PROPOSAL TO SUPPLY ADVANCED WASTE TO ELECTRICITY CONVERSION UNITS

PREPARED

BY

PRACTICAL ORGANIC
WASTE ENERGY RECOVERY
SYSTEMS, INC.

AND

CINERGEX SOLUTIONS LTD.

(CSL)

MAY 2002

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1. INTRODUCTION AND PRODUCT DETAILS

For over twelve years, Practical Organic Waste Energy Recovery Systems Inc. (POWER) has been perfecting the art of taking a problem and turning it into a profit. They are the manufacturers of the world's leading incineration technology – a technology so advanced that it is capable of handling any and all waste products but still meets the most stringent environmental standards in place anywhere in the world!

Over a decade ago, POWER, a Canadian company, bought the technology originally started by an American company, Olivine Corporation, and, since then, has made dramatic improvements, particularly in the areas of computerization and flow control. By controlling the rate at which the waste is processed in the combustion chamber, POWER ensures the most consistent temperature controls and, in so doing, ensures that there are no organic or inorganic airborne pollutants released during the incineration process. In fact, the newest models of the POWER system don't even have a traditional smoke stack – they are completely self-contained units.

The units are efficient, easily maintained, cost-effective, and rugged, while offering the highest environmental sensitivity possible.

We know that to be a successful solution to the waste disposal problems faced by municipalities around the world, the units must meet the following criteria:

- Low Initial Cost
- Ease of maintenance and operation
- Rapid parts replacement utilizing "off-the-shelf" availability
- Meet or exceed all EPA and US Department of the Environment (or similar) environmental standards for air and water.
- Utilize the greatest possible percentage of the latent energy stored in the waste products and which would, otherwise, be lost if disposed in traditional landfills

These units feature a unique refractory material that can handle temperatures exceeding 2500 degrees F, with little or no maintenance, and the plants are literally capable of running 24 hours a day, 365 days a year.

A constant temperature is maintained throughout the continuous burn by utilizing an under-fire fan system and automatic, computer controlled fuel feed, air lock, feed stock and ash removal systems. An over-fire fan introduces oxygen and imparts a circular motion to the gases and maintains them in the combustion chamber for approximately six seconds before they are drawn into the boiler system.

The boilers have been designed to handle municipal solid waste, including plastics that can condense and damage normal boiler tubes. The boilers are also computer controlled with manual bypass safety systems that meet all standards for safe and simple boiler operation.

The electrical system is built around a low pressure steam turbine generator set of 5 Megawatt capacity and comes complete with all synchronizing, transforming and load protection switch gear required for connection to a standard power line grid. All electrical systems are computer controlled.

Emissions and emissions control systems meet or exceed all EPA standards and guidelines for MSW incinerators. A spray dryer removes acid gases from the exhaust and fine particles are removed in the bag house, where they are continuously monitored. A very sophisticated monitoring system measures, records and controls emission performance. The burner ash is quenched and prepared for either transport to a landfill or to be used in the manufacture of building blocks, road barriers, asphalt, etc.

Our waste-to-energy systems are cutting-edge technology and we would be pleased to describe, in greater detail, the specific benefits your municipality or company would derive from their use.

We are pleased to offer for your consideration a proposal for the supply of waste to electric power conversion units. This proposal is directed to medium and large municipalities and corporations.

It is generally recognized that the problem of disposal and/or treatment of municipal and commercial waste, in many urban areas, requires an efficient and economical solution, within the financial means available to those communities and their residential and commercial taxpayers. Most of the major urban centers, world-wide, have an immediate need for low cost, efficient, compact and turn-key waste treatment facilities compatible with local sanitation, power supply and financial capabilities.

This proposal constitutes a general outline of the merit of compact solid waste-to-electric power conversion units, using solid waste as the <u>only</u> source of energy.

The economic rationale and the expected high rate of return to be generated by these proposed waste-to-electric power conversion units are based on the following facts:

- The present economic environment of most developing countries and many communities in the United States and Canada requires a low cost solution to the ever-increasing sanitation and waste disposal problems.

