Sustainable Energy Trust – Wind Energy and Biodigester Financial Analysis

Washington State Housing Finance Commission

February 5, 2010

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Section 1.0 Executive Summary

The Washington State Housing Finance Commission (Commission) commissioned David Paul Rosen & Associates (DRA) to conduct a financial analysis of renewable energy generation systems that can be financed by the Commission's Sustainable Energy Trust (SET). In previous phases of this study, DRA analyzed solar PV systems as applied to single family residential use, non-profit or government-owned school use, agricultural use and affordable and market rate multifamily residential use. For this phase of the study, DRA examined the financial feasibility of providing SET financing for renewable energy generation systems other than solar PV systems. DRA analyzed the following renewable energy generation system prototypes:

- Prototype #1: Large Wind Farm
- Prototype #2: Anaerobic Biodigester for Use in a Dairy Farm

DRA modeled the development costs for the wind and biodigester prototypes, as well as the available financing through federal, State and local funding programs. For each prototype, we examined the available funding sources assuming the systems are privately-owned. We assume that both the wind farm and the biodigester produce electricity that is sold to the local utility provider.

This report summarizes DRA's analysis of the alternative financing and ownership structures for the wind and biodigester prototypes described above. Our analysis assumes that the funding gap between the cost of installing the system and the financing available to the system's owner is filled by a loan provided by the SET. We then model the system owner's repayment of the SET loan and project the amount of time required to pay the loan back in full. We assume that the source for paying back the SET loan is, for the wind farm prototype, the farm owner's revenue earned in selling the electricity produced to the local utility provider, the revenue collected in selling the Renewable Energy Certificates (RECs) associated with the wind energy produced, and the Washington Renewable Energy Incentive payments received. For the biodigester prototype, the source for repayment of the SET loan is the dairy farm owner's savings in offset electricity costs as a result of the electricity produced by the biodigester, the revenue collected selling RECs, the revenue collected in plant waste tipping fees, the savings generated from offset fiber bedding costs, and the Washington Renewable Energy Incentive payments received.

Key Findings

Both the wind farm and biodigester prototypes, as modeled in this analysis, are able to repay the SET loan within the loan's term and are therefore financially feasible.

The results of the payback projection for the wind farm are detailed in Appendix A. The wind farm, as modeled, requires a large SET loan of $108 million but repays this loan in full in its fourteenth year of operation. This is based on conservative capital cost assumptions for the wind farm. However, our analysis does not include land, transmission or construction financing costs in the system's total cost.

We note that the wind farm's payback period is highly sensitive to the operations and maintenance cost assumptions employed. We use the industry standard of projecting annual operations and maintenance costs to be equal to 2 percent of the system's installed costs, per industry experts interviewed. However, we note that European wind farms have annual O&M costs that range from 4 to 6 percent of installed costs and that small wind installations in the US can have O&M costs of up to 10 percent of installed costs. While European wind farms' O&M costs are likely higher than those in the United States, due to a higher cost of doing business, should O&M costs be higher than the 2 percent of installed costs assumed in this prototype, the payback period is lengthened considerably.

As an illustration, we include in Appendix B-1 the payback projections for the wind farm assuming O&M costs equal to 4 percent of capital costs. In this scenario, the SET loan cannot be repaid within the loan term. In fact, after MACRS benefits expire in Year 6, the farm's O&M costs and return on developer equity are greater than the farm's revenue, thus providing no revenue stream to pay back the SET loan.

As shown in Appendix B-2, assuming the developer does not earn a return on his/her equity contribution, the SET loan would be paid back in Year 8 assuming O&M costs equal 4 percent of installed costs.

Appendix B-3 assumes O&M costs are equal to 6 percent of capital costs and there are no annual payments of return on developer equity. In this scenario, the wind farm is also unable to repay the SET loan within its 20 year term. While the loan balance decreases throughout the 20 years, it remains at $85 million at the end of Year 20.

The biodigester prototype modeled also repays the SET loan within its loan term. This prototype requires an SET loan of $525,000 and repays the loan in full in its first year of operation. The system's largest source of revenue to repay the SET loan is the payments the system owner collects in tipping fees, or in disposing of plant waste from external sources. We assume the system processes 8,152 tons of plant waste per year along with the animal waste from the dairy farm and collects $489,000 in tipping fees annually. While this is a substantial source of revenue for the biodigester owner, and the importance of this revenue stream was reiterated in interviews with biodigester owners in Washington, this prototype can pay off the SET loan in Year 1 even without collecting tipping fees. This is due to the relatively high price it attains for the electricity produced by the biodigester, the revenue collected from the sale of the RECs associated with the electricity produced and the tax credits awarded in its first year of operation.

Section 2.0 Wind Farm Prototype

DRA and Commission staff created a wind farm prototype for this analysis based on the attributes of wind farms currently being installed and in operation throughout the country and specifically in the Pacific Northwest. The prototype is assumed to use commercially available technology and equipment.

2.1 Wind Farm Capacity

According to the most recent Annual Report on US Wind Power, Installation, Cost, and Performance Trends, released in 2008 by the US Department of Energy, the average wind project size nationwide in 2007 was 120 Megawatts (MW).[1] This is the total rated power of the average wind farm's turbines. The average turbine's rated power in 2007 was 1.65 MW.

According to interviews with industry experts, a typical wind turbine used in wind farms being installed today is a v80 turbine rated at 2 MW. The wind farm prototype is therefore assumed to contain 60 turbines with rated capacities of 2 MW each for a total rated capacity of the wind farm of 120 MW.

There are two accepted ways of projecting the power output of wind turbines. The calculation used by utility companies and many wind product manufacturers involves calculating the actual power produced by individual turbines as a function of the turbines' rated power and their capacity factor. The capacity factor is a measure of the productivity of a wind turbine. It is the ratio of the actual amount of power produced by the turbine to the power it would produce if it operated at maximum output 100 percent of the time. The capacity factor, therefore, is affected by the location of the turbine, its height, and the wind levels and wind speed to which it is exposed.

In 2007, the weighted average capacity factor for all wind projects in the country was 34 percent. For wind projects in the Northwest, it was 31 percent. The national weighted average capacity factor is projected to be 35 percent in 2010, based on projected improvements in wind turbine technology. Our analysis assumes a capacity factor of 32 percent for wind farms in Washington in coming years. Using this assumption, the wind farm prototype in this study would produce

[1] "*Annual Report on US Wind Power Installation, Cost, and Performance Trends: 2007*," May 2008, US Department of Energy, Energy Efficiency and Renewable Energy.

approximately 5,500 Megawatt hours (MWh) per year per turbine, or approximately 330,000 MWh per year for the entire facility.

Some wind industry experts caution against using capacity factors as a means of projecting energy output of wind turbines because capacity factor measurements are based on assumptions made by wind turbine manufacturers regarding the wind speed to which the turbine will be exposed. These assumptions are not transparent and therefore can be subject to manipulation by manufacturers in order to inflate projected output and/or turbine costs.

An alternate means of projecting turbines' energy output, therefore, is based on a turbine's rotor diameter and the area of wind in which the rotor comes in contact. A v80 turbine has a rotor diameter of 80 meters and a wind swept area of 5,000 square meters. A relatively windy site in Eastern Washington has average wind speeds of approximately 7 meters per second, resulting in an average turbine production of 1,000 kWh per square meter of wind swept area per year. A v80 turbine would therefore produce approximately 5,000 MWh per year and the wind farm prototype used in this study would produce approximately 300,000 MWh per year of electricity. DRA's analysis uses this estimate of the wind farm's electricity production as a conservative assumption.

The wind farm prototype with a rated capacity of 120 MW, containing 60 v80 turbines rated at 2 MW each, is projected to produce 300,000 MWh of electricity per year.

2.2 Space Needed

For optimal energy production, turbines should be spaced to have approximately 5 to 10 turbine diameter's worth of space per turbine.[2] In addition, a wind farm's footprint requires approximately 0.25 to 0.50 acres per turbine for turbine towers, roads and support structures. Given these requirements, the wind farm prototype requires approximately 25 acres of land.

The largest contiguous areas of land with good to excellent wind in Washington are in the central part of the State: Kittitas Valley NW of Yakima, the ridges west of

[2] *"Power Technologies Energy Data Book, Wind Farm Area Calculator,"* National Renewable Energy Laboratory, http://www.nrel.gov/analysis/power_databook/calc_wind.php

the Columbia River northeast of Yakima, Horse Heaven Hills north of the Columbia River, and north of the Blue Mountains in southeastern Washington.[3]

2.3 Development Costs

2.3.1 Wind Energy System Installed Project Cost

A 2008 Lawrence Berkeley Laboratory study of wind power price trends cites the capacity-weighted average installed project cost for wind farms built in 2007 as $1,690 per rated kW. The cost rose to $2,025 per rated kW for projects built in 2008 and the study predicts, based on wind turbine orders in 2008, that the average installed cost for 2009 will be $2,250 per rated kW[4]. The increase in project costs are attributed, in part, to the rising cost of wind turbines. Interestingly, this is in contrast to recent decreases in costs for solar panels, dropping from approximately $8 per kW one year ago to approximately $7 per kW today.

While larger wind projects achieve some economies of scale and therefore slightly lower than average per kW project costs, as a conservative assumption we assume the average 2009 per kW installed project cost of $2,250 for the wind prototype analyzed in this study, or $2.25 million per installed MW, for a total cost of $270 million.

The above assumptions assume the prototype uses the lowest cost equipment and installers available. We therefore do not assume the system uses wind turbines manufactured in Washington, although some such equipment is available. This assumption will cause the systems to be eligible for the lowest Washington Renewable Energy Incentive rate, as the rate is increased when the installed system includes Washington-made turbines. However, due to the large size of the wind farm and the annual incentive cap of $5,000, a higher incentive rate will not benefit this project as it easily reaches the annual incentive limit at the base incentive rate.

[3] *"Wind Powering America, Washington Wind Resource Map,"* US Department of Energy, Energy Efficiency and Renewable Energy, www.windpoweringamerica.gov.
[4] *Wind Power Price Trends in the United States: Struggling to Remain Competitive in the Face of Strong Growth,* Mark Bolinger and Ryan Wiser, Lawrence Berkeley National Laboratory, October 2008.

