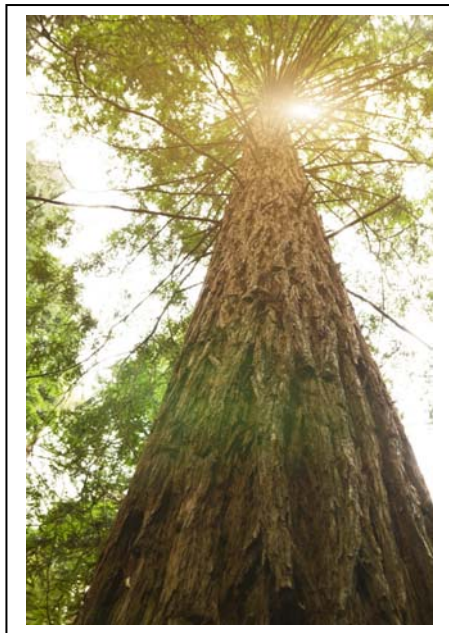




# Biomass Inventory and Bioenergy Assessment

An Evaluation of Organic Material Resources for Bioenergy Production in Washington State

December, 2005



Publication No. 05-07-047  
*printed on recycled paper*



A biomass inventory and bioenergy assessment for Washington State was completed producing this final report, as well as a web accessible computer database with GIS maps on a Visual Basic platform. This report is available on the Department of Ecology home page on the World Wide Web at <http://www.ecy.wa.gov/biblio/0507047.html>. The report will also be available along with the database and maps on the Washington State University Extension Office website (<http://www.pacificbiomass.org>).

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# **Biomass Inventory and Bioenergy Assessment**

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## **An Evaluation of Organic Material Resources for Bioenergy Production in Washington State**

by

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## Abstract

A biomass inventory and bioenergy assessment for Washington State was completed, producing this final report as well as a web accessible computer database complete with GIS maps on a Visual Basic platform (<http://www.pacificbiomass.org>). The goal of the study was to inventory Washington's bioresources as a first essential step for all related planning efforts to implement the state *Beyond Waste* strategy for reduction of organic residuals in solid waste. This inventory also represents a first step toward a sustainable energy policy and vision within the state since information on type and geographic distribution of biomass was perceived as critical for feasibility analysis and project prioritization.

This project geographically identified, categorized, and mapped 45 potential sources in Washington at a county level. The categories included field residues, animal manures, forestry residues, food packing/processing waste, and municipal wastes. The biomass inventory was then converted to potential energy production using anaerobic digestion and simple combustion as representative conversion technologies. A five-step method was used for inventorying and determining the biomass and potential electrical energy from Washington's biomass. First, agriculture, processing and municipal statistics and databases along with personal interviews with agriculture and solid waste processing leaders led to the development of a biomass inventory. Second, the resulting biomass was standardized to represent total dry matter. Third, woody or straw-like materials with a high lignocellulosic content were evaluated for potential energy production using combustion as a conversion technology. Heat value coefficients were determined for each individual woody or straw-like material and used to calculate the potential electrical energy and power using 20% conversion efficiency. Fourth, the wet biomass, represented largely by the animal manures and processing wastes, was evaluated for potential electrical energy production using anaerobic digestion as its representative conversion technology. In this process, the dry biomass was converted to available volatile solids and ultimately potential methane production using laboratory determined coefficients for each of the biomass types. From the methane production levels, estimates of electrical energy and power production were developed using 30% conversion efficiency. Lastly, the biomass and bioenergy databases at state and county levels across the varying categories were mapped on GIS and made web-accessible through a Visual Basic directory.

The results of this study show that Washington State has an annual production of over 16.9 million tons of underutilized dry equivalent biomass, which is capable of producing, via assumed combustion and anaerobic digestion, over 15.5 billion kWh of electrical energy or 1,769 MW of electrical power. This power total, assuming complete utilization of the inventoried biomass, is equivalent to just about 50% of Washington State's annual residential electrical consumption (EIA, 2003).

Washington is blessed with a vast and diverse, annually renewable biomass that is predominantly dispersed lignocellulosic waste (forestry, field straws and yard waste). These materials present technical and economic challenges in collection and processing. However, about 15 percent of the available biomass is in the form of more readily biodegradable and concentrated waste streams coming from the municipal solid, animal manure and food processing wastes. Mapping of the biomass showed regional areas of concentration with the highest concentrated areas being regions where forestry and municipal or forestry and agriculture intersect, such as the Puget Sound/Cascade and Yakima regions.

The abundance, diversity and distribution of these organic resources should begin to catalyze thinking about the development of renewable fuels and energy strategies within our state. Coincidentally, the distributed nature of the resource aligns geographically with areas of the state where development of new business opportunities and jobs is of vital interest. Distributed production also possesses substantial other benefits such as decreased dependence on outside supply, price elasticity, market independence and local control all which make development of these resources a vital interest of the state.

## Glossary

<i>Anaerobic Digestion</i>	Biological degradation of organic material under anoxic conditions which produces biogas in the form of methane and carbon dioxide gases
<i>Animal Mortality</i>	Total tons of animal mortality (cattle, swine, horse, and poultry) as determined using national mortality ratios for each animal
<i>Animal Proc. Waste</i>	Category total of seven different animal processing wastes (Poultry Feathers, Poultry Meat Waste, Beef Meat Waste, Pork Meat Waste, All Animal Mortality, Fish Waste and Shellfish Waste)
<i>Animal Waste</i>	Category total of five different animal manures (Dairy, Cattle, Horse, Swine, and Poultry)
<i>Apple Pomace</i>	Solids remaining after apple processing operations (8.6% of wet weight)
<i>Asparagus Butts</i>	End of stalk spears that are removed prior to market (25% of harvested mass)
<i>Asparagus Trimmings</i>	Solids remaining after asparagus processing operations (10% of wet weight)
<i>Barley Straw</i>	Collectable barley straw left on fields after harvest (25% collection factor)
<i>Beef Meat Proc.</i>	Waste material from beef meat production (0.187 tons by-product/ton live weight)
<i>Berry Pomace</i>	Solids remaining after berry processing operations (6% of wet weight)
<i>Biosolids</i>	Biosolids produced at municipal water treatment facilities
<i>Brown Grease</i>	Sewer and pipe grease that are trapped and collected via water treatment facilities (7.44 lbs/person year)
<i>Cattle Manure</i>	Manure waste from feedlots and cattle operations (22.8% collectible)
<i>Cheese Whey</i>	Solid by-product of cheese production (9:1 ratio whey to cheese production)
<i>CHP</i>	Combined heat and power refers to a common electrical generation system that utilizes some of the waste heat in the process to help sustain or run the system
<i>Combustion</i>	Chemical oxidative reaction of relatively dry organic material for energy and production of ash, carbon dioxide and other gases
<i>Conversion Efficiency</i>	Two assumed conversion efficiencies were used in this study; 20% for combustion and 30% for anaerobic digestion. These efficiencies refer to the mechanical system's ability to convert energy available to a particular desirable energy, in this case electricity.
<i>Corn Stover</i>	Collectable residue left on fields after corn harvest (25% collection factor)
<i>Cull Apple</i>	Apples not considered suitable for market and used for juice (10% of harvest)
<i>Cull Misc. Fruit</i>	Fruit not considered suitable for market and used for juice (10% of harvest)
<i>Cull Onion</i>	Onions not considered suitable for market (5% of harvest)
<i>Cull Potato</i>	Potatoes not considered suitable for market (10% of harvest)
<i>Dairy Manure</i>	Manure waste from dairy operations (85% collectible)
<i>Dry Matter</i>	Mass of inventoried item after representative moisture content mass was removed—moisture contents for each inventoried item were taken from known references or estimated from known references

<i>Grape Pomace</i>	Solids remaining after grape processing operations for both juice and wine (10% of wet weight)
<i>Grass Seed Straw</i>	Collectable wheat straw left on fields after harvest (2.2 tons of sustainable residue/acre harvested)
<i>Field Residue</i>	Category total of seven different agricultural field residues (Wheat Straw, Barley Straw, Corn Stover, Mint Slug, Hops Residue, and Other Field Residue)
<i>Fish Waste</i>	Waste from fish processing plants (Tuna~65% waste; Fin Fish~35% waste)
<i>Food Packing Waste</i>	Category total of five different agricultural packing operation wastes (Cull Apples, Cull Miscellaneous Fruit, Cull Potatoes, Cull Onions, Asparagus Butts)
<i>Food Proc. Waste</i>	Category total of eight different food processing wastes (Apple Pomace, Berry Pomace, Grape Pomace, Miscellaneous Fruit Pomace, Cheese Whey, Potato Solids, Asparagus Trimmings and Mixed Vegetable Trimming)
<i>Food Waste</i>	Food waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
<i>Forestry Waste</i>	Category total of four different forestry related residues and wastes (Logging Residue, Forest Thinning, Mill Residue, and Land Clearing Debris)
<i>Forest Trimming</i>	Combination of state silviculture burn data and pre-commercial thinning data
<i>HHV</i>	High heat value content is an estimation of the energy available in a substance via combustion and was chosen over the LHV or lower heat value content because it more accurately describes the potential energy available via non-assumed combined heat and power generation, as was the case in this study
<i>Hops Residue</i>	Vines, stems, and miscellaneous residue after harvest of hops (50% residue/harvest)
<i>Horse Manure</i>	Manure waste from small horse farms as well as horse operations (67% collectible)
<i>kWh</i>	Kilowatt hour is a common measurement for electrical energy; in this study, large amounts of kWh were calculated thus M kWh was often used which refers to a million kilowatt hours.
<i>Land Clearing Debris</i>	Land clearing debris from municipal and county land clearing of land for residential and commercial use
<i>Lignocellulosic</i>	Wood, straw and grass-like materials which are largely composed of a complex matrix of cellulose, hemicellulose and lignin
<i>Logging Residue</i>	Residue left behind in forest land after commercial logging
<i>MW</i>	Megawatt is a common measurement of electrical power generated in a year
<i>Mill Residue</i>	Bark/wood residue from sawmills, pulp mills, shake/shingle operations, whole log chippers, veneer plywood factories, post/pole/piling operations and log export
<i>Mint Slug</i>	Remaining grass residue after distillation of mint oil (50 lbs residue/lb mint)
<i>Misc. Fruit Pomace</i>	Solids remaining after fruit processing operations (17% of wet weight)
<i>Mixed Veg. Trims.</i>	Solids remaining after mixed vegetables (sweet corn, peas and carrots) are processed (13% of wet weight)

<i>MSW</i>	Category total of nine different municipal solid wastes (Food, Yard, Yard-Burn, Other Organics, Paper, Wood, Yellow Grease, Brown Grease, and Biosolids)
<i>Other Field Residue</i>	Combination of data referencing cereal grain burns, grassland and CRP clearing, orchard tear outs and orchard thinning
<i>Other Organics</i>	Organic waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases (Other organic defined as manures, carcasses and offal)
<i>Paper</i>	Paper waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
<i>Pork Meat Proc.</i>	Waste material from pork meat production (0.135 tons/by-product/ton live weight)
<i>Potato Solids</i>	Solids remaining after potato processing operations (3.7% of wet weight)
<i>Poultry Feathers</i>	Feathers remaining after processing of poultry (9% of live weight)
<i>Poultry Manure</i>	Manure waste from both broiler and egg-layer operations (80% collectible)
<i>Poultry Meat Proc.</i>	Waste material from poultry meat production (19.3% of live weight)
<i>Shellfish Waste</i>	Waste from shellfish processing plants (Oyster~86% waste; Crab~73% waste; Shrimp~80% waste; and Clam~80% waste)
<i>Swine Manure</i>	Manure waste from swine operations (100% collectible)
<i>TS</i>	Total solids is another way to refer to the total dry matter or mass of an item minus its moisture content
<i>VS</i>	Volatile solids is a scientific measurement that is utilized to more accurately quantify the amount of organic material that is available to the micro-organisms during anaerobic digestion—most reports on anaerobic digestion performance are recorded as percentage of VS reduction during the process or amount of methane produced per VS. The VS of an item is usually referenced as a percentage of its TS such as 8%TS where TS is the mass of an item minus its moisture content
<i>Wheat Straw</i>	Collectable wheat straw left on fields after harvest (25% collection factor)
<i>Wood Residue</i>	Wood waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
<i>Yard-Burn Waste</i>	Yard waste estimated to be burned in piles and not entering municipal waste collection system (125 pounds/pile)
<i>Yard Waste</i>	Yard waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
<i>Yellow Grease</i>	Restaurant grease collected (6.7 lbs/person year)



# Chapter 1 - Introduction

## BACKGROUND

### **Biomass as a Renewable Energy**

Recently, with ever increasing jumps in fossil fuel prices, threats to national security and concern over environmental impacts such as global warming, sustainability and renewable energy have rushed headlong into the forefront of public consciousness. Figure 1 below shows the present state of renewable energy use in the US with renewable energy representing only 6% of the total and biomass representing a little above 2.5%. In an effort to push forward greater utilization of renewable energy, the federal government through the Department of Energy has put forth benchmark biomass initiative goals for 2020 which are to have 5% of all power, 10% of all fuels, and 18% of all bioproducts be supplied by biomass and serve as replacements for what otherwise would be fossil fuel expenditures (DOE, 2002). On a state level, Washington State is looking to bioenergy as one of several potential means to resolve the above described concerns, but also to alleviate state concerns in regard to the struggles of its rural communities and agricultural/forestry sectors. To achieve these goals federal and state funds and laws will be needed to enhance basic and applied research, commercialize new methods and technologies aimed at collection and conversion of the biomass, as well as identify sources, locations and cost analyses for the available biomass. To that end, several federal and state programs and initiatives have begun so that many of these questions as well as technological and information difficulties can be resolved, with one first step often being the development of an inventory of available resources.

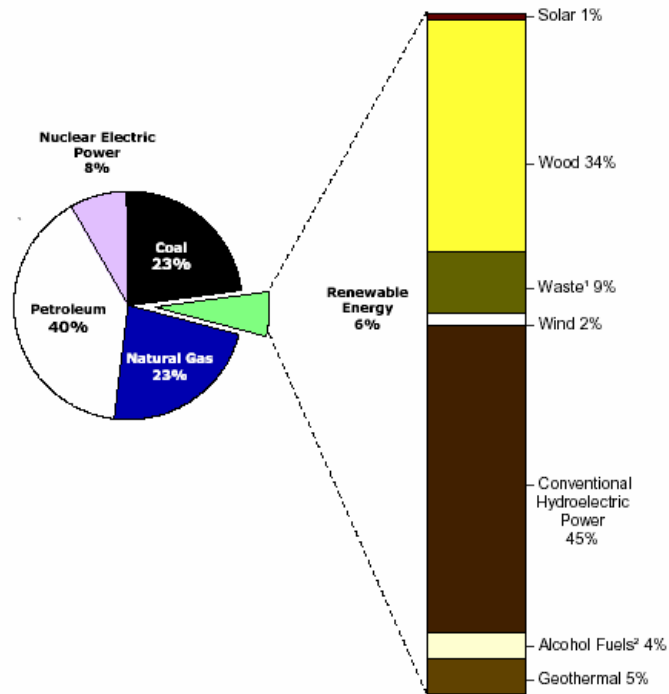


Figure 1. National Renewable Energy Percentages, 2003 (EIA, 2003)

(<sup>1</sup>Municipal solid waste, landfill gas, sludge waste, tires, agricultural byproducts, and other biomass)

### **Biomass and Bioenergy Inventories as a First Step**

Several national and state projects have been completed over the years in an attempt to inventory the available biomass either at a national, regional or state level. On the national front, Oak Ridge National Laboratory, the Energy Information Administration, the Office of Energy Efficiency and Renewable

Energy, as well as the University of North Dakota Energy and Environmental Research Center and the Energy Foundation have individually or collaboratively developed several biomass reports aimed at determining the raw tonnage and potential energy available within the country down to a regional and even state level (ORNL, 2005; ORNL, 1999; EIA, 2002; EERC, 2000, Energy Foundation, 2002). Several states also have taken the initiative to develop their own inventories including Wyoming, Ohio, Vermont, Connecticut, California, Minnesota, Oklahoma, New Mexico and in part Oregon and Colorado to name but a few (Fehrs, 2000; Leeper, 2004; McNeil Technologies, 2003; Turn et al, 2002; Zachritz and Lansford, 1990; PEMI, 2002; Hitzhusen, 2004; CEC, 2004; CTDA, 2002; NREL, 2005; Downs et al, 1991).

The majority of the inventories, however, differ from this present Washington State inventory in that they do not focus solely on under-utilized biomass or biomass ‘wastes’ and instead sometimes include energy crops such as poplar stands and switchgrass or cash crop biomass such as harvested timber and/or grain. In addition, most of the studies do not inventory as large a number of different waste types and do not count the biomass at a county level, with the county level exception being the studies by California and Wyoming. It should be noted that although biomass inventories can be beneficial to policy makers, scientists, and entrepreneurs in assisting to develop a more biobased economy, these inventories are mere snapshots into the recent past or present. Thus, when people choose to utilize the data to project policy or business plans ten to twenty years forward, it should be remembered that the data utilized is just a snapshot and as such is susceptible to future change.

### **State Concerns about Utilization of Biomass for Alternative Energy**

Washington State with its expanse of forests and its 8<sup>th</sup> place ranking in national crop production as well as its top 10 production in 36 differing commodities (WASS, 2004) has a vast annually renewable supply of biomass. In addition, because of the state’s broad climate range from rain forest to arid lands this supply is quite diverse in its form and location. This yields an even greater potential for an integrated biomass program focused on bioenergy, biofuels and bioproducts. Recognizing the importance of this natural asset, Washington’s federal and state legislative and executive leaders have called for increased attention to alternative energy; particularly from bio-resources. This focus is not only a result of the valuable supply, but because of recognition that biomass development for alternative energy and/or value-added use can potentially alleviate growing concerns about national security and our reliance on foreign oil, as well as simultaneously provide improved stewardship for our environment and new opportunities for local industries and jobs.

### **The Biomass and Bioenergy Inventory Project**

The Washington State Department of Ecology committed funds in 2003 to develop a preliminary biomass and bioenergy study for Eastern Washington. That report (WDOE, 2003) led to funding in 2005 for the completion of a full state biomass inventory and bioenergy assessment. The goal of the study was to inventory Washington’s bioresources as a first essential step for all related planning and implementation efforts. Information was collected on types and geographic distribution of biomass, which are needed for feasibility analysis and project prioritization. The project aimed at geographically identifying, categorizing, and mapping potential sources in Washington at a county level. The sources included field residues, animal manures, forestry residues, food packing/processing waste, and municipal wastes in each of the 39 counties throughout Washington and as mentioned earlier focused purposefully on perceived ‘waste’ streams (Table 1). WSU’s Department of Biological Systems Engineering undertook the biomass inventory designed across 45 unique organic resources. The biomass inventory was then converted to potential energy production using anaerobic digestion and simple combustion as representative conversion technologies. The products of the project include this report and a web accessible computer database complete with GIS maps on a Visual Basic platform (<http://www.pacificbiomass.org>) and a summary power point.

Table 1. Biomass Categories, Source Level of Raw Data, and Energy Conversion Approach

<b>Biomass</b>	<b>Source Level</b>	<b>Lignocellulosic (woody) Nature</b>	<b>Conversion Approach</b>
<i>Field Residue</i>			
Wheat Straw	County	Woody	Combustion
Grass Seed Straw	County	Woody	Combustion
Barley Straw	County	Woody	Combustion
Corn Stover	County	Woody	Combustion
Other Field Residue	County	Woody	Combustion
Mint Slug	County	Woody	Combustion
Hops Residue	County	Woody	Combustion
<i>Animal Manures</i>			
Dairy	County	Non-Woody	Anaerobic Digestion
Cattle	County	Non-Woody	Anaerobic Digestion
Horse	County	Non-Woody	Anaerobic Digestion
Swine	County	Non-Woody	Anaerobic Digestion
Poultry	County	Non-Woody	Anaerobic Digestion
<i>Forestry Residues</i>			
Logging Residue	County	Woody	Combustion
Forest Thinning	County	Woody	Combustion
Mill Residue	State Regional	Woody	Combustion
Land Clearing Debris	State, County	Woody	Combustion
<i>Food Packing/Proc.</i>			
Cull Onions	County	Non-Woody	Anaerobic Digestion
Cull Potatoes	County	Non-Woody	Anaerobic Digestion
Cull Apples	Regional, County	Non-Woody	Anaerobic Digestion
Cull Fruit	Regional, County	Non-Woody	Anaerobic Digestion
Asparagus Butts	County	Non-Woody	Anaerobic Digestion
Apple Pomace	Regional, County	Non-Woody	Anaerobic Digestion
Grape Pomace	State and County	Non-Woody	Anaerobic Digestion
Berry Pomace	County	Non-Woody	Anaerobic Digestion
Fruit Pomace	Regional, County	Non-Woody	Anaerobic Digestion
Cheese Whey	State and County	Non-Woody	Anaerobic Digestion
Potato Solids	County	Non-Woody	Anaerobic Digestion
Asparagus Trimmings	County	Non-Woody	Anaerobic Digestion
Mixed Vegetable Waste	County	Non-Woody	Anaerobic Digestion
Poultry Feathers	County	Non-Woody	Anaerobic Digestion
Poultry Meat Waste	County	Non-Woody	Anaerobic Digestion
Beef Meat Waste	State and County	Non-Woody	Anaerobic Digestion
Pork Meat Waste	State and County	Non-Woody	Anaerobic Digestion
Animal Mortality	National, County	Non-Woody	Anaerobic Digestion
Fish Waste	County	Non-Woody	Anaerobic Digestion
Shellfish Waste	County	Non-Woody	Anaerobic Digestion
<i>Municipal Solid Waste</i>			
Food Waste	County and State	Non-Woody	Anaerobic Digestion
Yard Non-Wood	County and State	Woody	Combustion
Yard Burn	County and State	Woody	Combustion
Other Organic	County and State	Non-Woody	Anaerobic Digestion
Paper	County and State	Woody	Combustion
Wood	County and State	Woody	Combustion
Yellow Grease	City and County	Non-Woody	Anaerobic Digestion
Brown Grease	City and County	Non-Woody	Anaerobic Digestion
Biosolids	County	Non-Woody	Anaerobic Digestion





# **C**hapter 2 - **R**esults

## Study Goals

WSU's Department of Biological Systems Engineering Agri-Environmental and Bioproducts Engineering (AEBE) research group, through funding from the Department of Ecology, the Northwest Biosolids Management Association, the City of Tacoma and Kitsap County, developed the Biomass Inventory and Bioenergy Assessment of Washington State. The goal of the project was to provide impetus towards development of a sustainable economy for the State of Washington; one based on a core tenant of Ecology's *Beyond Waste Plan*, 'zero waste'. It is hoped that this report and its findings can act as a first step for legislators, policy-makers, entrepreneurs, industry, farmers, researchers and concerned citizens in their effort to develop a new economy based on sustainable resources and renewable energy accomplished in part by the conversion of Washington's under-utilized biomass into value-added energy, fuels and bioproducts.

