MSWE
Municipal Solid Waste to Energy

rethinkenergy CLEVELAND

Cleveland MSWE Environmental Impacts

April 4, 2011

CITY OF CLEVELAND
Mayor Frank G. Jackson

CITY OF CLEVELAND
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WASTE COLLECTION

ClevelandPublicPower
Count on it

Agenda

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1. Introduction

Ridge Road Transfer Station

3741 Ridge Road, Cleveland

Current MSW Capacity and Collection at Ridge Road

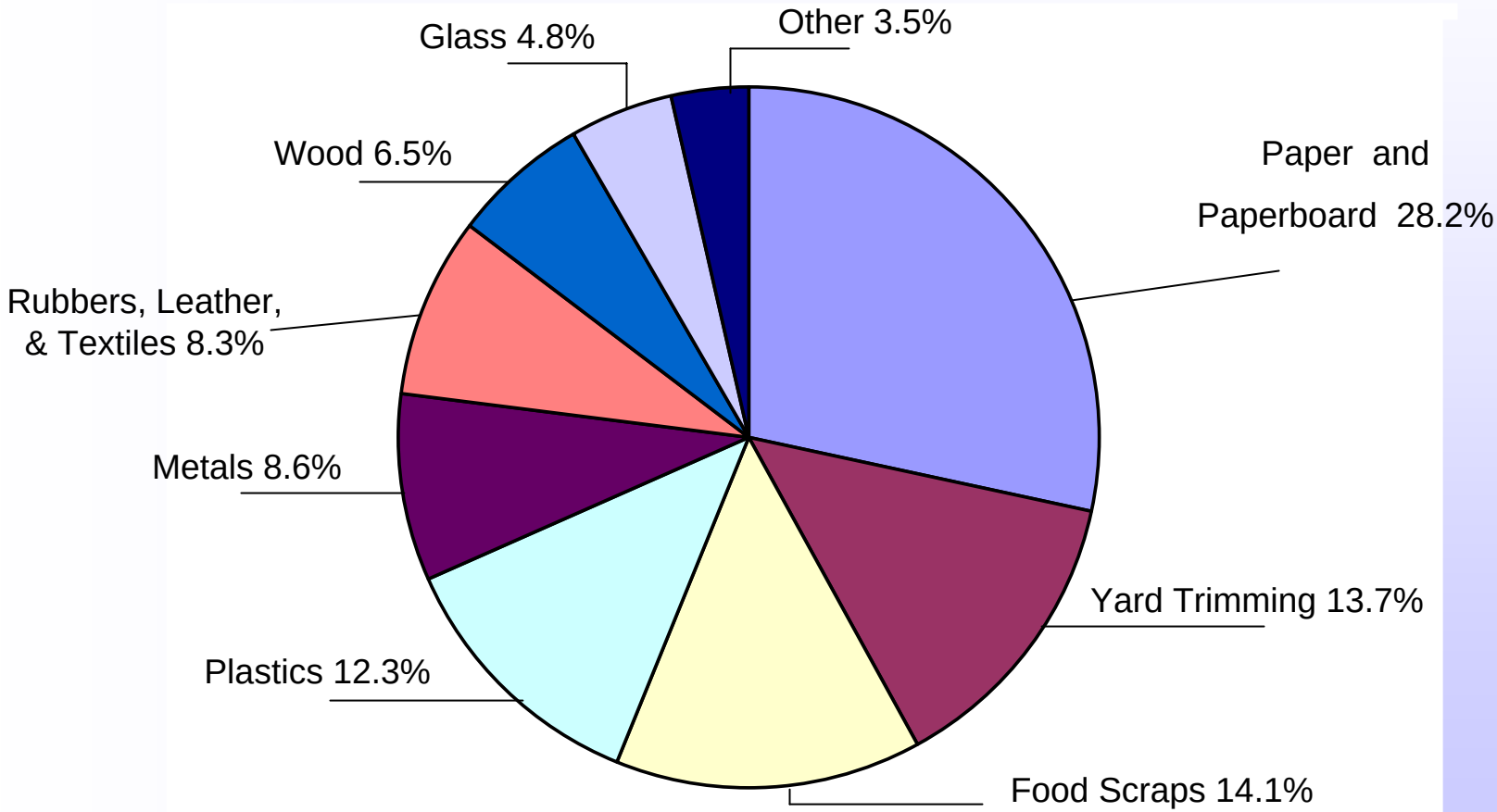
- Cleveland's Ridge Road Transfer Station has a daily MSW capacity of 3,000 tons (253 days of operation)

- Ridge Road daily collection of MSW
  - On-peak 1,500 tons daily
  - Off-peak 900 tons daily

- Ridge Road's unused capacity
  - On-peak 1,500 tons daily
  - Off-peak 2,100 tons daily

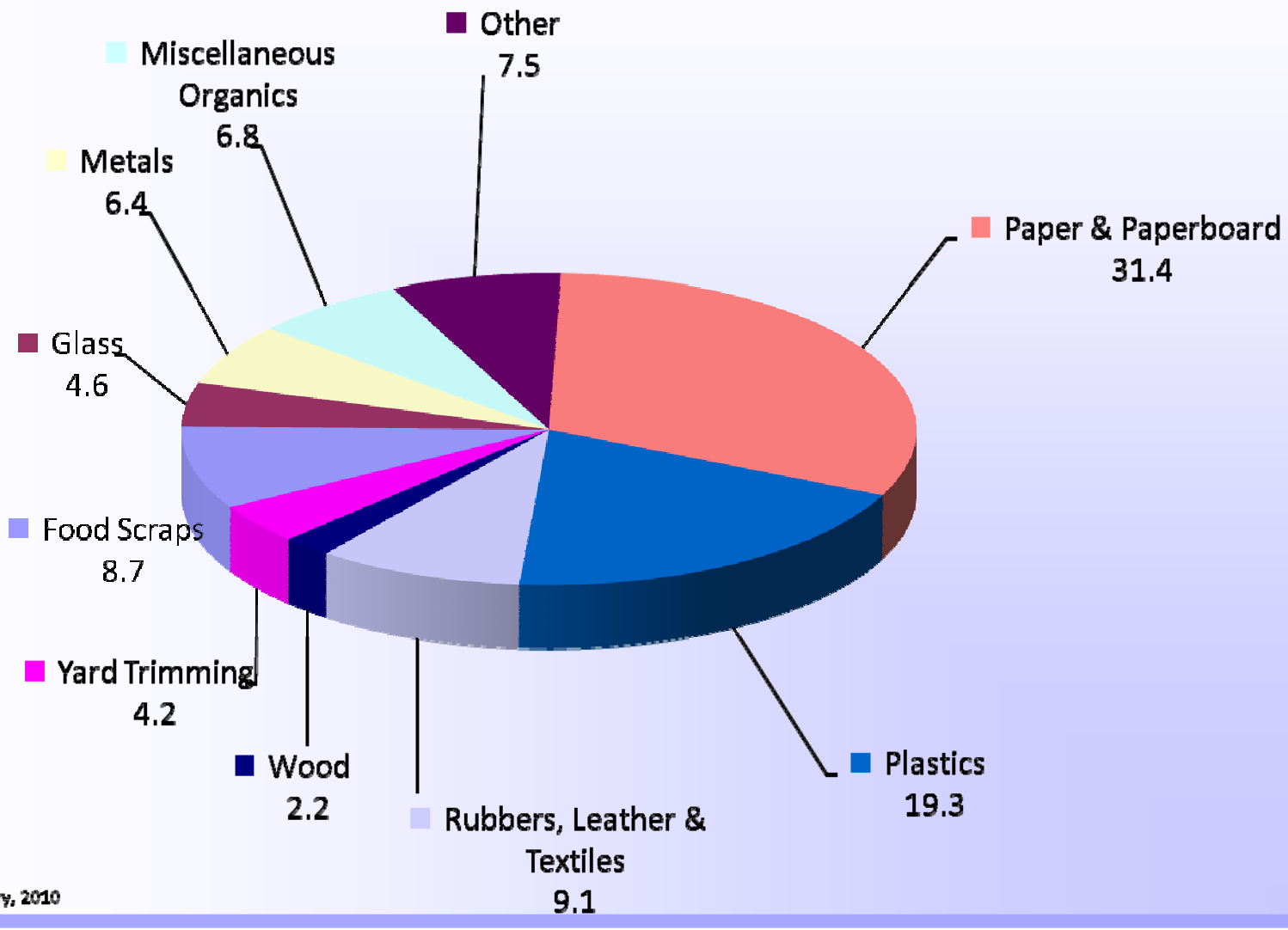
What Is In Municipal Solid Waste?