2.3.2 Transmission Costs

Some wind farms face substantial costs in installing transmission lines and infrastructure to connect the wind farm to the local utility grid. These costs vary greatly depending on the site and location of the wind farm and are therefore difficult to generalize. For the purposes of this analysis, then, we assume the prototype has no transmission costs.

2.3.3 Land Cost

Wind farm owners either own the land on which the wind farm is sited or lease it from the landowner. Because land purchase prices and lease rates vary considerably on a case-by-case basis, determining a prototypical land cost is difficult and likely not informative for the purposes of this analysis. Therefore, DRA's analysis does not include the land cost in the wind farm's development or annual operations costs. However, given the wind farm prototype's strong cash flow, it could likely support annual land lease payments.

2.3.4 Construction Financing Costs

DRA's analysis also does not include construction loan interest costs in the wind farm's cost.

Table 1	
Wind Farm Prototype Assumptions	
Wind Farm Specifications	
Total Rated Power (MW)	120 MW
Rated Power per Turbine (MW) [1]	2 MW
Capacity Factor [2]	32.00%
Number of Turbines	60
Land Area Needed	25 acres
Turbine Rotor Height (m) [1]	90 meters
Turbine Diameter (m) [1]	80 meters
Wind Sweep Area (m^2) [1]	5,000 m^2
Average Wind Speed (meters/sec)	7 m/s
Average Turbine Output per Year ($kWh/m^2/yr$)	1,000 $kWh/m^2/yr$
Electricity Output per Turbine per Year (kWh/yr)	5,000,000 kWh/yr
Electricity Output per Turbine per Year (MWh/yr)	5,000 MWh/yr
System Costs	
Capital Cost ($/MW) [3]	$2,250,000/MW
Capital Cost per Turbine	$4,500,000
Total System Capital Cost	$270,000,000
Annual O & M Costs (% of installed cost) [4]	2.00%
Annual O & M Cost ($) [4]	$5,400,000
O & M Escalation Rate [5]	3.00%
Generation Assumptions	
Average Annual Power Output (MWh) [6]	300,000 MWh
Electricity Purchase Price ($/MWh) [7]	$49/MWh
Annual Electricity Price Inflation	3.00%
Other Assumptions	
WA Renewable Energy Incentive Rate ($/kWh) [8]	$0.12/kWh
Maximum Energy Incentive per year	$5,000
Renewable Energy Certificate purchase price ($/MWh) [9]	$10/MWh
Annual Interest on SET Loan	6.75%

Notes to Table 1:

[1] Assumes a v80 wind turbine rated at 2 MW.

[2] Capacity factor measures the productivity of a wind turbine. It is the ratio of the actual amount of power produced to the power that would have been produced if the turbine operated at maximum output 100 percent of the time. The weighted average capacity factor for all wind projects in the country in 2007 was 34 percent. For wind projects in the Northwest it was 31 percent. The national weighted average capacity factor is projected to be 35 percent in 2010.

[3] Based on projections for wind project costs in 2009, US Department of Energy.

[4] Industry standard of 2 percent of installed costs for operations and maintenance for wind facilities in the US, per industry experts. Costs include repairs, maintenance, insurance and replacement expenses for blades, generators and windboxes.

[5] Based on recent historical inflation rates.

[6] As a conservative assumption, output is calculated based on average turbine output per year per square meter of wind swept area. Using capacity factor assumptions, total output would be approximately 335,000 MWh.

[7] Weighted average 2007 wind electricity sales price nationwide. Prices are likely to rise as demand for wind power increases.

[8] Base Washington Renewable Energy Incentive Rate for wind, per RCW 82.16.120

[9] This represents the REC price for power produced in the project's first year of operation. The REC price is assumed to increase by $1 per MWh per year in subsequent years until it reaches a cap of $15 per MWh, per interview with Bonneville Environmental Foundation staff.

Section 3.0 Wind Farm Development Sources

DRA modeled the sources and uses for the wind farm prototype, assuming the wind farm sells the electricity it produces to the local utility provider.

The financing required by the Sustainable Energy Trust to render the system feasible is equal to the gap between the total funding available from all applicable financing sources and the cost of the system. The prototype's sources and uses are shown in Table 2.

3.1 Development Financing Sources

DRA produced, under separate cover, a summary of federal, State and local funding sources available to leverage SET funds in financing renewable energy generation systems. These profiles include the major sources of financing available in Washington. DRA's wind farm financial analysis includes the following development financing sources:

- Federal Business Energy Investment Tax Credit (ITC) in lieu of the Renewable Energy Production Tax Credit (PTC)
- Developer Equity
- Washington Renewable Energy Incentive
- Renewable Energy Certificates (RECs)

Table 2	
Development Sources and Uses	
Wind Farm Prototype	
	New Construction
Uses:	
Total Wind Farm Capital Cost [1]	$270,000,000
	___________
Total Uses:	$270,000,000
Sources:	
Federal Business Energy Tax Credit [2]	$81,000,000
Developer Equity [3]	$81,000,000
SET Loan Financing	$108,000,000
Total Sources:	$270,000,000
Total SET Financing per watt produced/saved	$0.00036
SET Financing as % of total cost	40%

[1] Assumes no transmission costs to connect the wind farm to the utility grid.

[2] ARRA allows taxpayers, such as wind farm owners, who are eligible for the PTC to take the Federal Business Energy Investment Tax Credit (ITC) in lieu of the PTC. The ITC is equal to 30 percent of the system's capital cost.

[3] Assumes developer contributes equity equal to 30 percent of the project's total cost and earns an annual return of 12 percent.

3.1.1 Federal Business Energy Investment Tax Credit

The primary source of financing solar PV systems and small wind systems (those under 100 kW) is the Federal Business Energy ITC, which provides a credit for up to 30 percent of the eligible system's cost for systems placed in service before December 31, 2016. For large wind farms, the primary source of federal funding has, until recently, been the Renewable Electricity PTC. This tax credit is a per kilowatt hour (kWh) credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person. For 2009, the PTC rate for wind farms placed in service before December 31, 2013 is $0.021 per kWh of electricity produced. This rate increases annually by the rate of inflation and is paid for electricity produced over 10 years.

The American Recovery and Reinvestment Act of 2009 allows for any taxpayer eligible for the PTC to take the ITC instead or to receive a grant from the US Treasury Department. The ITC, providing a tax credit for up to 30 percent of the system's cost, is a more lucrative funding source for a large wind farm than the PTC. We therefore model the ITC as a financing source for the wind farm prototype.

3.1.2 Developer Equity

We assume that the wind farm's developer contributes his/her own equity to finance 30 percent of the project's total cost. This is shown as a development source for the prototype. We assume the developer earns an annual return on this equity equal to 12 percent.

3.1.3 Washington Renewable Energy Incentive

The Revised Code of Washington Section 82.16.120 establishes an investment cost recovery incentive for the installation of renewable energy generation systems. This incentive is provided to individuals, businesses, government entities and participants in community solar projects who own a solar or wind energy system in the State. The incentive is calculated based on the energy produced by the system and is provided as an annual payment by the recipient's utility provider. The incentive cannot exceed $5,000 per year and will be paid for the system's annual energy production through June 30, 2020.

The Renewable Energy Incentive base rate for wind is $0.12 per kWh produced. This rate can increase up to $0.18 per kWh if the system's inverters and/or wind turbine blades are manufactured in Washington. For the purposes of this analysis, we assume that the system's inverters and blades are manufactured outside of Washington and that the system's owner is therefore eligible for the base incentive rate of $0.12 per kWh. Due to the annual cap of $5,000 and the size of this wind farm, the system owner would not benefit from a higher incentive rate, as the cap is reached assuming the base rate.

In order to show the discounted present value of these incentive payments as a development source for financing the purchase and installation of the wind farm, we would have to assume that the farm's owner could provide the present value of the incentives in cash up front. This is not likely to be feasible for most system owners, especially given the large equity contribution made by the developer upfront. Therefore, DRA's financial analysis assumes that the incentive payments received by the system owners are not used as an up-front source of financing for the system but instead are shown as an annual source of repayment for the SET loan.

3.1.4 Renewable Energy Certificates

Washington's Initiative 937, passed in 1996, requires all electric utilities that serve more than 25,000 customers to obtain 3 percent of their electricity from renewable sources by 2012, and thereafter gradually stepping up to a requirement that they obtain 15 percent of their electricity from renewable sources by 2020. Seventeen of Washington's 62 utilities, representing about 84 percent of the State's electricity load, must meet this standard. Utilities will meet this requirement by producing renewable electricity themselves or by buying Renewable Energy Credits or Certificates (RECs) from producers of renewable energy. RECs are typically purchased for renewable energy produced in increments of 1 MW.

There is currently a relatively small active market for buying and selling RECs from larger renewable energy projects in the Pacific Northwest, through the Bonneville Environmental Foundation (BEF). Smaller projects can be aggregated together to sell their combined RECs. According to interviews with BEF staff, most contracts to buy and sell RECs are negotiated and executed on an annual basis. As a conservative estimate, RECs for renewable energy produced in Washington beginning in 2011 would likely sell for approximately $10 per MWh. This price would likely increase slightly in each year's new contract until it reaches a certain price cap. Previous contracts executed through BEF capped the REC price at $13 per MWh.

According to the BEF interviewee, RECs for power produced in Washington command relatively high prices, because of the strong demand from voluntary REC purchasers with a preference for power produced within the State, as well as the Renewable Portfolio Standards requirements placed on Washington utility companies by Initiative 937. It is likely that as the requirements on the State's utilities step up, more utility providers will enter the market for purchasing RECs from renewable energy system owners and this increased demand will likely raise the price of RECs. The Commission may want to consider assisting in developing this REC investor market in order to boost the pricing of RECs and to increase the capital available to renewable energy facilities in the State.

California also has aggressive Renewable Portfolio Standards placed on its utilities that increase over time, thus potentially increasing the demand for RECs from California utilities as well. Unlike in Washington, where renewable energy producers can sell their RECs and electricity to separate buyers, California currently does not permit RECs and electricity to be unbundled. Unless this policy changes, in order for Washington renewable energy producers to take advantage of the likely high REC prices California utilities will be offering in the near future, they will have to also sell and transport the power they produce to those California utilities purchasing the RECs. These transmission costs would likely make such an arrangement cost prohibitive in the current market. However, if the electricity and REC purchase prices offered by California utilities reach high enough levels, this may be feasible. It is therefore worth monitoring this potential market.

