Seattle Waste-to-Energy Facility

The proposal is prepared for Seattle Public Utilities.

Team Five

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Dear Waste Management:

The United States is one of the largest garbage producers in the world. The global production of garbage is increasing tremendously. Seattle is one of the leading cities working towards solving this problem.Despite this, Seattle produces 350,000 tons of garbage annually. Our team would like to propose a facility that would reduce garbage production and generate revenue from it. Attached is a proposal for the construction of a waste-to-energy power plant.

Team Five is writing this proposal for obtaining sufficient investment funds for this power plant to be constructed. This will reduce the production of garbage in the city of Seattle, and will also generate electricity thereby increasing the utility revenue of the city.

We believe that the proposed facility will provide an opportunity to reduce the cost of storing, maintaining, shipping and dumping the garbage, thereby benefiting the whole city in many ways. We also anticipate that if the proposed facility generates sufficient profit, we can expand to other neighboring cities as well.

Team Five would like to thank you for your time and resources to review this proposal. If you require any more information, please contact us.

Sincerely,

Team Five
Jacob Aylesworth
Joon Jung
Yamir Godil
Thomas Horst
Lucas James

Attached: The Seattle Waste-to-Energy Facility proposal

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Executive Summary

There is a global trend toward producing and burying trash as the countries of the world develop. Simply burying the trash in a landfill, or worse, simply dumping it into the environment damages our ecosystems and our human habitat. In light of the growing need to dispose of large amounts of trash, we see a waste-to-energy plant as a perfect opportunity to use waste as a fuel to generate energy.

We propose to build a waste to energy facility that will decrease the amount of refuse disposed of in landfills. The energy produced by our facility will also help reduce global dependence on fossil fuels. Our scope is to build a waste-to-energy plant near the city of Seattle to minimize the disposal of garbage in the Northwest. Benefits of doing so are:

1) Decrease the amount of refuse disposed of in landfills.
2) Generate electrical energy by using garbage as a fuel.
3) Minimize greenhouse gas emissions.
4) Reducethe cost of long distance garbage transportation.

The operation of the plant is quite simple: gather and burn municipal solid waste, generate power, filter the exhaust, and dispose of the ash. The expected cost of construction is 300 million dollars, and we expect an annual operation cost of 45 million dollars, but our plant is calculated to produce a profit of 5-15 million dollars per year. To implement the idea we need to purchaseland, obtain all required permits, hire workers, construct the facility, and then begin operations.

Introduction

This section will discuss the background information, scope, and purpose of the proposed Seattle waste-to-energy plant.

Background information

The global trash production is increasing at a tremendous rate. The industrial revolution has brought forward new mechanical, chemical, and other products which become difficult to dispose of at the end of their useful life. Most of the trash produced by mankind is either disposed of in oceans or landfills. The process of dumping trash is very expensive and has far-reaching, detrimental, and environmental consequences.

The Pacific Ocean is the largest garbage dump in the world. It contains a mass of floating trashthe size of Texas that extends 100 feet below the surface level. Many biologists estimate millions of birds and marine animals have died by ingesting pieces of plastic from the dump while foraging for food.

An alternative to dumping in the ocean is to dump trash in landfills. This is not a significantly better option. Landfills pollute the local environment through contamination of soil and groundwater, generation of greenhouse gases, and promotion of disease spread by agents such as rats, flies and mosquitoes. Landfills also affect the economy of the city by reducing land values and creating a negative environment for the society. Lastly, they cause an array of health problems as they emit harmful gases that cause cancer, affect our nervous system, and cause other diseases.

Disposing of trash is hazardous to the environment and squanders resources that can be reused. The city of Seattle annually produces and disposes of 350,000 tons of trash (excluding recyclable and compostable produce).

Scope

The scope of the proposed project is to build a waste-to-energy plant near the city of Seattle. The power plant will be collecting garbage disposed from Seattle and it will use this as a fuel to generate electricity, which will be sold for profit later during the operation. By the operation of this plant, the amount of landfill disposed from the city of Seattle will be significantly reduced, and we will also generate electricity that we will direct back to the city of Seattle.