US EPA 2009*



*243 Million Tons (before recycling)

What is in Cleveland's MSW Collected at Ridge Road?



[1]Study completed February, 2010

Long Term Waste Management Solution

Alternate Collection Method: convert the current manual process to a *fully-automated* and a *semi-automated system* for recycling utilizing carts.

Waste Sorting & Separation: invest in material recovery facility to prepare waste for processing and/or recycling.

Recyclables: *fully implement Cleveland's Waste Collection Recycling Program City-wide* and include metal collection and separation, waste paper collection and bundling, and more.

Power Production: use MSW as feedstock for electric generation.

Why This Option for Cleveland

Unlike other municipalities, Cleveland is unique in that it:

- ***Owns the MSW***
- ***Has a high volume and variety of MSW***
- ***Owns the transfer station***
- ***Has its own electric system with direct access to the electric grid***
- ***Manages its own Water System***
- ***Rail is proximate to Transfer Station***

2. Incineration ≠ Gasification

Waste-to-Energy Technology is Not New

- The first waste-to-energy plant in the US was an incineration plant located in Saugus, Massachusetts.
- In 2009, the European Union had 429 waste to energy incinerators in operation. The U.S., population 300 million, has 87. Denmark, population 5.5 million, has 27.
  - Europe has embraced waste to energy technology as evidenced by the European Union Landfill Directive to stop burying organic waste by 2020 or countries like Ireland or the U.K. will start paying 48 Euros per ton for disposal.
- Today, incineration is recognized as a practical method for disposing of certain hazardous waste materials, but some consider it a more controversial method of waste disposal due to issues such as emission of harmful gaseous pollutants.

Incineration ≠ Gasification

- Cleveland's MSW to Energy Facility will use gasification technology rather than incineration. Lets talk about the difference.
- Incineration vs. Thermal Gasification
  - Incineration of MSW is through combustion of organic materials in an oxygen rich environment that produces complex hazardous oxides in the process
  - Thermal gasification of MSW is through high temperature chemical conversion of organic materials into synthetic gas (composed primarily of H_2 and CO) in a controlled oxygen and heat environment
  - Thermal gasification breaks down hazardous organic substances such as dioxins and furans

Incineration ≠ Gasification

Incineration	Gasification
MSW seen as a fuel, destruction of waste material without emphasis on recycling, recovery or reuse	MSW seen as a feedstock for chemical conversion for the creation of valuable usable product (syngas)
Mass burn technology produces heat that is often used to produce steam and/or electricity without cleaning	Converts MSW into syngas which is cleaned and then used to fire a boiler for steam and electricity production
Designed to maximize the conversion of feedstock to CO_2 and H_2O	Designed to maximize the conversion of feedstock to CO and H_2
Large amounts of oxygen for complete combustion with high emission of green house gases, dioxins and furans	Requires limited quantities of oxygen for thermal conversion with lower emission of green house gases
Dioxins and furans have sufficient oxygen to form	The oxygen deficient atmosphere does not support dioxin or furan formation
Non-useable landfill waste ash product	Ash has commercial value depending on content of feedstock

Incineration ≠ Gasification

Incineration	Gasification
Supplemental fossil fuel often required to sustain the process	Supplemental fossil fuel is not required to sustain the process
Waste is converted to heat	Waste is decomposed into a rich fuel
Feedstock volume reduced 80% as ash	Feedstock volume reduced 95% as ash
Better Green House Gas (GHG) emission reduction compared to Landfill gas	Offers the highest level of GHG emission reduction compared to Incineration and Landfill gas
Does not have a neighborhood friendly reputation	Has a neighborhood friendly reputation and is used in urban settings abroad
Difficulty co-existing with recycling program	Ability to co-exist with recycling program

Incineration ≠ Gasification

Cleveland's waste-to-energy approach is not based on incineration but on a proven process called gasification.

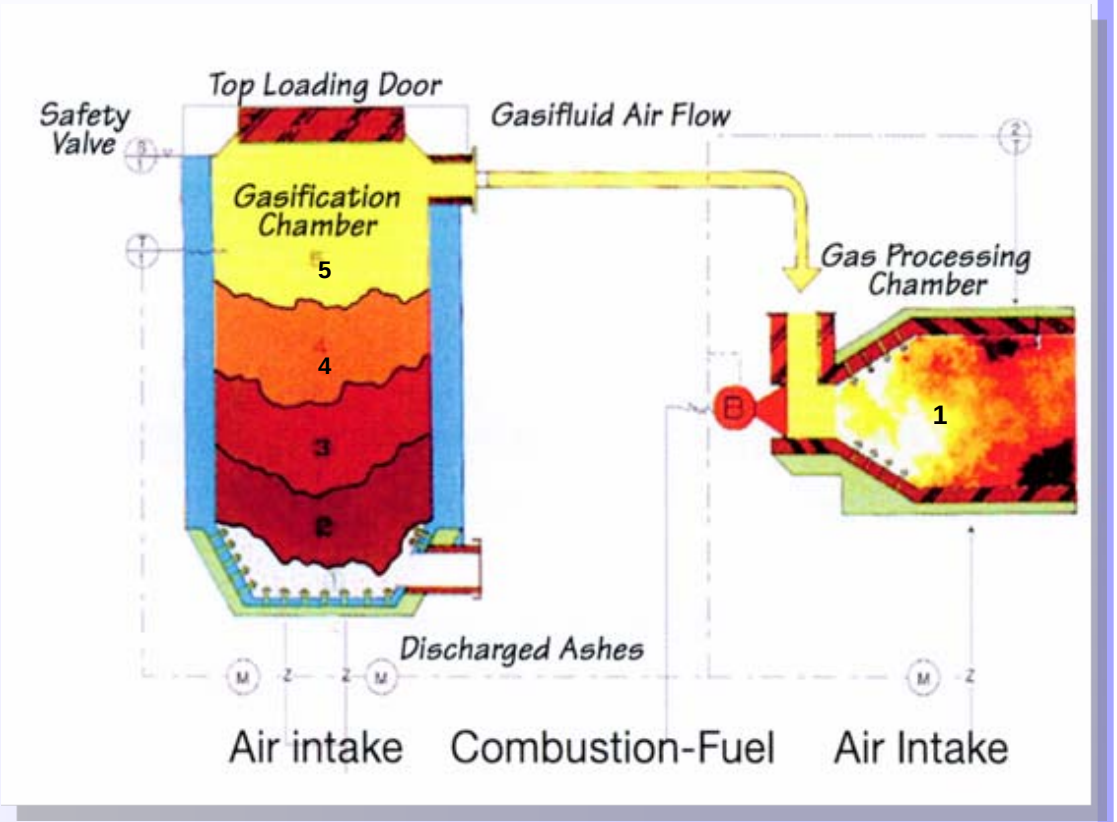
Three primary types of thermal gasification:

- Conventional gasification
- Plasma gasification
- Pyrolysis gasification

Cleveland will use a 2-stage process. After cleaning the output gas from the gasification process, the gas will be used to fire a boiler to produce steam. The steam will be used to turn a turbine to produce electricity.

