



Waste to Watts

Executive Summary

Who We Are	<ul style="list-style-type: none">● Start-up spearheading green waste management solutions and distributed electricity generation● Working with engineering partners in Asia
What We Offer	<ul style="list-style-type: none">● Innovative and affordable <u>waste-to-energy gasification systems</u> that serve the typical American municipality● Promote <u>circular economy</u>
Our Proposal	<ul style="list-style-type: none">● Put in place a <u>0.5 MW Proof-of-Concept facility</u>● Provide solution that will set example for other counties● Install full-scale gasification facilities across the U.S.

Waste Management Challenges

- Landfill capacity
 - 2017 tightening of waste & recycling restrictions by China
- Recycling markets
 - Economically challenged, cost money
- Public concerns
 - Pollution, GHG emissions, odor
- Economic challenges
 - Limited budget for waste management infrastructure
 - High costs of recycling & transport
- Logistical challenges
 - Centralized waste systems

The solution? **Kyklos**

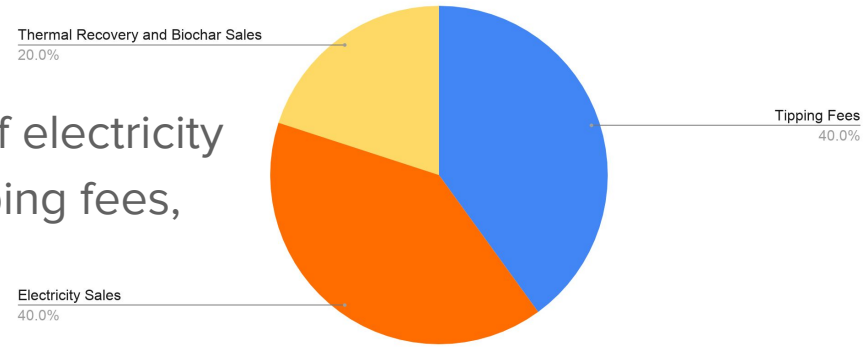
The Kyklos Solution

Gasification offers...

- 95% MSW volume reduction
- Handles waste that is not compostable or recyclable
- Can also handle recyclable and compostable waste if it's too expensive to separate and process

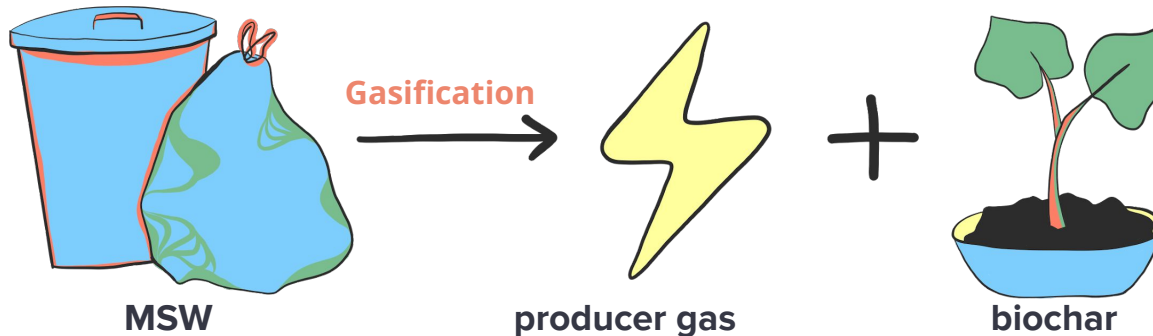
Waste can be converted to...

- 15,000 MT of waste can produce 1 MW of electricity
- Multiple revenue streams: electricity, tipping fees, biochar, and thermal recovery
- \$1.5M+ / 15,000 MT of waste



Benefits of Kyklos' Gasification System

- Self-sufficient waste management
- Wide range of waste types & loads
- Flexible outputs for a changing green economy
- Useful solid output (char)
- Multiple incentives (waste, green electricity)
- Favorable pollution characteristics compared to alternatives



