Evaluating Innovative Technology for Municipal Waste Management

Presented to
Northeast Waste Management Officials' Association
(NEWMOA)

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1.0 Introductions

- **Steven Torres, City Attorney**
  Taunton, Massachusetts
  Representing City Project to Replace Landfill
- **Jim Binder, P.E., Principal**
  Alternative Resources, Inc.;
  Independent Consulting Firm;
  Focus Solid Waste Management, including New and Emerging Technologies;
  Studies for NYC, LA County, CRRA, City/County of Santa Barbara, Taunton

2.0 Technology Options for Post-Recycled MSW

- Conventional
  - Transfer
  - Composting/Co-composting
  - Waste-to-Energy
  - Landfill

2.0 Technology Options for Post-Recycled MSW

- New and Emerging Conversion Technologies
  - Thermal
  - Biological
  - Chemical
  - Hydrolysis
  - Other

2.0 Technology Categories

- **Thermal**
  - Use or produce heat to change the composition of MSW
  - Products include synthesis gas, char and organic liquids
  - Descriptors: gasification, pyrolysis, cracking and plasma

- **Digestion (Aerobic and Anaerobic)**
  - Decomposes organic fraction of MSW using microbes
  - Produces biogas and compost
  - Aerobic digestion produces compost

- **Hydrolysis**
  - Chemical reaction in which water (typically with acid) reacts with another substance to form new substances
  - Extracts cellulose from MSW to form products or sugar which is fermented to ethanol
  - Some products include ethanol, levulinic acid

- **Chemical Processing**
  - Example: depolymerization – converts organic fraction into energy, oil, specialty chemicals, carbon solids

- **Mechanical Processing for Fiber Recovery**
  - Recovers fiber from MSW for paper making

2.0 Technology Options for Post-Recycled MSW

- In Addition to Conventional Technologies, Why Consider New and Emerging Conversion Technologies?
  - Environmental benefits, including reduction in greenhouse gas and other emissions
  - Enhanced beneficial use of waste; less waste requiring transfer and landfilling
  - Production of needed “renewable” products with strong, year-round markets
    - Electricity
    - Gas
    - Fuels – CNG, LNG, ethanol, hydrogen

2.0 Technology Options for Post-Recycled MSW

- **Examples of New and Emerging Technology Options**

Thermal

- Bioengineering Resources, Inc.
- Ebara Corporation
- GEM America
- Geoplasma
- International Environmental Solutions
- Interstate Waste Technologies/Thermoselect
- NTech Environmental
- Plasco Energy Group
- Primenergy, LLC
- Rigel Resources Recovery and Conversion Co./Westinghouse
- Ze-Gen

Biological

- ArrowBio
- Canada Composting
- Organic Waste Systems/DRANCO
- Orgaworld
- Waste Recovery Systems, Inc./Valorga

Chemical

- Changing World Technologies

Hydrolysis

- Arkenol/Blue Fire Ethanol
- Biofine
- Masada OxyNol

Other

- Herhof GmbH
- World Waste Technologies

2.0 Technology Options for Post-Recycled MSW

- Examples of Public Initiatives, New and Emerging Technologies
  - NYC
  - LA County
  - City of Los Angeles
  - St. Lucie County, Florida
  - Santa Barbara County, California
  - Connecticut Resources Recovery Authority
  - Delaware Solid Waste Management Authority
  - City of San Diego

2.0 NYC Phase 1 Summary of Findings (September 2004)

Development Status of Innovative Technologies by Category		
Technology Category	**Commercial Use Outside U.S. for MSW**	**Pilot Testing with MSW**
Anaerobic Digestion	✓	✓
Thermal Processing	✓	✓
Hydrolysis		✓

2.0 NYC Phase 1 Summary of Findings

Comparison of Commercially Adanced
New and Emerging Technologies
(Anaerobic Digestion and Thermal Processing)
to Modern Waste-to-Energy

Criteria	Advantageous	Comparable	Disadvantageous
Emissions	✓		
Public Acceptability	✓		
Residuals Requiring Disposal	✓		
Beneficial Use of Waste	✓	✓	
Cost		✓	
Ownership Preferences		✓	
Risk Allocation		✓	
Utility Needs		✓	
Facility Size and Flexibility		✓	✓
Acreage Required		✓	✓
Experience of Sponsors		✓	✓
Readiness and Reliability			✓

2.0 NYC Phase 2: Summary of Economic/ Financial Evaluation (March 2007)

- Planning level economic analyses indicate that anaerobic digestion and thermal processing technologies, on a commercial scale, are comparable to or less costly than costs for current export practices
- Projected cost for export practices (2014) = $124/ton
- Projected tipping fee for private ownership and financing (2014):
  - Anaerobic digestion (sale of compost) = $56-$80/ton
  - Anaerobic digestion (compost disposed) = $72-$108/ton
  - Thermal processing = $103-$165/ton
- Projected tipping fee for public ownership and financing (2014):
  - Anaerobic digestion = $43-$65/ton
  - Thermal processing = $76-$129/ton
- Corporate teaming experience in the U.S. continuing to develop for the technology suppliers

