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Date: 7.1.2019

The Member Secretary

Thermal Power Commitee

Ministry of Environment, Forests and Climate Change

Govt. of India, Indira Paryavaran Bhavan,

Jor Bagh Road, New Delhi-110003

Proposal No: IA/DL/THE/84113/2018

Reference: Query Letter Number J-13012/13/2018-IA.I (T) dated 31.12.2018.

Subject: Reply of queries for the project 55 MW Waste to Energy Power Plant based on 200 TPD Municipal Solid Waste using Cold Plasma Technology at East Delhi Municipal Corporation Opp. Gagan Theatre, Wazirpur Road, Mandoli Extension, Village Mandoli, Delhi by M/s A.G. Dauters Waste Processing Private Limited- reg. Terms of Reference

Dear Sir,
With reference to the above-mentioned subject, following queries vide letter no. J-13012/13/2018-IA.I (T) dated 31.12.2018. Thus, we are hereby submitting the reply of queries raised for Grant of Terms of Reference.

S. No.	Queries raised	Reply
1.	It has been noted that you have proposed 55 MW waste to energy power project from 200 tons/day Municipal Solid Waste. The proposed is based on cold plasma gasification technology which will convert MSW into 55 MW of green power, 30 KLD purified water and 30 KLD fuel. The proposal has been considered the EAC Thermal) in its 23rd meeting held on 30.11.2018. The EAC has deferred the project for want of detail project report along with the technology including the material balance. In view of this it is requested that the information be submitted within two weeks for further consideration.	The detailed project report along with technology and material balance is enclosed as Annexure-I.

Hope this will fulfil the Requirement and kindly do the needful.

Thanking you

Yours faithfully

(Authorized Signatory)

A.G. Dauters Waste Processing Pvt. Ltd. New Delhi

AG Dauters Waste Processing Private Limited
B2, Dhawan Deep Building, 6 Jantar Mantar Road, New Delhi-110001, India
Phone : +91-11-9811573730 · email : ajay@agdauters.com
www.agdauters.com

Annexure I

The detailed project report along with technology and material balance

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Development of
55 MW Waste to Energy (WTE) Plant
at Ghazipur SLF, East Delhi • New Delhi
for East Delhi Municipal Corporation
on “BOOM” basis

•

Project Report
Dec 2018

TABLE OF CONTENTS

BACKGROUND

Waste is viewed as a discarded material, which has no consumer value to the person abandoning it. According to Solid Waste Management Rules 2016, the term 'solid waste' means and includes solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non-residential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, agriculture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, bio-medical and e-waste, battery waste, radio-active waste. Uncontrolled waste dumping or waste disposed in unscientific landfills can have serious environmental impacts: landfills consume land space, and cause air, water and soil pollution. Growing population, increased urbanization rates and economic growth are dramatically changing the landscape of domestic solid waste in terms of generation rates, waste composition and treatment technologies.

Historically, open dumps were commonly located on the fringe of urban development and as the cities developed, the urban fringes moved beyond the open dumps brining residential and commercial development within close proximity of the open dump. This brought about a conflict in land use with dumps being considered incompatible with these uses, raising community and regulatory concerns and calling for its rehabilitation. (**Source: Asian Regional Research Programme on Sustainable Solid Waste Landfill Management in Asia**).

Without an effective and efficient solid-waste management program, the waste generated from various human activities, both industrial and domestic, can result in health hazards and have a negative impact on the environment. Understanding the waste generated, the availability of resources, and the environmental conditions of a particular society are important for developing an appropriate waste-management system.

The Ghazipur Landfill site located in the East Delhi caters to population of over 50 lacs came into existence before 1984 and has grown exponentially creating a huge mountain of garbage. Delhi is currently facing the problem of management of its solid waste. East Delhi generates about 2200 tonnes of solid waste per day and 13 million tonnes of legacy waste is lying in the Ghazipur landfill area. This landfill site caters to other parts of city as well. The infrastructure of East Delhi has been able to keep pace with economic development and population growth with poor collection of MSW and over-burdened dumps at different places. Improper disposal of solid wastes over several decades and open burning of garbage have led to serious environmental pollution and health problems. Given its increasing population, rapid expansion of urban areas, and scarcity of land. Delhi needs a solution to its burgeoning solid waste management problem that will be sustainable, cost effective, and minimizes public health, ecological, and climate change impacts.

The total geographical area of the landfill is 1,17,358 Square meters. It is situated at an average elevation of 206 meters between 28º37’35.94” N and 77º19’40.62” E. The maximum height of dump at Ghazipur is over 70 meters.

The present project proposed is for processing of 200 TPD Legacy waste by way of Waste to Energy (WTE) project at Ghazipur SLF site, East Delhi. 2000 KLD of wastewater flowing in nearby drain will also be pumped in the system.

LANGENBURG TECHNOLOGY

Technical Details

1. We are the India partners of Langenburg Technologies LLC, USA. We have developed the most advanced Waste – to - Energy (WTE) technology in the world which has been proven over the last 10 years & we convert any kind of Waste into Power, drinking water & Fuel Our Technology is integrated, modular and scalable. Each system can be operated independently or together in a variety of configurations, adaptable to a broad range of portable and on-site applications. The systems purify water up to medical grade; fuel is extracted from the water and its pollutants to generate electric power and plasmas for disintegration and destruction of solid & toxic wastes.

2. We provide Global Sustainable Solutions for:
    - Processing Solid waste & Liquid Waste
    - Industrial Effluents & Toxic Wastes
    - Generating Green power
    - Purifying & Desalinating Seawater
    - Portable Frack Water Processing

Waste and Products

SN	City	LEGACY WASTE (tons)		AGD - LANGENBURG PROPOSITION			
				OUR PROPOSITION	GREEN POWER (MW)	DRINKING WATER (KLD)	FUEL (KLD)
a1	East Delhi	200		WTE	55	925	925

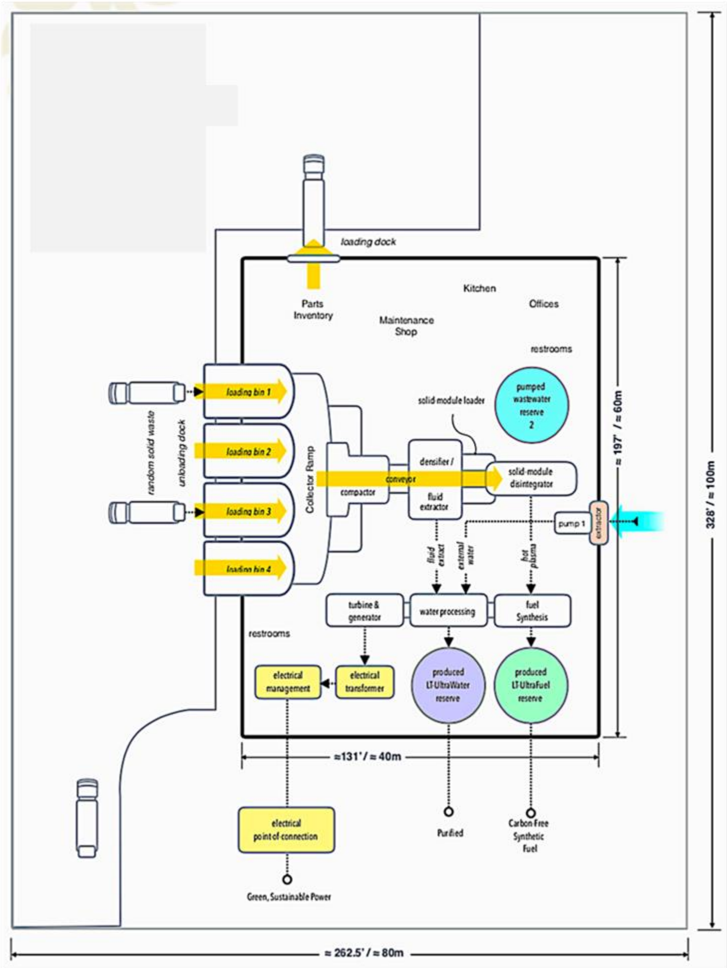
The above chart very clearly shows the potential of the waste and how East Delhi could become self-sustainable to certain extend; a city which generates its own Power, drinking water & fuel.

Following are the specs of the project being proposed at East Delhi

Pilot WTE Plant	:	To process Legacy Waste (Municipal) at East Delhi
Waste Status	:	Legacy Waste
Composition	:	Unsegregated & Inert
Capacity	:	200 tons
WTE Technology	:	LT Cold Plasma Gasification
Emissions	:	Zero (only waters vapors & warm air at 34˚ C)
Residue	:	5-30 Tonnes
Business Model	:	BOOM (Built – Own - Operate – Maintain)
Area required for Plant	:	3 acres
Location	:	At the dump site in East Delhi
Useful Energy outputs	:	• Power: 55 MWh • Drinking Water: 925 KLD • Fuel: 925 KLD
Land for inert disposal	:	Nil
Investment	:	100% self-funded
VGF	:	Not required
Concession period	:	25 years (extendable on mutual terms)
Plant Setup time	:	9 – 12 months

Figure 1: - Proposed conceptual site plan

INFLOW:
Any/all Solid Waste
OPTIONAL INFLOW:
Any/all wastewater (toxic/hazmat/medical/pharmaceutical/frack-water)
OUTFLOW:
Electrical Power
OPTIONAL OUTERFLOWS:
LT-Ultrawater™; LT-Ultrafuel™
OPTIONAL ONSITE RESERVE STORAGE:
LT-Ultrafuel™, LT-Ultrafuel ™, Inflow Wastewater

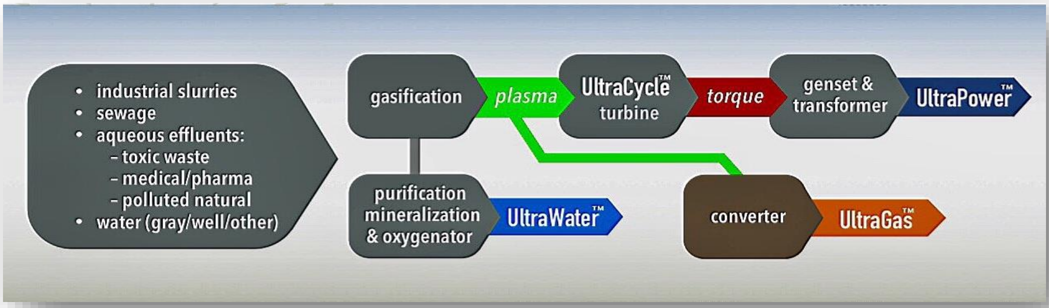


(NOT TO SCALE)

Figure 2 :- Process flow of Our Technology

NOTE- Plasma Rock, a by-product @ 2.5-15% would be generated.

Figure 3: - Simplified WTE Process Flow



Under the direction of, and by the innovations of Dr. Max Langenburg, Langenburg Technologies has over 40 years of R&D with extensive manufacturing capabilities and strategic alliances. Langenburg Technologies uses the most highly advanced water purification and plasma gasification, simultaneously producing clean fuel and electric power. This process is significantly more efficient, producing fuel in much larger volumes than similar technologies.

Figure 4: - Artistic impression of the Proposed Layout

3. Specifications of the input materials required for the sustenance of the plant:

- Waste Water Effulents ; plants are configured to handle any of the following
  - i. Municipal Solid Waste
  - ii. Sewage
  - iii. Sludges
  - iv. Heavy metal polluted water
  - v. Industrial / mining waste – solid & liquid
  - vi. Industrial brine
  - vii. Natural freshwater, river / lagoon / pond / lake / well
  - viii. Ocean / sea water
  - ix. Any constituent solution / suspension / slurry
  - x. Pharma / medical waste
  - xi. Industrial; heavy metal / toxic hazmat
  - xii. Oil frack-well water / tar-sand extraction chemicals
  - xiii. Hydroponics waste water
  - xiv. Fly-ash / bottom ash

- The broad parameters of our three outputs which we create are :
  - i. Solid Waste/Slag: from 01 – 05 TPD
    1. 01 MWh of green power
    2. Drinking water
    3. Fuel
  - ii. Sewage/ Effluent : from 01 mld
    1. 10 MWh of green power
    2. Drinking water
    3. Fuel

(Input-Output Matrix may vary depending upon conditions.)

4. Every conceivable impurity removed

- Microbiological Contaminants.
- Harmful & Mineral contaminants.
- Hydrocarbon Contaminants.
- Metal contaminants.
- Undesirable pollutant isotopes & isomers of water.

5. Green Power produced from our plant is :

- Configurable to any global standard ("high-tension") synchronized power-grid voltage.
- Typical voltages for India are 220/400/775 kV, however, there are newer installations for 1200 kV substations, of which LT power units can meet this standard.
- Configurable to any global standard frequency. We specify 50-60 Hz. In our load-bank test, 3-phase AC was developed at 50 Hz. Effectively, the frequency can be considered "dynamic", self-adjusting and self-correcting.
- LT generators available as 10/40/100/175/280 MW - easily configurable as modular components to any capacity (even in several GW).
- Multiple LT generator output terminals, one for each phase-angle (0/120/240 degree), plus one neutral. Four terminals total.
- LT generators don't use magnetic inductance to produce power, so any parameter related to synchronous reactance isn't relevant. Effectively, the impedance can be considered "dynamic", self-adjusting and self-correcting.

6. Langenburg Oxygen Water created is

- pH balanced – optimum 7.7
- Mineral Balanced
- Structurally Restored
- Micro clustered for Hydration
- Highly advanced purification
- High levels of stable monoatomic oxygen in addition to other salutary forms O_2, O_4, O_5, O_6 and O_7.

7. Water is Optimized

- Zeta Potential Optimization.
- Balancing of Minerals.
- Restoration and stabilization of natural liquid and crystalline properties.
- Relaxing waters electromagnetic qualities.
- Water micro cluster size minimization towards molecular levels.
- All Oxygen molecule types and sources levels optimized: Monoatomic, Diatomic, O_4, O_5, O_6, O_7.
- Seven-Sided Crystal Oxygen – crown jewel of Langenburg.
- Incorporation of resonance energies.

8. Water Purification Test: Following are the test reports of water produced from our plant;

Figure 5A: - Water Purification Test Reports

Grants Pass
Water Lab

"Fast & Reliable Water Testing Since 1978"

964 SE M Street · Grants Pass, OR 97526 · 541-476-0733 · www.gpwaterlab.com · ORELAP# OR100033

Mail To:

Attn: Dr. David Orr, Langenburg Technologies
1704 W. 2nd Ave.
Eugene, OR 97402

Date:	October 05, 2016
Address of Source:	Langenburg Technologies, LLC
Sample ID #:	21603477
Project Name:	LT-TW-092216 UT

Analysis Report

The following results pertain only to the samples submitted, and are for the sole and exclusive use of the above named client.

This report shall not be reproduced, except in full, without written approval of the laboratory.