Gasification Technology

- Gasification Process: The System is ignited at 80°C and rapidly increased to 800°C. Through precision temperature and air flow control, the system restrains formation of toxins. 8-12 hr process.
- After gasification, ash remains are reduced to 5% of initial input volume. Enhanced furnace can reduce ash to 1-2%. Ash discharges are 99% non-organic and non-toxic.



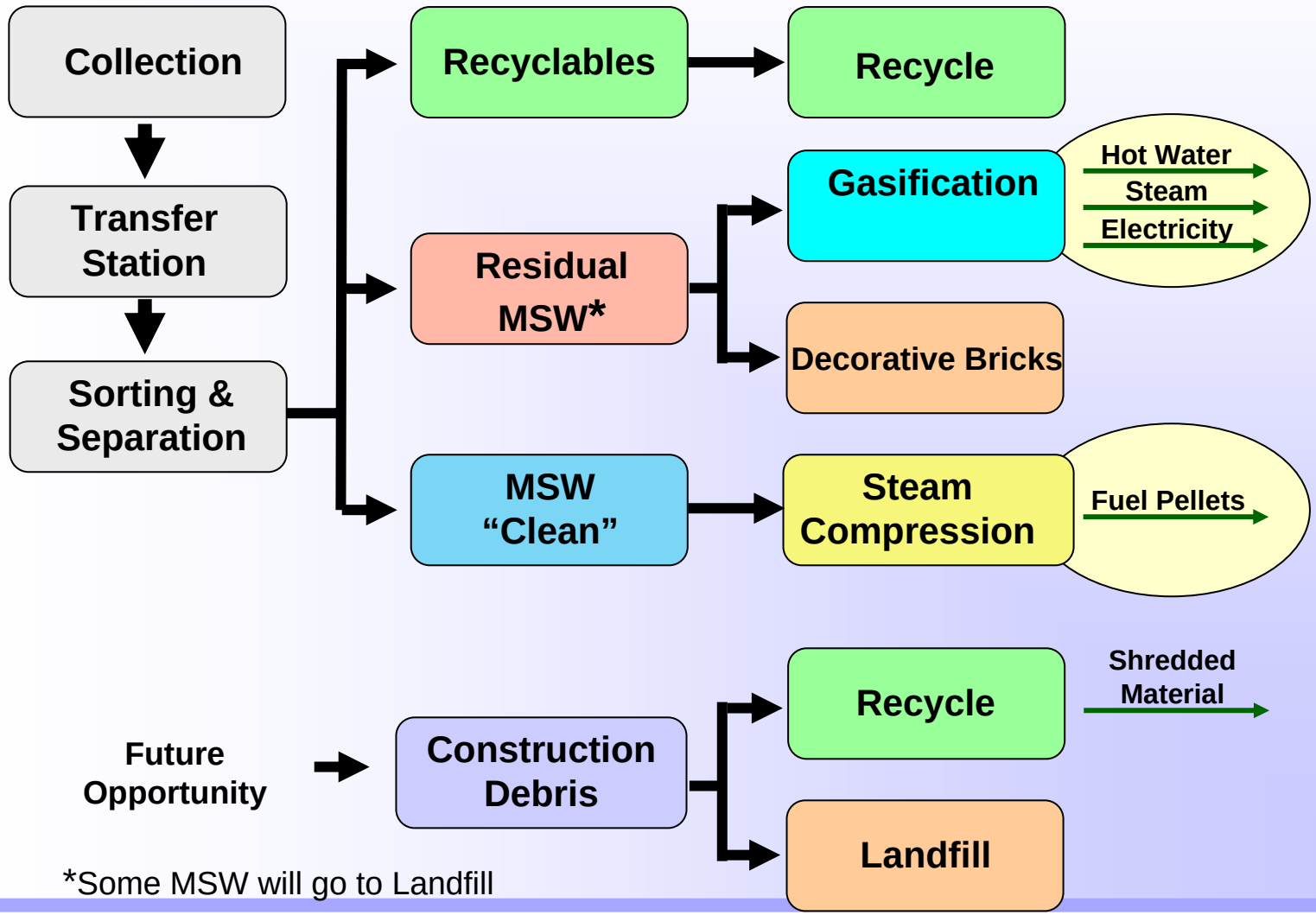
1. *Gasification Processing Chamber*
2. *Heating Chamber*
3. *Fluidization Chamber*
4. *Heat Transfer Chamber*
5. *Gasification Chamber*

3. System Requirements And Facility Design

Top Priorities

- Minimize MSW sent to landfill
- Environmentally conscious waste-to-energy facility
- Electric power generation to reduce market dependence
- Electric generation that helps meet the City's AEPS goals for CPP
- Recycling on a City-wide basis
- Sustainable Waste Recovery System

Facility Block Diagram



*Some MSW will go to Landfill

Collection Process

Current manual collection process replaced

City-wide Recycling Program

Semi and Fully-automated Collection Process City-wide

Collection and Sorting Processes

Curbside Collection

Collect and Transport

Transfer Station

Automated Sorting

Manual Separation

Recycling

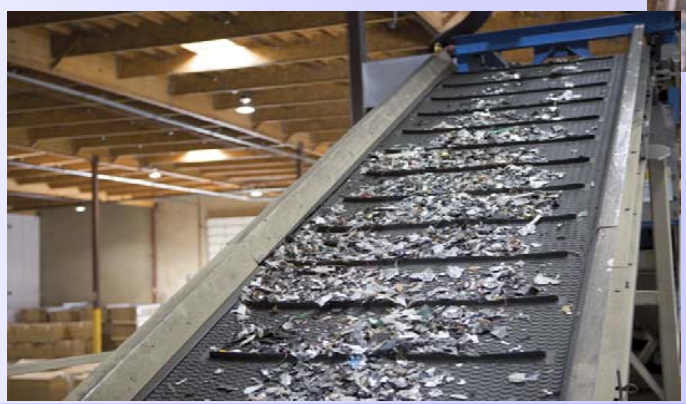
Feedstock for Gasification Processing

Material Recovery Facility (MRF)

Cleveland's MRF will use the latest in sorting technology

- Automated screen technology for sorting processes
- Manual and optical sorting, ferrios magnets and other technology such as eddie currents to separate aluminum cans and other metals
- This will be a state of the art multi stream waste sorting system. It will separate additional recyclable materials and perform the initial sorting for fuel pellet production and gasification.

The success of the MSWE Project depends on a successful MRF operation.



