 1990 Northwest Electric Utility Directory, Northwest Public Power Association, and Energy User News,
The Chilton Company

Table IV-3

Net Generation, Fuel Consumption, and Fuel Stock by Company and Plant

Company Plant	Generation (thousand kilowatthours)						Consumption (thousands)		Stocks (thousands)		
	Coal	Petro- leum	Gas	Hydro	Nuclear	Other**	Coal (short tons)	Petro- leum (bbls)	Gas	Coal (short tons)	Petro- leum (bbls)
Chelan Co. PUD....	--	--	--	779,415	--	--	--	--	--	--	--
Chelan	--	--	--	38,147	--	--	--	--	--	--	--
Rock Island	--	--	--	233,989	--	--	--	--	--	--	--
Rocky Reach	--	--	--	517,279	--	--	--	--	--	--	--
Grant Co. PUD.....	--	--	--	840,782	--	--	--	--	--	--	--
Pec Hdwks	--	--	--	--	--	--	--	--	--	--	--
Priest Rapids	--	--	--	435,871	--	--	--	--	--	--	--
Quincy Chut	--	--	--	--	--	--	--	--	--	--	--
Wanapum	--	--	--	404,911	--	--	--	--	--	--	--
Orcas P&L.....	--	--	--	--	--	--	--	--	--	--	--
Eastsound	--	--	--	--	--	--	--	--	--	--	--
PacifiCorp.....	533,779	429	--	104,116	--	--	373	1	1,470	3	--
Centralia	533,779	429	--	--	--	--	373	1	1,470	3	--
Naches Drop	--	--	--	557	--	--	--	--	--	--	--
Swift No. 2	--	--	--	28,259	--	--	--	--	--	--	--
Yale	--	--	--	75,300	--	--	--	--	--	--	--
Pend Oreille PUD	--	--	--	50,451	--	--	--	--	--	--	--
Box Canyon	--	--	--	50,451	--	--	--	--	--	--	--
Calispel Creek	--	--	--	--	--	--	--	--	--	--	--
Placer Co. Wtr Ag..	--	--	--	212	--	--	--	--	--	--	--
Hell Hole	--	--	--	212	--	--	--	--	--	--	--
Puget Sound P&L	--	74	175	172,839	--	--	--	*	2	--	205
Crystal Mountain	--	27	--	--	--	--	--	--	--	--	1
Electron	--	--	--	11,786	--	--	--	--	--	--	--
Frederickson	--	61	76	--	--	--	--	*	1	--	95
Fredonia	--	--	--	--	--	--	--	--	--	--	50

* = Number less than 0.5 rounded to zero.

** Other sources include geothermal, solar, wood, wind, and waste.

Table IV-3

Net Generation, Fuel Consumption, and Fuel Stock of by Company and Plant (Continued)

Company Plant	Generation (thousand kilowatthours)						Consumption (thousand)		Stocks (thousands)		
	Coal	Petro- leum	Gas	Hydro	Nuclear	Other**	Coal (short tons)	Petro- leum (bbls)	Gas	Coal (short tons)	Petro- leum (bbls)
Puget Sound P&L (cont'd)...											
Lower Baker	--	--	--	47,788	--	--	--	--	--	--	--
Nooksack	--	--	--	514	--	--	--	--	--	--	--
Shuffleton	--	(58)	--	--	--	--	--	*	--	--	--
Snoqualmie	--	--	--	26,874	--	--	--	--	--	--	--
South Widbey	--	15	--	--	--	--	--	*	--	--	--
Upper Baker	--	--	--	56,707	--	--	--	--	--	--	--
White River	--	--	--	29,170	--	--	--	--	--	--	--
Whitehorn	--	29	99	--	--	--	--	*	1	--	5
Seattle Light Dept.	--	--	--	837,351	--	--	--	--	--	--	--
Boundary	--	--	--	374,493	--	--	--	--	--	--	--
Cedar Falls	--	--	--	17,816	--	--	--	--	--	--	--
Diablo	--	--	--	110,893	--	--	--	--	--	--	--
Gorge	--	--	--	121,447	--	--	--	--	--	--	--
New Halem	--	--	--	1,261	--	--	--	--	--	--	--
Ross Dam	--	--	--	211,441	--	--	--	--	--	--	--
Spokane, City of....	--	--	--	--	--	--	--	--	--	--	1
Upriver	--	--	--	--	--	--	--	--	--	--	1
Tacoma PUD.....	--	--	--	369,114	--	--	--	--	--	--	--
Alder	--	--	--	26,486	--	--	--	--	--	--	--
Cushman 1	--	--	--	33,874	--	--	--	--	--	--	--
Cushman 2	--	--	--	11,847	--	--	--	--	--	--	--
La Grande	--	--	--	30,385	--	--	--	--	--	--	--
Mayfield	--	--	--	85,595	--	--	--	--	--	--	--
Mossyrock	--	--	--	180,927	--	--	--	--	--	--	--
Usbia Wapato Irr. ...	--	--	--	--	--	--	--	--	--	--	--
Drop 2	--	--	--	--	--	--	--	--	--	--	--
Drop 3	--	--	--	--	--	--	--	--	--	--	--

* = Number less than 0.5 rounded to zero.

** Other sources include geothermal, solar, wood, wind, and waste.

Table IV-3

Net Generation, Fuel Consumption, and Fuel Stock of by Company and Plant (Continued)

Company Plant	Generation (thousand kilowatthours)						Consumption (thousand)		Stocks (thousands)		
	Coal	Petro- leum	Gas	Hydro	Nuclear	Other**	Coal (short tons)	Petro- leum (bbls)	Gas	Coal (short tons)	Petro- leum (bbls)
USBR PacNW Reg	--	--	--	--	--	--	--	--	--	--	--
Chandler	--	--	--	--	--	--	--	--	--	--	--
Grand Coulee	--	--	--	(35)	--	--	--	--	--	--	--
Roza	--	--	--	1,244	--	--	--	--	--	--	--
USCE - N.Pac. Div.	--	--	--	2,077,452	--	--	--	--	--	--	--
Chief Joesph	--	--	--	934,777	--	--	--	--	--	--	--
Dalles	--	--	--	648,995	--	--	--	--	--	--	--
Ice Harbor	--	--	--	125,699	--	--	--	--	--	--	--
Little Goose	--	--	--	120,764	--	--	--	--	--	--	--
Lower Granite	--	--	--	121,591	--	--	--	--	--	--	--
Lower Monument	--	--	--	125,626	--	--	--	--	--	--	--
WPPSS.....	--	--	--	--	489,999	--	--	--	--	--	--
Hanford	--	--	--	--	--	--	--	--	--	--	--
Packwood	--	--	--	--	--	--	--	--	--	--	--
WNP-2	--	--	--	--	489,999	--	--	--	--	--	--
WA Wtr Pwr Co.	--	--	--	66,989	--	28,324	--	--	*	--	--
Kettle Falls	--	--	--	--	--	28,324	--	--	*	--	--
Little Falls	--	--	--	15,110	--	--	--	--	--	--	--
Long Lake	--	--	--	35,609	--	--	--	--	--	--	--
Meyers Falls	--	--	--	591	--	--	--	--	--	--	--
Monroe Street	--	--	--	--	--	--	--	--	--	--	--
Nine Mile	--	--	--	8,925	--	--	--	--	--	--	--
Northeast	--	--	--	--	--	--	--	--	--	--	--
Upper Falls	--	--	--	6,754	--	--	--	--	--	--	--

* = Number less than 0.5 rounded to zero.