The following accredited results meet all requirments of ISO/IEC17025:2005 unless otherwise noted by data flag indicators or comments.

The color coded key is only a guide for interpreting results. All evaluations should be compared to the limitations set by the EPA and/or your primary care physician.

Please do not hesitate to call to discuss results or ask any questions. We are at your service!

Sincerely,

Jessica Stark

Jessica Stark
Senior Chemist

AG Dauters

Figure 5 B:- Water Purification Test Reports

Before Process

Sample Information

Sample ID:	**21603477**	Collectors Name:	Paul Reynolds
Address of Source:	Langenburg Technologies, LLC	Sample Point:	BEFORE
Project Name:	LT-TW-092216 UT	Source:	Waste Water
Received Date:	09/26/2016	Treatment System:	None

Results of Chemical Analysis

Sample Notes: Collection Date: **09/22/16 1:00 PM**

Contaminate	Method	LOQ	RESULTS	Units	EPA Limit	Date Analyzed	Analyst	ID	Data Flags
Aluminum	EPA 200.7	0.04	**4.5972**	mg/L	0.05-0.2	09/28/16 9:51 am	JNS	AC	A,C
Arsenic	SM 3113 B	0.004	**0.1255**	mg/L	0.01	09/28/16 6:11 am	JNS	AD	A,C
Barium	EPA 200.7	0.003	**1.3573**	mg/L	2.0	09/28/16 9:51 am	JNS	AF	A,C
Beryllium	EPA 200.7	0.003	**ND**	mg/L	0.004	09/28/16 9:51 am	JNS	AG	A,C
Boron	EPA 200.7	0.03	**0.5327**	mg/L	5.5	09/28/16 9:51 am	JNS	AE	A,C
Cadmium	EPA 200.7	0.003	**0.0304**	mg/L	0.005	09/28/16 9:51 am	JNS	AI	A,C
Calcium	EPA 200.7	0.3	**498.31**	mg/L		09/28/16 7:59 am	JNS	AH	A,C
Chloride	EPA 300.0	0.5	**32960.5**	mg/L	250	09/26/16 8:31 pm	JNS	AJ	E,A,C
Chromium	EPA 200.7	0.015	**0.0875**	mg/L	0.1	09/28/16 9:51 am	JNS	AM	A,C
Cobalt	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:59 am	JNS	AK	AA,C
Conductivity	SM 2510 B	1.0	**90000.0**	umhos/cm	700	09/28/16 1:38 pm	JNS	AL	C
Copper	EPA 200.7	0.006	**0.2667**	mg/L	1.3	09/28/16 9:51 am	JNS	AN	A,C
Fluoride	EPA 300.0	0.5	**ND**	mg/L	4.0	09/26/16 8:31 pm	JNS	AP	A,C
Iron	EPA 200.7	0.03	**3.8409**	mg/L	0.3	09/28/16 9:51 am	JNS	AO	A,C
Lead	SM 3113 B	0.01	**0.1109**	mg/L	0.015	09/28/16 6:22 am	JNS	AZ	A,C
Lithium	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:59 am	JNS	AS	AA,C
Magnesium	EPA 200.7	0.3	**27.62**	mg/L		09/28/16 7:59 am	JNS	AT	A,C
Manganese	EPA 200.7	0.03	**3.1410**	mg/L	0.05	09/28/16 9:51 am	JNS	AU	A,C
Molybdenum	EPA 200.7	0.06	**ND**	mg/L		09/28/16 9:51 am	JNS	AV	A,C
Nickel	EPA 200.7	0.015	**0.1170**	mg/L	0.1	09/28/16 9:51 am	JNS	AX	A,C
Nitrate	EPA 300.0	0.5	**ND**	mg/L	10	09/26/16 8:31 pm	JNS	AY	H,A,C
pH	EPA 150.1		**10.51**	S.U.		09/26/16 4:13 pm	JNS	BA	H,C
Potassium	EPA 200.7	0.3	**466.77**	mg/L		09/28/16 7:59 am	JNS	AR	A,C
Selenium	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:59 am	JNS	BB	A,C
Silver	EPA 200.7	0.015	**ND**	mg/L		09/28/16 9:51 am	JNS	AB	A,C
Sodium	EPA 200.7	3.0	**24607.30**	mg/L		09/28/16 7:59 am	JNS	AW	A,C
Sulfates	EPA 300.0	0.5	**439.21**	mg/L		09/26/16 8:31 pm	JNS	BC	A,C
Total Hardness	SM 2340B	2.0	**1358.0**	mg/L		09/28/16 8:40 am	JNS	AQ	C
Vanadium	EPA 200.7	0.015	**0.0763**	mg/L		09/28/16 9:51 am	JNS	BD	A,C
Zinc	EPA 200.7	0.06	**1.7415**	mg/L		09/28/16 9:51 am	JNS	BE	A,C

DEFINITIONS AND DATA FLAGS

A	Analysis is covered under ORELAP scope of Accreditation
AA	Analysis is covered under ISO scope of Accreditation
C	Sample did not meet acceptance criteria
H	Analysis performed outside method hold time
ID	Subsample identifier for each Sample number
M	Matrix Spike recovery is out of control limits due to matrix interference The LCS was in acceptace limits showing the analysis is in control and the data is acceptable
E	Estimated Value
LOQ	Reporting Limit
N/A	Not Applicable
ND	None Detected
S	Sample Outsourced

Results Color Key

- White - No EPA Limit
- Low Risk within EPA Limit
- Medium Risk
- High Risk Exceeds EPA Limit
- Call the Lab to Discuss

Figure 5 C: - Water Purification Test Reports

After Process

Sample Information

Sample ID:	**21603478**	Collectors Name:	Paul Reynolds
Address of Source:	Langenburg Technologies, LLC	Sample Point:	AFTER
Project Name:	LT-TW-092216 T	Source:	Waste Water
Received Date:	09/26/2016	Treatment System:	None

Results of Chemical Analysis

Sample Notes: Collection Date: **09/26/16 1:45 PM**

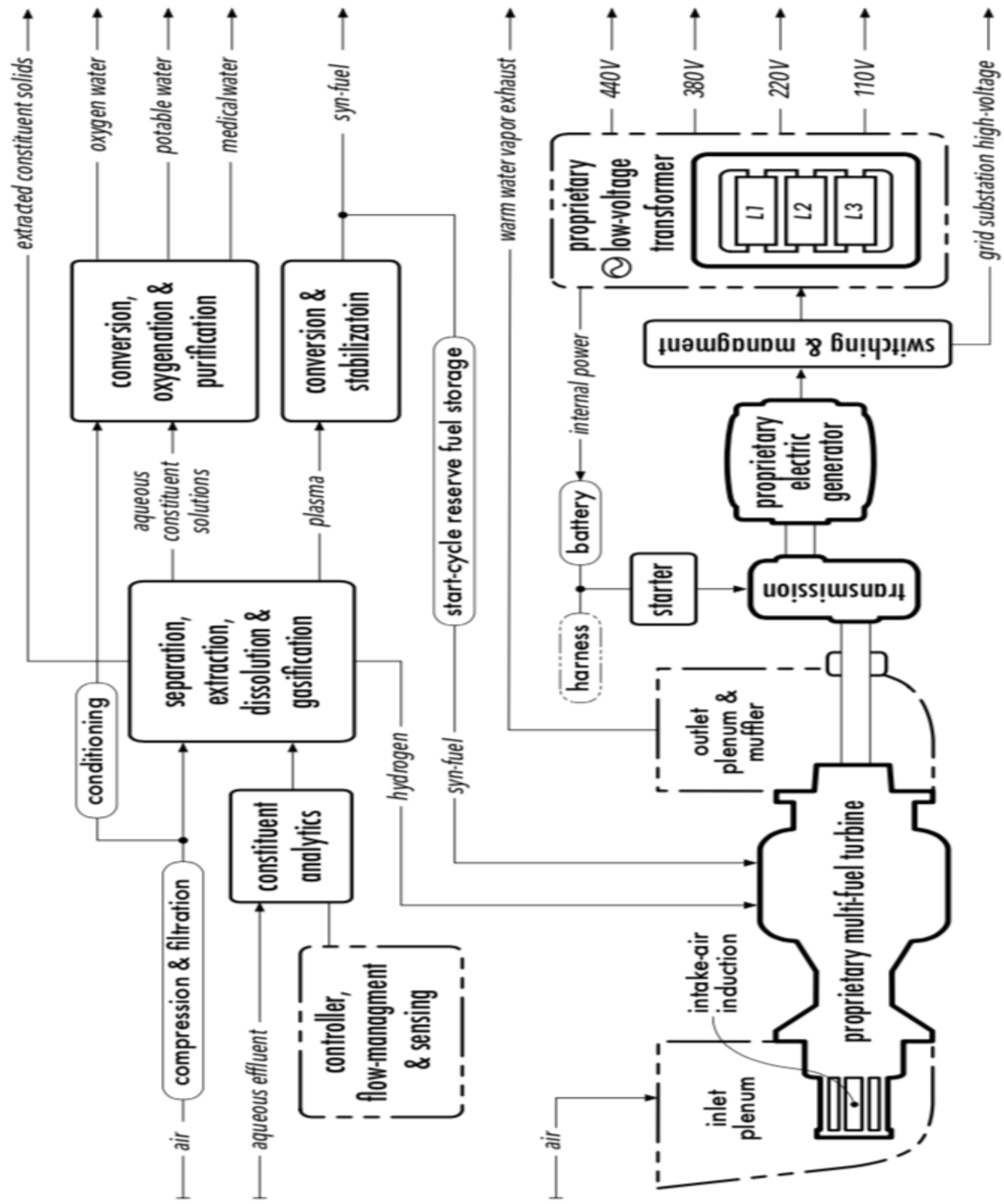
Contaminate	Method	LOQ	RESULTS	Units	EPA Limit	Date Analyzed	Analyst	ID	Data Flags
Aluminum	EPA 200.7	0.04	**ND**	mg/L	0.05-0.2	09/28/16 9:54 am	JNS	AC	A,C
Arsenic	SM 3113 B	0.004	**ND**	mg/L	0.01	09/28/16 6:11 am	JNS	AD	A,C
Barium	EPA 200.7	0.003	**ND**	mg/L	2.0	09/28/16 9:54 am	JNS	AF	A,C
Beryllium	EPA 200.7	0.003	**ND**	mg/L	0.004	09/28/16 9:54 am	JNS	AG	A,C
Boron	EPA 200.7	0.03	**ND**	mg/L	5.5	09/28/16 9:54 am	JNS	AE	A,C
Cadmium	EPA 200.7	0.003	**ND**	mg/L	0.005	09/28/16 9:54 am	JNS	AI	A,C
Calcium	EPA 200.7	0.3	**ND**	mg/L		09/28/16 7:29 am	JNS	AH	A,C
Chloride	EPA 300.0	0.5	**ND**	mg/L	250	09/26/16 8:48 pm	JNS	AJ	A,C
Chromium	EPA 200.7	0.015	**ND**	mg/L	0.1	09/28/16 9:54 am	JNS	AM	A,C
Cobalt	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:29 am	JNS	AK	AA,C
Conductivity	SM 2510 B	1.0	**15.7**	umhos/cm	700	09/28/16 1:38 pm	JNS	AL	C
Copper	EPA 200.7	0.006	**ND**	mg/L	1.3	09/28/16 9:54 am	JNS	AN	A,C
Fluoride	EPA 300.0	0.5	**ND**	mg/L	4.0	09/26/16 8:48 pm	JNS	AP	A,C
Iron	EPA 200.7	0.03	**ND**	mg/L	0.3	09/28/16 9:54 am	JNS	AO	A,C
Lead	SM 3113 B	0.01	**ND**	mg/L	0.015	09/28/16 6:22 am	JNS	AZ	A,C
Lithium	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:29 am	JNS	AS	AA,C
Magnesium	EPA 200.7	0.3	**ND**	mg/L		09/28/16 7:29 am	JNS	AT	A,C
Manganese	EPA 200.7	0.03	**ND**	mg/L	0.05	09/28/16 9:54 am	JNS	AU	A,C
Molybdenum	EPA 200.7	0.06	**ND**	mg/L		09/28/16 9:54 am	JNS	AV	A,C
Nickel	EPA 200.7	0.015	**ND**	mg/L	0.1	09/28/16 9:54 am	JNS	AX	A,C
Nitrate	EPA 300.0	0.5	**ND**	mg/L	10	09/26/16 8:48 pm	JNS	AY	H,A,C
pH	EPA 150.1		**5.97**	S.U.		09/26/16 4:13 pm	JNS	BA	H,C
Potassium	EPA 200.7	0.3	**ND**	mg/L		09/28/16 7:29 am	JNS	AR	A,C
Selenium	EPA 200.7	0.03	**ND**	mg/L		09/28/16 7:29 am	JNS	BB	A,C
Silver	EPA 200.7	0.015	**ND**	mg/L		09/28/16 9:54 am	JNS	AB	A,C
Sodium	EPA 200.7	3.0	**ND**	mg/L		09/28/16 7:29 am	JNS	AW	A,C
Sulfates	EPA 300.0	0.5	**ND**	mg/L		09/26/16 8:48 pm	JNS	BC	A,C
Total Hardness	SM 2340B	2.0	**ND**	mg/L		09/28/16 8:40 am	JNS	AQ	C
Vanadium	EPA 200.7	0.015	**ND**	mg/L		09/28/16 9:54 am	JNS	BD	A,C
Zinc	EPA 200.7	0.06	**ND**	mg/L		09/28/16 9:54 am	JNS	BE	A,C

DEFINITIONS AND DATA FLAGS

A	Analysis is covered under ORELAP scope of Accreditation
AA	Analysis is covered under ISO scope of Accreditation
C	Sample did not meet acceptance criteria
H	Analysis performed outside method hold time
ID	Subsample identifier for each Sample number
M	Matrix Spike recovery is out of control limits due to matrix interference The LCS was in acceptace limits showing the analysis is in control and the data is acceptable
E	Estimated Value
LOQ	Reporting Limit
N/A	Not Applicable
ND	None Detected
S	Sample Outsourced

Results Color Key
- White - No EPA Limit
- Low Risk within EPA Limit
- Medium Risk
- High Risk Exceeds EPA Limit
- Call the Lab to Discuss

9. Figure 6: - Detailed Flow Schematics with unit operations and conditions.



- Our plant is fine tuned to take in various kinds of raw materials as inputs (list of inputs given in point 3). Each LT water and Power system has multiple components to meet the output requirements of any project.
    i. **Waste Treatment**: As waste enters the system its physical and chemical characteristics are identified, recorded and tracked in real time, allowing the master control unit to modify/monitor subsequent processing, including feedback loops to continually meet the output requirements. The waste stream is re-screened and separated into solids and liquids. The solids are processed through multiple stages including grinding and liquefaction and further extraction of water/fluids. All particulate constituents are reduced, gasified and/or converted into LT fuels within the LT Plasma Unit.

    ii. **Waste Purification:** In the LT water purification process, liquid constituents are clarified through heat, pressure and proprietary processes leading to pure sterilized water. The remaining solids (down to microscopic level) are rerouted through the plasma unit. The resulting water is recalculated through a range of temperatures, pressure and catalyst processes that introduce and infuse oxygen from the LT Gas Extraction Unit, Balance pH and refine output water. Heat and electric power for this process comes from the LT turbine generator.

    iii. **Gas Extraction**: A fraction of the water is sent to the LT gas extraction system where a proprietary low-input-energy form of electrolysis is used to develop hydrogen and oxygen. These gases are stabilized using proprietary processes and catalysts – made available on demand to the LT water treatment unit, the LT Plasma process and the LT Turbine.

    iv. **Turbine Generator**: The turbine powers up in 60 seconds or less. It includes multiple modifications from standard turbines allowing the use of LT fuels (from gas extraction and plasma fuel synthesis). It is also modified to recapture and recirculate much normally wasted energy (turbulence and heat) allowing cooler operation, reduced heat distortion and vibration resulting in minimal war of components for safe long-term performance. The LT generator is uniquely designed (materially mechanically and electrically) to neutralize the negative loads and resistance that standard generators encounter. Thus, it has a higher power density than any other systems and in tandem with the proprietary LT transformer it produces typical 3-phase alternating current (AC) at 50Hz and 60Hz and is fully compatible with international performance & power standards.

    v. **Fuel Synthesis**: LT plasma is fully integrated into the treatment of all wastes and the production of proprietary, high energy, clean, hydrogen-based fuels.

