CONVERSION TECHNOLOGY EVALUATION REPORT

Prepared for

THE COUNTY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

AND

THE LOS ANGELES COUNTY SOLID WASTE MANAGEMENT COMMITTEE/INTEGRATED WASTE MANAGEMENT TASK FORCE'S ALTERNATIVE TECHNOLOGY ADVISORY SUBCOMMITTEE

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The County of Los Angeles Department of Public Works (DPW), the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force and its Alternative Technology Advisory Subcommittee (the Subcommittee) are currently promoting the development of conversion technologies as an alternative to traditional solid waste disposal practices. As part of this effort the Subcommittee is looking for an opportunity to create a partnership between a Materials Recovery Facility (MRF) and a conversion technology supplier. The main objectives of this partnership are:

- Develop a demonstration facility in Southern California that utilizes new state-of-the-art conversion technologies and tests the feasibility of such technologies.
- Increase diversion of MRF residual solid waste from disposal at landfills. This residual solid waste is the material remaining after all recyclable materials have been removed, and is therefore destined for disposal at landfill.
- Generate marketable products, including renewable energy or green fuels.
- Generate real data for regulatory permitting pathways in California. Currently there are no commercial operating conversion technology facilities processing MSW in the United States. They are commercialized in Europe and Japan.

In order to develop the first facility of its kind, DPW and the Subcommittee have engaged URS Corporation to perform the following tasks:

- Prepare a summary of conversion technologies.
- Analyze, screen, and rank conversion technologies. This evaluation will prioritize residues from a Material Recovery Facility (MRF) or Transfer Station (TS) as the feedstock for a potential conversion demonstration facility.
- Screen and rank MRFs/TSs in Southern California.
- Analyze the most suitable combinations of MRF/TSs and technologies.
- Prepare the following supporting documents:
    - Strategic Action Plan
    - Public Outreach Plan
    - Marketing Analysis
    - Siting Analysis

The results of this study including supporting documents are presented as a Final Report. The content of this Conversion Technology Evaluation Report prepared by URS Corporation is briefly described in this executive summary and consists of the following sections:

1. SUMMARY OF CONVERSION TECHNOLOGIES

This section provides descriptions of thermal and biological/chemical conversion technologies. The following technologies are described:

- Thermal Conversion
  - Pyrolysis
  - Pyrolysis/gasification
  - Pyrolysis/steam reforming
  - Conventional gasification (fixed bed and fluid bed)
  - Plasma gasification
  - Thermal depolymerization
- Biological/Chemical and Other Conversion
  - Anaerobic Digestion
  - Aerobic Digestion
  - Catalytic Cracking of Plastic
  - Syngas to Ethanol

The following issues are discussed for each of the above conversion technologies:

- Process Description
- Throughput
- Feedstock Characteristics
- Byproducts
- Environmental Issues

2. EVALUATION, SCREENING, AND RANKING OF TECHNOLOGIES

In this section conversion technologies were ranked and screened following these steps:

- Screen potential conversion technologies. The following technologies passed the screening process and are recommended for consideration in the next phase of this process:

  - Thermal conversion including pyrolysis, gasification, plasma gasification, and thermal depolymerization
  - Biological/Chemical conversion including anaerobic digestion, and gasification with fermentation to ethanol

- Screen and rank conversion technology suppliers, which included the following steps:

  - Prepare a long list of technology suppliers
  - Prepare a questionnaire for technology suppliers, distribute the questionnaire, and evaluate the responses
  - Develop screening criteria for technology suppliers
  - Screen technology suppliers
  - Develop ranking criteria for technology suppliers
  - Rank technology suppliers
  - Select preferred technologies for consideration in the next phase of the process

Note that the ranking is strictly based on information provided by the technology suppliers in the responses to questionnaire, and there was no independent verification of this information. The technology suppliers passing the screening criteria can be grouped into 3 general categories: thermal technologies, biological technologies, and emerging technologies. The results of the conversion technology ranking indicated that the top ranking screened technologies are thermal technologies such as gasification and pyrolysis. These technologies are well known and have been widely used overseas for MSW processing. These technologies generate electricity as their primary product and create only small quantities of residue. Four technology suppliers of this group ranked higher than any other technologies. The following thermal technology suppliers received ranked scores of more than 75%:

- Interstate Waste Technologies (IWT) – Pyrolysis/Gasification
- Primenergy LLC – Gasification
- Ntech Environmental – Gasification
- GEM America – Flash Pyrolysis

IWT, Ntech Environmental, and GEM America have operating facilities overseas. Primenergy has a commercial facility in the United States processing rice hulls. Also, Primenergy has an alliance with CR&R MRF and Community Recycling, and tested Refuse Derived Fuel (RDF) from these facilities.