Purpose

There are various immediate advantages of implementing the waste-to-energy power plant.

First,we will be reducing the amount of trash being disposed by roughly 65%, which means much less waste disposed of in landfills.

Second,trash is a source of energy, an untapped potential. We will harness this energy to support Seattle's need for energy while reducing the negative impact landfills currently have on the environment.

Third, landfills emit methane gas which is roughly 21 times more detrimental to the environment than carbon dioxide. By burning the trash, the energy content that would become methane can be used for human consumption. Carbon dioxide will be produced, but its effects on the environment will be minimal compared to methane. A waste-to-energy plant produces less carbon dioxide and methane per amount of energy produced than coal, gas, or oil power plants. See Figure 3 from Appendix A for a comparison of emissions of carbon dioxide and methane.

Fourth, by constructing our facility near the city of Seattle, we will vastly reduce the cost of transportation of trash from the Pacific Northwest collection facilities to the Columbia Ridge Landfill in Arlington, Oregon, where the city's trash is currently being disposed of.

Fifth, Seattle is an environmentally conscious city that will benefit from this facility. Once this plant is built and running, we can extend our services to nearby cities such as Bellevue, Tacoma, and Redmond to generate a greater profit and further reduce the environmental impact of the northwest cities.

This proposal contains a detailed plan for the construction and operation of the facility, along with an estimated cost and revenue based upon the Spokane waste-to-energy facility. The timeline will provide a visual representation of the expected steps of the project. Finally, the personnel requirements and qualifications of Team Five to accomplish this project are enclosed.

Technical Information

This section will discuss the process for constructing the waste-to-energy plant. Please refer Figure 1 to see a depiction of the following process.

Collection

For the proposed plant, the trash will be collected using the current infrastructure.
Trucks will collect the trash directly from homes and businesses on a regular basis and bring it to the transfer stations. From these central points, the trash will be shipped to the waste-to-energy plant.

Receiving

At the plant, the trash will be brought to the 2.1 acre receiving floor. The trash will either be moved to a storage area for future consumption or transferred to the bunker. The bunker will have a capacity of 7200 tons and have dimensions of 140' x 60' x 50' (1). Three overhead cranes, with a maximum operating capacity of nine tons, but general operation capacity will be three to four tons, which will transfer trash from the bunker to one of three hoppers. From the hopper, a moving grate with a capacity of 20 tons/hour will transfer the trash through the incinerator.

Incinerator

The incinerator will operate at a flame temperature of 2500 degrees Fahrenheit. The primary air flow will come through the grate at 150 m^3/hr. It will provide both cooling of the grate as well as the oxygen necessary for combustion. A secondary combustion stream from 42 nozzles above the grate will provide excess oxygen and extra methane, as needed, to maintain the burn temperature and ensure complete combustion of the flue gases. The trash will be carried along the grate until only ash and metal are left. At the end of the grate, the metal will be removed using a magnet, and the ash will be collected for disposal.

Boiler and Turbine

As the flue gases are burned, they will be vented upwards into the boiler. The boiler will be suspended from the ceiling, double walled, and have a tube length of 100'. The steam, at 750 degrees Fahrenheit, will be transferred through a three foot diameter pipe to a 3600 rpm turbine. The turbine will generate on average 30 MW of power. We will use 6MW will be used to power the plant while the other 24 MW will be sold to Seattle City Light. The cooled steam will be piped to a cooling tower where the water will be returned to its liquid state and pumped back to the boiler for reuse.

Flue Gas and Stack

After passing through the boiler, the flue gases, now at 400 degrees Fahrenheit, will pass through an electrostatic precipitator (ESP). This removes a majority of any ash particles in the gas. These particles will fall out and be collected for disposal. After the ESP, the flue gas will pass through a dry acid gas scrubber, lime reactor, DeNOx filter, and finally a bag house containing 3420 bags made of Gore-tex fabric (1).

