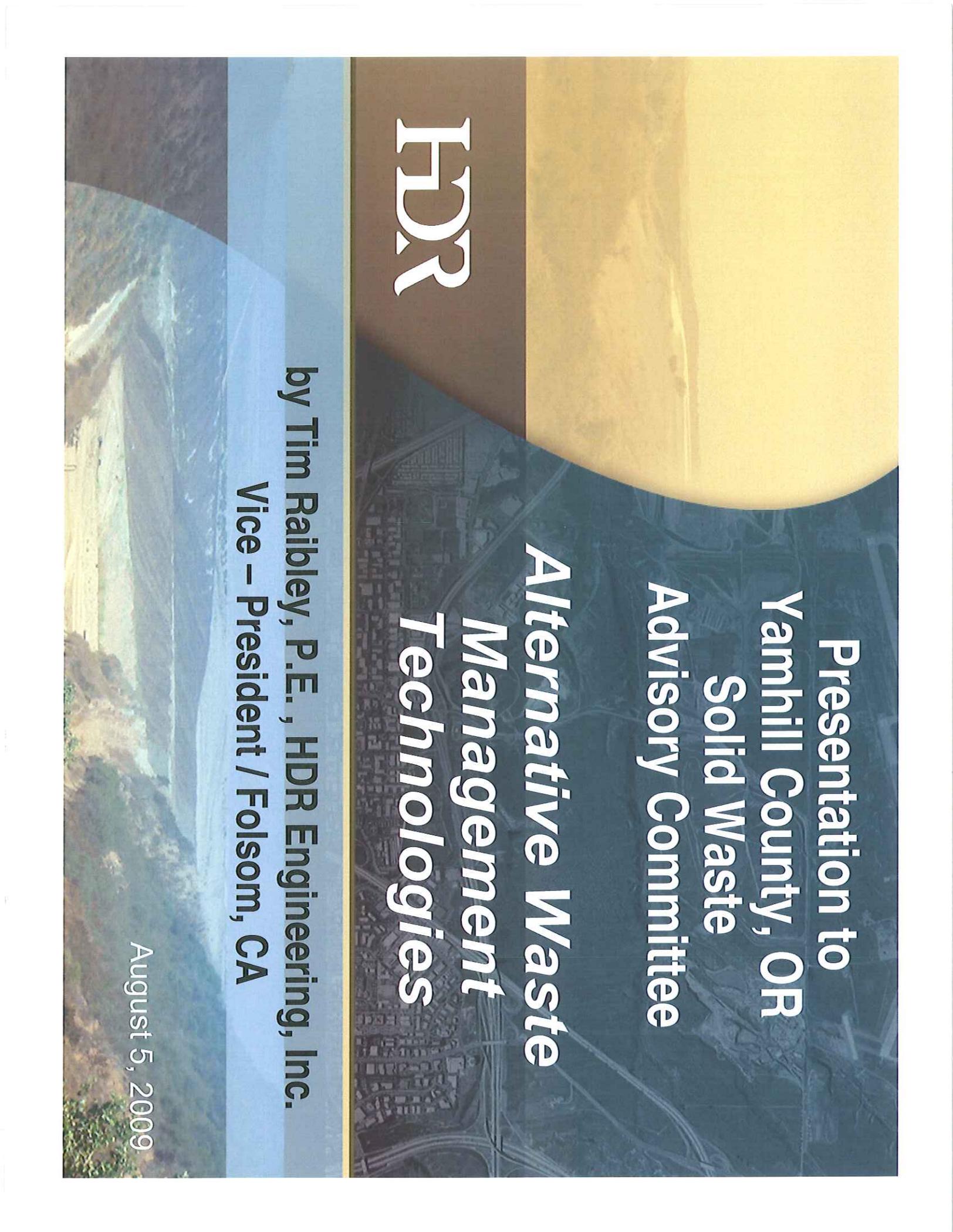


Appendix C

PowerPoint Presentation on Non – landfill Technologies



**Presentation to
Yamhill County, OR
Solid Waste
Advisory Committee**

HDR

**Alternative Waste
Management
Technologies**

**by Tim Raibley, P.E., HDR Engineering, Inc.
Vice – President / Folsom, CA**

August 5, 2009

1 / Overview of Technologies

Thermal Treatment

- ◆ Waste – to – Energy (WTE, Mass Burn)
 - ◆ Refuse – Derived Fuel
 - ◆ Gasification
 - ◆ Plasma Arc Gasification
 - ◆ Pyrolysis
 - ◆ Hydrolysis

Biological / Chemical Treatment

- ◆ Anaerobic Digestion
 - ◆ Waste – to – Ethanol
- ◆ Aerobic Digestion / Composting
 - ◆ Thermal Depolymerization

Other

- ◆ Aggressive Materials Recovery

Assumption

State Statutes / Regulations Establish
Waste Reduction and Recycling as Priorities

2 / Industry Drivers – Why Treatment Technologies?

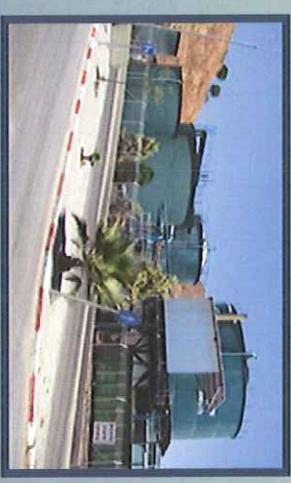
- Many communities / states adopting higher diversion level goals
- Landfill capacity and impacts
- Favorable economic factors – renewable energy status, tax credits
- Climate and other environmental impacts

Examples

- ◆ State of Florida – Recycling goal of 75% by 2020
- ◆ State of California – Pointing toward 75% diversion
 - ◆ State of Oregon – 50% recovery rate

3 / Five International Technology Tours in Three Years

- HDR travels with clients to see first – hand what is state – of – the – art in other countries
- Meet with technology developers, facility operators, elected officials and industry trade associations
- Ask the detailed questions and come away with the facts



