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Self-Sustaining and Synthesized Waste to Fuel Conversion System

Tarun Rathitra[1]
[1]Chettinad Vidyashram

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When we analyze the above six categories, it is clear that in summary a) we need heat energy and water as additional inputs for certain processes, b) we have potential to generate heat through bio gas, combustible waste etc, c) we can generate fuel from plastic, d) we can create paper and e) we can get metal blocks and ceramic/glass recycle material. If we can make the heat generated sufficient to meet the needs of metal recycling, paper pressing and plastic to fuel conversion, we can create a self-sustaining waste management cycle, which will only need water from outside and without no additional input generate fuel, paper, metal blocks and ceramic/glass recycle material. Primary interest in today's word of waste management seems to be on gasification of unsorted

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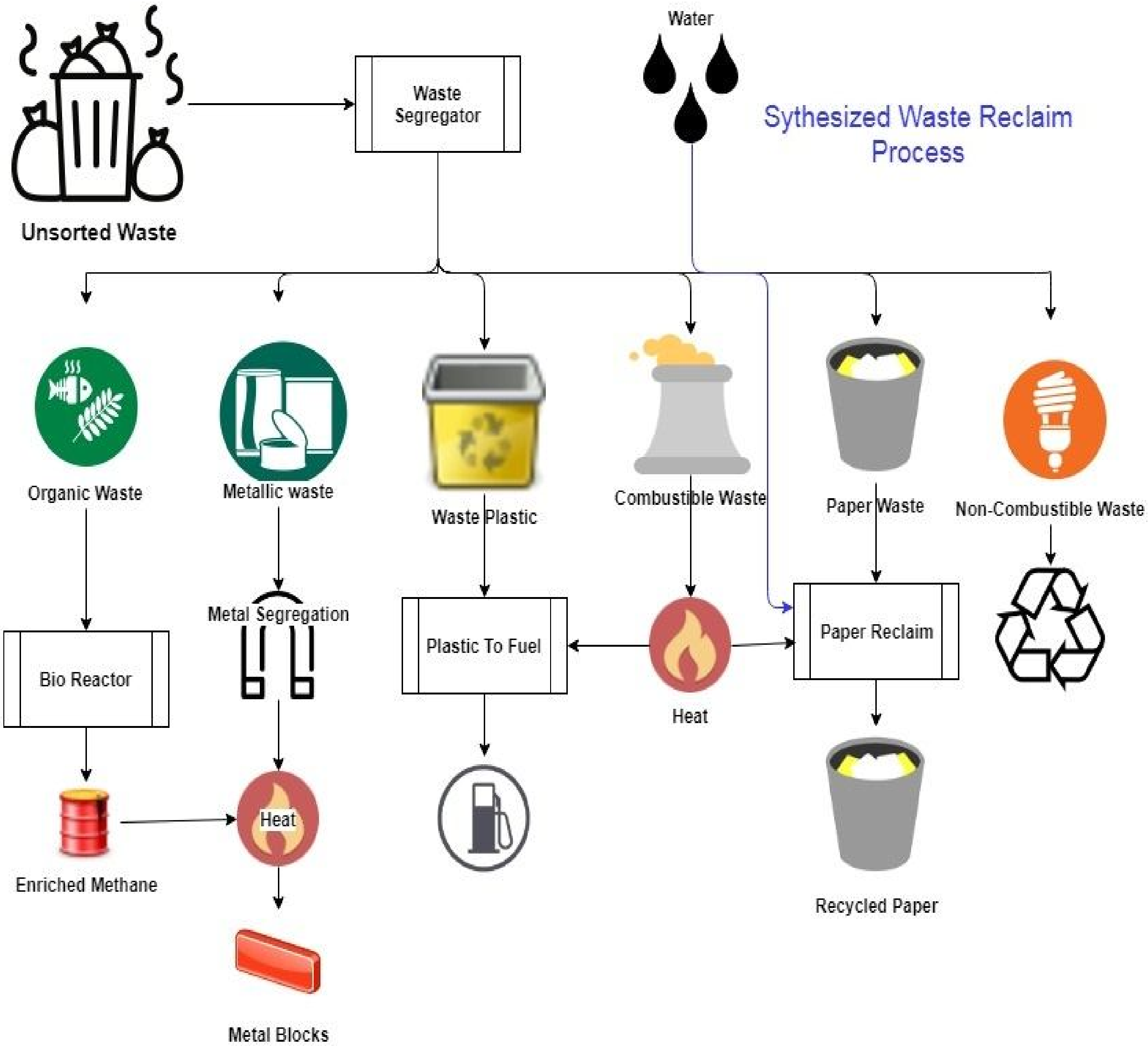

However, if this has to be successful and profitable as a solution, we need a certain composition amongst the waste categories that leads to adequate heat production in-process. To arrive at the right mix of various waste categories, we need to look at two data points. Firstly, we need to understand the standard proportion of various categories and secondly we need to study the measure of heat energy generated for certain measures of organic and combustible waste.