MSW Processing

MSW and Debris

Sorting

Shredding

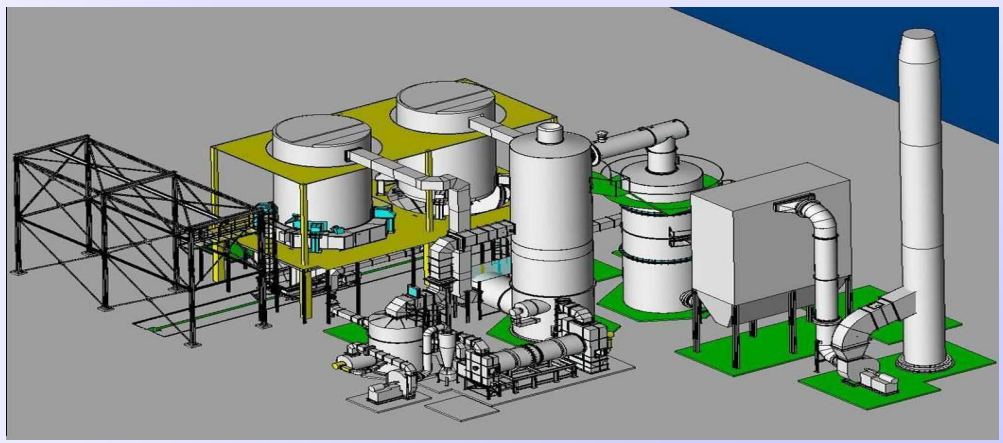
Fuel Pellets

Feedstock In

Steam

Boiler

Syngas out



Gasification System

Gasification System Operation

The Cleveland facility will have four gasification lines with two batch gasifiers operating in tandem in each gasification line.

- **Max Operating schedule:** 12 hours per day per gasifier (365 days per year)
- **Feedstock:** 70 tons of MSW/batch.
- **Cycle:** One batch of MSW will be processed each day in each gasifier.

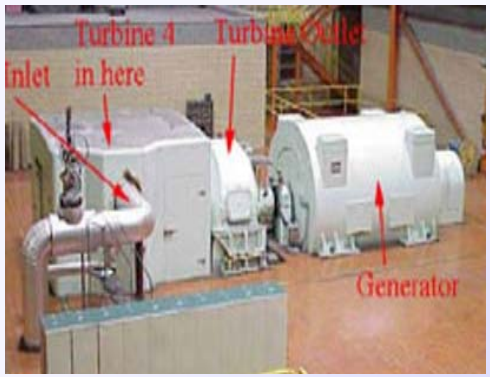
Gasification

- Batch operations vs. Continuous feed
  - In the initial step Cleveland will process the MSW through the MRF
  - After sorting, the MSW will be shredded and/or further processed as feedstock for gasification
  - The feedstock will be layered based on combustion characteristics and processed in the gasifiers in batches
- *The air emissions from this process will be far less due to the pre-processing of the MSW and the air pollution control systems in the facility.*

Steam Uses

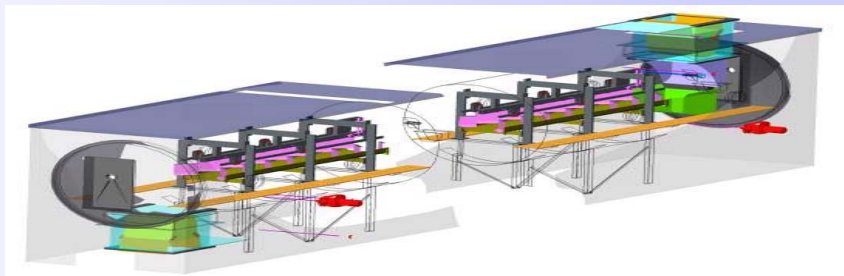
Boiler

Turbine Generator



Electricity

Steam used for fuel pellet production



Overview Fuel Pellets

- fiber exits the system at approx 40% moisture content with a gross calorific value of 11 MJ/kg (2629 Kcal/kg or about 11,000 BTU/Lb)
  - dried fiber has a gross heat value of <10000 BTU/lb
  - this biomass contains minimal sulfur and is much cleaner, when burnt, than fossil fuel
  - total sulfur content 0.12% (dry)
  - this is approx 10% of the sulfur content of coal

Decorative Bricks

Depending on its content, gasification ash may be mixed with construction debris and other materials to make bricks, or it may be processed further as road paving material.

Non-fired Brick Making Process

- Cleveland's approach will be based on a technique called cold injection molding.
- The bricks will not be fired in a kiln and are air dried. This could be marketed as a green product.
- The bricks would be for decorative purposes.


1
2
3

4. CPP Emissions vs. Benchmark Rules and Permits

Best Available Technology (BAT)

- The National Source Performance Standards (NSPS) subpart AAAA applies to small municipal waste combustion units for which construction occurred after August 30, 1999.
- The NSPS subpart Eb applies to new source performance standards for large municipal waste combustors constructed after September 20, 1994.
- Cleveland's facility as proposed will emit pollutants at or below all of these levels. ***The BAT limits proposed for the CPP project are equivalent to, or more stringent than, each of the relevant benchmarks.***

Air Quality Modeling

- Ohio EPA required an air quality computer model analysis be performed on the proposed Cleveland facility.

- The model completed by GT Environmental predicted how different air pollutants travel away from the source of pollution.

- **Based on the modeling analysis, the predicted maximum off-site air quality impact for each pollutant emitted by the operation of the proposed CPP facility is well within the guidelines established by Ohio EPA**

CPP Emissions vs. Benchmark

The Facility will emit 3 types of Air Contaminants

1. **Air contaminants for which the US EPA has adopted National Ambient Air Quality Standards (NAAQS)**
   - Ozone, Nitrogen Dioxide, Sulfur Dioxide, Particulate Matter less than 10 microns in diameter, Particulate Matter less than 2.5 microns in diameter, Lead, Carbon Monoxide

2. **Air contaminants that are listed as Hazardous Air Pollutants and/or identified as toxic air pollutants by the Ohio EPA**
   - Hydrogen chloride, Hydrogen fluoride, Cadmium, Mercury, Dioxin, Ammonia and Sulfuric acid

3. **Green House Gas Air Pollutants as designated by the US EPA**
   - Carbon dioxide, Nitrous oxide, and methane

The Cleveland facility will operate within the OEPA NSR and HAPs guidelines

Ohio EPA New Source Review (NSR)

- Particulate Matter (PM2.5)
- Particulate Matter (PM10)
- Sulfur Dioxide (SO2)
- Nitrogen Oxide (NOx)
- Nitrogen Dioxide (NO2)
- Carbon Monoxide (CO)
- Volatile Organic Compounds (VOC)
- Lead (Pb)