DRA's analysis does not show RECs as a development financing source for the wind farm prototype for the same reasons the Washington Renewable Energy Incentive is not shown as a development source: because the wind farm developer will likely not be able to provide an up-front source of capital for future REC payments. However, we show REC payments being received annually in the projections of cash flow.

3.1.5 USDA's Rural Energy for America Program (REAP)

The Rural Energy for America Program (REAP) provides grants to agricultural producers and rural small businesses to purchase renewable energy systems, including wind energy generation systems, which are used to make or sell electricity. The grant is equal to 25 percent of the project's cost and is capped at $500,000. REAP grants are intended to make otherwise infeasible projects feasible and usually are not awarded to projects of this size. DRA's analysis therefore does not show a REAP grant as a development source for the wind farm prototype.

3.1.6 Loan Guarantee Programs

Loan guarantee programs for wind energy projects are available through the Department of Energy (DOE) and the USDA Rural Development REAP program. These programs can assist a wind farm in securing beneficial loan terms and reducing borrowing costs. DOE offers awardees loan guarantees of up to 80 percent of the project costs. While there is significant authority available under this program, it has been greatly undersubscribed. DOE is currently examining the program and potentially revising it to be more responsive to borrowers' needs. The wind farm prototype modeled would likely be eligible for this loan guarantee program.

USDA's REAP loan guarantee program will guarantee loans that are 60 to 85 percent of the project's costs and do not exceed $25 million. Combined grant and loan guarantee assistance under REAP cannot exceed 75 percent of a project's cost. This program has been very active in recent years. This prototype may also be eligible for a REAP loan guarantee.

3.1.7 Carbon Offset Credits

There is considerable future potential for the sale of carbon offset credits to be a significant revenue stream for renewable energy system owners. Currently, the Chicago Climate Exchange (CCE) is the only voluntary cap and trade system for greenhouse gases in North America. CCE manages a carbon trading marketplace in which renewable energy systems can sell their carbon offset credits to industries in need of meeting carbon reduction requirements. The CCE's rules for renewable energy projects do not allow projects selling these credits to also sell RECs. DRA's current analysis therefore does not include the sale of carbon offset credits as a revenue stream. We note, however, that future wind energy projects may be able to take advantage of selling carbon credits as the market to do so expands and evolves.

3.2 SET Financing

We model the SET providing gap financing to the wind farm's owner in an amount equal to the difference between the wind farm's total cost and the total financing available from other sources. We then model the repayment of this loan by the system's owner. The annual SET repayment amount is equal to the revenue generated by selling the wind energy produced to a local utility, the revenue generated by selling RECs, the annual cash benefits of depreciation and the annual Washington Renewable Energy Incentive payment. We assume an interest rate on the SET loan of 6.75 percent and a term of 20 years, equal to the estimated useful life of the wind farm.

 

Section 4.0 Wind Farm Payback Projections

DRA projected the payback period for the SET loan for the wind farm prototype. Given the assumptions described below, the wind farm is able pay back the SET loan in Year 5 of its operations.

4.1 Payback Projection Assumptions

4.1.1 Electricity Purchase Price

Most wind farms in operation in Washington are owned by utility companies. Those wind farms in the United States that are owned privately and sell the electricity they produce to a utility company do not publish the terms of their power purchase agreements (PPAs) or the purchase price paid by the utility for the electricity they produce. DRA's analysis therefore relies on national data on wind energy purchase prices. According to the Department of Energy's 2008 Annual Report on US Wind Power, the weighted average sales price for electricity generated by wind farms in 2007 was approximately $45 per MW, with a range from $30 to $65 per MW.[5] Assuming an annual inflation rate of 3 percent, the 2007 average price is $49 per MW in 2010 dollars. DRA's analysis assumes this purchase price for the electricity produced by the wind farm. The Department of Energy report projects prices rising faster than inflation in coming years, due to increasing demand for wind energy. We also note that, because every agreement is negotiated individually, in negotiating a PPA with a utility company, a wind farm owner could secure a significantly higher purchase price than the price assumed in this analysis. On the other hand, given Washington's relatively low average electricity prices compared to the rest of the United States, wind farms in

[5] "*Annual Report on US Wind Power Installation, Cost, and Performance Trends: 2007*," May 2008, US Department of Energy, Energy Efficiency and Renewable Energy.

Washington may not be able to negotiate purchase prices comparable to, let alone higher than, the national average.

The lack of transparency regarding the electricity purchase prices paid by utility companies to wind energy producers creates an obstacle to new wind energy developers, as they cannot accurately project potential revenues. The market could therefore benefit from more transparency and competition in pricing of electricity from renewable sources. Some in the wind industry advocate requiring utilities to set and publish Feed-In Tariffs for purchasing wind energy, thus reducing uncertainty and potentially providing for higher purchase prices for wind energy producers. This is a policy issue the Commission may want to address in the future.

Annual Electricity Price Inflation Rate

We assume an annual inflation rate of 3 percent, based on recent historical inflation rates.

4.1.2 Renewable Energy Certificates (RECs)

RECs are purchased from renewable energy producers at a set rate per MWh of electricity produced. As discussed above, the REC purchase price is set in a contract negotiated and executed annually between the buyer and seller of the REC. For the purposes of this analysis, we assume the wind farm owner sells RECs at a rate of $10 per MWh in the project's first year in service. The rate increases by $1 per year until it reaches a cap of $15 per MWh. These assumptions are based on interviews with staff at the Bonneville Environmental Foundation, the primary purchaser of RECs in the Pacific Northwest.

4.1.3 Modified Accelerated Cost Recovery System

The Federal Modified Accelerated Cost Recovery System (MACRS) allows the owner of eligible renewable energy systems to take a depreciation deduction for the property and depreciate it over a six-year schedule. A wind system's turbines and plant equipment costs are eligible for MACRS. These MACRS-eligible costs typically represent approximately 90 to 95 percent of wind energy systems' total costs. The remainder of the systems' costs are depreciated over 15 to 20 years. The MACRS depreciation benefits accelerate the payback period for a wind energy system. The depreciation schedules, and the cash effect of the systems' depreciation, are detailed in Table 3.

INCOME TAX RATE

DRA assumes the following tax rates for the purposes of calculating the cash effects of MACRS for the systems' owners:

	Federal Income Tax Rate	State Income Tax Rate
Corporate:	35%	0.15%

The federal corporate income tax rate above applies to corporations with taxable income above $18,333,333. The state corporate income tax rate shown above refers to Washington's 2009 Business and Occupation Tax for service and other activities.

4.1.4 Operations and Maintenance

According to industry experts, the industry standard or annual operations and maintenance (O&M) costs for wind farms in the United States is 2 percent of installed costs. Annual O&M costs for wind farms in Europe range from 4 to 6 percent of installed system costs. Small wind facilities in the US have annual O&M costs equal to approximately 10 percent of installed system costs, with larger facilities achieving economies of scale and thus a lower O&M cost to installed cost ratio. Because European wind farms likely face higher costs of doing business than those in the US, we assume the industry standard in the US and calculate O&M costs as 2 percent of installed costs, or $5.4 million per year. This cost includes repairs, maintenance, insurance and replacement expenses for blades, generators and windboxes.

Table 3

Depreciation Calculations

Wind Farm Prototype

Total System Cost	$270,000,000
(Less Federal Tax Credit – 30%)	($81,000,000)
Total Depreciable Basis[1]	$206,550,000
Federal Tax Rate[2]	35.15%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
MACRS Depreciation Schedule	20.00%	32.00%	19.20%	11.52%	11.52%	5.76%
MACRS Depreciation Amount	$41,310,000	$66,096,000	$39,657,600	$23,794,560	$23,794,560	$11,897,280
Cash Effect of Depreciation	$14,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894
Federal Tax Credit	$81,000,000					
Total Annual Tax Savings	$95,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894
Cumulative Tax Savings	$95,520,465	$118,753,209	$132,692,855	$141,056,643	$149,420,431	$153,602,325

[1] Approximately 90 percent of a system's cost is eligible for accelerated depreciation. The remainder of the project costs is depreciated over 15 – 20 years. For calculating MACRS benefits, the Depreciable Basis is calculated as the system's total cost, less 50 percent of the Federal Tax Credit Amount.

[2] Assumes a federal tax rate of 35 percent and Washington's 2009 Business and Occupation Tax for service and other activities of 0.15 percent.

4.2 Payback Projection Results

The results of the payback projection for the wind farm are detailed in Appendix A. The wind farm, as modeled, requires a large SET loan of $108 million but repays this loan in full in its fourteenth year of operation. This is based on conservative capital cost assumptions for the wind farm. However, our analysis does not include land, transmission or construction financing costs in the system's total cost.

We note that the wind farm's payback period is highly sensitive to the O&M cost assumptions employed. We use the industry standard of projecting annual O&M costs to be equal to 2 percent of the system's installed costs, per industry experts interviewed. However, we note that European wind farms have annual O&M costs that range from 4 to 6 percent of installed costs and that small wind installations in the US can have O&M costs of up to 10 percent of installed costs. While European wind farms' O&M costs are likely higher than those in the United States, due to a higher cost of doing business, should O&M costs be higher than the 2 percent of installed costs assumed in this prototype, the payback period is lengthened considerably.

As an illustration, we include in Appendix B-1 the payback projections for the wind farm assuming O&M costs equal to 4 percent of capital costs. In this scenario, the SET loan cannot be repaid within the loan term. In fact, after MACRS benefits expire in Year 6, the farm's O&M costs and return on developer equity are greater than the farm's revenue, thus providing no revenue stream to pay back the SET loan.

As shown in Appendix B-2, assuming O&M costs equal to 4 percent of installed costs and that the developer does *not* earn a return on his/her equity contribution, the SET loan would be paid back in Year 8 in assuming. This is because the project is no longer making annual payments to the developer equal to 12 percent of his/her equity contribution.

Appendix B-3 assumes O&M costs are equal to 6 percent of capital costs and there are no annual payments of return on developer equity. In this scenario, the wind farm is also unable to repay the SET loan within its 20 year term. While the loan balance decreases throughout the 20 years, it remains at $85 million at the end of Year 20.

