MICROPOWER TC
Waste-to-Carbon (W2C) & Waste-to-Energy (W2E) Power Plants

Enormous Waste + Energy Problems Create Opportunity for Innovative Integrated Solutions

Enormous "Waste and Environmental" Challenges

- Enormous biomass/waste problems
- Increasing population
- Increasing urbanization
- Improving "standards of living"
- Landfill Issues
- Landfill closure issues
- Green house gas emissions
- Significant health and human problems

Enormous "Energy" Challenges

- Dependence on fossil fuels
- Increasing dependence on foreign oil imports
- Insatiable need for ever increasing electricity and power
- Improving energy security
- Global climate change mitigation
- Aging central power plants
- Untapped renewable energy resources

Opportunity for Next Generation State-of-the-art Waste Transformation Solutions
Biomass Waste to Carbon (W2C) and
Waste to Energy (W2E) Platforms

Worldwide Abundant Waste Streams- Energy & Carbon Rich Resources

- 1 Ton of MSW = ~ 480 kWh to 550 kWh
- 1 Ton of MSW avoids importing 0.75 to 1 Barrel (30 to 42 gallons) of oil
- 1 Ton of MSW avoids mining 1/3rd to 1/4th ton of coal
- 1 Ton of MSW avoids 1.3 Tons of CO_2

Next Generation Waste to Carbon (W2C) and Waste to Energy (W2E) Power Plants

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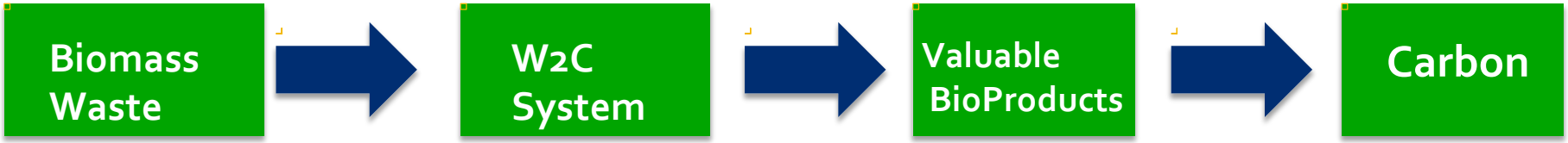

- Agricultural Waste
- Forestry Waste
- Wood Waste
- Yard Waste
- Food and Food Processing Waste

Primary	Secondary
• Biocarbon • Biocoke • Biochar or Biocoal • Carbon Black	• Bioenergy (Power) • Sterile Ash

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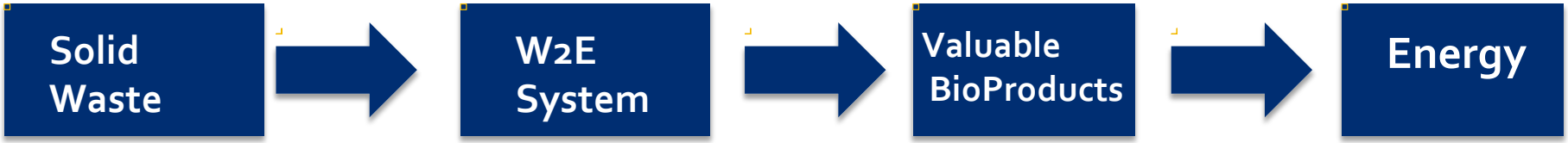


- Municipal Solid Waste
- Tires
- Sewage Waste
- Liquid Waste
- Medical Waste
- Plastics

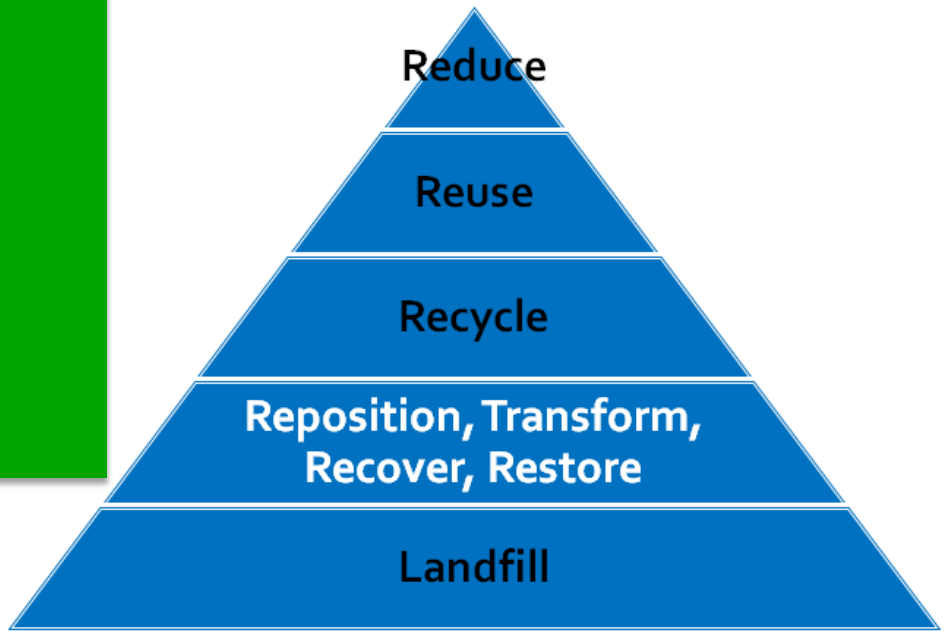
Primary	Secondary
• Bioenergy (Power) • Sterile Ash	• Biocarbon • Biocoke • Biochar or Biocoal • Carbon Black