2.0 LA County Phase II: Products and Residue (October 2007)

Technology Supplier	Residue Generated*	Types of Products Generated
ArrowBio	13%	Recyclables Biogas Electricity or Vehicle Fuel Compost
CWT	18%	BioDiesel Fuel Oil (light distillate to heavy fuel oil) Fuel Gas Carbon Fuel
IES	10%	Fuel Gas Electricity
IWT	0%	Syn Gas Electricity or Fuels Sulfur Salts Zinc Concentrate Metals & Minerals
NTech	2%	Recyclables Oil Fuel Gas Electricity

* % by Weight of MSW received for processing and requiring landfilling

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2.0 LA County Phase II: Project Concepts by Technology Supplier (October 2007)

Technology Supplier	Proposed Facility Size	Site Size	Estimated Tipping Fee
ArrowBio	300 TPD 1050 TPD	4 acres 12 acres	$50/ton(1) $50/ton(1)
CWT	220 TPD 1000 TPD	3 acres 5.8 acres	$60/ton not provided
IES	125 TPD (prepared) 242 TPD (as received)	1 acre	$56/ton(1), (2)
IWT	312 TPD 623 TPD 935 TPD	3.5 acres 5 acres 8 acres	$131/ton $70/ton $59/ton
NTech	413 TPD	3.5 acres	$55/ton(1)

(1) Integrated pricing with MRF, considers use of existing scales, roads and site infrastructure at MRF.

(2) Assumes waste feedstock is preprocessed by MRF to 2" in size, glass, metal removed.

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2.0 Net Energy Production and Landfill Diversion

Net Energy Production		
	Net Electric Output	**1,000 TPD 100% Availability**
Gasification	500 – 800 kWh/Ton	21 – 33 MWe
Anaerobic Digestion	250 kWh/Ton	10 MWe
Acid Hydrolysis	31 Gal/Ton	11 Million Gal/Year

Landfill Diversion (By weight)	
Gasification	> 90%
Anaerobic Digestion	> 75%

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2.0 Comparison of Air Emissions

	Conversion Technology as Compared to Incinerators in Massachusetts*
Dioxin	10 to >100 times less
Mercury	1 to 50 times less
Nitrogen Oxides (Precursor to Ozone)	Approximately 10 times less

* Data from 2006 Solid Waste Master Plan

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3.0 Thermal Conversion (Gasification) is not Incineration

Criteria	Thermal Conversion	Incineration
1. Combustion of Solid Waste	No	Yes
2. Ash Residual	Little – No Ash	25 – 30%
3. Potential to capture gases to make fuels	Yes	No
4. Potential to pre-clean gases prior to combustion	Yes	No
5. Air Emissions	Reduced	--
6. Diversion of waste from landfilling	> 90%	70-75%
7. Marketable products	Electricity, steam, fuels, vitrified aggregate, minerals	Steam, Electricity
8. Potential to install combined cycle generation to increase energy output	Yes	No

4.0 The Promise

- Next generation of technology
- Not perfect, but better than existing alternatives
- Lower emissions
- Reduction in amount waste landfilled
- Enhances recycling and conversion of waste for beneficial use
- Provides source of renewable energy