- *Most of the developing and developed countries' energy resources are composed, largely, of potential solid fuels such as agricultural wastes, forestry wastes, as well as industrial, municipal and medical wastes. Those resources have, traditionally, rarely been put to productive use.*

- The increasing volume of municipal and industrial waste discharge in major urban centers is complicated by a lack of cost-effective methods of waste disposal and insufficient financial resources to deal with the implementation of modern environmentally sensitive solutions.

- *The recent dramatic increase in oil prices has meant that diversification of energy sources would allow countries using oil for some or all of its domestic energy needs to allocate that fuel to other, higher value-added uses, by maximizing the reliance on biomaterial-based fuels and recycled materials.*

- Most of the developing countries, as well as many developed countries, do not have significant hydroelectric capabilities and have limited access to other domestic energy sources.

In view of these considerations, plus the reality of increasingly restrictive environmental protection regulations, municipalities have relatively few alternatives that are as cost effective as solid waste conversion to energy. Given the ever-increasing sanitary problems facing most populated centers today, and the certainty of increasing energy costs and demand, the most efficient, profitable and environmentally sensitive conclusion is the construction of versatile waste-to-electricity power plants. These power conversion units are not only competitive compared to other types of electric generating plants that utilize hydrocarbon-based fuels, but, unlike coal or diesel plants, they will comply with the most restrictive environmental protection requirements anywhere in the world.

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The technology of mass burning combustion technologies has been developed and refined by several North American and European companies to enable municipalities to satisfy all their waste disposal objectives, while operating within modern environmental constraints and requirements.

This document proposes the supply of low cost municipal and/or agricultural waste–to-power plants for major population centers, on a turn-key basis. These plants, or batteries of plants, will operate independently and, by recovering the latent energy contained with the waste products, satisfy some or all of the energy needs of those municipalities. These plants can also be connected to the national, regional or local power distribution systems with no need for large fuel unloading terminals and transformation systems. The plant's energy use versatility allows the operators to use any local energy resources and, thereby, reduce the dependency on more expensive sources of fuel. The plant's size, and the technology used in these plants, ensures that all environmental considerations are met while dramatically reducing, or eliminating altogether, the need for traditional landfills.

For any municipality, these proposed waste-to-power conversion plants will generate and provide some obvious economic benefits, including:

- The power plant will produce permanent and temporary employment during the initial construction and operation periods.
- Provide economic solution to the ever-increasing municipal, industrial and, especially, medical waste discharge needs, jointly with the production of substantial electric power, necessary for the city and the region development, all at a rate comparable to the present real cost of energy production.
- Provide a nucleus of economic activity around a new power source, which can be a powerful tool for economic development.
- Reduce the local or national dependency on more expensive and/or foreign sources of energy, and, simultaneously, increase the value-added potential of the domestic or regional agricultural, food processing and other industries by using agricultural and urban waste.
- Minimizing, or eliminating, waste disposal problems and costs by using the residual ash for the production of cement construction blocks. This is accomplished by adding a small concrete plant provided to each unit or battery of units. The size and production capacity of each concrete plant would be commensurate with the plant ash production.
- Generation of income and tax revenues.
- Elimination of long-term ground water contamination from traditional landfill use
- Possible improved access to World Bank and other international aid programs designed to promote environmental protection
- Can be used in connection with recycling initiatives or, alternatively, the units can use plastic and paper waste products to maximize energy recovery.

The construction time is relatively short, given that our units feature "off-the-shelf" components and are available for immediate shipment and on site assembly.

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2. PARTIAL LIST OF RECENT INSTALLATIONS

WORLD WIDE

CANADA:

1. McRAE TIMBER LTD, at Whitney, Ontario
2. WYNDELL LUMBER, at Wyndell, British Columbia
3. E.B. EDDY CO. at Nairane Center, Ontario
4. GEORGIA PACIFIC, at Deer Creek, British Columbia

UNITED STATES OF AMERICA:

2. ANGELO MFG., At Jonesboro, Arkansas
3. WI FOREST PRODUCTS, at Thompson Falls, Montana
4. WI FOREST PRODUCTS, at Bonners Ferry, Indiana
5. LOUISIANA PACIFIC, at Dear Lodge, Montana
6. LOUISIANA PACIFIC at Lakewood, Washington State

MALAYSIA

1. TABWOOD, Sarawak (Several installations)
2. GOODWOOD BINTULU, Sarawak

BORNEO, INDONESIA

2. GOODWOOD MANAGMENET (Several installations)

CHILE

1. ASBERRADEROS MININCO S.A., at Santiago, Metropolitan

There are over 500 incinerators of various sizes built since 1973 in North America, alone. There has been a marked improvement in the technology used for waste-to-electricity processing and, today, incineration represents the most progressive means of dealing with the growing problem of waste disposal worldwide.