The acid gas scrubber will remove any acids such as hydrochloric and nitric acid as well as heavy metals such as mercury. The lime reactor will remove sulfur dioxide. The DeNOx filter catalytically breaks down and captures NO_x compounds (2). All the filtered particles will be collected for disposal.

The bag house with the Gore-tex fabric bags are specifically designed to catalytically breakdown dioxins and furans while collecting any final particulate matter(3). After finishing the treatment, the flue gas will meet regulations and be sent up a 175' stack and released to the atmosphere.

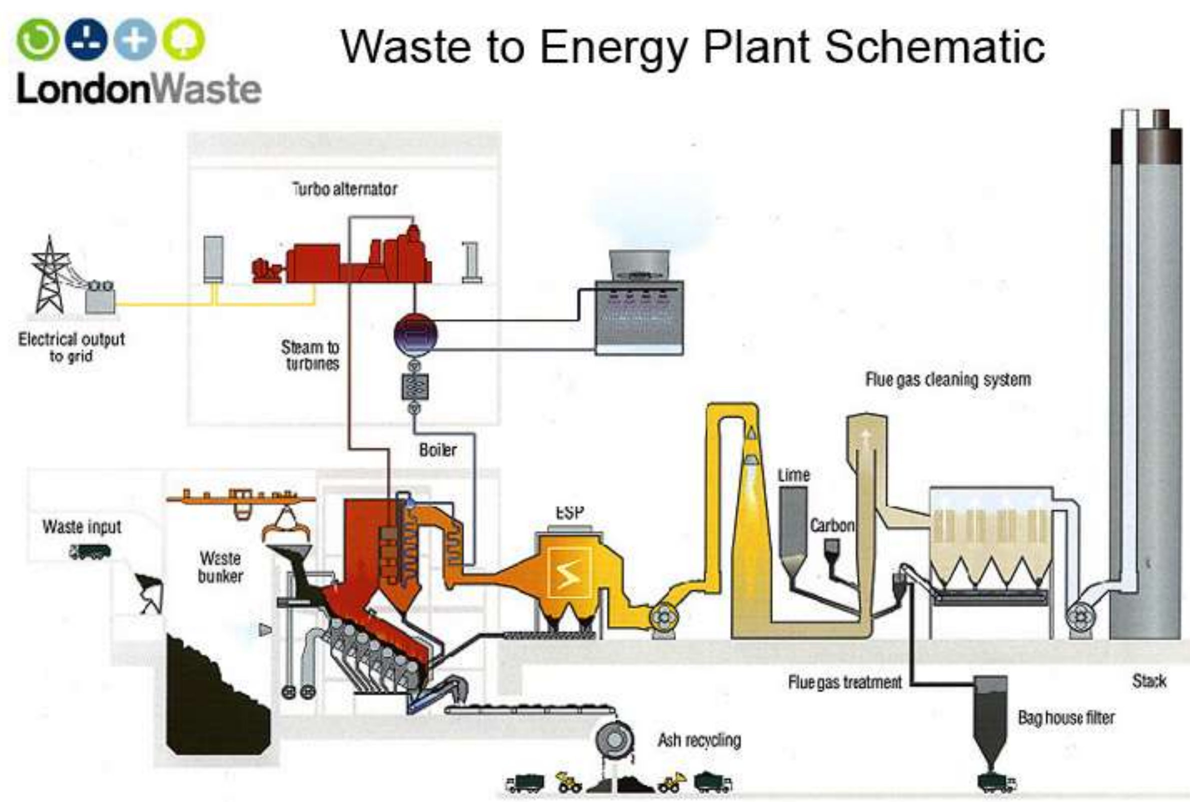

Figure 1: Schematic of waste-to-energy plant (4)

Statement of Work

The first step in completing the project is to locate and purchase property for the plant. Possible locations within the city include areas near the Duwamish mouth or east of Magnolia, but we will look into any site within 20 miles of Seattle. Then we will obtain permits from the city and meet regulatory requirements.This will require completion of appropriate land use applications (5) as well as undergoing review and obtaining approval by county public health officials and state ecology officials. This part will take about one year to complete, as is typical for waste-to-energy plants (6).