Most of the wind farms currently in operation in Washington are owned by utility companies that are required to meet minimum renewable energy production standards. These utilities then sell the wind energy produced to their customers. Utilities can use their traditional financing mechanisms to finance these farms and sell the electricity at market rates, or, under Green Power Programs, at higher than conventional electricity rates. Most privately-owned wind farms in other parts of the country are built by for-profit developers with a tax appetite who build the wind farm and enjoy the tax credits and depreciation benefits for the initial 5 to 7 years of its operation. They then often sell the wind farm, typically to a public utility company that cannot take advantage of the tax benefits but wants wind energy as a part of its portfolio in order to meet renewable energy production standards or to sell under Green Power Programs. The initial developer therefore receives the tax benefits in the first 7 years of the project's life and then a cash payment when the farm is sold.

Section 5.0 Anaerobic Biodigester Prototype

DRA and Commission staff created an anaerobic biodigester prototype for use on a dairy farm. There are currently four such systems operating in the State, with several more in the planning stages. An anaerobic biodigester converts plant and/or animal waste into energy. The process produces methane, or biogas, that can be converted to electricity. When compared with conventional manure treatment and storage processes, an anaerobic biodigester also produces less odors, flies, pathogens, solid waste, water pollution, and harmful methane emissions. A biodigester also produces several valuable byproducts beyond its energy production: a liquid fertilizer that is more concentrated and easier to use than manure, organic fibers that can be used for cattle bedding, and waste heat beyond what is necessary to heat the biodigester itself.

The specifications of the biodigester prototype developed for this study are based on interviews with those active in biodigester development, research and regulation in Washington as well as data available from the operating dairy biodigesters installed in the State, all of which are plug-flow biodigesters. These specifications are detailed in Table 4 below.

The biodigester prototype modeled in this study is a plug-flow system that is built on the dairy farm, as trucking manure to an offsite digester is costly and can render a system infeasible. We note that manure can be pumped up to 2 miles from its source, providing some flexibility to the dairy owner regarding the placement of the system.

5.1 Biodigester Capacity

According to the sources consulted for this study, the Washington dairy farms with installed biodigesters range from 750 to 3,500 cattle, with the median size containing 1,000 heads of cattle. While the average dairy farm in Washington was

480 in 2007, a dairy with 1,000 heads of cattle is considered medium sized.[6] Biodigesters can prove economically feasible for dairies of all sizes, but are most common in Washington's medium-sized operations. The State's largest dairy farms, located primarily in Eastern Washington, have not yet begun installing biodigesters.

Three of the four biodigesters in the State combine plant/food waste with animal waste to power the systems. This increases the system's efficiency, or energy output per cow, and improves its financial feasibility as more energy is produced and the biodigester owner can collect tipping fees for disposing of plant/food waste from external sources. The prototype used in this study therefore is sized based on the assumption that it is powered by a 1,000 cow dairy operation and also takes in plant/food waste from external sources. The assumed animal to plant/food waste ratio is three to one, the maximum ratio achievable, according to industry experts.

A typical rule of thumb for Washington biodigesters' energy production is that every 4 cows provide one kW of installed capacity. We therefore assume 0.25 kW of installed capacity per cow. This translates into approximately 2,000 kWh of generated electrical output per cow per year. Including plant/food waste in the system's inputs can increase its energy output by up to 50 percent. Therefore, we assume the system has an installed capacity of 0.38 kW per cow, or 375 kW total and an annual electricity generation of 3,000 kWh per cow or 3,000 MWh total.

DRA has conducted research on a plant waste biodigester currently in operation in California. This system processes 300,000 pounds of plant waste per day and produces 5,000 MWh per year. While slightly less efficient than a biodigester that processes both plant and animal waste, this system's output is comparable to the prototype modeled. According to the engineer who designed this system, it is projected to have a payback period of 3 to 5 years.

5.2 Biodigester Installed Project Costs

Installed project costs for anaerobic biodigesters include installation and materials for a container or area for premixing the organic material, a digesting tank, systems for storing and using the collected biogas and systems for storing and using the liquid and solid effluent outputs.

[6] *"Facts About the Washington Dairy Industry,"* Washington Dairy Products Commission, March 2008. http://havemilk.com/article.asp?id=2142

While many quote biodigester costs using a dollars per cow metric, a more useful metric is installed cost per rated kW, as this takes into account variations in systems' efficiencies. The current installed costs for all sizes of biodigesters in Washington are approximately $4,000 per rated kW. While larger systems may achieve some economies of scale in materials, they depend more on manure than food waste, making the systems less efficient per cow than smaller systems. Thus, the per-rated kW costs, which factor in the systems' efficiencies, remain relatively consistent for all system sizes.

This study's biodigester prototype assumes a per rated kW installed cost of $4,000 and a total system installed cost of $1.5 million.

5.2.1 Transmission Costs

Some biodigester systems may face substantial costs in installing transmission lines and infrastructure to connect the system to the local utility grid. Because these costs vary greatly on a case-by-case basis and are therefore difficult to generalize, for the purposes of this analysis, we assume the prototype has no transmission costs.

5.2.2 Waste Heat Recovery Costs

Due to the chemical processes used in a biodigester, the system both requires and produces heat. As a general rule, a biodigester uses approximately 25 percent, but up to 60 percent of its waste heat for its own heat needs. The remaining 40 to 75 percent of waste heat can be captured and used to heat nearby barns, homes, greenhouses, etc. Because of the climate in Washington and the resulting modest heat needs of the State's dairy farms, as well as the high cost of installing heat recovery systems to capture the heat and route it towards different uses, most biodigesters currently operating or being planned in Washington do not capture this waste heat and therefore do not use this potentially valuable output. Technologies and systems to make this heat recapture more cost effective are currently being explored. One Washington project in the planning stages intends to co-locate a biodigester with a greenhouse in order to use the biodigester's waste heat for the greenhouse's heat needs. Biodigesters such as this one being planned, that capture and use or sell the waste heat produced, will financially benefit as an additional revenue stream or offset cost will be generated. However, due to the obstacles noted above, this study's prototype does not assume that the system's waste heat is captured.

5.2.3 Land Costs

We assume that the biodigester is located on the dairy farm's land and therefore include no additional land costs in the project's costs.

5.2.4 Construction Financing Costs

DRA's analysis also does not include construction loan interest costs in the biodigester's cost.

Table 4	
Anaerobic Biodigester Prototype Assumptions	
Biodigester and Dairy Farm Specifications	
Total Number of Cattle	1,000
Rated output per cow (kW)	0.25 kW
Electricity produced per cow per year (kWh)	2,000 kWh
Ratio animal waste to food waste	3 : 1
Increase in energy output from food waste (%)	50%
Total rated output per cow, inclusive of food waste (kW)	0.38 kW
Total electricity produced per cow per yr, inclusive of food waste (kWh)	3,000 kWh
System Costs	
Total installed cost per rated kW ($/kW)	$4,000/kW
Total system installed cost	$1,500,000
O&M costs ($/kWh/yr)	$0.02/kW
O&M Annual Escalation Rate	3.00%
System Outputs	
Total electricity produced per year (MWh)	3,000 MWh
Electricity purchase price ($/MWh)	$70.91/MWh
Annual electricity purchase price inflation	2.10%
Fiber generated per year (cubic yards)	10,000 cu yds
Fiber avoided cost/sales price	$75,000
Plant/food waste tipping fee ($/ton)	$60/ton
Plant/food waste processed per year (tons)	8,100 tons
Other Assumptions	
WA Renewable Energy Incentive Rate ($/kWh) [1]	$0.15/kWh
Maximum Energy Incentive per year	$5,000
Renewable Energy Certificate purchase price ($/MWh)[2]	$20/MWh

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Notes to Table 4:

[1] Washington Renewable Energy Incentive rate for biodigesters, per RCW 82.16.120.

[2] This represents the REC price for power produced in the project's first year of operation. The REC price is assumed to increase by $1 per MWh per year in subsequent years until it reaches a cap of $30 per MWh, per Bonneville Environmental Foundation staff. This assumes the biodigester's RECs qualify under Washington RCW 19.285 for double the facility's power output and therefore sell at double the market rate.

Section 6.0 Biodigester Development Sources and Uses

DRA modeled the sources and uses for the biodigester prototype, assuming the system owner sells the electricity it produces to the local utility provider.

The financing required by the SET to render the system feasible is equal to the gap between the total funding available from all applicable financing sources and the cost of the system, or $525,000. The prototype's sources and uses are shown in Table 5 below.

6.1 Development Financing Sources

DRA produced, under separate cover, a summary of federal, State and local funding sources available to leverage SET funds in financing renewable energy generation systems. These profiles include the major sources of financing available in Washington. DRA's biodigester financial analysis includes the following development financing sources:

- The Federal Business Energy Investment Tax Credit (ITC) in lieu of the Production Tax Credit (PTC)
- USDA's Rural Energy for America Program (REAP)
- USDA's Value Added Producer Grant
- SET Loan Financing

Table 5	
Development Sources and Uses	
Anaerobic Biodigester Prototype	
	New Construction
Uses:	
Total Anaerobic Biodigester System Cost [1]	$1,500,000
	________
Total Uses:	$1,500,000
Sources:	
Federal Business Energy Tax Credit [2]	$450,000
Rural Energy for American Program (REAP) [3]	$375,000
USDA Value Added Producer Grant [4]	$150,000
SET Loan Financing	$525,000
Total Sources:	$1,500,000
Total SET Financing per watt produced/saved	$0.18
SET Financing as % of total cost	35%

[1] Assumes no transmission costs to connect the biodigester to the utility grid.

[2] ARRA allows taxpayers , such as biodigester owners, who are eligible for the Production Tax Credit (PTC) to take the Federal Business Energy Investment Tax Credit (ITC) in lieu of the PTC. The ITC is equal to 30 percent of the system's cost.

[3] REAP Grants are available to those projects in designated rural areas. Grants can be up to 25 percent of the project's cost, but may not exceed $500,000.

[4] USDA's Value Added Producer Grants range from $50,000 to $300,000.

6.1.1 Federal Business Energy Investment Tax Credit

The primary source of financing for renewable energy systems is the Federal Business Energy ITC, which provides a credit for up to 30 percent of the eligible system's cost. For anaerobic biodigesters, the primary source of federal funding has, until recently, been the Renewable Electricity PTC. This tax credit is a per kWh credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person. For 2009, the PTC rate for open-loop biodigesters, such as those using animal waste, that are placed in service before December 31, 2013 is $0.011 per kWh of electricity produced. This rate increases annually by the rate of inflation and is paid for electricity produced over 10 years.