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3. STATUS OF MUNICIPAL WASTE OPERATING INCINERATORS

IN THE U.S.A. & CANADA

There are over 500 Garbage (municipal wastes) incinerators, of all sizes, operating in the USA and Canada. Of these:

1. The majority of incinerators only deal with half the solution – they burn waste but don't recover the latest energy by producing electricity. For example,

   1.1 Florida has 33 units in operation
   1.2 New York State has 18 units in operation
   1.3 The State of Vermont has 11 units in operation
   1.4 The State of New Hampshire has 9 units in operation
   1.5 California has at least 22 incinerators in operation

2. Of those 500 units, approximately 45 incinerators produce electricity, like our model, and, below, we have listed several units located in California, the jurisdiction with the toughest environmental standards in the world. The recent power shortages in California have highlighted the importance of utilizing all possible sources of power generation and there is considerable interest in adding generation capability to existing incinerators.

3. Partial list of pure Garbage (Municipal & Medical wastes) incinerators operating units in major cities in California. Site visits can be arranged.

   City of Commerce, Los Angeles County
   Owned by the City of Los Angeles
   Incinerating Capacity: 500MT/Day
   Electricity production: 10MW
   Start operating year: 1985

   City of Long Beach, Los Angeles County
   Owned by the City of Long Beach
   Incinerating Capacity: 300MT/Day
   Electricity production: 5MW
   Start operating year: 1967

   City of San Diego, San Diego County
   Owned by the City of San Diego
   Incinerating Capacity: 250MT/Day
   Electricity production: 10MW
   Start operating year: 1985

   City of Sacramento
   Owned by the State of California central heating Plant
   Incinerating Capacity: 480MT/Day
   Electricity production:
   Start operating year: 1982

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4. TECHNICAL SUPPORT INFORMATION

250 TPD WASTE SYSTEM

Our plants are designed to handle an estimated 250 tons per day (TPD) of municipal or commercial solid waste, and, due to their modular design, they can be combined in batteries of one to twelve prefabricated 250 TPD units, able to satisfy any required capacity while maximizing energy recovery.

Our units boast the following advantages:

- *low installation, maintenance and operating costs*
- *capable of burning any solid waste of 50% combustible content*
- *complete combustion*
- *meet all air pollution standards, current and planned (US EPA)*
- *require no auxiliary fuel*
- *sorting, if required, can be done at the ash afterburner*
- *the most advanced technology available today*

On the following two pages, we illustrate a double silo model (500 TPD capacity), (with multiple bag-house cleaners, V-hearth combustion, continuous feed and ash removal system, and indoor storage for a three day supply of waste) along with an illustration of the exterior configuration of such a plant.

Scope of the equipment supplied:

- primary chamber 23' diam. 42' high
- chamber feed chute
- refractory V-hearth
- walking floor
- ash house with timer and loader access
- hydraulic controls, manually operated
- over-fire blower 50HP
- under-fire blower 40 HP
- secondary chamber 21' diam. X 42" high
- high temperature refractionary
- refractory cross-over duct
- refractory duct to boilers
- boiler system including pumps
- refractory cooling, water tank with conditioner timer
- one (1) stack cooler and bag house
- control room including computer controls
- steel waste storage building and waste water tank
- unloading sump and conveyor systems
- paved and fenced yard
- lighting for yard and buildings
- powerhouse including turbine 5 Megawatt turbine per unit
- construction blocks production plant, for ash disposal
-

This complete unit, installed and ready for operation, includes the initial training of local personnel. Ongoing management can be provided, if desired. We would be pleased to supply a more detailed report offering additional technical specifications.

