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BioCrude Technologies, Inc.'s waste management solution of its Integrated Municipal Solid Waste (MSW) to Energy Processing Complex in juxtaposition to existing practices within the waste management milieu

The provision of municipal solid waste services is a costly and troubling problem for local authorities everywhere. In many cities, service coverage is low, resources are insufficient, and uncontrolled dumping is widespread, with resulting environmental problems. Moreover, substantial inefficiencies are typically observed. The projected average garbage generation for the municipal corporation of Lusaka is approximately a minimum of 0.8 kg per capita per day (average amongst similar municipalities), thus a total quantum of solid waste generated is a minimum of 2,000 tons/day (considering a metro population of 2.47 million inhabitants), as well as not incorporating the waste generated from the tourism industry. Its waste management ordinance, surprisingly enough, encompasses landfilling until over exhaustion and inefficient waste collection.

Out of concern for the quality of life of their residents, local municipalities bear primary responsibility for waste management. Municipalities will work with other municipal levels to identify the best collection, transportation, treatment and disposal methods for their respective jurisdictions. This includes identifying suitable sites for municipal or regional waste management facilities and managing and operating collection, transportation and treatment systems. To increase the environmental and economic efficiency of waste management, local municipalities will be responsible for planning waste management infrastructure and systems at the urban community and regional county municipality levels.

Waste management planning, as well as the production of renewable energy resources, are vital issues facing any city or municipality today. Governments at all levels, on a global scale, are allocating large amounts of funding for development of systems to combat this problem. While certain municipalities have some infrastructures in place for waste collection, they have varying degrees of advancement in the implementation of redirection systems for recoverable and reformable waste products. In essence, room for improvement exists for the following:

1. Reduction, and eventually, the elimination of landfilling, as opposed to over exhausting (substituting proposed landfill sites with other forms of development (commercial, industrial, residential, agricultural, and community developments, amongst others – real estate value)).

2. Reduction of Greenhouse Gases, and environmental pollutants with reference to ground and surface water contamination (percolation of contaminated leachate) alongside with the elimination of odours.

3. Further enhanced separation process for MSW, which could prelude to a more optimal recycling program.

4. Procurement of Renewable Energy and Marketable by-products (fertilizer) from the exploitation of the calorific value of the MSW.

Nota Bene: Landfilling is NOT a solution, but a deferral of a problem for future generation to handle. In essence, it is what it is; a PRACTICE for the longest period of time! Nothing more!

The myth that landfilling is a cost effective solution is what it is; a myth. There are long term ramifications, especially when the landfills are not proper "**Scientific Landfills**" (environmental implications; rainfall, leachate, percolation, contamination (soil and water table)). Even the fact that if a Scientific Landfill is deployed (with membrane linings) at an astronomical cost (the cost of construction of a Scientific landfill that will host approximately 2,000 TPD of waste for 25 years is approximately 100 MUSD), after a few earth tremors or shifting of land, the membrane cracks, not mentioning the fact that over time, the membrane deteriorates, thus yielding the same negative environmental impacts, only deferred in time.

Another issue to address is the continual use of landfills. As time goes on, and waste is continuously generated by the populous and its activities, more and more landfills have to be created, to a point where a good part of the country will become a cemetery for garbage.

When a need will arise to reclaim back certain land (certain countries like Pakistan, India, Bangladesh, amongst others have already started requesting proposals for same) from being host to a landfill, the cleansing process for reclamation can cost a minimum of 120 USD/m^3 (do the math on a landfill that hosted 2,000 TPD of waste for 25 years, as well as cleansing all other soils to the point of the bedrock, as well as the lateral distance from the perimeter of the landfill).

Remember: the landfill gas (from the organic portion of the MSW) extracted from a landfill is a "**mise en cause**", to landfilling and a onetime event, with the consequence of the balance of the waste left in the landfill. Landfill gas extraction is not 100% efficient, with a certain percentage escaping into the atmosphere and another percentage trapped in pockets of the landfill.

If one was to do a Macro-economic and Cost-Benefit analysis and of same, incorporating all of the aforesaid, especially all of the negative environmental impacts, one would find that a properly engineered solution today outweighs the so-called norm of landfilling by a minimum of 300 to 1 (I did not even incorporate the negative effects to health implications).

Large municipalities and metropolitan regions are encouraged to routinely undertake citywide strategic planning to design and implement integrated solid waste systems that are responsive to dynamic demographic and industrial growth. Strategic planning starts with the formulation of long-term goals based, on the local urban needs, followed by a medium- and short-term action plan to meet these goals. The strategy and action plans should identify a clear set of integrated actions, responsible parties and needed human, physical and financial resources. Opportunities and concepts for private sector involvement are commonly included among the examined options, as the private sector's costs and productivity output require special consideration.