Important parameters of the study are as summarized:

- Unlike other national and state inventories this study concentrated its resources on inventorying only the under-utilized, 'waste' biomass resources and focused at a county level. As such, items like dedicated energy crops from poplar stands, switchgrass, and wheat grain were not inventoried. Note also that some inventoried items are already quite effectively utilized for energy such as the mill residues for industrial energy production, but other inventoried items, such as animal manures which although used to some extent as a field fertilizer, can be described as under-utilized at least in terms of a direct energy source. All waste types were inventoried in hopes of not only delineating the potential energy that could be derived from the individual waste type, but in also recognizing that higher value uses may be found through combined waste processing, synergistic applications, and secondary and tertiary value added "refinery" processes that would not be apparent without a combined inventory.
- The inventory was designed to give readers concrete, useful information in regard to type, amount and location of biomass and as such did not attempt to discern economic viability through analysis of such issues as collection, transportation, and processing costs. Future economic and cost studies are necessary to build upon this inventory.
- The bioenergy calculations were based upon simple combustion of the woody and straw-like biomass and anaerobic digestion of the wet manures, municipal and processing waste. Although numerous conversion technologies exist, some of which have environmental and 'zero waste' potentials beyond that of combustion in particular, these two technologies were chosen for both their best fit into the two main categories and their simplicity of calculation. This should not be taken as an endorsement for either technology or as a rebuff of other technologies. In fact it is more than likely that any renewable energy initiatives will include multiple technologies, including conversion to liquid fuels to replace fossil fuels. Final selection will need to best fit the different types of biomass streams to social, economic and environmental benefits. Additional work is needed to assemble criteria and evaluate "best fit" technologies.
- Electrical energy production was the calculated product for this study, however numerous other products such as fuels and chemical bioproducts are possible, and even more likely as valuable and viable products. Thus, any future studies and business plans building upon this study should emphasize the need for a well-researched biorefinery approach which leads to multiple co-products, increased distributed business opportunity, expanded market access and strives to achieve 'zero waste'.
- Lastly, the inventory not only shows potentials for biomass and bioenergy, but in the analysis process it has also proven useful as a tool to measuring where information or communication is lacking both within the public and private sectors in regard to tracking our state's biomass. It is hoped that lessons learned from this study will aid in the development of new avenues of

communication, more efficient release of proprietary information, and new data streams so that even greater strides can be made in reaching a truly sustainable state economy.

- Because of the difficulty in obtaining some county level information or in obtaining proprietary information several waste types were inventoried at a state level and brought down to a county level through utilization of such factors as population. This was particularly evident in some of the processing wastes although wherever possible specific county data was utilized. Table 1 summarizes the level at which source information was obtained for each of the inventoried biomass items. Specific information on the criteria and information used to determine the biomass for each inventoried item is available in Chapter 3 of the report.
- Although some reports, such as the California report divided their inventory into gross as well as collectible amounts, this report generated only a waste specific total. In particular, this total attempted to quantify available biomass taking by into consideration soil tilth as related to field residue (the amount of residue needed for sustaining productive soils). Field residue determinations took into account a residue collection factor since soil productivity protection as supplied by retention of some of the residue was deemed extremely important. In addition the report also took into account an animal manure collection factor so as to only inventory manures produced in concentrated areas and not in pastures. For more details on the specific assumptions made for each of the inventoried biomass items please refer to the details in Chapter 3.

### **Inventory Methodology**

A five-step method was used for inventorying and determining the biomass and potential electrical energy from Washington's biomass. First, agriculture, processing and municipal statistics and databases along with personal interviews with agriculture and processing leaders led to the development of a biomass inventory for the main biomass categories and their 45 inventoried biomass types. These databases were, wherever possible, averaged across multiple years (i.e. 2000-2004) to gain a more long-term representative number. Some inventoried items did not have data available across multiple years and in those cases, wherever possible, data was collected from the most recent year possible with all inventory years being within the last five years (refer to chapter 3 for specifics). Second, the resulting biomass figures were adjusted according to their respective moisture content and expressed as dry matter tons. Third, woody or straw-like materials with a high lignocellulosic content were evaluated for potential energy production using combustion as a conversion technology. Heat value coefficients were determined for each individual woody or straw-like material and used to calculate the potential electrical energy and power using a reference-based average of 20% conversion efficiency that exists for non-combined heat/power combustion systems (CEC, 2004; Wilbur, 1985; Klass, 1993; and Chartier, 1992). Fourth, the wet biomass, represented largely by the animal manures and processing wastes, was evaluated for potential electrical energy production using anaerobic digestion as its representative conversion technology. In this process, the dry biomass was converted to available volatile solids and ultimately potential methane production using laboratory determined coefficients for each of the biomass types. From the methane production levels, estimates of electrical energy and power production were developed using a reference-based average of 30% conversion efficiency that exists for generator-set biogas systems (CEC, 2004; Wilbur, 1985; Klass, 1993; and Chartier, 1992). Lastly, the biomass and bioenergy databases at state and county levels across the varying categories were mapped on GIS and made web-accessible through a Visual Basic directory. This report and its companion web-accessible GIS maps and database, both available at <http://www.pacificbiomass.org>, were deliverables of the study.

### **Results**

Study results show that Washington State has an annual production of over 16.9 million tons of underutilized dry biomass which is capable of producing, via assumed combustion and anaerobic digestion, over 15.5 billion kWh of electrical energy or 1,769 MW of electrical power. Figure 2 represents the break down of these numbers into two categories; woody, lignocellulosic material that used

combustion as a representative conversion technology for its calculation of energy and non-woody, wet material that used anaerobic digestion as a representative conversion technology for its energy calculation.

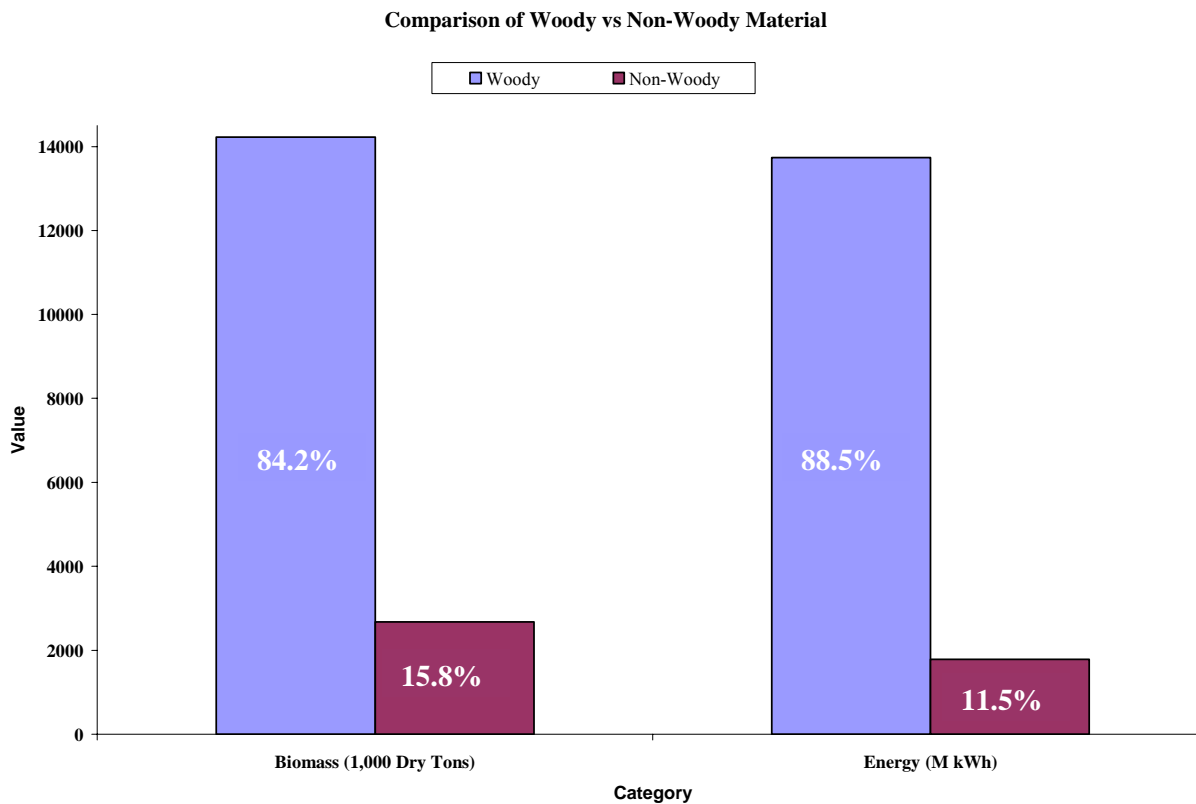


Figure 2. Woody vs Non-Woody Percentages

As can be seen, the majority of the biomass and resulting energy is a result of the woody biomass and resulting conversion of that biomass. Much of this woody biomass total is a result of forestry and field residues that are quite dispersed and therefore difficult to collect and process. However, some forms of the woody biomass are more concentrated such as the mill residues and the municipal yard and wood debris.

The electrical energy total of 15.5 billion kWh is equivalent to just about 50% of Washington State’s annual residential electrical consumption. The percentage of electrical energy consumption need met by the biomass as both a total and against the woody and non-woody categories is given below in Table 2 (EIA, 2003).

Table 2. Comparison of Biomass Energy Production and State Electrical Consumption

Biomass Inventory Results	Electrical Energy (billion kWh)		
	Biomass Total	Woody	Non-Woody
	15.5	13.7	1.8
State Energy Total (Yr. 2001)	31.6	31.6	31.6
% Available from Biomass	<b>49%</b>	43%	6%

This 16.9 million ton biomass value is of particular note, not just because of its huge mass and potential for electrical production, but in how it differs from the 1999 Biomass Feedstock Availability in the US report by DOE-ORNL and the 2004 Billion Ton report which in part utilizes ORNL numbers (ORNL, 1999; DOE, 2005). In the 1999 nation-wide report, Washington State’s inventory was capped, utilizing their highest cost supply curve, at having almost 10 million dry tons of available biomass, which is significantly lower than the value determined within this report. This shows the significance of doing a more specific state inventory instead of relying on a nation-wide report that struggles to identify the uniqueness of each state. One reason for the disparity in the results is that the national inventory only concentrated on five key categories (forest residue, mill residue, agricultural field residue, energy crops, and urban wood waste) while this inventory broadened many of these categories and in addition included the categories of animal waste, food packing/processing, and municipal waste. Below is Figure 3 which compares the values obtained by the two different inventories across the categories that were in common with approximately 5.5 million tons of other biomass, represented by animal manures, food packing/processing and non-wood municipal solid waste (reported as other), not being incorporated into the ONRL report.

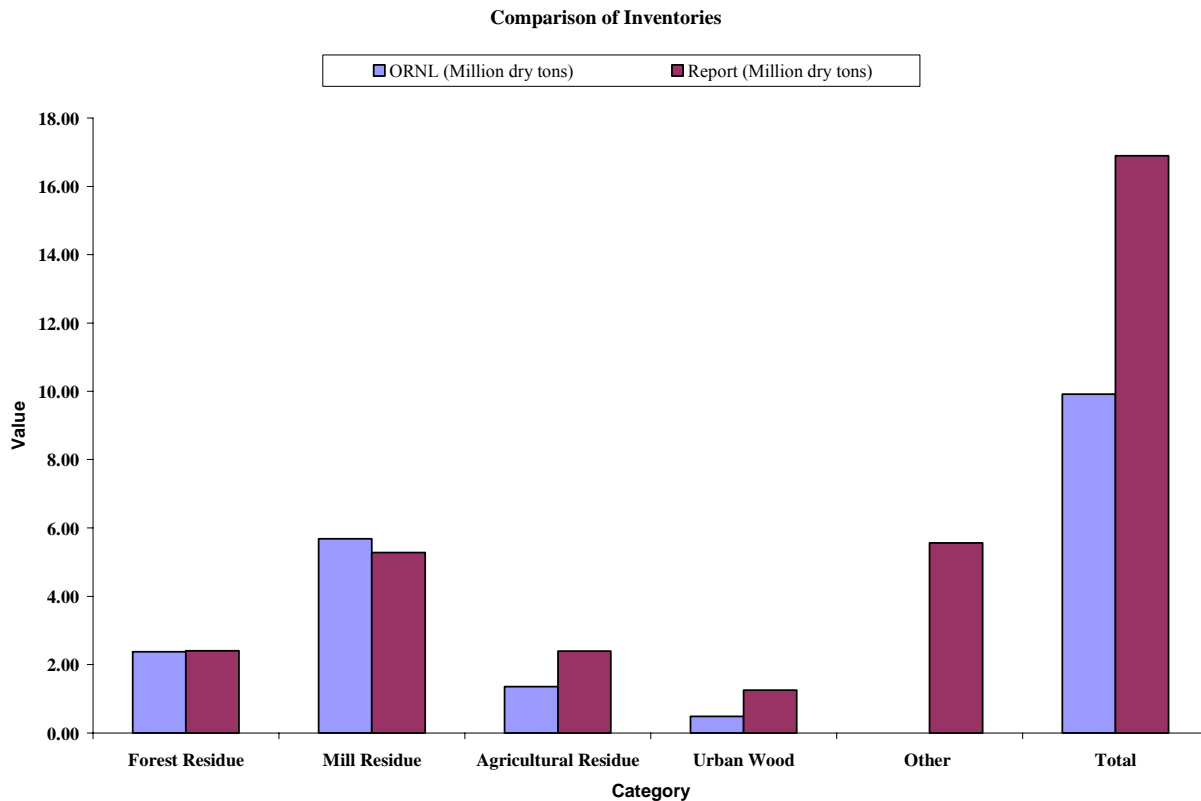


Figure 3. Comparison of Inventory Results between 1999 ORNL and 2005 Washington State Inventory (Other biomass represents total of animal manures, food packing/processing and non-wood MSW)

Figure 4 shows that the forestry category at 49% is by far the largest contributor to the state biomass followed by municipal with 24%, field with 14%, and animal waste at 11% as the next most important, respectively. The distribution of energy by category almost mirrors total biomass with the notable exception being the animal manure category which has a significant reduction in energy produced because of the lower productivity of the anaerobic digestion process with regard to horse manure. Particularly noteworthy is the fact that the largest contributors to the biomass, the woody and straw residue are the least concentrated of the wastes and as a result will be more difficult to collect and

process. Conversely, the more concentrated streams, as represented by the animal manures and municipal/processing wastes, are lower in overall quantity and often of a lower energy conversion quality because of their mixed and wet nature.

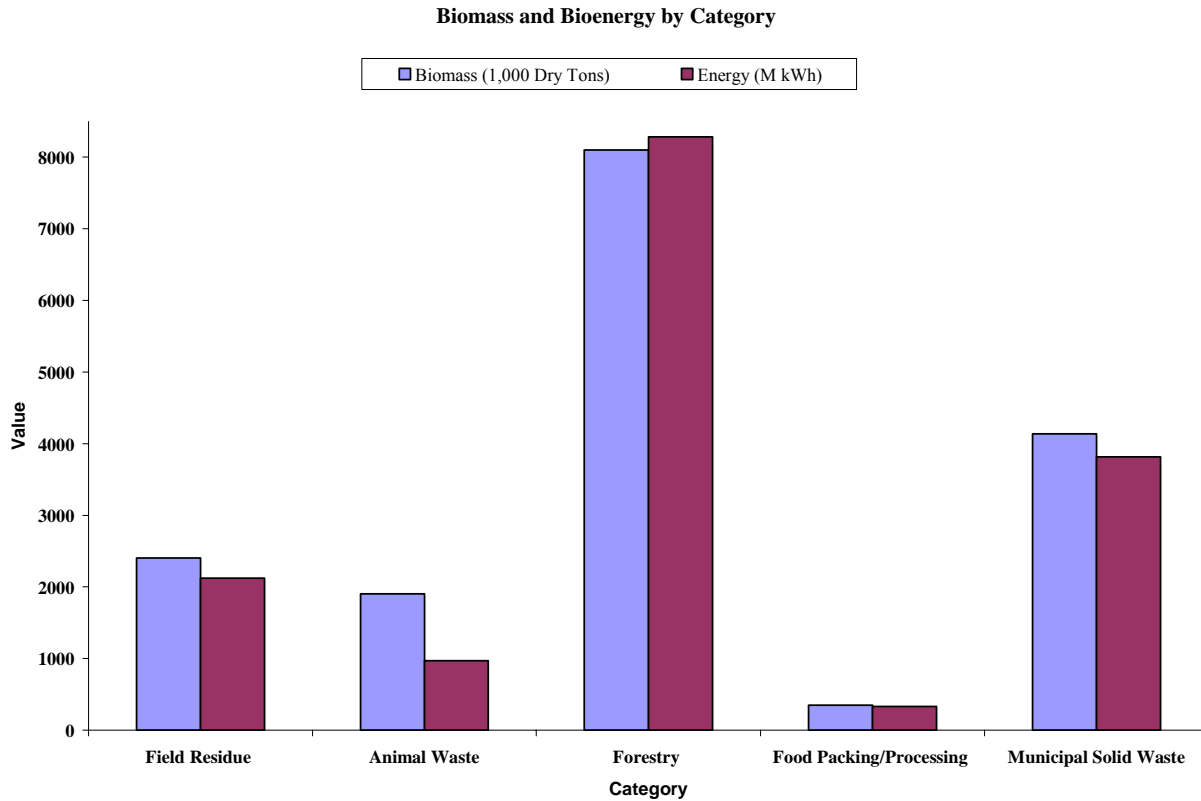


Figure 4. Biomass and Bioenergy by Category

Figure 5 differs from Figure 4 in that the biomass and bioenergy are related to county instead of category. Figures 6 and 7 show biomass quantity and energy potential by county on GIS maps. Figures 5 through 7 show areas of concentration where forestry intersects with another important category. These include the intersection of forestry with high municipal solid waste in populated counties and regions like Pierce, King, and Snohomish as well as the intersection of forestry and agriculture in the counties of Yakima, Lewis and Cowlitz. Note that King, Pierce, Snohomish, and Yakima represent almost 30% of the state's total biomass. More specifically, these maps and their concentrated areas hint at possible locations for regional biomass conversion facilities such as locations along the Cascade Range, within the Yakima and Columbia Basin and lastly, on the eastern edge near Spokane County.

A more in depth analysis, though, points the reader towards the large influence mill residue and MSW paper have on the totals and maps generated. This is evidenced both by seemingly odd discrepancies in county totals and in the resulting emphasis towards concentration on the Cascade Range which is high in both mill residue and MSW paper because of the expansive forests and high population. An example of a discrepancy within the totals and maps is the large totals brought by Clallam and Grays Harbor counties on the Olympic Peninsula while Jefferson County, sandwiched between them, has a relatively low total, even though all three counties are relatively similar in terms of forested land.