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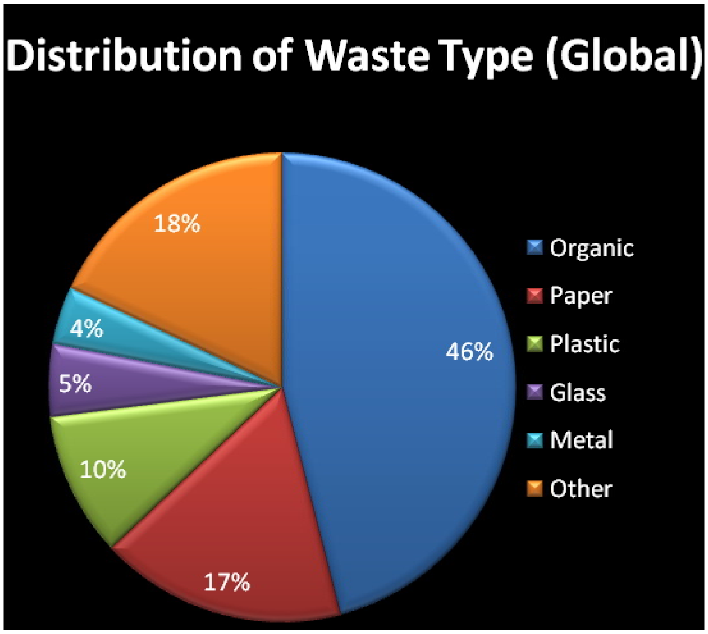
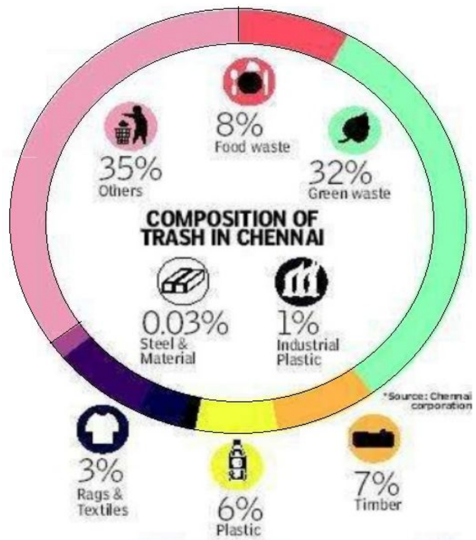
While each geography has its own mix of various waste categories, at global level waste composition is as depicted in the pie chart. The organic waste is nearly 50%, with another 18% as combustible waste. This 70% waste should be able to produce enough energy to process the 30% which comprise paper, plastic and metal.





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Area	**Residential & Commercial**	**Hospital**	**Total**	**e-waste**	**Construction Debris**
Chennai City	2620	80	2700	5	500
Municipalities	1073	11	1084	2	50
Town Panchayats	207	1	208	1	NA
Panchayat Union	255	1	256	2	-
Total	4155	93	4248	10	550

VI. ENERGY NEEDS AND MASS TO ENERGY CONVERSION RATIOS

A. Plastic to Fuel conversion

Indian Institute of Petroleum (IIP) of CSIR has developed a process in year 2014, which can convert more than 60% of plastic waste into gasoline or diesel. The plastic to fuel conversion volumetric is in the following form:

1) Mass of one plastic bottle: 30g
2) About 34 plastic bottles make up around 1kg of plastic
3) 1 kg of plastic converts to → 650 ml of gasoline
4) In other words, 100kg or 3400 bottles of plastic converts to → 65 litres of gasoline

To enable 30 kg of plastic to convert to gasoline, heating has to be done at 350 degrees for 4 hours with 6kW power consumption. In other words, 24kWh energy is required to convert 30kg of plastic to fuel.

5) Amount of heat required to recycle 1 plastic bottle: 53.91 kJ
6) Amount of heat required to recycle 100kg plastic: 179.7 MJ
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8) At 3Rs/kWh rate for electricity, this means → 240 Re for 65 litres of gasoline

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The below statistics provides a view on how much volume of waste produces what measure of energy or fuel:

1) The conversion ratio for waste plastic into fuel averages 65%.
2) Approximately 65 litres of gasoline is extracted from 100kg of plastic.
3) 1000 kg of biodegradable waste produces 30kg of methane.

4) 1kg of methane yields 55.5 MJ or 15.42 kWh of energy
5) Amount of energy in 1 kg of ethanol: 25MJ

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A. Zonal waste composition at Alandur

At Arsha Vidya Mandir School, we collected data sampling for determining the waste proportion in the Alandur zone. The following were the extrapolated waste distribution data we arrived at from the collected sample, for Alandur:

Composition of the municipal solid wastes in Alandur zone (in tonnes)	
Biodegradable matter	96.1
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Metals	1.9
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The following were the extrapolated waste distribution at Chennai city level

Composition of the municipal solid wastes in chennai extrapolated based on velachery region	
Biodegradable matter	50%
Glass	4%
Plastics, Leather and rubber	4%
Paper and Rags	10%
Metals	1%
Household hazardous	1%
Inert materials	30%

B. Hence, based on the aboveAlandur zone data and the fuel conversion parameters, the following can be arrived at:

1) From 7.7 tonnes of plastic 4,996 litres of gasoline can be extracted (approximately).
2) From 96 tonnes of biodegradable matter,2,882 kilos of methane can be extracted.
3) Also, 96 tonnes of biodegradable matter yields 44,455.86kWh of energy.
4) 7.7 tonnes of plastic to fuel conversion needs only 6,160kWh units of energy
5) 19.2 tonnes of paper needs about 4000 kWh units of energy for recycling
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7) In total, about 12,000 kWh units of energy will be used for synthesized reclaim

Hence if we look at a synthesized waste reclaim model as delineated in section IV, Alandur zone can produceapproximately a net of 2200 kilos of methane, 4,996 litres of gasoline and self-sufficiently recycle 19.2 tonnes of paper & 1.9 tonnes of metal with no additional energy needs.