The American Recovery and Reinvestment Act of 2009 allows for any taxpayer eligible for the PTC to take the ITC instead or to receive a grant from the US Treasury Department. Eligible systems must be placed in service by December 31, 2013. The ITC, providing a tax credit for up to 30 percent of the system's cost, is a more lucrative funding source for a biodigester than the PTC. We therefore model the ITC as a financing source for the biodigester prototype.

6.1.2 USDA's Rural Energy for America Program (REAP)

The Rural Energy for America Program (REAP) provides grants to agricultural producers and rural small businesses to purchase renewable energy systems, including anaerobic biodigester systems, which are used to make or sell electricity. The grant is equal to 25 percent of the project's cost and is capped at $500,000.

DRA's analysis shows a REAP grant as a development source for the biodigester prototype. The grant shown is $375,000, equal to 25 percent of the system's cost.

6.1.3 USDA's Value Added Producer Grant

The USDA Rural Development's Value Added Producer Grant program provides grants from $50,000 to $300,000 to producers, farmer and rancher cooperatives, agricultural producer groups, and producer-based business ventures for planning or working capital for value added activities. Value added activities include those that involve: a change in a product's physical state, a differentiated production or marketing process, product segregation or a product that produces renewable energy. Priority in this program is given to those projects that produce bio-energy. Grants are awarded in an annual national competition. We conservatively assume a grant of $150,000 for the biodigester prototype.

6.1.4 Washington State Energy Program (SEP) Loan and Grant

The State Energy Program (SEP) is funded through the federal American Recovery and Reinvestment Act of 2009. Washington State received an allocation of $60.9 million in SEP funds. The State Legislature allocated $38.5 million of these funds to the Department of Commerce to administer an Energy Efficiency and Renewable Energy loan and grant program. Approximately $20 million of these funds were awarded in the program's first round in October 2009. The second round will award $16.5 million in loans and grants ranging from $250,000 to $2 million. The SEP second round of funding allocates $3 million to funding waste-to-energy systems. Second round applications were due February 1, 2010, awardees will be under contract by June 2010 and funds will be expended by December 31, 2010. The program may be re-funded following the second round allocations.

The SEP loan and grant program allows applicants to request their award either as 100 percent loan funds or as 30 percent grant and 70 percent loan, to help with upfront capital costs. Receiving SEP funds in the form of a grant, however, triggers wage requirements (projects are required to pay the higher of Davis Bacon and State prevailing wages, rather than adhering only to Davis Bacon wage requirements) that may make this option undesirable from a cost perspective. The program also requires a one-to-one match of other funds to SEP funds, with higher matching ratios achieving more points in the applications competitive scoring.

We do not include an SEP loan or grant as a source for this prototype, as future allocations for the program are uncertain.

6.1.5 Washington Renewable Energy Incentive

The Revised Code of Washington Section 82.16.120 establishes an investment cost recovery incentive for the installation of renewable energy generation systems. This incentive is provided to individuals, businesses, government entities and participants in community solar projects who own a solar, wind or anaerobic biodigester energy system in the State. The incentive is calculated based on the energy produced by the system and is provided as an annual payment by the recipient's utility provider. The incentive cannot exceed $5,000 per year and will be paid for the system's annual energy production through June 30, 2020.

The Energy Incentive rate for anaerobic biodigesters is $0.15 per kWh produced. In order to show the discounted present value of these incentive payments as a development source for financing the purchase and installation of the PV system, we would have to assume that the system's owner could provide the present value of the incentives in cash up front. This is not likely to be feasible for most system owners. Therefore, DRA's financial analysis assumes that the incentive payments received by the system owners are not used as an up-front source of financing for the system but instead are shown as an annual source of repayment for the SET loan.

6.1.6 Renewable Energy Certificates

As discussed above, Washington's Initiative 937, passed in 1996, requires all electric utilities that serve more than 25,000 customers to obtain a portion of their electricity from renewable sources by 2012, and thereafter gradually steps up to the requirement until they are required to obtain 15 percent of their electricity from renewable sources by 2020. This Renewable Production Standard (RPS) creates a market for RECs, whereby renewable energy producers sell the credit for producing clean energy to those entities required to meet thresholds of renewable energy production or credits.

There is currently a small active market for buying and selling RECs in Washington and it is likely to expand greatly as the RPS requirements on utility companies become more substantial.

DRA's analysis does not show RECs as a development financing source for the biodigester prototype for the same reasons the Washington Renewable Energy Incentive is not shown as a development source: because the biodigester owner will likely not be able to come up with an up-front source of capital for future REC payments. However, we show REC payments being received annually in the projections of cash flow.

6.1.7 Carbon Offset Credits

There is considerable future potential for the sale of carbon offset credits to be a significant revenue stream for anaerobic biodigester system owners. Currently, the Bonneville Environmental Foundation is working on negotiating a deal for the sale of RECs and carbon credits from the owner of an anaerobic biodigester in Washington, but the deal has yet to be completed. BEF negotiates the sale of RECs and carbon credits for a few landfill projects throughout the Northwest and anticipates a more active market for selling carbon credits in the future. Because of the lack of completed carbon credit sales in Washington, DRA's current analysis does not include this as a revenue stream. We note, however, that future biodigester projects may be able to take advantage of this growing market.

6.1.8 Loan Guarantee Programs

Loan guarantee programs for biodigester projects are available through the DOE and USDA Rural Development (RD). These programs can assist a biodigester in securing beneficial loan terms and reducing borrowing costs. DOE offers awardees loan guarantees of up to 80 percent of the project's costs. While there is significant authority available under this program, it has been greatly undersubscribed. DOE is currently examining the program and potentially revising it to be more responsive to borrowers needs.

USDA RD's REAP loan guarantee program will guarantee loan amounts that are 60 to 85 percent of the project's costs and do not exceed $25 million. Combined grant and loan guarantee assistance under REAP cannot exceed 75 percent of a project's cost. This program has been very active in recent years.

USDA RD's Business and Industry loan guarantee program also guarantees loan amounts that are 60 to 85 percent of the project's cost and do not exceed $25 million. These loans can be for real estate, equipment, working capital and refinancing for rural businesses.

USDA Section 9003 Biorefinery Assistance Program provides guarantees for up to 90 percent of a loan amount for projects involving pre-commercial technologies. Guaranteed loans can be up to $250 million. As modeled here, the biodigester prototype would likely not qualify for this program, as it involves a proven and commercially-available technology.

While a biodigester like the one modeled here would likely qualify for and benefit from one of these loan guarantee programs, we do not model the lower financing costs associated with such a guarantee in this analysis.

6.2 SET Financing

We model the SET providing gap financing to the biodigester system's owner in an amount equal to the difference between the system's total cost and the total financing available from other sources. We then model the repayment of this loan by the system's owner. The annual SET repayment amount is equal to the revenue generated by selling the energy produced to a local utility, the revenue generated from the sale of RECs, tipping fees collected, the annual Washington Renewable Energy Incentive amount and the revenue generated or costs avoided from selling or using the biodigester's other valuable outputs. We assume an interest rate on the SET loan of 6.75 percent and a term of 15 years, equal to the estimated useful life of a biodigester system.

Section 7.0 Anaerobic Biodigester Payback Projections

DRA projected the payback period for the SET loan for the biodigester prototype. Given the assumptions described below, the biodigester is able pay back the SET loan within its first year of operation.

7.1 Payback Projection Assumptions

7.1.1 Annual Costs - Operations and Maintenance

Biodigesters require daily attention and moderate yearly maintenance. According to industry experts interviewed, O&M costs for anaerobic biodigesters are approximately $0.02 per installed kW. The prototype analyzed in this study therefore has annual operations and maintenance costs of $60,000, inflating at a rate of 3 percent per year.

7.1.2 Annual Sources of Revenue

ELECTRICITY PURCHASE PRICE

Under the Public Utility Regulatory Policies Act (PURPA) of 1978, electric utility companies are required to buy power from renewable energy producers at the "avoided cost" rate, equal to the lower of the cost the utility company would incur in producing the power itself and the market price of the power. In Washington, the three investor-owned utilities (IOUs) – Pacific Power and Light, Avista Corporation, and Puget Sound Energy – are required to set and publish tariffs for their purchase of renewable energy at its avoided cost. Other utilities also purchase renewable energy, but are not required to set standard rates for all renewable energy producers. In non-IOU utilities' territories, electricity purchase prices are often set on a case-by-case basis through the negotiation of a PPA between the utility company and renewable energy provider.

Avista and Pacific Power and Light's avoided cost rates apply to qualified renewable energy projects that are 1 MW of rated capacity or less. Puget Sound Energy's rates apply to qualified projects that are up to 2 MW. For contracts executed in 2010, Puget Sound Energy pays $84.67 per MWh for power produced in 2010 and increases the purchase price throughout the term of the contract until it reaches $108.38 in 2020. Avista's avoided cost for a project beginning operation in 2010 is $62.76 per MWh for a one year contract. The rate increases with the length of the PPA signed with the renewable energy producer until it reaches $64.54 per MWh for a 5-year contract. Pacific Power and Light's avoided cost rate is $61.33 per MWh plus $1.46 per kW per month for power delivered in 2010.

DRA's analysis bases the electricity purchase price for the biodigester prototype on the data that are available from the State's three IOUs. We therefore assume the biodigester owner sells the power produced at the average of the 2010 rates quoted above, or $70.91 per MWh produced. The three IOUs' avoided cost tariff schedules show annual increases in the tariffs. The average annual increase for the three schedules is 2.1 percent. We therefore assume this as the annual electricity purchase price inflation factor.

RENEWABLE ENERGY CERTIFICATES

RECs are purchased from renewable energy producers at a set rate per MWh of electricity produced. As discussed above, the REC purchase price is set in a contract negotiated and executed annually between the buyer and seller of the REC. The Bonneville Environmental Foundation estimates that a renewable energy system that begins operations in 2010 can sell its RECs at a rate of $10 per MWh in the project's first year in service. The rate will then increase by $1 per year until it reaches a pre-determined cap.