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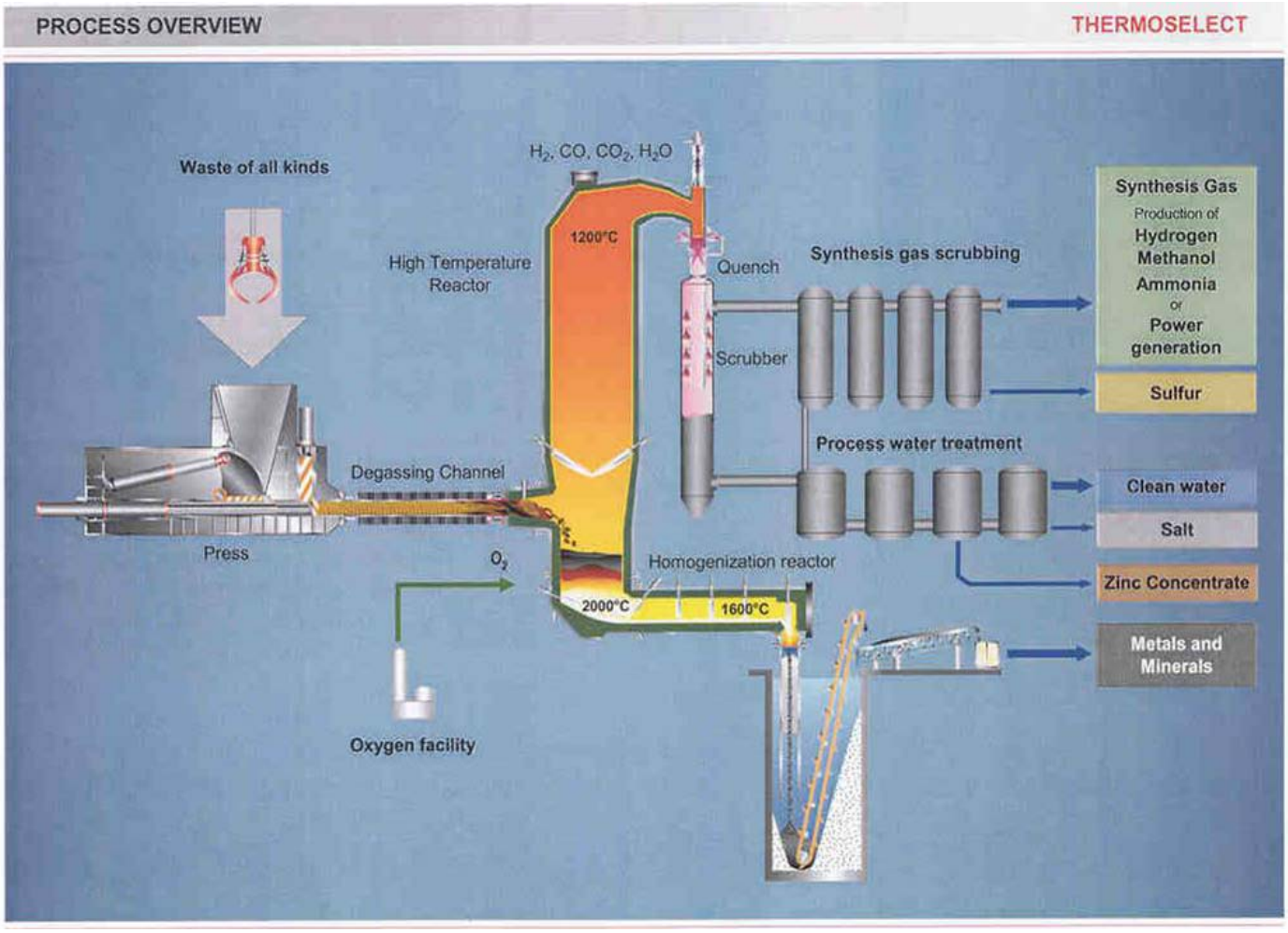
5.0 Hurdles

- Lack of commercial demonstration in US
- Lack of development/acceptance for certain product markets in US or regulatory hurdles for product use
- Applicability of regulations for environmental permitting is unclear, non-existent, or inadvertently problematic
- Qualification for renewable energy credits for power sale is not consistent
- Need for public education

Example Illustrations/Schematics of New and Emerging Technologies

IWT – Chiba, Japan
330 TPD
(Operating since 1999)