Anaerobic Digestion | Tel Aviv



Gasification | Tokyo



Waste – to – Energy | Europe



Plasma Arc | Ottawa

4 / Countries Visited

Europe

Sweden, Denmark, Holland, Belgium, Switzerland, Germany, France, Spain, Czech Republic, Italy

Asia

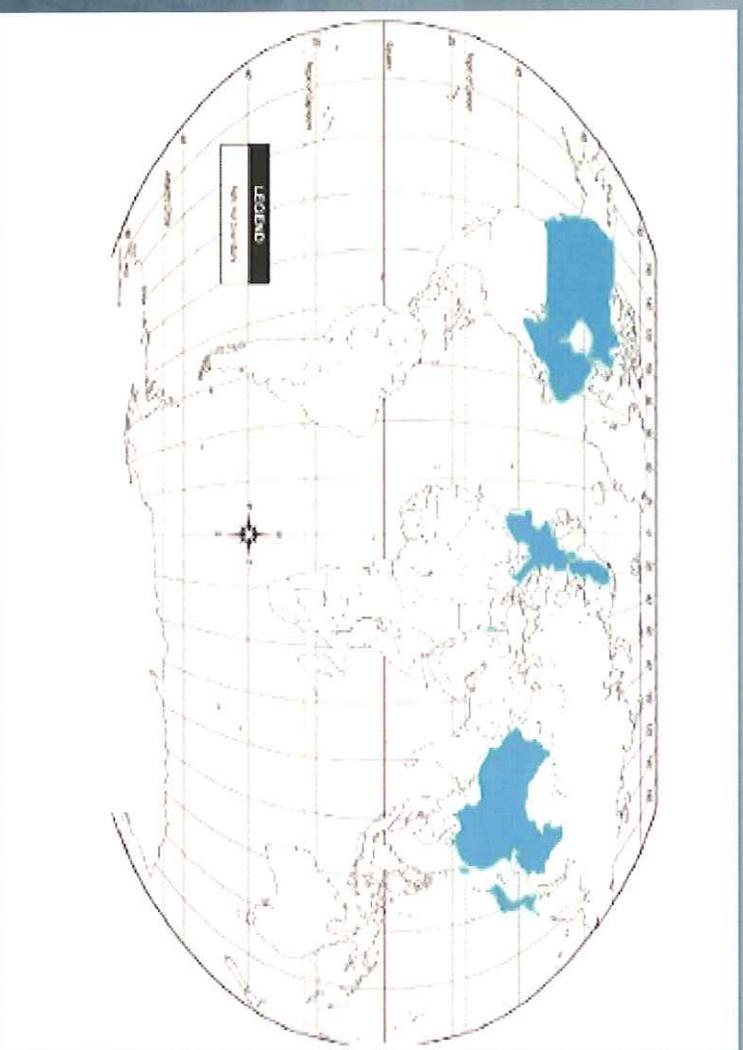
Japan, China, Taiwan

Middle East

Israel

North America

Canada



5 / Waste – to – Energy: Advanced Thermal Recycling

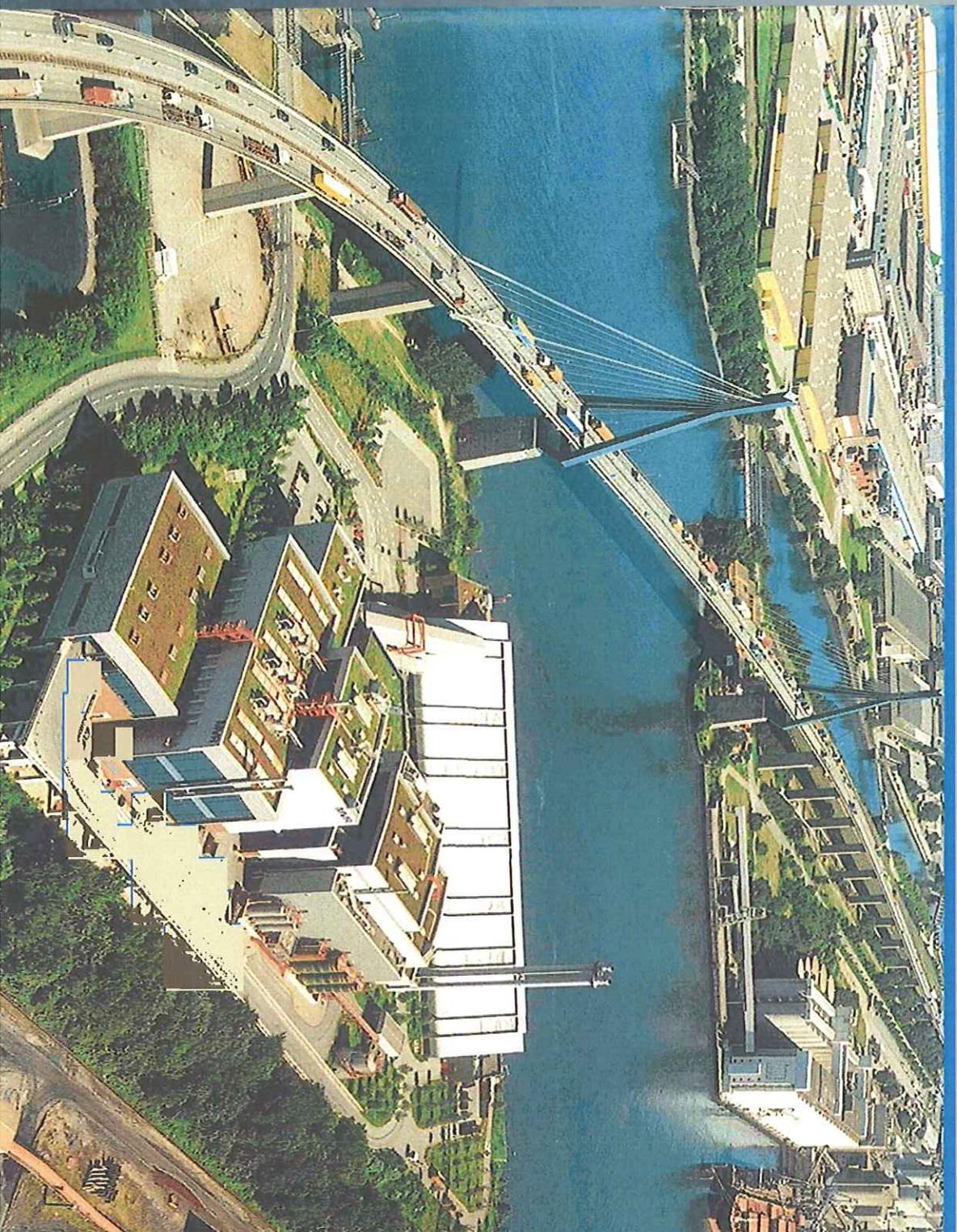
Key Process

- Incinerate feedstock (waste) in oxygen rich chamber
- Heat from incineration used to make steam / electricity
- Robust air control technology systems implemented to minimize emissions