Guiding Principles & Waste Management Hierarchy

Core Guiding Principles

- **Reposition**
  - Change the perspective for the way "we look at wastes"
  - Treat them as Assets rather than liabilities
- **Transform**
  - Transforms the "wastes" into value added products
- **Recover**
  - Recover the "values" and generate clean renewable energy
  - Focus on recovering Carbon & Energy
- **Restore**
  - Restore our environment – land, sea and air

Waste Management Hierarchy



The Next Generation Waste Transformation Technologies
Biomass Waste to Carbon (W2C) Platform &
Waste to Energy (W2E) System

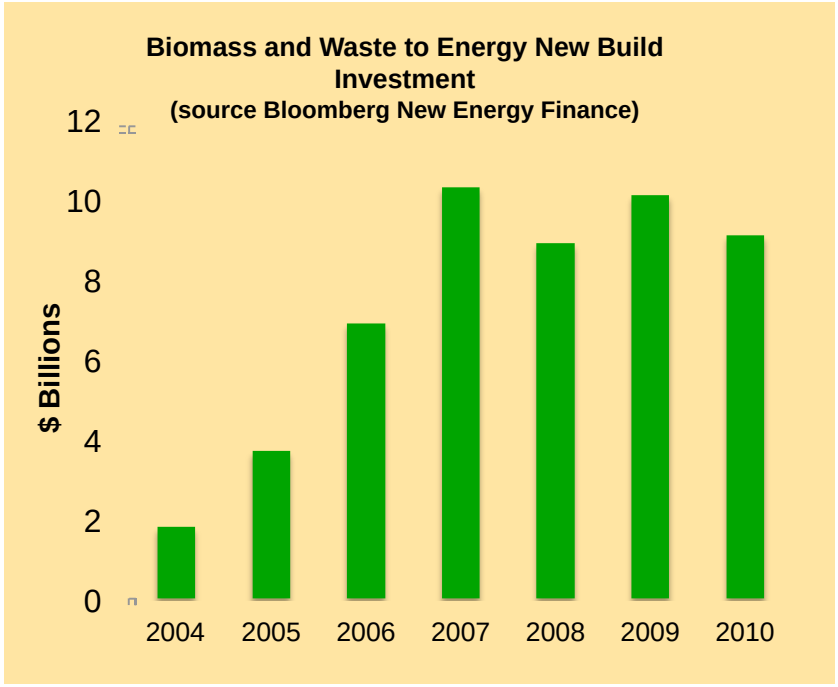
Waste to Power

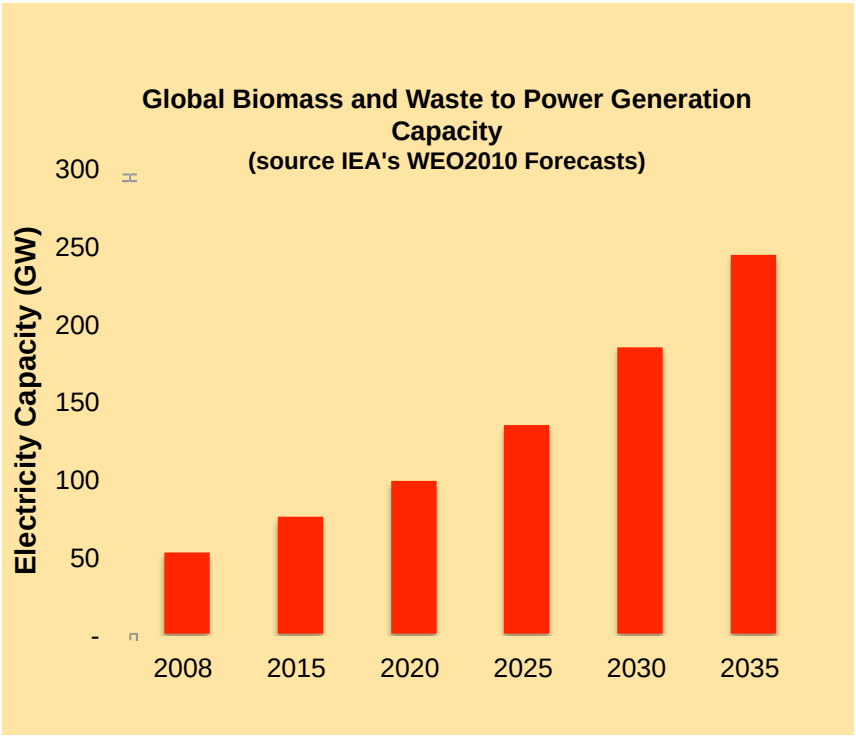
Market Overview

Rising demand for low carbon power driving investment worldwide

- Over $9 billion was invested in new build waste to power facilities in 2010, largely in Brazil, Europe, and Asia. China is currently the largest investor in the sector with over 70% of new commitments in H2 2010.