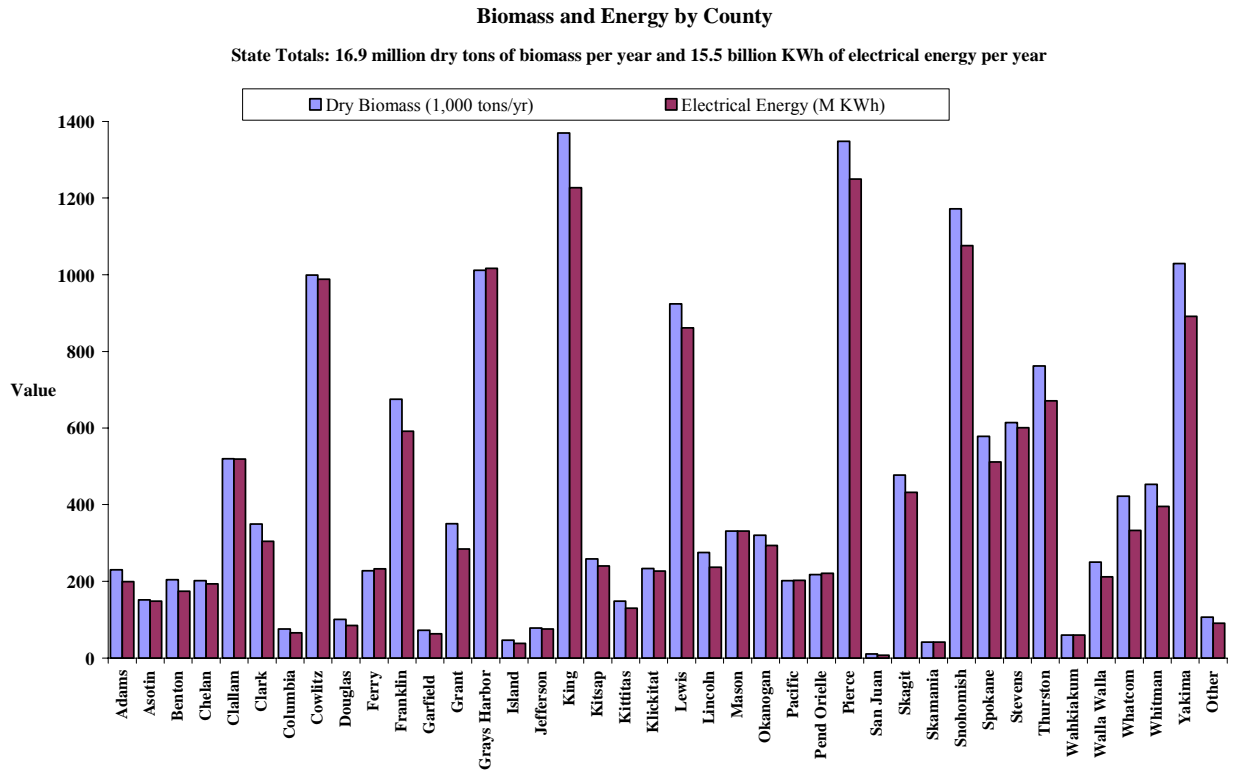


Figure 5. Biomass and Energy by County (Other results from agricultural databases that inventory negligible county totals within the other category)

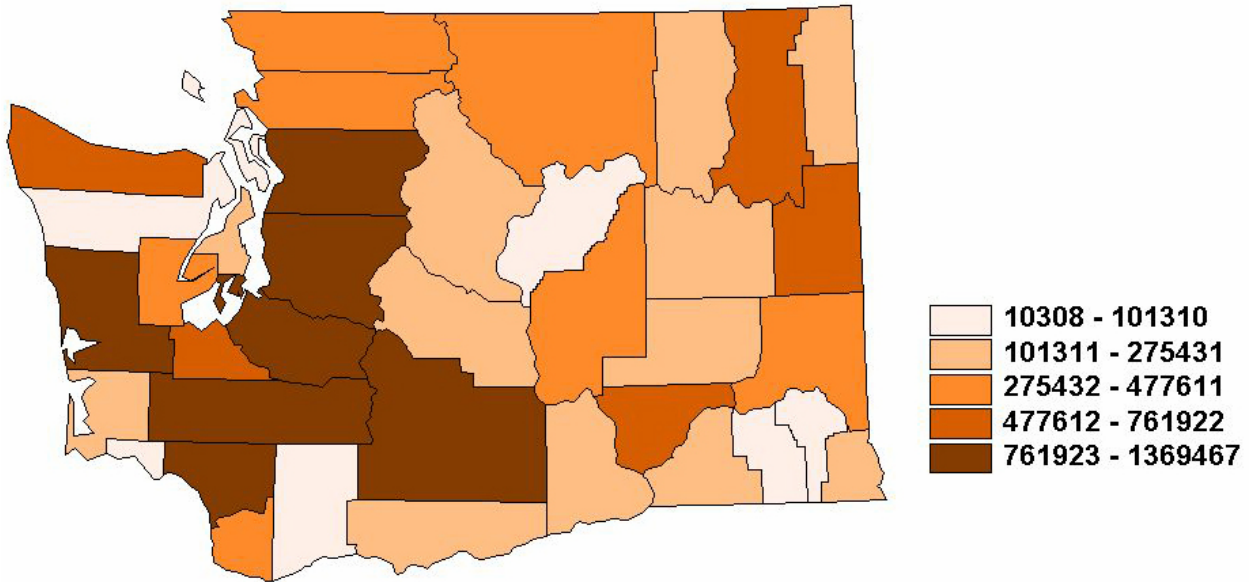


Figure 6. Biomass by County and Region (Biomass in dry tons)

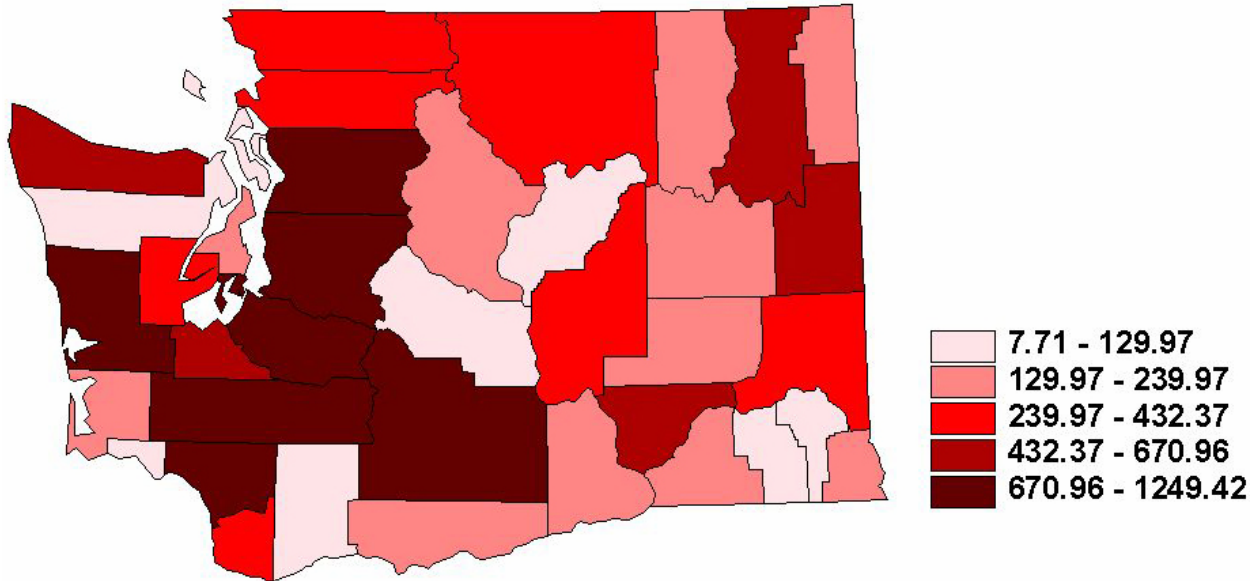


Figure 7. Bioenergy by County and Region (Bioenergy in M kWh)

The question then arises as to why the difference, which can potentially be answered in the fact that mill residues from nearby forested lands might disproportionately end up in certain counties because of the presence of more mills in that particular county. Thus, mill residue, as a very large residue waste type, can noticeably skew the totals and maps generated, much more than other inventoried items that represent a much smaller percentage of the overall total. This skewing can also be attributed to the next largest inventoried item in terms of total biomass percentage, MSW paper. Thus, a GIS map of the biomass totals minus mill residue and MSW paper has been generated in Figure 8 for comparison purposes. Another reason for the interest in viewing the county totals without these two inventoried items is because, of all of the inventoried items, it is mill residue and MSW paper that already have the greatest success at being utilized for either their energy or recycling as a bioproduct.

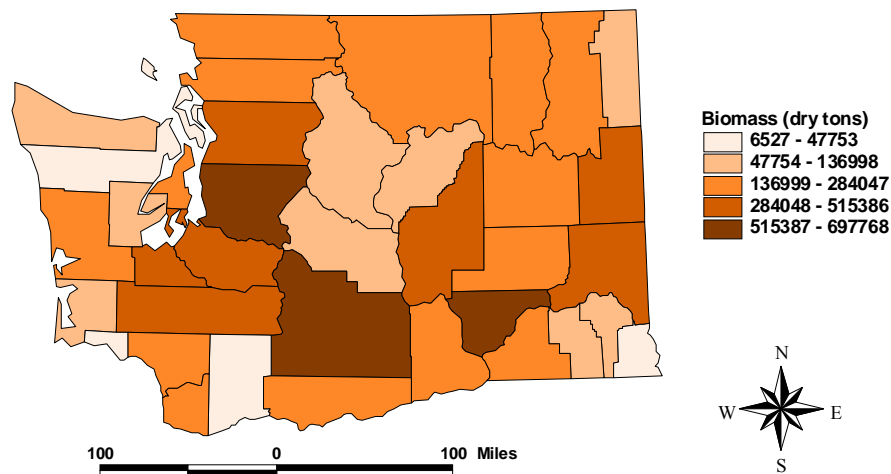


Figure 8. Biomass by County and Region without Mill Residue and MSW Paper (Biomass in Dry Tons)



Although Figure 8 does not differ much from Figure 6 it does show: (1) a representation of the biomass without the large effects of the two already well utilized items, mill residue and MSW paper; (2) offers a new perspective on some of the possible skewing or distortion that might have been caused by the placement of mill residue within particular county mills; and (3) gives an hint at the agricultural strength of some of the counties that otherwise might not have been seen. Please consult the Visual Basic inventory of maps that reside at [www.pacificbiomass.org](http://www.pacificbiomass.org) if there is interest in seeing other types of GIS maps by inventoried item, category or county.

## Summary

The overarching conclusions to be drawn from the biomass and bioenergy inventory are bulleted below and it is sincerely hoped that findings and conclusions from this Phase I inventory can lead to future studies that will more clearly look at the economics as well as the best suited conversion technologies for development of a biomass and bioenergy industry in Washington State:

- The state is blessed with a vast and diverse, annually renewable biomass, which although in places is presently utilized for energy, fertilizer and feed, in other places is still quite under-utilized and capable of being a significant factor in bioenergy, biofuel, or bioproduct production.
- Potential energy from this biomass using anaerobic digestion and combustion shows a total energy that meets about 50% of the state's residential energy need. When referring to this statistic recognition, though, must be given to its assumptions of: economically viable collection of the entire inventoried mass, no inclusion of entire process energy costs, assumed attainment of identified conversion parameters, no generator down time, and no factoring of transmission losses.
- The biomass total is heavily sided to disperse lignocellulosic (woody) waste which is both difficult to collect and to process for energy, particularly without serious concerns to pollution. Conversely, about 15% of the available biomass is in the form of more readily biodegradable and concentrated waste streams represented by some of the items within the municipal solid, animal manure and food processing wastes. This breakdown will have significant impact on the overall economics as well as the specifics of collection and type of conversion technology utilized.
- Regional and county distribution as well as notable areas of concentration center around areas that link significant contributions from forestry and municipal or forestry and agriculture. Thus, the heavy concentration around the Puget Sound/Cascade and Yakima areas and as stated early the disproportionate influence of forestry and paper residues on the totals and maps generated.
- The diversity of the waste streams opens the door to a potential bioproducts industry along side an exclusive bioenergy or biofuels industry. Contrary to some of the Midwest state's inventories that are much less diverse in their sources, Washington State could be well positioned to pursue a dual track which focuses on generating high value co-products from some of the concentrated, starch-based wastes while simultaneously devising collection and energy/fuel conversion capabilities for the lignocellulosic forestry and straw residues



# **C**hapter 3 - **B**iomass Inventory

# Wheat Straw



**State Total~ 1,614,234 dry tons**

## Biomass Data Collection

Wheat straw residue values were obtained by averaging the county production of wheat in terms of yield and acre for the years 2002-2003 (WASS, 2004) and then using a conversion equation from wheat to straw (lbs straw/acre = 69.76 X yield/acre + 1,067.7) to get total straw production (WSUCEEP, 2001). A sustainable collection factor of 25% was used across the board for all wheat fields to get an estimate of the potential harvestable straw with respect to conservation concerns ([www.fiberfutures.org](http://www.fiberfutures.org)). A moisture content of 28% for wheat straw was used to determine a final dry biomass (Klass, 1998).

*The final calculation was  $\{(69.76 \times \text{yield/acre} + 1,067.7) \times \# \text{ acres}\} / 2,000 \times 0.25 \times 0.72$*

## Data Collection Concerns and Comments

A primary concern with the data collection for wheat straw is the choice of an acceptable sustainability collection factor. The USDA NRCS advocates the use of their CORE4 guide which uses production values and tillage practices as a guide for what can acceptably be removed from the field (NRCS, 1999) while quick and fast ‘rules of thumb’ of 5,000 pounds removed/acre down to 3,000 pounds removed/acre were advocated from numerous personal conversations with soil and tillage scientists. The problem with the use of the rule of thumbs is that, by applying a constant value like 5,000 lbs/acre across the varied moisture level fields of Eastern Washington, what arises in places is extreme values. Thus, given the nature of this study and the difficulty in applying the NRCS guide to all the varied tillages and productions, Fiberfutures evaluation of a 25% across the board collection was decided upon. Note, though, that although the choice is deemed warranted for an overall state snapshot, there is the potential for high moisture fields to have an excess of straw while low moisture fields will be hard pressed to even supply the asked for 25%.

## Data

<i>Tons of Dry Biomass—1,614,234</i>							
Adams	120,407	Franklin	531,051	Lewis		Snohomish	4,427
Asotin	8,943	Garfield	33,974	Lincoln	173,687	Spokane	61,492
Benton	38,454	Grant	100,353	Mason		Stevens	2,863
Chelan		Grays Harbor		Okanogan	3,437	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	120,912
Columbia	47,689	King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	264,460
Douglas	66,375	Kittitas		Skagit	4,044	Yakima	13,692
Ferry		Klickitat	13,226	Skamania		Other	4,748

# Grass Seed Straw



**State Total~ 134,640 dry tons**

## **Biomass Data Collection**

Grass seed straw residue values were obtained by averaging and adding the county production of bluegrass, alfalfa and other seed crops in terms of acres for the years 2000-2003 (WASS, 2004). The amount of sustainable residue was determined by using a ratio of 2.2 tons residue per acre planted (Johnston, 2004). A moisture content of 20% for grass seed crop residue was used to determine a final dry biomass (Johnston, 2004).

*The final calculation was  $(\sum \text{average total acres for seed crops}) \times 2.2 \times 0.80$*

## **Data Collection Concerns and Comments**

The use of this flat residue factor is again potentially not taking into account the varied moisture in the fields across the state and as such some areas might be inventoried as collecting too much residue while others would be collecting too little. In addition the residue factor was taken from a study about bluegrass seed and applied to other seed crops such as alfalfa.

## **Data**

<i><b>Tons of Dry Biomass—134,640</b></i>							
Adams	7,040	Franklin	12,892	Lewis		Snohomish	
Asotin		Garfield	3,608	Lincoln		Spokane	41,800
Benton		Grant	8,756	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	13,376
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	7,876
Douglas		Kittitas		Skagit		Yakima	
Ferry		Klickitat		Skamania		Other	39,292

# Barley Straw



**State Total~ 318,522 dry tons**

## Biomass Data Collection

Barley straw residue values were obtained by averaging the county production of barley in terms of yield for the years 2000-2003 (WASS, 2004) and then calculating collectible barley straw using the equation: barley straw = yield (tons/yr) x residue factor (2.5) x available factor (0.25) (Klass, 1998)(Fiberfutures, 2004). Since the agricultural harvest statistics were given in number of bushels, conversion factors for bushel to cubic foot (0.8036:1) and bulk density of barley seed (40.5 pounds/cubic foot) were used to determine number of tons (SMICO, 2004). A moisture content of 9% for barley straw was used to determine a final dry biomass (Klass, 1998).

*The final calculation was average barley seed yield in tons x 2.5 x 0.25 x 0.91*

## Data Collection Concerns and Comments

Once again the primary concern is the use of an across the board residue factor that is being applied to a variety of fields with various yield potentials due to certain soil and moisture conditions, thereby creating a situation where certain fields and counties will have an over or under reporting of available, sustainable straw.

## Data

<i>Tons of Dry Biomass—318,522</i>							
Adams	5,654	Franklin		Lewis		Snohomish	
Asotin	4,278	Garfield	22,090	Lincoln	76,202	Spokane	29,866
Benton		Grant	4,977	Mason		Stevens	3,021
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	12,795
Columbia	15,708	King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	133,905
Douglas		Kittitas		Skagit		Yakima	527
Ferry		Klickitat	2,498	Skamania		Other	7,001

# Corn Stover



**State Total~ 73,502 dry tons**

## Biomass Data Collection

Corn stover residue values were obtained by averaging the county production of corn in terms of yield and for the years 2000-2003 (WASS, 2004) and then using a conversion equation from corn to straw (tons/yr of collectible corn stover = yield (tons/yr) x residue factor (1.1) x available factor (0.25)) to get total straw production (Klass, 1998)(Fiberfutures, 2004). Since the agricultural harvest statistics were given in number of bushels, conversion factors for bushel to cubic foot (0.8036:1) and bulk density of corn ear (56.0 pounds/cubic foot) were used to determine number of tons (SMICO, 2004). A moisture content of 47% for corn stover was used to determine a final dry biomass (Klass, 1998).

*The final calculation was yield x 1.1 x 0.25 x 0.53*

## Data Collection Concerns and Comments

Production grain corn, not silage corn, was the only inventoried item. Also, again a concern is the use of an across the board residue factor that is being applied to a variety of fields with various yield potentials due to certain soil and moisture conditions, thereby creating a situation where certain fields and counties will have an over or under reporting of available, sustainable straw.

## Data

<i>Tons of Dry Biomass—73,502</i>							
Adams	3,530	Franklin	8,537	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant	23,371	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	10,199
Ferry		Klickitat		Skamania		Other	27,865

# Other Field Residue



State Total~ 159,174 dry tons

## Biomass Data Collection

Other field residue values from controlled and permitted burns were obtained from data already compiled by the Department of Ecology Air Quality Program using 2002 permitting data (WAEAQP, 2004). The controlled field burns were primarily due to burns of cereal grains, clearing of grasslands, pastures and CRP land, orchard tear-outs and orchard thinnings. The methodology used by the WAEAQP was to calculate tons of residue burned by multiplying the acres burned x fuel loading factor x fuel consumption factor. The number of acres burned, fuel loading factors, and fuel consumption factors were supplied by review of the actual permits or by supply of parameters by the local air quality departments. A moisture content of 20% for the miscellaneous woody/grassy mixture was used for final calculation of the dry mass.

*The final calculation was  $[\sum(\text{acres burned} \times \text{fuel loading factor} \times \text{fuel consumption factor})] \times 0.80$*

## Data Collection Concerns and Comments

The primary concern here was the choice of an acceptable moisture value for conversion to dry value numbers. A moisture content of 20% was chosen in the end because of the high wood content of the overall burn due to the large contribution from orchard tear outs and thinnings. There also is the potential here for some double reporting as some of the controlled burn numbers arise from already inventoried potential straw productions from grass seed crops.

## Data

<i>Tons of Dry Biomass—159,174</i>							
Adams	8,823	Franklin	12,542	Lewis		Snohomish	
Asotin	28	Garfield	1,061	Lincoln	622	Spokane	
Benton	4,942	Grant	20,282	Mason		Stevens	
Chelan	2266	Grays Harbor		Okanogan	10,025	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	16,853
Columbia	4,611	King		Pierce		Whatcom	45
Cowlitz		Kitsap		San Juan		Whitman	9,751
Douglas	1,779	Kittitas	881	Skagit	282	Yakima	64,381
Ferry		Klickitat		Skamania		Other	

# Mint Slug



**State Total~96,878 dry tons**

## Biomass Data Collection

Mint slug values were obtained by averaging county production for the years 2000-2004 (WASS, 2004). A personal interview with FarWest Spearmint showed that 50 pounds of dry residue is produced per pound of distilled mint.

*The final calculation was county total x 50*

## Data Collection Concerns and Comments

The primary concern here was using the identified ratio of 50 pounds of dry residue per pound of distilled mint. Although this ratio was given by the Mint Commission it was in their minds only an estimation based upon farming and distillation experience and not based on hard science. Also, the distillation and subsequent storage of the mint slug was assumed to be within the county from which it was grown which is not necessarily true.

## Data

<i>Tons of Dry Biomass—96,878</i>							
Adams	32,765	Franklin		Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	6,388	Grant	20,737	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	36,988
Ferry		Klickitat		Skamania		Other	



# Hops Residue



**State Total~5,400 dry tons**

## Biomass Data Collection

Hops residue values were obtained by averaging state production for the years 2000-2003 (WASS, 2004). A personal interview with USA Hops showed that there is an 80-20% split in total state production between Yakima and Benton counties and that 50% of the total harvest becomes residue. A moisture level of 73% was used to determine total dry matter (USA hops, 2002).

*The final calculation was county hops production total x 0.27*

## Data Collection Concerns and Comments

Like the mint ratio the ratio of 50% harvest being residue was not one of scientific determination but based upon general farming and processing experience.

## Data

<i>Tons of Dry Biomass—5,400</i>							
Adams		Franklin		Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	1,080	Grant		Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	4,320
Ferry		Klickitat		Skamania		Other	

# Dairy Manure



**State Total~ 457,032 dry tons**

## Biomass Data Collection

Dairy manure values were obtained by first taking the average county production for the combined total of milkers and calves for the years 2000-2003 and sub-dividing this total into 87% milkers and 13% calves (WASS, 2004). Then, dry manure values of 13.1 lbs/cow day and 3.66 lbs/cow day for the respective milkers (1,200 lbs) and calves (330 lbs) were multiplied to the sub-category totals and added to get the overall production of dry manure (USDA, 1985). An 85% collection availability factor was used for the state and its preponderance of medium to large confined animal operations (Jaycor, 1990).

*The final calculation was  $\{[(county\ total\ x\ 0.87)\ x\ 13.1\ x\ 365] + [(county\ total\ x\ 0.13)\ x\ 3.66\ x\ 365]\}/2000\} x\ 0.85$ .*

## Data Collection Concerns and Comments

Bedding was not inventoried in this report as most of the bedding would either be from an inorganic nature like sand or from an organic recyclable that has already been counted in the inventory like straw, wood chips or composted fibrous solids.

## Data

<i>Tons of Dry Biomass—457,032</i>							
Adams	10,385	Franklin	10,421	Lewis	16,645	Snohomish	32,553
Asotin		Garfield		Lincoln		Spokane	4,235
Benton		Grant	25,813	Mason		Stevens	4,542
Chelan		Grays Harbor	6,186	Okanogan		Thurston	18,817
Clallam	1,657	Island	2,900	Pacific	3,424	Wahkiakum	884
Clark	7,549	Jefferson	1,382	Pend Oreille		Walla Walla	
Columbia		King	24,414	Pierce	10,090	Whatcom	113,751
Cowlitz	1,382	Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit	32,258	Yakima	115,224
Ferry		Klickitat	2,025	Skamania		Other	10,495

# Cattle Manure



**State Total~ 242,404 dry tons**

## Biomass Data Collection

Cattle manure values were obtained by first taking the average county production for the combined total of cattle and calves for the years 2000-2003 and sub-dividing this total into 87% cattle and 13% calves (WASS, 2004). Then, dry manure values of 5.52 lbs/cow day and 1.39 lbs/cow day for the respective cattle (793 lbs) and calves (200 lbs) were multiplied to the sub-category totals and added to get the overall production of dry manure (USDA, 1985). Jaycor (1990) determined that on average cattle on farm is confined 10% of the time and that the manure is 65% collectible, giving an overall collection rate of 6.5%. However, WASS (2004) statistics show that on average throughout the year 18% of the total Washington cattle are housed within feedlots where collection was assumed to be 97% collectible (NRC, 1983). Thus, the overall combination of collections within on farm and feedlot locations for the life of the cow is assumed to be 22.8%.

*The final calculation was then  $\{[(county\ total\ x\ 0.87)\ x\ 5.52\ x\ 365] + [(county\ total\ x\ 0.13)\ x\ 1.39\ x\ 365]\}/2000\ lbs/ton\} \times 0.228$*

## Data Collection Concerns and Comments

Bedding was not inventoried in this report as most of the bedding would be from an organic recyclable that has already been counted in the inventory like straw, wood chips or composted fibrous solids. This also, is the first instance of an inventory item which will unfortunately occur in other future items, where the item inventoried is perhaps not correctly housed within the county where the waste is developed and stored. More specifically, the cattle when housed on farm will be producing manure within the county they were inventoried in, but they perhaps will be moved to a feedlot outside of their county where they will then be supplying a manure stream in another county as opposed to in the same county which is assumed in this report. The reason for not reporting this change in location here and as well with the other inventoried items with similar concerns is that accurate numbers were not made available or were requested to not be made available due to concerns of a proprietary and commercial interest.

