Biomass Inventory and Bioenergy Assessment

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

December, 2005

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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

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

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Errata Sheet for

Biomass Inventory and Bioenergy Assessment: An Evaluation of Organic Material Resources for Bioenergy Production in Washington State

An error present in the 2005 Washington State Biomass Inventory results in an overstatement of wheat straw in Franklin County. The error occurs on page 85 where it states that 531,051 tons of Field Residue as wheat straw is produced in the county. This errata sheet corrects the Franklin County biomass to 53,105 tons of wheat straw. The error is large enough that it impacts the state total tables and figures in the main report. Total statewide biomass is corrected from 16.9M tons per year to 16.4M tons per year.

Please note that scientists at Washington State University are updating the estimates of available biomass. The models and assumptions used to produce county biomass estimates are being adjusted to reflect current thinking on benefits of soil carbon from biomass that remains in the field. Recent agricultural acreage and production statistics will also be included in the new biomass estimates. The updated biomass estimates will be made available following peer review and critical evaluation.

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**Non-numbered tables reside within each of the pages within both Chapters 3 and 5.

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

Anaerobic Digestion	Biological degradation of organic material under anoxic conditions which produces biogas in the form of methane and carbon dioxide gases
Animal Mortality	Total tons of animal mortality (cattle, swine, horse, and poultry) as determined using national mortality ratios for each animal
Animal Proc. Waste	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)
Animal Waste	Category total of five different animal manures (Dairy, Cattle, Horse, Swine, and Poultry)
Apple Pomace	Solids remaining after apple processing operations (8.6% of wet weight)
Asparagus Butts	End of stalk spears that are removed prior to market (25% of harvested mass)
Asparagus Trimmings	Solids remaining after asparagus processing operations (10% of wet weight)
Barley Straw	Collectable barley straw left on fields after harvest (25% collection factor)
Beef Meat Proc.	Waste material from beef meat production (0.187 tons by-product/ton live weight)
Berry Pomace	Solids remaining after berry processing operations (6% of wet weight)
Biosolids	Biosolids produced at municipal water treatment facilities
Brown Grease	Sewer and pipe grease that are trapped and collected via water treatment facilities (7.44 lbs/person year)
Cattle Manure	Manure waste from feedlots and cattle operations (22.8% collectible)
Cheese Whey	Solid by-product of cheese production (9:1 ratio whey to cheese production)
CHP	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
Combustion	Chemical oxidative reaction of relatively dry organic material for energy and production of ash, carbon dioxide and other gases
Conversion Efficiency	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.
Corn Stover	Collectable residue left on fields after corn harvest (25% collection factor)
Cull Apple	Apples not considered suitable for market and used for juice (10% of harvest)
Cull Misc. Fruit	Fruit not considered suitable for market and used for juice (10% of harvest)
Cull Onion	Onions not considered suitable for market (5% of harvest)
Cull Potato	Potatoes not considered suitable for market (10% of harvest)
Dairy Manure	Manure waste from dairy operations (85% collectible)
Dry Matter	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

Grape Pomace	Solids remaining after grape processing operations for both juice and wine (10% of wet weight)
Grass Seed Straw	Collectable wheat straw left on fields after harvest (2.2 tons of sustainable residue/acre harvested)
Field Residue	Category total of seven different agricultural field residues (Wheat Straw, Barley Straw, Corn Stover, Mint Slug, Hops Residue, and Other Field Residue)
Fish Waste	Waste from fish processing plants (Tuna~65% waste; Fin Fish~35% waste)
Food Packing Waste	Category total of five different agricultural packing operation wastes (Cull Apples, Cull Miscellaneous Fruit, Cull Potatoes, Cull Onions, Asparagus Butts)
Food Proc. Waste	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)
Food Waste	Food waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
Forestry Waste	Category total of four different forestry related residues and wastes (Logging Residue, Forest Thinning, Mill Residue, and Land Clearing Debris)
Forest Trimming	Combination of state silviculture burn data and pre-commercial thinning data
HHV	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
Hops Residue	Vines, stems, and miscellaneous residue after harvest of hops (50% residue/harvest)
Horse Manure	Manure waste from small horse farms as well as horse operations (67% collectible)
kWh	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.
Land Clearing Debris	Land clearing debris from municipal and county land clearing of land for residential and commercial use
Lignocellulosic	Wood, straw and grass-like materials which are largely composed of a complex matrix of cellulose, hemicellulose and lignin
Logging Residue	Residue left behind in forest land after commercial logging
MW	Megawatt is a common measurement of electrical power generated in a year
Mill Residue	Bark/wood residue from sawmills, pulp mills, shake/shingle operations, whole log chippers, veneer plywood factories, post/pole/piling operations and log export
Mint Slug	Remaining grass residue after distillation of mint oil (50 lbs residue/lb mint)
Misc. Fruit Pomace	Solids remaining after fruit processing operations (17% of wet weight)
Mixed Veg. Trims.	Solids remaining after mixed vegetables (sweet corn, peas and carrots) are processed (13% of wet weight)

MSW	Category total of nine different municipal solid wastes (Food, Yard, Yard-Burn, Other Organics, Paper, Wood, Yellow Grease, Brown Grease, and Biosolids)
Other Field Residue	Combination of data referencing cereal grain burns, grassland and CRP clearing, orchard tear outs and orchard thinning
Other Organics	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)
Paper	Paper waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
Pork Meat Proc.	Waste material from pork meat production (0.135 tons/by-product/ton live weight)
Potato Solids	Solids remaining after potato processing operations (3.7% of wet weight)
Poultry Feathers	Feathers remaining after processing of poultry (9% of live weight)
Poultry Manure	Manure waste from both broiler and egg-layer operations (80% collectible)
Poultry Meat Proc.	Waste material from poultry meat production (19.3% of live weight)
Shellfish Waste	Waste from shellfish processing plants (Oyster~86% waste; Crab~73% waste; Shrimp~80% waste; and Clam~80% waste)
Swine Manure	Manure waste from swine operations (100% collectible)
TS	Total solids is another way to refer to the total dry matter or mass of an item minus its moisture content
VS	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
Wheat Straw	Collectable wheat straw left on fields after harvest (25% collection factor)
Wood Residue	Wood waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
Yard-Burn Waste	Yard waste estimated to be burned in piles and not entering municipal waste collection system (125 pounds/pile)
Yard Waste	Yard waste entering the municipal waste collection system as reported by Department of Ecology through MSW, Diversion and Recycle Databases
Yellow Grease	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.

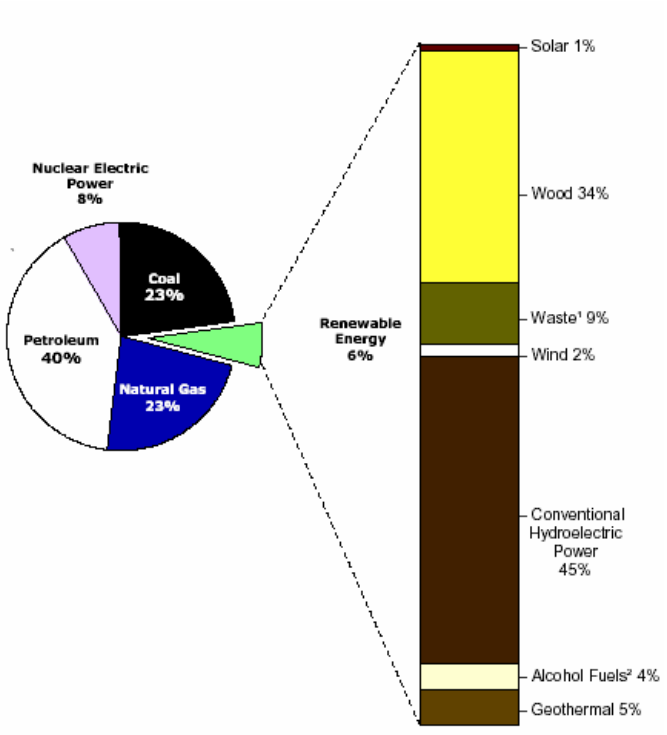

Figure 1. National Renewable Energy Percentages, 2003 (EIA, 2003)
([1]Municipal solid waste, landfill gas, sludge waste, tires, agricultural byproducts, and other biomass)

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 8th 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 form 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 in 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

Biomass	**Source Level**	**Lignocellulosic (woody) Nature**	**Conversion Approach**
Field Residue			
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
Animal Manures			
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
Forestry Residues			
Logging Residue	County	Woody	Combustion
Forest Thinning	County	Woody	Combustion
Mill Residue	State Regional	Woody	Combustion
Land Clearing Debris	State, County	Woody	Combustion
Food Packing/Proc.			
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
Municipal Solid Waste			
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

Chapter 2 - Results

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.