** Other sources include geothermal, solar, wood, wind, and waste.

Source: Energy Information Administration, "Electric Power Monthly," March 1991

Table IV-4

Natural and Other Gases Produced and Purchased by Natural Gas Pipeline Companies, October 1990

(Million Cubic Feet)

Pipeline Company	Trans- ported Gas	Natural Gas Production	Manufactured, Liquefied Nat., Gassified Coal and Synthetic Gas Production	From Producer	Intra- company Transfers	Imports	From Others	Total
Northwest	62,480	(3) *	0	1,465	(3) *	3,467	0	4,929
Pacific Gas Transm	13,185	0	0	174	0	32,259	0	32,433

* Includes out-of-period adjustments to correct data in prior month.

Source: Energy Information Administration, Natural Gas Monthly, January 1991; Form FERC-11

Table IV-5

Monthly Natural Gas Commercial and Industrial Utility Rates

Gas Company County (Region)	Type of Service	Charge Per Therm* (Cents)	Number of Therms Per Month	Effective Date
Cascade Natural Gas				
	General Commercial	0.5001	First 50	(03-12-90)
	General Industrial	0.4424	First 1,000	(03-12-90)
	Large Volume Gen. Industrial	0.4805	First 4,000	(03-05-90)
Northwest Natural Gas				
	Commercial & Industrial	0.5753	First 10	(10-01-90)
	Firm - High Load Factor	0.4213	First 500	(10-01-90)
	Large Firm	0.4574	First 4,000	(10-01-90)
Washington Natural Gas				
	Commercial & Industrial General (Optional)	0.5820	First 100	(06-01-88)
	Large General-Firm	0.3666	First 200	(08-01-90)
	High Annual Load Factor Large General-Firm	0.3567	First 500	(08-01-90)
Washington Water Power				
	General - Firm	0.3762	First 1	(08-01-90)
	High Annual Load Factor Large General-Firm	0.3567	First 500	(08-01-90)

* Charge per therm decrease as the number of therms consumed increases.

Note:

Cascade Natural Gas serves: Adams (SE), Benton (SE), Chelan (NC), Clark (SW), Cowlitz (SW), Douglas (NC), Franklin (SE), Grant (NC), Grays Harbor (W), Island (NW), Kitsap (PS), Mason (W), Skagit (NW), Snohomish (PS), Walla Walla (SW), Whatcom (NW), and Yakima (SC) Counties.

Northwest Natural Gas serves: Klickitat (SC), Skamania (SW), and Clark (SW) Counties.

Washington Natural Gas serves: King (PS), Lewis (SW), Snohomish (PS), Thurston (PS), and Pierce (PS) Counties.

Washington Water Power serves: Adams (SE), Asotin (SE), Ferry (NE), Franklin (SE), Garfield (SE), Grant (NC), Klickitat (SC), Lincoln (NE), Spokane (NE), Stevens (NE), and Whitman (SE) Counties.

Source: Washington State Utilities and Transportation Commission.

Table IV-6

Washington State Coal Consumption and Prices By Sector

Consumption and Price

Year	Residential				Commercial				Industrial				Electric Utilities			
	Billion Btu	\$/M Btu	Thous Short Tons	\$/Short Tons	Billion Btu	\$/M Btu	Thous Short Tons	\$/Short Tons	Billion Btu	\$/M Btu	Thous Short Tons	\$/Short Tons	Billion Btu	\$/M Btu	Thous Short Tons	\$/Short Tons
1960	1,424	NA	63	NA	2,644	NA	117	NA	9,492	NA	420	NA	0	NA	0	NA
1961	1,605	NA	71	NA	2,983	NA	132	NA	9,582	NA	424	NA	0	NA	0	NA
1962	1,220	NA	54	NA	2,260	NA	100	NA	10,554	NA	467	NA	0	NA	0	NA
1963	1,062	NA	47	NA	1,966	NA	87	NA	8,814	NA	390	NA	0	NA	0	NA
1964	1,017	NA	45	NA	1,898	NA	84	NA	7,729	NA	342	NA	0	NA	0	NA
1965	1,153	NA	51	NA	2,147	NA	95	NA	7,707	NA	341	NA	0	NA	0	NA
1966	1,062	NA	47	NA	1,966	NA	87	NA	7,119	NA	315	NA	0	NA	0	NA
1967	746	NA	33	NA	1,379	NA	61	NA	5,447	NA	241	NA	0	NA	0	NA
1968	542	NA	24	NA	994	NA	44	NA	4,836	NA	214	NA	0	NA	0	NA
1969	520	NA	23	NA	994	NA	44	NA	5,017	NA	222	NA	0	NA	0	NA
1970	271	0.95	12	21.47	520	0.52	23	11.75	4,746	0.52	210	11.75	0	NA	0	NA
1971	384	0.99	17	22.33	701	0.60	31	13.47	5,040	0.60	223	13.47	0	NA	0	NA
1972	249	1.03	11	23.19	475	0.67	21	15.19	3,277	0.67	145	15.19	31,231	NA	2,002	NA
1973	136	1.06	3	24.05	271	0.75	12	16.90	3,729	0.75	165	16.90	58,360	0.39	3,741	6.08
1974	113	1.10	5	24.91	203	0.82	9	18.62	6,192	0.82	274	18.62	45,630	0.37	2,925	5.77
1975	158	1.14	7	25.76	294	0.90	13	20.34	10,464	0.90	463	20.34	62,540	0.56	4,009	8.74
1976	181	1.76	8	39.87	339	1.18	15	26.58	15,029	1.18	665	26.58	64,069	0.75	4,107	11.70
1977	1,062	2.39	47	53.97	1,966	1.45	87	32.82	12,724	1.45	563	32.82	83,772	0.72	5,370	11.23
1978	1,446	3.01	64	68.07	2,667	1.73	118	39.05	12,611	1.73	558	39.05	66,035	0.77	4,233	12.01
1979	1,040	3.64	46	82.17	1,921	2.00	85	45.29	12,746	2.00	564	45.29	80,590	0.84	5,166	13.10
1980	1,311	4.26	58	96.28	2,441	2.28	108	51.53	7,933	2.28	351	51.53	77,220	0.96	4,950	14.98
1981	1,085	4.56	48	103.06	2,011	2.57	89	58.08	8,226	2.57	364	58.08	79,424	1.11	4,964	17.76
1982	1,469	4.81	65	108.71	2,735	2.67	121	60.34	8,678	2.67	384	60.34	61,504	1.39	3,844	22.24
1983	1,921	3.75	85	84.75	3,571	2.73	158	62.58	4,904	2.34	217	52.88	68,768	1.62	4,298	25.92
1984	1,808	3.76	80	84.98	3,367	2.87	149	66.76	4,497	2.36	199	53.34	72,096	1.72	4,506	27.52
1985	1,709	3.46	76	78.20	3,173	2.86	140	67.89	4,701	2.17	208	49.13	83,072	1.69	5,192	27.07
1986	704	3.11	31	70.29	1,307	2.81	58	67.40	4,475	1.96	198	44.30	53,280	1.74	3,330	27.84

Source: Washington State Energy Office, "Washington State Energy Use Profile, 1960 -1986," 1988.