## Data

<i>Tons of Dry Biomass—242,404</i>							
Adams	7,363	Franklin	9,930	Lewis	6,637	Snohomish	7,300
Asotin	2,487	Garfield	1,880	Lincoln	5,805	Spokane	5,058
Benton	5,055	Grant	33,509	Mason	333	Stevens	7,422
Chelan	309	Grays Harbor	2,115	Okanogan	10,555	Thurston	5,184
Clallam	975	Island	933	Pacific	1,494	Wahkiakum	810
Clark	3,588	Jefferson	663	Pend Oreille	1,098	Walla Walla	16,016
Columbia	1,505	King	4,665	Pierce	3,567	Whatcom	22,291
Cowlitz	996	Kitsap	333	San Juan	621	Whitman	4,332
Douglas	2,385	Kittitas	6,822	Skagit	7,152	Yakima	43,853
Ferry	2,010	Klickitat	5,248	Skamania	105	Other	

# Horse Manure



**State Total~ 407,160 dry tons**

## Biomass Data Collection

Horse manure values were obtained by applying King County findings to the 2002 USDA NASS Washington State county horse data (King County, 2004; NASS, 2004). King County characterized the horse waste situation within their county through a statistical analysis of a county-wide survey. Their findings estimated the county horse population to be around 20,000 which was four times higher than that reported by NASS in the 2002 census. Further validation of the need for increasing the NASS horse numbers came from personal communications with Snohomish County (Bobbi Lindemulder, Snohomish CD) which echoed the existence of a large number of hobby farms and horse farms that far exceed that stated by NASS and which potentially could be higher than the previously mentioned four multiplication factor. Thus, county wide NASS horse numbers were increased by a factor of 4 and then converted into manure values by assuming 11 lbs dry manure/horse day, 22% solids content, and a collection rate of 67% (King County, 2004).

*The final calculation was (# of horses/county from NASS x 4 x 11.0 x 0.67)/2,000*

## Data Collection Concerns and Comments

Bedding was not inventoried in this report as most of the bedding would be from an organic recyclable that has already been counted in the inventory like straw, wood chips or composted fibrous solids. Of most concern is the lack of data on a county, state and national level in regards to horse numbers. King County specifically funded a horse waste characterization report because of this concern with the results validating the hypothesis for larger than reported numbers. The lack of horse and horse waste data belies a larger problem in regard to hobby farms in general, especially within the fast growing rural/suburban areas of Washington's four large western counties. Further research will be needed to get a better handle on the exact horse and hobby farm numbers within the state and its counties.

## Data

<b>Tons of Dry Biomass—407,160</b>							
Adams	2,733	Franklin	6,569	Lewis	15,554	Snohomish	26,400
Asotin	2,319	Garfield	1,469	Lincoln	7,597	Spokane	30,252
Benton	13,095	Grant	15,758	Mason	2,701	Stevens	18,491
Chelan	4,498	Grays Harbor	4,347	Okanogan	27,352	Thurston	19,578
Clallam	4,998	Island	3,804	Pacific	1,727	Wahkiakum	732
Clark	18,470	Jefferson	2,071	Pend Oreille	3,443	Walla Walla	7,295
Columbia	1,754	King	26,901	Pierce	24,861	Whatcom	12,643
Cowlitz	5,735	Kitsap	9,883	San Juan	1,867	Whitman	4,885
Douglas	3,992	Kittitas	20,170	Skagit	7,258	Yakima	30,215
Ferry	6,774	Klickitat	8,205	Skamania	764	Other	

# Swine Manure



**State Total~ 13,632 dry tons**

## Biomass Data Collection

Swine manure values were obtained by finding the average number of pigs per county over the years 1999-2003 (WASS, 2004) and then multiplying this by a manure production factor of 0.9 lbs/swine day assuming an average swine weight of 150 pounds (USDA, 1985). Lastly, the manure total was assumed 100% collectable (Jaycor, 1990).

*The final calculation was (# of swine/county x 0.9 x 365)/2000*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—13,632</i>							
Adams	246	Franklin	181	Lewis	650	Snohomish	667
Asotin	16	Garfield		Lincoln	197	Spokane	148
Benton	33	Grant	890	Mason	16	Stevens	181
Chelan		Grays Harbor	16	Okanogan	49	Thurston	675
Clallam	16	Island		Pacific		Wahkiakum	
Clark	77	Jefferson		Pend Oreille		Walla Walla	350
Columbia		King	90	Pierce	131	Whatcom	220
Cowlitz	25	Kitsap	82	San Juan	33	Whitman	1,363
Douglas		Kittitas	66	Skagit		Yakima	125
Ferry		Klickitat	49	Skamania		Other	7,040

# Poultry Manure



**State Total~ 784,577 dry tons**

## Biomass Data Collection

Poultry manure values were obtained by finding the total amount of manure for both broilers and layers and adding them together. Broiler chicken numbers were determined by taking the state yearly production and dividing it amongst the known production percentages for the counties (Washington Fryer Commission, 2004). Broiler manure was determined by using 2 pounds as the average weight of a broiler across its eight week life span (56 days) and applying a manure production factor of 0.35 lbs dry manure/day for this weight broiler (USDA, 1985). Layer chicken numbers were obtained from NASS 2002 county level census and then multiplied by a manure production factor of 0.53 lbs dry manure/day assuming an average weight of 4 pounds (NASS, 2004; USDA, 1985). Lastly, the manure total was assumed 80% collectable (Jaycor, 1990).

*The final calculation is  $\{(\#egg\ layers \times 0.53 \times 365)/2000 + (\#broilers \times 0.35 \times 56)/2000\} \times 0.80$*

## Data Collection Concerns and Comments

Poultry litter products other than the manure itself were not inventoried in this report because like the other animal beddings it was believed that the majority of the bedding was from recycled organic material that is already being counted in the inventory.

## Data

<i>Tons of Dry Biomass—784,577</i>							
Adams		Franklin		Lewis	179,176	Snohomish	97,061
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason		Stevens	122
Chelan		Grays Harbor		Okanogan	87	Thurston	219,301
Clallam		Island		Pacific		Wahkiakum	
Clark	36,204	Jefferson		Pend Oreille		Walla Walla	
Columbia		King	287	Pierce	112,912	Whatcom	17,398
Cowlitz	25,468	Kitsap	112	San Juan		Whitman	
Douglas		Kittitas		Skagit	73,779	Yakima	22,670
Ferry		Klickitat		Skamania		Other	

# Logging Residue

State Total~1,901,072 dry tons



## Biomass Data Collection

Forest logging residue values were obtained by taking the annual county level timber harvest for 2002 and multiplying each of the categories (national forest, public forest, and private forest) (WSDNR, 2002) by a residue factor as supplied by Howard (1981) [clear cut national (34 cubic feet/thousand board feet), clear cut other public (40), clear cut private (28), partial cut national (103), partial cut other public (87), and partial cut private (106)]. These categories were then multiplied again by a harvest ratio as supplied by Kerstetter and Lyons (2001) which were 100% cut for all sources in Eastern Washington and 95%, 94%, and 97% for clear cuts occurring respectively within national, other public and private forests of Western Washington. Finally, the summation of all of these categories was multiplied by a volume to mass conversion ratio of 25 pounds dry weight wood/cubic foot (Howard, 1981).

*The final calculation was  $\sum$  (annual timber harvest x residue ratio x % harvest) cut x 25*

## Data Collection Concerns and Comments

Since forestry is such a large impact on total biomass volumes, any inaccuracies in any of its inventoried items will have a large impact on the overall data. However, having acknowledged that we found no specific concerns especially since the methodology was taken from a previous study.

## Data

<i>Tons of Dry Biomass—1,901,072</i>							
Adams		Franklin		Lewis	173,795	Snohomish	40,719
Asotin	852	Garfield	1,597	Lincoln	2,559	Spokane	28,570
Benton		Grant		Mason	54,502	Stevens	160,203
Chelan	16,438	Grays Harbor	199,066	Okanogan	64,142	Thurston	41,557
Clallam	81,860	Island	889	Pacific	104,627	Wahkiakum	28,595
Clark	22,638	Jefferson	32,035	Pend Oreille	110,006	Walla Walla	4,468
Columbia	1,721	King	37,521	Pierce	67,160	Whatcom	45,442
Cowlitz	86,967	Kitsap	8,233	San Juan	222	Whitman	240
Douglas	302	Kittitas	86,216	Skagit	56,044	Yakima	171,796
Ferry	76,626	Klickitat	81,199	Skamania	12,265	Other	

# Forest Thinning

State Total~505,666 dry tons



## Biomass Data Collection

Forest thinning residue values were obtained by adding together the state silviculture burn data from the Department of Natural Resources (WADNR, 2004) and the pre-commercial thinning data obtained from the Forest Inventory and Analysis Timber Product Output (TPO) Database (Forest Service, 2004). The pre-commercial data was given in cubic feet and converted to dry tons using the volume to mass conversion ratio of 25 pounds dry weight wood/cubic foot (Howard, 1981). The burn data was already computed in dry tons of combusted material.

*The final calculation was  $\sum ((\text{pre-commercial thinning in cft} \times 25)/2000 \text{ lbs/ton}) + \text{burn tonnage}$*

## Data Collection Concerns and Comments

There is a fear here for under-reporting of the potential. Although DNR burn data was used it can be assumed that not all burn, especially on a small private scale is permitted nor is probably the pre-commercial thinning data coming from small private acreage. Also, again since forestry is such a large impact on total biomass volumes, any inaccuracies in any of its inventoried items will have a large impact on the overall data.

## Data

<i>Tons of Dry Biomass—505,666</i>							
Adams		Franklin		Lewis	13,297	Snohomish	2,011
Asotin	11,002	Garfield	5,324	Lincoln	164	Spokane	19,454
Benton		Grant		Mason	5,059	Stevens	13,483
Chelan	15,462	Grays Harbor	14,873	Okanogan	118,499	Thurston	2,666
Clallam	9,878	Island	146	Pacific	10,490	Wahkiakum	3,762
Clark	2,308	Jefferson	3,578	Pend Oreille	10,993	Walla Walla	
Columbia	924	King	1,212	Pierce	5,037	Whatcom	1,312
Cowlitz	5,775	Kitsap	649	San Juan	116	Whitman	
Douglas		Kittitas	8,006	Skagit	1,120	Yakima	37,426
Ferry	138,873	Klickitat	41,284	Skamania	1,483	Other	



# Mill Residue



**State Total~5,278,353 dry tons**

## Biomass Data Collection

Mill residue values were obtained from a 2002 mill waste report given in dry tonnage by region which was then cross referenced against the number of mills within each county so that an average disbursement of this regional mill tonnage could be given for each county (WDNR, 2002). The mill residues represent the residue/bark left over from operations at the state’s sawmill, pulp, shake/shingle, whole log chipping, veneer plywood, post/pole/piling and log export businesses.

*The final calculation was regional mill dry tonnage X (% of regional total for each county based upon fraction of mills in county as compared to regional total)*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data as it is data obtained from a comprehensive state inventory of mill industries in the state, however, because of proprietary concerns the exact county locations were replaced by regional data which then had to be reverse computed to county numbers by comparing number of mills in each county and assuming that each mill was of an average size. Also, again since forestry is such a large impact on total biomass volumes, any inaccuracies in any of its inventoried items will have a large impact on the overall data.

Additionally, it is important to note that mill residue is unique to the other inventoried items in that it is a bioresource that already enjoys extensive sustainable energy use as an overwhelmingly large percentage is used in hog fuel boilers, mill heat and power sources, or as a source of wood fiber chips; and as such can be an wonderful example of how our state can lead by using it’s own local resources for energy independence.

## Data

<i>Tons of Dry Biomass—5,278,353</i>							
Adams		Franklin		Lewis	441,353	Snohomish	448,177
Asotin	11,1302	Garfield		Lincoln		Spokane	35,148
Benton		Grant		Mason	242,744	Stevens	363,195
Chelan	100,214	Grays Harbor	728,232	Okanogan	48,103	Thurston	331,015
Clallam	375,150	Island		Pacific	66,203	Wahkiakum	22,638
Clark	63,386	Jefferson	22,068	Pend Oreille	76,154	Walla Walla	
Columbia		King	23,588	Pierce	401,001	Whatcom	82,559
Cowlitz	733,471	Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit	224,089	Yakima	252,539
Ferry		Klickitat	63,386	Skamania	22,638	Other	

# Land Clearing Debris



**State Total~418,595 dry tons**

## Biomass Data Collection

Land clearing debris residue values were obtained by accessing the Washington State Department of Ecology Air Quality Program Annual Land Clearing Burning Potential (WEAQP, 2000). Within that report several key assumptions were made to evaluate the land clearing potential at a county level. These include assuming a linear population growth from the 1990-2000 statistics, a value of 0.08731 acres cleared/new person, 17 and 25 tons/acre respectively for Eastern and Western Washington, and an 85% solid volume per pile ratio. The heavily forested counties of King/Kitsap/Pierce and Snohomish had an alternative study completed in regards to land clearing and they used an assumption of 95 tons/acre and its results were used to assess the total for those counties (Puget Sound Clean Air, 2002). An approximate moisture level of 20% was used to determine total dry matter based on its woody nature and similarity to the forest residue thinnings.

*The final calculation was database query total x 0.80*

## Data Collection Concerns and Comments

There is the possibility that this burning potential under-reports the actual burnings taking place in the state, particularly in those counties with high growth. This suggestion is due to a comparison that was made with this database numbers and a partial report done by the Puget Sound Air Quality Program that assessed the land clearing debris numbers for King, Kitsap, Pierce and Snohomish counties (Puget Sound Air Quality, 2002; Kwame Agyei of Puget Sound Clean Air Authority and Sally Otterson of Ecology Air Quality Program). The totals for this report are approximately 4 times higher than that predicted by the complete county report and although the exact data for those four counties were included in the inventory, it could be assumed that many of the other counties, particularly with somewhat large urban growth are also under-reported. Also, again since forestry is such a large impact on total biomass volumes, any inaccuracies in any of its inventoried items will have a large impact on the overall data.

## Data

<i>Tons of Dry Biomass—418,595</i>							
Adams	277	Franklin	1,350	Lewis	1,622	Snohomish	102,904
Asotin	268	Garfield	17	Lincoln	120	Spokane	5,143
Benton	3,941	Grant	1,966	Mason	1,753	Stevens	759
Chelan	1,427	Grays Harbor	1,161	Okanogan	602	Thurston	7,110
Clallam	1,735	Island	2,577	Pacific	462	Wahkiakum	92
Clark	14,742	Jefferson	1,258	Pend Oreille	303	Walla Walla	822
Columbia	23	King	70,072	Pierce	84,968	Whatcom	5,542
Cowlitz	1,990	Kitsap	96,672	San Juan	570	Whitman	314
Douglas	503	Kittitas	582	Skagit	1,889	Yakima	2,359
Ferry	138	Klickitat	282	Skamania	280	Other	

# Cull Onions



**State Total~2,322 dry tons**

## Biomass Data Collection

Cull onion residue values were obtained by averaging state production for the years 2000-2003 (WASS, 2004) and multiplying this county level production by 5%. The 5% cull factor is a result of a personal interview with Sunspiced which estimated the overall cull production at 10% of which ½ of that goes on to further food processing and the other half goes back to the field as a soil supplement (Sunspiced, 2002). A moisture level of 90% was used to determine total dry matter (USDA, 2002).

*The final calculation was county total x 0.05 x 0.10*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—2,322</i>							
Adams	170	Franklin	593	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	551	Grant	858	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	78
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	44
Ferry		Klickitat		Skamania		Other	29

# Cull Potatoes



**State Total~91,412 dry tons**

## Biomass Data Collection

Cull potato values were obtained by averaging state production for the years 2000-2003 (WASS, 2004). A personal interview with the Washington Potato Commission showed that there is an estimated 10% cull production during the annual harvest (Washington Potato Commission, 2004). A moisture level of 81% was used to determine total dry matter (USDA, 2002).

*The final calculation was county total x 0.10 x 0.19*

## Data Collection Concerns and Comments

No estimate was able to be given about what percentage of these culls is sent for later food processing so it was assumed for this study that none of these culls were used in food processing which is most likely not accurate as a certain unknown percentage probably ends up in the food processing stream, thus there is the potential for double reporting.

## Data

<i>Tons of Dry Biomass—91,412</i>							
Adams	14,954	Franklin	19,158	Lewis		Snohomish	
Asotin		Garfield		Lincoln	3,287	Spokane	
Benton	19,255	Grant	21,223	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	6,896
Columbia		King		Pierce		Whatcom	708
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas	207	Skagit	3,384	Yakima	789
Ferry		Klickitat	886	Skamania		Other	665

# Cull Apples



**State Total~41,039 dry tons**

## Biomass Data Collection

Cull apple values were obtained by averaging regional state production for the years 1999-2003 (WASS, 2004) as well as determining from the 2002 Agricultural Census the percentage acre by county (NASS, 2002). With these two data sets a county level annual production was developed. A personal interview with Post-Harvest personnel at WSU Tree Fruit Extension pointed out that of 100 units of harvested apple, approximately 70 units are packed while 20 units are processed and 10 units are true culls used only for juice (WSUTFE, 2004). A moisture level of 84% was used to determine total dry matter (USDA, 2002).

*The final calculation was regional apple production tonnage x % of regional harvest due to specific county x 0.10 x 0.16*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—41,039</i>							
Adams	603	Franklin	1,516	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	3,718	Grant	6,031	Mason		Stevens	
Chelan	3,748	Grays Harbor		Okanogan	4,685	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	1,812
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas	3,279	Kittitas		Skagit		Yakima	14,870
Ferry		Klickitat		Skamania		Other	777

# Other Cull Fruit



**State Total~8,934 dry tons**

## Biomass Data Collection

Other cull fruit residue values were obtained by averaging the regional state production for the years 1999-2003 (WASS, 2004) as well as using the 2002 Agricultural Census to determine the percentage harvest in a region by county (NASS, 2002). These two data sets were then used to obtain an overall county level production of other cull fruit. Fruits inventoried in the other cull fruit category were apricots, cherries, pears, peaches, and prunes. A personal interview with Post-Harvest personnel at WSU Tree Fruit Extension pointed out that of 100 units of harvested apple, approximately 70 units are packed while 20 units are processed and 10 units are true culls used only for juice (WSUTFE, 2004). This ratio was assumed to be similar to that of miscellaneous fruit. A moisture level of 84% was used to determine total dry matter (USDA, 2002).

*The final calculation was regional apple production tonnage x % of regional harvest due to specific county x 0.10 x 0.16*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—8,934</i>							
Adams	295	Franklin	103	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	728	Grant	410	Mason		Stevens	
Chelan	1,276	Grays Harbor		Okanogan	1,595	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	347
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas	1,117	Kittitas		Skagit		Yakima	2,914
Ferry		Klickitat		Skamania		Other	149

# Asparagus Butts



**State Total~667 dry tons**

## Biomass Data Collection

Asparagus butt values were obtained by averaging state asparagus production for the years 2000-2003 (WASS, 2004). A personal interview with the Washington Asparagus Commission showed that 25% of the asparagus mass is due to the butt (WA Asparagus Commission, 2004). A moisture level of 92% was used to determine total dry matter (USDA, 2002).

*The final calculation was county total x 0.25 x 0.08*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—667</i>							
Adams	23	Franklin	282	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	48	Grant	50	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	36
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	221
Ferry		Klickitat		Skamania		Other	7

# Apple Pomace



**State Total~27,794 dry tons**

## **Biomass Data Collection**

Cull apple values were obtained by averaging regional state apple production for the years 1999-2003 (WASS, 2004) as well as determining from the 2002 Agricultural Census the percentage acre by county (NASS, 2002). With these two data sets a county level annual apple production was developed. A personal interview with Post-Harvest personnel at WSU Tree Fruit Extension pointed out that of 100 units of harvested apple, approximately 70 units are packed while 20 units are processed and 10 units are true culls used only for juice (WSUTFE, 2004). According to the National Research Council Committee on Animal Nutrition (NRC), 8.6% of the wet weight of the raw processed apple ends up as solid waste (NRC, 1983). A moisture level similar to that of grape pomace at 37% was used to determine total dry matter (USDA, 2002).

*The final calculation was regional apple production tonnage x % of regional harvest due to specific county x 0.20 x 0.086 x 0.63*

## **Data Collection Concerns and Comments**

Within all of the food processing categories there was the need for an estimation of the amount of dry solid waste produced during processing. This determination is fraught with error because of the large number of different processing plants, processes, and technologies. What is reported is an estimation of the average solids production given an assumption of average processing technique for the respective inventoried processed item.

## **Data**

<i><b>Tons of Dry Biomass—27,794</b></i>							
Adams	408	Franklin	1,027	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	2,518	Grant	4,085	Mason		Stevens	
Chelan	2,538	Grays Harbor		Okanogan	3,173	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	1,227
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas	2,221	Kittitas		Skagit		Yakima	10,071
Ferry		Klickitat		Skamania		Other	526



# Grape Pomace



**State Total~19,254 dry tons**

## Biomass Data Collection

Grape pomace values were obtained by averaging the state total production of wine and processed grapes for the years 1999-2003 (WASS, 2004) and using the 2002 Agricultural Census to determine a percentage of harvest by county (NASS, 2002). The use of both of these records led to the production of wine and processed grapes at a county level. On average, approximately 10% of the harvest grape weight is grape pomace (Ingels, 1992). A moisture level of 37.5% was used to determine total dry matter (NRC, 1983).

*The final calculation was state total x county % x 0.10 x 0.625*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—19,254</i>							
Adams		Franklin	963	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	6,932	Grant	2,118	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	1,155
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	7,124
Ferry		Klickitat	770	Skamania		Other	193

# Berry Pomace



**State Total~1,938 dry tons**

## Biomass Data Collection

Berry pomace values were obtained by averaging the county level production of berries for the years 1999-2003 (WASS, 2004). Berries inventoried include blueberries, raspberries, red strawberries, and cranberries. It was assumed that 90% of the berry production is used for processing (WASS, 2004) and the average solid waste produced from the berry processing was roughly 6% of the wet mass of the raw berry being processed (NRC, 1983). A moisture level of 37.5% was used to determine total dry matter (NRC, 1983).