BioCrude is a leader in waste management, having set as its objective the profitability of the activities issued of this sector, while building business relationships and social implications within the collectivity's / communities that BioCrude is called upon to serve, beyond the environmental and social implications, and beyond the business imperatives. BioCrude Technologies has been involved in the R&D of Environmental Technologies, both process and product based, whereby it has enhanced and optimized conventional Technology, whereby giving credence to environmental, economic, social and technological well-being, too numerous to mention, and as all can be referenced in its entirety within BioCrude's Integrated MSW-Energy Proposal for Lusaka, Zambia Republic. Shortlists of the aforesaid well-beings are mentioned herein under:

1. Secure, cost effective long-term processing capacity for recyclables and organics.
2. Improvement of effectiveness and efficiency of current waste systems/practices.
3. 100% Reduction of MSW, going to landfills.
4. Creation of Renewable Energy.
5. Reduction of Greenhouse Gases and other environmental pollutants.
6. Municipalities do not have to undergo cost of implementation; privatized via BOOT (Build, Own, Operate & Transfer).
7. Due to the profitability of the proposal, significant savings could be passed onto the Municipalities, to reduce their day to day on going expenses for Municipal Waste Management, for the duration of the BOOT (30 years), of approximately 50%, per annum, via MSW Tipping Fees. This surplus in savings can be used for other social and infrastructural programs.
8. Employment opportunities are created during the EPC (Engineering, Procurement & Construction) of the project (a few hundred jobs) and for the day to day operations of the project (approximately 86 jobs per shift per 2,000 TPD Plant plus 11 persons for administration X 3 shifts per, equating to a total quantum of a minimum of 269 persons).
9. The proposed solution is an integrated MSW management system based on energy recovery that respects the norms of a Clean Design Mechanism (CDM) inherent within the realms of article 12 of the Kyoto Protocol (UNFCCC), and qualifies for Carbon Emissions Reduction Credits (CER's). BioCrude will donate 10% of the CER's to a foundation for Children that BioCrude will create (BioCrude's Save our Children's foundation") for education, health care and social services, via a revenue sharing agreement, every year for the duration of the term. The foundation can also incorporate assistance to single mothers.

We firmly believe that our products and processes are viable, beneficial, and cost effective ingredients in any Residual (Waste) Management Plans or Systems of implementation. Our technology is easily scalable and can be customized for all individual needs.

To further put things into perspective, I would like to address the following: we are addressing the Municipal Solid Waste (MSW) issue of Lusaka, Zambia, which is <u>not</u> a homogenous feedstock (cute waste). There are different types of waste (MSW, agricultural, sewage sludge, toxic waste, tires, automotive shredded refuse and medical waste, amongst others). Each type of waste requires a treatment process, tailor made to optimally treat same in an environmentally benign manner. BioCrude's proposal to Lusaka is geared to remedy the Municipal Solid Waste (MSW) generated on a day to day basis.

Understanding the non-homogenous nature and characteristics of the waste, we can define distinct processes to handle the varied categories of waste (MSW can be classified into organics, fuels, recyclables, inerts and others), once segregated with an efficient separation process. BioCrude stands out from the competition in its knowhow, composting and fungal technologies, in order to maximize the outputs of procurement, as well as minimize actual energy inputs with respect to the ongoing concern of MSW-Energy procurement process complex.

Municipal Solid Waste (MSW)

All solid waste generated in an area except industrial and agricultural wastes, typically from residences, commercial or retail establishments. Sometimes includes construction and demolition debris and other special wastes that may enter the municipal waste stream. The EPA (1998c) defined municipal solid waste as "a subset of solid waste and as durable goods (e.g., appliances, tires, and batteries), non-durable goods (e.g., newspapers, books, and magazines), containers and packaging, food wastes, yard trimmings, and miscellaneous organic wastes from residential, commercial and industrial non-process sources.

The MSW can be classified in the following categories:

a) Organics
b) Fuels
c) Recyclables
d) Inerts
e) Miscellaneous

Each category has its own distinct composite classification. To achieve an optimal Waste to Energy procurement, one has to analyze separately the inherent category contributions to energy yield and its correlated technological process of extraction in obtaining same in the most economical sense available; thus, the importance of segregating the MSW into the appropriate categories of distinct feedstock is of principal importance for optimal performance in the appropriate technological processes.

In the MSW-Energy report that was prepared for the Municipality of Lusaka, Zambia Republic, and BioCrude Technologies, Inc. incorporated the following technologies in the Integrated Municipal Waste Processing (Waste to Energy) Complex:

1. Separation of Waste Facility
2. RDF (Refuse Derived Fuel) Plant in order to handle the fuels of the MSW and produce Energy with an ash by-product
3. Bio-Methanation Plant in order to handle the organic fraction of the MSW (OFMSW) to produce Energy with a fertilizer by-product
4. Composting Facility (maximum 50 TPD) in order to handle a percentage of the OFMSW alongside with the small particles (plastics, ceramics...) that could not be efficiently separated within the separation process of the MSW (fuels in the Bio Methanation plant (plug flow digester) inhibit the process). The economies are no longer apparent in Composting facilities surpassing the 50 TPD capacities.
5. Power Plant

It is very important to note that the Separation Process of the MSW into the appropriate feedstocks for each distinct process is of the utmost importance. Failure to do so can lead to complications and inevitable failure of each process in question. Evidence of Success and failure stories (especially with biomethanation plants, whereby the feedstock generated from MSW (organic fraction) had traces of more than 10% of polymer based products and/or inerts, thus inhibiting and/or limiting the viability of same) as can be found all over the world, and each outcome, in essence, can be summarized by Plant Technology Implementation and Feedstock Preparation (do not mix up technology viability with technology implementation and operation).