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1) From 104 tonnes of plastic 67,600 litres of gasoline can be extracted (approximately).
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Based on the above data points, we can conclude that if designed properly, we can make a self-propelling waste value claim processing system that can help manage waste better and also produce fuels, metal blocks and paper at very low cost.

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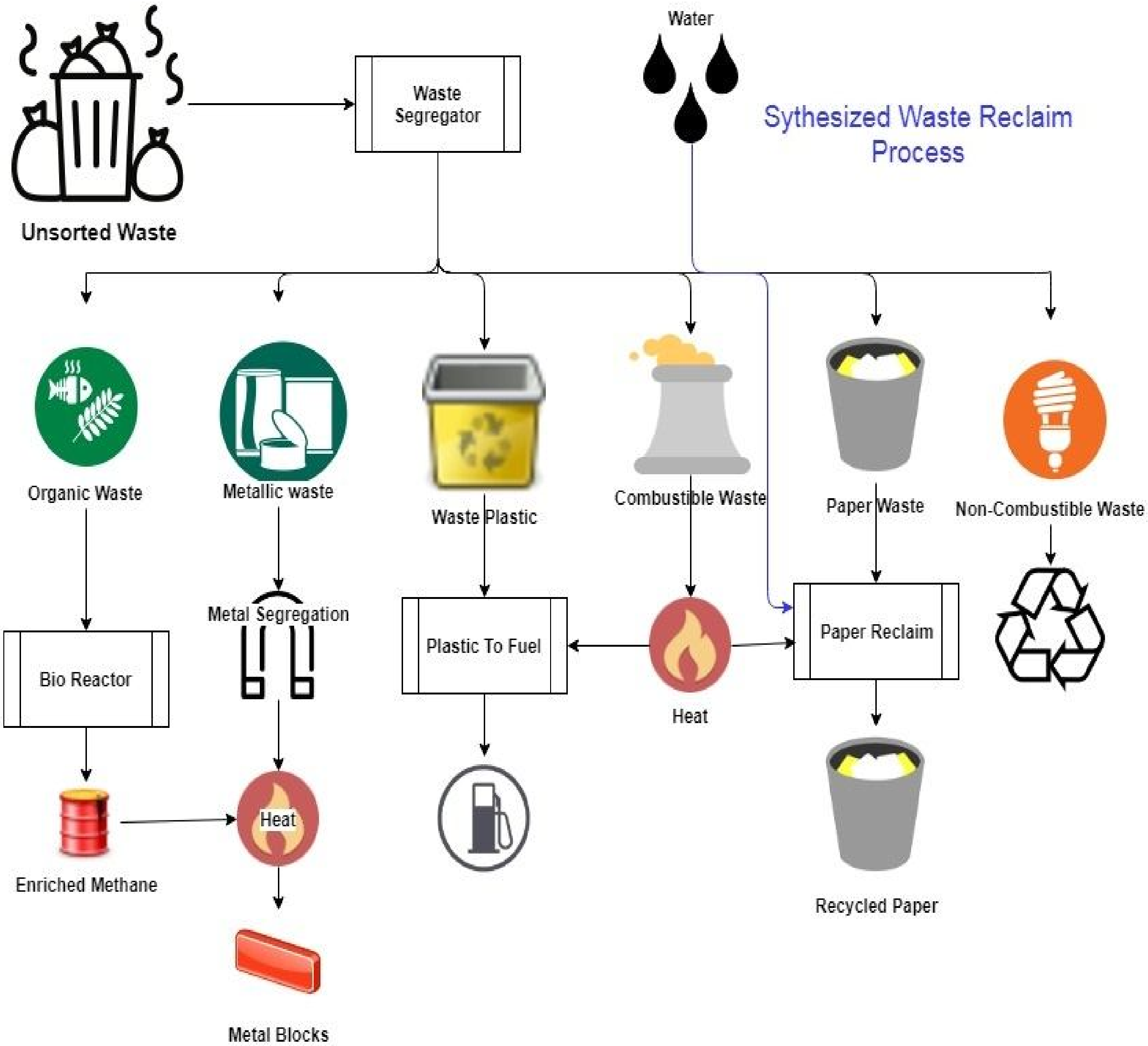

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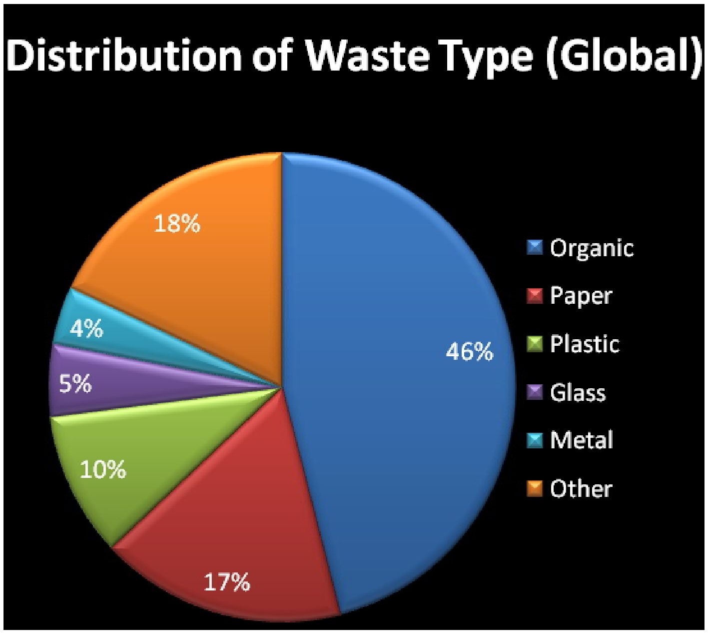