*The final calculation was  $(\sum \text{county total}) \times 0.90 \times 0.06 \times 0.625$*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—1,938</i>							
Adams		Franklin		Lewis	21	Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason		Stevens	
Chelan		Grays Harbor	57	Okanogan		Thurston	11
Clallam		Island		Pacific	197	Wahkiakum	
Clark	141	Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce	23	Whatcom	1,050
Cowlitz	53	Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit	285	Yakima	
Ferry		Klickitat		Skamania		Other	100

# Other Fruit Pomace



**State Total~11,865 dry tons**

## Biomass Data Collection

Other fruit pomace values were obtained by averaging regional state other fruit production for the years 1999-2003 (WASS, 2004) as well as determining from the 2002 Agricultural Census the percentage acre by county (NASS, 2002). With these two data sets a county level annual other fruit production was developed. Fruits inventoried in the other cull fruit category were apricots, cherries, pears, peaches, and prunes. A personal interview with Post-Harvest personnel at WSU Tree Fruit Extension pointed out that of 100 units of harvested apple, approximately 70 units are packed while 20 units are processed and 10 units are true culls used only for juice (WSUTFE, 2004). This ratio was assumed to be similar to that of other miscellaneous fruits. According to the NRC, 17% of the wet weight of the raw processed other fruit ends up as solid waste (NRC, 1983). A moisture level similar to that of grape pomace at 37% was used to determine total dry matter (USDA, 2002).

*The final calculation was regional apple production tonnage x % of regional harvest due to specific county x 0.20 x 0.17 x 0.63*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—11,865</i>							
Adams	392	Franklin	137	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	967	Grant	544	Mason		Stevens	
Chelan	1,695	Grays Harbor		Okanogan	2,119	Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	461
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas	1,483	Kittitas		Skagit		Yakima	3,870
Ferry		Klickitat		Skamania		Other	197

# Cheese Whey



**State Total~44,255 dry tons**

## Biomass Data Collection

Cheese whey values at a county level were obtained by averaging the state cheese production for the years 1999-2003 (WASS, 2004), multiplying this by the percentage of milk production in a particular county (WASS, 2004), and then multiplying the cheese production by a factor of 9 (Liu et al, 2004) to get the wet tonnage of whey. A moisture level of 93.5% was used to determine total dry matter (Liu et al, 2004).

*The final calculation was state cheese production x % milk production due to specific county x 9 x 0.065*

## Data Collection Concerns and Comments

There are very few cheese processing facilities within the state, however because of proprietary information the exact production values for these facilities and their respective county locations were not allowed, thus the total state production was divided across each of the state's milk procuring counties by number of milking cows which of course introduced significant error.

## Data

<i>Tons of Dry Biomass—44,255</i>							
Adams	779	Franklin	1,018	Lewis	1,633	Snohomish	3,186
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant	2,523	Mason		Stevens	
Chelan		Grays Harbor	606	Okanogan		Thurston	1,845
Clallam		Island		Pacific		Wahkiakum	
Clark	739	Jefferson		Pend Oreille		Walla Walla	
Columbia		King	2,390	Pierce	987	Whatcom	11,152
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit	3,160	Yakima	11,285
Ferry		Klickitat		Skamania		Other	2,952

# Potato Solids



**State Total~19,177 dry tons**

## Biomass Data Collection

Potato solids from food processing values were obtained by averaging county level state production of potatoes for the years 2000-2003 (WASS, 2004) and multiplying this by a processing percentage of 56.7% (USDA, 1990). Lastly, a NRC solid waste estimate of 3.7% of the raw weight of the potato being processed was used to get wet tonnage of solid potato processing waste (NRC, 1983). A moisture level of 81% was used to determine total dry matter (USDA, 2002).

*The final calculation was county total x 0.567 x 0.037 x 0.19*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—19,177</i>							
Adams	3,137	Franklin	4,019	Lewis		Snohomish	
Asotin		Garfield		Lincoln	690	Spokane	
Benton	4,040	Grant	4,452	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	1,447
Columbia		King		Pierce		Whatcom	148
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas	43	Skagit	710	Yakima	166
Ferry		Klickitat	186	Skamania		Other	139

# Asparagus Trimmings



**State Total~120 dry tons**

## Biomass Data Collection

Asparagus trimming values were obtained by first averaging state county level production for the years 2000-2003 (WASS, 2004). Then, using personal interview data from the Washington Asparagus Commission, it was assumed that 45% of this crop production goes to processing (25% of mass de-budded, leaving 75% of total in which 60% of this is processed) (WA Asparagus Commission, 2004). In another personal conversation it was estimated that about 10% of the raw processing asparagus ends up as trimmings (Senaca Foods, 2003). A moisture level of 92% was used to determine total dry matter (USA hops, 2002).

*The final calculation was county total x 0.45 x 0.10 x 0.08*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—120</i>							
Adams	4	Franklin	51	Lewis		Snohomish	
Asotin		Garfield		Lincoln		Spokane	
Benton	9	Grant	9	Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	7
Columbia		King		Pierce		Whatcom	
Cowlitz		Kitsap		San Juan		Whitman	
Douglas		Kittitas		Skagit		Yakima	40
Ferry		Klickitat		Skamania		Other	1

# Mixed Vegetables



**State Total~14,744 dry tons**

## Biomass Data Collection

Mixed vegetable processing values were obtained first by averaging and adding the county level productions of the mixed vegetables for the years 2000-2003 (WASS, 2004). Crops inventoried as mixed vegetables were sweet corn, green peas, and carrots. Then, the crop totals were multiplied by a processing solid waste production factor of 13% of raw vegetable being processed (NRC, 1983). A moisture level of 90% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $(\sum \text{county total}) \times 0.13 \times 0.10$*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—14,744</i>							
Adams	405	Franklin	2,690	Lewis	158	Snohomish	40
Asotin		Garfield		Lincoln		Spokane	
Benton	2,826	Grant	5,337	Mason		Stevens	
Chelan		Grays Harbor	147	Okanogan		Thurston	
Clallam		Island		Pacific		Wahkiakum	
Clark		Jefferson		Pend Oreille		Walla Walla	1,219
Columbia	3	King		Pierce		Whatcom	21
Cowlitz	98	Kitsap		San Juan		Whitman	67
Douglas		Kittitas	533	Skagit	115	Yakima	857
Ferry		Klickitat	228	Skamania		Other	

# Poultry Feathers



**State Total~7,932 dry tons**

## Biomass Data Collection

Poultry feather residue values were obtained by finding the number of broilers in a county, multiplying this number by 5 lbs/average broiler at production time to get the total pounds of broiler chicken in each county (Washington Fryer Commission, 2004) and then assuming that 9% of the total live weight is feathers (Vincent, 2004). A moisture level of 7.9% was used to determine total dry matter (Vincent, 2004).

*The final calculation was [(county total x 5)/2000] x 0.09 x 0.919*

## Data Collection Concerns and Comments

Only live-kill broilers were considered in this inventory, not egg layers or poultry mortalities, because not enough information was available about the processing of old layers nor the use of the feathers in mortalities. Thus the feather inventory will potentially be on the low end.

## Data

<i>Tons of Dry Biomass—7,932</i>							
Adams		Franklin		Lewis	3,877	Snohomish	395
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	851
Clallam		Island		Pacific		Wahkiakum	
Clark	913	Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce	170	Whatcom	
Cowlitz	747	Kitsap		San Juan		Whitman	365
Douglas		Kittitas		Skagit	611	Yakima	4
Ferry		Klickitat		Skamania		Other	



# Poultry Meat Processing



**State Total~5,479 dry tons**

## Biomass Data Collection

Poultry meat processing values were obtained by taking county broiler production (Washington Fryer Commission, 2004) multiplying this by 4 pounds/average broiler and assuming that 19.3% of the broiler weight is waste blood, heads, feet and intestines/organs (Dupps, 2004). A moisture level of 63% was used to determine total dry matter (Dupps, 2004).

*The final calculation was [(county total x 4)/2000] x 0.193 x 0.37*

## Data Collection Concerns and Comments

Only live-kill broilers were considered in this inventory, not egg layers, because not enough information was available about the processing of old layers for meat production. Thus the feather inventory will potentially be on the low end.

## Data

<i>Tons of Dry Biomass—5,479</i>							
Adams		Franklin		Lewis	2,678	Snohomish	273
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason		Stevens	
Chelan		Grays Harbor		Okanogan		Thurston	588
Clallam		Island		Pacific		Wahkiakum	
Clark	631	Jefferson		Pend Oreille		Walla Walla	
Columbia		King		Pierce	117	Whatcom	
Cowlitz	516	Kitsap		San Juan		Whitman	252
Douglas		Kittitas		Skagit	422	Yakima	3
Ferry		Klickitat		Skamania		Other	

# Beef Meat Processing



**State Total~35,842 dry tons**

## Biomass Data Collection

Beef meat processing values were first obtained by averaging state cattle weight sales for the years 2000-2004 (WASS, 2004). From the same report, the percentage of cattle in each county was determined and therefore the percentage of cattle weight sales by each county (WASS, 2004). An estimate of the weight of beef meat processing in each county was arrived at by multiplying the county weight sales by the ratio 0.187 tons of by-product/ton steer or cow live weight (Iowa State Extension, 2003). A moisture level of 64% was used to determine total dry matter (Iowa State Extension, 2003).

*The final calculation was (state beef weight sales x county %) x 0.187 x 0.36*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—35,842</i>							
Adams	1,219	Franklin	1,756	Lewis	1,004	Snohomish	1,075
Asotin		Garfield		Lincoln	896	Spokane	789
Benton		Grant	5,197	Mason		Stevens	1,362
Chelan		Grays Harbor	333	Okanogan	1,649	Thurston	538
Clallam		Island		Pacific		Wahkiakum	
Clark	538	Jefferson		Pend Oreille		Walla Walla	
Columbia		King	573	Pierce	502	Whatcom	3,369
Cowlitz		Kitsap		San Juan		Whitman	573
Douglas	351	Kittitas	896	Skagit	1,147	Yakima	6,882
Ferry	319	Klickitat	860	Skamania		Other	4,014

# Swine Meat Processing



**State Total~280 dry tons**

## Biomass Data Collection

Swine meat processing values were first obtained by averaging state hog weight sales for the years 1999-2003 (WASS, 2004). From the same report, the percentage of hogs in each county was determined and therefore the percentage of hog weight sales by each county (WASS, 2004). An estimate of the weight of hog meat processing in each county was arrived at by multiplying the county weight sales by the ratio 0.135 tons of by-product/ton hog live weight (Iowa State Extension, 2003). A moisture level of 64% was used to determine total dry matter (Iowa State Extension, 2003).

*The final calculation was (state beef weight sales x county %) x 0.135 x 0.36*

## Data Collection Concerns and Comments

No particular concerns exist in regards to the parameters used for the collection of this biomass data.

## Data

<i>Tons of Dry Biomass—280</i>							
Adams	15	Franklin	11	Lewis	6	Snohomish	7
Asotin		Garfield		Lincoln	12	Spokane	9
Benton		Grant	54	Mason		Stevens	11
Chelan		Grays Harbor		Okanogan		Thurston	7
Clallam		Island		Pacific		Wahkiakum	
Clark	5	Jefferson		Pend Oreille		Walla Walla	
Columbia		King	6	Pierce	8	Whatcom	
Cowlitz		Kitsap	5	San Juan		Whitman	84
Douglas		Kittitas		Skagit		Yakima	8
Ferry		Klickitat		Skamania		Other	33

# All Animal Mortalities



**State Total~5,857 dry tons**

## Biomass Data Collection

To find the dry weight of animal mortalities an inventory was taken of the total weight of animal mortalities for the year 2000 for a variety of livestock species for the nation as a whole (Sparks Corporation, 2002). Next, the percentage of the nation's livestock production for each animal type (total weight) was determined for each county (WASS, 2004). By using this percentage for the various livestock and by comparing it against the total weight of animal mortality numbers, a total of animal mortality weights by animal type were obtained for Washington counties. Animal types inventoried for the mortalities were dairy, beef, swine, sheep and chickens. A moisture content of 64% was assumed for determining the final dry values.

The final calculation was  $(\sum \text{domestic animal mortality tons} \times \text{Washington County Percentage}) \times 0.36$

## Data Collection Concerns and Comments

The numbers for animal mortalities could be quite a bit lower than actually exists because no pet animal mortalities were inventoried in this study because of the lack of available data, although some of the pet mortality was potentially inventoried in the later MSW other organics category. Note also that this inventoried item was taken from a national database and brought down to a county level through incorporation of other county level data, but as a result is much more prone to error than other inventoried items that used just county data.

## Data

<i>Tons of Dry Biomass—5,857</i>							
Adams	170	Franklin	212	Lewis	316	Snohomish	265
Asotin	26	Garfield	25	Lincoln	80	Spokane	95
Benton	1	Grant	628	Mason	4	Stevens	141
Chelan		Grays Harbor	57	Okanogan	151	Thurston	175
Clallam	10	Island	20	Pacific	40	Wahkiakum	15
Clark	118	Jefferson	13	Pend Oreille	15	Walla Walla	1
Columbia		King	154	Pierce	97	Whatcom	840
Cowlitz	42	Kitsap	4	San Juan	8	Whitman	68
Douglas	31	Kittitas	82	Skagit	289	Yakima	1,226
Ferry	29	Klickitat	86	Skamania		Other	323

# Fish Waste



**State Total~ 7,995 dry tons**

## Biomass Data Collection

Fish processing waste was determined by first accessing the Pacific Coast Fisheries Information Network (2004) to get county level data on fish harvests for Washington State for the averaged years 2002-2004. Then, approximate processing waste percentages were used to get wet tonnage of each of the different types of inventoried fish (waste as a percentage of live weight was as follows: Tuna-65%; Fin Fish-35%) (Carawan, 1977). Lastly, each of the inventoried fish were added to get a wet total and then converted to dry tons using the assumed average moisture content of 64%.

*The final calculation was  $[\sum (\text{county total} \times \text{waste } \%)] \times 0.36$*

## Data Collection Concerns and Comments

This inventory is a result of the Pacific Coast Fisheries Information Network which collects data about commercial (tribal and non-tribal) harvest and does not inventory the amount of non-commercial harvest and waste that is produced. There is also the concern about where the potential waste was produced, i.e. out at sea or on-shore which was not accurately addressable in this inventory. Note that this inventory item is mostly based on commercial fisherman reports to a regional database and is not directly related to data directly obtained from fish processors because of the difficulty in attaining processing data due to proprietary issues.

## Data

<i>Tons of Dry Biomass—7,995</i>							
Adams		Franklin		Lewis		Snohomish	105
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason	785	Stevens	
Chelan		Grays Harbor	2,063	Okanogan		Thurston	
Clallam	378	Island	1	Pacific	817	Wahkiakum	68
Clark		Jefferson	9	Pend Oreille		Walla Walla	
Columbia		King	646	Pierce	173	Whatcom	2,554
Cowlitz	60	Kitsap	6	San Juan	3	Whitman	
Douglas		Kittitas		Skagit	293	Yakima	
Ferry		Klickitat	34	Skamania		Other	

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# Shellfish Waste



**State Total~3,674 dry tons**

## Biomass Data Collection

Fish processing waste was determined by first accessing the Pacific Coast Fisheries Information Network (2004) to get county level data on fish harvests for Washington State for the averaged years 2002-2004. Then, approximate processing waste percentages were used to get wet tonnage of each of the different types of inventoried fish (waste as a percentage of live weight was as follows: Oyster-86%; Dungeness Crab-73%; Shrimp-80%; Clam-80%) (Carawan, 1977). Lastly, each of the inventoried fish were added to get a wet total and then converted to dry tons using the assumed average moisture content of 64%.

*The final calculation was  $[\sum (\text{county total} \times \text{waste } \%)] \times 0.36$*

## Data Collection Concerns and Comments

The same issues about fish waste were present with the shellfish waste inventory and again note that this inventory item is mostly based on commercial fisherman reports to a regional database and is not directly related to data directly obtained from fish processors because of the difficulty in attaining processing data due to proprietary issues.

## Data

<i>Tons of Dry Biomass—3,674</i>							
Adams		Franklin		Lewis		Snohomish	3
Asotin		Garfield		Lincoln		Spokane	
Benton		Grant		Mason	292	Stevens	
Chelan		Grays Harbor	1,575	Okanogan		Thurston	
Clallam	166	Island	26	Pacific	488	Wahkiakum	8
Clark		Jefferson	99	Pend Oreille		Walla Walla	
Columbia		King	77	Pierce	51	Whatcom	537
Cowlitz		Kitsap	70	San Juan	4	Whitman	
Douglas		Kittitas		Skagit	278	Yakima	
Ferry		Klickitat		Skamania		Other	

# Food Waste



**State Total~246,011 dry tons**

## Biomass Data Collection

MSW Food waste values were obtained by first determining the percentage of food waste in the MSW waste stream for various counties (WDOE, 2003) and then multiplying this percentage by the overall annual MSW waste stream for that county (WDOE, 2004). In addition to the total attained in the MSW stream, totals from recyclables and diversion were added, thus giving a total MSW food waste tally for the counties. The recyclable and diversion numbers were obtained by taking state totals in recycled and diverted food waste and multiplying that by the percentage population for each county (WDOE, 2004). A moisture level of 80% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(\% \text{ food composition} \times \text{total MSW}) + (\text{state recyclable number} \times \% \text{ population}) + (\text{state diversion number} \times \% \text{ population})\} \times 0.20$*

## Data Collection Concerns and Comments

The major concern with this and most of the other municipal solids being inventoried is that recyclable and diversion data were only available on a state not a county level and thus the need for applying population statistics to get a possible county number. The assumption then is that the level of production of food waste or other municipal solids being inventoried is spread evenly across the state by population which is not necessarily accurate. In future inventories it will be necessary to have access to county level data to ensure a better representation of the numbers for each county.

## Data

<i>Tons of Dry Biomass—246,011</i>							
Adams	542	Franklin	4,165	Lewis	4,590	Snohomish	21,327
Asotin	386	Garfield	91	Lincoln	104	Spokane	23,201
Benton	3,645	Grant	2,738	Mason	1,206	Stevens	2,607
Chelan	2,460	Grays Harbor	3,344	Okanogan	1,226	Thurston	5,960
Clallam	2,771	Island	1,697	Pacific	510	Wahkiakum	96
Clark	9,224	Jefferson	898	Pend Oreille	1,150	Walla Walla	1,512
Columbia	97	King	67,269	Pierce	45,406	Whatcom	5,527
Cowlitz	10,102	Kitsap	8,157	San Juan	387	Whitman	589
Douglas	1,085	Kittitas	1,097	Skagit	2,883	Yakima	7,165
Ferry	102	Klickitat	564	Skamania	131	Other	

# Yard Non-Wood



**State Total~421,489 dry tons**

## Biomass Data Collection

MSW yard-non wood waste values were obtained by first determining the percentage of yard non-wood waste in the MSW waste stream for various counties (WDOE, 2003) and then multiplying this percentage by the overall annual MSW waste stream for that county (WDOE, 2004). In addition to the total attained in the MSW stream, totals from recyclables and diversion were added, thus giving a total MSW yard non-wood waste tally for the counties. The recyclable and diversion numbers were obtained by taking state totals in recycled and diverted yard non-wood waste and multiplying that by the percentage population for each county (WDOE, 2004). A moisture level of 54.6% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(\% \text{ yard non-wood composition} \times \text{total MSW}) + (\text{state recyclable number} \times \% \text{ population}) + (\text{state diversion number} \times \% \text{ population})\} \times 0.454$*

## Data Collection Concerns and Comments

The major concern with this and most of the other municipal solids being inventoried is that recyclable and diversion data were only available on a state not a county level and thus the need for applying population statistics to get a possible county number. The assumption then is that the level of production of this or other municipal solids being inventoried is spread evenly across the state by population which is not necessarily accurate. In future inventories it will be necessary to have access to county level data to ensure a better representation of the numbers for each county.

## Data

<i>Tons of Dry Biomass—421,489</i>							
Adams	1,026	Franklin	4,647	Lewis	4,961	Snohomish	31,206
Asotin	1,492	Garfield	170	Lincoln	493	Spokane	33,220
Benton	11,802	Grant	4,516	Mason	2,448	Stevens	3,380
Chelan	6,939	Grays Harbor	4,709	Okanogan	2,498	Thurston	10,569
Clallam	4,036	Island	3,751	Pacific	1,168	Wahkiakum	211
Clark	16,376	Jefferson	1,421	Pend Oreille	1,252	Walla Walla	4,984
Columbia	261	King	147,076	Pierce	48,697	Whatcom	8,150
Cowlitz	9,220	Kitsap	12,958	San Juan	682	Whitman	2,440
Douglas	2,006	Kittitas	3,247	Skagit	5,027	Yakima	21,811
Ferry	377	Klickitat	1,790	Skamania	472	Other	



# Yard Burn



**State Total~35,826 dry tons**

## Biomass Data Collection

MSW yard burn waste values were obtained by accessing the residential yard burn waste database where yard burn waste was estimated for all counties within the state (WDEAQP, 2004). The equation used to determine the amount was:  $\# \text{ of households} \times (\text{fraction burning waste}) \times (\text{piles/HH}) \times (\text{lbs burned/pile}) \times (T/2000 \text{ lbs})$ . The counties were divided into the following categories with the attached parameters and a pile was assumed to be 125 pounds on average (WDEAQP, 2004). A moisture level of 54.6% was used to determine total dry matter (USDA, 2002).

Area	Fraction Burning	Piles per HH
Incorporated	0.077	2.56
Eastern WA w/forest	0.184	3.64
Eastern WA w/o forest	0.210	2.84
Western WA	0.265	3.37

*The final calculation was  $\{\# \text{ of households} \times (\text{fraction burning waste}) \times (\text{piles/HH}) \times (\text{lbs burned/pile}) \times (T/2000 \text{ lbs})\} \times 0.454$*

## Data Collection Concerns and Comments

No special concerns were present beyond the already identified assumptions that took place during the Air Quality Program inventory.