Key Products

- Industrial steam, electricity, bottom ash (rock), fly ash, metals

6 / Waste – to – Energy: Hamburg, Germany



7 / Waste -- to -- Energy: Madrid, Spain



8 / WTE – Advanced Thermal Recycling Pictures



WTE Plant – Breisgau, Germany

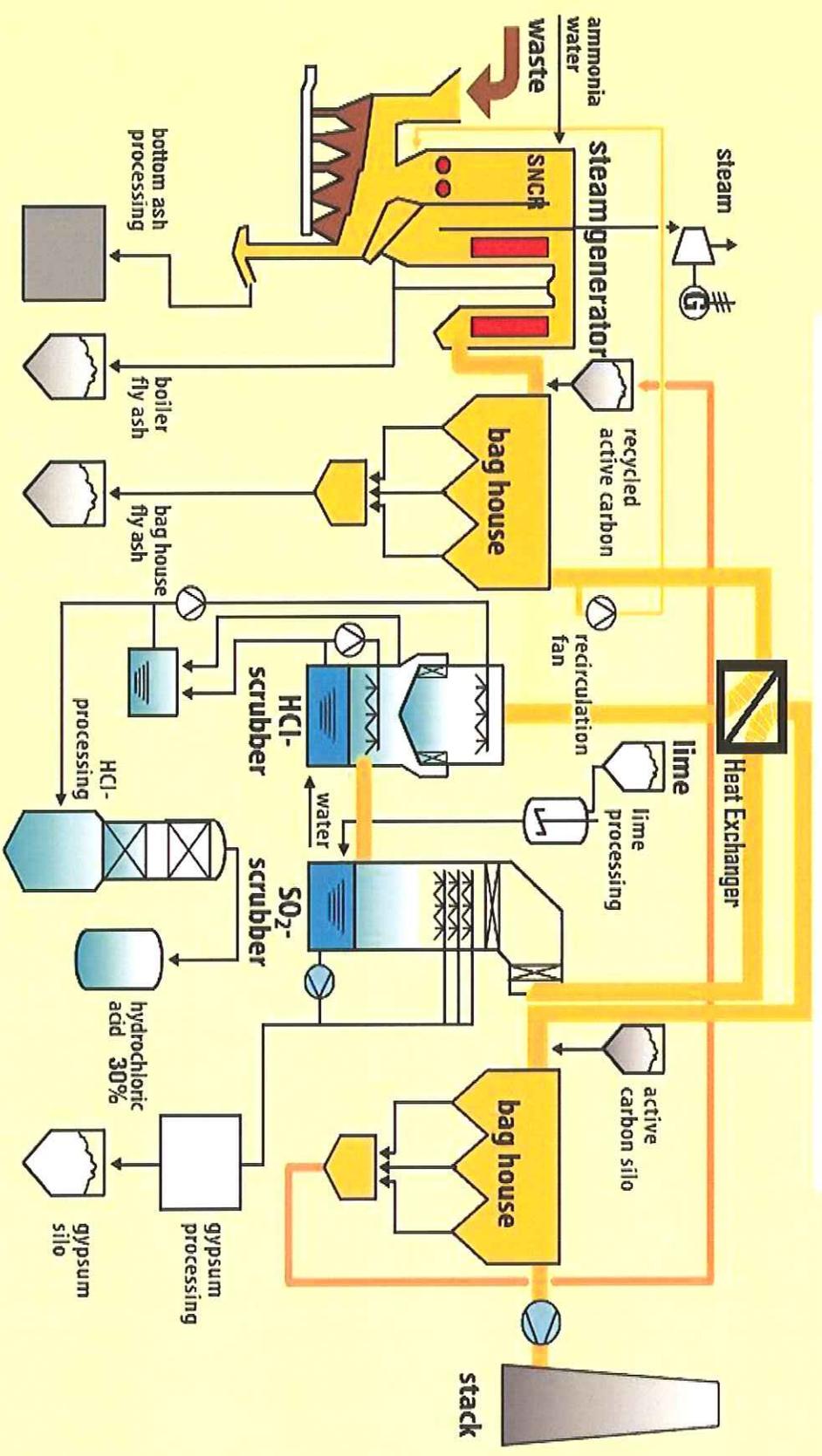
9 / WTE – Advanced Thermal Recycling Pictures



WTE Plant – Antwerp, Belgium

10 / WTE – Advanced Thermal Recycling Schematic Diagram

MWR Fluegas Cleaning System with additional Heat Exchanger



11 / General Observations on WTE

- Prevalent throughout Japan and Europe – over 300 plants in Europe
- Officials report WTE supportive of high recycling rates
- Bottom ash processed for construction aggregates and metals recovery
- Fly ash used to fill salt mines in Europe

12 / General Observations on WTE – Advanced Thermal Recycling

- All air emissions reported to be well below permit limits at plants visited
- Real time air emission readings posted on publicly accessible Web sites as well as scoreboards at plant entrances
- Emphasis on aesthetics with landscape and architectural treatments
- Tipping fees in the \$ 150 – \$ 200 US / ton range