5. DELIVERY, INSTALLATION & PERSONNEL TRAINING

After the initial visit to the area designated for the installation of the plant and following the execution of the purchase contract and receipt of the deposit of five per cent (5%) down payment, the supplier will present the buyer with a comprehensive installation plan that will outline the precise installation and operation schedules. It will incorporate any site-specific requirements relating to the connection to the local electricity distribution grid, plant layout, road access, etc.

The plan will also outline the details of the management and staffing required, as well as detailing the training program for the local management. In most instances, given the high degree of computerization of our units, the normal staff complement is ten per shift. The supplier will, if requested, present the buyer with a proposal to provide ongoing management and servicing. Alternatively, local personnel will be able to assume the management within the time frame shown below. The contract will specify the warranty on all parts and labour and the units will be fully operational before any transfer to the purchaser.

The buyer will have the responsibility of providing the plant site and all the required permits and licenses, including any permits required to import equipment or to connect the plant(s) to the existing electric power grid. Prior to the development of final unit esigns, the buyer will be required to provide the parameters of the local electricity distribution network. The units supplied will be equipped with connections and generator(s) compatible with that network.

It will outline the details of the management team, as well as the training program for the local management. The suppliers will present the buyers with a management proposal. Local ownership personnel will be able to assume the management within a reasonable time frame.

The buyers will have the responsibility to provide the suppliers with the plant site and all the required permits and licenses, equipment import facilitation, including the permit to connect the plants to the existing electric power grid.

Power Unit Installation Schedule

Start Finish
Weeks

0 6 15 28 42

Land and site prep.
Shipping
Plant installation
Local Personnel Training

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6. ECONOMIC JUSTIFICATION

6.1 Assumptions and parameters:

6.1.1	Waste incineration capacity	= 250 ton per day (24 hours)
6.1.2	Unit power potential	= Five (5) megawatts net
6.1.3	Total unit price	=Twenty five million dollars (U.S.)
6.1.4	Fuel saving compared to an equal Potential oil firing plant	= 1.5 ton per hour
6.1.5	Cost of fuel (oil)	= USD 10.0 per ton
6.1.6.1	Cost of municipal waste treatment ("tippage" cost) – Scenario 1	= USD 5.0 per ton
6.1.6.2	Scenario 2	= USD 10.0 per ton
6.1.6.3	Scenario 3	= USD 15.0 per ton
6.1.6.4	Scenario 4	= USD 20.0 per ton
6.1.7	Plant operation time	= 360 days per year, at 24 hour/day
6.1.8	Total power production	= 43,200,000 Kwh / year
6.1.9	Debt service terms	= 10% interest, 20 year term
	Debt service coefficient (P&I)	= .11580259

6.2 Estimated Electricity Production Cost (Example only).

6.2.1	Total amount financed	= Twenty five Million US Dollars (USD 25,000,000.00)	
6.2.2	Capacity investment cost	= USD 6,250 per Kwh capacity	
6.2.3	Plant estimated annual costs		
	- Operating and Maintenance	USD	530,000.00
	- Annual debt service	USD	2,547,657.00
	Sub-Total Annual Costs	USD	3,077,657.00
	Less electricity revenue (43,200,000 Kwh x .0575 USD)	USD	2,484,000.00
	Total estimated annual cost	USD	593,657.00
6.2.4	Less imputed charge to offset landfill costs		
	Scenario 1 - $5.00. Net operating cost =	USD	143,657.00
	Scenario 2 - $10.00. Net operating cost =	USD	306,343.00
	Scenario 3 - $15.00 Net operating cost =	USD	(756,343.00)
	Scenario 4 - $20.00 Net operating cost =	USD	(1,206,343.00)

Please note that:

- The operating cost of this system is below the average real cost of Kwh produced in most developing and developed countries.
- This cost analysis does not consider any related positive economic benefits, such as a significant reduction in costs associated with sanitation and public health.

7. FREQUENTLY ASKED QUESTIONS

We are proud of our product and we are eager to supply complete details and technical information. We listed some of the most frequestly asked questions. Should you have any additional questions, we would be pleased to address them, in as much detail as you require.

- **Water Uses**

What are the water outflows from the unit?