## Data

<i>Tons of Dry Biomass—35,826</i>							
Adams	59	Franklin	163	Lewis	468	Snohomish	3,498
Asotin	103	Garfield	10	Lincoln	44	Spokane	1,993
Benton	451	Grant	285	Mason	419	Stevens	240
Chelan	292	Grays Harbor	365	Okanogan	207	Thurston	1,384
Clallam	476	Island	545	Pacific	170	Wahkiakum	35
Clark	2,030	Jefferson	227	Pend Oreille	72	Walla Walla	6,065
Columbia	17	King	6,913	Pierce	3,924	Whatcom	957
Cowlitz	505	Kitsap	1,679	San Juan	151	Whitman	112
Douglas	166	Kittitas	193	Skagit	559	Yakima	809
Ferry	49	Klickitat	109	Skamania	82	Other	

# Other Organics



**State Total~42,152 dry tons**

## Biomass Data Collection

MSW other organic waste values were obtained by first determining the percentage of other organic waste in the MSW waste stream for various counties (WDOE, 2003) and then multiplying this percentage by the overall annual MSW waste stream for that county (WDOE, 2004). In addition to the total attained in the MSW stream, totals from recyclables and diversion were added, thus giving a total MSW other organic waste tally for the counties. The recyclable and diversion numbers were obtained by taking state totals in recycled and diverted other organic waste and multiplying that by the percentage population for each county (WDOE, 2004). Other organics was defined as manures, carcasses, and offal that was disposed within the various MSW streams. A moisture level of 63% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $(\% \text{ other organic} \times \text{total MSW}) + (\text{state recyclable number} \times \% \text{ population}) + (\text{state diversion number} \times \% \text{ population}) \times 0.37$*

## Data Collection Concerns and Comments

The major concern with this and most of the other municipal solids being inventoried is that recyclable and diversion data were only available on a state not a county level and thus the need for applying population statistics to get a possible county number. The assumption then is that the level of production of this or other municipal solids being inventoried is spread evenly across the state by population which is not necessarily accurate. In future inventories it will be necessary to have access to county level data to ensure a better representation of the numbers for each county.

## Data

<i>Tons of Dry Biomass—42,152</i>							
Adams	16	Franklin	129	Lewis	871	Snohomish	4,986
Asotin	41	Garfield	3	Lincoln	2	Spokane	696
Benton	420	Grant	81	Mason	180	Stevens	58
Chelan	297	Grays Harbor	528	Okanogan	26	Thurston	1,061
Clallam	436	Island	248	Pacific	74	Wahkiakum	16
Clark	1,608	Jefferson	140	Pend Oreille	26	Walla Walla	173
Columbia	3	King	15,465	Pierce	8,282	Whatcom	1,002
Cowlitz	1,905	Kitsap	1,478	San Juan	59	Whitman	95
Douglas	31	Kittitas	130	Skagit	657	Yakima	843
Ferry	2	Klickitat	65	Skamania	19	Other	

# Paper

State Total~2,428,084 dry tons



## Biomass Data Collection

MSW paper waste values were obtained by first determining the percentage of paper waste in the MSW waste stream for various counties (WDOE, 2003) and then multiplying this percentage by the overall annual MSW waste stream for that county (WDOE, 2004). In addition to the total attained in the MSW stream, totals from recyclables and diversion were added, thus giving a total MSW paper waste tally for the counties. The recyclable and diversion numbers were obtained by taking state totals in recycled and diverted paper waste and multiplying that by the percentage population for each county (WDOE, 2004). A moisture level of 10% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(\% \text{ paper} \times \text{total MSW}) + (\text{state recyclable number} \times \% \text{ population}) + (\text{state diversion number} \times \% \text{ population})\} \times 0.90$*

## Data Collection Concerns and Comments

The major concern with this and most of the other municipal solids being inventoried is that recyclable and diversion data were only available on a state not a county level and thus the need for applying population statistics to get a possible county number. The assumption then is that the level of production of this or other municipal solids being inventoried is spread evenly across the state by population which is not necessarily accurate. In future inventories it will be necessary to have access to county level data to ensure a better representation of the numbers for each county.

## Data

<i>Tons of Dry Biomass—2,428,084</i>							
Adams	4,797	Franklin	26,547	Lewis	36,057	Snohomish	231,628
Asotin	5,292	Garfield	799	Lincoln	1,865	Spokane	171,232
Benton	42,319	Grant	22,104	Mason	12,765	Stevens	25,097
Chelan	25,123	Grays Harbor	29,038	Okanogan	14,476	Thurston	59,375
Clallam	24,472	Island	18,897	Pacific	5,804	Wahkiakum	1,133
Clark	97,145	Jefferson	8,278	Pend Oreille	10,367	Walla Walla	17,850
Columbia	1,105	King	728,785	Pierce	431,417	Whatcom	55,055
Cowlitz	80,348	Kitsap	76,680	San Juan	3,781	Whitman	14,900
Douglas	9,446	Kittitas	11,715	Skagit	33,631	Yakima	78,537
Ferry	1,701	Klickitat	6,426	Skamania	2,097	Other	

# Wood Residue - MSW



**State Total~834,057 dry tons**

## Biomass Data Collection

MSW wood waste values were obtained by first determining the percentage of wood waste in the MSW waste stream for various counties (WDOE, 2003) and then multiplying this percentage by the overall annual MSW waste stream for that county (WDOE, 2004). In addition to the total attained in the MSW stream, totals from recyclables and diversion were added, thus giving a total MSW wood waste tally for the counties. The recyclable and diversion numbers were obtained by taking state totals in recycled and diverted wood waste and multiplying that by the percentage population for each county (WDOE, 2004). A moisture level of 20% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(\% \text{ wood} \times \text{total MSW}) + (\text{state recyclable number} \times \% \text{ population}) + (\text{state diversion number} \times \% \text{ population})\} \times 0.80$*

## Data Collection Concerns and Comments

The major concern with this and most of the other municipal solids being inventoried is that recyclable and diversion data were only available on a state not a county level and thus the need for applying population statistics to get a possible county number. The assumption then is that the level of production of this or other municipal solids being inventoried is spread evenly across the state by population which is not necessarily accurate. In future inventories it will be necessary to have access to county level data to ensure a better representation of the numbers for each county.

## Data

<i>Tons of Dry Biomass—834,057</i>							
Adams	2,218	Franklin	11,600	Lewis	17,672	Snohomish	93,888
Asotin	3,138	Garfield	369	Lincoln	940	Spokane	76,323
Benton	25,830	Grant	10,041	Mason	5,655	Stevens	7,028
Chelan	15,726	Grays Harbor	12,145	Okanogan	4,912	Thurston	29,682
Clallam	10,292	Island	8,478	Pacific	2,618	Wahkiakum	496
Clark	41,106	Jefferson	3,528	Pend Oreille	2,677	Walla Walla	10,862
Columbia	531	King	170,538	Pierce	86,089	Whatcom	22,883
Cowlitz	30,360	Kitsap	38,166	San Juan	1,639	Whitman	5,963
Douglas	4,354	Kittitas	7,267	Skagit	14,016	Yakima	49,396
Ferry	708	Klickitat	3,936	Skamania	987	Other	

# Yellow Grease



**State Total~18,486 dry tons**

## Biomass Data Collection

Yellow grease values were obtained by first referring to the Urban Waste Grease Resource Assessment report for Olympia Washington and using its determined value of 6.7 pounds/year person as a representative value for production of yellow grease across all municipalities and counties in the state (Wiltsee, 1998). This value was then multiplied by the respective county populations to get an estimate of the amount of yellow grease produced in each county per year (US Census Bureau, 2004). A moisture level of 10% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(county\ population \times 6.7)/2,000\} \times 0.9$*

## Data Collection Concerns and Comments

The greatest concern in regards to this inventoried item is the assumption that the data for Olympia is universally applicable across the state and its different counties and municipalities. Given the diverse nature of the counties and cities within the state and therefore the varying number of restaurants, types of restaurants, disposal methods and lastly eating habits it should be assumed that this assumption could be a source of error.

## Data

<i>Tons of Dry Biomass—18,486</i>							
Adams	50	Franklin	169	Lewis	212	Snohomish	1,928
Asotin	62	Garfield	7	Lincoln	31	Spokane	1,300
Benton	463	Grant	237	Mason	157	Stevens	123
Chelan	205	Grays Harbor	209	Okanogan	118	Thurston	669
Clallam	202	Island	230	Pacific	64	Wahkiakum	11
Clark	1,144	Jefferson	84	Pend Oreille	36	Walla Walla	171
Columbia	12	King	5,311	Pierce	2,234	Whatcom	532
Cowlitz	287	Kitsap	726	San Juan	45	Whitman	123
Douglas	102	Kittitas	106	Skagit	329	Yakima	684
Ferry	22	Klickitat	59	Skamania	31	Other	

# Brown Grease



**State Total~20,528 dry tons**

## Biomass Data Collection

Brown grease values were obtained by first referring to the Urban Waste Grease Resource Assessment report for Olympia Washington and using its determined value of 7.44 pounds/year person as a representative value for production of brown grease across all municipalities and counties in the state (Wiltsee, 1998). This value was then multiplied by the respective county populations to get an estimate of the amount of yellow grease produced in each county per year (US Census Bureau, 2004). A moisture level of 10% was used to determine total dry matter (USDA, 2002).

*The final calculation was  $\{(county\ population \times 7.44)/2,000\} \times 0.9$*

## Data Collection Concerns and Comments

The greatest concern in regards to this inventoried item is the assumption that the data for Olympia is universally applicable across the state and its different counties and municipalities. Given the diverse nature of the counties and cities within the state and therefore the varying number and type of grease entering the municipal traps it should be assumed that this assumption could be a source of error.

## Data

<i>Tons of Dry Biomass—20,528</i>							
Adams	56	Franklin	188	Lewis	236	Snohomish	2,141
Asotin	69	Garfield	8	Lincoln	34	Spokane	1,443
Benton	514	Grant	263	Mason	175	Stevens	137
Chelan	228	Grays Harbor	232	Okanogan	131	Thurston	743
Clallam	224	Island	256	Pacific	71	Wahkiakum	13
Clark	1,271	Jefferson	93	Pend Oreille	41	Walla Walla	190
Columbia	14	King	5,897	Pierce	2,481	Whatcom	591
Cowlitz	319	Kitsap	806	San Juan	49	Whitman	136
Douglas	113	Kittitas	118	Skagit	366	Yakima	759
Ferry	25	Klickitat	65	Skamania	34	Other	

# Biosolids



**State Total~94,820 dry tons**

## Biomass Data Collection

Biosolids dry waste values were obtained by consulting the Washington State Biosolids Production and Land Application Information Spreadsheet for 2002 which contained 2002 dry value data of biosolids for each of the counties in the state (WDOE, 200).

*The final calculation was tons of dry biosolids*

## Data Collection Concerns and Comments

The greatest concern with this inventoried item is the fact that only a single year of data was inventoried. The result is that some counties reported zero biosolids for that particular year although in reality they did produce biosolids but did not for example dredge their ponds for that year.

## Data

<i>Tons of Dry Biomass—94,820</i>							
Adams		Franklin	242	Lewis	340	Snohomish	13,865
Asotin	155	Garfield		Lincoln		Spokane	6,886
Benton	4,896	Grant	237	Mason	250	Stevens	
Chelan	913	Grays Harbor	660	Okanogan	237	Thurston	2,562
Clallam	449	Island	1,689	Pacific	1,179	Wahkiakum	
Clark	7,611	Jefferson	255	Pend Oreille	68	Walla Walla	481
Columbia	30	King	29,618	Pierce	7,419	Whatcom	5,382
Cowlitz	2,213	Kitsap	2,119	San Juan	71	Whitman	645
Douglas	189	Kittitas	335	Skagit	1,533	Yakima	2,155
Ferry	4	Klickitat	99	Skamania	33	Other	



# **C**hapter 4 - **E**nergy Inventory



### Biomass Conversion to Electrical Energy

Another aspect of the inventory project was to calculate an approximate electrical power production from the available biomass. There are numerous technologies available and under research and development for the conversion of various types of biomass to energy, fuels and/or bioproducts. Below (Table 3) is a list of just some of these base technologies and their main characteristics. As can be seen in the summary, certain conversion technologies are better suited for particular biomass types such as anaerobic digestion for the conversion of wet, non-lignocellulosic material into electrical power or thermal processes such as combustion or pyrolysis for the conversion of dry lignocellulosic material. In fact, in all likelihood a regional or state renewable energy program for the conversion of available under-utilized biomass will most certainly involve the use of multiple technologies as opposed to a single technology and will most definitely need to focus on a biorefinery approach and the development of co-products that move well beyond just the production of power; incorporating such end products as biofuels and bioproducts.

For the purposes of this report and its goal of offering a rough estimate of energy potential, though, electrical energy was targeted as the final product and as such technologies were chosen that focused on energy as opposed to producing biofuels or bioproducts. A quick review of the available under-utilized biomass in the state shows that two general streams are being produced: (1) the relatively dry lignocellulosic material from the forestry, agricultural residue, and municipal sectors and (2) the relatively wet residues constituted by the animal manures and processing wastes. Thus, similar to the case of the California Biomass Assessment, two simple representative technologies, combustion and anaerobic digestion, were chosen to roughly calculate the amount of electrical energy or power available from the biomass (CEC, 2004).

The choices of inventorying the energy via anaerobic digestion and combustion are by no means a statement of support for their use in a future bioenergy economy, but should simply be viewed as a relatively efficient way to generate estimates of potential energy within this report. In regard to successfully implementing the appropriate infrastructure in a future bioenergy economy within the state, policy makers and industry representatives will need to put forward much more detailed business plans that look more closely at the appropriate technologies to be used, recognizing both their strengths and weaknesses in generating energy, protecting the environment, and maintaining a philosophy of ‘no waste’. For example, simple combustion of the lignocellulosic waste most definitely can be seen as a well known conversion technology that yields potentially harsh impacts on air quality, but leads to generation of solid waste (ash) and as such does not effectively embrace the Ecology commitment to ‘zero waste’. Thus, it is hoped that through procurement of additional funds, a Phase II biomass and bioenergy report can be completed which will more effectively look at the economic and environmental concerns of collection and processing of the biomass through various specific conversion technologies, and ultimately better assisting future industries in choosing the appropriate methods and business plans.

Table 3. Conversion Technologies

<b>Technology</b>	<b>Products</b>	<b>Comments</b>
<i>Thermo-chemical</i>	<i>In general, high temperature and high conversion processes best suited for low moisture biomass</i>	
Combustion	Heat	High temperature incomplete oxidation using high volumes of air producing gaseous and solid pollutants, no useful high value by-products
Gasification	Fuel Gases	Controlled incomplete oxidation using air control and/or indirect heating for production of fuels and tars, oils, condensates, char and ash as well. Fuels can be converted to methanol and/or Fischer-Tropschs for higher value bioproducts
Pyrolysis	Fuel Oils	High temperature thermal, non-oxygenated degradation to

		fuel oils as well as by-product gases and solids. Fuel oils can be used directly in boilers or converted to higher value bio-products. Catalysts, cracking and arcing can be used as refinements for the thermal process
<i>Bio-chemical</i>	<i>In general, lower temperature and lower conversion rate processes better suited for higher moisture biomass</i>	
Anaerobic Digestion	Biogas (CH <sub>4</sub> + CO <sub>2</sub> )	Non-oxygen bacterial conversion. Sensitivity to required bacterial growth conditions such as temperature, C/N ratio, pH, retention time, etc. Pre-treatment required for lignocellulosic material degradation with lignins non-reactive
Aerobic	Stable solid	Oxygenated bacterial conversion such as composting or activated sludge. Higher conversion rate than anaerobic digestion but generally no gaseous fuel products. Also bacterial growth considerations required
Fermentation	Fuel (Ethanol) or High Value Bio-products	Oxygenated microbial fermentation for production of fuel and/or high value bio-products. Pre-treatment required for lignocellulosic material degradation with lignins non-reactive
<i>Physio-chemical</i>	<i>In general, suitable for oils, fats, greases, and animal tallows</i>	
Trans-esterification	Biodiesel	Catalytic production of fatty acid alkyl esters (biodiesel) by removal of glycerols through combination with alcohol

### Energy Calculation Methodology for Combustion

A three step process was utilized to determine the potential energy production from the combustion of the woody and straw waste. First, coefficients of higher heating value (HHV) were obtained for each of the inventoried biomass (Table 4) (CEC, 2004). These HHV values were then multiplied by the dry tonnage of the selected biomass as well as a pound to ton conversion ratio to determine the number of Btu available. Second, a conversion ratio for Btu to kWh ( $2.9307 \times 10^{-4}$  kWh/Btu) was used to determine the number of kWh potentially available. Third a conversion efficiency of 20% was used as a responsible average for existing combustion conversion technology that does not employ utilization of the extracted hot combustion gases (CEC, 2004; Wilbur, 1985; Klass, 1993; and Chartier, 1992). Note that this conservative efficiency approach was utilized knowing full well that many facilities generate from modern combined heat/power systems (CHP), but it was assumed that for immediate dissemination of project results it should be estimated that the number of older, less efficient non-CHP systems outnumbers the more efficient ones. The items inventoried that underwent the assumed combustion conversion included: all seven agricultural field residues; all four forestry residues; as well as yard, yard burn, paper and construction/demolition wood from the municipal solids category (Table 1). Please note also that some of the items inventoried via combustion are actively recycled, such as MSW paper and mill residue, and as such would not be available for energy production, but for purposes of this report, which aimed at generating an estimate of overall potential, they were all assumed available for energy conversion. All other inventoried biomass items underwent an assumed anaerobic digestion process for their energy calculation.

#### *Step 1: HHV Coefficients*

HHV was used for the coefficient as opposed to LHV because HHV as been shown to be a more accurate indicator of energy potential for systems that are not utilizing extracted hot combustion gases as is presumed in this study (ORNL, 2005). Below is a table of the coefficients used with sources for the information having been obtained from Phyllis, 2005; Themelis et al, 2002; Tchobanoglous et al, 1993 and the CEC (2004) report.

Table 4. HHV Coefficients for Selected Biomass

<b>Biomass</b>	<b>HHV (Btu/dry lb)</b>
Wheat Straw	7,527
Grass Seed Straw	7,931
Barley Straw	7,441
Corn Stover	7,587
Other Field Residue	7,527
Mint Slug	7,527
Hops Residue	7,527
Logging Residue	9,027
Forest Thinnings	9,027
Mill Residue	8,597
Land Clearing Debris	8,597
Yard Waste	6,448
Yard Waste-Burn	6,448
Paper	7,642
MSW Wood Residue	8,304

**Energy Calculation Methodology for Anaerobic Digestion**

The general procedure for calculating the potential bioenergy from the inventoried dry biomass that was envisioned to undergo anaerobic digestion was to: (1) calculate the amount of volatile solids (VS) using the dry biomass data and VS content for each biomass type; (2) calculate the production of methane using the VS data and known or estimated methane yield/unit VS parameters for the individual biomass types; and (3) calculate the production of energy using the methane data and typical conversion efficiencies from methane to energy. The efficiency from biomass to electrical energy can largely be divided into three levels: low efficiency (about 20%), medium efficiency (about 30%), and high efficiency (about 40%) with all three efficiency categories a result of the strong dependence on the scale of power plants and the type of electric generation. The representative efficiency chosen for the anaerobic digestion process utilizing the conversion of biogas to electricity was 30% which is approximately the average or median efficiency level, and it is also a reachable level under current available technology (Wilbur, 1985; Klass, 1993; and Chartier, 1992).

The ensuing information outlines the necessary assumptions and corresponding references used when following the above described three-step process. Within each step described is a short paragraph describing the general approach made and a table displaying the important assumptions and references.

**Step 1: Calculating Volatile Solids (VS)**

Volatile solids (VS) are the most prevalent index of methane production in anaerobic digestion, and the production of methane is often expressed as per unit VS. VS content is typically expressed as the percentage of total solid (TS). Table 5 below gives VS content values for the dry biomass studied.

Table 5. VS Contents of Biomass Used in the Project

<b>Biomass</b>	<b>Value Used</b>	<b>Reference</b>
Dairy Manure	83% TS	USDA, 1985
Cattle Manure	85% TS	USDA, 1985
Horse Manure	67% TS	USDA, 1985
Swine Manure	78% TS	USDA, 1985

Poultry Manure	76% TS	USDA, 1985
Cull Onions	95% TS	Gunaseelan, 1997
Cull Potatoes	95% TS	Gunaseelan, 1997
Cull Apples	95% TS	Gunaseelan, 1997
Cull Miscellaneous Fruit	95% TS	Gunaseelan, 1997
Asparagus Butts	95% TS	Gunaseelan, 1997
Apple Pomace	95% TS	Gunaseelan, 1997
Grape Pomace	95% TS	Gunaseelan, 1997
Berry Pomace	95% TS	Gunaseelan, 1997
Miscellaneous Fruit Pomace	95% TS	Gunaseelan, 1997
Cheese Whey	95% TS	Hall and Adams, 1988
Potato Solids	95% TS	Gunaseelan, 1997
Asparagus Trimmings	95% TS	Gunaseelan, 1997
Mixed Vegetable Trimmings	95% TS	Gunaseelan, 1997
Poultry Feathers	96.7% TS	Salminen and Rintala, 2002
Poultry Meat Processing	85% TS	Salminen and Rintala, 2002
Beef Meat Processing	85% TS	Salminen et al, 2000
Swine Meat Processing	85% TS	Salminen et al, 2000
All Animal Mortality	85% TS	Salminen et al, 2000
Fish Processing Waste	55.3% TS	Mshandete et al, 2004
Shellfish Processing Waste	69% TS	O'Keefe et al, 1996
Food Waste	90% TS	Chynoweth et al, 2003
Other Organic Waste	90% TS	Estimated
Yellow Grease	90% TS	Estimated
Brown Grease	90% TS	Estimated
Biosolids	76.5% TS	Wilbur, 1985

*Step 2: Calculating Methane Yield*

Methane yield from biomass is expressed as the amount of methane produced per VS unit. The data in Table 6 shows that methane yield can differ greatly for different biomass. The values obtained range from small laboratory scale biochemical methane potential experiments to actual pilot scale or commercial scale reported values. With some of the biomass types such as greases and the animal tallow and waste, only estimates could be made because so little research has been done on the anaerobic digestion of grease like material because of its ineffectiveness at breaking down the chemical structure.