13 / Gasification

Key Process

- Heat feedstock (waste) in oxygen starved chamber
- Syn – gas used as fuel for industrial heat or electrical generation
- Stringent air control systems implemented to minimize emissions
- Synthetic gas, fuel for electrical generation, slag (glass like rock), metals

Key Products

14 / Gasification Plant Pictures



Gasification Plant – Tokyo, Japan

15 / Gasification Plant Pictures



Kazusa Clean System Co., Ltd. Gasification Plant - Japan

HDR

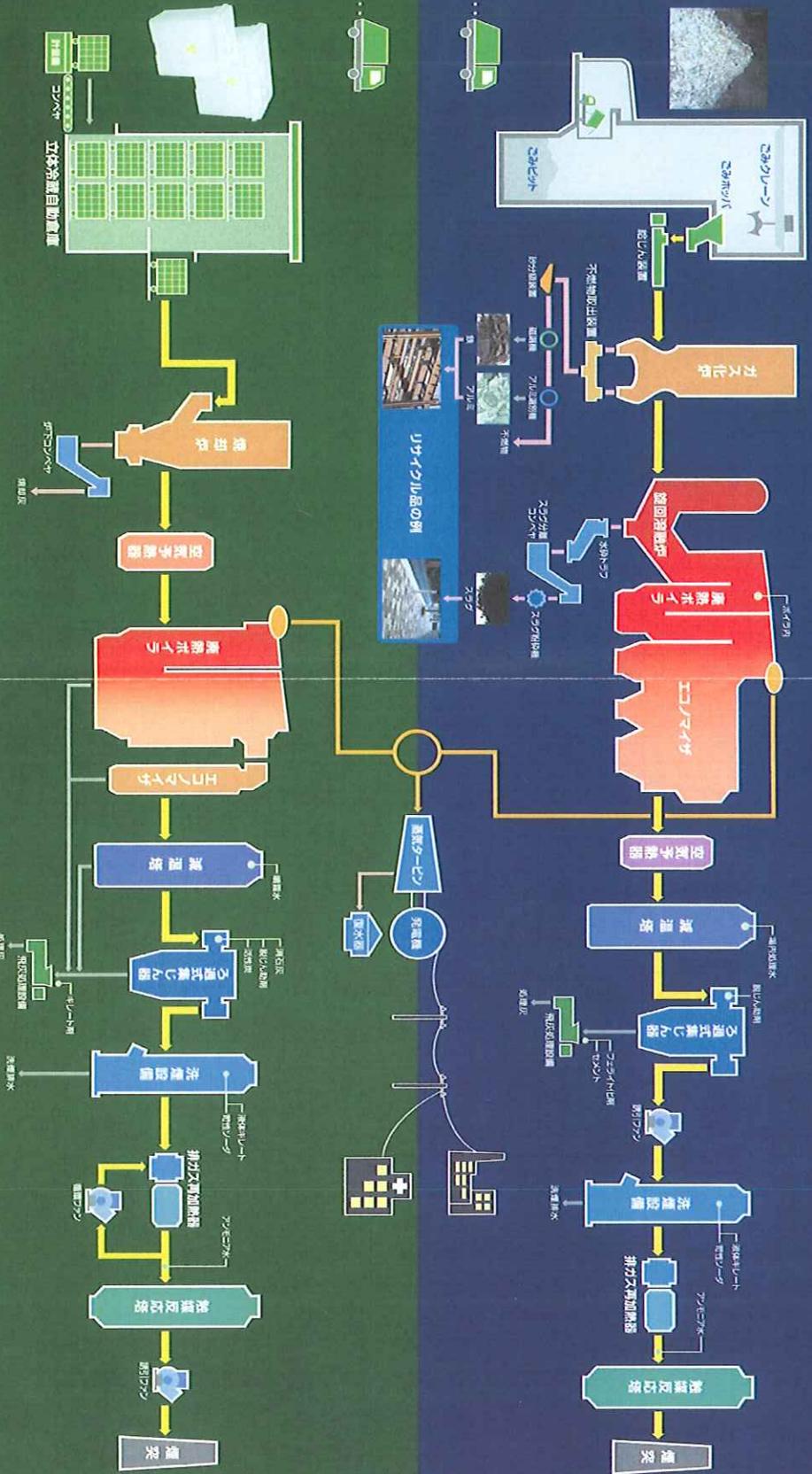
16 / Additional Gasification Pictures



17 / Gasification Schematic Diagram

産業廃棄物

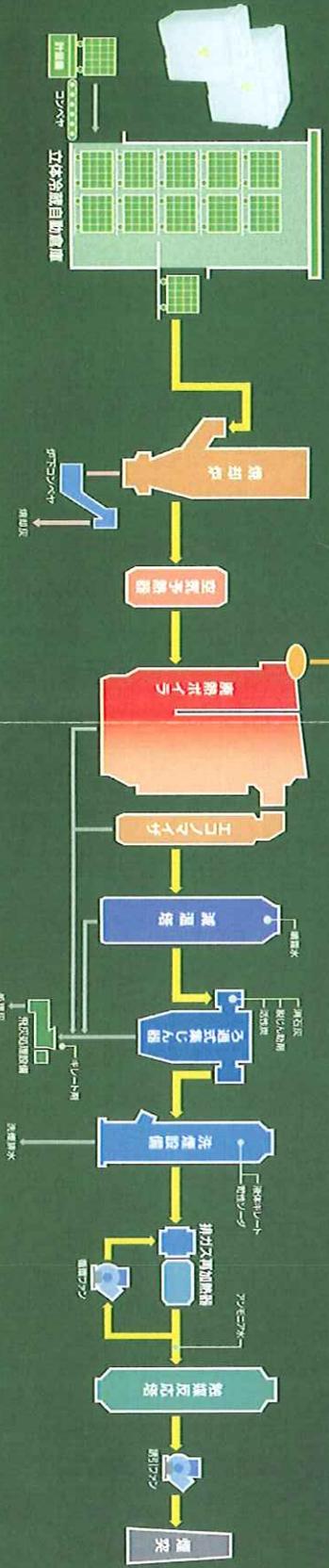
許可品目 | 汚泥(脱水後のもの) 容器入りもの、廃プラスチック類 紙くず 木くず 繊維くず
 コムくず カラス・コングリート・陶磁器くず 廃磁(容器入り) 廃アルカリ(容器入り)
 動物性残渣(容器入り) ばいじん 燃え殻 灰塵 金属くず