The next step will be to construct the plant. This will be the longest part of the project, taking an estimated 36 months to complete (1). We will install an incinerator, boiler, turbine, and generator for energy production, and we will build flue gas stacks with filtering equipment. We will also includecranes and conveyor belts to transport trash and ash. Near the end of construction, we will work with Seattle City Light to connect our plant to the local electric grid. We will then need to stockpile trash and hire and train workers, at which time we may begin operations. The plant will run 24 hours a day, but we will vary operations between peak and non-peak hours.

Expected Timeline

The entire project is expected to takeapproximately four and a half years to complete. The timeline for the process is illustrated in Figure 2: Expected timeline.

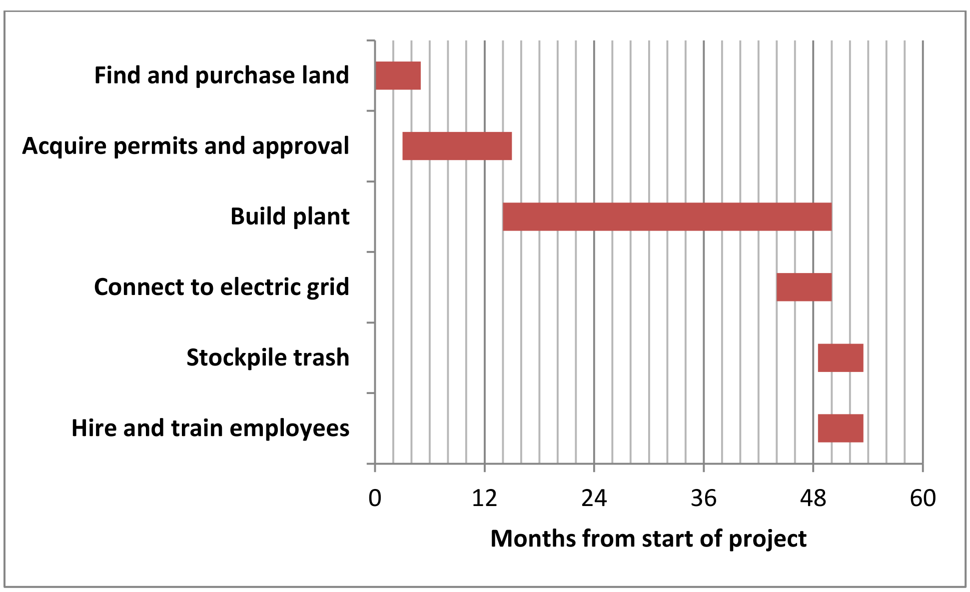

Figure 2: Expected timeline

Personnel Information

Yamir Godil will be graduating in 2011 from the University of Washington with a degree in computer science. As an engineer working in professional industry, he has learned skills to communicate effectively. He will be in charge of public relations, and will also build the web interface for better communication. He will also assist in business decisions as to which companies to partner with, hiring staff members and on expansion strategies.

Jacob Aylesworth will be graduating in 2012 from the University of Washington with a degree in chemical engineering. The degree will provide him with the technical knowledge necessary to design and construct a waste-to-energy plant. As a student assistant at the university power plant, he became proficient at communicating with both the administrative staff and the technicians and operators. This skill will be useful in maintaining smooth communication between the administration and technical staff.

Thomas Horst is graduating December 2011from the University of Washington with a degree in mechanical engineering. Thomas has studied thermodynamics and mechanical systems, making him an important member of a team designing such a complicated system. His perspectives on the mechanical aspects of the plant are necessary for thorough analysis of all systems.

Lucas James is graduating in 2011 from the University of Washington with a degree in chemical engineering. He is knowledgeable in chemical thermodynamics and energy balances, making him capable of handling technical aspects of plant operations. He has also taken courses in large-scale renewable energy and energy conservation, giving him a useful perspective in a major project like this.