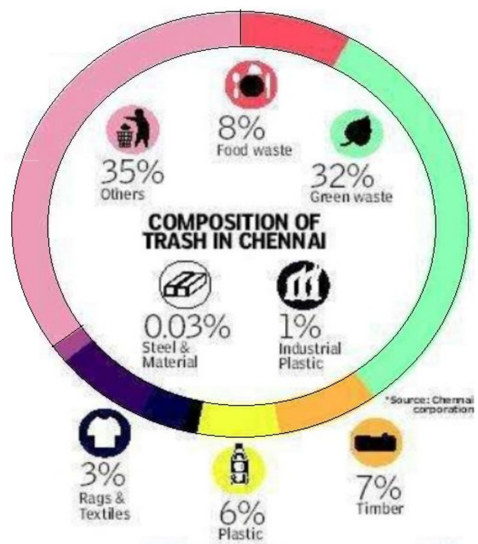

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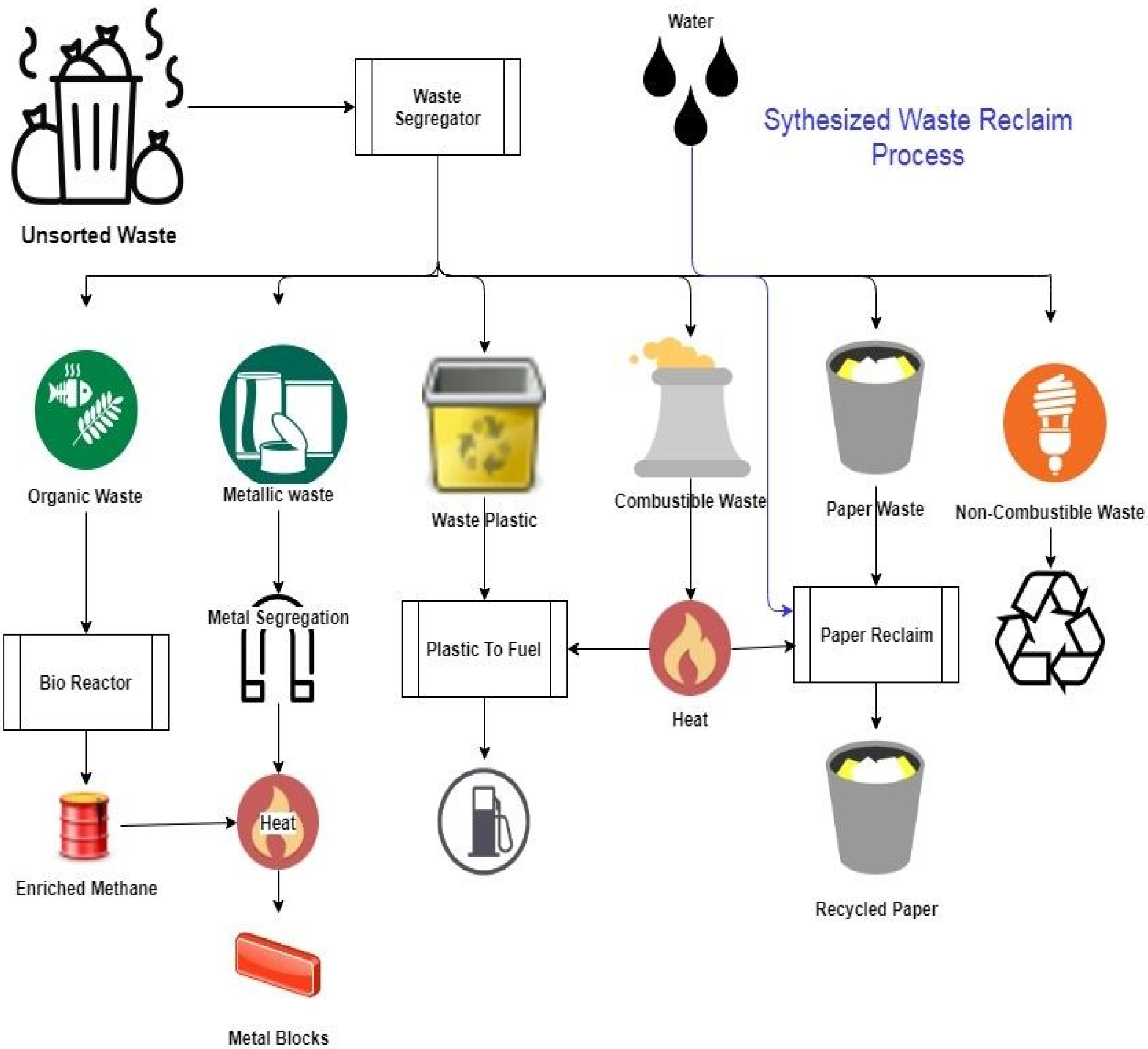