Table IV-7

Washington State Residential Heating Oil and Residual Fuel Consumption and Price

Year	-----Residential Heating Oil-----				-----Residual Fuels-----			
	Billion Btu	Dollars per Million Btu	Thousand Barrels	Dollars per Gallon	Billion Btu	Dollars per Million Btu	Thousand Barrels	Dollars per Gallon
1960	42,540	1.08	7,303	0.150	58,475	NA	9,301	NA
1961	41,427	1.12	7,112	0.156	47,574	NA	7,567	NA
1962	38,567	1.12	6,621	0.156	47,869	NA	7,614	NA
1963	38,317	1.15	6,578	0.160	48,209	NA	7,668	NA
1964	41,282	1.16	7,087	0.161	55,162	NA	8,774	NA
1965	37,833	1.15	6,495	0.160	57,457	NA	9,139	NA
1966	39,767	1.18	6,827	0.164	62,166	NA	9,888	NA
1967	34,880	1.22	5,988	0.169	60,971	NA	9,698	NA
1968	38,952	1.25	6,687	0.174	75,142	NA	11,952	NA
1969	39,645	1.28	6,806	0.178	70,823	NA	11,265	NA
1970	40,979	1.33	7,035	0.185	65,284	0.39	10,384	0.058
1971	40,565	1.41	6,964	0.196	59,607	0.53	9,481	0.079
1972	38,783	1.42	6,658	0.197	74,337	0.57	11,824	0.085
1973	36,453	1.64	6,258	0.228	71,269	0.70	11,336	0.105
1974	28,484	2.60	4,890	0.360	64,027	1.49	10,184	0.223
1975	27,995	2.72	4,806	0.377	53,207	1.70	8,463	0.254
1976	28,909	2.93	4,963	0.406	46,612	1.60	7,414	0.240
1977	31,898	3.32	5,476	0.460	60,582	1.72	9,636	0.257
1978	31,193	3.50	5,355	0.486	72,099	1.67	11,468	0.250
1979	28,210	5.03	4,843	0.697	81,071	2.19	12,895	0.328
1980	19,933	7.27	3,422	1.008	108,815	3.24	17,308	0.485
1981	17,475	8.40	3,000	1.165	102,975	5.03	16,379	0.753
1982	18,914	8.48	3,247	1.176	85,151	5.19	13,544	0.777
1983	15,687	7.86	2,693	1.090	31,184	5.12	4,960	0.766
1984	17,731	7.40	3,044	1.026	32,202	5.26	5,122	0.787
1985	18,028	7.29	3,095	1.011	52,251	3.80	8,311	0.569
1986	18,930	5.26	3,250	0.730	54,877	1.93	8,729	0.289

Source: Washington State Energy Office, Washington State Energy Use Profile, 1960 -1986, 1988

Part V

Bibliography

Part V

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Appendix A

Glossary

Appendix A

Glossary

Agricultural residues: Above-ground organic matter left in the field after the harvest of a crop (in this publication it is stubble and straw left from harvesting barley and wheat).

Gross agricultural residues: All residues generated from agricultural activities.

Net agricultural residues: Agricultural residues available for energy consumption.

Bioenergy: The conversion of the complex carbohydrates in organic matter into energy, either by using it directly as a fuel or by processing it into liquids and gases that are more efficient.

Biogas: A combustible gas derived from decomposing biological waste.

Biomass: Any organic matter that is available to be used as a fuel on a renewable basis including forest residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residue, aquatic plants, and municipal wastes.

Biomass fuel: Any liquid, solid, or gaseous fuel produced by conversion from biomass.

Bone dry (oven dry): Having zero percent moisture content. Wood heated in an oven at a constant temperature of 212 degrees F. or above until its weight stabilizes.

British Thermal Unit (Btu): The amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

Capacity: The maximum instantaneous output of a resource, often expressed in kilowatts or megawatts.

Cogeneration: Technology to produce electric energy and forms of useful energy (thermal or mechanical) for industrial, commercial, heating, or cooling purposes, through the sequential use of an energy source.

Combustion: A chemical process, especially oxidation, accompanied by the production of heat and light.

Cubic foot (CF): 12" x 12" x 12" or 1' x 1' x 1'

Dry ton: 2,000 lbs. of material dried to a constant weight.

Feedstock: Any material that is converted to another form or product.

Forest residues: Wasted and unused wood in the forest, including logging residue; rough, rotten, and dead trees; and annual mortality.

Fuel handling system: The delivered wood fuel is unloaded from vans or trucks and transported to a storage pile or bin. From storage, the wood fuel is conveyed mechanically or pneumatically to the energy conversion system.

Hogged (hog) fuel: Wood waste such as sawdust, planer shavings, and wood chunks normally used for fuel purposes.

Kilowatt: 1,000 Watts, a measure of electrical power.

Logging residues: The unused portions of saw timber and pole timber trees cut or killed during the harvesting process.

Megawatt (MW): An electrical generation unit of one million Watts or 1,000 kW.

Mill residue: Wood and bark residues produced in processing lumber.

Municipal solid waste (MSW): Waste generated from the commercial, industrial, residential, and government sectors of our economy.

Private ownerships: Include forest industry and large and small nonindustrial companies and individuals.

Forest industry: Companies and individuals operating wood-using plants with no acreage limitations.

Large nonindustrial: Companies and individuals not operating wood-using plants and having holdings of 1,000 or more acres.

Small nonindustrial: Companies and individuals not operating wood-using plants and having holdings of less than 1,000 acres.

Public ownership lands: Owned by U.S. Forest Service, State, Bureau of Indian Affairs, and other Federal and Nonfederal lands.

State: Harvest from Department of Natural Resources-managed trust lands.

Other Nonfederal: Public land owned by cities, counties, public utility districts, and state agencies other than the Department of Natural Resources.

Forest Service: National forest harvest.

Bureau of Indian Affairs (BIA) - Timber harvest from several Native American tribes (Colville, Quinault, Yakima, etc.) located in Washington state.

Other Federal - Other federal agencies (military, National Park Service, Wildlife Service) selling timber for industrial wood harvest in the state.

RDF: Refuse-derived fuel; the combustible portion of solid waste that has been processed to remove heavier, noncombustible materials.

Renewable energy resource: Any energy resource that has recently originated in the sun, including direct and indirect solar radiation and intermediate solar energy forms such as wind, ocean thermal gradients, ocean currents and waves, hydropower, photovoltaic energy products of photosynthetic processes, organic wastes, and others.

Secondary wood processing facility: Companies that use lumber to produce their products (manufacturers of flooring, millwork, kitchen cabinets, boxes, pallets, skids, mobile homes, and prefabricated wood buildings).

Watt: The common base unit of power in the metric system. 1 kilowatt = 1,000 watts; 1 kWh (kilowatt hour) = the amount of power consumed for one hour. 1 megawatt = 1,000,000 watts.

Note: A number of these definitions were excerpted from U.S. Department of Energy, *Pacific Northwest and Alaska Bioenergy Program Glossary*, (1985), the U.S. Department of Energy *Biomass Energy Project Development Guidebook*, 1989, and Washington State Department of Natural Resources, *Washington Timber Harvest* — 1988.