Joon Jung will be graduating in 2011 with a Bachelor of Sciencedegree in mechanical engineering from the University of Washington. Joon has taken classes on renewable energy and relating courses relatingto the operation of the power plant, which will be beneficial for the energy generation analysis. Also, Joon has an extensive experience with manufacturing process, which was gained from his previous horizontal axis wind turbine project. This particular experience will be helpful in overseeing the installation of the components in the plant.

Cost

The Seattle waste-to-energy plant will cost $300 million to build. This includes the purchase of 60 acres of land, permits, large equipment, contractor costs, and other materials necessary for construction such as electrical wiring, connecting metals, joints, and smaller equipment. For further information on the land, permits, major equipment, contractors, and budget please see Table 1 from Appendix B.

Once the plant has begun operations, the operational cost is estimated to be $45.4 million. This figure is based upon Spokane's waste-to-energy plant. The operational costs will consist of labor, material and resource consumption, external services, other costs, amortization, and interest payment. The operational cost is further broken down in Table 2 from Appendix B.

A work force of 70 employees will be vital to the running of the plant. Currently, the budget for labor cost has been set at $8 million. This covers salary and other expenses such as vacation, sick leave, benefits, and taxes. The plant will require the services of administration, operators, specialists, engineers, mechanics, and technicians. Detail on the employees and salary can be found in Table 3 from Appendix B. Further detail of personnel expenses can be found in Table 4 from Appendix B.

In terms of revenue, the plant will be selling electricity to Seattle City Lights at for an estimated income of $17.1 million. Furthermore, a gate fee of $95 per ton of waste will be charged to offset the operational costs. The gate fee is expected to generate $37.4 million. A minor contribution of $200,000 will come from recycling recovered metals. Overall, a gross income of $57.4 million is expected.Revenue can be found in Table 2 from Appendix B. The net profitis expected to be $9.3 million.

Conclusion

Reducing the amount of trash disposed of in landfills is necessary in today's increasingly crowded and wasteful world. Therefore, we propose to build a waste-to-energy plant near the city of Seattle. The proposed idea is an immediate solution to reduce the amount of trash Seattle sends to Oregon. Furthermore, the plant will minimize the greenhouse emissions that would be emitted from landfills generating electricity. Through the selling of electricity and gate fees, an estimated nine million dollars in net profit is expected. The waste-to-energy will benefit the environment and generate revenue for Seattle.

To build a waste-to-energy power plant facility, four steps are necessary to begin operation. First, land will have to be purchased near city of Seattle. Second, the appropriate experts will be hired and consulted to gather the necessary permitsto ensure the proper operation of the plant. Third, the waste-to-energy plant will be constructed. Construction is projected to take three years. Lastly, the necessary manpower will be hired. After all four steps, the power plant will begin operations.

Team Five is enthused and ready to work closely with the city of Seattle to make the waste-to-energy plant a reality.

Appendices

This section will include all the necessary appendices that are related to the project.

Appendix A

Burning waste produces only 19 kg of carbon dioxide per GJ of energy as compared to 95 kg for coal and 72 kg for gas oil. This is a significant difference in carbon dioxide emissions. Additionally, waste produces a little less than half of the amount of methane per GJ of energy as coal or gas oil.