10. SCIENCE BEHIND TECHNOLOGY

To understand the Mass Balance and the Energy Balance of Langenburg Technology, following is the scientific research on which is based.

BACKGROUND

The scientific background of Langenburg Technologies Waste-to-Power and Water Purification Technology is described in white papers (Abstract enclosed). The first of these papers outlines the physics of energy exchange with the quantum vacuum which is well accepted in the academic area of atomic and subatomic particle physics. This paper describes the relevant physical framework regarding negative temperature and negative mass; it provides the basis for analyzing the phenomenon of interactions between positive energy and negative energy waves. Further scientific paper outlines the role of quantum vacuum in the structure and behavior of matter fermions and bosons/particles and waves; and address the physics of Langenburg Technologies.

These papers refer to international scientific publication of third-party authors from prestigious research organizations. The references cited in the papers were examined and represent the scientific verification of general functionality of the Langenburg Technologies Waste-to-Power and Water Purification Technology.

❖ Quantum Physics- Scientific Context for Langenburg Technologies

- The laws of thermodynamics consider a system's energy flow, and that no system can be 100% efficient due to mechanical and thermodynamic losses (entropy). Entropy refers to energy in a system that becomes diffused, chaotic, scattered, radiated and therefore is irretrievable/ lost to come back into useable mechanical work.

- A new context is required to successfully analyze any system of energy utilizing subatomic forces and quantum electrodynamics, especially those utilizing feedback loops in a hydrodynamic configuration. Industrial systems generally follow "linear" processes (input-process-output) that can be described using classical physics. For example, a jet turbine engine operating under the Brayton Heat Cycle resembles a linear system: intake-compression-combustion-exhaust. However, a system utilizing internal feedback, recirculation, subatomic reactions and quantum electrodynamics, can only be fully described with quantum physics.

- Quantum Principals and associated mathematics date back more than a century, and recently it has become academically acceptable to cite the motive-force (prime-mover) in a mechanical electro-mechanical system, as the quantum vacuum. Quantum mechanics which have historically been considered fringe, strange, and even pseudo-science now are very relevant to particle physics, particle accelerations, and various anomalous forces.

- Using only water-based input, a case is made from Langenburg's produced output capacity that extends beyond thermodynamic calculation- for example, it's well known that water expands upon freezing, capable of bursting rigid metal waterpipes in plumbing applications. As heat radiates out (entropy) of water, an anomalous force is exerted through the ice as the crystal geometry morphs during dendrite formation. The result is in a nearly unstoppable, 9-22% volumetric expansion upon freezing. This force acting upon the crystal matrix is die to a collective "quantum acoustic" excitation within the hydrogen bond matrix, called "phonons".

❖ Langenburg Technologies and the Quantum Vacuum

The quantum vacuum has become the focus of numerous experiments and peer-reviewed, published papers. Reasons have been:

i. Nano-technology and nano-machines are subject to the processes of the vacuum and these forces must be accounted for in system design.

ii. The Casimir effects, specifically, the dynamic Casimir effect, is the subject of numerous experiments to understand the process of matter and energy extraction from the vacuum. The theories of the particle physics implicitly, or explicitly incorporate the provisions that all matter are condensations from the quantum vacuum.

iii. Anomalous discharges of energy in electrical, plasma and hydrodynamical systems- reported in scientific literature- are explained in terms of negative energy and negative energy waves emanating from the vacuum.

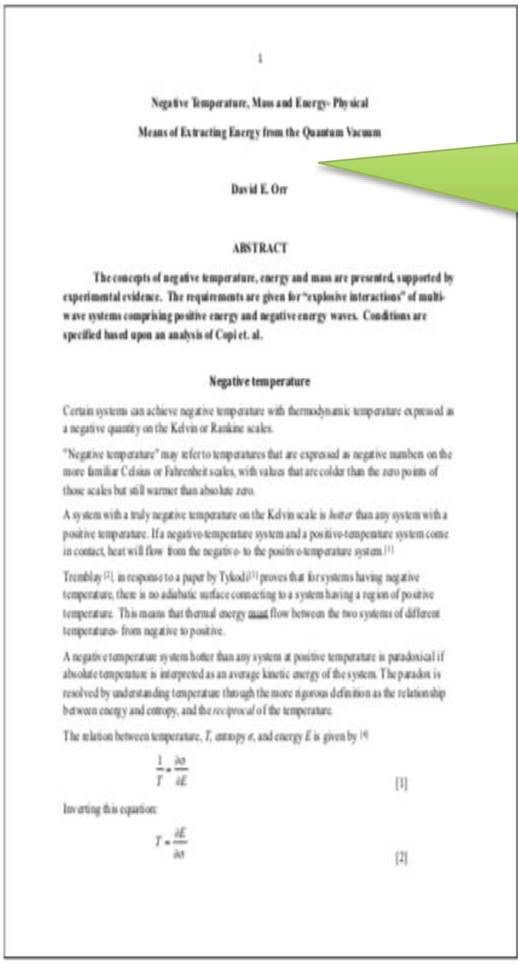
iv. The concepts of negative energy, negative masses and negative temperature are summarized and explained in the enclosed paper as Supplement 2-1a: "Negative Temperature, Mass and Energy- Physical Means of Extracting Energy from the Quantum Vacuum". In this paper, various experiments, and other tech papers- related primarily to plasma physics- are summarized and surveyed. Of primary interest is the reference to the book by Peter W. Milonni of Los Alamos National Laboratories, in which he surveys what is known about the quantum vacuum and the theory of mankind. Milonni's book also discusses how the second law of thermodynamics is "violated" (superseded) by quantum effects, such as quantum vacuum processes.

v. The physics of energy exchange with quantum vacuum can be accounted for in classical physics, such as the Ampere force law, and the Maxwell- Heaviside equations, without imposing restrictions on these equations it is clear that vacuum energy extraction is rational and possible, explaining many experiments involving what said to be "anomalous energy and particle discharge"; refer to the enclosed paper as Supplement 2-1b: " Anomalous Discharge from the Quantum Vacuum".

vi. A further analysis is provided in the enclosed paper as Supplement 2-1c: " The Ampere Force Law". In this paper, the Ampere law and supporting experiments show that longitudinal forces are propagated along current carrying conductors. These forces are not accounted for in the widely used Lorentz law that superseded the Grassman law. These forces can only come from the vacuum, in support of the physics of vacuum energy extraction.

The described Ampere Force Law demonstrates vacuum energy extraction by classical physics, while these papers explain mechanisms that stem from quantum electrodynamics, they do not describe the engineering that is used in Langenburg Technologies, which remains proprietary.

❖ Langenburg Technologies – Titles/Abstracts of Supplemental papers.



1

Negative Temperature, Mass and Energy- Physical Means of Extracting Energy from the Quantum Vacuum

David E. Orr

ABSTRACT

The concepts of negative temperature, energy and mass are presented, supported by experimental evidence. The requirements are given for "explosive interactions" of multi-wave systems comprising positive energy and negative energy waves. Conditions are specified based upon an analysis of Copi et. al.

Negative temperature

Certain systems can achieve negative temperature with thermodynamic temperature expressed as a negative quantity on the Kelvin or Rankine scales.

"Negative temperature" may refer to temperatures that are expressed as negative numbers on the more familiar Celsius or Fahrenheit scales, with values that are colder than the zero points of those scales but still warmer than absolute zero.

A system with a truly negative temperature on the Kelvin scale is *hotter* than any system with a positive temperature. If a negative-temperature system and a positive-temperature system come in contact, heat will flow from the negative- to the positive-temperature system.[1]

Tremblay [2], in response to a paper by Tykodi[3] proves that for systems having negative temperature, there is no adiabatic surface connecting to a system having a region of positive temperature. This means that thermal energy must flow between the two systems of different temperatures- from negative to positive.

A negative temperature system hotter than any system at positive temperature is paradoxical if absolute temperature is interpreted as an average kinetic energy of the system. The paradox is resolved by understanding temperature through the more rigorous definition as the relationship between energy and entropy, and the *reciprocal* of the temperature.

The relation between temperature, T, entropy σ, and energy E is given by [4]

$$\frac{1}{T} = \frac{\partial \sigma}{\partial E} \qquad [1]$$

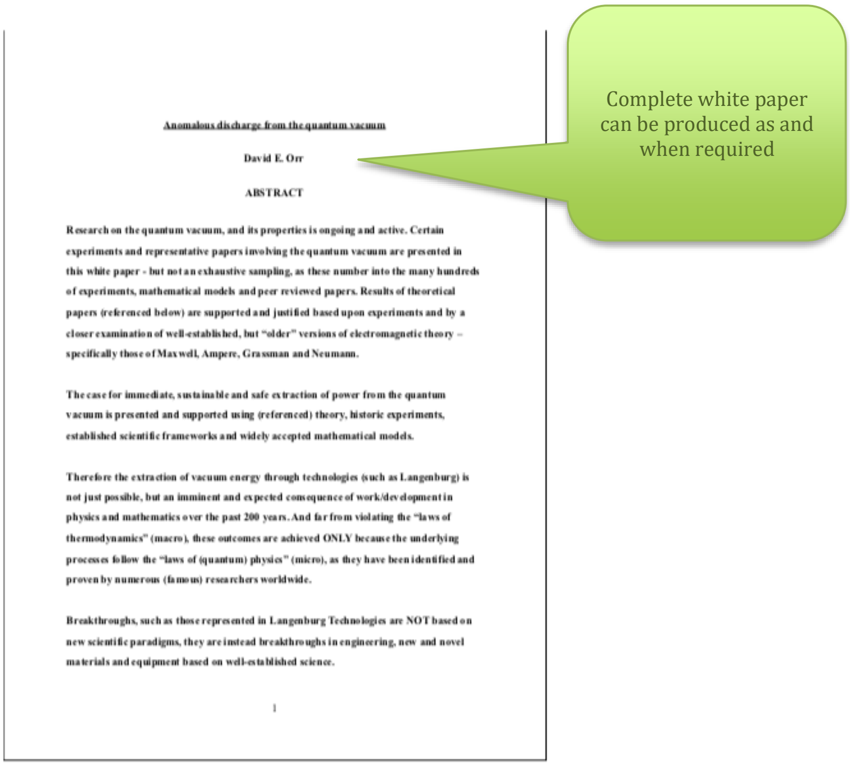
Inverting this equation:

$$T = \frac{\partial E}{\partial \sigma} \qquad [2]$$

Complete white paper can be produced as and when required

Title – "Negative Temperature/Mass/Energy – Physical Means of Extracting Energy from the Quantum Vacuum"

Abstract – *The concepts of negative temperature, energy and mass are presented, supported by experimental evidence. The requirements are given for "explosive interactions" of multi-wave systems comprising positive energy and negative energy waves. Conditions are specified based upon an analysis of Copi et. al.*



Anomalous discharge from the quantum vacuum

David E. Orr

ABSTRACT

Research on the quantum vacuum, and its properties is ongoing and active. Certain experiments and representative papers involving the quantum vacuum are presented in this white paper - but not an exhaustive sampling, as these number into the many hundreds of experiments, mathematical models and peer reviewed papers. Results of theoretical papers (referenced below) are supported and justified based upon experiments and by a closer examination of well-established, but "older" versions of electromagnetic theory – specifically those of Maxwell, Ampere, Grassman and Neumann.

The case for immediate, sustainable and safe extraction of power from the quantum vacuum is presented and supported using (referenced) theory, historic experiments, established scientific frameworks and widely accepted mathematical models.

Therefore the extraction of vacuum energy through technologies (such as Langenburg) is not just possible, but an imminent and expected consequence of work/development in physics and mathematics over the past 200 years. And far from violating the "laws of thermodynamics" (macro), these outcomes are achieved ONLY because the underlying processes follow the "laws of (quantum) physics" (micro), as they have been identified and proven by numerous (famous) researchers worldwide.

Breakthroughs, such as those represented in Langenburg Technologies are NOT based on new scientific paradigms, they are instead breakthroughs in engineering, new and novel materials and equipment based on well-established science.

1

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1

The Ampere Force Law [1]

David Orr, PhD, ME

ABSTRACT

The in-depth study of the forces accompanying the transfer of electric charge (electric current), including original work by Ampere, Lorentz, Graneau and others, demonstrates the existence of forces that are currently ignored throughout the fields of classical science and modern engineering – mostly because they are considered non-significant on a gross (macro) scale.

When viewed through a quantum lens however, these forces take on great significance, as their impact, harnessing and use, has consequences far beyond what was previously understood. In essence, as electrons move left to right (for example), counter balancing positrons move right to left, and because of the mass differential (between electrons and positrons), and through effects defined in Einstein's theory of relativity ($e = mc^2$), enormous leverage (a "positron gearbox") is available in the extraction of force, power, light and other effects.

Ampere's "hairpin experiment"

Experiments demonstrating the existence of longitudinal Ampere forces have been known for 160 years and have fomented a certain amount of controversy. Argument could have been avoided had it been recognized that the validity of the Ampere electrodynamics is confined to metallic conductors. The conduction electron travelling through the metallic lattice appears to be subject to a more complex force system than the free electron travelling through vacuum. For this reason, Lorentz was compelled to drop Ampere's force law when he tried to explain the dynamics of isolated electric charges in vacuum tubes. He found it necessary to substitute Grassman's law which later became known as the Lorentz force law.