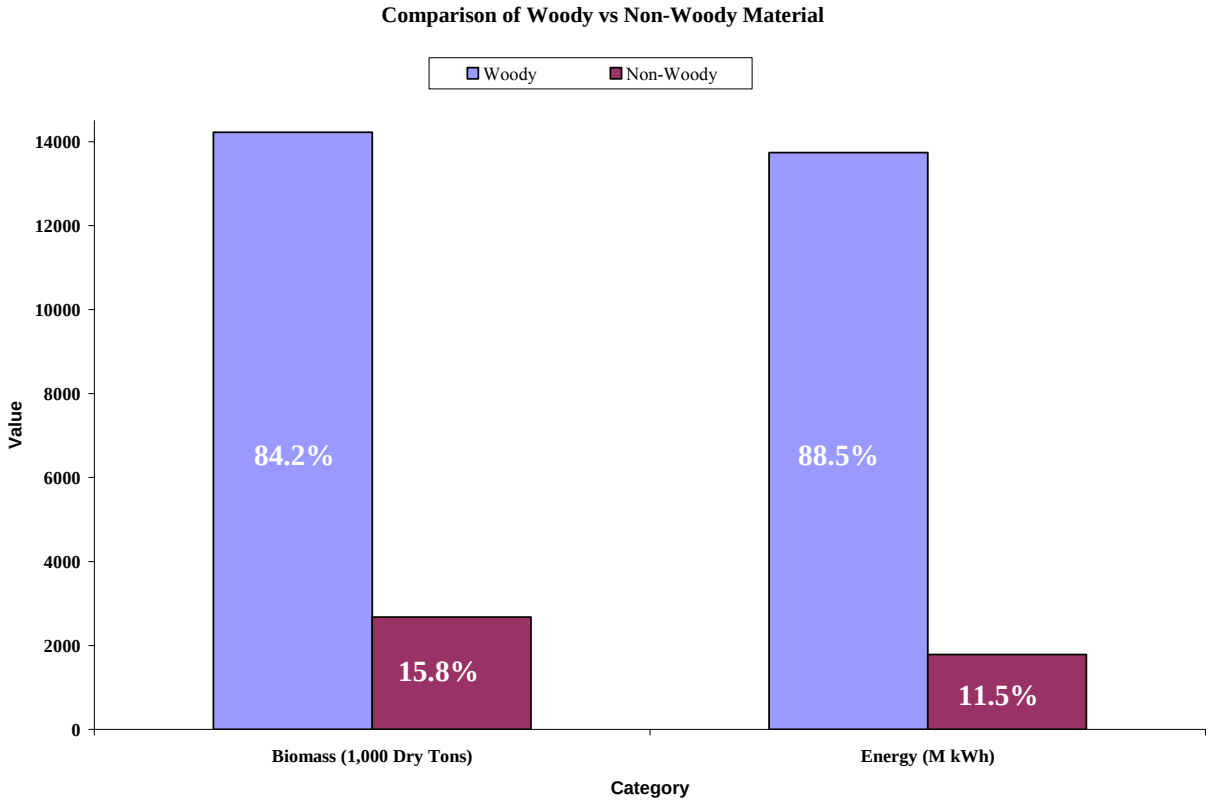

Figure 2. Woody vs Non-Woody Percentages

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	***49%***	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.

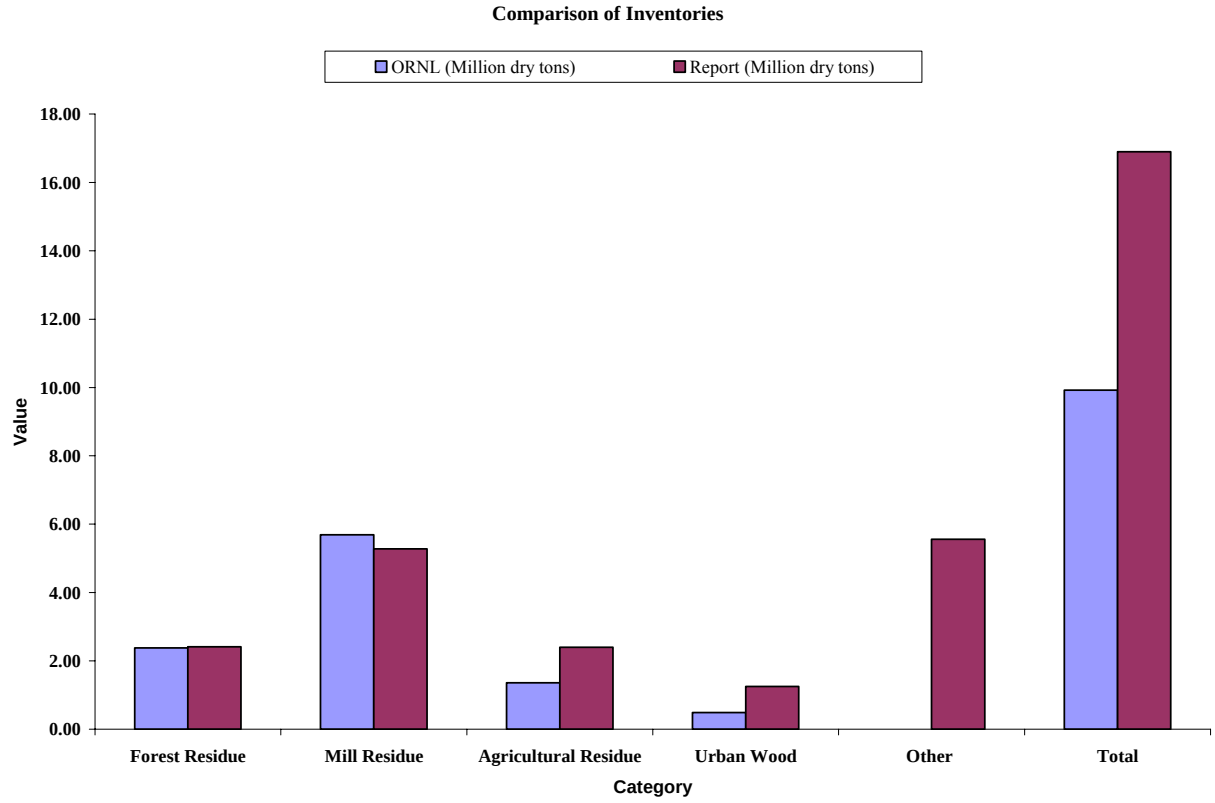

Figure 3. Comparison of Inventory Results between 1999 ORNL and 2005 Washington State Inventory (Other biomass represents total of animal manures, food packing/processing and non-wood MSW)

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.