MSW Categories

Can Be Gasified

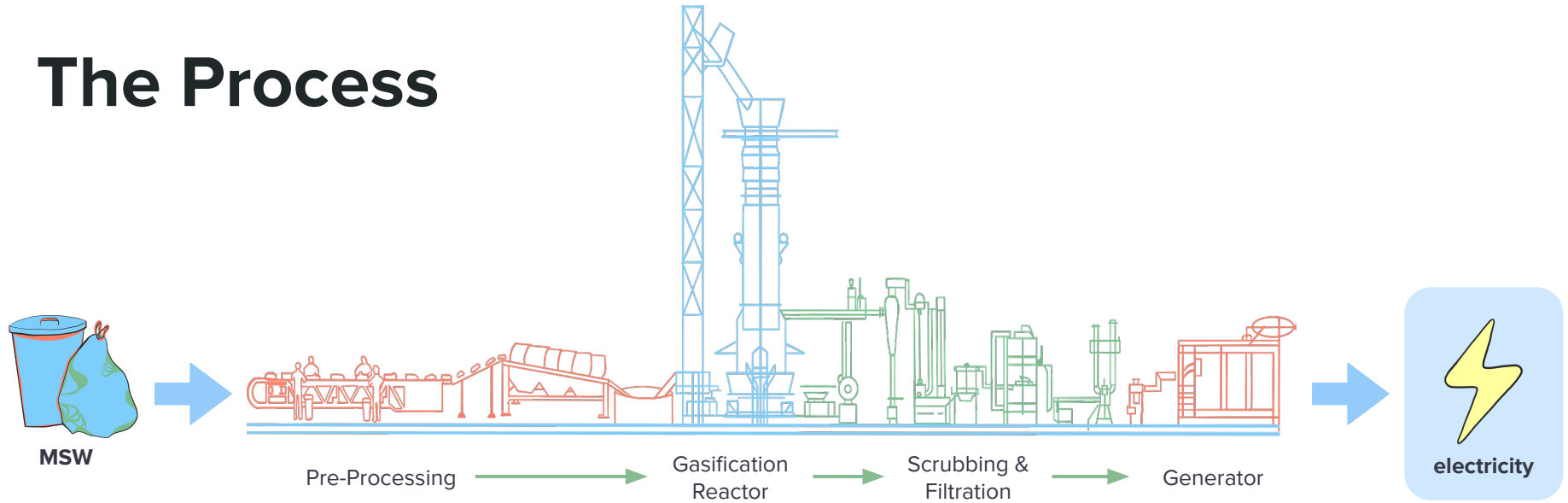
Need To Be Removed



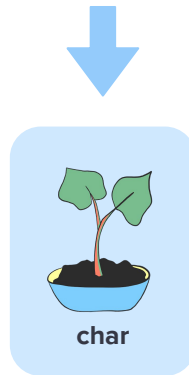
Large pieces of...

- Glass
- Metals
- Building materials
- Sand, soil, & stones
- PVC
- Concentrated food items/ very wet waste

The Process



Organic materials are heated to high temperatures without oxygen, converting carbon into syngas and biochar. The syngas is combusted to produce electricity.



Our Technological Advantages

Flexible Gasifier

Proprietary design can process a wide range materials together.

Minimized

Pre-preprocessing Costs

Limited sorting, sizing, and drying of inputs.

No Waste Water

Dry scrubbing system eliminates waste water by cleaning syngas with high temperatures instead of water scrubbing.

High Operational Reliability

Proprietary design reduces jamming by separating and removing non-gasifiable materials from sensitive areas.

Multiple Revenue Streams

Green electricity, tipping fees, biochar output, and thermal recovery.

Flexible Range of Output Ratings (1.5-150 KMT/yr)

(0.5-10 MW)
Can operate at smaller scales to accommodate a range of municipalities' needs.

Scale & Cost Comparison

Technology	Input Type	Typical Size (KMTA)	Capacity (MW)	Revenue (\$M)	Revenue (\$M)/KMTA
<i>Digestion</i>	Liquid organics (ex. manure, food)	90	3	4	0.04
<i>Incineration</i>	Industrial solids	550	60	60	0.11
<i>Recycling</i>	Select paper / plastics	125	0	+/-	+/-
<i>Gasification</i>	Smaller solid organics	15	1	1.5	0.10

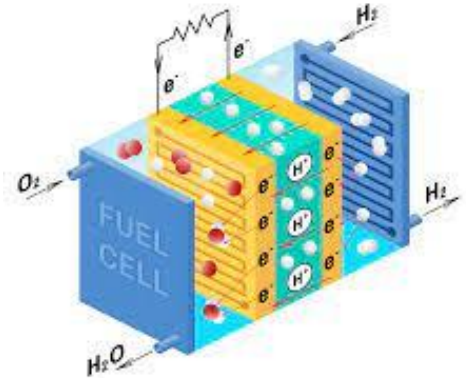
Small-scale system **decentralizes** waste management.

- Suburbs or rural areas
- Satellite plants complement large centralized Waste-to-Energy facilities

Works **in parallel** with other green pathways.