Long before Lorentz, Ampere appears to have been under some pressure to provide an explicit demonstration of longitudinal forces. He had taken the view that his empirical law was the generalization of many experimental results, collected mainly by himself, which all implied the existence of longitudinal forces and no explicit demonstration was necessary.

Complete white paper can be produced as and when required

<u>Title</u> – "The Ampere Force Law"

<u>Abstract</u> – *The in-depth study of the forces accompanying the transfer of electric charge (electric current), including original work by Ampere, Lorentz, Graneau and others, demonstrates the existence of forces that are currently ignored throughout the fields of classical science and modern engineering; mostly because they are considered non-significant on a gross (macro) scale.*

When viewed through a quantum lens however, these forces take on great significance, as their impact, harnessing and use, has consequences far beyond what was previously understood. In essence, as electrons move left to right (for example), counter balancing ions move right to left, and because of the mass differential (between electrons and ions), and through effects defined in Einstein's theory of relativity ($E = mc^2$), enormous leverage (a "positron gearbox") is available in the extraction of force, power, light and other effects.

Example: Energy in Water • 560 MW Mass – Flow Scenario

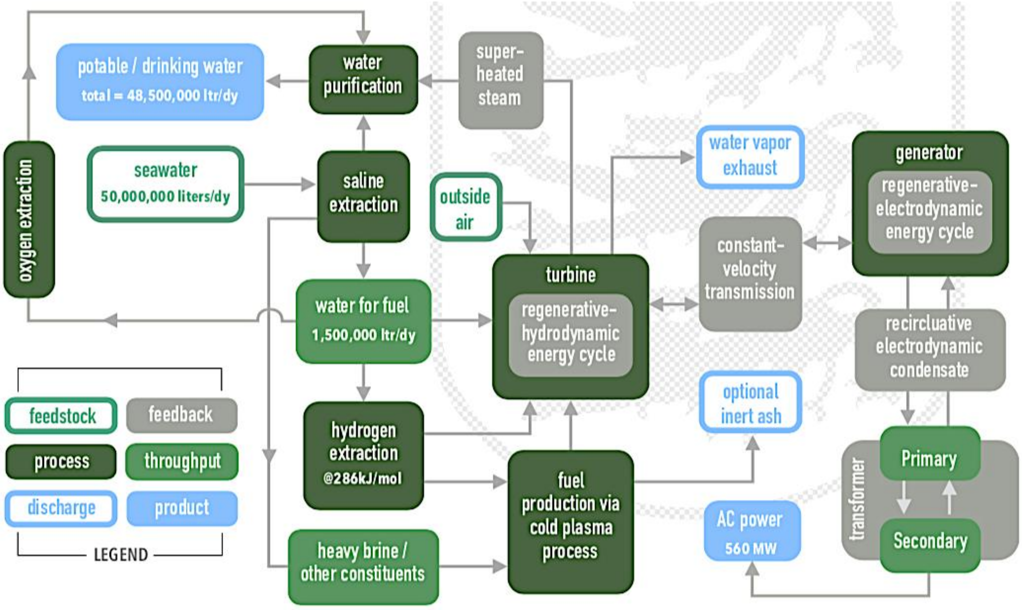
Waste to Power

Available Energy Form	:	Pure water component of the waste water feedstock
Total Water Requirement	:	≈3.1%of total pure water component
Energy Units	:	1 mol (18 grams) H_2O
Available Energy for Combustion	:	2 mols H_2 (@286kJ/mol) per mol H_2O
Waste Energy Requirement	:	Langenburg proprietary

Mols To Megawatts

H_2O Usage Rate	:	(1.75 mols H_2O/sec)/MW
Energy Derivation Method	:	Extraction & combustion of H_2 from H_2O (each 2 mols = 572 kJ)
Turbine Combustion/Reaction Efficiency	:	Langenburg proprietary regenerative-electrodynamic, supercharged, combustion-primed hydrogen-reactive energy cycle
Supercharger Efficiency	:	Langenburg proprietary hydrodynamic-implosive supercharging intake plenum (no thermal – radiative intercooler)
Generator Efficiency at Power Factor >0.9	:	Langenburg proprietary regenerative-electrohydrodynamic, capacitive quantum – reactive energy cycle
Energy Release Rate	:	560 MW baseload/constant power
H_2 - Extraction Energy Requirement	:	Langenburg proprietary (no hydrolysis/steam reformation/Fischer Tropsch)

Scenario: 560 MW Classical Mass Balance Flow
• 50 million lit/day (5000 KLD) waste water feedstock



Energy - Balance Calculation for 560 MW • Quantity 2;280MW Generators
Using ≈3% of the pure water component of 50 MLD waste water feedstock

H_2 FROM PURE WATER CONVERTED TO POWER

≈ 3% of 50,000,000 lit/day	:	≈1,500,000 lit/day
Quantity H_2O to yield 1 MW	:	0.032 lit/sec
Quantity H_2O to yield 1 MW/day	:	2767 lit/day
Quantity H_2O to yield 560 MW / day	:	1,549,596 lit / day
Corrected Quantity Water Requirement to yield 560 MW/day	:	3.1% of 50,000,000 lit/day

The proposal is for taking waste water from drain along with legacy Municipal Solid Waste as input. It would be converted to energy using Langenburg Technology™, 55 MW energy along with 925 KLD Purified water and liquid fuel.

Figure 7 C: - Unit wise Material and Energy Balances

Baseline Specs — **Langenburg Technologies LLC | LT40MWGE 40MW Water/Power/Waste Plant**

<table>
<tr><th></th><th></th></tr>
<tr><td>FEEDSTOCK</td><td>water + any waterborne effluent :
toxic / industrial / municipal / natural-source</td></tr>
<tr><td>Daily Remediation Amount [gal | ltr]</td><td>250,000–10,000,000 | 946,353–37,854,118</td></tr>
<tr><td>Discharge vs. Inlet Temp (+/-) [F | C]</td><td>2° | 16.6° dependent upon inlet temperature</td></tr>
<tr><td>Fraction Consumed for Power [%]</td><td>5–8 dependent upon feedstock effluent constituents</td></tr>
<tr><td>Discharge Water Oxygen Levels [ppm]</td><td>400–700 (7)</td></tr>
<tr><td>FLOW CONNECTIONS</td><td>stainless Steel 8-Bolt Round Flange Pattern (2)</td></tr>
<tr><td>Feedstock Inlet – Dia [in | cm]</td><td>10 | 25.4</td></tr>
<tr><td>Purified H2O Outlet – Dia [in | cm]</td><td>10 | 25.4</td></tr>
<tr><td>GAS TURBINE [make | model]</td><td>Langenburg | LTG-1500-M40 (3)</td></tr>
<tr><td>Proprietary Motive Power Source</td><td>Langenburg UltraCycle™</td></tr>
<tr><td>Proprietary Fuel Source</td><td>UltraGas™ generated from feedstock (1)</td></tr>
<tr><td>Exhaust Gas Channel</td><td>vertical exterior exhaust stack</td></tr>
<tr><td>Gas Outlet Temp [F | C]</td><td>87.44° | 30.8° (8)</td></tr>
<tr><td>Exhaust Mass Flow & Feedback</td><td>see Heat & Mass-Balance Flow Diagram</td></tr>
<tr><td>HC/CO/NOx Emissions</td><td>none (8)</td></tr>
</table>

(1) Langenburg Technologies Systems' proprietary process creates fuels from waterborne effluent in Feedstock used to operate the Langenburg Technologies Turbine and for UltraGas™ production.
(2) Connector types customizable to project configuration.
(3) Langenburg Technologies-Modified Gas Turbines / Generator Sets custom-manufactured in Germany per Langenburg Technologies Systems' specification.
(4) Remote-sensing & management via satellite via Langenburg's proprietary process.
(5) Discharges configurable per project via Langenburg's proprietary process.
(6) Optional trailer-mounted units available upon request.
(7) Optional water oxygenation unit installed.
(8) Outlet exhaust gas is pure water vapor.
(9) Reactances measured at saturation.
(10) Short-Circuit Ratio dependent on installation & dynamic load conditions.

<table>
<tr><th></th><th></th></tr>
<tr><td>GENERATOR SET [make | model]</td><td>Leroy Somer | LSA58 (3)</td></tr>
<tr><td>Gross Power Output [MW]</td><td>41.5</td></tr>
<tr><td>Gross Efficiency [%]</td><td>76</td></tr>
<tr><td>Power Output [MW]</td><td>40</td></tr>
<tr><td>Power Voltage [kV]</td><td>55.2</td></tr>
<tr><td>Power Frequency [Hz]</td><td>60</td></tr>
<tr><td>Power Factor</td><td>0.8</td></tr>
<tr><td>Armature Speed [rpm]</td><td>3000</td></tr>
<tr><td>Efficiency [%]</td><td>97.7</td></tr>
<tr><td>Enclosure Ingress Protection Rating</td><td>IP 44</td></tr>
<tr><td>Synchronous Reactance [%]</td><td>247 (9)</td></tr>
<tr><td>Transient Reactance [%]</td><td>22 (9)</td></tr>
<tr><td>Sub-Transient Reactance [%]</td><td>14.8 (9)</td></tr>
<tr><td>Neg Sequence Reactance [%]</td><td>19 (9)</td></tr>
<tr><td>Short Circuit Ratio [%]</td><td>1 (10)</td></tr>
<tr><td>Armature Winding Insulation [class]</td><td>F</td></tr>
<tr><td>Connection [type]</td><td>Y</td></tr>
<tr><td>CONTROL PANELS [make | model]</td><td>Emerson | ASCO Series</td></tr>
<tr><td>TRANSFORMERS [make]</td><td>Pacific Crest or Siemens</td></tr>
<tr><td>SYSTEM ENVELOPE</td><td>skid-mounted container (6)</td></tr>
<tr><td>Size L x W x H [ft | m]</td><td>40 x 15 x 10 | 12.2 x 4.57 x 3.05</td></tr>
<tr><td>Weight [lbs | kg]</td><td>TBD | TBD</td></tr>
<tr><td>REMOTE-SENSING & MANAGEMENT</td><td>via Langenburg satellite</td></tr>
<tr><td>Data Measurements</td><td>PH, O2-Level, Exhaust Gas - Temp, Voltage-Out (4)</td></tr>
<tr><td>Liquid/Solid Discharge Type</td><td>slurry / inert ash / none (5)</td></tr>
<tr><td>Configurable</td><td>per project parameters</td></tr>
</table>

11. **Proprietory Equipments:** LT waste – power – fuel systems are integrated and made with proprietory processes like in case of **UltraFuel™**…it is made with proprietory process, independent of any intermediate and energy – intensive processes such as the Fisher-Tropsch method. Our prorietory processes are integrated within the accepted and proven principals of physics, chemistry, engineering and quantum physics and as such are not made as independent systems and neither are sold anywhere in the world.

12. **Proprietory Catalysts used in the process, its life, disposal ways and costs :** There are prorietory catalysts used in the process & no toxic materials are released in to the air or on ground of any manner.

13. **By Products generated and their fate of disposal** : All compounds not delivered in a final product or byproducts are under the ownership of LT and are either ionized or otherwise used but no toxic materials are released into the environment or in ground of any manner

14. **Safety and Disaster Management plan in plant premises :** All plants have redundency built in. There are no exposed combustible materials, neither there is a storage of any hazardous chemical/ substance or hazardous waste,toxic materials or by products and there are no processes that are explosive or high heat in any traditional sense.

15. **Emissions :** We would further like to add here that there are no carbon or toxic emissions from the LT Waste to Energy systems. LT Turbine exhaust is only warm, clean air with some water vapour content. The only byproduct which is generated is a small amount of non – toxic, inert, solid plasma rock material. For example in a plant which is consuming 01 MLD of liquid waste per day, only prodces a bagful of inert ash (approx. 47-48 kgs) in the entire day and that is around 0.004% which is a raw material for construction industry.

16. **Controls :** All systems are remotely monitored 24/7 through our own Langenburg satellite and have multiple built in protection / override systems for safe and continuos operations. Each system has built in state of the art security. All systems can be disabled remotely and may require pre-approved (programmed) biological signatures for restart.

17. **Startup Power :** LT Waste to energy systems do not require any sratrt up power but start using a 12-volt battery, reaching full power in 60 seconds.

18. **Adaptability :** All LT Systems have advanced sensors and programming, allowing automatic adjustment for changing (waste / water) inputs while continuosly producing specified outputs.

19. **Water Purification :** LT does not used screens or reverse –osmosis in its water prcessing. For this reason, the capacity, water quality, toxic remedition capability, production efficiancy and utility robustness of all LT sytems will far exceed thise conventional wastewater treatment and / or desalination systems.

20. **By Products :** There are no toxic byproducts from the LT seperatrion of salt from seawater. The salts removed are either dried for reuse or destroyed /ionized.

21. **LT water purification systems** can be customised to add minerals and oxygen using proprietory Langenburg Technologies processes, increasing resistence to the growth of pathogens, while delivering a variety of benefits for people, animals and agricultural operations.

22. **LT Power production** meets all local standards and regulations and includes standard interfaces allowing it to be connected to electrical systems / grids around the world.

23. **LT UltraGas™:** LT UltraGas™ fuel is a product of LT Plasma Gasification & is derived from waste water effluent through a production process developed by biochemist Dr. Albrect (Max) Langenburg. The LT UltraGas™ is similar to Synthetic Gas (SynGas). SynGas consists of hydrogen with carbon monoxide compounds, while UltraGas™ is primarily hydrogen. It may also include small amounts of carbondioxide derived from

gasified organic compounds in wastewater/effluent; converted to zero carbon through LT's hot-plasma. UltraGas™ is made by proprietory process, independent of any intermediate and energy-intensive process such as the Fisher-Tropsch method. Langenburg developed a continuous, single step method for splitting water into hydrogen and oxygen, using significantly less than 243kj/mole of endothermic energy that is required by typical electrolysis. UltraGas™ is an energy-enriched form of hydrogen that can be transformed into a liquid that is stable, non-inflamable and non-combustable at room temperature and pressure. Using other LT proprietory processes, UltraGas™ is far less energy-intensive to produce and easier to store since it doesn't cause the typical metallic embrittlement issues of conventional H_2 gas. UltraGas™ is made as a liquid with energy content (heat of combustion) of 135,000 BTU per gallon.

24. **Each LT Generator** is driven by a proprietory LT Turbine fuel - LT Ultra Gas™ which is a high performance form of SynGas manufactured with in the LT Water and Power process.

25. **LT does not use electrolysis** to relase hydrogen from water.LT is using proprietory methods developed by Dr. Albrecht (Max) Langenburg in Germany.

26. **Variable loads** do not stress LT Power Systems. Each LT Generator responds in real time to electrical load flux on every local network(s), grid sub-network(s) or grid application(s) – a performance milestone that cannot be achieved by conventional state of the art power generation systems.

27. **LT water and Power Systems** can dynamicaly match electrical load at multiple frequencies (50,60 Hz etc.) and meet power demands (110/220/440/880) without any time lag.