Table 6. Methane Yield from Different Biomass (m<sup>3</sup>/kg VS)

<b>Biomass</b>	<b>Value Used</b>	<b>Reference</b>
Dairy Manure	0.21 (average)	Wilbur, 1985
Cattle Manure	0.21 (same value as dairy)	Wilbur, 1985
Horse Manure	0.021	Hammad et al, 1999
Swine Manure	0.33	Gerwig, 1996
Poultry Manure	0.33 (high grain diet)	Gerwig, 1996
Cull Onions	0.40	Gunaseelan, 2004
Cull Potatoes	0.426	Stewart et al, 1984
Cull Apples	0.228 (estimated from peels)	Lane, 1984
Cull Miscellaneous Fruit	0.286	Gunaseelan, 1997
Asparagus Butts	0.23 (estimated from waste)	Knol et al, 1978
Apple Pomace	0.228 (estimated from peels)	Lane, 1984

Grape Pomace	0.252 (average 6 fruits)	Viswanath et al, 1992
Berry Pomace	0.261 (strawberry slurry)	Knol et al, 1978
Miscellaneous Fruit Pomace	0.286 (apricot)	Gunaseelan, 1997
Cheese Whey	0.31	Hall and Adams, 1988
Potato Solids	0.267	Gunaseelan, 2004
Asparagus Trimmings	0.219	Knol et al, 1978
Mixed Vegetable Trimmings	0.417 (carrot)	Gunaseelan, 1997
Poultry Feathers	0.21	Salminen and Rintala, 2002
Poultry Meat Processing	0.60	Salminen and Rintala, 2002
Beef Meat Processing	0.54 (general slaughter solid)	Salminen et al, 2000
Swine Meat Processing	0.54 (general slaughter solid)	Salminen et al, 2000
All Animal Mortality	0.54 (general slaughter solid)	Salminen et al, 2000
Fish Processing Waste	0.30	Mshandete et al, 2004
Shellfish Processing Waste	0.31	O'Keefe et al, 1996
Food Waste	0.54	Chynoweth et al, 2003
Other Organic Waste	0.21 (estimate from manure)	Estimate
Yellow Grease	0.35 (estimate from oils)	Ergu et al, 2000 and Bayrakci et al, 2001
Brown Grease	0.35 (estimate from oils)	Ergu et al, 2000 and Bayrakci et al, 2001
Biosolids	0.327	Klass, 1998

Once the biochemical methane potential parameters were used to determine volume of methane production for each of the individual inventoried items, two conversion factors were used to determine electrical energy in terms of kWh. These conversion factors were: (1) 1,048 BTU/ft<sup>3</sup> of methane which is the heat value of pure, dry methane gas under normal atmospheric and temperature conditions and (2) 2.931 x 10<sup>-4</sup> kWh/BTU which is the conversion ratio between electrical energy in kWh and thermal energy in BTU. This kWh calculation is a theoretical electrical energy production and does not take into consideration generation efficiency so a third step was employed to factor in a reasonable, average generation efficiency factor which for the purposes of this report was the aforementioned 30% efficiency.

### Energy Results

Below is a summary of the energy from each inventoried item-- county level information is in Chapter 5.

Table 7. Energy Values by Biomass Type (Via Assumed Combustion and Anaerobic Digestion)

Wheat	1,424.02	Cull Onions	2.60	Pork Meat	0.36
Grass Seed	118.77	Cull Potatoes	109.21	All Mortality	7.64
Barley	280.99	Cull Apples	26.24	Fish	3.91
Corn	64.84	Cull Fruit	7.17	Shellfish	2.32
Other Burn	140.42	Asparagus Butts	0.43	Food	352.95
Mint Slug	85.46	Apple Pomace	17.77	Yard	318.52
Hops	4.76	Grape Pomace	13.61	Yard Burn	27.07
Dairy	235.16	Berry Pomace	1.42	Other Organic	23.51
Cattle	127.73	Fruit Pomace	9.52	Paper	2,174.69
Horse	16.91	Cheese Whey	38.47	Wood	811.73
Swine	10.36	Potato Solids	13.74	Yellow Grease	17.02
Poultry	580.88	Asparagus T.	0.07	Brown Grease	18.90
Logging Residue	2,011.27	Vegetables	17.24	Biosolids	70.02
Forest Thinning	534.98	Feathers	4.75	<b>Total</b>	15,522.51
Mill Residue	5,318.30	Poultry Meat	8.24		
Land Clearing	421.76	Beef Meat	46.77		



# Chapter 5 - County Data

# Totals by County

## Adams

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	120,407	7,040	5,654	3,530	8,823	32,765		178,219		
<b>Energy (million kWh):</b>	106.22	6.21	4.99	3.11	7.78	28.90		157.22		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	10,385	7,363	2,733	246				20,727		
<b>Energy (million kWh):</b>	5.34	3.88	0.11	0.19				9.52		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>					277			277		
<b>Energy (million kWh):</b>					0.28			0.28		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>	170	14,954	603	295	23			16,046		
<b>Energy (million kWh):</b>	0.19	17.87	0.39	0.24	0.01			18.69		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	408			392	779	3,137	4	405	5,126	
<b>Energy (million kWh):</b>	0.26			0.31	0.68	2.25		0.47	3.97	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			1,219	15	170			2		
<b>Energy (million kWh):</b>			1.59	0.02	0.22			1.83		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	542	1,026	59	16	4,797	2,218	50	56		8,764
<b>Energy (million kWh):</b>	0.78	0.78	0.04	0.01	4.30	2.16	0.05	0.05		8.16
<b>Biomass (tons/year) County Grand Total:</b>		230,562		<b>Energy (million kWh) County Grand Total:</b>				199.68		

# Asotin

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	8,943		4,278		28			13,249
<b>Energy (million kWh):</b>	7.89		3.77		0.02			11.69

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		2,487	2,319	16		4,822
<b>Energy (million kWh):</b>		1.31	0.10	0.01		1.42

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	852	11,002	111,302	268	123,424
<b>Energy (million kWh):</b>	0.90	11.64	112.14	0.27	124.96

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>									
<b>Energy (million kWh):</b>									

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>					26			0
<b>Energy (million kWh):</b>					0.03			0.03

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	386	1,492	103	41	5,292	3,138	62	69	155	10,738
<b>Energy (million kWh):</b>	0.55	1.13	0.08	0.02	4.74	3.05	0.06	0.06	0.11	9.81
<b>Biomass (tons/year) County Grand Total:</b>		152,259								
<b>Energy (million kWh) County Grand Total:</b>							147.91			



# Benton

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	38,454				4,942	6,388	1,080	50,863		
<b>Energy (million kWh):</b>	33.92				4.36	5.63	0.95	44.87		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>		5,055	13,095	33				18,183		
<b>Energy (million kWh):</b>		2.66	0.54	0.03				3.23		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>					3,941			3,941		
<b>Energy (million kWh):</b>					3.97			3.97		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>	551	19,255	3,718	728	48			24,300		
<b>Energy (million kWh):</b>	0.62	23.00	2.38	0.58	0.03			26.61		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	2,518	6,932		967		4,040	9	2,826	17,291	
<b>Energy (million kWh):</b>	1.61	4.90		0.78		2.89	0.01	3.30	13.49	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>					1					
<b>Energy (million kWh):</b>										
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	3,645	11,802	451	420	42,319	25,830	463	514	4,896	90,341
<b>Energy (million kWh):</b>	5.23	8.92	0.34	0.23	37.90	25.14	0.43	0.47	3.62	82.28
<b>Biomass (tons/year) County Grand Total:</b>	204,920		<b>Energy (million kWh) County Grand Total:</b>				174.46			

# Chelan

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>					2,266			2,266
<b>Energy (million kWh):</b>					2.00			2.00

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		309	4,498			4,807
<b>Energy (million kWh):</b>		0.16	0.19			0.35

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	16,438	15,462	100,214	1,427	133,541
<b>Energy (million kWh):</b>	17.39	16.36	100.97	1.44	136.16

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>			3,748	1,276		5,024
<b>Energy (million kWh):</b>			2.40	1.02		3.42

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>	2,538			1,695					4,233
<b>Energy (million kWh):</b>	1.62			1.36					2.98

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>								
<b>Energy (million kWh):</b>								

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	2,460	6,939	292	297	25,123	15,726	205	228	913	52,183
<b>Energy (million kWh):</b>	3.53	5.24	0.22	0.17	22.50	15.30	0.19	0.21	0.67	48.04

**Biomass (tons/year) County Grand Total:**

202,054

**Energy (million kWh) County Grand Total:**

192.95

# Clallam

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

1,657	975	4,998	16		7,646
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Energy (million kWh):

0.85	0.51	0.21	0.01		1.59
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

81,860	9,878	375,150	1,735	468,623
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Energy (million kWh):

86.60	10.45	377.99	1.75	476.79
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

				10	0	0	0
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Energy (million kWh):

				0.01	0.19	0.10	0.30
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

2,771	4,036	476	436	24,472	10,292	202	224	449	43,358
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Energy (million kWh):

3.98	3.05	0.36	0.24	21.92	10.02	0.19	0.21	0.33	40.29
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Biomass (tons/year) County Grand Total:

520,181

Energy (million kWh) County Grand Total:

518.97

# Clark

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals		
<b>Biomass (tons/year):</b>	7,549	3,588	18,470	77	36,204			65,888		
<b>Energy (million kWh):</b>	3.88	1.89	0.77	0.06	26.80			33.40		
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals		
<b>Biomass (tons/year):</b>	22,638	2,308	63,386	14,742				103,074		
<b>Energy (million kWh):</b>	23.95	2.44	63.87	14.85				105.11		
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals	
<b>Biomass (tons/year):</b>			141		739				880	
<b>Energy (million kWh):</b>			0.10		0.64				0.75	
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals		
<b>Biomass (tons/year):</b>	913	631	538	5	118			2		
<b>Energy (million kWh):</b>	0.55	0.95	0.70	0.01	0.15			2.36		
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	9,224	16,376	2,030	1,608	97,145	41,106	1,144	1,271	7,611	177,515
<b>Energy (million kWh):</b>	13.23	12.38	1.53	0.90	87.01	40.01	1.05	1.17	5.62	162.90
<b>Biomass (tons/year) County Grand Total:</b>		349,562						304.52		
<b>Energy (million kWh) County Grand Total:</b>										

# Columbia

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	47,689		15,708		4,611			68,008
<b>Energy (million kWh):</b>	42.07		13.86		4.07			59.99

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		1,505	1,754			3,259
<b>Energy (million kWh):</b>		0.79	0.07			0.87

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	1,721	924		23	2,668
<b>Energy (million kWh):</b>	1.82	0.98		0.02	2.82

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>								3	3
<b>Energy (million kWh):</b>									

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>								
<b>Energy (million kWh):</b>								

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	97	261	17	3	1,105	531	12	14	30	2,070
<b>Energy (million kWh):</b>	0.14	0.20	0.01		0.99	0.52	0.01	0.01	0.02	1.90
<b>Biomass (tons/year) County Grand Total:</b>		76,008								
<b>Energy (million kWh) County Grand Total:</b>							65.58			

# Cowlitz

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

1,382	996	5,735	25	25,468	33,606
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Energy (million kWh):

0.71	0.52	0.24	0.02	18.86	20.35
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

86,967	5,775	733,471	1,990	828,203
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Energy (million kWh):

92.01	6.11	739.02	2.01	839.14
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

53	98	152
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Energy (million kWh):

0.04	0.11	0.15
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## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

747	516	42	0	1
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Energy (million kWh):

0.45	0.78	0.05	0.03	1.31
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

10,102	9,220	505	1,905	80,348	30,360	287	319	2,213	135,258
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Energy (million kWh):

14.49	6.97	0.38	1.06	71.96	29.55	0.26	0.29	1.63	126.61
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Biomass (tons/year) County Grand Total:

998,584

Energy (million kWh) County Grand Total:

987.56

# Douglas

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	66,375				1,779			68,154		
<b>Energy (million kWh):</b>	58.55				1.57			60.12		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>		2,385	3,992					6,377		
<b>Energy (million kWh):</b>		1.26	0.17					1.42		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>	302				503			805		
<b>Energy (million kWh):</b>	0.32				0.51			0.83		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>			3,279	1,117				4,396		
<b>Energy (million kWh):</b>			2.10	0.90				2.99		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	2,221			1,483					3,704	
<b>Energy (million kWh):</b>	1.42			1.19					2.61	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			351			31		1		
<b>Energy (million kWh):</b>			0.46			0.04		0.50		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	1,085	2,006	166	31	9,446	4,354	102	113	189	17,492
<b>Energy (million kWh):</b>	1.56	1.52	0.13	0.02	8.46	4.24	0.09	0.10	0.14	16.25
<b>Biomass (tons/year) County Grand Total:</b>	101,310		<b>Energy (million kWh) County Grand Total:</b>					84.72		

# Ferry

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals		
<b>Biomass (tons/year):</b>		2,010	6,774					8,784		
<b>Energy (million kWh):</b>		1.06	0.28					1.34		
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals		
<b>Biomass (tons/year):</b>	76,626	138,873			138			215,637		
<b>Energy (million kWh):</b>	81.07	146.92			0.14			228.13		
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals	
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals		
<b>Biomass (tons/year):</b>			319		29			0		
<b>Energy (million kWh):</b>			0.42		0.04			0.45		
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	102	377	49	2	1,701	708	22	25	4	2,990
<b>Energy (million kWh):</b>	0.15	0.28	0.04		1.52	0.69	0.02	0.02		2.72
<b>Biomass (tons/year) County Grand Total:</b>		227,759								
<b>Energy (million kWh) County Grand Total:</b>							232.65			



# Franklin

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	531,051	12,892		8,537	12,542			565,022
<b>Energy (million kWh):</b>	468.47	11.37		7.53	11.06			498.44

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>	10,421	9,930	6,569	181		27,101
<b>Energy (million kWh):</b>	5.36	5.23	0.27	0.14		11.01

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>				1,350	1,350
<b>Energy (million kWh):</b>				1.36	1.36

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>	593	19,158	1,516	103	282	21,652
<b>Energy (million kWh):</b>	0.66	22.89	0.97	0.08	0.18	24.79

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>	1,027	963		137	1,018	4,019	51	2,690	9,904
<b>Energy (million kWh):</b>	0.66	0.68		0.11	0.89	2.88	0.03	3.15	8.39

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>			1,756	11	212			3
<b>Energy (million kWh):</b>			2.29	0.01	0.28			2.58

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	4,165	4,647	163	129	26,547	11,600	169	188	242	47,850
<b>Energy (million kWh):</b>	5.98	3.51	0.12	0.07	23.78	11.29	0.16	0.17	0.18	45.26

**Biomass (tons/year) County Grand Total:**

674,858

**Energy (million kWh) County Grand Total:**

591.82

# Garfield

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	33,974	3,608	22,090		1,061			60,733
<b>Energy (million kWh):</b>	29.97	3.18	19.49		0.94			53.58

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		1,880	1,469			3,349
<b>Energy (million kWh):</b>		0.99	0.06			1.05

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	1,597	5,324		17	6,938
<b>Energy (million kWh):</b>	1.69	5.63		0.02	7.34

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>									
<b>Energy (million kWh):</b>									

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>					25			0
<b>Energy (million kWh):</b>					0.03			0.03

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	91	170	10	3	799	369	7	8		1,457
<b>Energy (million kWh):</b>	0.13	0.13	0.01		0.72	0.36	0.01	0.01		1.36
<b>Biomass (tons/year) County Grand Total:</b>	72,502				<b>Energy (million kWh) County Grand Total:</b>		63.36			

# Grant

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	100,353	8,756	4,977	23,371	20,282	20,738		178,476		
<b>Energy (million kWh):</b>	88.53	7.72	4.39	20.62	17.89	18.29		157.45		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	25,813	33,509	15,758	890				75,970		
<b>Energy (million kWh):</b>	13.28	17.66	0.65	0.68				32.27		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>					1,966			1,966		
<b>Energy (million kWh):</b>					1.98			1.98		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>	858	21,223	6,031	410	50			28,572		
<b>Energy (million kWh):</b>	0.96	25.36	3.86	0.33	0.03			30.53		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	4,085	2,118		544	2,523	4,452	9	5,337	19,068	
<b>Energy (million kWh):</b>	2.61	1.50		0.44	2.19	3.19	0.01	6.24	16.18	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			5,197	54	628			8		
<b>Energy (million kWh):</b>			6.78	0.07	0.82			7.67		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	2,738	4,516	285	81	22,104	10,041	237	263	237	40,503
<b>Energy (million kWh):</b>	3.93	3.41	0.22	0.05	19.80	9.77	0.22	0.24	0.18	37.81
<b>Biomass (tons/year) County Grand Total:</b>		350,434		<b>Energy (million kWh) County Grand Total:</b>				283.88		

# Grays Harbor

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

6,186	2,115	4,347	16		12,664
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Energy (million kWh):

3.18	1.11	0.18	0.01		4.49
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

199,066	14,873	728,232	1,161	943,332
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Energy (million kWh):

210.60	15.74	733.74	1.17	961.25
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

		57		606			147	810
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Energy (million kWh):

		0.04		0.53			0.17	0.74
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## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

		333			57	1	3
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Energy (million kWh):

		0.43			0.07	1.01	2.51
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

3,344	4,709	365	528	29,038	12,145	209	232	660	51,231
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Energy (million kWh):

4.80	3.56	0.28	0.29	26.01	11.82	0.19	0.21	0.49	47.65
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Biomass (tons/year) County Grand Total:

1,012,064

Energy (million kWh) County Grand Total:

1016.65

# Island

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

2,900	933	3,804			7,637
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Energy (million kWh):

1.49	0.49	0.16			2.14
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

889	146		2,577	3,612
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Energy (million kWh):

0.94	0.15		2.60	3.69
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

				20		0	0
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Energy (million kWh):

				0.03		0.02	0.04
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

1,697	3,751	545	248	18,897	8,478	230	256	1,689	35,791
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Energy (million kWh):

2.43	2.83	0.41	0.14	16.92	8.25	0.21	0.24	1.25	32.69
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Biomass (tons/year) County Grand Total:

47,087

Energy (million kWh) County Grand Total:

38.57

# Jefferson

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

1,382	663	2,071			4,116
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Energy (million kWh):

0.71	0.35	0.09			1.15
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

32,035	3,578	22,068	1,258	58,939
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Energy (million kWh):

33.89	3.79	22.24	1.27	61.18
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

				13		0	0
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Energy (million kWh):

				0.02		0.06	0.08
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

898	1,421	227	140	8,278	3,528	84	93	255	14,923
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Energy (million kWh):

1.29	1.07	0.17	0.08	7.41	3.43	0.08	0.09	0.19	13.81
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Biomass (tons/year) County Grand Total:

78,099

Energy (million kWh) County Grand Total:

76.22

# King

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals		
<b>Biomass (tons/year):</b>	24,414	4,665	26,901	90	287			56,357		
<b>Energy (million kWh):</b>	12.56	2.46	1.12	0.07	0.21			16.42		
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals		
<b>Biomass (tons/year):</b>	37,521	1,212	23,588	70,072				132,393		
<b>Energy (million kWh):</b>	39.70	1.28	23.77	70.60				135.35		
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals	
<b>Biomass (tons/year):</b>					2,390				2,390	
<b>Energy (million kWh):</b>					2.08				2.08	
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals		
<b>Biomass (tons/year):</b>			573	6	154	0	0	1		
<b>Energy (million kWh):</b>			0.75	0.01	0.20	0.32	0.05	1.32		
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals	
<b>Biomass (tons/year):</b>	67,269	147,076	6,913	15,465	728,785	170,538	5,311	5,897	29,618	1,176,872
<b>Energy (million kWh):</b>	96.51	111.15	5.22	8.63	652.73	165.97	4.89	5.43	21.87	1072.40
<b>Biomass (tons/year) County Grand Total:</b>		1,369,467								
<b>Energy (million kWh) County Grand Total:</b>							1227.57			

# Kitsap

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

Energy (million kWh):

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

Energy (million kWh):

Biomass (tons/year) County Grand Total:

258,818

Energy (million kWh) County Grand Total:

239.97



# Kittitas

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals		
<b>Biomass (tons/year):</b>					881			881		
<b>Energy (million kWh):</b>					0.78			0.78		
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals		
<b>Biomass (tons/year):</b>		6,822	20,170	66				27,058		
<b>Energy (million kWh):</b>		3.59	0.84	0.05				4.48		
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals		
<b>Biomass (tons/year):</b>	86,216	8,006			582			94,804		
<b>Energy (million kWh):</b>	91.21	8.47			0.59			100.27		
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals		
<b>Biomass (tons/year):</b>		207						207		
<b>Energy (million kWh):</b>		0.25						0.25		
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals	
<b>Biomass (tons/year):</b>						43		533	576	
<b>Energy (million kWh):</b>						0.03		0.62	0.65	
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals		
<b>Biomass (tons/year):</b>			896			82		1		
<b>Energy (million kWh):</b>			1.17			0.11		1.28		
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	1,097	3,247	193	130	11,715	7,267	106	118	335	24,208
<b>Energy (million kWh):</b>	1.57	2.45	0.15	0.07	10.49	7.07	0.10	0.11	0.25	22.26
<b>Biomass (tons/year) County Grand Total:</b>		148,713								
<b>Energy (million kWh) County Grand Total:</b>								129.97		

# Klickitat

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	13,226		2,498					15,724		
<b>Energy (million kWh):</b>	11.67		2.20					13.87		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	2,025	5,248	8,205	49				15,527		
<b>Energy (million kWh):</b>	1.04	2.77	0.34	0.04				4.19		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>	81,199	41,284	63,386	282				186,151		
<b>Energy (million kWh):</b>	85.91	43.68	63.87	0.28				193.73		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>		886						886		
<b>Energy (million kWh):</b>		1.06						1.06		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>		770				186		228	1,184	
<b>Energy (million kWh):</b>		0.54				0.13		0.27	0.94	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			860		86	0		1		
<b>Energy (million kWh):</b>			1.12		0.11	0.02		1.25		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>	
<b>Biomass (tons/year):</b>	564	1,790	109	65	6,426	3,936	59	65	99	13,113
<b>Energy (million kWh):</b>	0.81	1.35	0.08	0.04	5.76	3.83	0.05	0.06	0.07	12.05
<b>Biomass (tons/year) County Grand Total:</b>		233,565					227.10			
<b>Energy (million kWh) County Grand Total:</b>										

# Lewis

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year): 16,645 6,637 15,554 650 179,176 218,662

Energy (million kWh): 8.56 3.50 0.65 0.49 132.66 145.86

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
-----------------	------------------	--------------	----------------------	-----------------

Biomass (tons/year): 173,795 13,297 441,353 1,622 630,067

Energy (million kWh): 183.87 14.07 444.69 1.63 644.26

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
--------------	--------------	--------------	-------------------	-------------	---------------	---------------------	------------------	------------------------