- According to the latest IEA assessment, global biomass and waste to power generation capacity is expected to grow 6% annually thru 2035 with 30GW of new generation capacity forecast for the US alone.





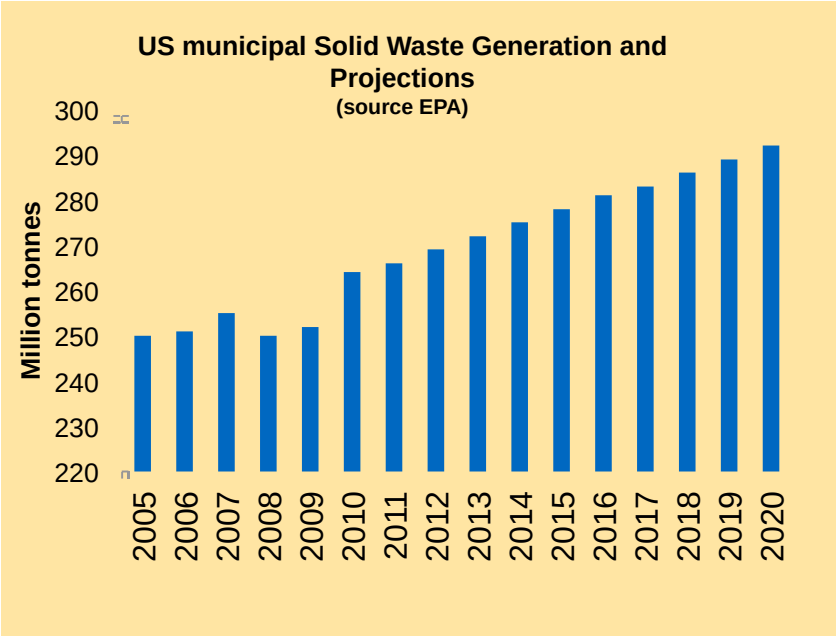
Waste to Power

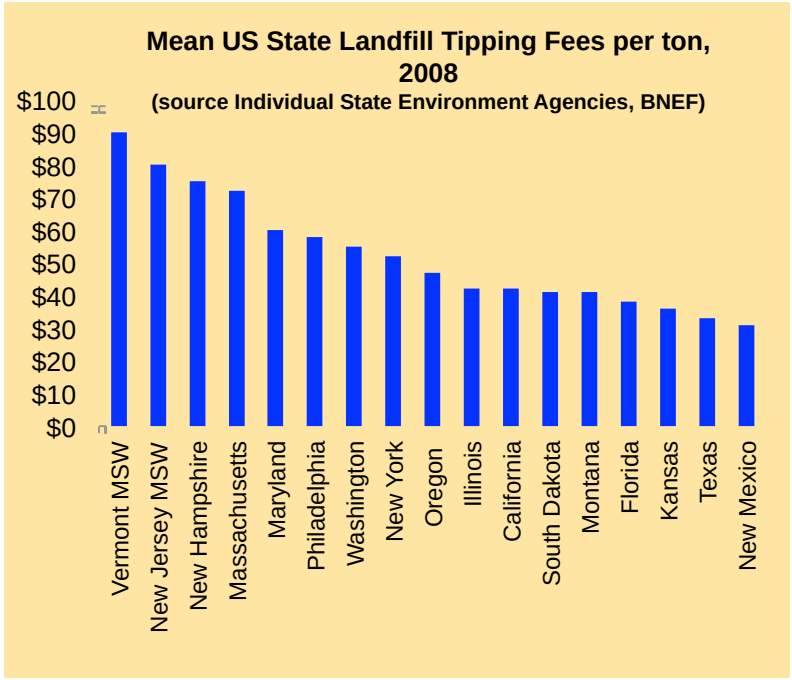
US Market Overview

Strict emission standards, high tipping fees, tax credits driving opportunities in the US

- The number of waste to power facilities in the US has fallen from over 180 in the 1980s to around 90 today due to a heavy historical reliance on dirty, inefficient incinerators that can no longer meet emission standards.

- Tipping fees for municipal solid waste (MSW) are continuing to rise in line with EPA forecasts for waste generation, creating an opportunity to lock in long-term inflation adjusted contracts for MSW feed stocks.