Flexible Outputs for a Changing Green Economy

- Gasification system can produce
 - Electricity, Thermal Energy, Hydrogen, Ethanol
- Thermal recovery improves overall economics
- Innovative solution applicable for venture funding
- Potential heat uses
 - Heating or cooling
 - Greenhouses
 - Autoclaving of PPE & medical wastes
 - Variety of industrial applications



Carbon Reduction & Offsetting

- Biochar output is a powerful soil amendment & a source of carbon negativity
- Process can be tuned for desired char/electricity output
- Char characteristics depend on feedstock type & process conditions
- Other uses of char:
 - Concrete filler
 - Stormwater control



Environmental Advantage

- Solid char/ash output is non-toxic
- Both sources of gaseous emissions meet strict state-level standards
 - Engine genset exhaust
 - Stack of the condensate evaporator
- High process temperatures destroy unwanted furans & dioxins
- Low oxygen content prevents the formation of unwanted chlorine
- Research opportunity: gasification for PFAS destruction

Case Studies

India

- 200 kW pilot
- 3500 TPY (12 TPD)
- Commissioned by national utility to erect systems in 200 cities

Indonesia

- 8 MW facility
 - 8x 1 MW facilities in parallel
- 120,000 TPY of MSW (400 TPD)
- In detail engineering stage

Philippines

- 100 kW MSW-to-energy pilot
- Testing feedstocks
- Operational since Jan 2021

Mexico

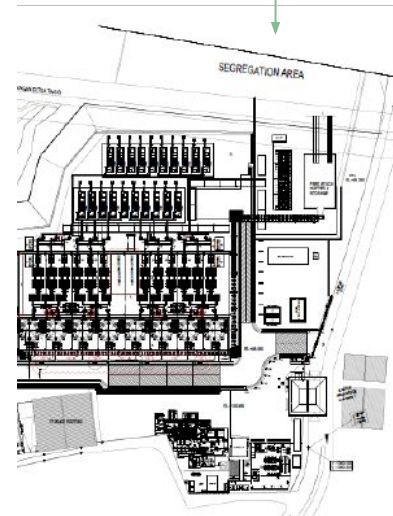
- CHP (combined heat & power)
- 50/50 MSW and biomass input
- 500 kW electricity, 70 kW thermal



Philippines



Indonesia



India



Our Proposal: LA County



- Install demo facility (1 MW)
 - Modularly expand to 3-4 MW (45-60,000 MT waste/yr)
- Provide renewable MSW management solution
 - Generates revenue
 - Organics disposal (AB 1826)
 - Divert from both landfill & incineration → conversion technology
 - Green energy source
 - Carbon capture
 - System works well with existing MRF infrastructure
- Possible locations:
 - On site at local landfill
 - Could be distributed to minimize transport costs & collection issues

Team & Advisors

Principals



Teddy Horangic

Founder & CEO

Yale

Econ & Envi Science



Tova Kleiner

Head of Development

MIT

Design & Engineering

Advisors

Ashok Chaudhuri

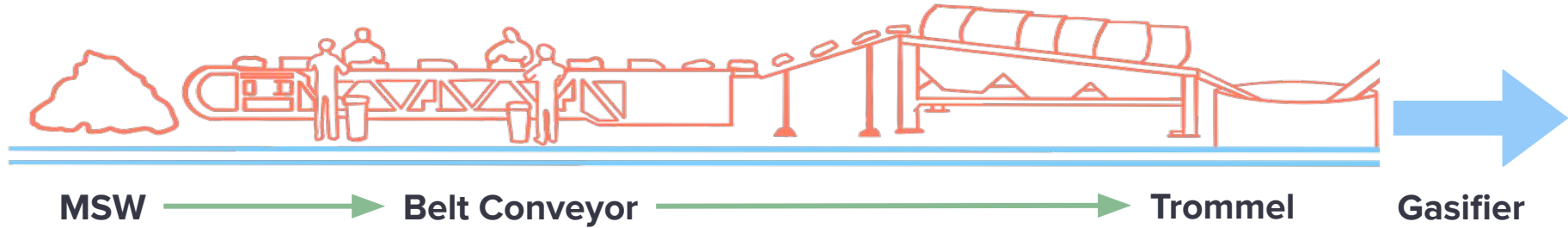
- *Vice President Of Business Development at Ankur Scientific Energy Technologies Pvt Ltd*

Vital Aelion

- 15 years in banking at J.P. Morgan, Bank of America, UBS, Bear Stearns, Standard Chartered Bank in Singapore
- *VP, Planning, Business Planning & International Operations at Cool Planet Energy Systems*
- *Co-founder & CEO at AB Energia LLC*