The Washington RCW Section 19.285 allows RECs purchased from distributed generation facilities to count at double the facilities' output for the utility company purchasing the RECs. Anaerobic biodigesters with a rated capacity of 5 MW or less qualify as distributed generation facilities under this section. Therefore, anaerobic biodigester owners can likely sell the RECs associated with their facilities at double the market REC price. We therefore assume that the biodigester prototype sells

RECs at a rate of $20 per MWh in its first year of operation, increasing by $2 annually until the rate reaches a cap of $30 per MWh.

PLANT/FOOD WASTE TIPPING FEES

Tipping fees paid to biodigester owners for disposing of plant/food waste vary greatly by project and supplier. An industry expert quoted an average tipping fee of $60 per ton of waste. He also noted that, while the tipping fee rate is vital for ensuring a biodigester's financial feasibility, the reliability of the waste source over the long term is equally important.

This analysis assumes a tipping fee is paid to the biodigester owner at a rate of $60 per ton. Because the system is assumed to process animal to plant waste at a ratio of three to one, we assume it is processing one third the amount of plant waste as animal waste. Dairy cows that weigh 1,400 pounds produce approximately 148 pounds, or 0.067 tons of waste per day. We therefore assume the system processes approximately 24,500 tons of animal waste per year and 8,200 tons of plant waste. The system owner will therefore collect approximately $489,000 in tipping fees annually.

FIBER BEDDING MATERIAL

While the amount of organic fiber produced as a byproduct by the biodigester depends on the system's efficiency and ratio and quality of its inputs, it is estimated that a typical combined plant/food and animal waste system will produce approximately 10 to 15 cubic yards of fiber waste per cow per year. Most dairies use this fiber themselves to replace the bedding material they otherwise would purchase although some dairies may sell the fiber. Whether this material is used internally on the dairy farm that owns the biodigester or sells it externally, the avoided costs and/or revenue generated is estimated to be approximately $50 to $100 per cow per year. We assume a savings of $75 per cow per year or $75,000 annually.

LIQUID FERTILIZER

Anaerobic biodigesters produce a liquid fertilizer that is more concentrated and easier to transport and use than the manure that a dairy farm would otherwise use as plant fertilizer. The liquid fertilizer that is a byproduct of the biodigester typically simply replaces the manure the farm would otherwise use. While the liquid fertilizer byproduct is an easier form of fertilizer to use, it is difficult to estimate a cost to this benefit. Thus, most biodigester owners assume that there is no additional cost or savings due to replacing the previous forms of fertilizer used with this byproduct. Our analysis therefore shows no revenue or savings generated by the liquid fertilizer byproduct.

WASTE HEAT

As discussed above, a biodigester uses 25 to 60 percent of the heat it produces. The remaining 40 to 75 percent of heat is considered waste heat. While this heat could be captured and used to heat barns, greenhouses or provide for other heating needs on the farm, the Washington dairies with biodigesters do not currently capture this heat for use. Waste recapture systems are currently being developed and improved so that future biodigesters may more easily take advantage of the heat they produce. For this current analysis, we assume the waste heat is not recaptured and put to use.

7.2 Payback Projection Results

The biodigester prototype requires an SET loan of $525,000 and repays the loan in full in its first year of operation. The system's largest source of revenue to repay the SET loan is the payments the system owner collects in tipping fees, or in disposing of plant waste from external sources. We assume the system processes 8,100 tons of plant waste per year along with the animal waste from the dairy farm and collects $489,000 in tipping fees annually. While this is a substantial source of revenue for the biodigester owner, and the importance of this revenue stream was reiterated in interviews with biodigester owners in Washington, this prototype can pay off the SET loan in Year 1 even without collecting tipping fees. This is due to the relatively high price it attains for the electricity produced by the biodigester, the revenue collected from the sale of the RECs associated with the electricity produced and the tax credits awarded in its first year of operation.


Acknowledgements

DRA wishes to thank the following individuals for offering their expertise in the field of wind energy, biodigester technology, public utility policy, renewable energy financing and the renewable energy market in Washington: Paul Gipe, Wind-Works; Steve Johnson, Washington Utilities and Transportation Commission; Ed Kennel; Kevin Maas, Farm Power Northwest; Peter Moulton, Washington State Department of Commerce, Trade and Economic Development; Mike Nelson, Washington State University Extension Energy Program; Howard Schwartz, Washington State Department of Commerce, Trade and Economic Development; Summer Scobell, California Energy and Power; Dave Sjoding, Washington State University Extension Energy Program; and David Wang, Bonneville Environmental Foundation.

Table A-1

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

Total System Cost	$270,000,000	WSHFC Loan Interest Rate	6.75%
Total System Rated Power (MW)	120 MW	WSHFC Loan Term	20 years
Ave Annual Power Output (MWh)	300,000 MWh		
Electricity Purchase Price ($/MWh)	$49		
Electricity Price Inflation	3.00%		
Annual O&M Costs (% of capital cost)	2.00%		
Annual O&M Costs	$5,400,000		
O&M Cost Escalation Rate	3.00%		

	Year 1 **2010**	**Year 2** **2011**	**Year 3** **2012**	**Year 4** **2013**	**Year 5** **2014**	**Year 6** **2015**	**Year 7** **2016**	**Year 8** **2017**	**Year 9** **2018**	**Year 10** **2019**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$49.00	$50.47	$51.98	$53.54	$55.15	$56.80	$58.51	$60.26	$62.07	$63.93
Renewable Energy Certificate Price (per MWh)	$10	$11	$12	$13	$14	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation	$14,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894	$0	$0	$0	$0
Revenue from Sale of Electricity	$14,700,000	$15,141,000	$15,595,230	$16,063,087	$16,544,980	$17,041,329	$17,552,569	$18,079,146	$18,621,520	$19,180,166
Revenue from Sale of RECs	$3,000,000	$3,300,000	$3,600,000	$3,900,000	$4,200,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Operations & Maintenance Cost	($5,400,000)	($5,562,000)	($5,728,860)	($5,900,726)	($6,077,748)	($6,260,080)	($6,447,882)	($6,641,319)	($6,840,558)	($7,045,775)
Return on Developer Equity	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)
Subtotal - Amount Available for Loan Repayment	*$17,105,465*	*$26,396,744*	*$17,691,016*	*$12,711,149*	*$13,316,020*	*$9,748,143*	*$5,889,686*	*$6,222,827*	*$6,565,962*	*$6,919,391*
SET Principal Balance	$108,000,000	$98,184,535	$78,415,247	$66,017,260	$57,762,276	$48,345,210	$41,860,369	$38,796,257	$35,192,178	$31,001,688
Interest	$7,290,000	$6,627,456	$5,293,029	$4,456,165	$3,898,954	$3,263,302	$2,825,575	$2,618,747	$2,375,472	$2,092,614
Payment	($17,105,465)	($26,396,744)	($17,691,016)	($12,711,149)	($13,316,020)	($9,748,143)	($5,889,686)	($6,222,827)	($6,565,962)	($6,919,391)
Ending Balance	$98,184,535	$78,415,247	$66,017,260	$57,762,276	$48,345,210	$41,860,369	$38,796,257	$35,192,178	$31,001,688	$26,174,911

Table A-1

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

Total System Cost	$270,000,000
Total System Rated Power (MW)	120 MW
Ave Annual Power Output (MWh)	300,000 MWh
Electricity Purchase Price ($/MWh)	$49
Electricity Price Inflation	3.00%
Annual O&M Costs (% of capital cost)	2.00%
Annual O&M Costs	$5,400,000
O&M Cost Escalation Rate	3.00%

	Year 11 2020	**Year 12 2021**	**Year 13 2022**	**Year 14 2023**	**Year 15 2024**	**Year 16 2025**	**Year 17 2026**	**Year 18 2027**	**Year 19 2028**	**Year 20 2029**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$65.85	$67.83	$69.86	$71.96	$74.12	$76.34	$78.63	$80.99	$83.42	$85.92
Renewable Energy Certificate Price (per MWh)	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation										
Revenue from Sale of Electricity	$19,755,571	$20,348,238	$20,958,685	$21,587,446	$22,235,069	$22,902,121	$23,589,185	$24,296,860	$25,025,766	$25,776,539
Revenue from Sale of RECs	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000									
Operations & Maintenance Cost	($7,257,148)	($7,474,863)	($7,699,109)	($7,930,082)	($8,167,985)	($8,413,024)	($8,665,415)	($8,925,377)	($9,193,139)	($9,468,933)
Return on Developer Equity	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)
Subtotal - Amount Available for Loan Repayment	*$7,283,422*	*$7,653,375*	*$8,039,576*	*$8,437,364*	*$8,847,084*	*$9,269,097*	*$9,703,770*	*$10,151,483*	*$10,612,627*	*$11,087,606*
SET Principal Balance	$26,174,911	$20,658,295	$14,399,355	$7,331,736	$0	$0	$0	$0	$0	$0
Interest	$1,766,807	$1,394,435	$971,956	$494,892	$0	$0	$0	$0	$0	$0
Payment	($7,283,422)	($7,653,375)	($8,039,576)	($8,437,364)	$0	$0	$0	$0	$0	$0
Ending Balance	$20,658,295	$14,399,355	$7,331,736	$0	$0	$0	$0	$0	$0	$0

Table B-1

WA State Housing Finance Commission
Sustainable Energy Trust Analysis
Wind Energy Analysis Payback Projections
4% O&M Cost

Total System Cost	$270,000,000	WSHFC Loan Interest Rate	6.75%
Total System Rated Power (MW)	120 MW	WSHFC Loan Term	20 years
Ave Annual Power Output (MWh)	300,000 MWh		
Electricity Purchase Price ($/MWh)	$49		
Electricity Price Inflation	3.00%		
Annual O&M Costs (% of capital cost)	4.00%		
Annual O&M Costs	$10,800,000		
O&M Cost Escalation Rate	3.00%		