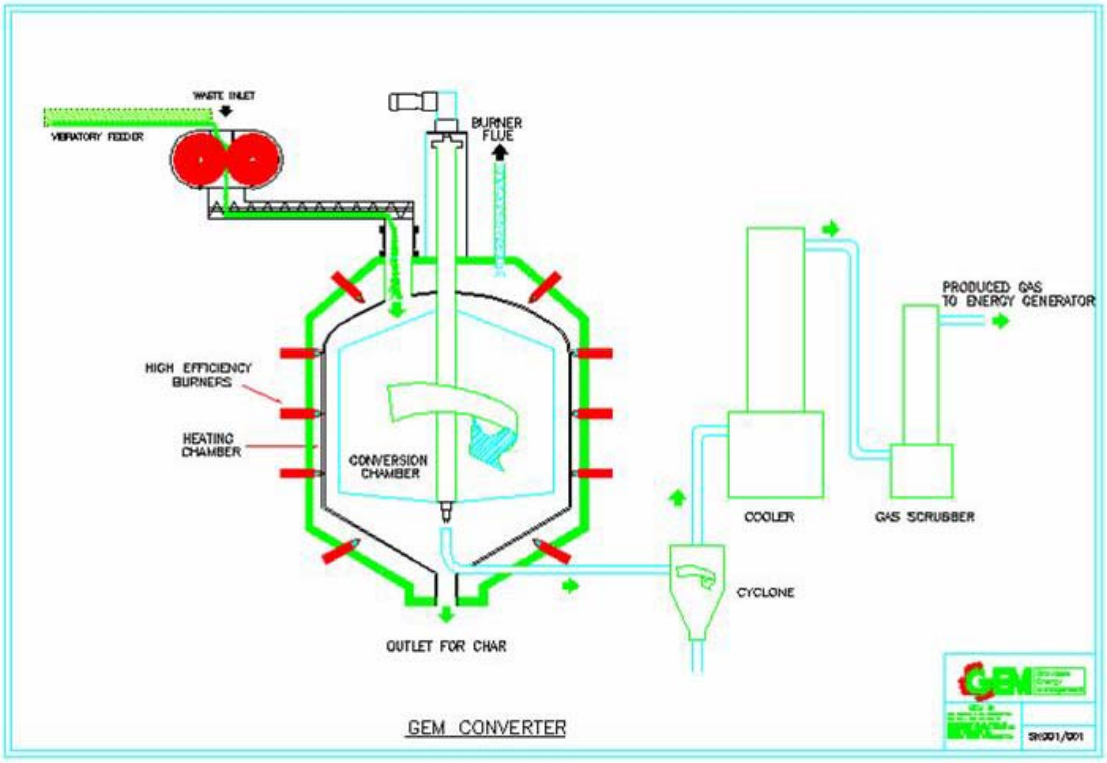


IWT – Thermoselect Schematic Diagram

GEM America – Pilot Converter, South Wales

40 TPD

(Operated in 2001-2002)



GEM America – Schematic Diagram

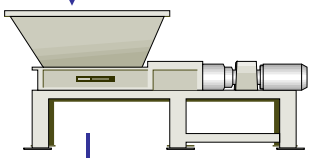
IES – Romoland, CA
50 TPD
(Operating since March 2005)