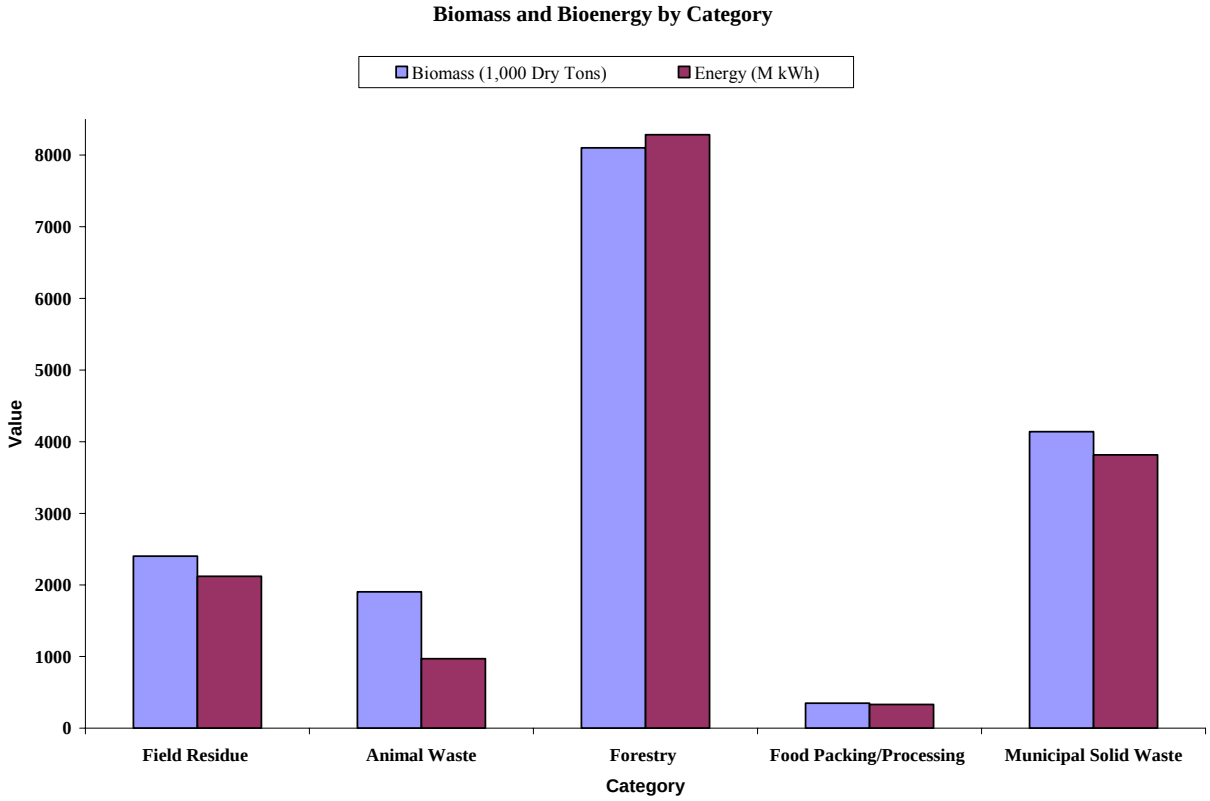

Figure 4. Biomass and Bioenergy by Category

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.

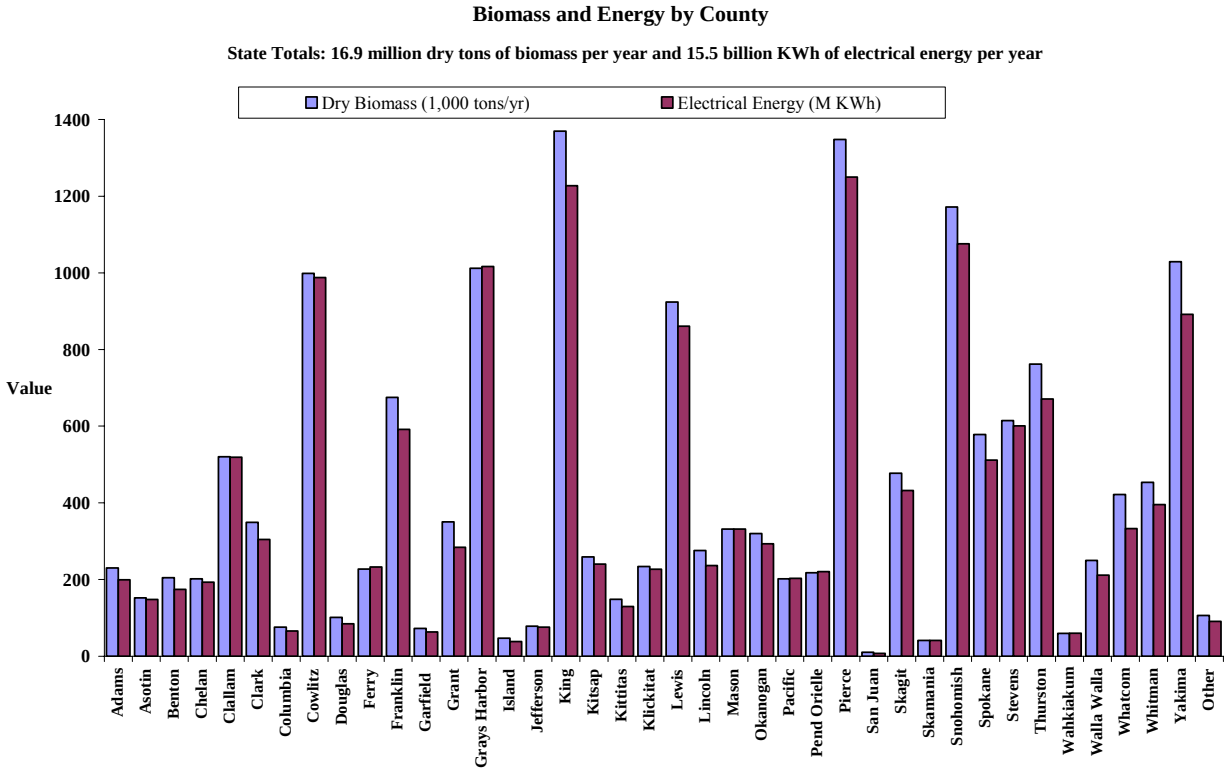

Figure 5. Biomass and Energy by County (Other results from agricultural databases that inventory negligible county totals within the other category)