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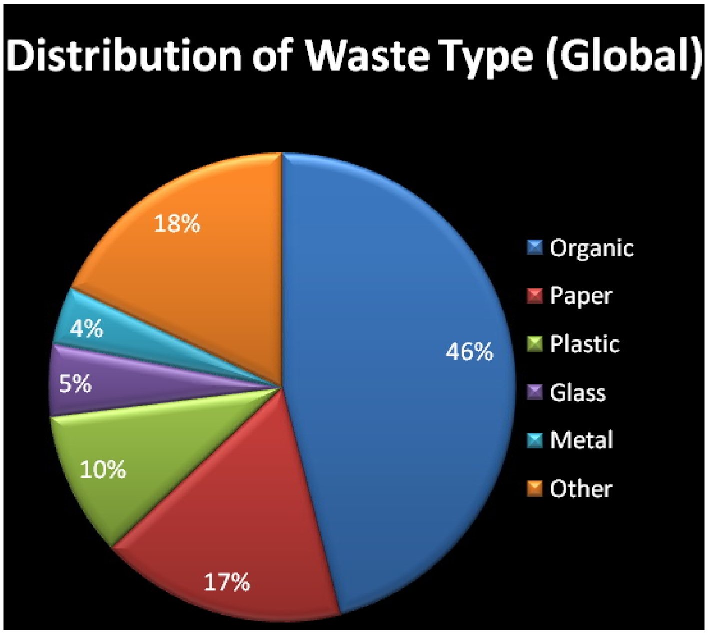
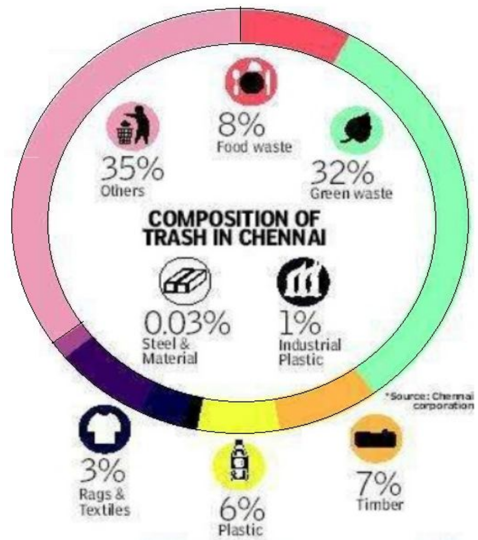
V. GLOBAL AND CHENNAI CITY WASTE COMPOSITIONS

While each geography has its own mix of various waste categories, at global level waste composition is as depicted in the pie chart. The organic waste is nearly 50%, with another 18% as combustible waste. This 70% waste should be able to produce enough energy to process the 30% which comprise paper, plastic and metal.





The below table provides a view on waste generation in chennai region

Solid Waste Generated Daily in CMA (in tonnes)					
Area	**Residential & Commercial**	**Hospital**	**Total**	**e-waste**	**Construction Debris**
Chennai City	2620	80	2700	5	500
Municipalities	1073	11	1084	2	50
Town Panchayats	207	1	208	1	NA
Panchayat Union	255	1	256	2	-
Total	4155	93	4248	10	550

VI. ENERGY NEEDS AND MASS TO ENERGY CONVERSION RATIOS

A. Plastic to Fuel conversion

Indian Institute of Petroleum (IIP) of CSIR has developed a process in year 2014, which can convert more than 60% of plastic waste into gasoline or diesel. The plastic to fuel conversion volumetric is in the following form:

1) Mass of one plastic bottle: 30g
2) About 34 plastic bottles make up around 1kg of plastic
3) 1 kg of plastic converts to → 650 ml of gasoline
4) In other words, 100kg or 3400 bottles of plastic converts to → 65 litres of gasoline

To enable 30 kg of plastic to convert to gasoline, heating has to be done at 350 degrees for 4 hours with 6kW power consumption. In other words, 24kWh energy is required to convert 30kg of plastic to fuel.

5) Amount of heat required to recycle 1 plastic bottle: 53.91 kJ
6) Amount of heat required to recycle 100kg plastic: 179.7 MJ
7) For 100kg of plastic to convert to 65 litres of gasoline → 80kWh energy is required
8) At 3Rs/kWh rate for electricity, this means → 240 Re for 65 litres of gasoline

B. Bio-degradable waste to bio-fuel conversion

The below statistics provides a view on how much volume of waste produces what measure of energy or fuel:

1) The conversion ratio for waste plastic into fuel averages 65%.
2) Approximately 65 litres of gasoline is extracted from 100kg of plastic.
3) 1000 kg of biodegradable waste produces 30kg of methane.

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4) 1kg of methane yields 55.5 MJ or 15.42 kWh of energy
5) Amount of energy in 1 kg of ethanol: 25MJ

VII. ALANDUR ZONE FUEL GENERATION FEASIBILITY VOLUMES

A. Zonal waste composition at Alandur

At Arsha Vidya Mandir School, we collected data sampling for determining the waste proportion in the Alandur zone. The following were the extrapolated waste distribution data we arrived at from the collected sample, for Alandur:

Composition of the municipal solid wastes in Alandur zone (in tonnes)	
Biodegradable matter	96.1
Glass	7.7
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Paper and Rags	19.2
Metals	1.9
Household hazardous	1.9
Inert materials	57.6

The following were the extrapolated waste distribution at Chennai city level

Composition of the municipal solid wastes in chennai extrapolated based on velachery region	
Biodegradable matter	50%
Glass	4%
Plastics, Leather and rubber	4%
Paper and Rags	10%
Metals	1%
Household hazardous	1%
Inert materials	30%

B. Hence, based on the aboveAlandur zone data and the fuel conversion parameters, the following can be arrived at:

1) From 7.7 tonnes of plastic 4,996 litres of gasoline can be extracted (approximately).
2) From 96 tonnes of biodegradable matter,2,882 kilos of methane can be extracted.
3) Also, 96 tonnes of biodegradable matter yields 44,455.86kWh of energy.
4) 7.7 tonnes of plastic to fuel conversion needs only 6,160kWh units of energy
5) 19.2 tonnes of paper needs about 4000 kWh units of energy for recycling
6) 1.9 tonnes of metal needs 1540 kWh units of energy
7) In total, about 12,000 kWh units of energy will be used for synthesized reclaim

Hence if we look at a synthesized waste reclaim model as delineated in section IV, Alandur zone can produceapproximately a net of 2200 kilos of methane, 4,996 litres of gasoline and self-sufficiently recycle 19.2 tonnes of paper & 1.9 tonnes of metal with no additional energy needs.