PROCESS FLOW DIAGRAM

Waste Material

Municipal Solid Waste
Medical Waste
Biosolids
Tires

Shredder

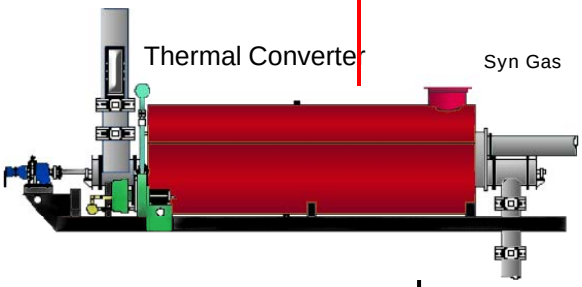


1400°-1600°
Waste Heat

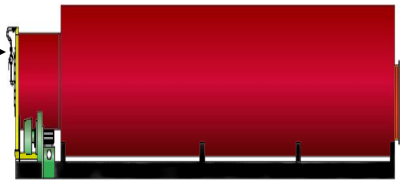
Optional Dryer or other process

Thermal Converter

Syn Gas



Thermal Oxidizer

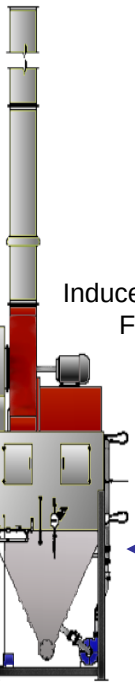


Recyclables

Carbon Char
Metal
Glass

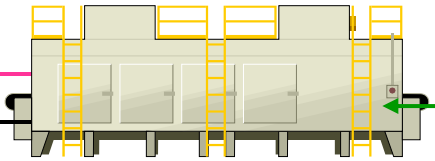
Heat Recovery
Steam Generator

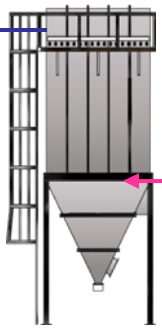
System Stack



Mist Eliminator

Induced Draft
Fan





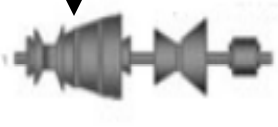
Steam

Dust Collector

Generator

Substation

Electricity

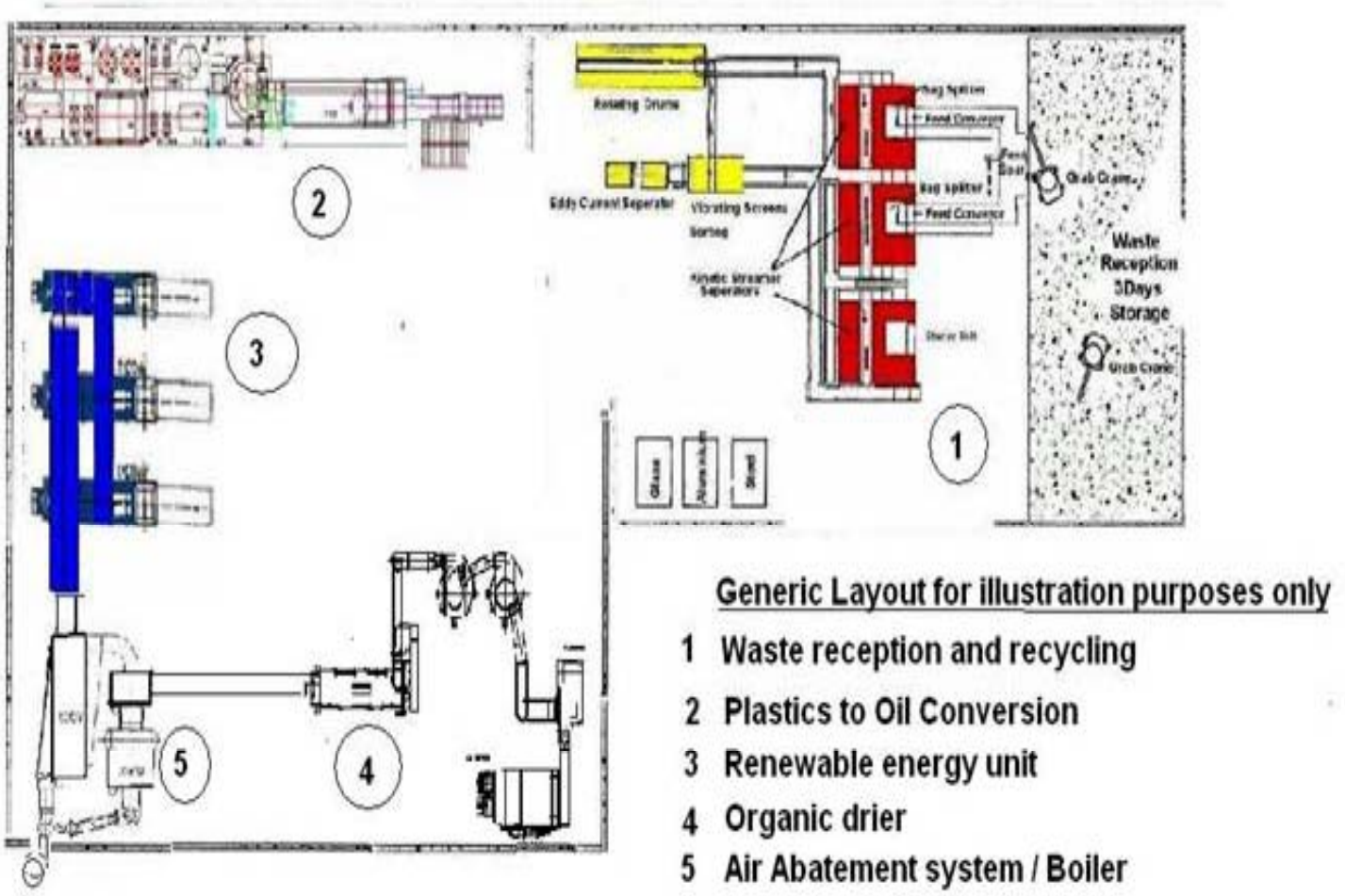


Steam
Turbine

Transformer /
Switchgear

Transmission

Wet Scrubber



Entech Integrated Process Layout

Kinetic Streamer
Wastec Facility, York UK
(Operating since January 2005)