The MSW do not emit residual water. If the municipality has garbage with an exceptionally high moisture content, the excess water can be recycled and utilized on-site (landscaping, cleaning, etc)

What are the total water requirements?

When it comes to the total water demand of a one (1) standard MSW 250TPD/5 MW unit, note that,

- The system, as far as water usage is concerned, is a closed system
- There are three (3) water sources for those units:

- The water contained in the garbage constitutes, normally, about 10% to 15% of the weight of the waste entering the system. Water is generated during the garbage drying & incineration process, and, subsequently, the condensation of the vapor. Five percent (5%) of this water evaporates during the storage time and through the exhaust. Ten percent (10%) of this water is recaptured and recycled into the unit's system for the re-production of steam.
- Water released from the garbage (by gravity) during the storage time (two to three days), is negligible, and can be recaptured for recycling into the production of concrete blocks.
- Water added to the unit during operation from external sources.

How is water used in the process?

Its primary use is for the production of steam to generate power in the turbine-generator. Four cubic metres of water are released to the air, daily, in the course of this generation. A secondary use is during the production of ecoblocks (construction material), using the ash as a cement substitute. Depending on the moisture content of the waste being incinerated, there may be a requirement for an auxiliary water source for the production of cement products.

How much ash is produced?

Ash production in a 250 TPD unit, on average, amounts to 5% to 10% of the weight of the garbage entered to the system, depending on the type of waste used. This ash can be used in the production of cement blocks at a ration of 1/3/6 of ash/cement/aggregates.

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<u>Water balance (assuming garbage water content of 15%)</u>

250 TPD (re-capture and release by gravity) * 10% =25 tons =25M3
Water usage for ash cleaning & production of Ecoblocks:
250 TPD garbage (only the combustible part) * 5% =12.5 Tons/day
Ash usage at 1/3/6 ash/cement/aggregates ration implies the production of 125 tons
Ecoblock weight, or 12.5 ton * 10 = 125 ton concrete mix
Water used in the Ecoblocks production = 50% of the Ecoblocks weight
Or 1 M3 for each 1 ton of concrete mix
125 concrete mix * 1 M3 water = 125 tons of water =125 M3 of water
Turbine vapor release = 4 M3

Water requirement from external sources: 25M3 – 125 M3 – 4 M3= 104M3

The user has to be aware of the different water plant requirement of the combustion and electric generation components, compared to the cement plant requirement. As far as the incineration – power unit is concerned the plant generates a water surplus of 21 M3. If a cement block production facility is included, in this example, an external source of water that will supply the plant with 104 M3 per day, or 4.5M3 per hour is required.

<u>What gases are released in this process?</u>

The environmental report, the EPA certificate, and the EPA test of our system, are detailed in this booklet. This report is based on the test the EPA did on our MSW unit as part of its policy of its routine, periodic, unadvised visits to all plants in the USA.

NOx gas is not formed during the incineration process in our units, due to their constant burn temperature of 1,800 degrees F, and the immediate introduction of air (oxygen) above the combustion fire.

Chlorine Organics are removed by the addition of Soda Ash in the treatment tower.

Aromatic polycyclic hydrocarbons are treated in the treatment tower and removed in the bag house.

Opacity and particulates emissions are detailed in the environmental reports

Standard ash filters are supplied with the units. The temperature in the bag house is 350 degrees F and in the stack it is 275 degrees F. Further information can be found in the environmental report provided.

<u>Are there any concerns about the combustion of fertilizers when burning agricultural wastes?</u>

At 1,800 degrees F, all pesticides and fertilizers are completely broken down and combusted.

8. ENERGY PRODUCTION COMPARISONS

Assumptions:

Essentially, in the case of municipal wastes, the cost of fuel is equal to the cost of collection and transportation of the wastes.

The lower energy conversion efficiency of municipal waste is due to higher moisture content compared to other fuels. This analysis considers that the production of one (1) Kwh using municipal waste will require 60% more energy, or 10,500 BTU/Kwh compared to 6,350 BTU/Kwh required using an average of other fuel.

In those countries that utilize oil for all or part of their energy requirements, the substitution of municipal waste would relieve oil for export or other uses and, thereby, generate higher return per unit of this energy source, compared to the use of the same oil, domestically, to produce electric power.