Appendix B

Spokane County Profile

SPOKANE

County Seat
West 1116 Broadway
Spokane, Washington 99260
Phone: (509) 456-2265

GENERAL COUNTY INFORMATION^{1,2,3,4}

Area (Square Miles):	1,764	Rank:	19
Assessed Value:	\$9,417,000,000	Rank:	4
Per Capita Personal Income:	13,656	Rank:	19

Public Lands Acreages:

Total Land Acreage	1,125,120
Public Lands	100,458
Federal Lands	21,396
State Lands	51,371
Indian Lands	
County Lands	27,691

Temperature:

Average Annual Maximum Temperature:	60.9
Average Annual Minimum Temperature:	39.7
Average Annual Mean Temperature:	50.3
Average Annual Precipitation:	17.41 Inches

Population:

Yr.	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70 & Over	Total
87	55,495	49,813	58,657	58,071	41,995	29,821	30,136	31,912	355,900
89	56,003	48,811	56,250	58,736	46,216	29,791	29,393	32,801	358,000

Major Cities:

City	Population
Spokane	170,700
Cheney	7,630
Medical Lake	3,790
Deer Park	2,380
Airway Heights	1,905

Principal Economic Activities:

Food Processing, Apparel & Textile Manufacturing, Publishing, Metal Fabrication, Agriculture, Electronics, Machinery Manufacturing, and Wood Products

Major Industries:**Services**

Average No. of Employees:	34,858	Percent of Total:	25.6
Wages Paid (\$ in 000's):	502,589	Percent of Total:	20.5

Employees:	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	> 999
1986 Firms:	1,800	622	308	180	64	27	7	5	3
1988 Firms:	1,713	666	376	192	64	32	8	4	3

Retail Trade

Average No. of Employees:	28,465	Percent of Total:	20.9
Wages Paid (\$ in 000's):	302,967	Percent of Total:	12.4

Employees:	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	> 999
1986 Firms:	930	530	305	264	78	20	2	1	0
1988 Firms:	843	534	305	265	88	24	1	0	0

Government (Local, State, Federal)

Average No. of Employees:	22,812	Percent of Total:	16.8
Wages Paid (\$ in 000's):	517,545	Percent of Total:	21.1

Manufacturing

Average No. of Employees:	18,770	Percent of Total:	13.8
Wages Paid (\$ in 000's):	442,098	Percent of Total:	18

Employees:	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	> 999
1986 Firms:	173	87	67	70	36	20	3	2	4
1988 Firms:	160	103	79	70	37	24	2	8	2

Wholesale Trade

Average No. of Employees:	10,091	Percent of Total:	7.4
Wages Paid (\$ in 000's):	223,271	Percent of Total:	19.1

Employees:	1-4	5-9	10-19	20-49	50-99	100-249	250-499	500-999	> 999
1986 Firms:	307	199	181	88	25	5	3	0	0
1988 Firms:	315	220	172	79	19	7	2	0	0

Economic Development Assistance:

Spokane Area EDC
Phone: (509) 624-9285
P.O. Box 203 (N. 221 Wall, Suite 310)
Spokane, Washington 99201

Infrastructure:

Highways: Interstate 90; State 27, 206, 290, 291, 902, 904; U.S 2, 195, 395

Railroads: Burlington Northern, Union Pacific

Airports: Spokane, Deer Park, Felts Field, Spokane International

Mineral Resources, Energy Potential:

Type: Uranium

Power Generating Facilities:

Long Lake
Type: Hydroelectric
MW: 70

Electric Utilities:

City of Cheney Light Department
Municipality Operating with BPA
609 Second Street
Cheney, WA 99004
(509) 235-7211
Year: 1987
KWh Sales: 93,745,374
Dollar Sales: \$3,685,796
Average Cost per kwh: \$0.04

Kootenai Electric Cooperative
Cooperative Operating with BPA
P.O. Box 278
Hayden Lake, ID
(208) 765-1200
Year:
KWh Sales:
Dollars Sales:
Average Cost per kwh:

Inland Power & Light Company
Cooperative Operating with BPA
P.O. Box 4429
East 320 Second Avenue
Spokane, WA 99202
(509) 747-7151
Year: 1989
KWh Sales: 433,866,000
Dollar Sales: \$20,912,000
Average Cost per kwh: \$0.05

Vera Water and Power
Cooperative Operating without BPA
P.O. Box 630
601 North Evergreen
Veradale, WA 99037-0630
(509) 924-3800
Year: 1989
KWh Sales: 162,781,390
Dollar Sales: \$5,587,270
Average Cost per kwh: \$0.03

Modern Electric Company
 Cooperative Operating without BPA
 Box 14008, Opportunity Branch North
 904 Pines Road (Opportunity)
 Spokane, WA 99214
 (509) 928-4540
 Year: 1988
 KWh Sales: 165,000,000
 Dollar Sales: \$6,779,000
 Average Cost per kwh: \$0.03

The Washington Water Power Company
 Investor Owned Utility
 Ms. Dorothy Mercer, Rate & Research
 P.O. Box 3727
 Spokane, WA 99220
 (509) 489-0500
 Year: 1988
 KWh Sales: 9,306,000,000
 Dollar Sales: \$371,000,000
 Average Cost per kwh: \$0.04

AGRICULTURE⁵

Agricultural Extension Contacts:

Spokane County
 N. 222 Havana
 Spokane, WA 99202
 (509) 456-3651

Faculty:

Jonathan R. Newkirk, Chair, ANR
 E. Adams, ANR, CRD Area: Adams, Lincoln, Pend Oreille, Steven
 Tonie J. Fitzgerald, ANR Area: Stevens, Pend Oreille
 Dabra S. Marple, 4-H

Program Staff:

Janet Edwards, 4-H Ext. Program Assistant
 Clarice R. Reilly, Research Ext. Prog. Assistant
 Sydney McCrea, Master Gardener Program Coordinator

Farms and Cropland:

Harvested Cropland-Farms:	1,429
Harvested Cropland-Acres:	271,180
Cropland for Grazing-Farm:	704
Cropland for Grazing-Acre:	29,810
Other Cropland-Farms:	677
Other Cropland-Acres:	97,764

Spokane County Annual Spring Wheat Residues (Dryland)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	10,500	17,199	0	0	0	42	0	441,000
1983	7,800	11,232	0	0	0	37	0	288,000
1984	6,500	11,115	0	0	0	44	0	285,000
1985	9,400	10,452	0	0	0	29	0	268,000
1986	8,400	10,608	0	0	0	32	0	272,000
1987	6,200	10,257	0	0	0	42	0	263,000
1988	6,400	11,895	0	0	0	48	0	305,000
1989	42,800	76,752	0	0	0	46	0	1,968,000
Min.:	6,200	10,257	0	0	0	29	0	263,000
Max.:	42,800	76,752	0	0	0	48	0	1,968,000
Ave.:	12,250	19,939	0	0	0	40	0	511,250

Spokane County Annual Spring Wheat Residues (Irrigated Land)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	3,000	8,190	2,190	1	32,850	70	11	210,000
1983	2,800	8,190	2,590	1	38,850	75	14	210,000
1984	1,700	5,460	2,060	1	30,900	82	18	140,000
1985	600	1,521	321	1	4,815	65	8	39,000
1986	600	1,248	48	0	720	53	1	32,000
1987	400	1,404	604	2	9,060	90	23	36,000
1988	700	1,404	4	0	60	51	0	36,000
1989	2,200	6,552	2,152	1	32,280	76	15	168,000
Min.:	400	1,248	4	0	60	51	0	32,000
Max.:	3,000	8,190	2,590	2	38,850	90	23	210,000
Ave.:	1,500	4,246	1,246	1	18,692	70	11	108,875