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On this proportional basis, if we consider entire chennai region total waste of 2620 tonnes of domestic waste, we can make the following deductions:

Chennai municipal waste distribution	
Biodegradable matter	1310
Glass	104
Plastics, leather and rubber	104
Paper and rags	262
Metals	26
Household and hazardous	26
Inert materials	79

A. Hence, based on the above Chennai city data and the fuel conversion parameters, the following can be arrived at:

1) From 104 tonnes of plastic 67,600 litres of gasoline can be extracted (approximately).
2) From 1310 tonnes of biodegradable matter, 39,300 kilos of methane can be extracted.
3) Also, 1310 tonnes of biodegradable matter yields 606,625kWh of energy.
4) 104 tonnes of plastic to fuel conversion needs only 84,058kWh units of energy
5) 262 tonnes of paper needs about 54,583 kWh units of energy for recycling
6) 26 tonnes of metal needs 21,014 kWh units of energy
7) In total, about 160,000 kWh units of energy will be used for synthesized reclaim

Hence if we look at a synthesized waste reclaim model as delineated in section IV, Chennai city can produce approximately a net of 30,000 kilos of methane, 67,600 litres of gasoline and self-sufficiently recycle 104 tonnes of paper &26 tonnes of metal with no additional energy needs.

IX. CONCLUSION

Based on the above data points, we can conclude that if designed properly, we can make a self-propelling waste value claim processing system that can help manage waste better and also produce fuels, metal blocks and paper at very low cost.

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Self-Sustaining and Synthesized Waste to Fuel Conversion System

Tarun Rathitra[1]
[1]Chettinad Vidyashram

Abstract: Waste management initiatives have so far either a) considered all the waste as a collective lot with a composition of various types of material which can be combusted together to reclaim some value or b) have segregated the waste or suggested recycling individually. This study has focused on synthesizing the waste category value reclaim in a way that the energy output from some of the categories of waste reinforces the value reclaim from some of the other categories, thereby creating a self-propelling energy value chain that can produce a net output of fuels and recycled matter. It was arrived that Alandur zone can produce approximately a net of 2200 kilos of methane, 4,996 litres of gasoline and self-sufficiently recycle 19.2 tonnes of paper & 1.9 tonnes of metal with no additional energy needs. Similarly, entire Chennai city can produce approximately a net of 30,000 kilos of methane, 67,600 litres of gasoline and self-sufficiently recycle 104 tonnes of paper & 26 tonnes of metal with no additional energy needs.

I. INTRODUCTION

There have been numerous studies, production grade design efforts and legal enforcements that have sought to address the handling of solid waste in a way that can be beneficial to the world, but the results have not yet been integrated solutions that are profitable and economically successful. If a country is to generate greater economic returns at lower costs to the environment then it must find ways to extract more value from the resources that it takes from nature, while cutting the burden of emissions and waste. One key means of achieving that is by shifting waste management up the waste hierarchy — reducing waste disposal (for example land filling) and instead focusing on waste prevention, reuse, recycling and profitable recovery. Our planet currently faces the twin challenges of resource depletion and waste accumulation leading to rapidly escalating raw material costs and increasingly expensive waste management systems.

II. WASTE CATEGORIES

The multi tonne scale waste that gets generated across the worldcan be broadly classified into six categories:food supply chain organic waste, waste plastics, metallic wastes, paperwaste, combustible other waste (like wood, cardboard etc)and non-combustible other waste (like glass, ceramic, light bulb etc). Interestingly each of these six categories has its own value reclaim cycle. Amongst these, a) waste plastic that contains large majority of organic polymers which are made up of carbon and other elements (made up of large link of repeat units), needs various processes like gasification, pyrolysis etcto convert the longer hydrocarbon into smaller units of hydrocarbon like naphtha, diesel etc. Thermo fuel is a process of converting waste selected plastic into useful fuel. Similarly b) organic waste like wheat straw surpluses, spent coffee grounds or citrus peels, represent a resource for an integrated, product focused bio-refinery. Likewise, c) segregated waste paper is chopped into tiny pieces, mixed with water and chemicals and heated up to break it down into organic plant material called fibre. Deinking washes the pulp with chemicals to remove printing ink and glue residue, floatation process removes stubborn stains, wet pulp sprayed onto a large metal screen in continuous mode, wherefibres bond with each other, moves through the paper-making machines, heated dry and coated. Metal reclaim process involves d) sorting, processing, shredding, melting, purifying, and solidifying. While the e) combustible waste becomes a source of heat energy, the f) non-combustible waste can be recycled (like ceramic, glass etc).