28. **When processing mixed Municipal Solid Waste**, no pre-treatment or sorting is required. If for any reason there is insufficient solid waste to produce power, the LT Power sytem can continue to produce full – power levels using wastewate, seawater or water only as fuel.

29. **When processing solid waste**, the LT Water Power and Waste System will capture 90% of the water contained, converting the majority to safe, clean drinking water.

30. **Cold Plasma Gasification Technology:** Plasma is an elastically conducting medium in which there are roughly equal number of positively and negatively charged particles produced when the atoms in get ionized. It is called the 4th state of matter. Cold plasma is achieved by ionization of atoms using electricity. Cold Plasma Gasification is a process through which energy is generated from the produced as i.e Syngas. Cold Plasma gasification is a novel gasification technology which offers a promising treatment of low heating/ calorific value fuels like MSW, BMW and other types of wastes (slags) including effluents and sewage. It is a two- stage process. Gasifier converts MSW/BMW into hydrogen rich Syngas. The levels of tars are indistinct in the first stage and almost negligible after Plasma treatment. The municipal solid waste on application of Cold

plasma Gasification Technology gets converted into syngas using hydrogen nuclei. The moisture content in MSW is converted to Syngas, primarily hydrogen.

Traditionally typical Syngas generated by any of three methods namely Fischer- Tropsch Conversion, Methanol to Gasoline conversion or Direct Coal Liquefaction consists of Hydrogen, Carbon monoxide, Carbon dioxide and small amount of Sulphur and Nitrogen compounds. However, LT UltraFuel™ is Langenburg proprietary hydrogen syngas fuel derived from MSW/BMW waste water effluent and its formulation has hydrogen with non-detectable level of carbon and/or other compounds used in certain industrial processes. Traditional thermal plasma process collect heat as benefit while LT process makes its own hydrogen enriched Syngas for powering the plasma field and also derive energy from the atoms (by converting heavier atoms to lighter atoms) which no other process is achieving. LT UltraFuel™ is energy enriched stable form of hydrogen i.e non-flammable, non-toxic and non-combustible at room temperature and normal pressure. Through proprietary energy enrichment process, LT UltraFuel™ concentrates latent heat density to about 100- fold beyond natural as or typical Syngas (produced by above three processes) with heat of combustion being 135000 BTU per gallon(approx.). Typical/other syngas has heat of combustion as 15000 BTU/gallon and here lies the difference.

ANALYSIS AND MANAGEMENT OF MUNICIPAL SOLID WASTE

Waste Management Strategy for East Delhi

East Delhi Municipal Corporation a local authority for East Delhi is responsible for providing municipal and civic services to the citizens of East Delhi, including collection, transportation, and disposal of Municipal Solid Waste (MSW) generated within their jurisdiction. Waste processing is mandated under SWM Rule 2016. AG Dauters has offered to set up the plant for Municipal Corporation, East Delhi & the plant will have a capacity of processing approx. 200 tons per day of Legacy Waste (the “Project”) and which is compliant with SWM Rules 2016 and all other applicable rules. The present Detailed Project Report (DPR) is prepared for developing the Waste-to-Energy (WTE) Project for at Ghazipur SLF, East Delhi. This is based on the applicable Rules and regulatory requirements for MSW management in India. Also taken into consideration various guidelines and best practices in this sector.

The integrated waste management approach discussed as the latest waste management philosophy advocates 5R’s principal emphasizing on Refuse, Reduce, Reuse, Recycle and Rot. Minimization of wasteful usage and proper segregation of waste are the key areas of waste management. However, for East Delhi, the most advanced waste to energy technology plant is being proposed and the salient features of that are:

- No segregation of waste, even in case of legacy waste.
- Any levels of moisture are accepted
- Calorific value has no concern
- No emissions from the plant
- No residues: inert or residues from the plant
- Entire waste is converted into: power, drinking water and fuel
- We will be processing the legacy waste of approx. 200 TPD lying in the landfill site.

COMPOSITON OF MUNICIPAL SOLID WASTE

The components of the Solid Waste are Food Waste, Paper, Cardboard, Plastic, Textiles, Rubber, Leather, Yard wastes, Wood and other category of wastes. The physical and chemical characteristics of MSW can be described as:

Table 1; Physical and Chemical Characteristics of MSW at Okhla Landfill Site.

S. No.	Parameters	Minimum	Maximum	Average
(A) Physical Characteristics (All values are in percent by wet weight)				
1	Biodegradable	23.79	30.62	28.62
2	Paper	03.10	05.42	03.78
3	Plastic	03.57	06.14	04.45
4	Metal	00.03	01.10	00.10
5	Glass & Crockery	00.38	02.10	01.45
6	Bioresistant	17.00	23.36	19.73
7	Inert	30.75	41.80	32.70
(B) Chemical Characteristics (All values are in percent by dry weight)				
S. No.	Parameters	Minimum	Maximum	Average
1	Moisture	22.97	30.11	25.58
2	Organic Carbon	10.77	19.81	14.82
3	Nitrogen as N	00.52	00.74	00.65
4	Phosphorus as P_2O_5	00.22	00.33	00.27
5	Potassium as K_2O	00.44	01.22	00.91
6	C/N Ratio	20.71	26.77	22.80
7	Lower Calorific Value (Kcal/Kg)	380.0	610.0	528.5

REFRENCE: - *Municipal Solid Waste Management in Delhi- the Capital of India.* (Bhavik Gupta & Dr. Shakti Kumar Arora; International Journal of Innovative Research in Science Engineering and Technology Vol. 5, Issue 4, April 2016)

NOTE: - Data on E-waste content in MSW is not available since it is a legacy waste. The project is to handle the legacy waste.

Table 2; COMPOSITION OF SEWAGE SLUDGE

Particulars	Quantity (in %)
Carbon	31.79
Hydrogen	4.36
Oxygen	20.57
Nitrogen	4.88
Sulphur	1.67
Fluorine	0.013
Chlorine	0.22
Residue*	36.5
TOTAL	100

*It may include silicates, sulphates, metals, etc.

REFERENCE- *Analysis of Organic and Inorganic Contaminants in Dried Sewage Sludge and By-products of Dried Sewage Sludge Gasification*, Sebastian Werle and Mariusz Dudziak (2014)

PHYSICAL AND CHEMICAL CHARACTERISATION OF MSW

Physical and chemical characteristics of municipal solid waste are very important to know that the presence of different toxic metals and their possibility of polluting the underground water resources. About 500 gm of dry MSW passing through 425-micron sieve was dried and investigated for both physical and chemical characteristics by standard procedure in an NABL accredited laboratory. It was observed that the value of pH is in the range of 7.4 to 7.6 for three different ae samples. This indicates that MSW sample is slightly acidic in nature. Based on the leachate result, it can be concluded that MSW is non-hazardous material as concentration of heavy metals is within the permissible limit.

(**REFERENCE-** Report on *UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD EMBARKMENT*, prepared by GEOTECHNICAL ENGGINEERING DIVISION, CSIR-CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI (JUNE 2016)

Physical and chemical characteristics of Municipal Solid Waste: Analysis

Parameters	Units	A	B	C	Average (mg/kg)	Quantity	
						gms	Tons
pH	-	7.4	7.6	7.6	NA	NA	NA
Total nitrogen (N)	mg/kg	92.4	60.74	59.89	71.0	9941.4	0.0099
Phosphorous (P)	mg/kg	36.96	28	20.7	28.6	3997.5	0.0040
Nitrate (NO_3)	mg/kg	10	<5.0	10.3	8.4	1180.7	0.0012
Nitrogen	mg/kg	92.4	60.74	59.89	71.0	9941.4	0.0099
Electrical Conductivity	µs/cm	3017	1720	1935	NA	NA	NA
Sulphur	mg/kg	5143	3001.2	3495.3	3879.8	543176.7	0.5432
Nitrite (NO_2-N)	mg/kg	<5.0	9	<5.0	6.3	886.7	0.0009
C:N ratio	mg/kg	13.584	279:01:00	317:01:00	NA	NA	NA
Total Inorganic Content	%	87	90.1	92.1	NA	NA	NA
Chloride (Cl)	mg/kg	2563	1590	1843	1998.7	279813.3	0.2798
Sulphate (SO_4)	mg/kg	15430	9003.7	10485	11639.6	1629539.3	1.6295
Calcium (Ca)	mg/kg	2718	1172.4	1225.5	1705.3	238742.0	0.2387
Magnesium (Mg)	mg/kg	1020	890	868	926.0	129640.0	0.1296
Organic Matter	%	5.17	2.93	3.3	NA	NA	NA
Cation Exchange Capacity	meq/100gm	40.41	31.5	44.59	NA	NA	NA
TOTAL					20334.7	2846858.9	2.8469

(REFERENCE- Report on *UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD EMBARKMENT*, prepared by GEOTECHNICAL ENGGINEERING DIVISION, CSIR-CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI (JUNE 2016

Heavy metals content in the leachate of MSW: Analysis

Heavy Metals	A (mg/l)	B (mg/l)	C (mg/l)	Regulatory Limit (mg/l)	Average (mg/l)	Quantity	
						gm	kg
Antimony & antimony compounds	<0.03	<0.03	<0.03	15	0.003	0.42	0.00042
Arsenic & arsenic compounds	<0.03	<0.03	<0.03	5	0.003	0.42	0.00042
Cadmium & cadmium compounds	<0.1	<0.1	<0.1	1	0.1	14	0.014
Mercury & mercury compounds	<0.1	<0.01	<0.01	0.2	0.04	5.6	0.0056
Selenium & selenium compounds	<0.03	<0.03	<0.03	1	0.03	4.2	0.0042
Total chromium compounds	<0.1	<0.014	0.032	5	0.04867	6.8133	0.0068
Cobalt compounds	<0.1	<0.1	<0.1	80	0.1	14	0.014
Copper compounds	0.58	0.59	1.02	25	0.73	102.2	0.1022
Lead & lead compounds	<0.1	<<0.1	<0.1	5	0.1	14	0.014
Molybdenum compounds	<0.1	<0.1	<<0.1	350	0.1	14	0.014
Nickel compounds	0.13	0.23	0.33	20	0.23	32.2	0.0322
TOTAL					1.4846	207.8533	0.2078

Regulatory limits as per G.S.R 395 (E) [04-04-2016]: Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

(REFERENCE- Report on *UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD EMBARKMENT*, prepared by GEOTECHNICAL ENGGINEERING DIVISION, CSIR-CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI (JUNE 2016)

Heavy metal content in the solid mass of MSW: Analysis

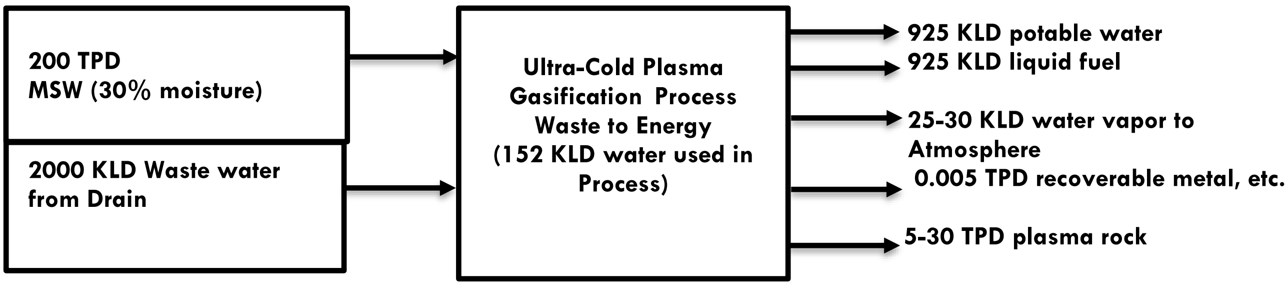
Heavy Metals	A (mg/kg)	B (mg/kg)	C (mg/kg)	Regulatory Limit (mg/kg)	Average (mg/kg)	Quantity	
						gms	tons
Antimony & antimony compounds	<1.0	<1.0	<1.0	50	1.0	140	0.00015
Arsenic & arsenic compounds	<1.0	<1.0	<1.0	50	1.0	140	0.00015
Cadmium & cadmium compounds	<2.0	<2.0	<2.0	50	2.0	280	0.00031
Mercury & mercury compounds	<1.0	<1.0	<1.0	50	1.0	140	0.00015
Selenium & selenium compounds	<1.0	<1.0	<1.0	50	1.0	140	0.00015
Total chromium compounds	<2.0	<2.0	<2.0	5000	2.0	280	0.00031
Cobalt compounds	<2.0	<2.0	<2.0	5000	2.0	280	0.00031
Copper compounds	11.6	11.6	20	5000	14.4	2016	0.00222
Lead & lead compounds	<2.0	<2.0	<2.0	5000	2.0	280	0.00031
Molybdenum compounds	<2.0	<2.0	<2.0	5000	2.0	280	0.00031
Nickel compounds	2	4	6	5000	4.0	560	0.00062
TOTAL					32.4	4536	0.005

Regulatory limits as per G.S.R 395 (E) [04-04-2016] : Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

(REFERENCE- Report on *UTILIZATION OF MUNICIPAL SOLID WASTE IN ROAD EMBARKMENT*, prepared by GEOTECHNICAL ENGGINEERING DIVISION, CSIR-CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI (JUNE 2016)