Spokane County Annual Winter Wheat Residues (Dryland)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	121,700	345,219	40,969	0	614,535	56	5	6,769,000
1983	118,700	442,476	145,726	1	2,185,890	73	18	8,676,000
1984	123,300	344,964	36,714	0	550,710	55	5	6,764,000
1985	102,300	231,540	0	0	0	44	0	4,540,000
1986	98,300	275,247	29,497	0	442,455	55	5	5,397,000
1987	89,900	313,854	89,104	1	1,336,560	69	15	6,154,000
1988	81,000	321,504	119,004	2	1,785,060	78	22	6,304,000
1989	79,900	230,622	30,872	0	463,080	57	6	4,522,000
Min.:	79,900	230,622	0	0	0	44	0	4,522,000
Max.:	123,300	442,476	145,726	1	2,185,890	78	22	8,676,000
Ave.:	101,888	313,178	61,486	1	922,286	61	9	6,140,750

Spokane County Annual Winter Wheat Residues (Irrigated Land)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	6,000	27,693	15,693	3	235,395	91	39	543,000
1983	7,200	32,079	17,679	3	265,185	87	37	629,000
1984	7,300	33,048	18,448	3	276,720	89	38	648,000
1985	800	3,009	1,409	2	21,135	74	26	59,000
1986	1,000	4,080	2,080	2	31,200	80	31	80,000
1987	1,000	5,100	3,100	3	46,500	100	47	100,000
1988	1,500	6,885	3,885	3	58,275	90	39	135,000
1989	1,100	5,049	2,849	3	42,735	90	39	99,000
Min.	800	3,009	1,409	2	21,135	74	26	59,000
Max.	7,300	33,048	18,448	3	276,720	100	47	648,000
Ave.	3,238	14,618	8,143	2	122,143	88	37	286,625

Spokane County Annual Barley Residues (Dryland)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	89,600	137,088	0	0	0	51	0	4,569,600
1983	75,400	158,340	0	0	0	70	0	5,278,000
1984	86,200	145,320	0	0	0	56	0	4,844,000
1985	66,500	87,570	0	0	0	44	0	2,919,000
1986	68,700	105,150	0	0	0	51	0	3,505,000
1987	60,200	105,780	0	0	0	59	0	3,526,000
1988	48,500	97,470	0	0	0	67	0	3,249,000
1989	51,000	94,884	0	0	0	62	0	3,162,800
Min.	48,500	87,570	0	0	0	44	0	2,919,000
Max.	89,600	158,340	0	0	0	70	0	5,278,000
Ave.	68,263	116,450	0	0	0	57	0	3,881,675

Spokane County Annual Barley Residues (Irrigated Land)

Year	Acreage Harvested	Gross Tons	Straw Net Tons	Straw Net Tons/Acre	Straw MBTU	Net Bushels per Acre	Net MBTU per Acre	Harvested Bushels
1982	3,400	8,976	2,176	1	32,640	88	10	299,200
1983	3,200	9,984	3,584	1	53,760	104	17	332,800
1984	3,800	10,800	3,200	1	48,000	95	13	360,000
1985	2,500	5,430	430	0	6,450	72	3	181,000
1986	800	1,740	140	0	2,100	73	3	58,000
1987	500	1,650	650	1	9,750	110	20	55,000
1988	1,200	3,960	1,560	1	23,400	110	20	132,000
1989	1,100	3,597	1,397	1	20,955	109	19	119,900
Min.:	500	1,650	140	0	2,100	72	3	55,000
Max.:	3,800	10,800	3,584	1	53,760	110	20	360,000
Ave.:	2,063	5,767	1,642	1	24,632	95	13	192,238

BIOGAS

Spokane Wastewater Treatment Plant
Spokane, WA
Capacity mgd: 44
Output mcubft/yr: 20
Gross energy mbtu/yr: 120,000

MUNICIPAL SOLID WASTE

1989 Waste Generation:

1989 Population:	358,000
Estimated Lbs./Person:	6.26
Est. Annual Lbs./Person:	2,285
Estimated Total Waste Generated in 1989 (tons):	408,997

Spokane County Landfills:⁶

Type	Facility Name	Owner
Inert/Demolition	44th & Sands Landfill	Joe Bascetta
Inert/Demolition	8th & Camahan Pit	Acme Concrete
Inert/Demolition	Bascetta Demo Site	
Inert/Demolition	Broadway Pld	Acme Concrete
Inert/Demolition	Central Pre-Mix Site	Central Pre-Mix Company
Inert/Demolition	KACC-Mead Landfill	Kaiser Aluminum
Inert/Demolition	Old Materne Pit Site	Charles Materne
Inert/Demolition	Park Drive Landfill	Spokane County
Inert/Demolition	Swan Disposal Site	Robert Swan
Inert/Demolition	WS-C-12 Landfill	WA Dept. of Trans.
Inert/Demolition	Whitman College Site	Whitman College
Inert/Demolition	Wilson Landfill	Ralph Wilson
Inert/Demolition	Yardley Landfill	Central Pre-Mix Company
Municipal	Marshall Landfill	Glen Gillson
Municipal	Mica Landfill	Spokane County
Municipal	Myers Landfill	Thomas Myers
Municipal	North Landfill	Spokane County
Municipal	South Landfill	City of Spokane
Tire Pile	A.A. Auto Wrecking	A.A. Auto Wrecking
Tire Pile	Four Lake Tire Pile	AA Distributing
Tire Pile	Lindsay Tire Pile	John Lindsey
Tire Pile	Lindsey Tire Pile	John Lindsey
Tire Pile	Maak Tire Recyclers	Carl Maak
Transfer Station	Appleway T.S.	
Transfer Station	Deep Creek T.S.	Spokane County
Transfer Station	Fairfield T.S.	Spokane County
Transfer Station	Sunshine Recyclers T.S.	Sunshine Disposal
Woodwaste	Quartz Quarry Landfill	Dan Loshbaugh

Garbage Haulers:

Ada-Lin Waste Systems, Inc.
North 2405 University Road
Spokane, WA 99206

Metropolitan Services Corp.
East 4004 Peone Road
P.O. Box 369
Mead, WA 99021

Western Refuse Company
1805 4th St.
Cheney, WA 99004

Valley Garbage Service, Inc.
East 11720 First Avenue
P.O. Box 14000
Opportunity, WA 99206

Hi-Valley Disposal, Inc.
E. 4004 Peone
P.O. Box 369
Mead, WA 99021

Waste Paper Services, Inc.
East 3407 Main Avenue
Spokane, WA 99202

WOOD RESIDUES**Spokane County Annual Forest Residue -- All Land Ownerships⁷**

Year	Dry Tons
1981	18,757
1982	13,368
1983	29,296
1984	23,050
1985	30,262
1986	29,413
1987	30,732
1988	28,306
Minimum:	13,367
Maximum:	30,732
Average:	25,398

Spokane County Annual Forest Residues on Private Lands⁷
(in Dry Tons)

Year	Industry	Large	Small	Total
1981	991	765	15,050	16,806
1982	441	955	10,906	12,302
1983	0	2,486	23,941	26,426
1984	645	5,539	16,735	22,918
1985	3,892	5,479	19,450	28,821
1986	3,631	5,039	19,218	27,888
1987	2,969	6,335	16,776	26,080
1988	54	5,935	18,170	24,158
Minimum:	0	765	10,906	12,302
Maximum:	3,892	6,335	23,941	28,821
Average:	1,578	4,067	17,531	23,175