III. SYNTHESIS OF VALUE RECLAIM PROCESS ACROSS CATEGORIES

When we analyze the above six categories, it is clear that in summary a) we need heat energy and water as additional inputs for certain processes, b) we have potential to generate heat through bio gas, combustible waste etc, c) we can generate fuel from plastic, d) we can create paper and e) we can get metal blocks and ceramic/glass recycle material. If we can make the heat generated sufficient to meet the needs of metal recycling, paper pressing and plastic to fuel conversion, we can create a self-sustaining waste management cycle, which will only need water from outside and without no additional input generate fuel, paper, metal blocks and ceramic/glass recycle material. Primary interest in today's word of waste management seems to be on gasification of unsorted

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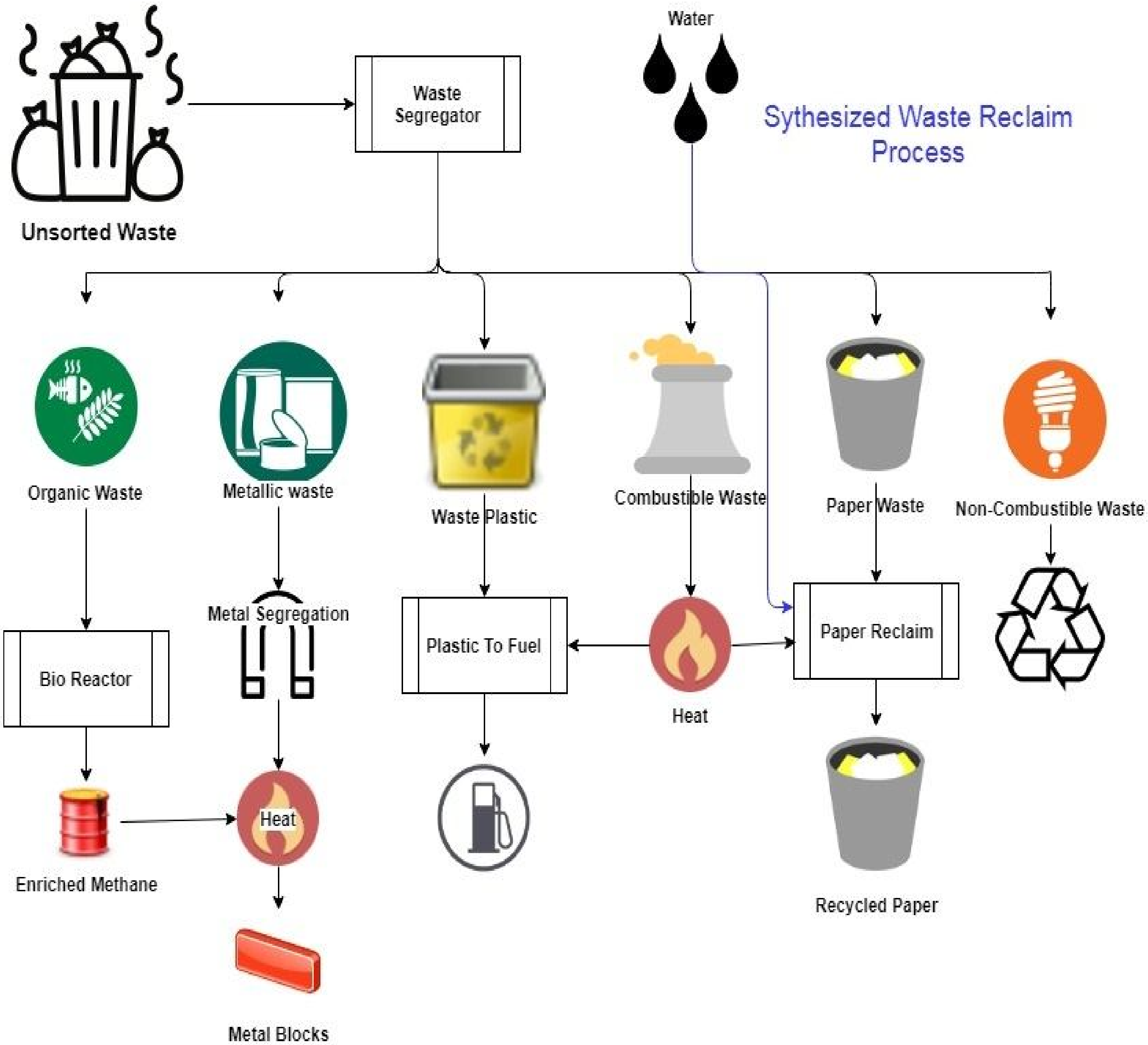
waste, a process for converting unsorted garbage into fuel and electricity without incinerating it, which is considered as a step closer to large-scale commercialization. However, if we consider recycling process models and tools in a synergistic way, where an interdependence is created between the waste categories which finally leads to above output, it would certainly provide opportunities to develop better solid waste management strategies that are self-sustaining.

IV. SYNTHESIS OF VALUE RECLAIM PROCESS ACROSS CATEGORIES

The below process shows how we can synthesize the value reclaim process across the categories of waste.