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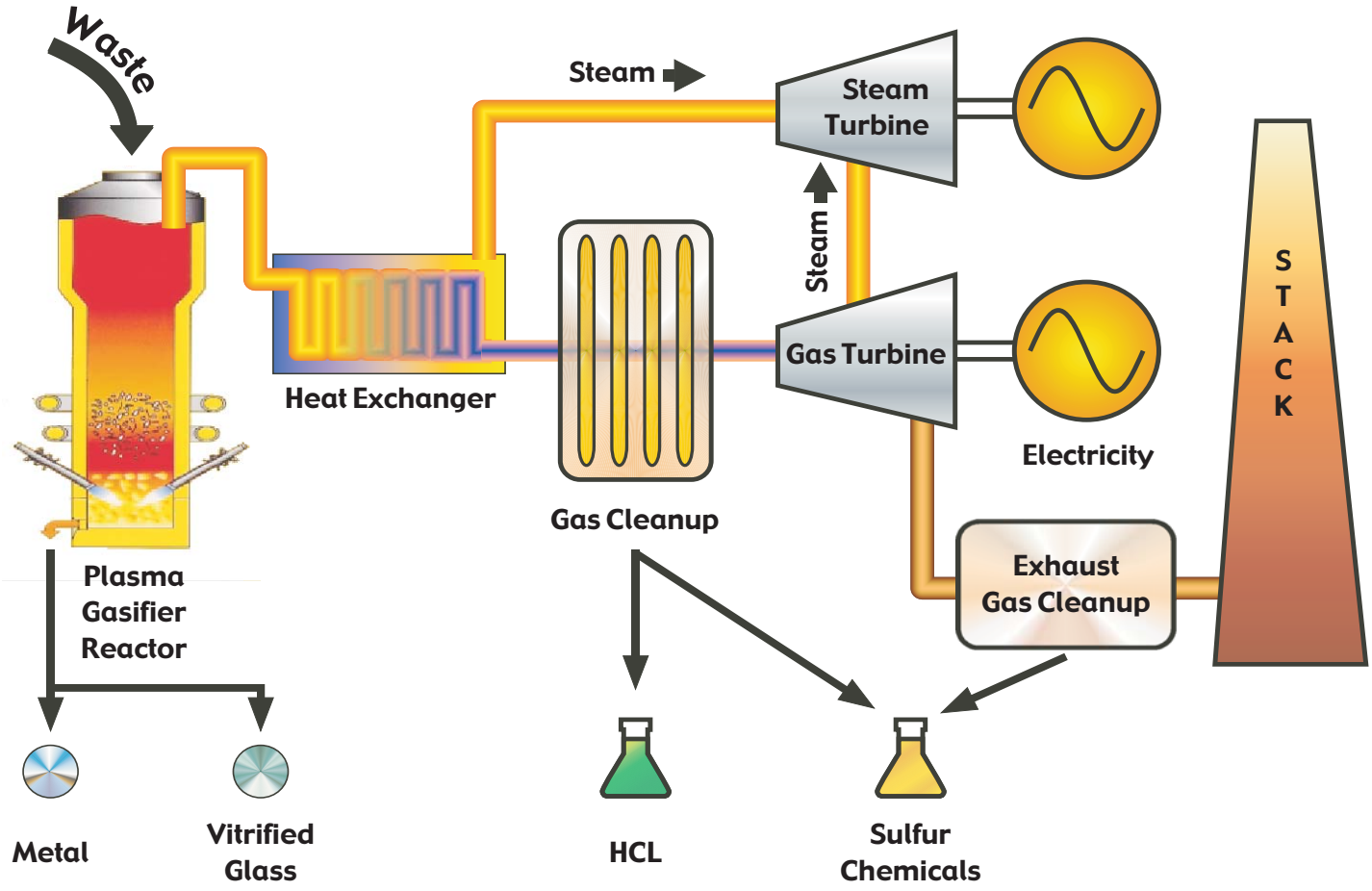
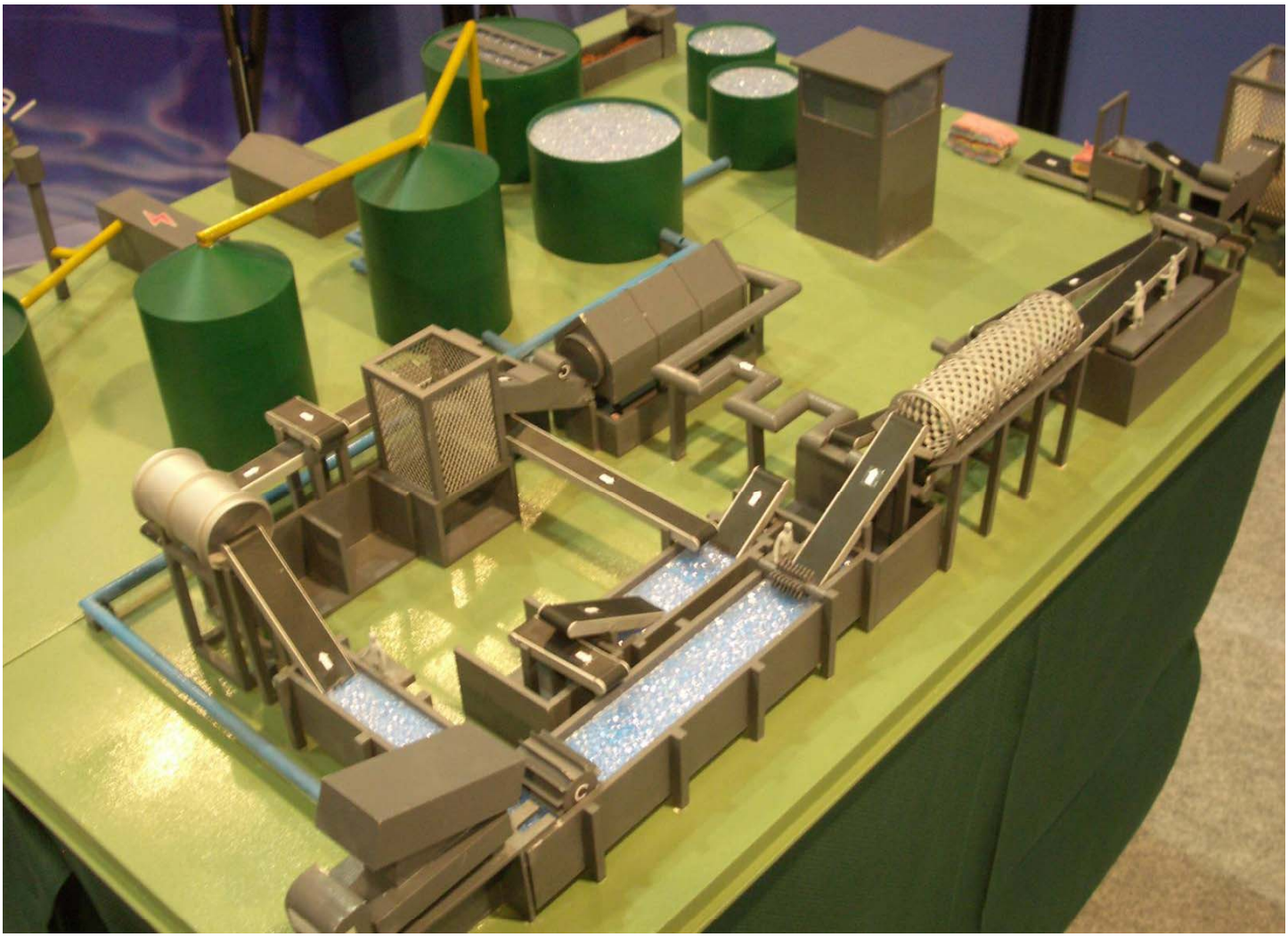
Gasifier and Thermal Oxidizer
Entech Facility, Bydgoszcz, Poland
25 TPD – Hospital Waste
(Operating since February 2003)