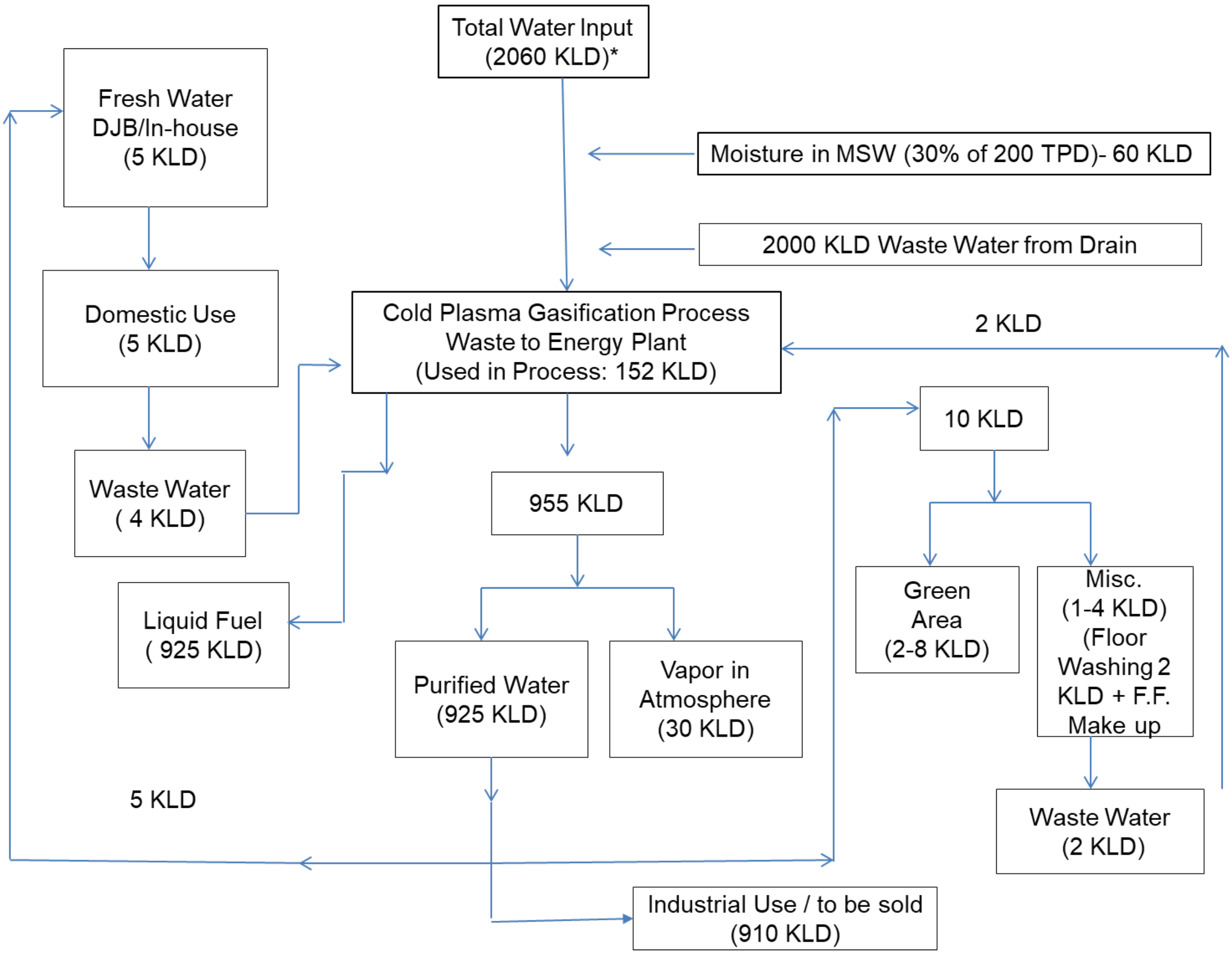
To sum-up, **Material/ Mass Balance** and **Water Balance** for 50 MW Waste to Energy plant at Ghazipur, Delhi (Cold Plasma Gasification Process) is :-

Material /Mass Balance



REFERENCE :-(for moisture) Project Report on *Reclamation of Ghazipur Landfill, Infrastructure Development Finance Company* for MCD (May 2010)

Water Balance



ROLES AND OBLIGATIONS OF EACH PARTY

The key roles and responsibilities of Applicant Concessionaire and East Delhi Municipal Corporation will be:

Applicant Concessionaire responsibilities:

- ✓ The project will be 100% self-funded and the ownership of the plants for the entire concession period will be with the Concessionaire. Plant or technology will never be transferred.
- ✓ It is our proprietary technology and the entire plant will come in CKD form which will be assembled at site.
- ✓ The entire site development of the plant complex, periphery walls, roads and building will be done by us at our own cost.
- ✓ We require a land parcel of 03 acres and should be close to the landfill site.
- ✓ Since the sites come under East Delhi MC, the land will be given to us for a period of 25 years either on lease or allotted to us an Industrial Enterprise under the state policy of land allotment and East Delhi MC will coordinate & ensure that the same is given to us asap.
- ✓ The freshwater pipes to the nearest pumping station will be laid by us at our own cost, but the permissions for laying the pipes has to be coordinated and taken by East Delhi MC from the relevant bodies (max battery limit: 4-5 kms).
- ✓ The power generated will be evacuated from the nearest 66kva or 120 kVA sub -station and the cabling for the same will be done by us at our own cost but the permissions for erecting the transmission towers has to be coordinated and taken by East Delhi MC from the relevant bodies (max battery limit: 4-5 kms).
- ✓ The fuel evacuation and disbursing station/s will be made and run by us and East Delhi MC will help and facilitate in getting the relevant permissions from the state government.
- ✓ All statutory permissions from various departments will be taken by us including all the relevant charges but facilitation of the same has to be done by East Delhi MC.
- ✓ We will ensure that all documentation and support documents required by various departments for granting permission/s will be provided by us in real time.
- ✓ All security at the plant site and pumping stations will be provided by us 24 x 7 x 365.
- ✓ We ensure that all the useful outputs from our plant i.e. power, water and fuel will be available to the Government for a period of 25 years at the pre-agreed prices and we will ensure 100% redundancy.
- ✓ We will take all safety measurements at the plant site, as per Govt. of India and Govt. of New Delhi regulations at our cost for the entire duration of our agreement.
- ✓ AGDWP will be undertaking CSR activities in the region on regular basis and East Delhi MC will help in coordinating and getting the same implemented in the right manner

East Delhi Municipal Corporation responsibilities:

- ✓ East Delhi MC will be the nodal body for the establishment of the WTE plants for processing Solid Waste into Energy.
- ✓ East Delhi MC will coordinate and facilitate the entire permission/s from the State government and relevant bodies for setting up the plant. All paperwork and relevant charges will be paid by AGDWP.
- ✓ East Delhi MC will provide the required land all relevant charges will be paid by the Concessionaire.
- ✓ Availability of solid waste for the entire concession period: free of cost.
- ✓ All permissions for pipe laying, power transmission towers will have to be facilitated by East Delhi MC
- ✓ East Delhi MC will coordinate and facilitate the power purchase agreement/s (PPA), water purchase agreements (WPA) and fuel purchase agreements (FPA) with the relevant bodies at the pre-agreed prices for the period of the concession agreement i.e. 25 years.
- ✓ East Delhi MC will coordinate and facilitate various CSR activities which the company will undertake in developing the social awareness environment in the region
- ✓

Statutory Framework of Standard Permissions:

S.No.	Project Stage	Complaince/Requirements	Agency
1.	Pre-Establishment	Obtaining Approval by the State Level Single Window Clearance & Monitoring Authority (SLSWC&MA)	Department of Industries, Government of NCT, Delhi
2.	Pre-Establishment	Obtaining Lease agreement at token amount for 3 acres land.	East Delhi Municipal Corporation (EDMC)
3.	Pre-Establishment	Obtaining Environmental Clearance	Ministry of Environment, Forest and Climate Change (MOEF&CC)
4.	CTE- Pre-Establishment CTO- Pre-Operational	Obtaining Consent to Establish/operate industrial Unit under Section 25/26 of Water (Prevention & Control of Pollution) Act, 2981	Delhi Pollution Control Committee (DPCC)
5.	CTE- Pre-Establishment CTO- Pre-Operational	▪ Obtaining Consent to Establish/operate industrial Unit under Section 21 of Air (Prevention & Control of Pollution) Act, 2981 ▪ Authorization under the Hazardous & Other Wastes (Management & Transboundary Movement) Rules, 2016 (If Applicable)	Delhi Pollution Control Committee (DPCC)
6.	Pre-Establishment	Obtaining Power Availability Certificate	BSES/ Rajdhani
7.	Pre-Operational	Obtaining permission under Sub-Section (1) of Section 30 for Development of Land.	Municipal Corporation of Delhi (MCD)/Delhi Development Authority (DDA)
8.	Pre-Operational	No Objection Certificate from Fire Angle	Fire Department
9.	Pre-Establishment	Registration & Grant of License under the Factories Act, 1948.	Department of Industries, Government of NCT, Delhi
10.	Pre-Establishment	Registration & Renewal under The Legal Metrology	Department of Food, Civil Supplies and Consumer Affairs, Government of NCT, Delhi.
11.	Pre-Establishment	Approval of Plan & Permission to construct /extend or take into use any building as a factory under the Factories Act, 1948.	Department of Industries, Government of NCT, Delhi
12.	Pre-Establishment	Registration under the Principal Employers' Establishment under provision of The Contracts Labor Act, 1970.	Department of Industries, Government of NCT, Delhi
13.	Pre-Establishment	Construction Permit	Municipal Corporation of Delhi (MCD)/Delhi Development Authority (DDA)
14.	Pre-Establishment	Obtaining Water Connection	Delhi Jal Board (DJB)
15.	Pre-Operational	License for Contractors under provision of The Contracts Labor (Regulation & Abolition) Act, 1970	Department of Industries, Government of NCT, Delhi
16.	Pre-Operational	Certification of Electrical Installation by Chief Electrical Inspector	Electrical Officer

OTHER DETAILS :

A. Area Required for setting up the processing plants

Land parcel of approx 3 acres has to be provided by East Delhi Municipal Corporation at token lease amount.

B. Maintenance of the plant

The Operations and maintenance of the plant , with all related costs will be done by the Applicant Concessionaire for the entire duration of the concession period.

C. Safety Aspects

As mentioned in our technical details point 11-13.

D. Manpower Plan

Our plants are fully automatic and each step is computer controlled and managed.Therefore as such we do not require not much manpower except supervising engineers and security staff which will be on our rolls. A detailed manpower strength required has been given in Financials.

E. Conformity to environmental norms :

Our plants and technology are zero effluent, zero emission and little plasma rock. We do not release out anything in the air or any toxic inert on the ground, thus there is no negative environmental impact from our plant.

F. Exceptions to the input quality proposed :

If any new input materials are added, the configuration of the same will be provided to us and the same after analysis will be added to the feedstock in due course

PROJECT FINANCIALS:

Quantity and Cost Estimation

Quantity Estimates

Quantity estimation of items has been worked out as per the drawings and unit basis.

Cost Estimates

The Cost estimates for the proposed WtE project using Langenburg's Proprietary Plasma Gasification Technology at Ghazipur site of East Delhi Municipal Corporation, New Delhi includes capital investment for MSW Processing Plant, Pollution Control Equipment, Continuous Emission Monitoring System, Information Communication Technology, Auxiliary Power Supply System and Allied Infrastructure. It is summarized in below table. This cost is worked out on the basis of standards reference documents of Technology Provider and current market rates for civil construction. In calculation of cost estimates, provisions for Operation & maintenance up to one year of commencement of commercial production, provisions for overheads for pre-operation period and up to one year of operation and provisions for unforeseen/contingency has also been incorporated. The entire plant and machinery will be supplied by the Technology Partner from US in closed container which will be assembled at site. The entire plant will have provision of 100% redundancy. This forms the basis of the present financial evaluation. Entire cost of the project is considered in Indian Rupees.

Table: Summary of Block Cost Estimate of Solid Waste to Energy Project at East Delhi, using Langenburg' s Proprietary Plasma Gasification technology

Description	Cost (INR in Crores)
➢ Site & Peripheral Preparations: Site Survey, Geotechnical Investigations, waste characterization study, site clearance, excavation, filling & Compaction, Compound wall fencing, Pipeline and pumping station, landscaping etc. ➢ Designs including all approvals ➢ Processing Plant including power generation equipments and turbines, Civil, Electrical, Mechanical, I&C, Water systems, Pollution control equipments, construction and supervision etc.	450.00 crores (approx.)

➢ Allied infrastructures including Internal Roads, Water drainage, Fire rings main, Weighbridge, Water Treatment plant and finished product storage, Truck parking area, Security Booth, Admin./Laboratory building, Car Parking, Material entry and exit gates, Visitor entry and exit gates, workers area, canteen, landscape area with irrigation systems, Pile foundations, Continuous Emission monitoring systems, Information communication technology, Auxiliary power supply systems, Laboratory equipments, Safety and security systems, etc. ➢ Collection and transportation equipments for secondary collection and transportation ➢ Power Evacuation line and sub-station ➢ Process by-products management systems ➢ Tests on completion and training ➢ Maintenance Spares for 1 year from COD ➢ General provisions for expenses & overheads for pre-operation period and up to 1 year of operation ➢ Contingencies	
Total Estimated Project cost (INR in Crores)	**450.00**
Note: Above estimates are subject to change based on following considerations: 1. Standard Manuals, Reports and Market rates 2. There is scope for the contractor to use innovative technologies for site clearances, excavations and filling which may lead to reduction in cost and time of site preparation. 3. Some of the Components considered for above estimate may not be applicable or may get replaced depending upon the processing technology. 4. Above cost estimates are inclusive of prevailing taxes.	

A. Funding Scenarios and Financial Model

The most important aspect for Solid Waste Management (SWM) using LT Plasma Gasification process is its processing in environmentally safe manner and at the same time, deriving useful products including energy. The advantage of Plasma Gasification processing is that entire input waste is processed, and nothing is left as residue either in air or on ground. The final residues if any can further be utilized within the plant itself for filling of low-lying areas and nothing goes to landfill. Another important advantage of LT Plasma Gasification process is recovery of substantially high energy units from waste, i.e. Waste to Energy (WtE) projects.

The WtE projects are generally cost intensive due to higher inputs for Plant & Machinery and later on pollution control equipment required during plant operation. However, WtE projects using LT Proprietary Plasma Gasification Technology is cost effective as compared to other traditional and prevalent technologies and is still a viable option considering the long-term waste management. The proposed project to be set up in Ghazipur Landfill of East Delhi will be the First Legacy waste to energy plant in India of its kind using most advanced LT Plasma Gasification Technology for processing of Legacy waste with almost zero emission and zero residue.

The Ministry of Non-Conventional Energy (MNRE) is promoting all the technology options available for setting up projects for recovery of energy from urban wastes. In developed countries, environmental concerns rather than energy recovery is the prime motivator for waste-to-energy facilities, which help in treating and disposing of wastes. Energy in the form of gas, heat or power is seen as a bonus, which improves the viability of such projects.