	Year 1 2010	**Year 2 2011**	**Year 3 2012**	**Year 4 2013**	**Year 5 2014**	**Year 6 2015**	**Year 7 2016**	**Year 8 2017**	**Year 9 2018**	**Year 10 2019**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$49.00	$50.47	$51.98	$53.54	$55.15	$56.80	$58.51	$60.26	$62.07	$63.93
Renewable Energy Certificate Price (per MWh)	$10	$11	$12	$13	$14	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation	$14,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894	$0	$0	$0	$0
Revenue from Sale of Electricity	$14,700,000	$15,141,000	$15,595,230	$16,063,087	$16,544,980	$17,041,329	$17,552,569	$18,079,146	$18,621,520	$19,180,166
Revenue from Sale of RECs	$3,000,000	$3,300,000	$3,600,000	$3,900,000	$4,200,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Operations & Maintenance Cost	($10,800,000)	($11,124,000)	($11,457,720)	($11,801,452)	($12,155,495)	($12,520,160)	($12,895,765)	($13,282,638)	($13,681,117)	($14,091,550)
Return on Developer Equity	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)
Subtotal - Amount Available for Loan Repayment	*$11,705,465*	*$20,834,744*	*$11,962,156*	*$6,810,423*	*$7,238,272*	*$3,488,063*	*($558,196)*	*($418,492)*	*($274,597)*	*($126,385)*
SET Principal Balance	$108,000,000	$103,584,535	$89,741,747	$83,837,159	$82,685,744	$81,028,759	$83,010,138	$88,613,322	$94,594,721	$100,979,865
Interest	$7,290,000	$6,991,956	$6,057,568	$5,659,008	$5,581,288	$5,469,441	$5,603,184	$5,981,399	$6,385,144	$6,816,141
Payment	($11,705,465)	($20,834,744)	($11,962,156)	($6,810,423)	($7,238,272)	($3,488,063)	$0	$0	$0	$0
Ending Balance	$103,584,535	$89,741,747	$83,837,159	$82,685,744	$81,028,759	$83,010,138	$88,613,322	$94,594,721	$100,979,865	$107,796,006

Table B-1

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

4% O&M Cost

Total System Cost	$270,000,000
Total System Rated Power (MW)	120 MW
Ave Annual Power Output (MWh)	300,000 MWh
Electricity Purchase Price ($/MWh)	$49
Electricity Price Inflation	3.00%
Annual O&M Costs (% of capital cost)	4.00%
Annual O&M Costs	$10,800,000
O&M Cost Escalation Rate	3.00%

	Year 11 2020	**Year 12 2021**	**Year 13 2022**	**Year 14 2023**	**Year 15 2024**
Electricity Produced/Rate					
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$65.85	$67.83	$69.86	$71.96	$74.12
Renewable Energy Certificate Price (per MWh)	$15	$15	$15	$15	$15
SET Loan Repayment					
Cash Effect of Depreciation					
Revenue from Sale of Electricity	$19,755,571	$20,348,238	$20,958,685	$21,587,446	$22,235,069
Revenue from Sale of RECs	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000				
Operations & Maintenance Cost	($14,514,297)	($14,949,726)	($15,398,218)	($15,860,164)	($16,335,969)
Return on Developer Equity	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)
Subtotal - Amount Available for Loan Repayment	*$26,274*	*$178,512*	*$340,467*	*$507,281*	*$679,100*
SET Principal Balance	$107,796,006	$115,045,962	$122,633,053	$130,570,316	$138,876,531
Interest	$7,276,230	$7,765,602	$8,277,731	$8,813,496	$9,374,166
Payment	($26,274)	($178,512)	($340,467)	($507,281)	($679,100)
Ending Balance	$115,045,962	$122,633,053	$130,570,316	$138,876,531	$147,571,597

	Year 16 2025	**Year 17 2026**	**Year 18 2027**	**Year 19 2028**	**Year 20 2029**
Electricity Produced/Rate					
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$76.34	$78.63	$80.99	$83.42	$85.92
Renewable Energy Certificate Price (per MWh)	$15	$15	$15	$15	$15
SET Loan Repayment					
Cash Effect of Depreciation					
Revenue from Sale of Electricity	$22,902,121	$23,589,185	$24,296,860	$25,025,766	$25,776,539
Revenue from Sale of RECs	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive					
Operations & Maintenance Cost	($16,826,048)	($17,330,830)	($17,850,754)	($18,386,277)	($18,937,865)
Return on Developer Equity	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)	($9,720,000)
Subtotal - Amount Available for Loan Repayment	*$856,073*	*$1,038,355*	*$1,226,106*	*$1,419,489*	*$1,618,674*
SET Principal Balance	$147,571,597	$156,676,607	$166,213,923	$176,207,257	$186,681,758
Interest	$9,961,083	$10,575,671	$11,219,440	$11,893,990	$12,601,019
Payment	($856,073)	($1,038,355)	($1,226,106)	($1,419,489)	($1,618,674)
Ending Balance	$156,676,607	$166,213,923	$176,207,257	$186,681,758	$197,664,103

Table B-2

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

4% O&M Cost and No Return on Developer Equity

Total System Cost	$270,000,000	WSHFC Loan Interest Rate	6.75%
Total System Rated Power (MW)	120 MW	WSHFC Loan Term	20 years
Ave Annual Power Output (MWh)	300,000 MWh		
Electricity Purchase Price ($/MWh)	$49		
Electricity Price Inflation	3.00%		
Annual O&M Costs (% of capital cost)	4.00%		
Annual O&M Costs	$10,800,000		
O&M Cost Escalation Rate	3.00%		

	Year 1 **2010**	**Year 2** **2011**	**Year 3** **2012**	**Year 4** **2013**	**Year 5** **2014**	**Year 6** **2015**	**Year 7** **2016**	**Year 8** **2017**	**Year 9** **2018**	**Year 10** **2019**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$49.00	$50.47	$51.98	$53.54	$55.15	$56.80	$58.51	$60.26	$62.07	$63.93
Renewable Energy Certificate Price (per MWh)	$10	$11	$12	$13	$14	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation	$14,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894	$0	$0	$0	$0
Revenue from Sale of Electricity	$14,700,000	$15,141,000	$15,595,230	$16,063,087	$16,544,980	$17,041,329	$17,552,569	$18,079,146	$18,621,520	$19,180,166
Revenue from Sale of RECs	$3,000,000	$3,300,000	$3,600,000	$3,900,000	$4,200,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Operations & Maintenance Cost	($10,800,000)	($11,124,000)	($11,457,720)	($11,801,452)	($12,155,495)	($12,520,160)	($12,895,765)	($13,282,638)	($13,681,117)	($14,091,550)
Return on Developer Equity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal - Amount Available for Loan Repayment	*$21,425,465*	*$30,554,744*	*$21,682,156*	*$16,530,423*	*$16,958,272*	*$13,208,063*	*$9,161,804*	*$9,301,508*	*$9,445,403*	*$9,593,615*
SET Principal Balance	$108,000,000	$93,864,535	$69,645,647	$52,664,572	$39,689,007	$25,409,743	$13,916,838	$5,694,421	$0	$0
Interest	$7,290,000	$6,335,856	$4,701,081	$3,554,859	$2,679,008	$1,715,158	$939,387	$384,373	$0	$0
Payment	($21,425,465)	($30,554,744)	($21,682,156)	($16,530,423)	($16,958,272)	($13,208,063)	($9,161,804)	($9,301,508)	$0	$0
Ending Balance	$93,864,535	$69,645,647	$52,664,572	$39,689,007	$25,409,743	$13,916,838	$5,694,421	$0	$0	$0

Table B-2

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

4% O&M Cost and No Return on Developer Equity

Total System Cost	$270,000,000
Total System Rated Power (MW)	120 MW
Ave Annual Power Output (MWh)	300,000 MWh
Electricity Purchase Price ($/MWh)	$49
Electricity Price Inflation	3.00%
Annual O&M Costs (% of capital cost)	4.00%
Annual O&M Costs	$10,800,000
O&M Cost Escalation Rate	3.00%

	Year 11 2020	**Year 12 2021**	**Year 13 2022**	**Year 14 2023**	**Year 15 2024**	**Year 16 2025**	**Year 17 2026**	**Year 18 2027**	**Year 19 2028**	**Year 20 2029**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$65.85	$67.83	$69.86	$71.96	$74.12	$76.34	$78.63	$80.99	$83.42	$85.92
Renewable Energy Certificate Price (per MWh)	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation										
Revenue from Sale of Electricity	$19,755,571	$20,348,238	$20,958,685	$21,587,446	$22,235,069	$22,902,121	$23,589,185	$24,296,860	$25,025,766	$25,776,539
Revenue from Sale of RECs	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000									
Operations & Maintenance Cost	($14,514,297)	($14,949,726)	($15,398,218)	($15,860,164)	($16,335,969)	($16,826,048)	($17,330,830)	($17,850,754)	($18,386,277)	($18,937,865)
Return on Developer Equity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal - Amount Available for Loan Repayment	*$9,746,274*	*$9,898,512*	*$10,060,467*	*$10,227,281*	*$10,399,100*	*$10,576,073*	*$10,758,355*	*$10,946,106*	*$11,139,489*	*$11,338,674*
SET Principal Balance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Payment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ending Balance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table B-3

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Wind Energy Analysis Payback Projections

6% O&M Costs and No Return on Developer Equity

Total System Cost	$270,000,000	WSHFC Loan Interest Rate	6.75%
Total System Rated Power (MW)	120 MW	WSHFC Loan Term	20 years
Ave Annual Power Output (MWh)	300,000 MWh		
Electricity Purchase Price ($/MWh)	$49		
Electricity Price Inflation	3.00%		
Annual O&M Costs (% of capital cost)	6.00%		
Annual O&M Costs	$16,200,000		
O&M Cost Escalation Rate	3.00%		