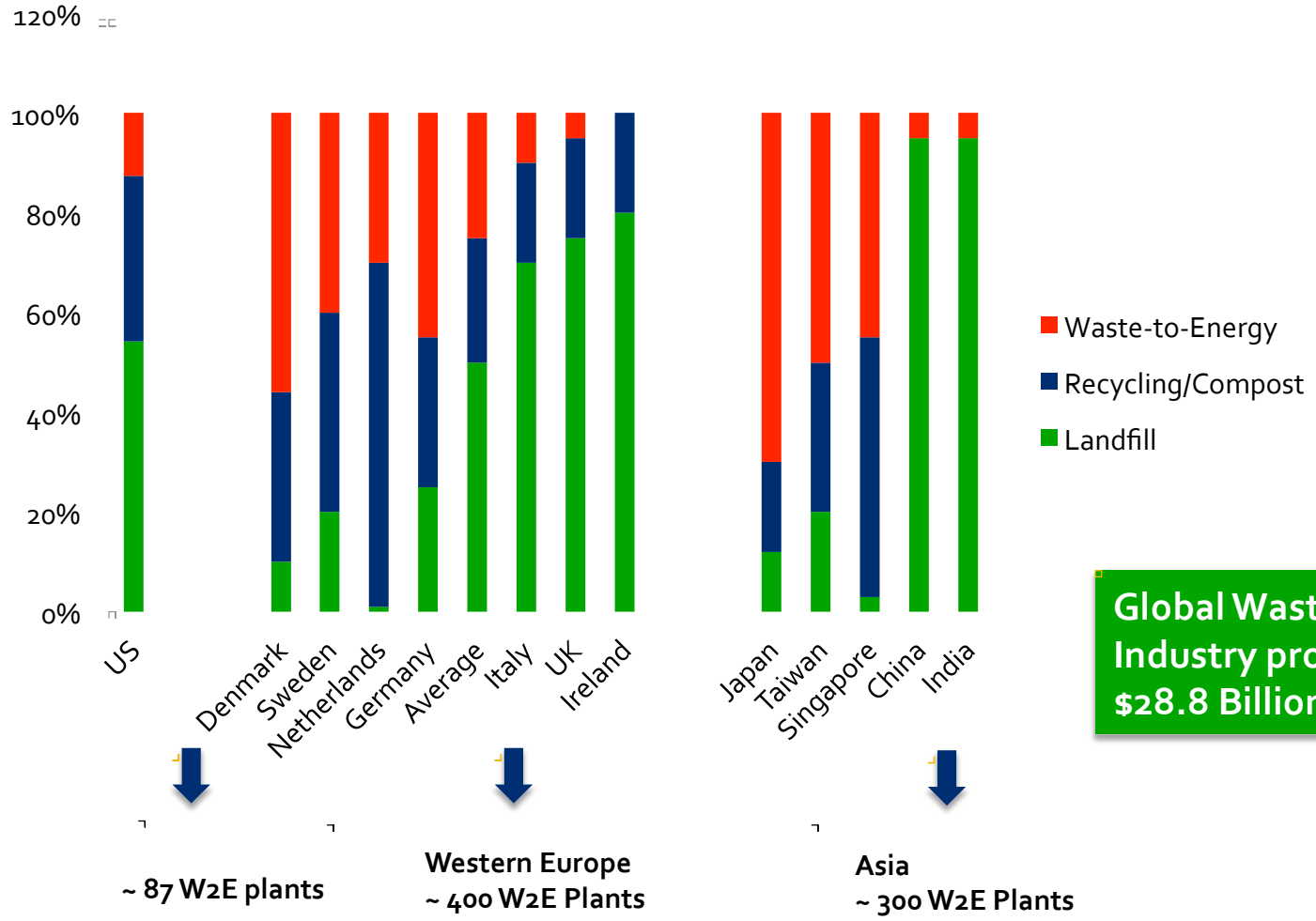


Global Solid Waste-to-Energy Market & Opportunity for Innovative W2E Plants

Landfill 1.2 B Tons

Recycle/Compost 0.7 B Tons

WTE 0.2 B Tons



Global Waste-to-Energy Industry projected to be $28.8 Billion by 2015!

Shortcomings of Current Competitive Approaches & the Opportunity

- Currently 87 W2E plants in US in 31 states
  - Mostly combustion plants with 20-25+ year-old technology
  - Process only 12-13% of solid wastes in US and generate 2,700 MW of electricity
  - Lagging behind Japan and Europe
- Expensive - Higher $/MW
- Not modular or scalable
- Not decentralized
- Not distributed
- Not adaptive
- Not sustainable
- Perceived to be not environment-friendly