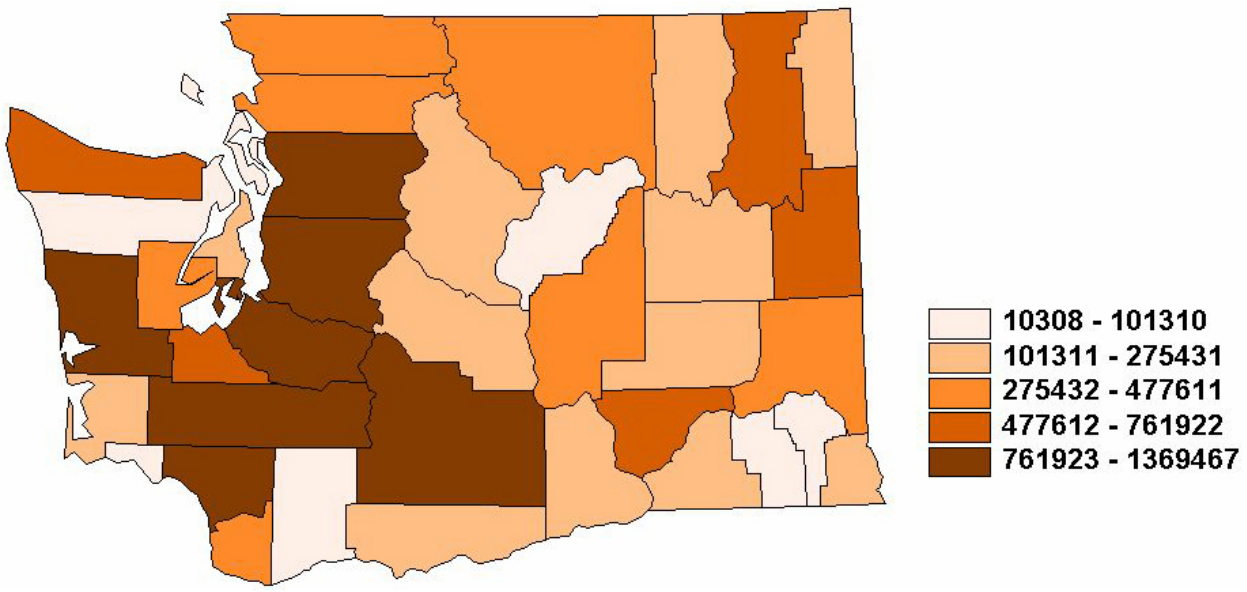

Figure 6. Biomass by County and Region (Biomass in dry tons)

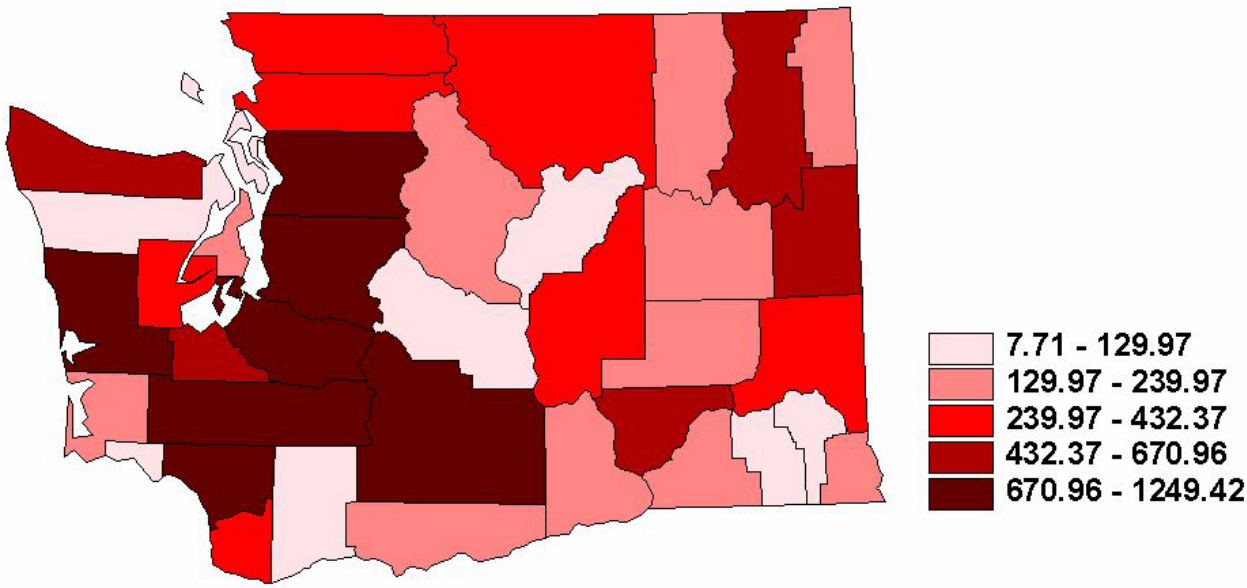

Figure 7. Bioenergy by County and Region (Bioenergy in M kWh)

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.

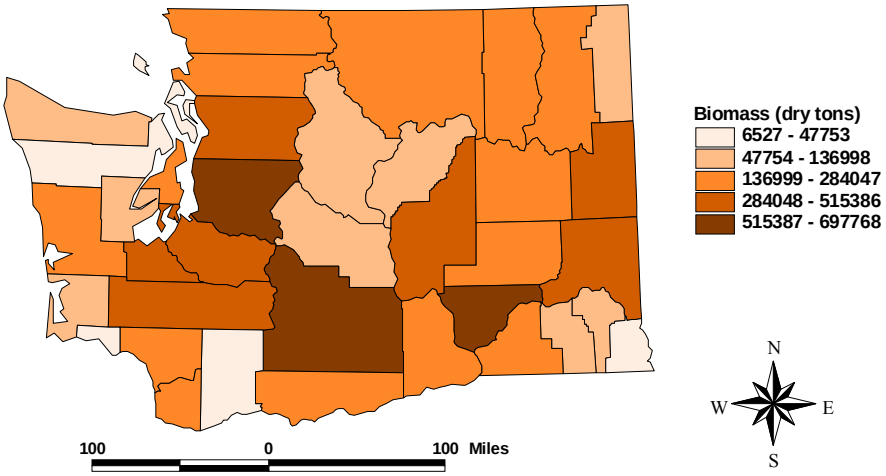

Figure 8. Biomass by County and Region without Mill Residue and MSW Paper (Biomass in Dry Tons)

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 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

Chapter 3 - Biomass 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). A moisture content of 28% for wheat straw was used to determine a final dry biomass (Klass, 1998).

The final calculation was {(69.76 x yield/acre + 1,067.7) x # acres]/2,000} x 0.25 x 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

Tons of Dry Biomass—1,614,234							
Adams	120,407	Franklin	53,105	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 (∑average total acres for seed crops) x 2.2 x 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

Tons of Dry Biomass—134,640							
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

Tons of Dry Biomass—318,522							
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

Tons of Dry Biomass—73,502							
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 where 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 [∑(acres burned x fuel loading factor x fuel consumption factor)] x 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

Tons of Dry Biomass—159,174							
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

Tons of Dry Biomass—96,878							
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

Tons of Dry Biomass—5,400							
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

Tons of Dry Biomass—457,032							
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} x 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

Tons of Dry Biomass—242,404							
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

Tons of Dry Biomass—407,160							
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

Tons of Dry Biomass—13,632							
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 x 0.53 x 365)/2000 + (#broilers x 0.35 x 56)/2000} x 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

Tons of Dry Biomass—784,577							
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 ∑ (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

Tons of Dry Biomass—1,901,072							
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 ∑ ((pre-commercial thinning in cft x 25)/2000 lbs/ton) + 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

Tons of Dry Biomass—505,666							
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

Tons of Dry Biomass—5,278,353							
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

Tons of Dry Biomass—418,595							
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

Tons of Dry Biomass—2,322							
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

Tons of Dry Biomass—91,412							
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

Tons of Dry Biomass—41,039							
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

Tons of Dry Biomass—8,934							
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

Tons of Dry Biomass—667							
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

Tons of Dry Biomass—27,794							
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

Tons of Dry Biomass—19,254							
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 (∑county total) x 0.90 x 0.06 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

Tons of Dry Biomass—1,938							
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

Tons of Dry Biomass—11,865							
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

Tons of Dry Biomass—44,255							
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

Tons of Dry Biomass—19,177							
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-butted, 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

Tons of Dry Biomass—120							
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 (∑ county total) x 0.13 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

Tons of Dry Biomass—14,744							
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

Tons of Dry Biomass—7,932							
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

Tons of Dry Biomass—5,479							
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

Tons of Dry Biomass—35,842							
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

Tons of Dry Biomass—280							
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 (∑ domestic animal mortality tons x Washington County Percentage) x 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