スーパーエコプラント処理フロー図

医療廃棄物

許可品目 | 感染性廃棄物 廃プラスチック類 紙くず 木くず 繊維くず コムくず 金属くず
 カラス・コングリート・陶磁器くず 廃磁(容器入り) 廃アルカリ(容器入り)
 動物性残渣(容器入り)



18 / General Observations on Gasification

- Mostly prevalent in Japan, not in other countries that were visited
- Commercial – scale operating facilities in Japan
- Seems to work best with a more uniform and select feedstock – plastics, biomass, industrial waste
- Ash is melted, vitrified and rendered non – hazardous, much of which is sold as a slag material

19 / General Observations on Gasification

- All air emissions reported to be well below permit limits at plants visited
- At some plants, real time emission data posted on publicly accessible Web sites
- Tipping fees about \$ 300 US / ton

20 / Plasma Arc -- Gasification

Key Process

- Superheat char feedstock (waste) using a plasma arc in an oxygen depleted chamber
- Syn – gas used as fuel for electrical generation in internal combustion engines
- Extensive air control systems implemented to minimize emissions

Key Product

- Synthetic gas, fuel for electrical generation, vitrified slag (glassy rock), metals

21 / Plasma Arc Gasification Pictures



Plasma Arc Gasification Facility – Ottawa, Canada

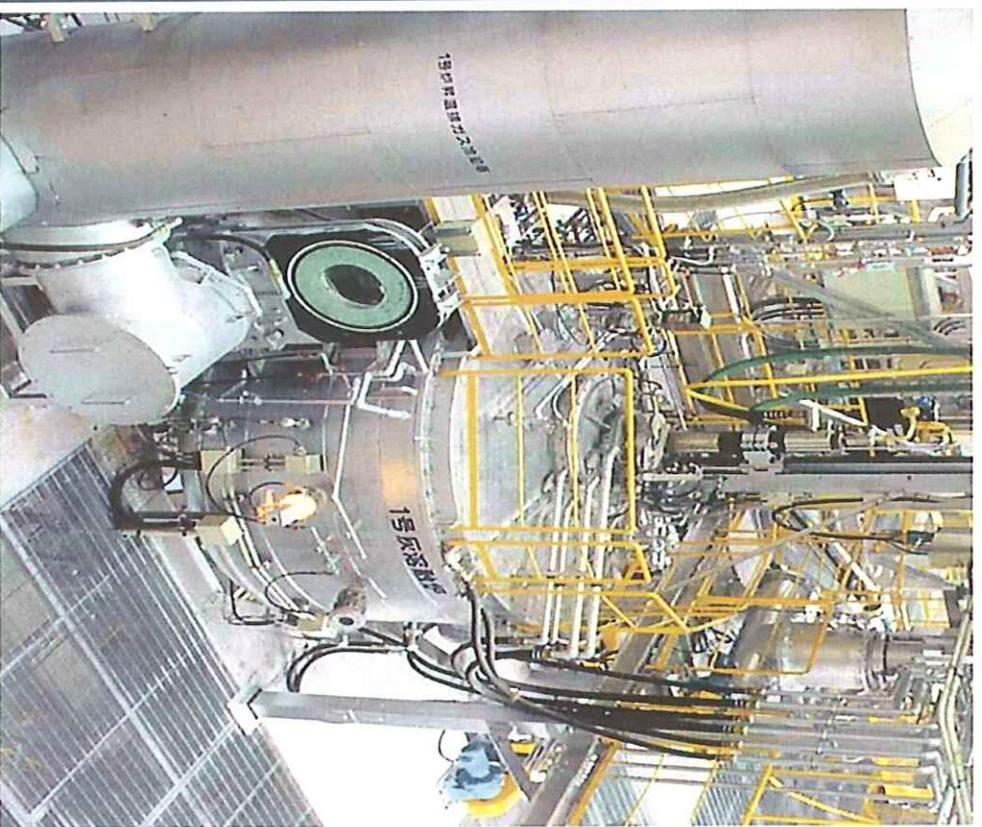
22 / Plasma Arc Gasification Pictures



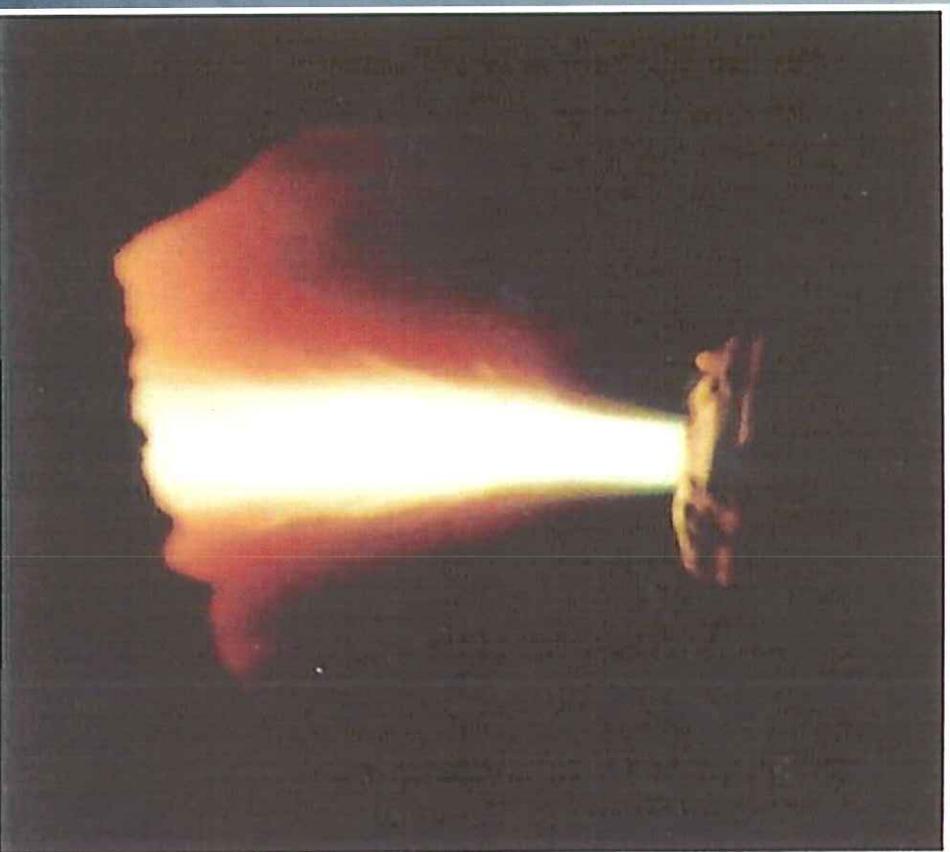
Plasma Arc Gasification Facility – Ottawa, Canada