Spokane County Annual Forest Residues on Public Lands ⁷
(in Dry Tons)

Year	National	State	Other	Bia	Total
1981	0	1,615	336	0	1,951
1982	342	286	438	0	1066
1983	0	2,870	0	0	2,870
1984	0	131	0	0	131
1985	0	1,220	221	0	1,441
1986	0	632	893	0	1,525
1987	0	2,016	2,636	0	4,652
1988	0	2,700	1,447	0	4,147
Minimum:	0	131	0	0	131
Maximum:	342	2,870	2,636	0	4,652
Average:	43	1,434	746	0	2,223

Spokane County Sawmill Residues⁸

Year	Total Residue (Tons, dry weight)	Total Used (Tons, dry weight)
1988 ¹	234,707	234,707
1986 ²	419,066	418,412
1984 ³	96,012	96,012
1982 ³	42,846	35,624
1980 ³	60,308	50,577
1978 ⁴	195,820	123,178

- 1 Includes Ferry and Pend Oreille counties
- 2 Includes Stevens county
- 3 Includes Pend Oreille county
- 4 Includes Pend Oreille and Stevens counties

Spokane County Secondary Wood Processing Facilities:

SNE Enterprises, Inc.
East End, Bldg 14 Spokane Ind. Park
Spokane, WA 99216
Contact: Ken Kaiyala, Ray Willman
(509) 927-8300
Residue (tons): 89

Jeld-Wen of Washington
P.O. Box 4364
Spokane, WA 99202
Contact: Frank DeVaul
(509) 534-0471
Residue (tons): 9,672

Design Millwork, Inc.
North 3808 Sullivan Road
Spokane, WA 99216
Contact: Dave Benghammer
(509) 924-0300
Residue (tons): 7,680

Eagle Woodworking
Route 4, Box 184
Spokane, WA 99204
Contact: Barnett & Kent
(509) 244-2058
Residue (tons): 3

Interior Specialties
N 9527 Bruce Road
Spokane, WA 99207
Contact: Don Kassa
(509) 467-7418
Residue (tons): 4.32

Palanio Cabinets
P.O. Box 972
Deer Park, WA 99006
(509) 276-5436
Residue (tons): 0

T.R.A. Industries Inc./Huntwood Industries
Spokane Industrial Park, Bldg 26
Spokane, WA 99216
Contact: Tim Hunt
(509) 924-5858
Residue (tons): 51.975

Creative Wood Design
14511 East 18th Street
Veradale, WA 99037
Contact: Warren Smith
(509) 924-2787
Residue (lbs): 200

D-Mac Carpentry
North 4828 Stevens
Spokane, WA 99205
Residue (lbs): 260

R & D Commercial Woodworking
W 1224 Grace
Spokane, WA 99205
(509) 448-4531
Residue (lbs): 500

Wood Magic
E 1104 41st Avenue
Spokane, WA 99203
Contact: Victor & Judy Schaum
(509) 624-9037
Residue (tons): 3.541

Columbia Cabinets, Inc.
West 1927 Maxwell
Spokane, WA 99201
(509) 328-2450
Residue (tons): 0

Specialty Woods
16911 W Four Mound Road
Nine Mile Falls, WA 99026
Contact: Neal D. Burns
(509) 466-4684
Residue (lbs): 100

Kelley's Custom Cabinets
Route 2, Box 320-B
Deer Park, WA 99006
(509) 276-2015
Residue (lbs): 1,200

Rick Ward Custom Cabinets
E 1606 Holyoke, #4
Spokane, WA 99207
(509) 487-0048
Residue (tons): 1.20

Keller Cabinetry
N 22324 Orchard Bluff
Chattaroy, WA 99003
Contact: Leland A. Keller
Residue (lbs): 438

Cooper's Cabinets, Inc.
East 3310 Sprague
Spokane, WA 99202
Contact: Steve Cooper
(509) 535-5539
Residue (lbs): 600

Journeyman Cabinets, Inc.
E 2929 Providence
Spokane, WA 99207
Contact: Paul Ruckhaber
(509) 483-6864
Residue (tons): 4

The Freight Crate
P.O. Box 15124
Spokane, WA 99215
(509) 928-3544
Residue (tons): 0

Porta-Panel Buildings
13900 East Mission
Spokane, WA 99216
Residue (lbs): 200

Pre-Built Structures, Inc.
5315 N Corrigan
Otis Orchards, WA 99027
(509) 928-1442
Residue (tons): 3.41

CURRENT USERS

Solid Fuel Processing Facilities:

Spokane Pres-To-Logs
Spokane, WA

Plant Capacity (tons/yr):

69,000

Ave. Plant Output (tons/yr):

52,000

Gross Energy Equivalent (MBtu/yr):

884,000

POTENTIAL USERS

Wood Combustion Facilities:

W.I. Forest Products
Spokane, WA
Source: In-house
Biomass wood use bdt/yr: 19,764
Biomass energy output mb: 36
Energy equiv mbtu/yr: 338,436

Businesses:

Carnation Company
Spokane, WA 99220
Billion Btu Fuels: NA

Layrite Products Co.
Spokane, WA 99202
Billion Btu Fuels: 23.51

Central Premix Concrete
Spokane, WA 99220
Billion Btu Fuels: 72.70

Olympic Foods, Inc
Spokane, WA 99220
Billion Btu Fuels: 20.78

Consolidated Dairy Products
Spokane, WA 99208
Billion Btu Fuels: 30.24

Quarry Tile Co.
Spokane, WA 99216
Billion Btu Fuels: 25.72

Dellen Wood Products
Spokane, WA 99216
Billion Btu Fuels: 25.29

Ralston Purina Co.
Spokane, WA 99211
No. of Boilers: 2
Boiler Fuels: NG
Billion Btu Fuels: 42.84

Ideal Cement
Spokane, WA 99212
Billion Btu Fuels: NA

Spokane Pres-To-Log Co.
Spokane, WA 99220
No. of Boilers: 2
Boiler Fuels: Wood/NG
Boiler Info Source: WSU
Billion Btu Fuels: 31.08

Inland Empire Paper Co.
Spokane, WA 99212
No. of Boilers: 2
Boiler Fuels: NG
Billion Btu Fuels: 242.25

Spokane Seed Co.
Spokane, WA 99211
Billion Btu Fuels: 41.06

ITT Continental Baking Co.
Spokane, WA 99210
Billion Btu Fuels: 55.37

Standard Traffic Controls
Spokane, WA 99211
Billion Btu Fuels: NA

Kaiser Aluminum & Chemical
Spokane, WA 99215
Boiler Fuels: NG
Billion Btu Fuels: 1477.80

Western Bottling Co., Inc.
Spokane, WA 99202
Billion Btu Fuels: 19.19

Colleges:

Community Colleges of Spokane
N. 2000 Green Street
Spokane, WA 99207
(509) 536-7247

Spokane Community College
Sq.Ft. 684,858
Elect MMBtu: 33,009
Elect Cost: \$413,712.50
Fuel MMBtu: 56,130
Fuel Cost: \$201,568.90

Spokane Falls Community College
Sq.Ft. 407,012
Elect MMBtu: 20,536
Elect Cost: \$294,491.80
Fuel MMBtu: 27,740
Fuel Cost: \$98,311.95