Tons of Dry Biomass—5,857							
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 [∑ (county total x waste %)] x 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

Tons of Dry Biomass—7,995							
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	

…

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 [∑ (county total x waste %)] x 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

Tons of Dry Biomass—3,674							
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 {(% food composition x total MSW) + (state recyclable number x % population) + (state diversion number x % population} x 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

Tons of Dry Biomass—246,011							
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 {(% yard non-wood composition x total MSW) + (state recyclable number x % population) + (state diversion number x % population} x 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

Tons of Dry Biomass—421,489							
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: *# of households x (fraction burning waste) x (piles/HH) x (lbs burned/pile) x (T/2000 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 {# of households x (fraction burning waste) x (piles/HH) x (lbs burned/pile) x (T/2000 lbs)} x 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

Tons of Dry Biomass—35,826							
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 {(% other organic x total MSW) + (state recyclable number x % population) + (state diversion number x % population} x 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

Tons of Dry Biomass—42,152							
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 {(% paper x total MSW) + (state recyclable number x % population) + (state diversion number x % population} x 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

Tons of Dry Biomass—2,428,084							
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 {(% wood x total MSW) + (state recyclable number x % population) + (state diversion number x % population} x 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

Tons of Dry Biomass—834,057							
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 x 6.7)/2,000} x 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

Tons of Dry Biomass—18,486							
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 x 7.44)/2,000} x 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

Tons of Dry Biomass—20,528							
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

Tons of Dry Biomass—94,820							
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	

Chapter 4 - Energy 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

Technology	**Products**	**Comments**
Thermo-chemical	*In general, high temperature and high conversion processes best suited for low moisture biomass*	
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
Bio-chemical	*In general, lower temperature and lower conversion rate processes better suited for higher moisture biomass*	
Anaerobic Digestion	Biogas ($CH_4 + CO_2$)	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
Physio-chemical	*In general, suitable for oils, fats, greases, and animal tallows*	
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 (2.9307×10^{-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; Tchobanalglous et al, 1993 and the CEC (2004) report.

Table 4. HHV Coefficients for Selected Biomass

Biomass	HHV (Btu/dry lb)
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

Biomass	Value Used	Reference
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^3/kg VS)

Biomass	**Value Used**	**Reference**
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^3 of methane which is the heat value of pure, dry methane gas under normal atmospheric and temperature conditions and (2) 2.931 x 10^{-4} 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	***Total***	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

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	120,407	7,040	5,654	3,530	8,823	32,765		178,219
Energy (million kWh):	106.22	6.21	4.99	3.11	7.78	28.90		157.22

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	10,385	7,363	2,733	246				20,727
Energy (million kWh):	5.34	3.88	0.11	0.19				9.52

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):				277				277
Energy (million kWh):				0.28				0.28

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals
Biomass (tons/year):	170	14,954	603	295	23			16,046
Energy (million kWh):	0.19	17.87	0.39	0.24	0.01			18.69

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	408			392	779	3,137	4	405	5,126
Energy (million kWh):	0.26			0.31	0.68	2.25		0.47	3.97

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			1,219	15	170			2
Energy (million kWh):			1.59	0.02	0.22			1.83

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	542	1,026	59	16	4,797	2,218	50	56		8,764
Energy (million kWh):	0.78	0.78	0.04	0.01	4.30	2.16	0.05	0.05		8.16

Biomass (tons/year) County Grand Total: 230,562

Energy (million kWh) County Grand Total: 199.68

Asotin

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

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

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	852	11,002	111,302	268	123,424
Energy (million kWh):	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
Biomass (tons/year):						
Energy (million kWh):						

FOOD PROCESSING	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
Biomass (tons/year):					26			0
Energy (million kWh):					0.03			0.03

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

Biomass (tons/year) County Grand Total: 152,259

Energy (million kWh) County Grand Total: 147.91

Benton

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	38,454				4,942	6,388	1,080	50,863
Energy (million kWh):	33.92				4.36	5.63	0.95	44.87

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		5,055	13,095	33		18,183
Energy (million kWh):		2.66	0.54	0.03		3.23

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):				3,941	3,941
Energy (million kWh):				3.97	3.97

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):	551	19,255	3,718	728	48	24,300
Energy (million kWh):	0.62	23.00	2.38	0.58	0.03	26.61

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	2,518	6,932		967		4,040	9	2,826	17,291
Energy (million kWh):	1.61	4.90		0.78		2.89	0.01	3.30	13.49

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

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	3,645	11,802	451	420	42,319	25,830	463	514	4,896	90,341
Energy (million kWh):	5.23	8.92	0.34	0.23	37.90	25.14	0.43	0.47	3.62	82.28

Biomass (tons/year) County Grand Total: 204,920

Energy (million kWh) County Grand Total: 174.46

Chelan

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

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

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	16,438	15,462	100,214	1,427	133,541
Energy (million kWh):	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
Biomass (tons/year):			3,748	1,276		5,024
Energy (million kWh):			2.40	1.02		3.42

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

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	2,460	6,939	292	297	25,123	15,726	205	228	913	52,183
Energy (million kWh):	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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	1,657	975	4,998	16		7,646
Energy (million kWh):	0.85	0.51	0.21	0.01		1.59

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	81,860	9,878	375,150	1,735	468,623
Energy (million kWh):	86.60	10.45	377.99	1.75	476.79

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

FOOD PROCESSING	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
Biomass (tons/year):					10	0	0	0
Energy (million kWh):					0.01	0.19	0.10	0.30

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	2,771	4,036	476	436	24,472	10,292	202	224	449	43,358
Energy (million kWh):	3.98	3.05	0.36	0.24	21.92	10.02	0.19	0.21	0.33	40.29

Biomass (tons/year) County Grand Total: 520,181

Energy (million kWh) County Grand Total: 518.97

Clark

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	7,549	3,588	18,470	77	36,204			65,888
Energy (million kWh):	3.88	1.89	0.77	0.06	26.80			33.40

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	22,638	2,308	63,386	14,742				103,074
Energy (million kWh):	23.95	2.44	63.87	14.85				105.11

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			141		739				880
Energy (million kWh):			0.10		0.64				0.75

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	913	631	538	5	118			2
Energy (million kWh):	0.55	0.95	0.70	0.01	0.15			2.36

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	9,224	16,376	2,030	1,608	97,145	41,106	1,144	1,271	7,611	177,515
Energy (million kWh):	13.23	12.38	1.53	0.90	87.01	40.01	1.05	1.17	5.62	162.90

Biomass (tons/year) County Grand Total: 349,562

Energy (million kWh) County Grand Total: 304.52

Columbia

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

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

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

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

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

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

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

Biomass (tons/year) County Grand Total: 76,008

Energy (million kWh) County Grand Total: 65.58

Cowlitz

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	1,382	996	5,735	25	25,468			33,606
Energy (million kWh):	0.71	0.52	0.24	0.02	18.86			20.35

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	86,967	5,775	733,471	1,990				828,203
Energy (million kWh):	92.01	6.11	739.02	2.01				839.14

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			53					98	152
Energy (million kWh):			0.04					0.11	0.15

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	747	516			42	0		1
Energy (million kWh):	0.45	0.78			0.05	0.03		1.31

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	10,102	9,220	505	1,905	80,348	30,360	287	319	2,213	135,258
Energy (million kWh):	14.49	6.97	0.38	1.06	71.96	29.55	0.26	0.29	1.63	126.61

Biomass (tons/year) County Grand Total: 998,584

Energy (million kWh) County Grand Total: 987.56

Douglas

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	66,375				1,779			68,154
Energy (million kWh):	58.55				1.57			60.12