B. Project Funding Model

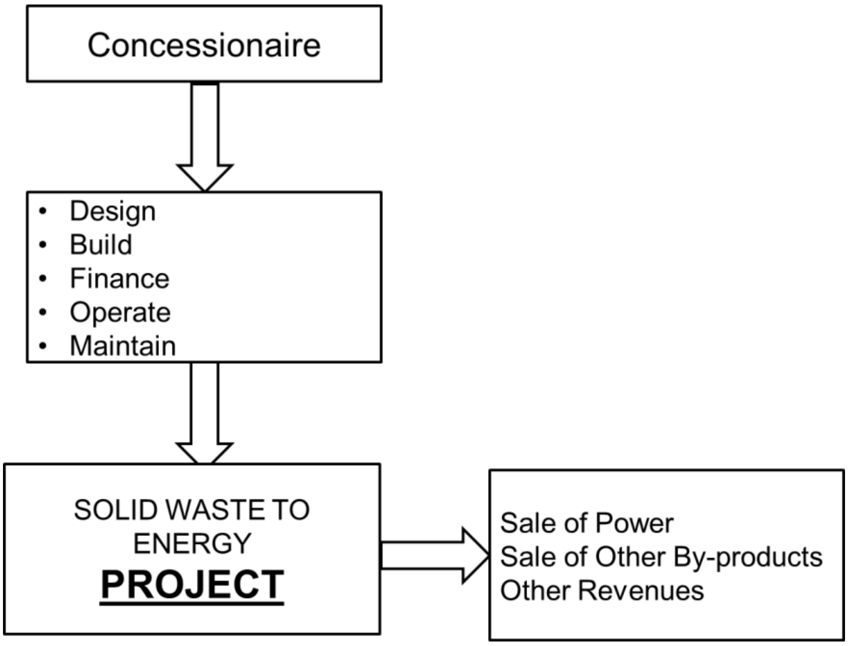
Design, Build, Finance, Operate and Maintain (DBFOM)

The Proposed Project of Solid waste to Energy will be set up by the Applicant (the concessionaire) in East Delhi using most advanced Langenburg' s Proprietary Plasma Gasification Technology on “Design, Build, Finance, Operate and Maintain” (DBFOM) basis. In this model, the entire project is to be developed, financed and maintained by the Applicant Concessionaire in association with its Technology partner Langenburg Technologies LLC, USA through “Special Purpose Vehicle” (SPV) to be formed for the specific purpose. The East Delhi Municipal Corporation, the Urban Local Body (ULB) shall provide the land for the project on lease at nominal cost and waste for processing. The Concessionaire’s SPV shall own, operate and maintain the Plant for an agreed period of Concession Agreement of 25 years.

The Entire Investment of INR 450 Crores will be done in the project as "Foreign Direct Investment" (FDI) under automatic route of FDI policy of Govt. of India.

The Concessionaire and its Technology partner gets his return on investment in terms of CERC Tariff prescribed for Solid waste to Energy by selling of power generated to Power distribution company (DISCOM) i.e. BSES Yamuna Power Limited in terms of Power Purchase Agreement.

Project on "DBFOM" Model



A. Financial feasibility of the Project

The Solid Waste to Energy project proposed to be set up in East Delhi is for processing of approx. 200 TPD of Legacy waste and would generate about 55 MWh of power. The Total project cost is fairly lower than similar other projects elsewhere using other non- conventional Waste to energy technologies. The Estimated Investment in setting up the Solid Waste to Energy Plant using LT Proprietary Plasma Gasification technology would be around INR 450 Crores including unforeseen/contingencies and project life is expected to be about 25 years. The operation and maintenance expenses in such a project is also relatively lower as the entire plant is fully automated and have very less human intervention. Further the Land required for setting up this project is only about 3-4 acres which will be made available by the Urban Local Body of East Delhi on long term lease at very nominal lease rentals.

The Ministry of Power, Government of India vide Gazette Notification dated 28-01-2016 issued the revised Tariff Policy and provided compulsory procurement of 100% power produced from all the Waste-to-Energy plants in the State by the Distribution Licensees for disposal of waste besides generation of electricity.

The Revenues of the proposed Solid Waste to Energy plant at East Delhi is calculated for the purpose of this Report as revenues from the sale of electricity power to New Delhi State Discom i.e. BSES Yamuna Power Limited. The rate has been taken as Rs.7/kW per hr as per the CERC Tariff Policy as amended. The total economic efficiency is calculated with an availability of 95%. This high utilization ratio is based on unique performance characteristics of Langenburg Technologies Systems. Further for the safety reasons, an additional 5% of transformation and grid loss are calculated in the net sales, because the effective sold kW per hr is paid by the consumer and not the produced kW per hr.

To simplify the economic efficiency calculation, it is assumed that the entire cost of plant is financed by the Technology Partner and no outside investment equity is used to finance the project. The required debt has an interest of 6%. The payback period is fixed for 15 years, beginning with the first year of full operation.

The Solid waste to Energy Plant using proprietary technology of Langenburg Technologies produces electricity 24 hours per day, 7 days a week and 365 days a year. During the Operation of Plant, a sufficient number of staff should be deployed for supervision, control and maintenance of the Plant. Due to the novel and high-class LT technology used in the plant, a protection of the Plant against sabotage from outside and theft is essential. The following details shows the average estimation of personnel costs:

Personnel Costs:

Job Description	Number	Month/Staff	Year/Staff	Cost/Year
General Manager	01	Rs. 250,000	Rs. 30,00,000	Rs. 30,00,000
Operation Manager	02	Rs. 125,000	Rs. 15,00,000	Rs. 30,00,000
Shift Manager	05	Rs. 75,000	Rs. 9,00,000	Rs. 45,00,000
Plant Personnel	12	Rs. 40,000	Rs. 4,80,000	Rs. 57,60,000
Security Staff	17	Rs. 15,000	Rs. 1,80,000	Rs. 30,60,000
Total	**37**			**Rs. 1,93,20,000**

Broad Assumptions taken in Projected Profit & Loss Account:

1. In Projected Profit & Loss statement, secondary collection and transportation cost has been taken as Direct Cost as there are no raw material cost. Increase in direct cost is assumed at 3% per year.
2. Operational cost are consisting mainly of personnel, maintenance, insurance, consultancy & management, infrastructure, utilities and other general overheads.
3. Increase in personnel cost, maintenance cost, insurance, and other overheads is assumed at 3% per year while increase in utilities, infrastructure and consultancy & management charges is assumed at 2% per year.
4. The Plant operational efficiency is assumed at 85% in first year and 90% in subsequent years.

5. In Projected Profit & Loss statement, secondary collection and transportation cost has been taken as Direct Cost as there are no raw material cost. Increase in direct cost is assumed at 3% per year.
6. Operational cost are consisting mainly of personnel, maintenance, insurance, consultancy & management, infrastructure, utilities and other general overheads.
7. Increase in personnel cost, maintenance cost, insurance, and other overheads is assumed at 3% per year while increase in utilities, infrastructure and consultancy & management charges is assumed at 2% per year.
8. The Plant operational efficiency is assumed at 85% in first year and 90% in subsequent years.
9. The Tariff rate for sale of electricity is assumed as fixed at Rs.7/kWh for the entire duration.
10. The Depreciation is taken on Straight line method.
11. Interest charges have been taken at 6% p.a.

The absolute financial numbers and operating figures are shown below:

A G DAUTERS: WASTE TO ENERGY PLANT REVENUE PROJECTION & PROJECT VIABILITY							
							(INR in Cr)
PARTICULARS	**FY 2019-20**	**FY 2020-21**	**FY 2022-23**	**FY 2023-24**	**FY 2024-25**	**FY 2025-26**	**FY 2026-27**
INSTALLED PLANT CAPACITY (MW)	**55**	**55**	**55**	**55**	**55**	**55**	**55**
QTY. OF LEGACY WASTE (MTPD)	200	200	200	200	200	200	200
PROJECT CAPITAL COST	**450**						
AVERAGE PLANT LOAD FACTOR (PLF)	90%	90%	90%	90%	90%	90%	90%
NUMBER OF UNITS PRODUCED (in Cr)	**40**	**40**	**40**	**40**	**40**	**40**	**40**
REVENUE FROM ELECTRICITY	**277.20**	**277.20**	**277.20**	**277.20**	**277.20**	**277.20**	**277.20**
ASSUMED RATE PER UNIT (CREC)	7	7	7	7	7	7	7
MATERIAL COST	**63.76**	**63.76**	**65.14**	**65.14**	**66.53**	**67.91**	**68.61**

GROSS PROFIT	213.44	213.44	212.06	212.06	210.67	209.29	208.59
Gross Profit in % of sales revenue	77%	77%	77%	77%	76%	76%	75%
REPAIR & MAINTENANCE	42.69	42.69	46.65	46.65	48.45	48.14	47.98
OTHER OVERHEADS	21.34	21.34	21.21	21.21	21.07	20.93	20.86
PBDTA	149.41	149.41	144.20	144.20	141.15	140.22	139.76
EBIDTA in % of sales revenue	54%	54%	52%	52%	51%	51%	50%
DEPRECIATION	11.25	11.25	11.25	11.35	11.35	11.35	11.40
PBT	138.16	138.16	132.95	132.85	129.80	128.87	128.36
INCOME TAX	41.45	41.45	39.88	39.85	38.94	38.66	38.51
PAT (PROFIT AFTER TAX)	96.71	96.71	93.06	92.99	90.86	90.21	89.85
Net Profit in % of sales revenue	35%	35%	34%	34%	33%	33%	32%

The above projected financials shows clear net profit margin of project of about 32% annually and the investments are expected to be recovered in 15 years. As such the Project is absolutely viable and the Promoters of the Applicant Concessionaire are confident about achieving the financials objectives of the Project.

ENCLOSURE 1- MUNICIPAL SOLID WASTE MANAGEMENT IN DELHI- THE CAPITAL OF INDIA

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Municipal Solid Waste Management in Delhi – the Capital of India

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ABSTRACT: Solid waste management is one of the most challenging issues in urban cities, which are facing a serious pollution problem due to the generation of huge quantities of solid waste. This paper presents a review of the existing situation of municipal solid waste management (MSWM) in Delhi, the capital of India. Also, an insight to the landfills in the city and the leachate generated from them has been provided. Delhi being the most densely populated and urbanized city of India, generates about 9000 tonnes/day of MSW, which is projected to rise to 17,000–25,000 tonnes/day by the year 2021. An attempt has been made to provide a comprehensive review about the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in Delhi.

KEYWORDS: Delhi, environment conservation, landfills, leachate, municipal solid waste management

I. INTRODUCTION

India is the second fastest growing economy and the second most populated country in the world. The population of India is expected to increase from 1029 million to 1400 million during the period 2001–2026, an increase of 36% in 26 years, at the rate of 3.35% annually [1]. The level of urbanization of the country has increased from 17.35% to 31.2% in the last 60 years and is expected that as much as 50% of Indian population will live in cities in next 10 years [2]. Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, which generate thousands of tons of municipal solid waste (MSW) daily. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020 [3]. An important feature of India's urbanization is the phenomenal concentration of the population in Class I cities (metropolitan cities), urban agglomerations/cities having a population of more than 1 million, as depicted by the increase in the number of metropolitans from 35 to 46 in the last decade [1]. Among these metropolitans, Greater Mumbai is India's largest city with a population of 18.4 million, followed by Delhi and Kolkata.

It has been estimated that urban India is generating approximately 1,88,500 tonnes of municipal solid waste per day (68.8 million tonnes per year). The capital of India, Delhi generates approximately 11,558 tonnes of municipal solid waste daily [4]. The generation rate is about 700 gm/person/day, which is almost five times the national average. Poor collection and inadequate transportation are responsible for the accumulation of MSW at every nook and corner. The collection efficiency ranges between 70% and 90% in the major metro cities in India, whereas in several smaller cities collection efficiency is below 50% [5].The management of MSW is going through a critical phase, due to the unavailability of suitable facilities to treat and dispose off the larger amount of MSW generated daily in metropolitan cities. Generally, MSW is disposed off in low-lying areas without taking any precautions or operational controls. Therefore, municipal solid waste management is one of the major environmental problems of Indian megacities. It involves activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes. But, in most cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. Landfills have not been designed with liners or leachate collection and treatment systems. Leachate is the liquid that leaches from a landfill. Any precipitation or external source of water contributes to leachate

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Vol. 5, Issue 4, April 2016

generation. The amount of leachate generated is dependent on the available water, landfill constituents, its surface and the foundation soils.

The management of municipal solid waste requires proper infrastructure, maintenance and upgradation for all activities. This becomes increasingly expensive and complex due to the continuous and unplanned growth of the city. The difficulties in providing the desired level of public service in the urban centres are often attributed to the poor financial status of the municipal corporations.

II. LITERATURE SURVEY

Kumar *et al*. (2001) talked about daily municipal waste generated and ways of its disposal. The most common method of disposal being land filling, the various shortcomings of the landfills were discussed like lack of proper liner and leachate collection and treatment systems. The authors also calculated the leachate generated in New Delhi yearly, by taking the average of the precipitation and pan evaporation data collected during the period 1987-1999, by applying the water balance method. The various leachate generation parameters have been shown in Fig.1.

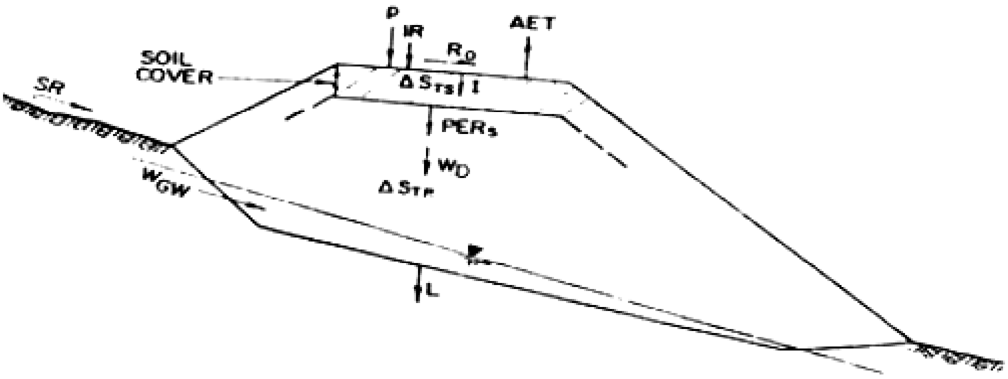

Fig. 1: Leachate generation parameters. [7]

where,
SR = Input water from surrounding surface runoff,
W_{GW} = Water from the groundwater underflow,
P = Input water from precipitation,
IR = Input water from irrigation,
I = Infiltration,
R_o = Surface runoff,
dS_{TS} = Change in moisture storage in soil,
PER_S = Portion of I that will percolate through the soil cover,
W_D = Water from decomposition of solid waste,
dS_{TR} = Change in moisture storage in refuse,
L = Amount of leachate generated, and
AET = Actual Evapotranspiration (i.e. the sum of water loss from evaporation and plant water use).

Using the parameters shown and explained in Fig. 1, the water balance method can be applied which allows the estimation of percolation based on one-dimensional flow, conservation of mass, and the retention and transmission characteristics of the soil cover and solid waste in the landfill.

Kumar and Alappat (2003) have put forward the results of the experimental work carried out by them at an active landfill site in Okhla Phase I in New Delhi, India, to ascertain the composition of leachate, and its effect to the ground water below the site. They also studied the variation in the leachate composition with the age of deposition of solid.

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Vol. 5, Issue 4, April 2016

This study indicated that it might be worthwhile to use different methods for the treatment of leachate from different parts of landfill, if collected separately. The study was concluded with a few suggestions for the flaws seen on the landfill site.