Opportunity for next generation, state of the art Waste Transformation Platforms

Technology Comparison

	MICROPOWER TC Gasification	Incineration	Anaerobic Digestion	Arc Plasma Gasification
Process Description	Waste feedstock is converted at moderate temperatures with controlled amount of oxygen to produce syngas	Waste fuel is directly combusted to produce heat	Biodegradable waste is broken down by micro-organisms to produce a methane rich biogas	Waste feedstock is converted at very high temperatures with controlled amount of oxygen to produce syngas
Scale	Decentralized, 300tpd, scalable modular 10-12 MW units, small footprint, $37- $41 MM/facility	Centralized, >1000tpd, difficult to scale under 50MW, large footprint, requires large amounts of waste, $250-500MM/facility	Decentralized, <100tpd, difficult to scale above 1MW, large footprint, $15-20MM/facility	Centralized, >1000tpd, difficult to scale under 50MW, large footprint, $400-500MM/facility
Conversion Efficiency	90% of energy content of waste is used to make electricity	Less than 60% of energy content of waste is used to make electricity	Less than 35% of energy content of waste is used to make electricity	Less than 50% of energy content of waste is used to make electricity
External Fuel Source	Powered by self-generated clean energy	Typically powered by fossil fuels reducing net energy output	Low operational power costs	Typically uses high voltage electrical power from the grid reducing net energy output
Emissions	Surpasses all US and European Air Quality Standards	Pollution-laden process requiring large investment in pollution control	Odor issues a persistent problem for local communities	Cumulative emissions tend to be high due to the size of the facilities
Process By-product	Waste is reduced 98% with sterile bottom ash being the only by-product	Waste is reduced 70% with toxic ash and slag still requiring disposal	Waste largely remains in landfill	Waste is reduced by 90% with a dense, solid slag material remaining

W2C/W2E Competitive Advantages Over Combustion/Incineration Technologies

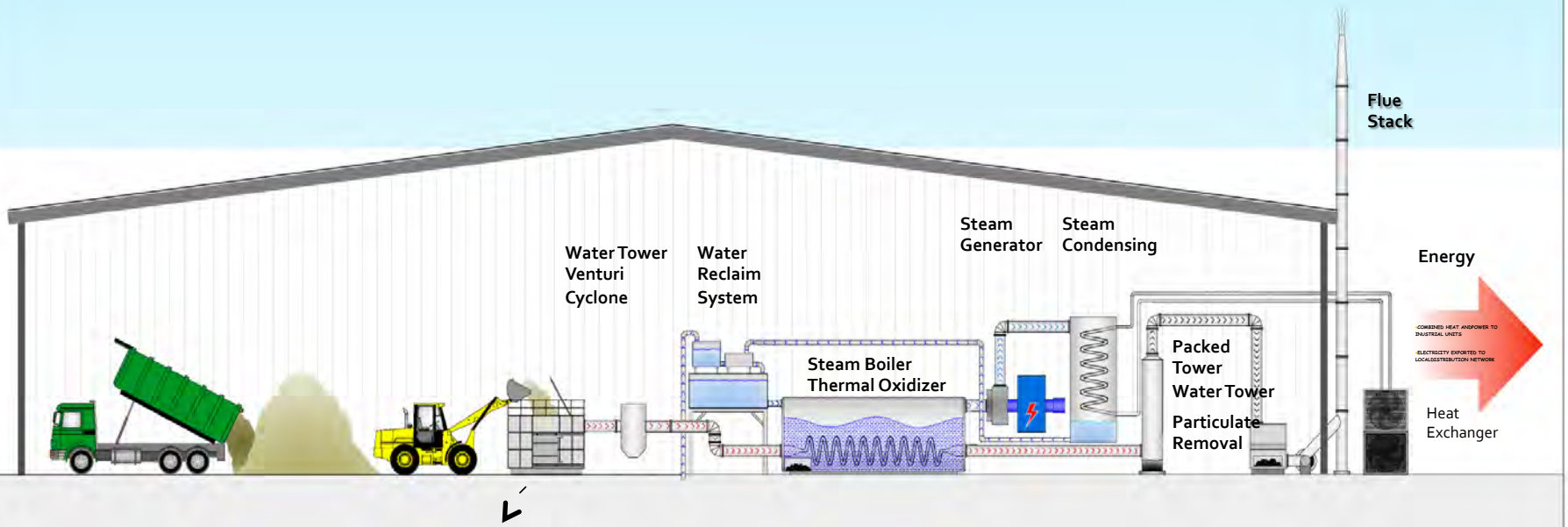
- State-of-the-Art technology
- Moderate Temperature Advanced Pyrolytic Gasification Process
- Oxygen-Starved
- Runs Clean
- 98% volume reduction (for W2E systems)
- 2% Sterile Ash without any dross, clinkers or slag
  - Can be used as valuable byproduct
- Resource Recovery
  - All ferrous and glass materials recycled after processing
- Manages contaminants before they become emissions

Not Combustion or Incineration

MICROPOWER TC Advanced W2E Gasification Technology

- Step 1 - MSW is loaded at a waste-to-energy plant into 25 ton (50 tons/day) advanced, specially designed waste tranformation modules;
- Step 2 - The waste is then heated and then gasified (cooked slowly) in an oxygen starved, pressure and temperature controlled, fully automated environment to chemically transform the waste to energy-rich syngas and sterile ash (2% to 10% of original volume);
- Step 3 - Syngas is then cleaned and ignited into a conventional water tube boiler to generate steam;
- Step 4 - Steam then turns a turbine and generates clean green energy

MICROPOWER TC Process Flow



Feedstock

Carbon Focus	Energy Focus
Agricultural	MSW
Forestry	Tires
Wood Chips	Sewage Sludge
Paper waste	Liquid waste
Food waste	Industrial
Yard waste	Plastic