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		2,385	3,992			6,377
Energy (million kWh):		1.26	0.17			1.42

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	302			503	805
Energy (million kWh):	0.32			0.51	0.83

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):			3,279	1,117		4,396
Energy (million kWh):			2.10	0.90		2.99

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	2,221			1,483					3,704
Energy (million kWh):	1.42			1.19					2.61

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			351		31			1
Energy (million kWh):			0.46		0.04			0.50

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,085	2,006	166	31	9,446	4,354	102	113	189	17,492
Energy (million kWh):	1.56	1.52	0.13	0.02	8.46	4.24	0.09	0.10	0.14	16.25

Biomass (tons/year) County Grand Total: 101,310 **Energy (million kWh) County Grand Total:** 84.72

Ferry

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		2,010	6,774			8,784
Energy (million kWh):		1.06	0.28			1.34

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	76,626	138,873		138	215,637
Energy (million kWh):	81.07	146.92		0.14	228.13

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

FOOD PROCESSING	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
Biomass (tons/year):			319		29			0
Energy (million kWh):			0.42		0.04			0.45

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	102	377	49	2	1,701	708	22	25	4	2,990
Energy (million kWh):	0.15	0.28	0.04		1.52	0.69	0.02	0.02		2.72

Biomass (tons/year) County Grand Total: 227,759

Energy (million kWh) County Grand Total: 232.65

Franklin

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

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

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

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	1,027	963		137	1,018	4,019	51	2,690	9,904
Energy (million kWh):	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
Biomass (tons/year):			1,756	11	212			3
Energy (million kWh):			2.29	0.01	0.28			2.58

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	4,165	4,647	163	129	26,547	11,600	169	188	242	47,850
Energy (million kWh):	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
Biomass (tons/year):	33,974	3,608	22,090		1,061			60,733
Energy (million kWh):	29.97	3.18	19.49		0.94			53.58

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

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

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

FOOD PROCESSING	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
Biomass (tons/year):					25			0
Energy (million kWh):					0.03			0.03

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

Biomass (tons/year) County Grand Total: 72,502

Energy (million kWh) County Grand Total: 63.36

Grant

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	100,353	8,756	4,977	23,371	20,282	20,738		178,476
Energy (million kWh):	88.53	7.72	4.39	20.62	17.89	18.29		157.45

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	25,813	33,509	15,758	890		75,970
Energy (million kWh):	13.28	17.66	0.65	0.68		32.27

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):				1,966	1,966
Energy (million kWh):				1.98	1.98

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):	858	21,223	6,031	410	50	28,572
Energy (million kWh):	0.96	25.36	3.86	0.33	0.03	30.53

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	4,085	2,118		544	2,523	4,452	9	5,337	19,068
Energy (million kWh):	2.61	1.50		0.44	2.19	3.19	0.01	6.24	16.18

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			5,197	54	628			8
Energy (million kWh):			6.78	0.07	0.82			7.67

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	2,738	4,516	285	81	22,104	10,041	237	263	237	40,503
Energy (million kWh):	3.93	3.41	0.22	0.05	19.80	9.77	0.22	0.24	0.18	37.81

Biomass (tons/year) County Grand Total: 350,434

Energy (million kWh) County Grand Total: 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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	6,186	2,115	4,347	16		12,664
Energy (million kWh):	3.18	1.11	0.18	0.01		4.49

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	199,066	14,873	728,232	1,161	943,332
Energy (million kWh):	210.60	15.74	733.74	1.17	961.25

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			57		606			147	810
Energy (million kWh):			0.04		0.53			0.17	0.74

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			333		57	1	1	3
Energy (million kWh):			0.43		0.07	1.01	0.99	2.51

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	3,344	4,709	365	528	29,038	12,145	209	232	660	51,231
Energy (million kWh):	4.80	3.56	0.28	0.29	26.01	11.82	0.19	0.21	0.49	47.65

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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	2,900	933	3,804			7,637
Energy (million kWh):	1.49	0.49	0.16			2.14

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	889	146		2,577	3,612
Energy (million kWh):	0.94	0.15		2.60	3.69

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

FOOD PROCESSING	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
Biomass (tons/year):					20		0	0
Energy (million kWh):					0.03		0.02	0.04

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,697	3,751	545	248	18,897	8,478	230	256	1,689	35,791
Energy (million kWh):	2.43	2.83	0.41	0.14	16.92	8.25	0.21	0.24	1.25	32.69

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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	1,382	663	2,071			4,116
Energy (million kWh):	0.71	0.35	0.09			1.15

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	32,035	3,578	22,068	1,258	58,939
Energy (million kWh):	33.89	3.79	22.24	1.27	61.18

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

FOOD PROCESSING	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
Biomass (tons/year):					13		0	0
Energy (million kWh):					0.02		0.06	0.08

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	898	1,421	227	140	8,278	3,528	84	93	255	14,923
Energy (million kWh):	1.29	1.07	0.17	0.08	7.41	3.43	0.08	0.09	0.19	13.81

Biomass (tons/year) County Grand Total: 78,099 **Energy (million kWh) County Grand Total:** 76.22

King

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	24,414	4,665	26,901	90	287			56,357
Energy (million kWh):	12.56	2.46	1.12	0.07	0.21			16.42

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	37,521	1,212	23,588	70,072				132,393
Energy (million kWh):	39.70	1.28	23.77	70.60				135.35

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):					2,390				2,390
Energy (million kWh):					2.08				2.08

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			573	6	154	0	0	1
Energy (million kWh):			0.75	0.01	0.20	0.32	0.05	1.32

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	67,269	147,076	6,913	15,465	728,785	170,538	5,311	5,897	29,618	1,176,872
Energy (million kWh):	96.51	111.15	5.22	8.63	652.73	165.97	4.89	5.43	21.87	1072.40

Biomass (tons/year) County Grand Total: 1,369,467

Energy (million kWh) County Grand Total: 1227.57

Kitsap

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):		333	9,883	82	112			10,410
Energy (million kWh):		0.18	0.41	0.06	0.08			0.73

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	8,233	649		96,672				105,554
Energy (million kWh):	8.71	0.69		97.40				106.80

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

FOOD PROCESSING	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
Biomass (tons/year):				5	4		0	0
Energy (million kWh):				0.01	0.01		0.04	0.06

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	8,157	12,958	1,679	1,478	76,680	38,166	726	806	2,119	142,769
Energy (million kWh):	11.70	9.79	1.27	0.82	68.68	37.14	0.67	0.74	1.56	132.39

Biomass (tons/year) County Grand Total: 258,818

Energy (million kWh) County Grand Total: 239.97

Kittitas

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):					881			881
Energy (million kWh):					0.78			0.78

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		6,822	20,170	66		27,058
Energy (million kWh):		3.59	0.84	0.05		4.48

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	86,216	8,006		582	94,804
Energy (million kWh):	91.21	8.47		0.59	100.27

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):		207				207
Energy (million kWh):		0.25				0.25

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):						43		533	576
Energy (million kWh):						0.03		0.62	0.65

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			896		82			1
Energy (million kWh):			1.17		0.11			1.28

MUNICIPAL Totals	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,097	3,247	193	130	11,715	7,267	106	118	335	24,208
Energy (million kWh):	1.57	2.45	0.15	0.07	10.49	7.07	0.10	0.11	0.25	22.26

Biomass (tons/year) County Grand Total: 148,713

Energy (million kWh) County Grand Total: 129.97

Klickitat

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	13,226		2,498					15,724
Energy (million kWh):	11.67		2.20					13.87

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	2,025	5,248	8,205	49		15,527
Energy (million kWh):	1.04	2.77	0.34	0.04		4.19