Energy source BTU content measured in BTU/Lb (at the plant):

Heavy heating oil No.2	150,000
Shredded tires	15,500
Natural Gas (1000 C.F.)	1,000
Coal	10,500
Wood wastes	3,375
Municipal wastes	5,400

Energy source cost – C.I.F. Plant:

	Unit	**Unit Price (U.S. cents)**	**Price per Lb (U.S. cents)**	**Price per BTU (U.S. cents)**
Heavy heating oil #2	Gallon (F.O.B.)	59.25	7.92	.0000528
	Gallon (C.I.F.)	80.50	10.76	.0000717
Tires	Ton (C.I.F.)	5,000.00	2.27	.0001513
Shredded Tires	Ton (C.I.F.)	12,000.00	5.55	.0003700
Natural Gas	1MM BTU (C.I.F.)	280.00		.0002800
Coal	Ton (C.I.F.)	7,500.00	3.41	.0003250
Municipal wastes	Ton (C.I.F.)	600.00	.27	.0000454
	Ton (C.I.F.)	1,000.00	.45	.0000909
	Ton (C.I.F.)	2,000.00	.91	.0001818
	Ton (C.I.F.)	3,000.00	1.36	.0002727

EQUIVALENT FUEL VALUES
(AS RECEIVED BASIS)

Component	Btu/lb
Coal (Anthracite)	13,500
Coal (Bituminus)	14,000
Peat	3,600
#2 Fuel Oil	18,000
#2 Fuel Oil (Btu/gal)	139,000
#2 Fuel Oil (Btu/Bl	5,285,000
Natural Gas (Btu/CuFt)	1,116
Mixed M.S.W.	**4,800**
Mixed Paper	6,800
Newsprint	7,950
Corrugated	7,043
Junk Mail	6,088

Component	Btu/lb
Magazines	5,250
Mixed Food Waste	2,370
Wax Milk Cartons	11,325
Polyethylene	18,687
Polyethylene	16,419
Mixed Plastic	14,100
Tires	13,800
Leaves (50% moist)	3,535
Leaves (10% moist)	7,984
Grass (65% moist)	2,690
Green Wood	2,100
Cured Lumber	7,300

SOURCE: Environmental Protection Agency (USA)

ULTIMATE ANALYSIS OF MUNICIPAL SOLID WASTE COMPONENTS
(percent by weight)

MATERIAL	C	H	0	N	CI	S	Moisture	Ash	HHV (Btu/lb)
Mixed Waste	27.5	3.7	20.6	0.45	0.5	0.83	23.2	23.4	4,830
Corrugated	36.79	5.08	35.41	0.11	0.12	0.23	20	2.26	6,322
Newsprint	36.62	4.66	31.76	0.11	0.11	0.19	25	1.55	6,233
Magazines	32.93	4.64	32.85	0.11	0.13	0.21	16	13.13	5,466
Other paper	32.41	4.51	29.91	0.31	0.61	0.19	23	9.06	5,481
Plastics	56.43	7.79	8.05	0.85	3.00	0.29	15	8.59	11,586
Rubber/leather	43.09	5.37	11.57	1.34	4.97	1.17	10	22.49	8,433
Wood	41.20	5.03	34.55	0.24	0.09	0.07	16	2.82	6,933
Textiles	37.23	5.02	27.11	3.11	0.27	0.28	25	1.98	6,595
Yard Waste	23.29	2.93	17.54	0.89	0.13	0.15	45	10.07	4,005
Food Waste	17.93	2.55	12.85	1.13	0.38	0.06	60	5.10	3,265

SOURCE: Environmental Protection Agency (USA)

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Conclusions:

This simple cost comparison indicates that, if the municipality imputes a charge for the real cost of collection and transportation of waste to the plant, the cost per BTU used for the conversion of the waste to one (1) kWh of electric power will be the lowest compared to other sources of energy and far cheaper than the use of oil.

At an imputed cost of USD 10.00 for each ton of municipal waste received, it will almost equalize the cost of energy created by burning oil. By comparison, the cost per BTU of using natural gas would be seven times higher and coal would be nine times higher than the cost of using municipal waste!