Waste Transformation Module

Carbon Products
Sterile Ash

Fly Ash Removal

Steam Production & Heat Recovery

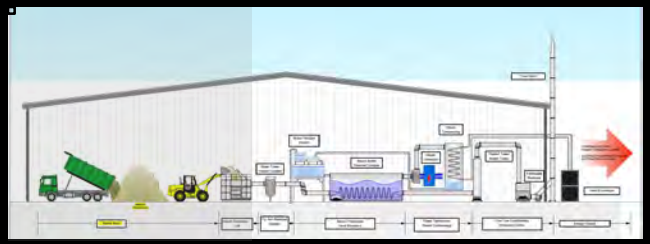
Power Generation & Steam Condensing

Flue Gas Conditioning & Emission Control

Energy Output

- Slow, Moderate Temperature
- Two Stage, Pyrolytic/Gasification Technology
- 400 °C – 500 °C, 1000 °C – 1200 °C

MICROPOWER TC Technology



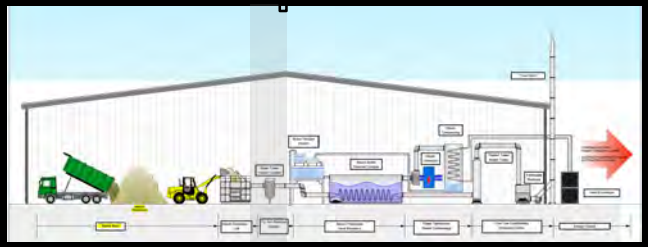
- The waste transformation process starts with untreated municipal, industrial, forestry, agricultural or medical waste being bulk-loaded into the **waste processing modules.**
- Once loading is complete, the gasification process occurs in the absence of oxygen at the relatively moderate temperatures of 600-800°C. The modules **automated control system** uses over 600 sensors to monitor temperature, emissions, airflow, and pressure during the conversion process.
- The waste is reduced by 98 percent, leaving only a residue of sanitized, **non-toxic sterile fly ash** that can then be sold as an additive for concrete or as an amendment for asphalt.

Waste Processing Modules

Automated Control System

Non-toxic Sterile Fly Ash

MICROPOWER TC Technology

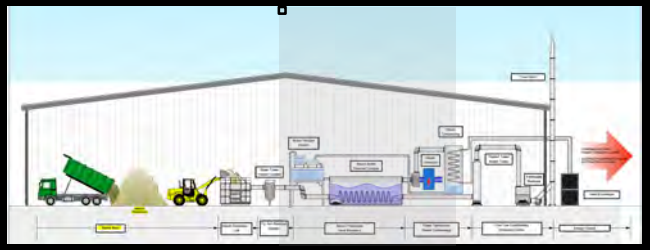


- Although the waste is processed in an undisturbed state, small particles of **fly ash** and other impurities may exist within the syngas and need to be removed.
- The MICROPOWER TC technology uses a **Venturi Cyclone** to condition the syngas, which relies on particle density and velocity to separate out the fly ash and other impurities.
- Filters may also be used to capture the smallest of particles in order to enhance the quality and combustibility of the syngas.

Fly Ash Vacuum

Venturi Cyclone

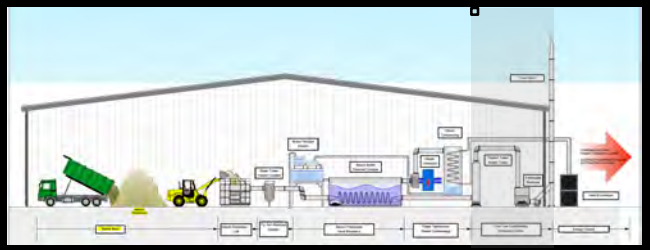
MICROPOWER TC Technology



- During the steam production phase, the syngas is ignited and the heat is transferred through the walls of sealed water tubes to produce steam.
- The boiler also recovers heat from other areas within the system to preheat the water source, increasing system output.
- The steam produced by the **watertube boiler** is then pressurized and superheated to turn the steam turbine and produce electricity.

Fire Packaged Watertube Boiler

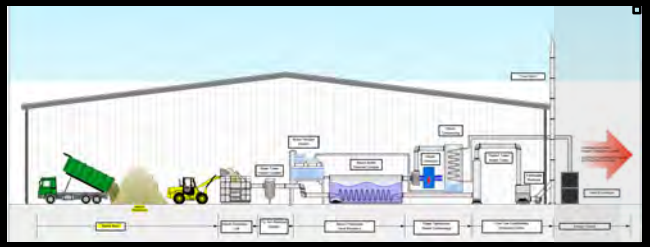
MICROPOWER TC Technology



- The Packed Bed Scrubber, or **Thermal Oxidizer**, is designed to remove gaseous or vaporous pollutants from an air stream.
- The process is accomplished by contacting the contaminated air stream with a scrubbing liquor that absorbs or chemically reacts with the pollutants.
- The cleaned air is then discharged to the atmosphere and the contaminated scrubbing liquor is either disposed of in an approved manner or recycled.