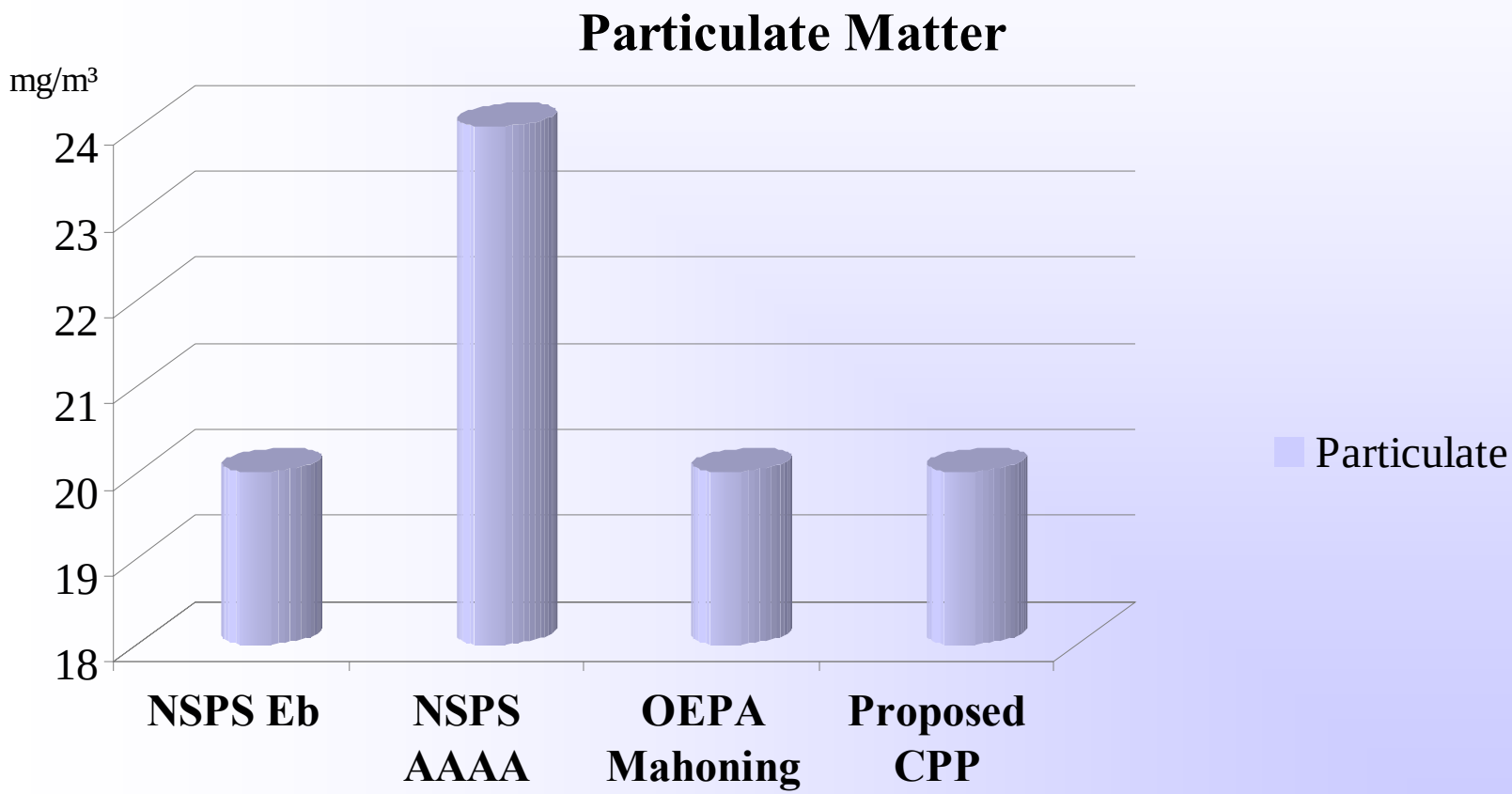
Ohio EPA Hazardous Air Pollutants (HAPs) Toxic Air Pollutants

- Hydrogen Chloride (HCI)
- Dioxin
- Cadmium
- Mercury
- Hydrogen Fluoride (HF)
- Sulfuric Acid (H2SO4)
- Ammonia

CPP Emissions vs. Benchmark

- Although air quality modeling is not required pursuant to Ohio EPA Engineering Guide #69 for mercury or dioxin, CPP elected to include modeling for those two pollutants to demonstrate the impact from the proposed facility is far less than authorized by the Ohio EPA Air Toxic Policy “Option A”.

CPP BAT Emissions vs. Benchmark Rules and Permit



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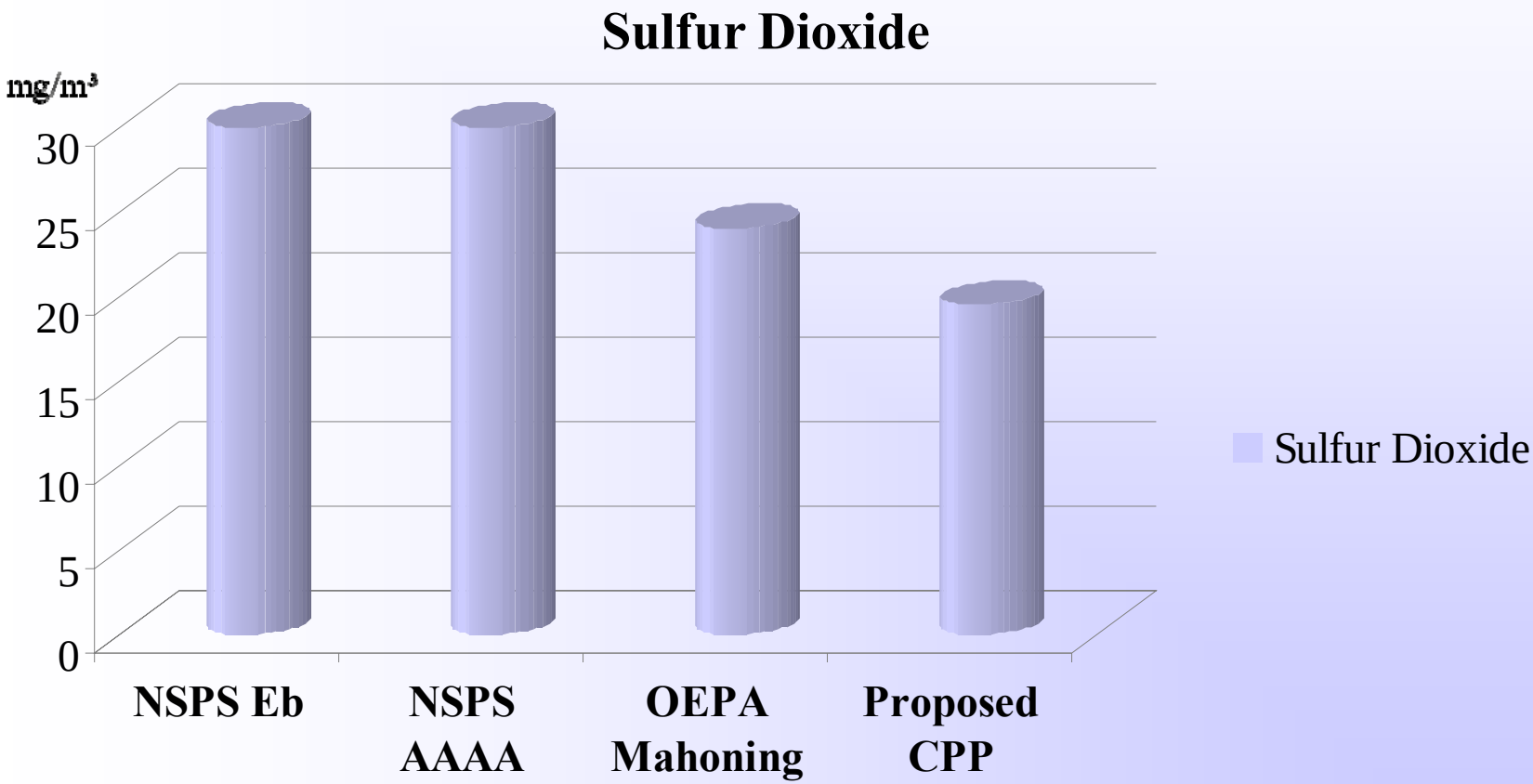