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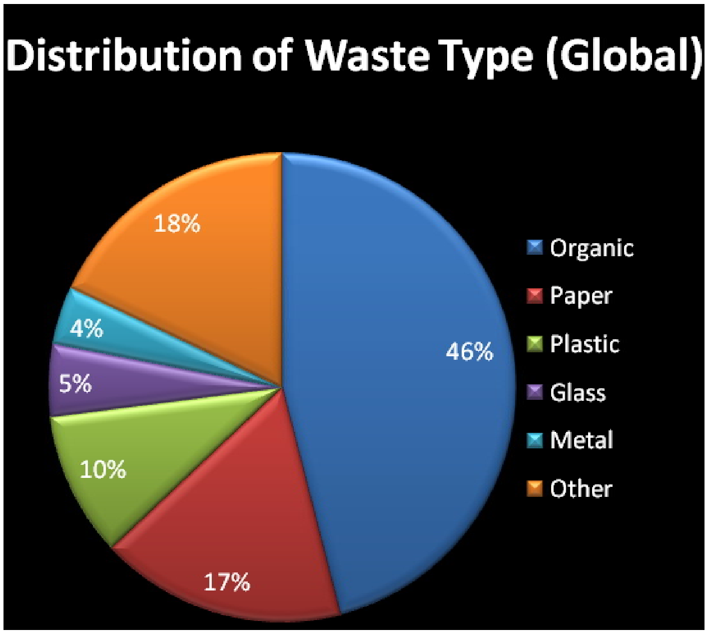

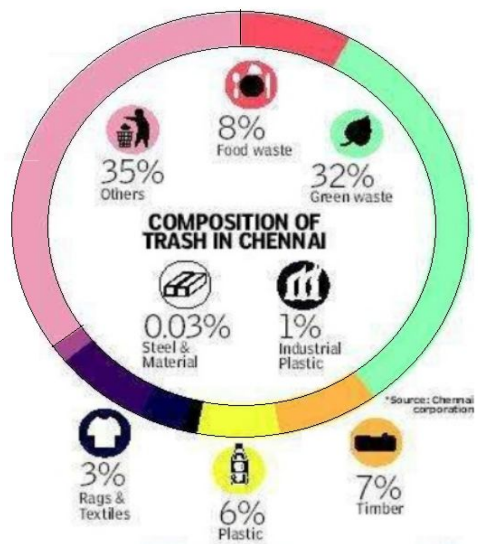

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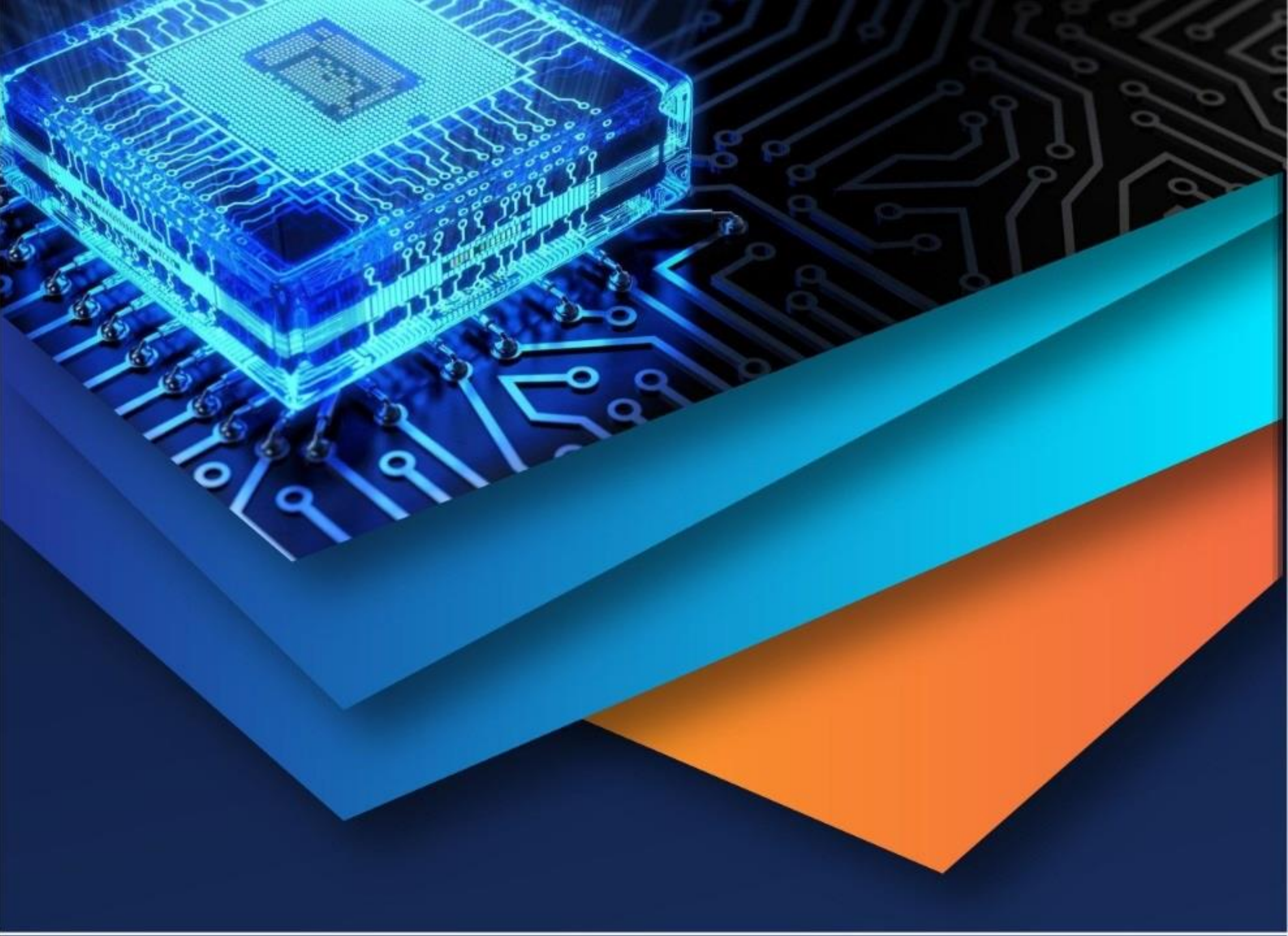

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