MICROPOWER TC Thermal Oxidizer

MICROPOWER TC Technology



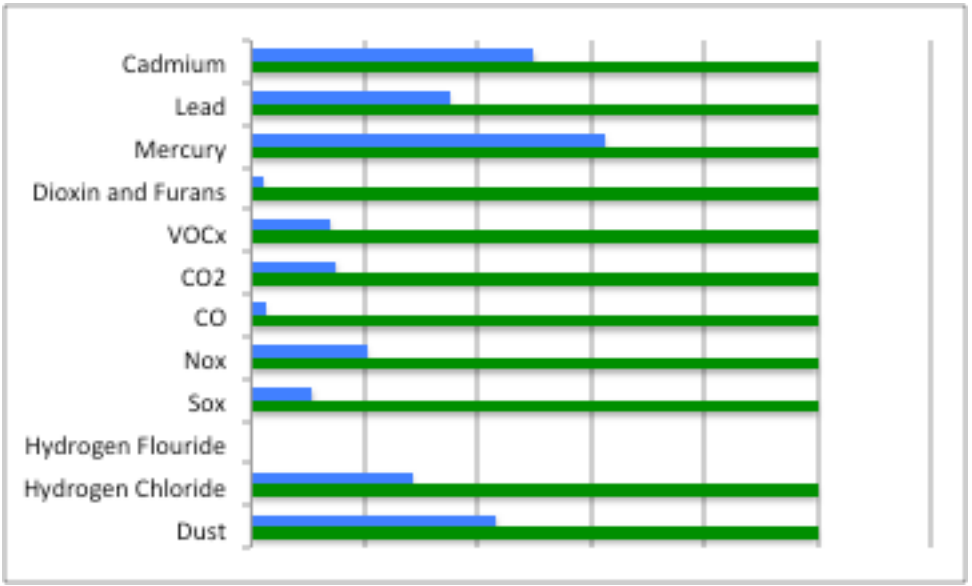
- During the energy output phase the **steam turbine generator set** produces electricity that is then exported to local distribution networks.
- The output can also be exported as heat to local industrial users.
- The system's heat exchanger also works to capture any residual heat from the waste stream so that it can be looped back into the system.

Steam Turbine Generator Set

Emission Profile

Advanced gasification system delivers clean energy that meets or surpasses all US EPA standards

	US EPA Requirements	MICROPOWER TC System Rating *	Unit
Dust	0.03	0.013	gridsci
Hydrogen Chloride	25	7.12	ppm
Hydrogen Flouride	no standard	none detected	
Sox	50	5.44	ppm
Nox	150	30.74	ppm
CO	150	3.73	ppm
CO2	359	54	ppm
VOCx	150	21	ppm
Dioxin and Furans	125	2.71	mg/cft
Mercury	0.08	0.05	mg/m3
Lead	< 0.2	0.07	mg/m3
Cadmium	0.02	0.01	mg/m3



In 2003, EPA named WTE one of the cleanest sources of energy
(US Environmental protection Agency 2003, www.wte.org/docs/epaletter.pdf)

W2C Platforms/W2E Systems – Proven Technology!

Reposition | Transform | Recover | Restore

FOCUS

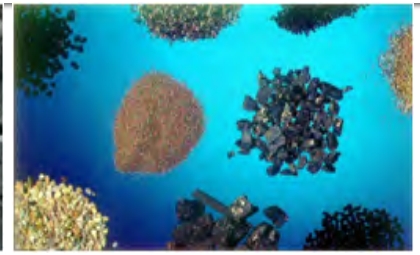
Feedstock Processing → **W2C/W2E Platform** → **Valuable BioProducts** → **Carbon / Energy**

- Modular
- Scalable
- Adaptive
- Base Modul 50 TPD
- W2C - Standard System 150-200 TPD
- W2E – Standard System 200- 300 TPD

- Small Footprint
  - 10,000 sq ft /module
- Decentralized
- Distributed
- Optimized for Low Cost & Efficiency
- Long Life
- Automated
- Controlled
- Monitored
- Sustainable
- Environment-Friendly

- Per Module
  - 25-30 TPD Biochar
  - 25-30 TPD Biocarbon
  - 25-30 TPD Biocoke
  - 20-25 TPD Carbon Black
- Per System
  - 75-120 TPD Biochar/ Biocoke/Biocarbon
  - 60 – 100 TPD Carbon Black
- W2C - 2 MW
- W2E – 10 MW!
  - 98% Conversion
  - 2% Sterile Ash

W2C/W2E Platforms
Five Valuable Bioproducts – Broad Applications and Their Value Ranges