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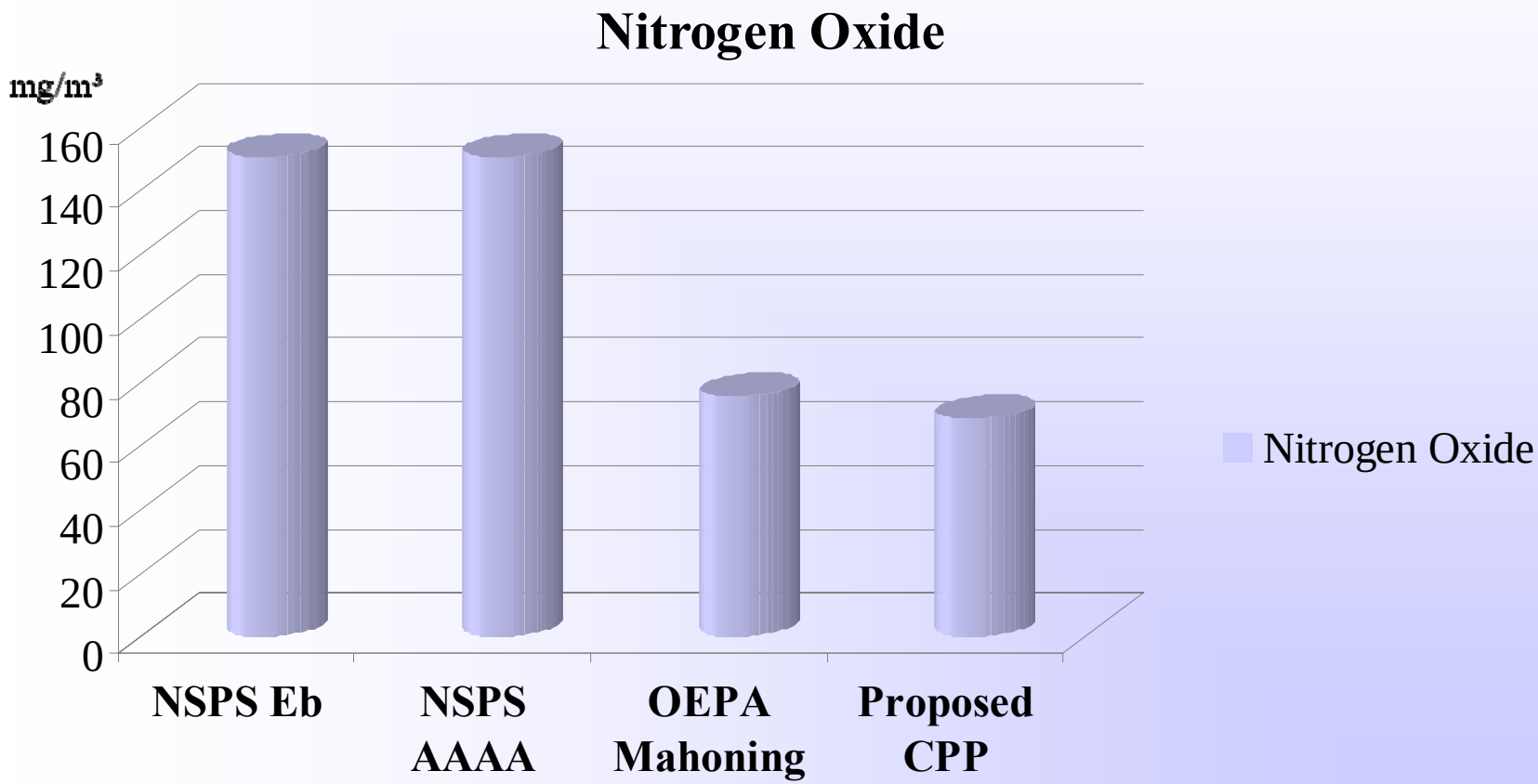

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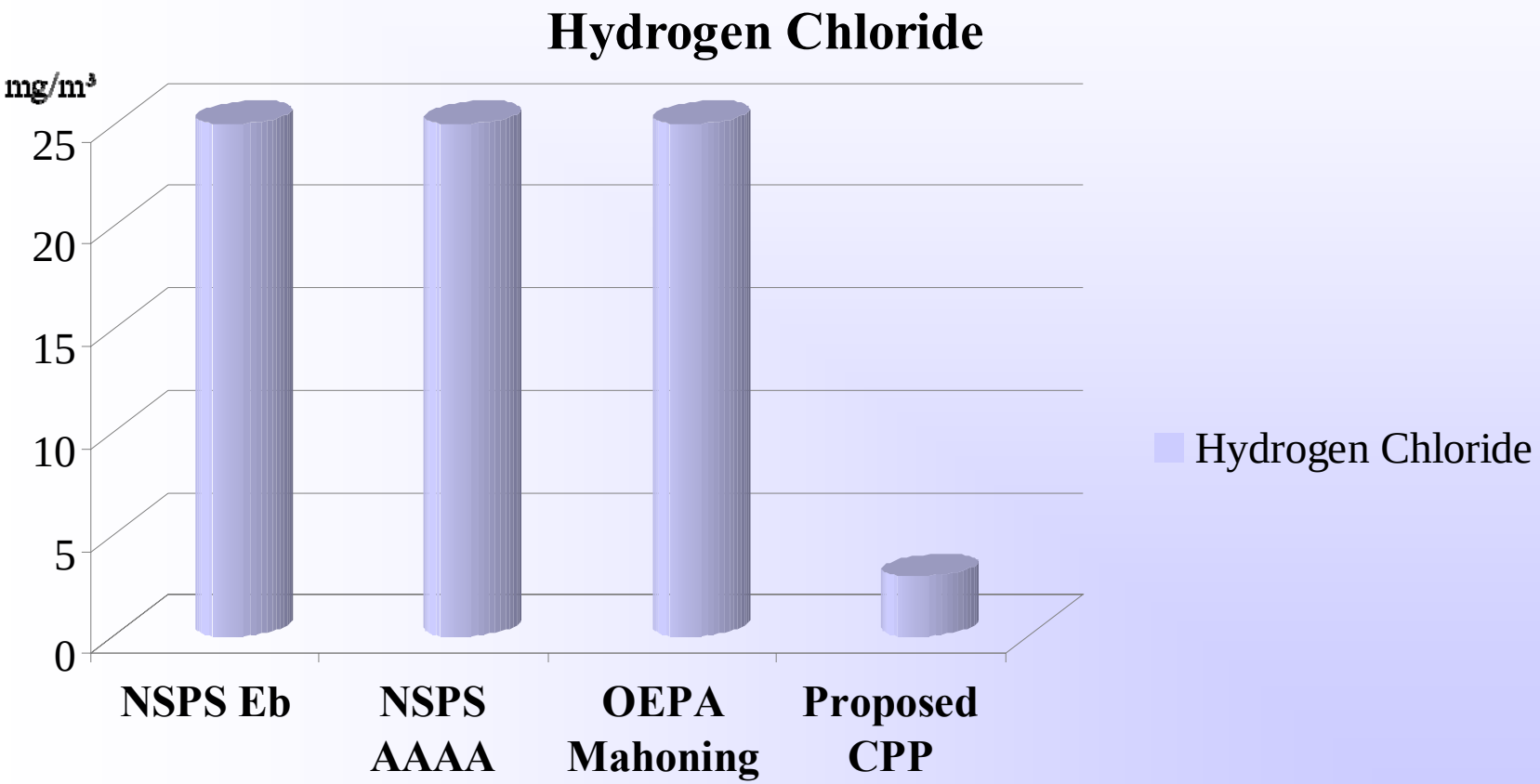