	Year 1 **2010**	**Year 2** **2011**	**Year 3** **2012**	**Year 4** **2013**	**Year 5** **2014**	**Year 6** **2015**	**Year 7** **2016**	**Year 8** **2017**	**Year 9** **2018**	**Year 10** **2019**
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$49.00	$50.47	$51.98	$53.54	$55.15	$56.80	$58.51	$60.26	$62.07	$63.93
Renewable Energy Certificate Price (per MWh)	$10	$11	$12	$13	$14	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation	$14,520,465	$23,232,744	$13,939,646	$8,363,788	$8,363,788	$4,181,894	$0	$0	$0	$0
Revenue from Sale of Electricity	$14,700,000	$15,141,000	$15,595,230	$16,063,087	$16,544,980	$17,041,329	$17,552,569	$18,079,146	$18,621,520	$19,180,166
Revenue from Sale of RECs	$3,000,000	$3,300,000	$3,600,000	$3,900,000	$4,200,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Operations & Maintenance Cost	($16,200,000)	($16,686,000)	($17,186,580)	($17,702,177)	($18,233,243)	($18,780,240)	($19,343,647)	($19,923,957)	($20,521,675)	($21,137,326)
Return on Developer Equity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal - Amount Available for Loan Repayment	*$16,025,465*	*$24,992,744*	*$15,953,296*	*$10,629,697*	*$10,880,525*	*$6,947,983*	*$2,713,922*	*$2,660,189*	*$2,604,845*	*$2,547,840*
SET Principal Balance	$108,000,000	$99,264,535	$80,972,147	$70,484,471	$64,612,475	$58,093,293	$55,066,607	$56,069,681	$57,194,196	$58,449,959
Interest	$7,290,000	$6,700,356	$5,465,620	$4,757,702	$4,361,342	$3,921,297	$3,716,996	$3,784,703	$3,860,608	$3,945,372
Payment	($16,025,465)	($24,992,744)	($15,953,296)	($10,629,697)	($10,880,525)	($6,947,983)	($2,713,922)	($2,660,189)	($2,604,845)	($2,547,840)
Ending Balance	$99,264,535	$80,972,147	$70,484,471	$64,612,475	$58,093,293	$55,066,607	$56,069,681	$57,194,196	$58,449,959	$59,847,491

Table B-3
WA State Housing Finance Commission
Sustainable Energy Trust Analysis
Wind Energy Analysis Payback Projections
6% O&M Costs and No Return on Developer Equity

Total System Cost	$270,000,000
Total System Rated Power (MW)	120 MW
Ave Annual Power Output (MWh)	300,000 MWh
Electricity Purchase Price ($/MWh)	$49
Electricity Price Inflation	3.00%
Annual O&M Costs (% of capital cost)	6.00%
Annual O&M Costs	$16,200,000
O&M Cost Escalation Rate	3.00%

	Year 11 2020	Year 12 2021	Year 13 2022	Year 14 2023	Year 15 2024	Year 16 2025	Year 17 2026	Year 18 2027	Year 19 2028	Year 20 2029
Electricity Produced/Rate										
Electricity Generation (MWh)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Electricity Purchase Price (per MWh)	$65.85	$67.83	$69.86	$71.96	$74.12	$76.34	$78.63	$80.99	$83.42	$85.92
Renewable Energy Certificate Price (per MWh)	$15	$15	$15	$15	$15	$15	$15	$15	$15	$15
SET Loan Repayment										
Cash Effect of Depreciation										
Revenue from Sale of Electricity	$19,755,571	$20,348,238	$20,958,685	$21,587,446	$22,235,069	$22,902,121	$23,589,185	$24,296,860	$25,025,766	$25,776,539
Revenue from Sale of RECs	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000	$4,500,000
WA Renewable Energy Incentive	$5,000									
Operations & Maintenance Cost	($21,771,445)	($22,424,589)	($23,097,326)	($23,790,246)	($24,503,954)	($25,239,072)	($25,996,244)	($26,776,132)	($27,579,416)	($28,406,798)
Return on Developer Equity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal - Amount Available for Loan Repayment	*$2,489,125*	*$2,423,649*	*$2,361,359*	*$2,297,199*	*$2,231,115*	*$2,163,049*	*$2,092,940*	*$2,020,729*	*$1,946,350*	*$1,869,741*
SET Principal Balance	$59,847,491	$61,398,071	$63,118,792	$65,017,952	$67,109,464	$69,408,237	$71,930,244	$74,692,596	$77,713,617	$81,012,936
Interest	$4,039,706	$4,144,370	$4,260,518	$4,388,712	$4,529,889	$4,685,056	$4,855,291	$5,041,750	$5,245,669	$5,468,373
Payment	($2,489,125)	($2,423,649)	($2,361,359)	($2,297,199)	($2,231,115)	($2,163,049)	($2,092,940)	($2,020,729)	($1,946,350)	($1,869,741)
Ending Balance	$61,398,071	$63,118,792	$65,017,952	$67,109,464	$69,408,237	$71,930,244	$74,692,596	$77,713,617	$81,012,936	$84,611,568

Table C-1

WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Anaerobic Biodigester Analysis Payback Projections

Total System Cost	$1,500,000	WSHFC Loan Interest Rate	6.75%
Total System Rated Power (kW)	375 kW	WSHFC Loan Term	15 years
Ave Annual Power Output (MWh)	3,000 MWh		
Electricity Purchase Price ($/MWh)	$70.91		
Electricity Price Inflation	2.10%		
Federal Renewable Energy PTC ($/kWh)	$0.210/kWh		
Annual O&M Costs	$60,000		
O & M Escalation Rate	3.00%		

	Year 1 2010	**Year 2 2011**	**Year 3 2012**	**Year 4 2013**	**Year 5 2014**	**Year 6 2015**	**Year 7 2016**	**Year 8 2017**	**Year 9 2018**	**Year 10 2019**	**Year 11 2020**
Electricity Produced/Rate											
Electricity Generation (MWh)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Electricity Purchase Price (per MWh)	$70.91	$72.40	$73.92	$75.47	$77.06	$78.67	$80.33	$82.01	$83.74	$85.49	$87.29
Renewable Energy Certificate Price (per MWh)	$20.00	$22.00	$24.00	$26.00	$28.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00
Tax Benefits and Savings											
Business Energy Investment Tax Credit	$450,000										
Subtotal-Tax Benefits and Rebates	*$450,000*										
SET Loan Repayment											
Tax Benefits and Credits	$450,000										
Revenue from Sale of Electricity	$212,730	$217,197	$221,758	$226,415	$231,170	$236,025	$240,981	$246,042	$251,209	$256,484	$261,870
Revenue from Sale of RECs	$60,000	$66,000	$72,000	$78,000	$84,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000
WA State Renewable Energy Incentive	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Avoided fiber costs	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
Tipping fees collected	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100
Operations & Maintenance Cost	($60,000)	($61,800)	($63,654)	($65,564)	($67,531)	($69,556)	($71,643)	($73,792)	($76,006)	($78,286)	($80,635)
Replacement Reserve	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)
Subtotal - Amount Available for Loan Repayment	*$1,216,830*	*$775,497*	*$784,204*	*$792,952*	*$801,740*	*$810,568*	*$813,438*	*$816,349*	*$819,302*	*$822,298*	*$825,335*
SET Principal Balance	$525,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest	$35,438	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Payment	($1,216,830)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ending Balance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

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WA State Housing Finance Commission

Sustainable Energy Trust Analysis

Anaerobic Biodigester Analysis Payback Projections

Total System Cost	$1,500,000
Total System Rated Power (kW)	375 kW
Ave Annual Power Output (MWh)	3,000 MWh
Electricity Purchase Price ($/MWh)	$70.91
Electricity Price Inflation	2.10%
Federal Renewable Energy PTC ($/kWh)	$0.210/kWh
Annual O&M Costs	$60,000
O & M Escalation Rate	3.00%

	Year 12 2021	Year 13 2022	Year 14 2023	Year 15 2024	Year 16 2025	Year 17 2026	Year 18 2027	Year 19 2028	Year 20 2029	Year 21 2030	Year 22 2031
Electricity Produced/Rate											
Electricity Generation (MWh)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Electricity Purchase Price (per MWh)	$89.12	$90.99	$92.91	$94.86	$96.85	$98.88	$100.96	$103.08	$105.24	$107.45	$109.71
Renewable Energy Certificate Price (per MWh)	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00
Tax Benefits and Savings											
Business Energy Investment Tax Credit											
Subtotal-Tax Benefits and Rebates											
SET Loan Repayment											
Tax Benefits and Credits											
Revenue from Sale of Electricity	$267,370	$272,984	$278,717	$284,570	$290,546	$296,647	$302,877	$309,237	$315,731	$322,362	$329,131
Revenue from Sale of RECs	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000
WA State Renewable Energy Incentive											
Avoided fiber costs	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
Tipping fees collected	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100	$489,100
Operations & Maintenance Cost	($83,054)	($85,546)	($88,112)	($90,755)	($93,478)	($96,282)	($99,171)	($102,146)	($105,210)	($108,367)	($111,618)
Replacement Reserve	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)	($15,000)
Subtotal - Amount Available for Loan Repayment	*$823,415*	*$826,539*	*$829,705*	*$832,915*	*$836,168*	*$839,465*	*$842,806*	*$846,191*	*$849,621*	*$853,095*	*$856,614*
SET Principal Balance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Payment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ending Balance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table C-1
WA State Housing Finance Commission
Sustainable Energy Trust Analysis
Anaerobic Biodigester Analysis Payback Projections

Total System Cost	$1,500,000
Total System Rated Power (kW)	375 kW
Ave Annual Power Output (MWh)	3,000 MWh
Electricity Purchase Price ($/MWh)	$70.91
Electricity Price Inflation	2.10%
Federal Renewable Energy PTC ($/kWh)	$0.210/kWh
Annual O&M Costs	$60,000
O & M Escalation Rate	3.00%

	Year 23 2032	Year 24 2033	Year 25 2034
Electricity Produced/Rate			
Electricity Generation (MWh)	3,000	3,000	3,000
Electricity Purchase Price (per MWh)	$112.01	$114.37	$116.77
Renewable Energy Certificate Price (per MWh)	$30.00	$30.00	$30.00
Tax Benefits and Savings			
Business Energy Investment Tax Credit			
Subtotal-Tax Benefits and Rebates			
SET Loan Repayment			
Tax Benefits and Credits			
Revenue from Sale of Electricity	$336,043	$343,100	$350,305
Revenue from Sale of RECs	$90,000	$90,000	$90,000
WA State Renewable Energy Incentive			
Avoided fiber costs	$75,000	$75,000	$75,000
Tipping fees collected	$489,100	$489,100	$489,100
Operations & Maintenance Cost	($114,966)	($118,415)	($121,968)
Replacement Reserve	($15,000)	($15,000)	($15,000)
Subtotal - Amount Available for Loan Repayment	*$860,177*	*$863,785*	*$867,438*
SET Principal Balance	$0	$0	$0
Interest	$0	$0	$0
Payment	$0	$0	$0
Ending Balance	$0	$0	$0