Nota Bene: With gasification and/or incineration (mass burn), MSW is dumped into the boiler as-is and combusted at temperatures ranging from 800 – 1200 ^{0}C (minimum; plasma arc gasification temperatures range from 7,000 – 10,000 ^{0}C). All waste is burned yielding an approximate net yield of energy for reuse (after self-consumption) of 30 – 40%. The organic fraction of the MSW (OFMSW) is burned, whereby the fertilizer potential via a biomethanation process (cooking) is substituted for an ash from the gasification / incineration process (es). Let us not even entertain what happens to the methane potential of same via gasification / incineration in lieu of biomethanation. Bottom line "Potential Revenues" lost and operational costs of gasification / incineration processes are increased dramatically. One can do their own sensitivity analysis to evaluate same and come to their own conclusions! BioCrude's Integrated MSW-Energy Solution evolves from first principles of Science, Chemistry, Engineering, Economics and Common Sense!

The Organics portion of the MSW is treated via a biomethanation process, whereby all methane gas is extracted for the eventual realization of renewable energy creation, and a fertilizer procured as an additional by-product, which can be marketed to the agricultural industry.

The polymer-based (plastics, thermocol, etc…) and textiles portion of the MSW will be treated via an RDF process (a derivative of gasification, but with the incorporation of a Materials Recovery Facility (MRF) and a Separation process, we have the luxury of operating at lower temperatures (350 – 400^{0}C), i.e. lower temperatures reflects less operational self-consumption, hence more outputs (energy) for resale), whereby the thermal combustion will generate renewable energy and the by-product of ash can be marketed to the construction industry for the following purposes:

- Concrete production, as a substitute material for Portland cement and sand
- Embankments and other structural fills (usually for road construction)
- Grout and Flowable fill production
- Waste stabilization and solidification
- Cement clinkers production - (as a substitute material for clay)
- Mine reclamation
- Stabilization of soft soils
- Road sub base construction
- As Aggregate substitute material (e.g. for brick production)
- Mineral filler in asphaltic concrete
- Agricultural uses: soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards, and agricultural stakes
- Loose application on rivers to melt ice
- Loose application on roads and parking lots for ice control
- Other applications include cosmetics, toothpaste, kitchen counter tops, floor and ceiling tiles, bowling balls, flotation devices, stucco, utensils, tool handles, picture frames, auto bodies and boat hulls, cellular concrete, geopolymers, roofing tiles, roofing granules, decking, fireplace mantles, cinder block, PVC pipe, Structural Insulated Panels, house siding and trim, running tracks, blasting grit, recycled plastic lumber, utility poles and cross arms, railway sleepers, highway sound barriers,

marine pilings, doors, window frames, scaffolding, sign posts, crypts, columns, railroad ties, vinyl flooring, paving stones, shower stalls, garage doors, park benches,

The fly ash can also be marketed to the agricultural industry for the following purposes:

- It improves permeability status of soil
- Improves fertility status of soil (soil health) / crop yield
- Improves soil texture
- Reduces bulk density of soil
- Improves water holding capacity / porosity
- Optimizes pH value
- Improves soil aeration and reduces crust formation
- Provides micro nutrients like Fe, Zn, Cu, Mo, B, Mn, etc.
- Provides macro nutrients like K, P, Ca, Mg, S etc.
- Works as a part substitute of gypsum for reclamation of saline alkali soil and lime for reclamation of acidic soils
- Surface cover of bio reclaimed vegetated ash pond get stabilized and can be used as recreational park
- Ash ponds provides suitable conditions and essential nutrients for plant growth, helps improve the economic condition of local inhabitants
- Works as a liming agent
- Helps in early maturity of crop & improves the nutritional quality of food crop
- Reduces pest incidence
- Conserves plant nutrients / water

There is a definite market for the fly ash by-product; the industry players in the global market place have to be clearly identified for the realization of commercialization. BioCrude can even offer this ash by-products pro-bono to the industry or landfill, for there is no environmental hazard of same.

The recyclables can be easily sold to the recyclable industry milieu (metals, glass, ceramics, etc…)

The balance of the inerts (Construction and Demolition Debris, gravel, sand, bricks, etc…) can either be landfilled with no negative environmental impacts, or crushed and given to companies specializing in the fabrication of construction materials (if a market is identified, BioCrude can offer them these by-products (crushed or uncrushed).