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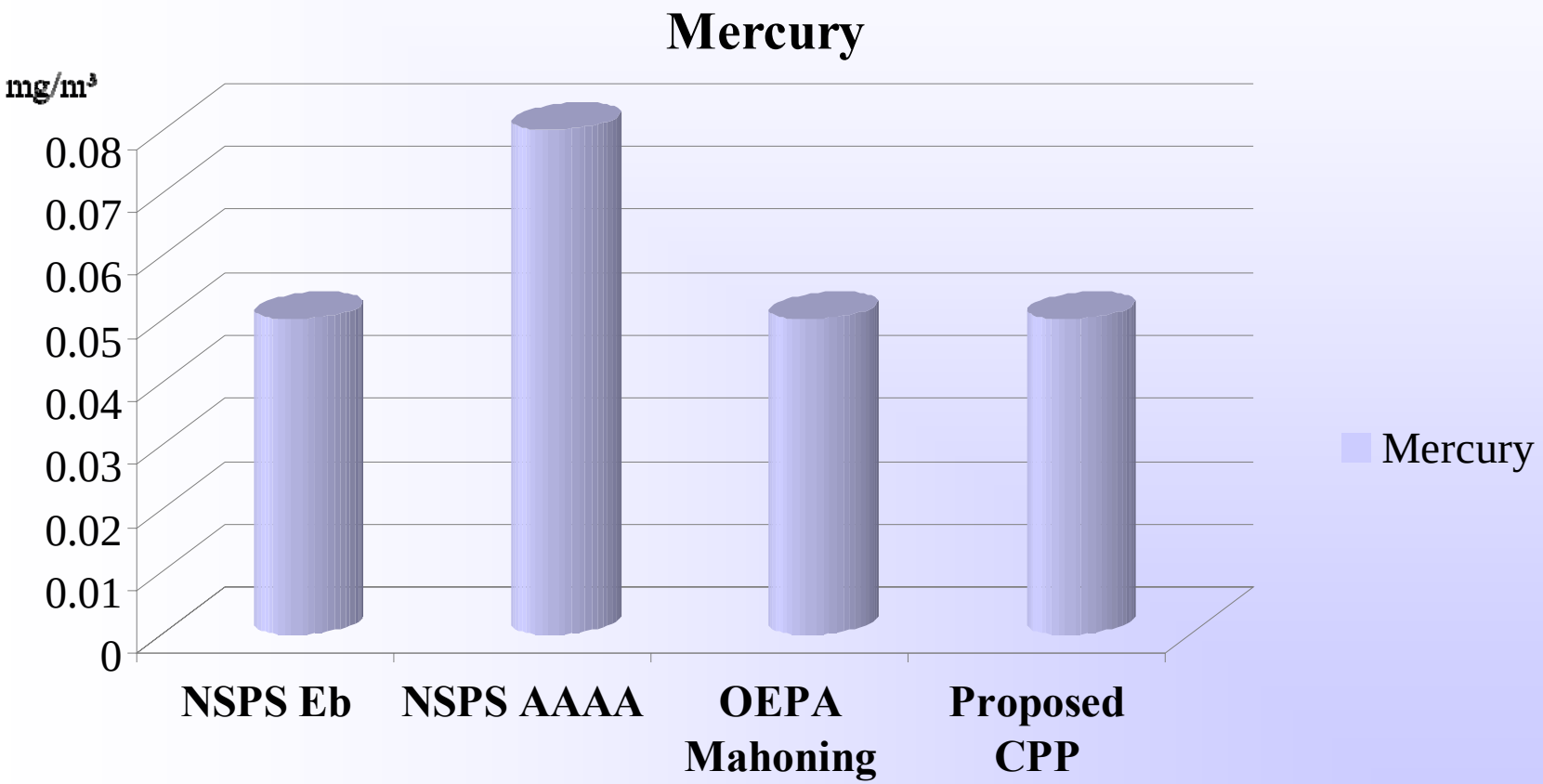

5. MSWE Emissions Compared to Other Sources In the Area

- Under the Federal and State New Source Review rules the CPP facility is classified as a “minor source” because of the stringent BAT performance specifications in the City’s MSWE permit application.
- Title V Operating Permit: The City will operate the MSWE under the strict continuous monitoring and record keeping terms of the Title V Operating Permit program.

Regardless of air contaminant category, the maximum annual potential emissions from the proposed MSWE facility compare very favorably to the actual emissions from other facilities that are currently operating in NE Ohio.

Emission Comparisons

- The following tables compare the proposed MSWE facility's potential annual emissions vs. actual annual emissions reported by other major industrial and utility sources in NE Ohio.

  Actual annual air contaminant emissions from the CPP facility will be less than amounts presented in the tables for two reasons:

  - The maximum potential annual emissions from the proposed MSWE facility assume that four gasifier lines will operate at the maximum allowable hourly emission rate *every hour each line is operated*.
  - The actual emissions during many hours of the year will be *less* than the allowable emission rate because the allowed rate incorporates safety margins to ensure continuous compliance.

Emission Comparisons

The 2009 actual emissions from other operating facilities in NE Ohio are based on actual emission rates that in many cases are less than the allowable emission rates for these facilities.

1. During 2009 almost all of the industrial and utility sources were operated at less than their historic operational capacity
2. Operating facilities are not required to report HAP and air toxic emissions unless the amount of raw materials exceed specific thresholds

Maximum Potential Emissions from the CPP Facility vs. Actual 2009 Emissions from Major Industrial and Utility Sources

County	NAAQS 2009 Air Contaminant Emissions by County							
	VOC	NOx	SO2	PM (cond)	PM (filt)	CO	Lead (Pb)	Total
Ashtabula County	3,056	1,245	4,833	148	230	59,995	0.02	69,507
Cuyahoga County	973	2,296	5,684	142	776	6,402	2.6	16,276
Geauga County	18	10	6	NR	9	NR	0.004	43
Lake County	196	7,800	52,030	2,839	498	1,494	0.15	64,857
Lorain County	584	5,655	37,608	499	773	826	4.2	45,949
Medina County	174	75	57	16	34	88	0.004	444
Portage County	359	101	24	8	71	148	0.001	711
Summit County	378	426	2,153	18	107	310	0.39	3,392
NE Ohio Total	5,739	17,607	102,394	3,671	5,678	69,264	7.34	204,360
CPP Ridge Road Potential NAAQS Emissions (TPY)	34	187	99	64	36	112	0.25	532
CPP Ridge Road Project % of NE Ohio Major Sources	0.59%	1.06%	0.10%	1.74%	0.63%	0.16%	3.4%	0.26%

NR = None Reported by Major Sources

Maximum Potential Total HAP and Air Toxic Emissions from the CPP Facility

vs.

Actual Reported 2009 Total HAP and Air Toxic Emissions from Operating Sources

County	Total of All Air Toxic and HAP Contaminants (tons of actual 2009 emissions reported)
Ashtabula County	3,085
Cuyahoga County	272
Geauga County	24
Lake County	1,652
Lorain County	1,264
Medina County	96
Portage County	34
Summit County	654
NE Ohio Total	7,083
CPP Ridge Road Potential Total of All HAP and Air Toxic Emissions (TPY)	**39**
CPP Ridge Road Project % of NE Ohio Sources	0.55%

Maximum Potential Emissions from the CPP Facility
vs.
Ozone and PM2.5 SIP Inventories for Sources in NE Ohio

Source Category	Emissions from Ozone and PM2.5 SIP Inventories (tons)				
	VOC	NOx	PM2.5	SO2	Total
Major Industrial	3,853	4,796	862	17,760	27,271
Utility	258	23,905	2,158	91,065	117,386
Area	37,045	10,982	1,643	942	50,612
Non-Road	23,710	15,960	787	284	40,741
Marine	443	6,478	52	767	7,740
Mobile	18,512	48,068	596	362	67,538
Total	86,224	113,040	6,352	112,709	318,325
CPP Ridge Road Potential Emissions (TPY)	**34**	**187**	**99.8**	**99**	**320.8**
CPP Ridge Road Project % of NE Ohio Major Sources	**0.04%**	**0.03%**	**1.57%**	**0.09%**	**0.10%**

Maximum Potential Total PM (F + C) Emissions from the CPP Facility
vs.
Actual Reported 2009 Total PM Emissions from
Operating Major Industrial and Utility Sources