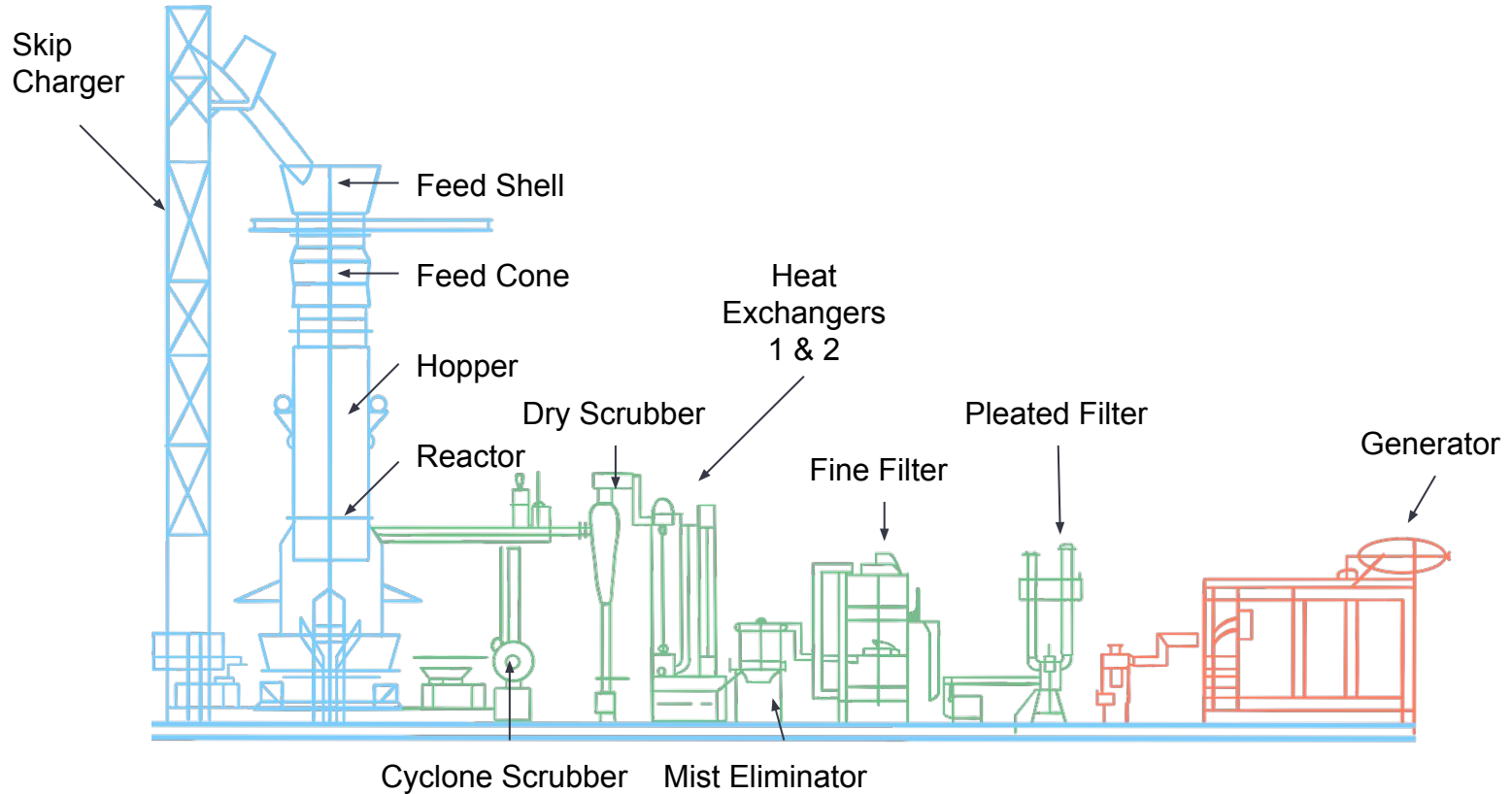
Appendix Slides

Pre-Processing

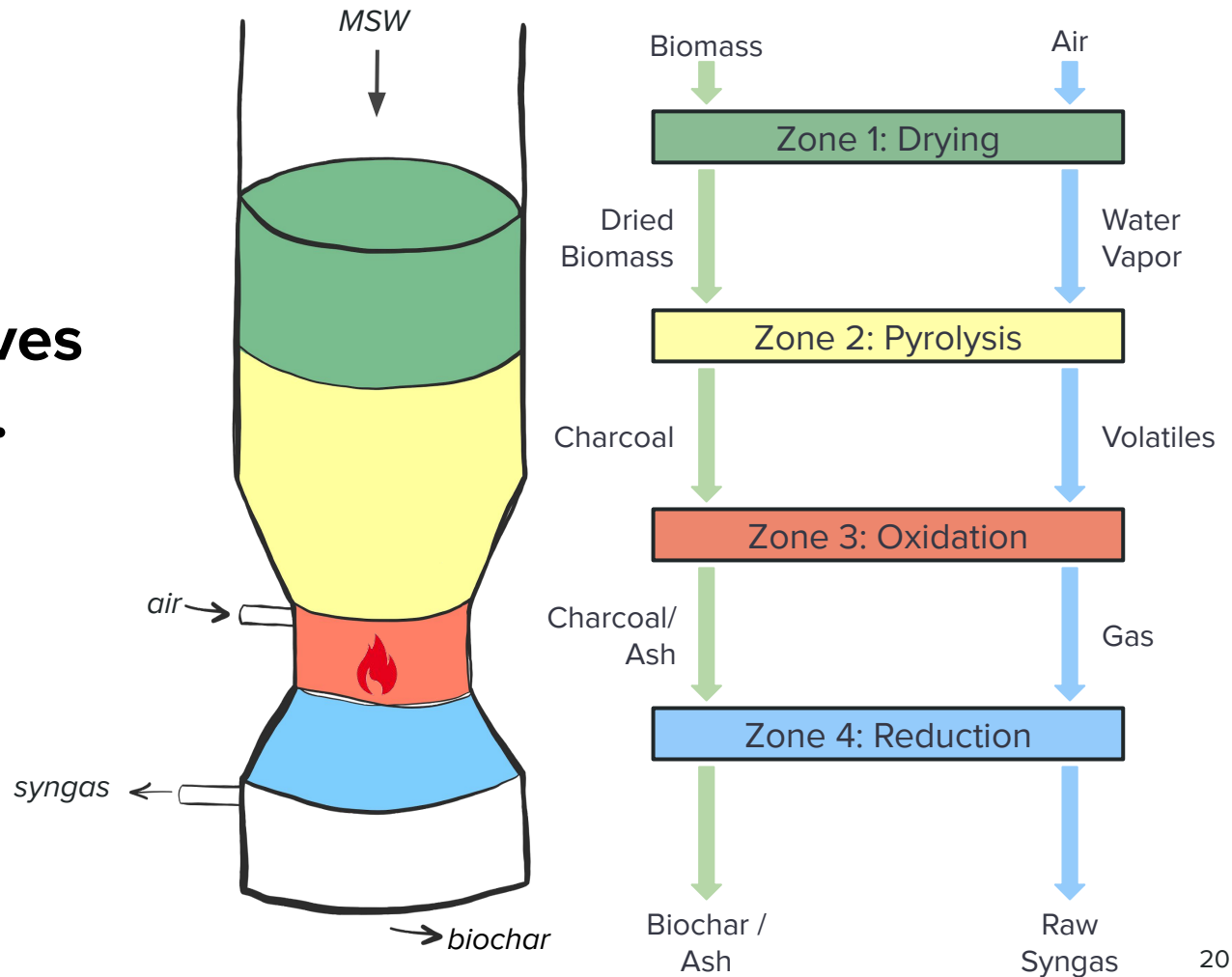


- Minimal preprocessing, our partners carefully tune the gasifier to the specific composition of the municipalities' waste
- Waste is dried if necessary to <20%
- Larger pieces of non-gasifiable material removed

Gasification



Gasification involves four major stages.



Potential Financing Plans

Municipal Ownership	Municipality owns and finances project. Municipality offers PABs (tax-exempt bonds for low-risk public works projects).
Private Ownership	Private investors own and finance project. Could place gasifier in Economic Opportunity Zone (lower taxation).
Mixed Ownership	Private investors fund project. Investors own for the first 2-3 years. Kyklos proves that the facility functions as planned and work out kinks in process while charging slightly higher tipping fees. After 2 years, municipality buys gasifier. Lowers tipping fees, easier to sell bonds, and lower-risk purchase.

Potential Financing Plans

Low risk purchase

Low tipping fees for residents

Ease selling PABS + to investors

**Municipal
Ownership**



**Private
Ownership**



Mixed Ownership



Toxic Non-gaseous Outputs

Gaseous Emissions

Repurposes Inputs

Landfill

Yes
Leachate

Yes
CH₄, CO₂, & more

Maybe
Gas-to-energy recovery
available at some landfills

Incineration

Yes
Concentrated Ash

Yes
Furans, Dioxins, CO₂ &
more

Yes
Energy recovery only

**Kyklos
Gasification**

No
Non-toxic (useful) Char

No
Significantly reduced CO₂
emissions after syngas
filtration

Yes
Both energy and materials
(biochar) recovery