Biomass (tons/year): 21 1,633 158 1,812

Energy (million kWh): 0.02 1.42 0.18 1.62

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year): 3,877 2,678 1,004 6 316 8

Energy (million kWh): 2.32 4.03 1.31 0.01 0.41 8.09

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year): 4,590 4,961 468 871 36,057 17,672 212 236 340 65,407

Energy (million kWh): 6.59 3.75 0.35 0.49 32.29 17.20 0.20 0.22 0.25 61.33

Biomass (tons/year) County Grand Total:

923,829

Energy (million kWh) County Grand Total:

861.16

# Lincoln

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	173,687		76,202		622			250,511
<b>Energy (million kWh):</b>	153.22		67.22		0.55			220.99

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		5,805	7,597	197		13,599
<b>Energy (million kWh):</b>		3.06	0.32	0.15		3.52

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	2,559	164		120	2,843
<b>Energy (million kWh):</b>	2.71	0.17		0.12	3.00

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>		3,287				3,287
<b>Energy (million kWh):</b>		3.93				3.93

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>						690			690
<b>Energy (million kWh):</b>						0.49			0.49

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>			896	12	80			1
<b>Energy (million kWh):</b>			1.17	0.02	0.10			1.29

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	104	493	44	2	1,865	940	31	34		3,513
<b>Energy (million kWh):</b>	0.15	0.37	0.03		1.67	0.91	0.03	0.03		3.20

**Biomass (tons/year) County Grand Total:**

275,431

**Energy (million kWh) County Grand Total:**

236.43

# Mason

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

Energy (million kWh):

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
-----------------	------------------	--------------	----------------------	-----------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
--------------	--------------	--------------	-------------------	-------------	---------------	---------------------	------------------	------------------------

Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
------------	---------------	-----------	----------------	-------	--------------	---------------	--------------	-----------	------------------

Biomass (tons/year):

Energy (million kWh):

Biomass (tons/year) County Grand Total:

331,444

Energy (million kWh) County Grand Total:

331.66

# Okanogan

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	3,437				10,025			13,462
<b>Energy (million kWh):</b>	3.03				8.84			11.88

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		10,555	27,352	49	87	38,043
<b>Energy (million kWh):</b>		5.56	1.14	0.04	0.06	6.80

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	64,142	118,499	48,103	602	231,346
<b>Energy (million kWh):</b>	67.86	125.37	48.47	0.61	242.30

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>			4,685	1,595		6,280
<b>Energy (million kWh):</b>			3.00	1.28		4.28

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>	3,173			2,119					5,292
<b>Energy (million kWh):</b>	2.03			1.70					3.73

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>			1,649		151			2
<b>Energy (million kWh):</b>			2.15		0.20			2.35

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	1,226	2,498	207	26	14,476	4,912	118	131	237	23,831
<b>Energy (million kWh):</b>	1.76	1.89	0.16	0.01	12.97	4.78	0.11	0.12	0.18	21.97

**Biomass (tons/year) County Grand Total:**

320,054

**Energy (million kWh) County Grand Total:**

293.30

## Other

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	4,748	39,292	7,001	27,865				78,906		
<b>Energy (million kWh):</b>	4.19	34.66	6.18	24.58				69.61		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	10,495			7,040				17,535		
<b>Energy (million kWh):</b>	5.40			5.35				10.75		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>	29	665	777	149	7			1,626		
<b>Energy (million kWh):</b>	0.03	0.79	0.50	0.12				1.44		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	526	193	100	197	2,952	139	1		4,108	
<b>Energy (million kWh):</b>	0.34	0.14	0.07	0.16	2.57	0.10			3.37	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			4,014	33	323			6		
<b>Energy (million kWh):</b>			5.24	0.04	0.42			5.70		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>Biomass (tons/year) County Grand Total:</b>		106,545								
<b>Energy (million kWh) County Grand Total:</b>							90.87			

# Pacific

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

3,424	1,494	1,727			6,645
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Energy (million kWh):

1.76	0.79	0.07			2.62
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

104,627	10,490	66,203	462	181,782
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Energy (million kWh):

110.69	11.10	66.70	0.47	188.96
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

		197						197
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Energy (million kWh):

		0.14						0.14
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## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

				40	0	0	1
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Energy (million kWh):

				0.05	0.40	0.31	0.76
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

510	1,168	170	74	5,804	2,618	64	71	1,179	11,657
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Energy (million kWh):

0.73	0.88	0.13	0.04	5.20	2.55	0.06	0.07	0.87	10.52
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Biomass (tons/year) County Grand Total:

201,626

Energy (million kWh) County Grand Total:

203.01



# Pend Orielle

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

Energy (million kWh):

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

Energy (million kWh):

Biomass (tons/year) County Grand Total:

217,701

Energy (million kWh) County Grand Total:

220.47

# Pierce

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals		
<b>Biomass (tons/year):</b>	10,090	3,567	24,861	131	112,912			151,561		
<b>Energy (million kWh):</b>	5.19	1.88	1.03	0.10	83.60			91.80		
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals		
<b>Biomass (tons/year):</b>	67,160	5,037	401,001		84,968			558,166		
<b>Energy (million kWh):</b>	71.05	5.33	404.04		85.61			566.03		
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals		
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals	
<b>Biomass (tons/year):</b>			23		987				1,010	
<b>Energy (million kWh):</b>			0.02		0.86				0.88	
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals		
<b>Biomass (tons/year):</b>	170	117	502	8	97	0	0	1		
<b>Energy (million kWh):</b>	0.10	0.18	0.66	0.01	0.13	0.08	0.03	1.19		
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	45,406	48,697	3,924	8,282	431,417	86,089	2,234	2,481	7,419	635,949
<b>Energy (million kWh):</b>	65.14	36.80	2.97	4.62	386.40	83.78	2.06	2.28	5.48	589.53
<b>Biomass (tons/year) County Grand Total:</b>		1,347,804						1249.42		
<b>Energy (million kWh) County Grand Total:</b>										

# San Juan

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

Energy (million kWh):

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
-----------------	------------------	--------------	----------------------	-----------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
--------------	--------------	--------------	-------------------	-------------	---------------	---------------------	------------------	------------------------

Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

Energy (million kWh):

Biomass (tons/year) County Grand Total:

10,308

Energy (million kWh) County Grand Total:

7.71

# Skagit

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	4,044				282			4,326		
<b>Energy (million kWh):</b>	3.57				0.25			3.82		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	32,258	7,152	7,258		73,779			120,447		
<b>Energy (million kWh):</b>	16.60	3.77	0.30		54.62			75.29		
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>	56,044	1,120	224,089	1,889				283,142		
<b>Energy (million kWh):</b>	59.29	1.18	225.78	1.90				288.17		
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>		3,384						3,384		
<b>Energy (million kWh):</b>		4.04						4.04		
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>			285		3,160	710		115	4,270	
<b>Energy (million kWh):</b>			0.21		2.75	0.51		0.13	3.60	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>	611	422	1,147		289	0	0	3		
<b>Energy (million kWh):</b>	0.37	0.64	1.50		0.38	0.14	0.18	3.19		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>	
<b>Biomass (tons/year):</b>	2,883	5,027	559	657	33,631	14,016	329	366	1,533	59,001
<b>Energy (million kWh):</b>	4.14	3.80	0.42	0.37	30.12	13.64	0.30	0.34	1.13	54.26
<b>Biomass (tons/year) County Grand Total:</b>	477,611		<b>Energy (million kWh) County Grand Total:</b>					432.37		

# Skamania

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

Energy (million kWh):

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
-----------------	------------------	--------------	----------------------	-----------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

Energy (million kWh):

Biomass (tons/year) County Grand Total:

41,421

Energy (million kWh) County Grand Total:

41.26

# Snohomish

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	4,427							4,427
<b>Energy (million kWh):</b>	3.90							3.90

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>	32,553	7,300	26,400	667	97,061	163,981
<b>Energy (million kWh):</b>	16.75	3.85	1.10	0.51	71.86	94.06

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	40,719	2,011	448,177	102,904	593,811
<b>Energy (million kWh):</b>	43.08	2.13	451.57	103.68	600.46

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>					3,186			40	3,226
<b>Energy (million kWh):</b>					2.77			0.05	2.82

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>	395	273	1,075	7	265	0		2
<b>Energy (million kWh):</b>	0.24	0.41	1.40	0.01	0.35	0.05		2.46

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	21,327	31,206	3,498	4,986	231,628	93,888	1,928	2,141	13,865	404,467
<b>Energy (million kWh):</b>	30.60	23.58	2.64	2.78	207.46	91.37	1.77	1.97	10.24	372.42

**Biomass (tons/year) County Grand Total:**

1,172,033

**Energy (million kWh) County Grand Total:**

1076.12

# Spokane

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	61,492	41,800	29,866					133,158
<b>Energy (million kWh):</b>	54.25	36.87	26.35					117.47

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>	4,235	5,058	30,252	148		39,693
<b>Energy (million kWh):</b>	2.18	2.67	1.26	0.11		6.21

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	28,570	19,454	35,148	5,143	88,315
<b>Energy (million kWh):</b>	30.23	20.58	35.41	5.18	91.40

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>									
<b>Energy (million kWh):</b>									

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>			789	9	95			1
<b>Energy (million kWh):</b>			1.03	0.01	0.12			1.17

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	23,201	33,220	1,993	696	171,232	76,323	1,300	1,443	6,886	316,294
<b>Energy (million kWh):</b>	33.29	25.10	1.51	0.39	153.36	74.28	1.20	1.33	5.09	295.54

**Biomass (tons/year) County Grand Total:**

578,353

**Energy (million kWh) County Grand Total:**

511.79

# Stevens

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	2,863		3,021					5,884		
<b>Energy (million kWh):</b>	2.53		2.67					5.19		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>				
<b>Biomass (tons/year):</b>	4,542	7,422	18,491	181	122	30,758				
<b>Energy (million kWh):</b>	2.34	3.91	0.77	0.14	0.09	7.24				
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>	<b>Forestry Totals</b>					
<b>Biomass (tons/year):</b>	160,203	13,483	363,195	759	537,640					
<b>Energy (million kWh):</b>	169.49	14.26	365.94	0.76	550.46					
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>				
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>										
<b>Energy (million kWh):</b>										
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>			1,362	11	141			2		
<b>Energy (million kWh):</b>			1.78	0.01	0.18			1.98		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper</b>	<b>Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	2,607	3,380	240	58	25,097	7,028	123	137		38,669
<b>Energy (million kWh):</b>	3.74	2.55	0.18	0.03	22.48	6.84	0.11	0.13		36.06
<b>Biomass (tons/year) County Grand Total:</b>	614,466		<b>Energy (million kWh) County Grand Total:</b>					600.94		



# Thurston

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year): 18,817 5,184 19,578 675 219,301 263,555

Energy (million kWh): 9.68 2.73 0.81 0.51 162.37 176.11

## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
-----------------	------------------	--------------	----------------------	-----------------

Biomass (tons/year): 41,557 2,666 331,015 7,110 382,348

Energy (million kWh): 43.97 2.82 333.52 7.16 387.47

## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
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Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year): 11 1,845 1,856

Energy (million kWh): 0.01 1.60 1.61

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
------------------	--------------	-----------	-----------	-----------------	------------	-----------------	--------------------------

Biomass (tons/year): 851 588 538 7 175 2

Energy (million kWh): 0.51 0.88 0.70 0.01 0.23 2.33

## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year): 5,960 10,569 1,384 1,061 59,375 29,682 669 743 2,562 112,005

Energy (million kWh): 8.55 7.99 1.05 0.59 53.18 28.89 0.62 0.68 1.89 103.43

Biomass (tons/year) County Grand Total:

761,922

Energy (million kWh) County Grand Total:

670.96

# Wahkiakum

## FIELD RESIDUE

Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL WASTE

Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
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Biomass (tons/year):

884	810	732			2,426
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Energy (million kWh):

0.45	0.43	0.03			0.91
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## FORESTRY

Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
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Biomass (tons/year):

28,595	3,762	22,638	92	55,087
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Energy (million kWh):

30.25	3.98	22.81	0.09	57.13
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## FOOD PACKING

Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
-------------	---------------	-------------	-----------------	-----------------	---------------------

Biomass (tons/year):

Energy (million kWh):

## FOOD PROCESSING Totals

Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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Biomass (tons/year):

Energy (million kWh):

## ANIMAL PROCESSING

Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
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Biomass (tons/year):

				15	0	0	0
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Energy (million kWh):

				0.02	0.03	0.01	0.06
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## MUNICIPAL Totals

Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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Biomass (tons/year):

96	211	35	16	1,133	496	11	13		2,011
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Energy (million kWh):

0.14	0.16	0.03	0.01	1.01	0.48	0.01	0.01	0.00	1.85
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Biomass (tons/year) County Grand Total:

59,615

Energy (million kWh) County Grand Total:

59.96

# Walla Walla

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	120,912	13,376	12,795		16,853			163,936
<b>Energy (million kWh):</b>	106.66	11.80	11.29		14.87			144.62

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		16,016	7,295	350		23,661
<b>Energy (million kWh):</b>		8.44	0.30	0.27		9.01

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	4,468			822	5,290
<b>Energy (million kWh):</b>	4.73			0.83	5.56

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>	78	6,896	1,812	347	36	9,169
<b>Energy (million kWh):</b>	0.09	8.24	1.16	0.28	0.02	9.79

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>	1,227	1,155		461		1,447	7	1,219	5,515
<b>Energy (million kWh):</b>	0.78	0.82		0.37		1.04		1.43	4.43

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>								1
<b>Energy (million kWh):</b>								

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	1,512	4,984	6,065	173	17,850	10,862	171	190	481	42,288
<b>Energy (million kWh):</b>	2.17	3.77	4.58	0.10	15.99	10.57	0.16	0.17	0.36	37.86

**Biomass (tons/year) County Grand Total:**

249,860

**Energy (million kWh) County Grand Total:**

211.26

# Whatcom

<b>FIELD RESIDUE</b>	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals	
<b>Biomass (tons/year):</b>					45			45	
<b>Energy (million kWh):</b>					0.04			0.04	
<b>ANIMAL WASTE</b>	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals	
<b>Biomass (tons/year):</b>	113,751	22,291	12,643	220	17,398			166,303	
<b>Energy (million kWh):</b>	58.53	11.75	0.53	0.17	12.88			83.85	
<b>FORESTRY</b>	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals	
<b>Biomass (tons/year):</b>	45,442	1,312	82,559	5,542				134,855	
<b>Energy (million kWh):</b>	48.08	1.39	83.18	5.58				138.23	
<b>FOOD PACKING</b>	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals	
<b>Biomass (tons/year):</b>		708						708	
<b>Energy (million kWh):</b>		0.85						0.85	
<b>FOOD PROCESSING Totals</b>	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>			1,050		11,152	148		21	12,370
<b>Energy (million kWh):</b>			0.77		9.70	0.11		0.02	10.59
<b>ANIMAL PROCESSING</b>	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals	
<b>Biomass (tons/year):</b>			3,369		840	1	0	7	
<b>Energy (million kWh):</b>			4.40		1.10	1.25	0.34	7.08	
<b>MUNICIPAL Totals</b>	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	5,527	8,150	957	1,002	55,055	22,883	532	591	5,382
<b>Energy (million kWh):</b>	7.93	6.16	0.72	0.56	49.31	22.27	0.49	0.54	3.97
<b>Biomass (tons/year) County Grand Total:</b>		421,661							
<b>Energy (million kWh) County Grand Total:</b>							332.60		

# Whitman

## FIELD RESIDUE

	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
<b>Biomass (tons/year):</b>	264,460	7,876	133,905		9,751			415,992
<b>Energy (million kWh):</b>	233.30	6.95	118.13		8.60			366.97

## ANIMAL WASTE

	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
<b>Biomass (tons/year):</b>		4,332	4,885	1,363		10,580
<b>Energy (million kWh):</b>		2.28	0.20	1.04		3.52

## FORESTRY

	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
<b>Biomass (tons/year):</b>	240			314	554
<b>Energy (million kWh):</b>	0.25			0.32	0.57

## FOOD PACKING

	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
<b>Biomass (tons/year):</b>						
<b>Energy (million kWh):</b>						

## FOOD PROCESSING Totals

	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
<b>Biomass (tons/year):</b>								67	67
<b>Energy (million kWh):</b>								0.08	0.08

## ANIMAL PROCESSING

	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
<b>Biomass (tons/year):</b>	365	252	573	84	68			2
<b>Energy (million kWh):</b>	0.22	0.38	0.75	0.11	0.09			1.54

## MUNICIPAL Totals

	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
<b>Biomass (tons/year):</b>	589	2,440	112	95	14,900	5,963	123	136	645	25,003
<b>Energy (million kWh):</b>	0.85	1.84	0.08	0.05	13.35	5.80	0.11	0.13	0.48	22.69

**Biomass (tons/year) County Grand Total:**

453,537

**Energy (million kWh) County Grand Total:**

395.38

# Yakima

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>	
<b>Biomass (tons/year):</b>	13,692		527	10,199	64,381	36,988	4,320	130,107	
<b>Energy (million kWh):</b>	12.08		0.46	9.00	56.79	32.63	3.81	114.78	
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>	<b>Animal Waste Totals</b>			
<b>Biomass (tons/year):</b>	115,224	43,853	30,215	125	22,670	212,087			
<b>Energy (million kWh):</b>	59.29	23.11	1.26	0.09	16.78	100.53			
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>		<b>Forestry Totals</b>			
<b>Biomass (tons/year):</b>	171,796	37,426	252,539	2,359		464,120			
<b>Energy (million kWh):</b>	181.75	39.60	254.45	2.38		478.18			
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>	<b>Food Packing Totals</b>			
<b>Biomass (tons/year):</b>	44	789	14,870	2,914	221	18,837			
<b>Energy (million kWh):</b>	0.05	0.94	9.51	2.34	0.14	12.98			
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>
<b>Biomass (tons/year):</b>	10,071	7,124		3,870	11,285	166	40	857	33,412
<b>Energy (million kWh):</b>	6.44	5.03		3.10	9.81	0.12	0.02	1.00	25.53
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>	
<b>Biomass (tons/year):</b>	4	3	6,882	8	1,226			11	
<b>Energy (million kWh):</b>			8.98	0.01	1.60			10.59	
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>
<b>Biomass (tons/year):</b>	7,165	21,811	809	843	78,537	49,396	684	759	2,155
<b>Energy (million kWh):</b>	10.28	16.48	0.61	0.47	70.34	48.07	0.63	0.70	1.59
<b>Biomass (tons/year) County Grand Total:</b>	1,028,844		<b>Energy (million kWh) County Grand Total:</b>					891.76	

# Total

<b>FIELD RESIDUE</b>	<b>Wheat Straw</b>	<b>Grass Seed Straw</b>	<b>Barley Straw</b>	<b>Corn Stover</b>	<b>Other Field Residue</b>	<b>Mint Slug</b>	<b>Hops Residue</b>	<b>Field Residue Totals</b>		
<b>Biomass (tons/year):</b>	1,614,234	134,640	318,522	73,502	159,174	96,878	5,400	2,402,349		
<b>Energy (million kWh):</b>	1424.02	118.77	280.99	64.84	140.42	85.46	4.76	2119.27		
<b>ANIMAL WASTE</b>	<b>Dairy</b>	<b>Cattle</b>	<b>Horse</b>	<b>Swine</b>	<b>Poultry</b>				<b>Animal Waste Totals</b>	
<b>Biomass (tons/year):</b>	457,032	242,404	407,160	13,632	784,577				1,904,805	
<b>Energy (million kWh):</b>	235.16	127.73	16.91	10.36	580.88				971.05	
<b>FORESTRY</b>	<b>Logging Residue</b>	<b>Forest Thinnings</b>	<b>Mill Residue</b>	<b>Land Clearing Debris</b>					<b>Forestry Totals</b>	
<b>Biomass (tons/year):</b>	1,901,072	505,666	5,278,353	418,595					8,103,686	
<b>Energy (million kWh):</b>	2011.27	534.98	5318.30	421.76					8286.31	
<b>FOOD PACKING</b>	<b>Cull Onions</b>	<b>Cull Potatoes</b>	<b>Cull Apples</b>	<b>Cull Misc Fruit</b>	<b>Asparagus Butts</b>				<b>Food Packing Totals</b>	
<b>Biomass (tons/year):</b>	2,322	91,412	41,039	8,934	667				144,374	
<b>Energy (million kWh):</b>	2.60	109.21	26.24	7.17	0.43				145.65	
<b>FOOD PROCESSING Totals</b>	<b>Apple Pomace</b>	<b>Grape Pomace</b>	<b>Berry Pomace</b>	<b>Misc Fruit Pomace</b>	<b>Cheese Whey</b>	<b>Potato Solids</b>	<b>Asparagus Trimmings</b>	<b>Mixed Vegetables</b>	<b>Food Processing Totals</b>	
<b>Biomass (tons/year):</b>	27,794	19,254	1,938	11,865	44,255	19,177	120	14,744	139,148	
<b>Energy (million kWh):</b>	17.77	13.61	1.42	9.52	38.47	13.74	0.07	17.24	111.83	
<b>ANIMAL PROCESSING</b>	<b>Poultry Feathers</b>	<b>Poultry Meat</b>	<b>Beef Meat</b>	<b>Pork Meat</b>	<b>All Animal Meat</b>	<b>Fish Waste</b>	<b>Shellfish Waste</b>	<b>Animal Processing Totals</b>		
<b>Biomass (tons/year):</b>	7,932	5,479	35,842	280	5,857	4	2	74		
<b>Energy (million kWh):</b>	4.75	8.24	46.77	0.36	7.64	3.91	2.32	73.99		
<b>MUNICIPAL Totals</b>	<b>Food Waste</b>	<b>Yard Non-Wood</b>	<b>Yard Burn</b>	<b>Other Organics</b>	<b>Paper Wood Residue</b>	<b>Yellow Grease</b>	<b>Brown Grease</b>	<b>Biosolids</b>	<b>Municipal Totals</b>	
<b>Biomass (tons/year):</b>	246,011	421,489	35,826	42,152	2,428,084	834,057	18,486	20,528	94,820	
<b>Energy (million kWh):</b>	352.95	318.52	27.07	23.51	2174.69	811.73	17.02	18.90	70.02	
<b>Biomass (tons/year) County Grand Total:</b>		16,902,873		<b>Energy (million kWh) County Grand Total:</b>			15522.51			



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