Eastern Washington University
Cheney, WA 99004
(509) 359-6200
Sq.Ft. 2,017,730
Elect MMBtu: 72,546
Elect Cost: \$739,335.60
Fuel MMBtu: 188,103
Fuel Cost: \$569,421.80

Eastern Washington University - Spokane
Center
Sq.Ft. 60,099
Elect MMBtu: 4,050
Elect Cost: \$60,949.61
Fuel MMBtu: 2,509
Fuel Cost: \$9,578.79

Correctional Institutions:

Pine Lodge Correction Center
P.O. Box C MS:
Medical Lake, WA 99022
(509) 299-5135, (Scan) 545-2902

Developmentally Disabled Centers:

Interlake School
Sq.Ft. 182,408
Elect MMBtu: 10,002
Elect Cost: \$138,689.30
Fuel MMBtu: 31,510
Fuel Cost: \$95,357.88

Lakeland Village
Sq.Ft. 490,624
Elect MMBtu: 21,019
Elect Cost: \$292,312.80
Fuel MMBtu: 100,035
Fuel Cost: \$323,010.30

Hospitals:⁹

Deaconess Medical Center
Type: Acute Care
Corporation Type: Non-Profit Corporation
Owner Name: Deaconess Medical Center, Inc.
Administrator: Thomas J. Zellers
Total Beds: 388
800 West Fifth Ave.
Spokane, WA 99210
(509) 458-5800

Deer Park Health Center and Hospital
Type: Acute Care
Corporation Type: Proprietary Corporation
Owner Name: Rural Health Services, Inc.
Administrator: Robert D. Brown
Total Beds: 26
Forest and "D" Street
Dear Park, WA 99006
(509) 276-5061

Eastern State Hospital
Sq.Ft. 559,176
Elect MMBtu: 22,609
Elect Cost: \$312,287.80
Fuel MMBtu: 117,541
Fuel Cost: \$339,354.20

Holy Family Hospital
Type: Acute Care
Corporation Type: Dominican Health Services
Owner Name: Holy Family Hospital
Administrator: Ronald Schurra
Total Beds: 272
North 5633 Lidgerwood
Spokane, WA 99207
(509) 482-0111

Mountainview Hospital
Type: Alcoholism
Corporation Type: Proprietary Corporation
Owner Name: Samissa Spokane, Inc.
Administrator: Ben Camp
Total Beds: 34
628 South Cowley
Spokane, WA 99202
(509) 624-3226

Sacred Heart Medical Center
Type: Acute Care
Corporation Type: Church
Owner Name: Sisters of Providence
Administrator: Gerald Leahy
Total Beds: 615
West 101 Eighth Avenue
Spokane, WA 99204
(509) 455-3131

Shriners Hospitals for Crippled Children
Type: Acute Care
Corporation Type: Non-Profit Corporation
Owner Name: Shriners Hospital for Crippled Children, A Colorado Corp.
Administrator: Howard L. Parrett
Total Beds: 30
North 820 Summit Boulevard
Spokane, WA 99201
(509) 327-9521

St. Luke's Memorial Hospital
Type: Acute Care
Corporation Type: Non-Profit Corporation
Owner Name: St. Luke's Memorial Hospital
Administrator: Thomas M. White
Total Beds: 146
P.O. Box 288
South 711 COWLEY
Spokane, WA 99210
(509) 838-4771

Valley Hospital and Medical Center
Type: Acute Care
Corporation Type: Non-Profit
Owner Name: St. Luke's Memorial Hospital
Administrator: Michael Liepman
Total Beds: 123
Street 12606 East Mission Avenue
Spokane, WA 99216
(509) 924-6650

Schools:10

School	District	Span	Sq. Ft.	FTEs	Heat Source	Heat System
Adams Elem.	356	K-6	39,812	500	Gas	Steam
Adams Elem.	081	K-6	33,883	574	Gas	Steam
Alt. Spokane Valley High	363	9-12	30,258	129	Gas	Steam
Arcadie Elem.	414	3-6	42,551	398	Electric	
Argonne Junior High	363	6-8	81,751	0	Gas	Steam
Arlington Elem.	081	K-6	50,070	522	Gas	Hot Water
Arthur B. Ness Elem.	363	1-4	27,329	259	Gas	Steam
Audubon Elem.	081	K-6	50,070	559	Gas	Hot Water
Balboa Elem.	081	K-6	30,823	268	Gas	Steam
Bemiss Elem.	081	K-6	52,243	546	Gas	Hot Water
Betz Elem.	360	K-6	35,963	399	Oil/Gas	Steam
Blair Elem.	326	P-6	89,585	708	Gas	Steam
Blake Elem.	356	K-6	34,157	442	Gas	Hot Water
Bowdish Junior High	356	7-9	74,498	441	Gas	Steam
Brentwood Elem.	354	K-6	38,141	639	Gas	
Broadway Elem.	356	K-6	40,648	356	Gas	Steam
Browne Elem.	081	K-6	36,218	428	Gas	Steam
Bryant Special	081	K12	21,046	22	Gas	Hot Water
Centennial Middle	363	5-8	89,870	762	Gas	Hot Water
Central Valley High	356	10-12	145,043	1,135	Gas/Elec	Steam
Chattaroy Primary	416	K-4	27,935	259	Oil	Steam
Cheney High	360	10-12	89,061	635	Electric	
Cheney Junior High	360	7-9	106,478	708	Electric	Hot Water
Chester Elem.	356	1-6	38,388	401	Gas	
Colbert Elem.	354	K-6	43,011	716	Gas	Hot Water
Cooper Elem.	081	K-6	52,243	573	Gas	Hot Water
Dear Park Elem.	414	K-3	25,691	405	Gas/Elec	Hot Water
Dear Park High	414	9-12	80,730	494	Gas/Elec	Hot Water
Dear Park Junior High	414	7-8	32,882	227	Oil	Steam
East Farms Elem.	361	K-5	46,995	402	Gas	
East Valley High	361	10-12	198,970	1,121	Gas	
East Valley Junior High	361	7-8	70,416	472	Gas	
Evergreen Elem.	354	K-6	35,336	456	Gas	Steam
Evergreen Junior High	356	7-9	68,690	491	Electric	
Farwell Elem.	354	K-6	35,918	466	Oil	Steam
Finch Elem.	081	K-6	48,158	557	Gas	Steam
Franklin Elem.	081	K-6	42,972	345	Gas	Steam
Freeman Elem.	358	K-8	64,414	463	Oil	Hot Water
Freeman Spokane	358	9-12	51,060	188	Oil	Hot Water
Garden Springs Elem.	360	K-2	14,564	61	Oil	Hot Water
Garfield Elem.	081	K-6	50,070	545	Gas	Hot Water
Glover Junior High	081	7-8	108,040	747	Gas	Hot Water
Gonzaga Child Dev. Ctr.	362		18,268	0		
Grant Elem.	081	K-6	50,070	565	Gas	Hot Water
Great Northern Elem.	312	K-6	8,034	31	Oil/Elec	
Greenacres Elem.	356	K-6	55,875	637	Gas	Hot Water
Greenacres Junior High	356	7-9	86,937	444	Gas/Elec	Hot Water
Hamblen Elem.	081	K-6	18,357	515	Gas	Steam
Havermale Junior High	081		83,161	0	Gas	Steam

Schools: (continued)