Biochar/ Biocoal	Biocoke	Biocarbon	Carbon Black	Bioenergy/ Power
				
• Soil Amendment • Cooking • Sequestering Carbon • Co-firing	•Replace up to 20% of Bituminous Coke for GHG Reduction • Fuel for Sintering & Pelletizing • Reductant	•Mercury scrubbing from coal fired power plants • Gas and Chemical Refinement •Metal extraction	• Tires in Rubber and Auto industries • Toners , Ink & Paints • Plastic industry	• On-Grid Power Generation • Feed-in Tariff • Net Metering
$100-$200/Ton) (for soil amendment) $200-$300/Ton) (for biocoke & cooking)	$200-$300/Ton)	$250-$500/Ton (ready to be activated) $500-$800/Ton (Activated Carbon)	$400- $800/Ton	$60 - $120/MWh (Varies from state to state)
Agriculture, Cooking	Metallurgy	Gas, Air & Water Filtration	Industrial	Power Utilities

W2C Platform/W2E System Revenue Generation Model

Tipping Fees *	Valuable Byproducts	Investment Credits
•MSW $25 - $30/Ton •Tires ~ $70 - $80/Ton •Wood Chips ~ $25-30/Ton • Sludge Cake – $50/Ton • Others Vary	•Biocarbon (Ready to be Activated) •Biocoke •Biochar •Carbon Black •Power •Sterile Ash ~ $10 - $20/Ton •Ferrous Metals - Varies	•Investment Tax Credit (if applicable) •Carbon Credit •Renewable Energy Certificates (REC) •Others

•Attractive Financial Model (2 key components)
•Tipping Fees cover debt financing payments

* Tipping fees model for US

W2C/W2E System Cost - Financial

Components	W2C System	W2E System
Base System	200 TPD/2MW	300 TPD/10 MW
Basic System Cost ($mm)	10	29
Site Development Cost + Installation Cost ($mm)	4	6
6-Months Working Capital ($mm)	1	1
Total Cost ($mm)	15	37
Debt Interest Payment *		
Break Even Period	3-5 Years	3-5 Years

- Requires $350K of readiness assessment fee up front that can be credited towards the final purchase
- Crucial to do feedstock, site assessment & determine the optimum system configuration & final cost

* Financing terms and duration depends on each specific situation

Differentiated Value Propositions of W2C Platforms & W2E Systems

Economic	• Low Cost
Flexible Waste Processing	• Various Feedstock types
Flexible Bioproducts	• Biochar, Biocarbon, Biocoke , Carbon Black & Bioenergy
Scalable	• Modular, Adaptive and Customizable per Site
Decentralized	• Small Footprint
Distributed	• Located Close to the Source
Environment-Friendly	• Meets or Beats all EPA Emission Standards
Proven Technology	• Operation for 10 Years

Next Generation
Waste Transformation Platforms

Third Party Technology Evaluation * Abstract

- **Precedent-Setting Environmentally**
  "In our opinion, the capability to provide heated air to the units should allow a shorter residence time to process a batch than a system using ambient temperature air…Further, the gas cleanup technology appears to be robust and could set a needed precedent in the industry by providing significant cleanup before combustion."
- **Best Practices**
  "In our opinion, this technology, especially for treatment of municipal solid waste, could be considered "best practices" gasification around the world as it gains additional commercial operating experience across the overall market."
- **High-Level Assessment**
  "The Technology Developer has incorporated certain innovative designs that have the potential to optimize the production of syngas from MSW and has demonstrated a good understanding of the gasification field as a whole. At a high level, nothing came to our attention to indicate a fatal flaw with the Technology Developer's approach. The Technology Developer's next step is pilot-scale testing, followed by more detailed due diligence review of technical design details

… SAIC Energy, Environment & Infrastructure, LLC
E. Larry Beaumont, P.E. Senior Project Manager

* December 5, 2011, High-Level Review of Cocurrent Gasification Technology, SAIC

MICROPOWER TC Build Out Methodology

Readiness Assessment

- Questionnaire
- Preliminary feedstock testing
- Preliminary system configuration
- Final review of financial model and pro-forma
- Statement of work issued

Discovery and Design

- Full-scale feedstock testing
- Site review and analysis
- Engineering and construction requirements
- System Configuration and customizations
- Project plan

Pre-configuration and Staging

- Planning and scheduling
- Facility construction and procurement
- Fabrication
- Pre-testing and quality review
- Factory acceptance testing
- Breakdown and packaging
- Shipping and logistics

Installation and Training

- Site assembly
- Feedstock production testing
- Performance testing
- System certification
- System and operations training
- System maintenance training

System Acceptance and Go-Live

- Final quality review
- System sign-off
- System go-live
- Production

System Care

- Technical Support
- Service and Maintenance
- Upgrades and additions

W2C/W2E Summary

- Next Generation, State-of-the-Art, Disruptive and Innovative Waste Transformation Technology
- Superior, Cost effective and Environment-Friendly
- Designed to Address Enormous Problem of Increasing Waste& Energy
- Reduce Green House Gas emissions, Protect the Environment
- Generate Valuable Clean Energy, Provide Energy Security
- Small Foot print - Ideal Decentralized, Distributed Operation
- Create Financial Revenues
  Help Local Economies – Create Jobs
- Help achieve Self-Sustainable Goals
- Attractive Business Model - Quick Return on Investment
  - Break-Even Period 3 to 5 years