NTech – Malaysia
67 TPD



Rigel Waste Conversion System: Westinghouse Plasma System

(Operating since 2004, Utashinai, Japan)



ArrowBio – Anaerobic Digestion System

Tel Aviv

110 TPD

(Operating since 2003)

Separation/Processing

ArrowBio, Tel Aviv

Tipping to Process

ArrowBio, Tel Aviv

Primary Flotation

ArrowBio, Tel Aviv

Digestion Tanks

ArrowBio, Tel Aviv

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Soil Amendment
Results

ArrowBio, Tel Aviv

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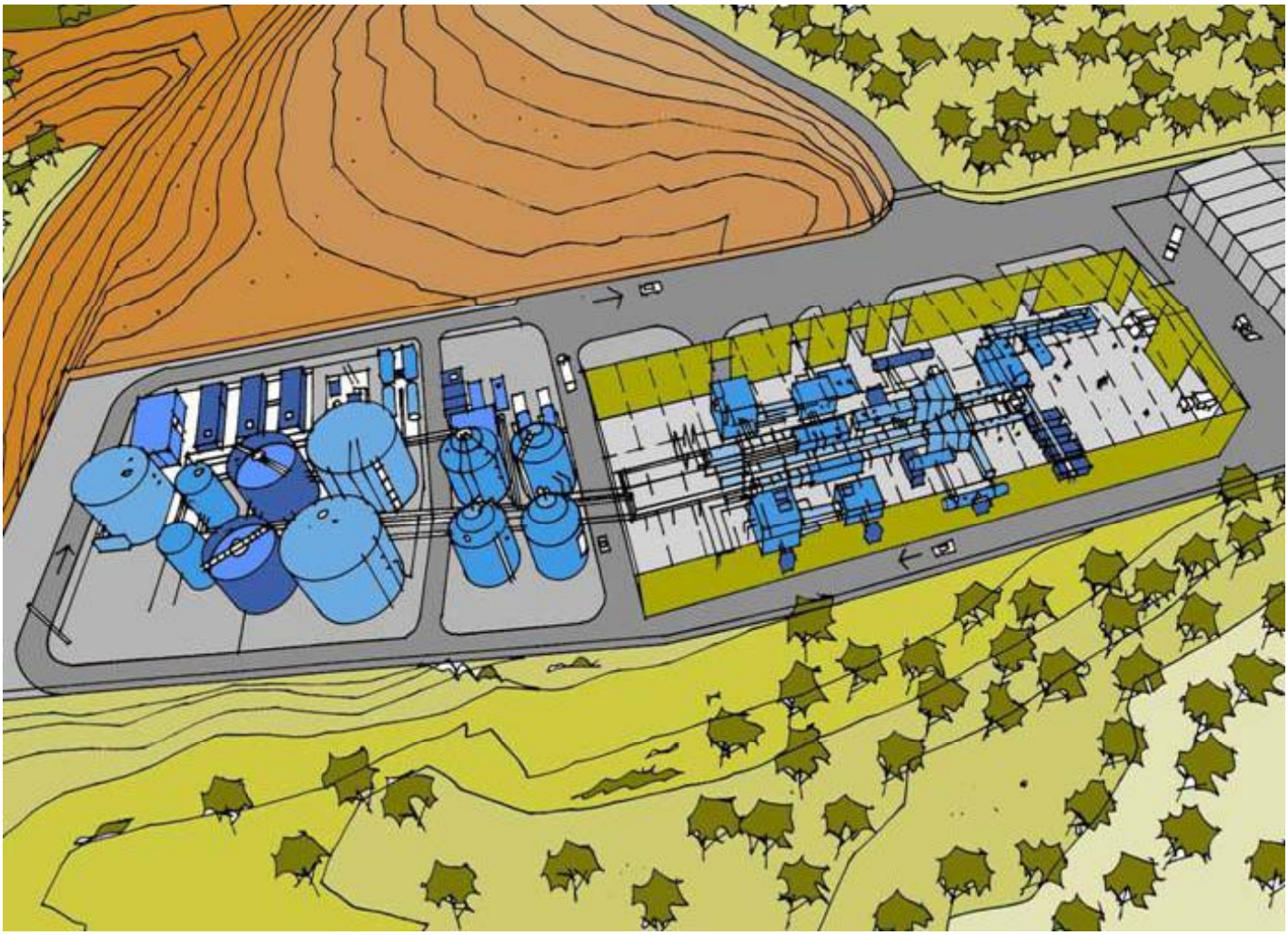
Reciprocating Engine/Gen Set