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	81,199	41,284	63,386	282	186,151
Energy (million kWh):	85.91	43.68	63.87	0.28	193.73

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):		886				886
Energy (million kWh):		1.06				1.06

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):		770				186		228	1,184
Energy (million kWh):		0.54				0.13		0.27	0.94

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			860		86	0		1
Energy (million kWh):			1.12		0.11	0.02		1.25

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	564	1,790	109	65	6,426	3,936	59	65	99	13,113
Energy (million kWh):	0.81	1.35	0.08	0.04	5.76	3.83	0.05	0.06	0.07	12.05

Biomass (tons/year) County Grand Total: 233,565

Energy (million kWh) County Grand Total: 227.10

Lewis

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
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	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
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	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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
Biomass (tons/year):	173,687		76,202		622			250,511
Energy (million kWh):	153.22		67.22		0.55			220.99

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

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

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

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

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

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	104	493	44	2	1,865	940	31	34		3,513
Energy (million kWh):	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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		333	2,701	16		3,050
Energy (million kWh):		0.18	0.11	0.01		0.30

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	54,502	5,059	242,744	1,753	304,058
Energy (million kWh):	57.66	5.35	244.58	1.77	309.36

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

FOOD PROCESSING	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
Biomass (tons/year):					4	0	0	1
Energy (million kWh):					0.01	0.38	0.18	0.57

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,206	2,448	419	180	12,765	5,655	157	175	250	23,255
Energy (million kWh):	1.73	1.85	0.32	0.10	11.43	5.50	0.14	0.16	0.18	21.42

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
Biomass (tons/year):	3,437				10,025			13,462
Energy (million kWh):	3.03				8.84			11.88

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

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	64,142	118,499	48,103	602	231,346
Energy (million kWh):	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
Biomass (tons/year):			4,685	1,595		6,280
Energy (million kWh):			3.00	1.28		4.28

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	3,173			2,119					5,292
Energy (million kWh):	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
Biomass (tons/year):			1,649		151			2
Energy (million kWh):			2.15		0.20			2.35

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,226	2,498	207	26	14,476	4,912	118	131	237	23,831
Energy (million kWh):	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

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	4,748	39,292	7,001	27,865				78,906
Energy (million kWh):	4.19	34.66	6.18	24.58				69.61

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	10,495			7,040		17,535
Energy (million kWh):	5.40			5.35		10.75

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):	29	665	777	149	7	1,626
Energy (million kWh):	0.03	0.79	0.50	0.12		1.44

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	526	193	100	197	2,952	139	1		4,108
Energy (million kWh):	0.34	0.14	0.07	0.16	2.57	0.10			3.37

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			4,014	33	323			6
Energy (million kWh):			5.24	0.04	0.42			5.70

MUNICIPAL	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: 106,545

Energy (million kWh) County Grand Total: 90.87

Pacific

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	3,424	1,494	1,727			6,645
Energy (million kWh):	1.76	0.79	0.07			2.62

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	104,627	10,490	66,203	462	181,782
Energy (million kWh):	110.69	11.10	66.70	0.47	188.96

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			197						197
Energy (million kWh):			0.14						0.14

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):					40	0	0	1
Energy (million kWh):					0.05	0.40	0.31	0.76

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	510	1,168	170	74	5,804	2,618	64	71	1,179	11,657
Energy (million kWh):	0.73	0.88	0.13	0.04	5.20	2.55	0.06	0.07	0.87	10.52

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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		1,098	3,443			4,541
Energy (million kWh):		0.58	0.14			0.72

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	110,006	10,993	76,154	303	197,456
Energy (million kWh):	116.38	11.63	76.73	0.31	205.05

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

FOOD PROCESSING	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
Biomass (tons/year):					15			0
Energy (million kWh):					0.02			0.02

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,150	1,252	72	26	10,367	2,677	36	41	68	15,689
Energy (million kWh):	1.65	0.95	0.05	0.01	9.29	2.61	0.03	0.04	0.05	14.68

Biomass (tons/year) County Grand Total: 217,701

Energy (million kWh) County Grand Total: 220.47

Pierce

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	10,090	3,567	24,861	131	112,912	151,561
Energy (million kWh):	5.19	1.88	1.03	0.10	83.60	91.80

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	67,160	5,037	401,001	84,968	558,166
Energy (million kWh):	71.05	5.33	404.04	85.61	566.03

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			23		987				1,010
Energy (million kWh):			0.02		0.86				0.88

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	170	117	502	8	97	0	0	1
Energy (million kWh):	0.10	0.18	0.66	0.01	0.13	0.08	0.03	1.19

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	45,406	48,697	3,924	8,282	431,417	86,089	2,234	2,481	7,419	635,949
Energy (million kWh):	65.14	36.80	2.97	4.62	386.40	83.78	2.06	2.28	5.48	589.53

Biomass (tons/year) County Grand Total: 1,347,804 **Energy (million kWh) County Grand Total:** 1249.42

San Juan

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		621	1,867	33		2,521
Energy (million kWh):		0.33	0.08	0.03		0.43

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	222	116		570	908
Energy (million kWh):	0.23	0.12		0.57	0.93

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

FOOD PROCESSING	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
Biomass (tons/year):					8			0
Energy (million kWh):					0.01			0.01

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	387	682	151	59	3,781	1,639	45	49	71	6,864
Energy (million kWh):	0.56	0.52	0.11	0.03	3.39	1.60	0.04	0.05	0.05	6.34

Biomass (tons/year) County Grand Total: 10,308

Energy (million kWh) County Grand Total: 7.71

Skagit

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	4,044				282			4,326
Energy (million kWh):	3.57				0.25			3.82

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	32,258	7,152	7,258		73,779	120,447
Energy (million kWh):	16.60	3.77	0.30		54.62	75.29

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	56,044	1,120	224,089	1,889	283,142
Energy (million kWh):	59.29	1.18	225.78	1.90	288.17

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):		3,384				3,384
Energy (million kWh):		4.04				4.04

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			285		3,160	710		115	4,270
Energy (million kWh):			0.21		2.75	0.51		0.13	3.60

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	611	422	1,147		289	0	0	3
Energy (million kWh):	0.37	0.64	1.50		0.38	0.14	0.18	3.19

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	2,883	5,027	559	657	33,631	14,016	329	366	1,533	59,001
Energy (million kWh):	4.14	3.80	0.42	0.37	30.12	13.64	0.30	0.34	1.13	54.26

Biomass (tons/year) County Grand Total: 477,611

Energy (million kWh) County Grand Total: 432.37

Skamania

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):		105	764			869
Energy (million kWh):		0.06	0.03			0.09

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	12,265	1,483	22,638	280	36,666
Energy (million kWh):	12.98	1.57	22.81	0.28	37.64

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

FOOD PROCESSING	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
Biomass (tons/year):								
Energy (million kWh):								

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	131	472	82	19	2,097	987	31	34	33	3,886
Energy (million kWh):	0.19	0.36	0.06	0.01	1.88	0.96	0.03	0.03	0.02	3.54

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
Biomass (tons/year):	4,427							4,427
Energy (million kWh):	3.90							3.90

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

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	40,719	2,011	448,177	102,904	593,811
Energy (million kWh):	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
Biomass (tons/year):						
Energy (million kWh):						

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):					3,186			40	3,226
Energy (million kWh):					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
Biomass (tons/year):	395	273	1,075	7	265	0		2
Energy (million kWh):	0.24	0.41	1.40	0.01	0.35	0.05		2.46

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	21,327	31,206	3,498	4,986	231,628	93,888	1,928	2,141	13,865	404,467
Energy (million kWh):	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
Biomass (tons/year):	61,492	41,800	29,866					133,158
Energy (million kWh):	54.25	36.87	26.35					117.47