Major Industrial/Utility Facility	City	County	2009 PM (F + C) (tons)
CEI Eastlake Plant	Eastlake	Lake	3,121
RRI Energy Avon Lake Power Plant	Avon Lake	Lorain	824
FirstEnergy Ashtabula Plant	Ashtabula	Ashtabula	255
ArcelorMittal Cleveland Inc.	Cleveland	Cuyahoga	180
Painesville Municipal Electric Plant	Painesville	Lake	167
Elyria Foundry	Elyria	Lorain	163
Lorain Tubular Company LLC	Lorain	Lorain	100
CPP Ridge Road Potential Total PM (F + C)	Cleveland	Cuyahoga	**99**
CEI Lake Shore Plant	Cleveland	Cuyahoga	84
Cleveland Thermal LLC	Cleveland	Cuyahoga	73
Cargill, Incorporated - Salt Division	Akron	Summit	62
The Medical Center Company	Cleveland	Cuyahoga	29

GHG Impact of Cleveland's MSWE Project

Estimated Net Reduction in Greenhouse Gas (CO_2e) Emissions from the Operation of the Proposed CPP Facility		
CO_2e Netting	**2013 - 2030**	**2031 - 2060**
Estimated CO_2e Emissions from the CPP Project	**210,00**	**210,000**
Estimated CO_2e Reductions:		
(1) Reduced CO_2e from transportation to the landfill	3,665	3,665
(2) Reduced CO_2e emissions at landfill*	319,312	68,965
(3) Reduced CO_2e from coal-fired power generation	267,580	267,580
Total Estimated CO_2e Reductions	**590,556**	**340,210**
Net Change in Annual CO_2e Emissions	**-380,556**	**-130,210**

*Reflects the remaining useful life of the Landfill where Cleveland's MSW is disposed

6. Recycle, Reuse and Recover

- Cleveland's MRF will increase the recycling rate
  - ✶Early estimates suggest that the addition of an onsite-sorting facility will increase our material recycling rate by a magnitude of 10.
- The MSWE Project will enable faster deployment of curbside recycling City-wide
  - ✶Curbside recycling and automated pick-up is saving the City money and significantly increasing the recycling rate
  - ✶The MSWE Project budget estimate provides resources needed to implement a City-wide recycling program

For every ton of waste diverted from the landfill, Cleveland saves over $40.00. With over 150,000 tons going to the landfill, this represents $6 million we will no longer dump in the ground.

Not all products are recyclable

Sample materials that are not recycled:

Tissue paper, wrapping paper, food wrappers, food containers, napkins, paper cups, coated fax paper, carbon paper, blueprints, any paper product contaminated by grease, oil or food residue, wax paper, plastic shrink wrap, hanging file folders, plastic bindings, metal bindings, plastic findings, metal findings, fruits and vegetable boxes, pizza boxes, poly-coated boxes, egg cartons, wax coated boxes, plastic corrugated boxes, any corrugated cardboard contaminated by cooked food, grease or oil, sanitary products, diapers, aerosol cans, paint cans, and propane tanks, plastic bags, oil containers and wide-mouth plastic food containers, non-bottle plastics, packaging material, rigid polystyrene, plastic shrink wrap, sponges and bubble pack.

Recycle, Reuse and Recover

Our analysis indicates the MSWE Project will recover:

- ✶ 34% of the City's MSW for recycling
- ✶ 61% for fuel pellet production and gasification
- ✶ 5% appears as non-productive waste
  - ♦ What comprises non-productive waste?
    - ▲ Anything that cannot be recycled, made into fuel pellets or gasified. Ash from the gasification process is not included.

Recycle, Reuse and Recover

Non- Recyclable Waste Example:

The City can not recycle soiled or contaminated paper or plastic products. Cleaning them is not economic and would cause further environmental concerns.

The City's approach is closer to a *Zero Landfill* than a *Zero Waste* strategy.

- One requires changes within the City's control and the other requires changes beyond our control. However, the first is a big step toward the second.

7. Other Impacts

Ridge Road
Transfer Station

Existing
Layout
Aerial View

Ridge Road Transfer Station View

Ridge Road Transfer Station View

Everything is enclosed

Impact on Truck Traffic

- At the current level, approximately 240 various types of trucks go in and out of the transfer station each day. (Some trucks make two or more trips, which are included in these numbers).
- A higher usage level, 2,000 and 3,000 tons per day, would result in 370 to 550 trucks per day.
- Other communities – most communities collect their waste at the same time (between 6 a.m. to 5 p.m.). *We will retain the flexibility to accept waste per our requirements.*
- Just like the current operation, MSW received will be processed daily.

Sight, Smell and Noise

Sample Technology

- Gasification- Processes MSW with high temperatures in separate stages and restrains the formation of toxic substances (Dioxin, CO, NOx, Sox).

- Removes more than 97% of airborne odor
- Primarily water vapor emissions (no black/gray smoke)
- No increased or high volume noise effects
- Used abroad in residential areas
- The facility will be enclosed and will have even less odor than the current operation

Huntington Beach, CA
Material Recovery Facility

The signs are the only indication

Across the street is a school

and playground

8. Economic Development and Cost

- Advanced Energy can be one basis of the region's economic turnaround as new industries in the region develop new products and services and bring more jobs to the area.
- If the desire is to attract new technologies and businesses to the region, Cleveland's MSW to Energy facility could serve as the foundation upon which we build:
  - To nurture the growth of the advanced technology industry
  - To facilitate the business development of local corporations
  - To propel Cleveland and the Region to the front of the international stage of advanced energy technology development

Summary of Facility Cost

Estimated Facility Cost:

♦ City-Wide Recycling (equipment & vehicles)	$29 million
♦ MSW Receiving Station	$21 million
♦ Recycling Station	$12 million
♦ Gasification Equipment	$21 million
♦ Power Plant (20 MW)	$15 million
♦ Steam Compression Equipment	$45 million
♦ Construction	$21 million
♦ Civil Engineering*	$ 8 million
♦ Decorative Brick Equipment	$ 8 million

Total Estimated Cost	$180 million

*Cost of Facility Design: $1.5 million

Jobs Per Component

MSW to Energy facility operation 24/7 in 3 shifts

Full time staffing needs

Collection Process:	N/A
Waste Sorting:	24-36
Waste Processing:	12-18
Steam Compression:	18-24
Gasification Operation:	18-24
Power Plant Operation:	18-24

Total Direct Jobs: 90-126

Economic Development

Manufacturing Facilities

- Components of Cleveland's systems could be assembled, and some manufactured, locally
  - Sorting Systems (manual and/or automatic)
  - Gasification Facility
  - Steam Compression System
- This would mean more jobs and demand as Cleveland's model is duplicated nationally

Regional Impact

Participating Municipalities will:

- Pay lower tipping fees and save money
- Experience lower MSW transportation cost since their MSW will not be trucked to a landfill
- Reduce carbon emissions caused by trucking MSW long distances to landfills

9. Summary of Development Process

Cleveland's MSWE development process outline

- Feasibility Study
  - ✶Consultants: RNR Consulting, URS Corporation, DLZ Ohio, Inc., Cloud & Associates
  - ✶Contributors: AMP Ohio, APPA, Cleveland Foundation and Cleveland Public Power
- Visit to see technology in Japan and China
  - ✶August and December 2009
- Waste Composition Studies
  - ✶Consultants: SCS Engineers; Contributor: Cleveland Public Power
- Facility Design Agreement
  - ✶Consultants: Princeton Environmental Group, subs include Kinsei Sangyo Co. LTD., GT Environmental, Ralph Tyler Companies, and PFK Associates
  - ✶Contributors: AMP Ohio, APPA, Cleveland Foundation and Cleveland Public Power

Q&A

Questions?

Reference Handouts

- Comparison of the Proposed Maximum Annual Emission Rates for the CPP Ridge Road MSW Energy Recovery Facility verses Other Operating Emission Sources in Northeast Ohio.
- Garbage to Burn or to Bury?