School	District	Span	Sq. Ft.	FTEs	Heat Source	Heat System
Holmes Elem.	081	K-6	52,243	593	Gas	Hot Water
Horizon Junior High	356	7-9	84,795	490	Gas	Hot Water
Hutton Elem.	081	K-6	40,796	525	Oil	Steam
Indian Trall Elem.	081	K-6	26,416	357	Gas	Hot Water
Jefferson Elem.	081	K-6	41,285	508	Gas/Oil	Steam
Joel E. Ferris High	081	9-12	213,250	1,525	Gas	Hot Water
John R. Rogers High	081	9-12	167,097	1,450	Gas	Steam
Joseph Jantsch High	081	9-12	78,524	200	Gas	Steam
Keystone Elem.	356	P-6	33,669	305	Gas	Hot Water
Lake Spokane Elem.	325	K-5	17,670	493	Electric	
Lewis and Clark High	081	9-12	241,827	1,459	Gas	Steam
Libby Junior High	081	7-8	65,875	486	Gas	Steam
Liberty High	362	9-12	41,580	175	Gas	Hot Water
Liberty Junior High & Elem.	362	K-8	47,500	388		
Lincoln Heights Elem.	081	K-6	18,231	316	Oil/Gas	Steam
Linwood Elem.	081	K-6	40,017	430	Gas	Steam
Logan Elem.	081	K-6	52,118	416	Gas	Steam
Longfellow Elem.	081	K-6	50,070	603	Gas	Hot Water
Madison Elem.	081	K-6	36,738	332	Gas	Steam
McDonald Elem.	356	K-6	30,949	308	Gas	Steam
Mead Junior High	354	7-9	109,841	855	Gas	Steam
Mead Senior High	354	10-12	212,985	1,726	Gas	
Medical Lake Elem.	326	K-6	44,261	557	Gas/Elec	Steam
Medical Lake High	326	9-12	81,524	433	Gas	Steam
Medical Lake Middle	326	7-8	52,519	253	Gas	
Midway Elem.	354	K-6	51,066	673	Gas	Hot Water
Millwood Early Childhood Ed.	363	P-1	27,132	215	Gas	Steam
Mountain View Jr. High	361	6-8	66,986	425	Gas	
Mullan Road Elem.	081	K-6	49,528	572	Gas	Hot Water Steam
New Jr./Sr. High Lakeside	325		84,555	0		
Nine Mile Falls Elem.	325	6-9	30,377	395	Oil/Elec	
North Central High	081	9-12	179,095	1,394	Gas	Hot Water
North Pines Junior High	356	7-9	102,170	394	Gas	Steam
Northwood Junior High	354	7-9	100,829	660	Gas	Steam
Opportunity Elem.	356	K-6	42,848	459	Gas	Hot Water
Orchard Center Elem.	363	1-4	28,984	272	Gas	Steam
Orchard Prairie Elem.	123	K-7	7,309	52	Gas	
Otis Orchards Elem.	361	K-5	35,104	503	Oil	
Pasadena Park Elem.	363	1-4	27,615	279	Gas	Steam
Ponderosa Elem.	356	K-6	51,377	426	Gas	Hot Water
Pratt Elem.	081	K-6	21,424	329	Gas	Steam
Progress Elem.	356	1-3	37,573	201	Gas	Steam
Regal Elem.	081	K-6	52,243	543	Gas	Hot Water
Ridgeview Elem.	081	K-6	23,291	438	Oil/Gas	Steam
Riverside High	416	9-12	48,272	507		
Riverside Middle	416	5-8	60,056	570	Electric	
Riverside Primary	416	P-4	52,984	456	Electric	
Roosevelt Elem.	081	K-6	50,070	599	Gas	Hot Water

Schools: (continued)

School	District	Span	Sq. Ft.	FTEs	Heat Source	Heat System
Sacajawea Junior High	081	7-8	112,613	938	Gas	Hot Water
Salk Junior High	081	7-8	110,386	655	Gas	Hot Water
Salnave Elem.	360	K-6	49,737	406	Electric	Hot Water
Seth Woodard Primary	363		28,659	0	Oil	Steam
Shadle Park High	081	9-12	260,025	1,309	Gas	Steam
Shaw Junior High	081	7-8	112,613	551	Gas	Hot Water
Sheridan Elem.	081	K-6	50,070	512	Gas	Hot Water
Shiloh Hills Elem.	354	K-6	51,066	522	Gas	Hot Water
Skills Center	081	11-12	69,994	0	Gas	Hot Water
Skyview Elem.	361	K-5	42,090	342	Gas	
South Pines Elem.	356	K-6	41,640	437	Gas	Hot Water
Spokane Garry Junior High	081	7-8	98,878	545	Gas	Hot Water
Spokane Guilds Room	081		1,717	0		
Stevens Elem.	081	K-6	53,808	466	Gas	Steam
Sunrise Elem.	356	K-6	53,673	577	Gas	Hot Water
Sunset Elem.	360	K-6	45,769	322	Electric	Hot Water
Trent Elem.	361	K-5	58,171	323	Gas	
Trentwood Elem.	361	K-5	46,115	393	Gas	
University Elem.	356	K-6	37,947	514	Gas	Steam
University High	356	10-12	144,522	1,032	Gas/Oil	Steam
West Valley High	363	9-12	117,892	739	Gas	Steam
Westview Elem.	081	K-6	39,068	480	Gas	Steam
Whitman Elem.	081	K-6	52,243	627	Gas	Hot Water
Whitworth Elem.	354		30,826	0	Gas	Steam
Willard Elem.	081	K-6	50,070	590	Gas	Hot Water
Wilson Elem.	081	K-6	28,099	369	Gas/Elec	Steam
Windsor Elem.	360	K-6	37,919	443	Oil	Steam
Woodridge Elem.	081	K-6	50,070	503	Gas	Hot Water

State Buildings:

Cheney Cowles Museum
 Sq.Ft. 48,950
 Elect MMBtu: 1,759
 Elect Cost: \$26,424.87
 Fuel MMBtu: 4,429
 Fuel Cost: \$16,179.63

Department of Transportation -- Dist. 6
 Headquarters, Spokane
 Sq.Ft. 63,690
 Elect MMBtu: 2,928
 Elect Cost: \$49,579.93
 Fuel MMBtu: 7,913
 Fuel Cost: \$29,544.38

Court of Appeals -- Spokane Office
 Sq.Ft. 14,654
 Elect MMBtu: 848
 Elect Cost: \$14,302.63
 Fuel MMBtu: 617
 Fuel Cost: \$2,540.79

Spokane District 4 Headquarters
 Sq.Ft. 17,467
 Elect MMBtu: 792
 Elect Cost: \$14,574.59
 Fuel MMBtu: 0
 Fuel Cost: \$0.00

Appendix B Sources

- 1 Office of Financial Management. *Data Book 1989*. 1989
- 2 The Information Press. *1986 Washington State Yearbook*. 1986
- 3 U.S. Department of Commerce. *County Business Patterns 1986*. 1986
- 4 Northwest Public Power Association. *1989 NW Electric utility Directory*. 1989.
- 5 Washington State Department of Agriculture. *Agricultural Statistics*. 1982-1989.
- 6 Washington State Department of Ecology.
- 7 Washington State Department of Natural Resources. *Timber Harvest Report*. 1981-1988.
- 8 Washington State Department of Natural Resources. *Mill Surveys*. 1978-1988.
- 9 Washington State Department of Health. *Directory of Licensed Hospitals*. 1989.
- 10 Superintendent of Public Instruction

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