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

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	28,570	19,454	35,148	5,143	88,315
Energy (million kWh):	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
Biomass (tons/year):						
Energy (million kWh):						

FOOD PROCESSING	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
Biomass (tons/year):			789	9	95			1
Energy (million kWh):			1.03	0.01	0.12			1.17

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	23,201	33,220	1,993	696	171,232	76,323	1,300	1,443	6,886	316,294
Energy (million kWh):	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

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	2,863		3,021					5,884
Energy (million kWh):	2.53		2.67					5.19

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	4,542	7,422	18,491	181	122	30,758
Energy (million kWh):	2.34	3.91	0.77	0.14	0.09	7.24

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	160,203	13,483	363,195	759	537,640
Energy (million kWh):	169.49	14.26	365.94	0.76	550.46

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

FOOD PROCESSING	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
Biomass (tons/year):			1,362	11	141			2
Energy (million kWh):			1.78	0.01	0.18			1.98

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	2,607	3,380	240	58	25,097	7,028	123	137		38,669
Energy (million kWh):	3.74	2.55	0.18	0.03	22.48	6.84	0.11	0.13		36.06

Biomass (tons/year) County Grand Total: 614,466

Energy (million kWh) County Grand Total: 600.94

Thurston

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

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
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
Biomass (tons/year):								
Energy (million kWh):								

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
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	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
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
Biomass (tons/year):								
Energy (million kWh):								

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	884	810	732			2,426
Energy (million kWh):	0.45	0.43	0.03			0.91

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	28,595	3,762	22,638	92	55,087
Energy (million kWh):	30.25	3.98	22.81	0.09	57.13

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

FOOD PROCESSING	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
Biomass (tons/year):					15	0	0	0
Energy (million kWh):					0.02	0.03	0.01	0.06

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	96	211	35	16	1,133	496	11	13		2,011
Energy (million kWh):	0.14	0.16	0.03	0.01	1.01	0.48	0.01	0.01	0.00	1.85

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
Biomass (tons/year):	120,912	13,376	12,795		16,853			163,936
Energy (million kWh):	106.66	11.80	11.29		14.87			144.62

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

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

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

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	1,227	1,155		461		1,447	7	1,219	5,515
Energy (million kWh):	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
Biomass (tons/year):					1			
Energy (million kWh):								

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	1,512	4,984	6,065	173	17,850	10,862	171	190	481	42,288
Energy (million kWh):	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

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):					45			45
Energy (million kWh):					0.04			0.04

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	113,751	22,291	12,643	220	17,398			166,303
Energy (million kWh):	58.53	11.75	0.53	0.17	12.88			83.85

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	45,442	1,312	82,559	5,542				134,855
Energy (million kWh):	48.08	1.39	83.18	5.58				138.23

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals
Biomass (tons/year):		708						708
Energy (million kWh):		0.85						0.85

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):			1,050		11,152	148		21	12,370
Energy (million kWh):			0.77		9.70	0.11		0.02	10.59

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):			3,369		840	1	0	7
Energy (million kWh):			4.40		1.10	1.25	0.34	7.08

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	5,527	8,150	957	1,002	55,055	22,883	532	591	5,382	100,080
Energy (million kWh):	7.93	6.16	0.72	0.56	49.31	22.27	0.49	0.54	3.97	91.96

Biomass (tons/year) County Grand Total: 421,661

Energy (million kWh) County Grand Total: 332.60

Whitman

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

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

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

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

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

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

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	589	2,440	112	95	14,900	5,963	123	136	645	25,003
Energy (million kWh):	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

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	13,692		527	10,199	64,381	36,988	4,320	130,107
Energy (million kWh):	12.08		0.46	9.00	56.79	32.63	3.81	114.78

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry			Animal Waste Totals
Biomass (tons/year):	115,224	43,853	30,215	125	22,670			212,087
Energy (million kWh):	59.29	23.11	1.26	0.09	16.78			100.53

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris				Forestry Totals
Biomass (tons/year):	171,796	37,426	252,539	2,359				464,120
Energy (million kWh):	181.75	39.60	254.45	2.38				478.18

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts			Food Packing Totals
Biomass (tons/year):	44	789	14,870	2,914	221			18,837
Energy (million kWh):	0.05	0.94	9.51	2.34	0.14			12.98

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	10,071	7,124		3,870	11,285	166	40	857	33,412
Energy (million kWh):	6.44	5.03		3.10	9.81	0.12	0.02	1.00	25.53

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	4	3	6,882	8	1,226			11
Energy (million kWh):			8.98	0.01	1.60			10.59

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	7,165	21,811	809	843	78,537	49,396	684	759	2,155	162,159
Energy (million kWh):	10.28	16.48	0.61	0.47	70.34	48.07	0.63	0.70	1.59	149.18

Biomass (tons/year) County Grand Total: 1,028,844

Energy (million kWh) County Grand Total: 891.76

Total

FIELD RESIDUE	Wheat Straw	Grass Seed Straw	Barley Straw	Corn Stover	Other Field Residue	Mint Slug	Hops Residue	Field Residue Totals
Biomass (tons/year):	1,614,234	134,640	318,522	73,502	159,174	96,878	5,400	2,402,349
Energy (million kWh):	1424.02	118.77	280.99	64.84	140.42	85.46	4.76	2119.27

ANIMAL WASTE	Dairy	Cattle	Horse	Swine	Poultry	Animal Waste Totals
Biomass (tons/year):	457,032	242,404	407,160	13,632	784,577	1,904,805
Energy (million kWh):	235.16	127.73	16.91	10.36	580.88	971.05

FORESTRY	Logging Residue	Forest Thinnings	Mill Residue	Land Clearing Debris	Forestry Totals
Biomass (tons/year):	1,901,072	505,666	5,278,353	418,595	8,103,686
Energy (million kWh):	2011.27	534.98	5318.30	421.76	8286.31

FOOD PACKING	Cull Onions	Cull Potatoes	Cull Apples	Cull Misc Fruit	Asparagus Butts	Food Packing Totals
Biomass (tons/year):	2,322	91,412	41,039	8,934	667	144,374
Energy (million kWh):	2.60	109.21	26.24	7.17	0.43	145.65

FOOD PROCESSING	Apple Pomace	Grape Pomace	Berry Pomace	Misc Fruit Pomace	Cheese Whey	Potato Solids	Asparagus Trimmings	Mixed Vegetables	Food Processing Totals
Biomass (tons/year):	27,794	19,254	1,938	11,865	44,255	19,177	120	14,744	139,148
Energy (million kWh):	17.77	13.61	1.42	9.52	38.47	13.74	0.07	17.24	111.83

ANIMAL PROCESSING	Poultry Feathers	Poultry Meat	Beef Meat	Pork Meat	All Animal Meat	Fish Waste	Shellfish Waste	Animal Processing Totals
Biomass (tons/year):	7,932	5,479	35,842	280	5,857	4	2	74
Energy (million kWh):	4.75	8.24	46.77	0.36	7.64	3.91	2.32	73.99

MUNICIPAL	Food Waste	Yard Non-Wood	Yard Burn	Other Organics	Paper	Wood Residue	Yellow Grease	Brown Grease	Biosolids	Municipal Totals
Biomass (tons/year):	246,011	421,489	35,826	42,152	2,428,084	834,057	18,486	20,528	94,820	4,141,452
Energy (million kWh):	352.95	318.52	27.07	23.51	2174.69	811.73	17.02	18.90	70.02	3814.42

Biomass (tons/year) County Grand Total: 16,902,873

Energy (million kWh) County Grand Total: 15522.51

Chapter 6 - References

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