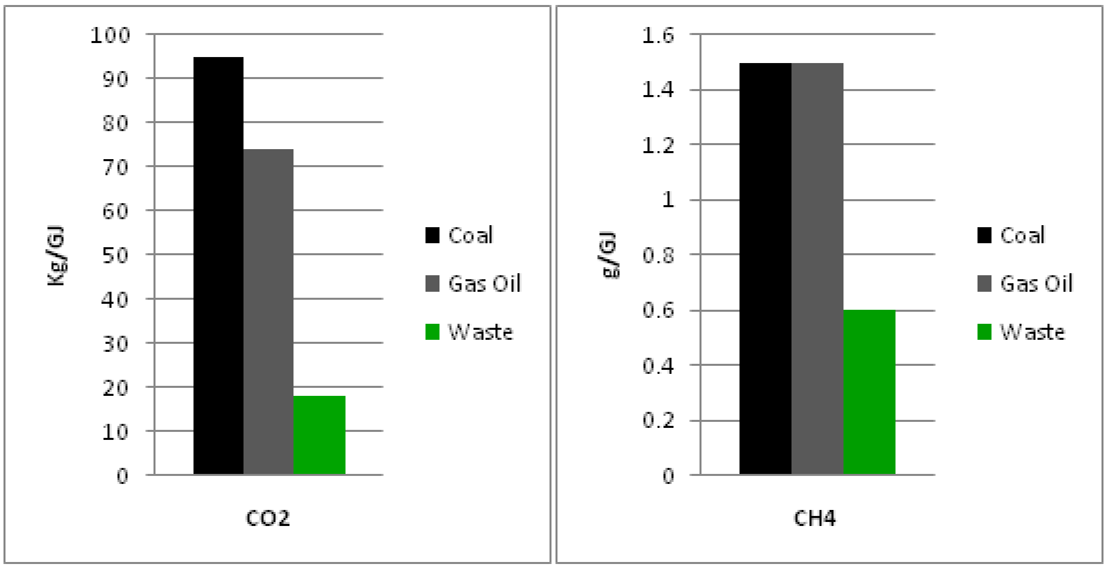

Figure 3: Emissions of carbon dioxide and methane

Appendix B

This appendix contains all the cost-related data. Please note that the estimated costs are based on other operating waste-to-energy plants (1)(2)(8).

Table 1: Bill of Materials with Prices

Waste-to-Energy Plant Construction Components	Quantity	Individual Cost (million dollars)	Total Cost (million dollars)
Property Area: 60 acres	1	82.00	82
Permits (specifics not listed)	multiple	0.25	0.25
Receiving Floor: 2.1 acres	1	10	10
Bunker: 140' x 60' 50' capacity 7200 tons	1	4	4
Refuse Crane: capacity 9 tons	3	6.5	19.5
Incineration Unit	3	2	6
Boiler: tube length 100 feet	3	1	3
Turbine	3	1	3
Generator	3	1	3
Cooling Stack	1	1	1
Electrostatic Precipitator	3	1.5	4.5
Bottom Ash Handling System	3	2	6
Dry Scrubbers	3	0.1	0.3
Dry Lime Reactor	3	0.2	0.6
DeNOx System	3	0.2	0.6
Bag House: 3420 bags; Gore-Tex fabric	3	1.5	4.5
FlueStack	3	1	3
Stack: 175' tall, contains three flues	1	2	2
			0
Contractors Budgeted	1	83	83
Budget: other materials	1	64	64
		Total Cost	**300**

Table 2: Estimated Operating Costs and Revenue

Operation Cost and Revenue	Prices
Operations	**Cost (million dollars)**
Labor Cost	8.0
Material and Resource Consumption	7.8
External Services	8.7
Other Costs	3.2
Amortization	10.5
Interest Payment	7.3
Total	**45.4**
	Gate Fee (dollars/ton)
Gate Fee	95.0
Revenue	**Income (million dollars)**
Electricity	17.1
Recycled Materials	0.2
Gate Fee	37.4
Total	**54.7**
	Profit (million dollars)
Net	**9.3**

Table 3: Personnel Salaries

Positions	Quantity	Salary Individual (thousand dollars)	Total Salary (thousand dollars)
Administration	6	130	780
Crane Operator	9	60	540
Engineer	2	70	140
Mechanic	13	50	650
Specialist	4	65	260
System Operator	10	55	550
Technician	16	50	800
Vehicle Operator	10	50	500
Total Employees	**70**	**Total Salary**	**4220**

Table 4: Personnel Expenses

Position	Vacation/Holiday/Sick (thousand dollars)	Benefits (thousand dollars)	Taxes (thousand dollars)	Total (thousand dollars)
Administration	273	187	161	1401
Crane Operator	189	130	111	970
Vehicle Operator	175	120	103	898
System Operator	193	132	113	988
Specialist	91	62	54	467
Engineer	49	34	29	251
Mechanic	228	156	134	1167
Technician	280	192	165	1437
			Grand Total	**7,579**

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