HDR

23 / Additional Plasma Arc Gasification Pictures

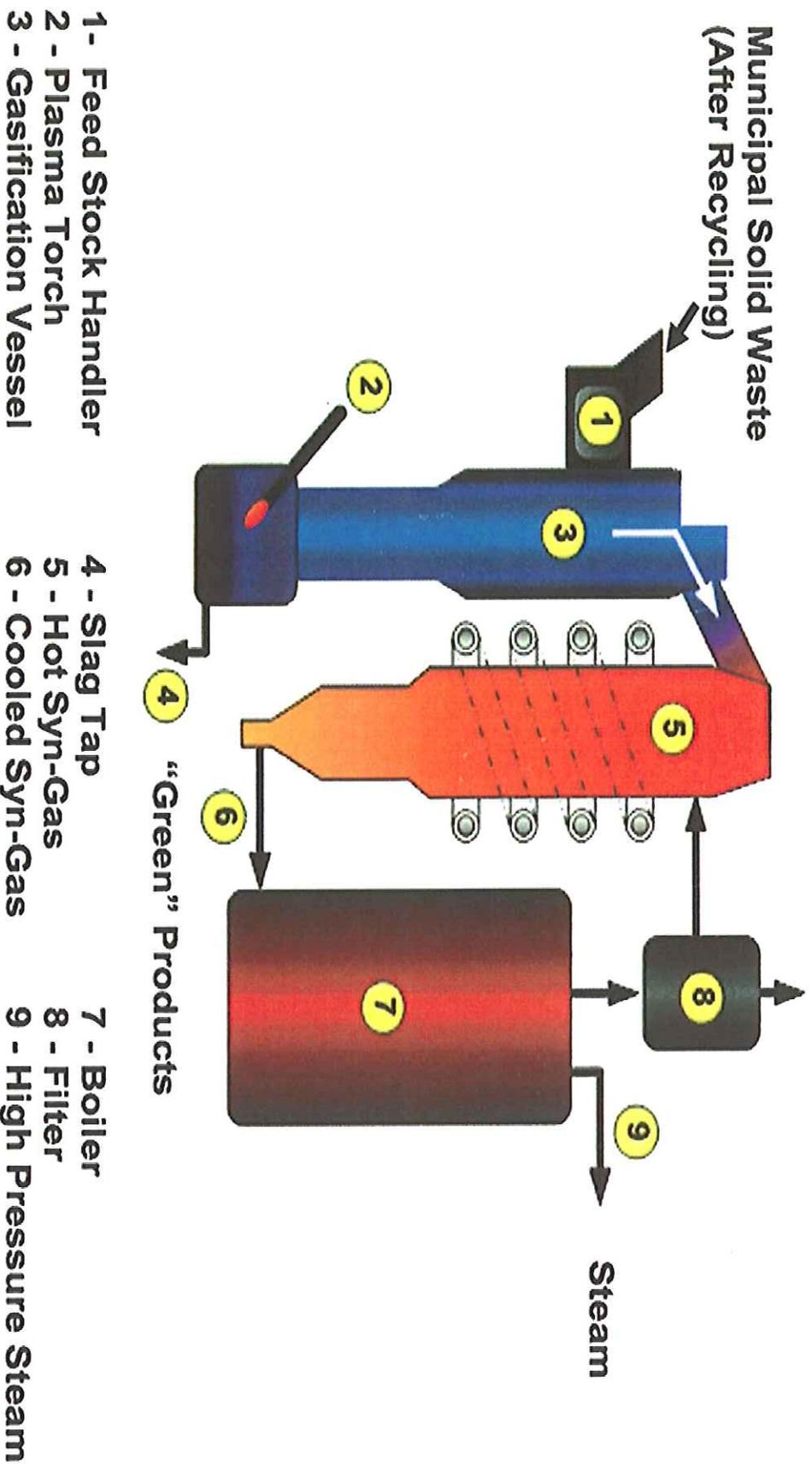


Furnace



In-furnace conditions

24 / Representative Plasma Arc Schematic



25 / General Observations on Plasma Arc Gasification

- Operational issues due to fuel feed system still being worked out
- More extensive operations at full load needed
- More long duration test runs needed
- More stack testing data needed
- System looks promising but needs more demonstration at full load for longer operating cycles with engines and all systems operating

26 / Anaerobic Digestion

Key Process

- Digest feedstock in oxygen starved chamber; feedstock = organic portion of waste
- Bio – gas (methane and carbon dioxide) from digester used as low grade natural gas replacement for industrial heating or electricity generation
- Odor control systems implemented to minimize emissions

Key Products

- Bio – gas, renewable electricity, “digestate”