Table 1: Physical and Chemical Characteristics of MSW at Okhla landfill site. [9]

(A) Physical Characteristics (All values are in percent by wet weight)				
S. No.	Parameters	Minimum	Maximum	Average
1	Biodegradable	23.79	30.62	28.62
2	Paper	03.10	05.42	03.78
3	Plastic	03.57	06.14	04.45
4	Metal	00.03	01.10	00.10
5	Glass & Crockery	00.38	02.10	01.45
6	Bioresistant	17.00	23.36	19.73
7	Inert	30.75	41.80	32.70
(B) Chemical Characteristics (All values are in percent by dry weight)				
S. No.	Parameters	Minimum	Maximum	Average
1	Moisture	22.97	30.11	25.58
2	Organic Carbon	10.77	19.81	14.82
3	Nitrogen as N	00.52	00.74	00.65
4	Phosphorus as P_2O_5	00.22	00.33	00.27
5	Potassium as K_2O	00.44	01.22	00.91
6	C/N Ratio	20.71	26.77	22.80
7	Lower Calorific Value (Kcal/Kg)	380.0	610.0	528.5

Table 1 lists out the physical and chemical characteristics of the municipal solid waste at the landfill site in Okhla Phase I. As it is evident, waste mostly comprises of inert and biodegradable materials, containing high calorific values nad moisture content.

Kumar and Alappat (2005) described a concept of the leachate pollution index, a tool for quantifying the leachate's contamination potential of landfill sites. Table-2 gives the list of the pollutant parameters along with their respective weights that are included in the LPI. The system was developed by surveying 80 penalists, using Rand Corporation's Delphi Technique. The theoretical range of LPI is from 5 to 100.
Along with this, the authors also demonstrated its practical application by comparing the leachate contamination potential of two active and two closed landfill sites in Hong Kong. Through this study, it was found out that leachate generated from the closed landfills can have equal or even more contamination potential in comparison to the active landfill sites. Hence, the remediation measures and post-closure monitoring should be ensured at the closed landfills, till the leachate generated is stabilized and poses no further threat to the environment.

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International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 4, April 2016

Table 2: Weights of the pollutant parameters included in leachate pollution index (LPI). [10]

S. No.	Pollutant	Significance	Pollutant weight
1	pH	3.509	0.055
2	Total Dissolved Solids	3.196	0.050
3	BOD5	3.902	0.061
4	COD	3.963	0.062
5	Total Kjeldahl Nitrogen	3.367	0.053
6	Ammonia Nitrogen	3.250	0.051
7	Total Iron	2.830	0.045
8	Copper	3.170	0.050
9	Nickel	3.321	0.053
10	Zinc	3.585	0.056
11	Lead	4.019	0.063
12	Total Chromium	4.057	0.064
13	Mercury	3.923	0.062
14	Arsenic	3.885	0.061
15	Phenolic Compounds	3.627	0.057
16	Chlorides	3.078	0.048
17	Cyanide	3.694	0.058
18	Total Coliform Bacteria	3.289	0.052
	Total	63.165	1.000

Agarwal *et al* (2005) investigated and analyzed recycling of MSW in the Indian capital city of Delhi. Market mechanisms of the recycle trade in the city were studies and the details of the informal sector were revealed by carrying out extensive interviews and surveys with recyclists from various slums. The authors were also able to identify the complete hierarchy from recyclists to the final sellers of the recycled products (Fig. 2) and also the profits at each level were determined. The MSW sector is labor intensive and comprises a chain constituted by recyclists, recyclable dealers and finally the recycler units at the top. It has a hierarchical structure, with increasing specialization and decreasing numbers as we move upwards. At every stage of the transaction, waste is sorted more specifically and in bulk, to assort the most valuable components.

In the end, two models were also proposed to evaluate the possibility of formalizing the unorganized waste trade. Finally, the study was concluded by saying that it is possible to organize the sector but this would leave a huge number of recyclists unemployed, who mainly belong to the poorest strata of the society.

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

Figure-2:Waste recycle hierarchy in Delhi. [11]

Sharholy *et al.* (2008) provided a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practised in India. The study pertaining to MSWM for Indian cities was carried out to evaluate the current status and identify the current problems. Also, various adopted treatment technologies for MSW like landfilling, recycling of organic waste, thermal treatment technologies and recovery of recyclable materials were critically reviewed, along with their advantages and limitations. The study was concluded with a few fruitful suggestions, which may be beneficial to encourage the competent authorities/researchers to work towards further improvement of the present system.

Talyan *et al.* (2008) discussed and evaluated the present state of municipal solid waste in Delhi. The paper also talked about the various Policies and legislative frameworks for MSWM in India along with the generation and composition of MSW in Delhi. The authors also talked about collection, storage, transportation and treatment of the MSW in Delhi, and also the various other initiatives of the government towards improvement of MSWM were described briefly. The study concluded that the existing facilities and policies for MSWM in Delhi are inadequate in dealing with the ever increasing population and the rapid pace of urbanization.

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

Table 3: Summary of Acts & Rules on MSW in India. [14]

Acts and Rules	Brief Description	Issuer
Municipal Solid Waste (Management and Handling) Rules, 2000	Set criteria and procedure for municipal authorities for collection, segregation, storage, transportation, processing and disposal of MSW. The criteria and procedure for management and handling of MSW are specifies in schedule II, specifications for landfill sites in schedule III and setting up of waste processing facilities with the adoption of appropriate technology in schedule IV.	MoEF*, Govt. Of India.
The Delhi plastic bag (Manufacture, Sales and Usage) And Non-Biodegradable Garbage (Control) Act, 2000	Prevents manufacturing, sale, etc of recycled plastic bags for food packaging and also prohibits throwing or depositing non-biodegradable garbage in public drains, roads and places open to public view. Act also defines that the placement of receptacles and places for deposit of garbage is the responsibility of MCD, NDMC or DCB.	Legislative Assembly of the National Capital Territory of Delhi.
Hazardous Wastes(Management and Handling) Rules, 1989 and Amendments Rules, 2000 and 2003	Specify the processes, hazardous wastes, constituents, concentration limits and waste applicable for import and export. The occupier should take responsibility for proper management and handling of waste either himself or through the operator of a facility. The different categories of the hazardous waste are specified in schedule I.	MoEF, Govt. Of India.
The Bio-Medical Waste (Management and Handling) Rules, 1998 and Amendment Rules, 2003	Recommended treatment and disposal options according to the 10 different categories of biomedical waste generated are defined in schedule I of the rules. Standards for the treatment technologies are given in schedule V.	MoEF, Govt. Of India.
Delhi Municipal Corporation Act, 1957	Early legislation, deals with the environment pollution caused by MSW. The provisions related to MSW are defined under chapter 3 'Functions of the Corporations' and chapter 7 'Sanitation and public health'.	Act of Parliament, Govt. Of India

*MoEF - Ministry of Environment and Forest

Table 3 lists the acts and rules drafted by the GoI and the state governments to deal with solid waste management. Besides these rules, a comprehensive manual on Municipal Solid Waste Management was published by the CPHEEO in 2000, under the Ministry of Urban Development for the guidance of urban local bodies to implement the MSW Rules 2000.

Despite consistent efforts of different regulatory bodies and directives from Honourable Supreme Court of India, the implementation of these rules is still a distant dream. As shown in Fig. 3, there has been insignificant progress in the matter of processing of waste and construction of sanitary landfills, and only about one-third compliance in the remaining five steps.

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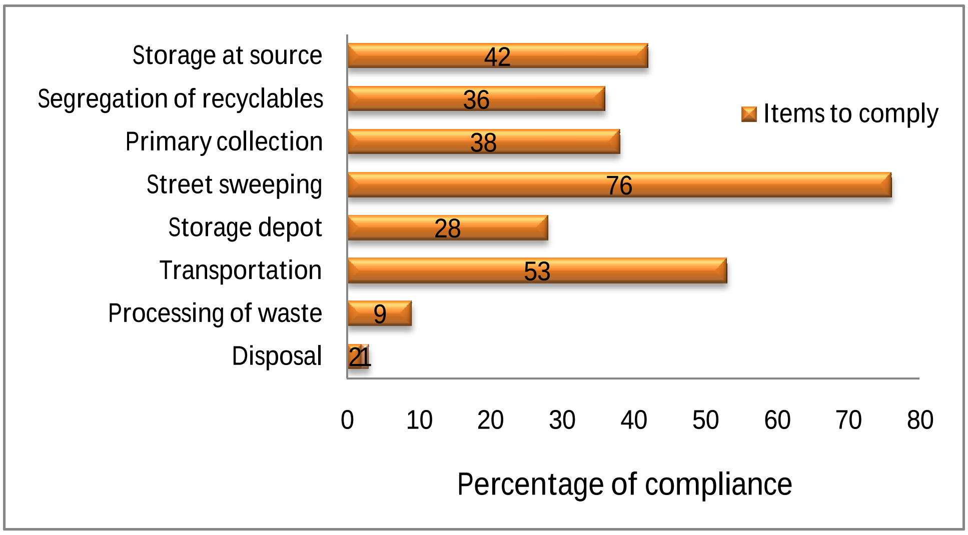

Figure-3: Status of compliance of MSW Rules 2000 by Class-1 cities. [14]

Kumar *et al.* (2009) presented an assessment of the existing situation of the MSWM of major cities in India. Quantification, analysis of physical composition, and characterization of MSW was done by extensive field investigation in each of the 59 identified cities. Fig. 4 shows the salient findings with respect to different components such as waste quantity, waste generation rate, and different categories of waste of MSWM systems in all 59 cities, based on the data collected and extensive field investigations.

The MSW management status (as per MSW Rules, 2000) has also been assessed, and an action plan for better management has been formulated. The study shows that there are various shortcomings in the existing practises pertaining mainly to inadequate manpower, financial resources, implements, and machinery required for effectively carrying out various activities for MSWM.

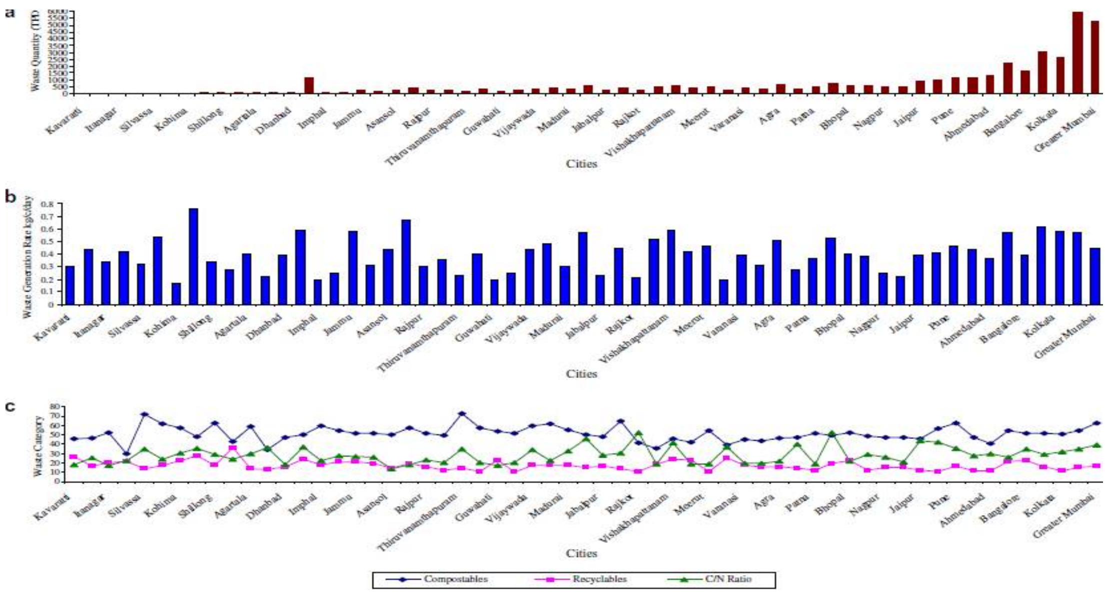

Figure-4: Waste quantity generation rates, and waste category for cities in India. (a) Waste quantity (TPD) vs. cities, (b) Waste generation rates (kg/c/day) vs. cities, and (c) Waste category vs. Cities. [15]

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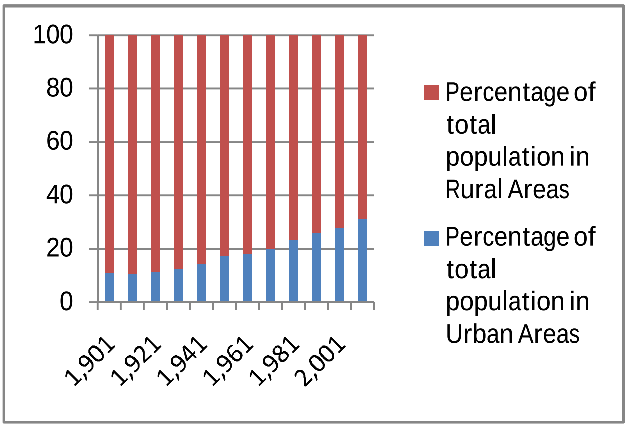

Figure 5: Level of Urbanization. [4]

Year	Per capita waste generation (g/day)	Total urban municipal waste generation (MT/yr)
1971	375	14.9
1981	430	25.1
1991	460	43.5
1997	490	48.5
2025	700	Double the amt. Of 1997

Table-4:Waste generation trends in India. [4]

Vij (2012) presented a report on urbanization and solid waste management in India. The report focused on the upcoming trends of urbanization in India and accordingly the changes in waste generation. Fig. 5 clearly depicts that the percentage of population living in urban areas has increased from 17.9% in 1951 to 31.16% in 2011. Urbanization directly contributes to waste generation, as modern urban living brings on the problem of waste because of everything in packaging and fast food products which increases the quantity of waste and changes its composition with each passing day, which is prominent from Table 4.

The paper also evaluated the current practices prevalent in India to deal with solid waste and problems associated with it, along with the measures to deal with the waste in healthy and environment friendly manner so that it may prove a resource instead of waste.

III. CONCLUSION

Solid waste management has become acute in Delhi, the capital of India. With an ever increasing population and a rapid pace of urbanization, the effects of poor waste management practices on human health and the environment have never been more pronounced. Municipal Corporation of Delhi and the Government of Delhi have realized the seriousness of the situation and framed guidelines in the form of the Master Plan (2005–2021) for disposal and treatment of MSW for the entire state of Delhi. MCD took a big step towards improving municipal solid waste management practices, by privatizing the collection, segregation, transportation and disposal of waste. Non-government organisations, with the assistance from resident welfare associations (RWAs), have played an important role in establishing an infrastructure for Door To Door Collection (DTDC) services and segregation of waste at the source in certain areas of Delhi; this kind of cooperation needs to be replicated at a larger scale. Public co-operation is essential for successful operation of an effective and well-founded system. The Bhagidari scheme initiated by the Government of Delhi has been instrumental in promoting civil partnership in local governance, in the field of MSWM. More such initiatives need to be taken towards educating people about correct practices of solid waste disposal. Initiatives taken by policy makers never yield results unless matched by proper implementation at every level. It is clear that any substantial change in the present scenario is not possible without a three-way partnership of the government, the private sector and the citizens. Finally, there is also a need to develop a methodology of research for developing interactive techniques for system's design and operational control.

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Vol. 5, Issue 4, April 2016

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