Using oil (C.I.F. plant)	1.08 cents per Kwh
Using tires (C.I.F. plant)	1.59 cents per Kwh
Using natural gas (C.I.F. plant)	9.14 cents per Kwh
Using coal (C.I.F. plant)	1.53 cents per Kwh
Using municipal waste (C.I.F. plant)	.74 cents per Kwh

Cost of Electric Power produced

To consider the cost of electricity production, in detail, a broader analysis of each city's municipal solid waste capabilities has to be examined. Our plant design is based on the experience accumulated in countries around the world, and the analysis of the municipal waste information received from large municipalities, in particular. While the Kcal/Kg content of municipal waste varies considerably between cities, the experience obtained in urban and rural installations enables us to offer an unconditional assurance that we can achieve successful and profitable operations in any municipality – large or small.

Basically, our MSW units will burn solid waste of any composition. No pre-treatment of the garbage is required, therefore no additional costs are involved. The system raises the incinerator's temperature to 1,800 degrees F in a very short time. At that temperature, all combustible material (organic and inorganic) and contaminated material, will be incinerated without the need to add any other fuel at additional cost. In this regard, the computerized temperature controls ensure that our units offer a considerable cost advantage over all other incinerators sold today.

The short time interval that elapses from the reception of the garbage to its incineration allows a continuous recapture and incineration of particles and gases and the high retention of heat. This, in turn, minimizes the cost of incineration and, consequentially, reduces the cost of electricity generation.

The evaporation of all moisture contained in the garbage, followed by the condensation of the vapors within a closed system, minimizes the use of external water and the associated costs of acquisition or disposal.

Continuous collection of ash, and its use in the production of building materials, creates a secondary source of revenue and eliminates another cost, thereby further reducing the cost of the electricity produced.

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Energy Balance:

To compute the real costs of the municipal waste's treatments and the cost of the electricity produced, it is important to note that our MSW units burn solid waste of any composition. Nevertheless, as far as energy conversion efficiency is concerned, wastes (municipal or other) of less than 50% combustible components will reduce the amount of heat available, thereby lessening the economics of the energy conversion process, and its technical efficiency. Such a circumstance is extremely rare and we have yet to encounter a municipal waste stream that offers an insufficient level of combustible materials. In the event that waste with excessive moisture content is received, the plant design allows for the on-site storage of waste for up to three days to allow drainage into a closed water recycling system.

Here are two examples of waste streams: in a major urban center.

Sampled municipal waste composition (percentage)

	Rio de Janeiro Section #1 (Dry material)	Rio de Janeiro Section #2 (Wet material)
Paper & carton	22.25%	17.00%
Plastic	15.09%	4.70%
Textile	2.50%	5.00%
Metals	3.09%	4.90%
Glass	3.60%	10.50%
Carton	na	3.00%
Construction material	.97%	2.00%
Organic material	48.89%	40.00%
Leaves	2.46%	na
Wood	.53%	1.00%
Rubber	.18%	na
Hides	.16%	na
Bones	.33%	na
Other small aggregates	na	6.90%
Water	na	5.00%
Total	**100.00%**	**100.00%**
Combustible material	92.23%	77.60%

Na = no information available

For this analysis, we used the Rio de Janeiro example due to the size of the municipality and the fact that its waste stream offers similar characteristics with those of other large cities around the world.

To compare the energy content of various waste items, please refer to the charts contained elsewhere in this proposal.

According to the information above, the residential municipal waste in Rio de Janeiro, at 70% humidity, has an energy content equal to 1,500 Kcal/kg.

Obviously, calculating the energy content of the same waste at 20% humidity (after drying) will result in:

At 70% humidity: 1,500 Kcal/Kg = 5,948.59 BTU/Kg = 2,703 BTU/Lb

Equal to (approximately)

At 20% humidity 6,750 BTU/Lb!

Given the high level of water content, the production of 1.0Kwh of electric power by our MSW unit, using the waste composition as indicated, requires 16,390 BTU/Kwh compared to 10,500 BTU/Kwh required by conventional oil firing power plants. This considers the energy required for the drying process of the material to the 0% humidity level, and full energy conversion.