27 / Anaerobic Digestion of MSW Pictures



Anaerobic Digestion of MSW – Barcelona, Spain

NOTE – MSW = Municipal Solid Waste

28 / Anaerobic Digestion of MSW Pictures



Anaerobic Digestion of Selected MSW – Germany

HDR

29 / Anaerobic Digestion of MSW Pictures



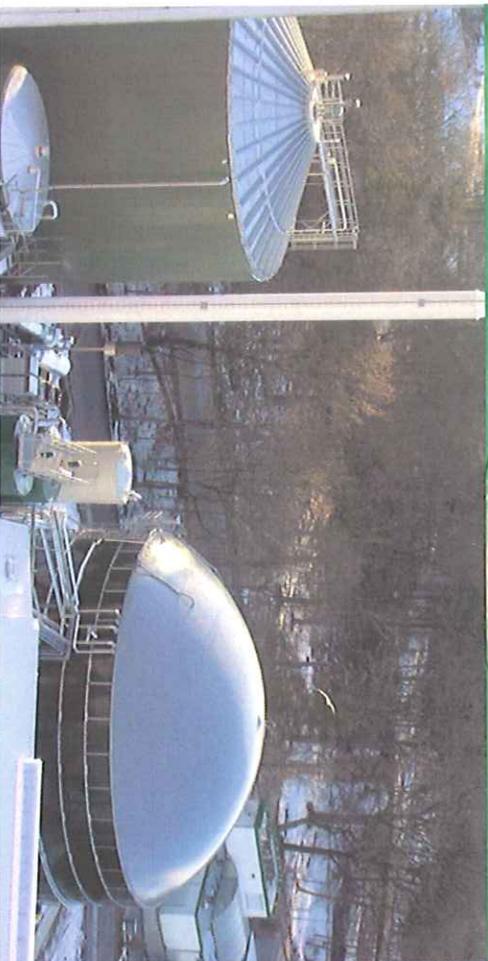
Anaerobic Digestion of MSW – Tel Aviv, Israel

HDR

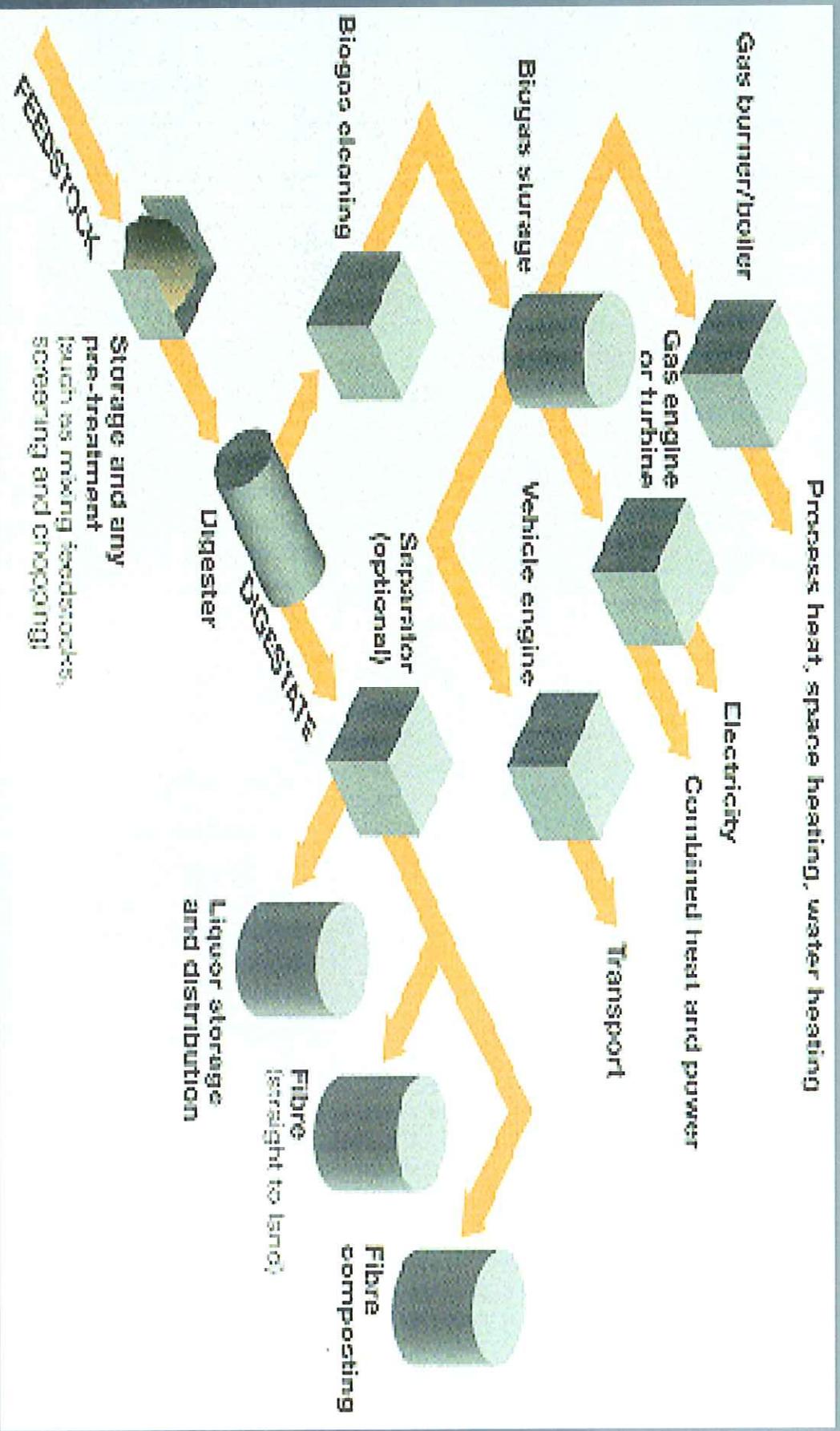
30 / Anaerobic Food Waste Digester, UC Davis



31 / Anaerobic Digestion of MSW Pictures



32 / Anaerobic Digestion of MSW Schematic Diagram



33 / General Observations on Anaerobic Digestion

- Biological decomposition of organic matter in the absence of oxygen
- Bacteria convert organic materials to methane gas
- Produces electricity, steam, hot water and compostable “digestate”
- European plants utilizing green waste, also some taking food waste

34 / General Observations on Anaerobic Digestion

- Feedstock preparation is key
- Feedstock = biodegradable components of MSW
- Significant up front, pre – processing of mixed MSW is required
- Some materials removed for recycling, some for other processing techniques, some are unacceptable
- Need materials recovery facility (MRF) and / or similar operation to accomplish pre – processing
- Potential negative impacts include odor, air emissions