ArrowBio, Tel Aviv



ArrowBio – Artist Rendering for
Sydney, Australia
300 TPD

ArrowBio

Jacks Gully

Sydney, Australia

May 2007

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ArrowBio

Jacks Gully

Sydney, Australia

November 2007

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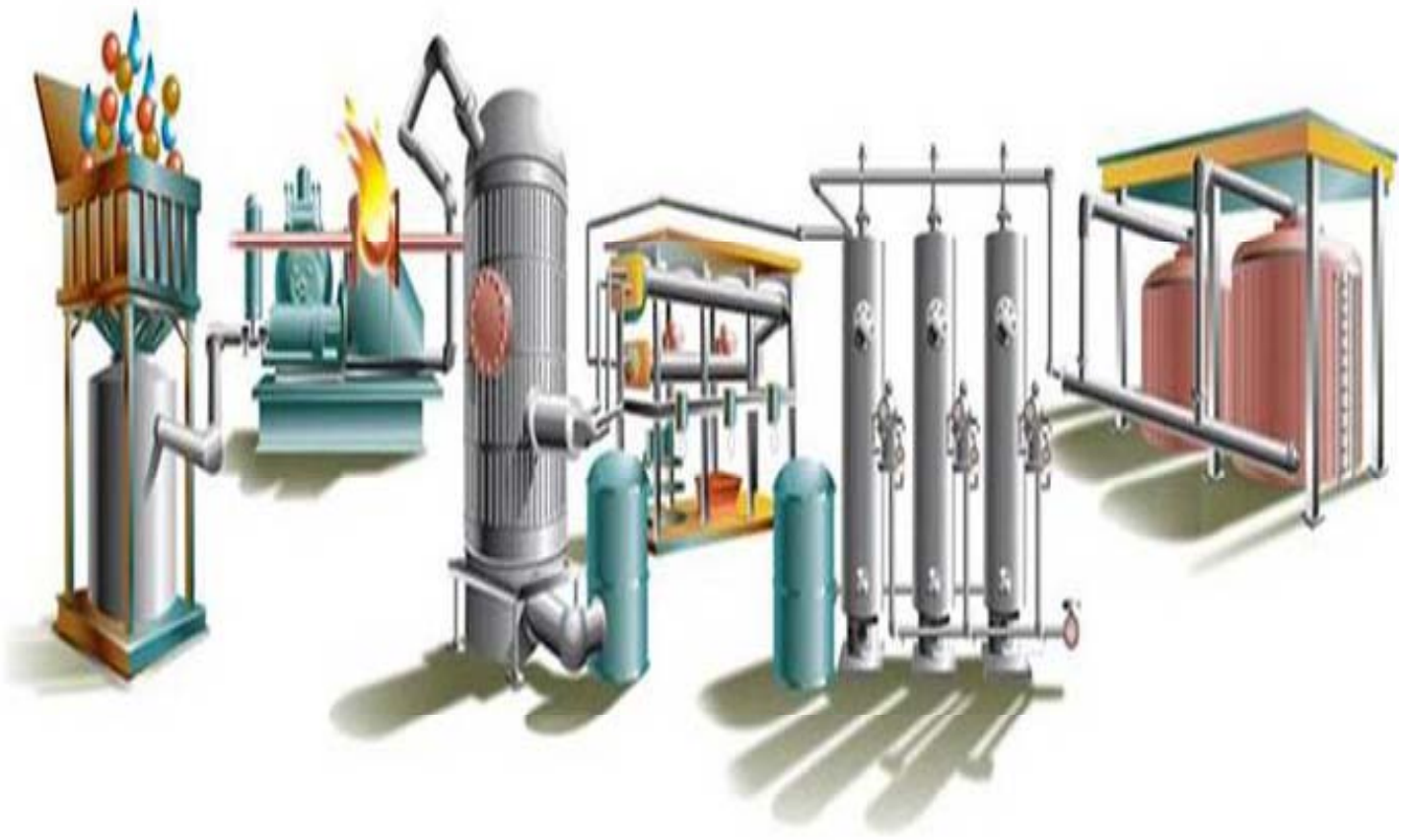
CWT – Process Equipment
Carthage, MO

250 TPD
(Operating since February 2005)



Changing World Technologies – Process Steps

CWT – Oil Products