An average municipal waste generated energy content is at the lower value of solid waste's scale of 5,400 BTU/Lb (see previous section). As another example, consider the lesser value of Bucharest municipal waste energy content of 5,050 BTU/Lb.

For a daily production of electric power, by this plant of 5MW capacity, the balance of energy is as follows:

Energy demand = 5,000 Kwh * 24 hours * 16,390 BTU/kwh = 1,966,800,000 BTU

Energy supply = 250 MT waste * 2,200 lb/ton * 5,050 BTU/Lb = 2,777,500,000 BTU

This implies that, even at 80% conversion efficiency, the energy supply meets the energy demand for the full production of the 5MW capacity.

Expressed in specific terms, the incineration of municipal waste in Bucharest would provide the following results:

<u>On the supply side:</u>

- Average Bucharest garbage Kcal/Kg content = 1,500 Kcal/Kg
- 1 Kcal/Kg = 3.97 BTU/Kg
- 1,500 Kcal/Kg = 4765 BTU/Kg, at 70% humidity (wet)
- 1,500 Kcal/Kg = 2,165 BTU/Lb, at 70% humidity (wet)
  = 5,050 BTU/Lb, at 0% humidity (dry)

<u>Equivalent units:</u>

1 Kwh = 860 Kcal
= 1,595 gram vaporized at 100 degrees C
= 7.9 Kg water heating from 20 degrees C to 100 degrees C
5,890 BTU = Total requirement of BTUs to evaporate 1.0 Lb of water at 20 degrees C

On the demand side:

- production of 1.0 Kwh requires the use of 10,500 BTU
- the reduction of garbage humidity from 70% humidity to 0% humidity will require 5,890 BTU/Lb which implies that:
- production of 1.0 Kwh require the total supply of 16, 390 BTU (or 16,390 BTU/Kwh)

Which implies:

- an existing surplus energy that can sustain additional generating capacity of .41MW (810,200,000/16,390/5000/24 = .41 MW), or 8% surplus
- at 80% efficiency conversion, the existing surplus of energy can sustain additional generating capacity of .13MW, or 2.6% surplus
- that the energy supply exceeds the energy demand for the full production of the 5MW capacity
- that the waste being disposed must only contain 1,500 Kcal/kg to supply the necessary energy at 250 TPD

Conclusion:

The energy balance shown here indicates that the Bucharest or the Rio de Janeiro municipal waste energy content is more than sufficient to provide the energy required for the production of 5MW during the incineration of 250 tons of waste per day. The same would be true of the waste-to-energy potential of municipal waste in almost any other medium or large city.

The performance indicators of the system (MSW units) are detailed in the Independent Environmental Consulting company report, and the American EPA certification.

Those performance indicators and norms are maintained, and confirmed to the American EPA standards and regulations, throughout the operating life-span of the unit..

If co-generation of electricity and steam by our units is required, then any plant that produces the necessary steam to operate a 5 MW turbo-generator, can use some of the steam for the power generation, and divert a portion of the steam for a heated-water delivery system. It should be clear that in this case the options are:

- Shut off the turbo-generator for a specific time period and alternate the supply of electricity or steam
- Permanent co-generation of steam and electricity. To do so, the buyer will have to define the required combination, and the size of a the turbo-generator will be adjusted to suit the available steam.
- If the heating water system is closed-loop, and the units can retain the water, then the heated-water distribution system will act as the cooling system to the plant, and only negligible power is lost. The unit will produce the same 5MW of electric power.

9. OPTIONS

The units are designed to utilize any form of municipal or agricultural waste. Some clients have chosen to customize the incinerators to deal with specific waste products, such as medical waste. Others have chosen to utilize options that would permit the recovery of certain metal or plastic products with relatively high value if recycled. We can customize the waste-to-power plants to offer the most efficient and effective materials recovery and incineration possible. We can also provide technology to utilize the fly ash as a component of the manufacture of concrete blocks or asphalt, to completely eliminate the need for waste disposal.

Just some of the available options are:

Picking conveyor with picking stations

Bag slitter

Gimo refuse conditioner

Hospital waste station, complete with sterilizing equipment

Metal & plastic baling station

Plastic wash station

“Ecoblock” concrete block production facility