35 / General Observations on Anaerobic Digestion

- Compost product quality can be an issue with contaminants
- Electricity can be sold to grid, as renewable
- Bio – gas and heat need local market
- Unable to obtain long – term operational data
- No emissions data provided but expected to be low compared to EPA standards

36 / General Observations on Anaerobic Digestion

- The potential for significant production of H₂S which needs to be controlled (2,500 ppm)
- Service fee projected in range of \$ 120 – \$ 150 / ton (includes other technologies in integrated system)
- Digestate could be a source of energy and soils amendment, depending on contaminant content
- Biological system could fit into multi – faceted integrated waste management program

37 / Aerobic Digestion – Composting

Key Process

- Biologically digest feedstock (organic portion of waste) in oxygen rich environment
- Bacteria convert organic materials to compost
- Odor control systems implemented to minimize emissions

Key Products

- Digestate (compost)

38 / Aerobic Digestion / Composting of MSW



Aerobic Composting of Selected MSW – CA

HDR

39 / In – Vessel Composting



Composting of Selected MSW – CA

HDR

40 / General Observations on MSW Composting

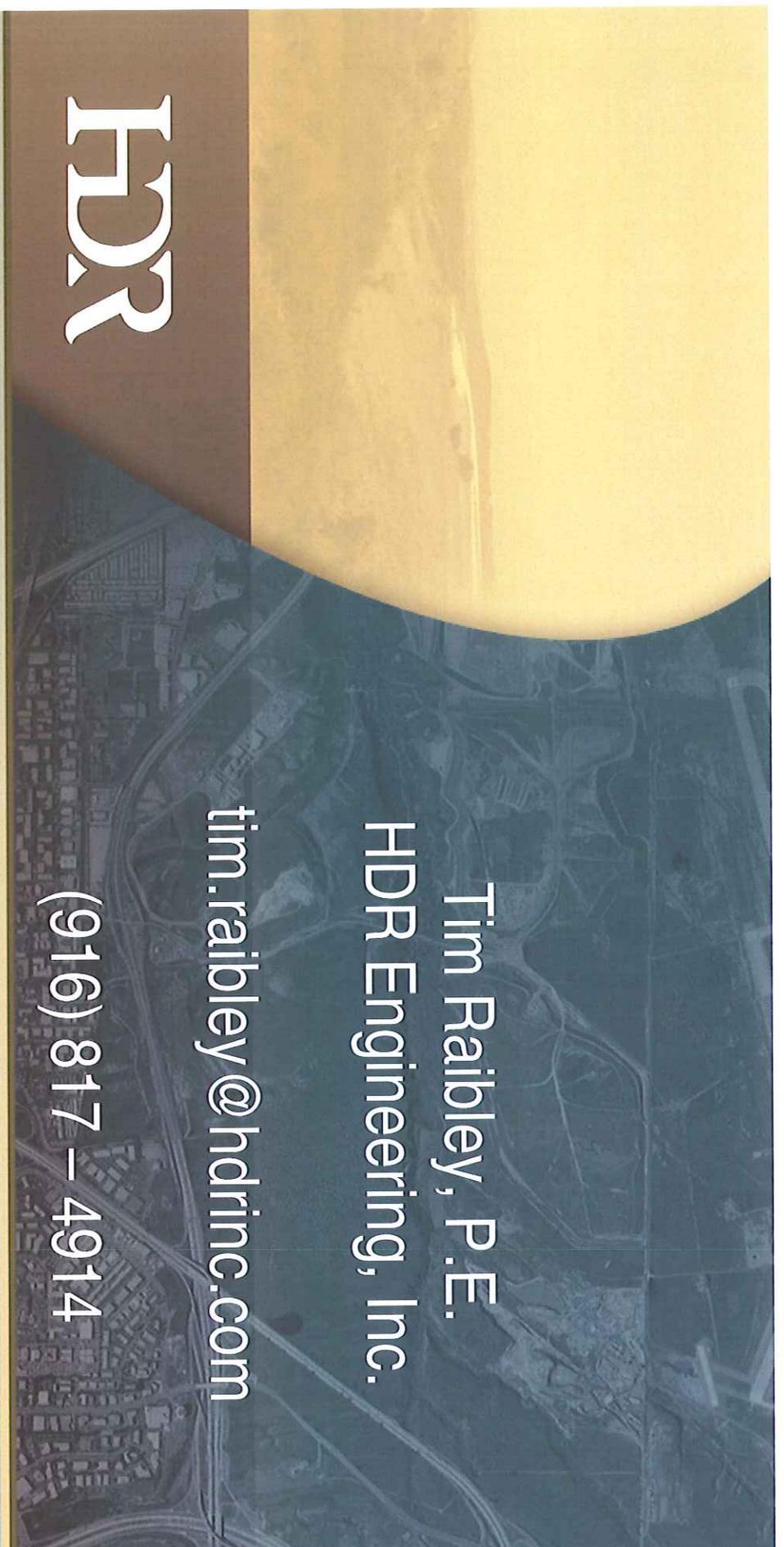
- Feedstock = biodegradable portion of MSW
- Feedstock preparation is essential
- Need significant up front, pre – processing of mixed MSW to yield feedstock, or separate collection of materials
- One or more facilities required to accomplish pre – processing such as removal of recyclable materials
- Containments in compost product pose threat to product acceptance
- Potential negative impacts = odor, air emissions

41 / Overall Conclusions

- Serious movement towards greater diversion, beyond traditional recycling
- Conversion technologies are becoming viable
- Factual performance, emissions and cost information difficult to obtain
- Pilot and demonstration projects needed

42 / Overall Conclusions

- Toxic and criteria air pollutants mixed, depending on technology
- When proven feasible, conversion technologies may be an important part of the solution for more sustainable waste management

The image features a background with a large yellow circle on the left and a dark blue aerial photograph of a highway interchange on the right. The HDR logo is positioned in the upper left, and contact information is centered in the lower right.

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