The capital and operational costs for a demonstration facility using the IWT system are higher than the other three pyrolysis and gasification technologies in this group ($186/ton processing 300 tons/day). However, IWT has a number of commercial operating facilities overseas processing MSW, and submitted the most complete response to the questionnaire. Primenergy, Ntech Environmental, and GEM America's estimated costs are $87, $129, and $105 per ton, respectively, for processing 100 tons/day. These costs will be much lower with higher throughput in a commercial facility.

Other thermal technology suppliers ranked lower (47 to 75%). These suppliers do not have commercial facilities processing MSW, only a pilot or test unit. Additionally, their submitted information was not as complete, therefore they were not recommended to be considered in the next phase of the process.

The second group of technologies includes anaerobic digestion (which falls under the California Integrated Waste Management Board's (CIWMB) composting definition). These technologies are also well known, and many facilities using this process are operating overseas using MSW or source separated organics as feedstock. The primary product of anaerobic digestion is compost, along with some electricity. A considerable quantity of residue is created that must be landfilled. In addition, compost marketability is unproven/unstable. Although some suppliers from this group are ranked second to thermal technologies (50-75% ranking scores), anaerobic digestion was not recommended for consideration in the next phase of this process, for the reasons provided below and in Section 4 of this Report.

The third group of technologies includes emerging technologies such as waste to green fuel. This group of technologies includes thermal depolymerization, and gasification with fermentation to ethanol. These technologies can be termed "emerging," since there are no operating commercial facilities processing MSW, and design data is limited. While these technologies demonstrate significant promise, the development risk is significant. The suppliers of these technologies are:

- Changing World Technologies (Thermal Depolymerization) – CWT has one operating demonstration/commercial facility using turkey waste as a feedstock.
- BRI (Gasification-Fermentation) – BRI has only a pilot facility.

If green fuel production becomes an objective of the proposed conversion facility, the syngas or biogas produced by the thermal or bioconversion technologies can be used to produce green fuel. In this case, a combination of thermal, chemical, and/or bioconversion technologies may be required, and such a combination can be evaluated in the next phase of this project.

3. EVALUATION OF FACILITIES

All MRFs/TSs in Southern California were evaluated to find the most suitable facility for development of a conversion demonstration project. The following procedures were followed:

- Screen and rank potential facilities. This step included:
  - Prepare a comprehensive list of MRF/TSs operating in Southern California
  - Prepare questionnaire in the form of postcard and send it to all MRF/TSs in Southern California
  - Screen MRF/TSs in Southern California
  - Develop ranking criteria for MRF/TSs
  - Evaluate selected MRF/TSs by requesting more information and site visits
  - Select preferred MRF/TSs in Southern California

A detailed evaluation of Southern California MRF/TSs indicates that the following MRF/TSs made the shortlist of preferred MRF/TSs for development of a conversion demonstration facility:

- Del Norte Regional Recycling and Transfer Station operated by Republic Services (City of Oxnard, Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) operated by Burrtec Industries (City of Aqua Mansa, Riverside County)
- Perris MRF/TS operated by CR&R (City of Perris, Riverside County)
- Central Los Angeles Recycling Center and Transfer Station operated by the City of Los Angeles Bureau of Sanitation (City of Los Angeles, Los Angeles County)
- Community Recycling/Resource Recovery, Inc. MRF in Sun Valley operated by Community Recycling (City of Los Angeles, Los Angeles County)
- Santa Clarita MRF/TS (Planned MRF to be built by Burrtec Industries, likely in or near the City of Santa Clarita, Los Angeles County)

4. ANALYSIS OF SUITABLE TECHNOLOGY/FACILITY COMBINATIONS

In this section the most suitable combinations of conversion technologies and MRF/TSs in Southern California were analyzed and the following issues discussed:

- Preferred MRF/TS

- Preferred Conversion Technologies
- Most Suitable Technology/MRF Combinations

The most suitable combinations of conversion technology/MRF/TS were analyzed on the following bases:

- Solid Waste Suitability
- Feedstock Availability
- Preprocessing
- Space Availability
- Infrastructure Availability
- Environmental Capability

Results for the first phase of this study concluded that the most suitable conversion technology/MRF combinations are thermal conversion and waste to green fuel technologies. Anaerobic digestion was not recommended to be considered in the next phase of this process for the following reasons:

- Anaerobic digestion requires extensive preprocessing of the feedstock, therefore MRF residue may not be a suitable feedstock for anaerobic digestion.
- Anaerobic digestion requires more acreage for development because of its larger footprint.
- An anaerobic digestion technology vendor (WRSI/Valorga) is in the process of building a commercial facility in Southern California and, therefore, there is no need for a demonstration facility.
- Anaerobic digestion generates a larger percentage of residue, and therefore has a lower diversion rate.
- Anaerobic digestion generates mostly compost and soil amendment with a small amount of biogas to generate electricity. The marketability of the compost is questionable.

The six MRFs in the list of preferred facilities are the most suitable facilities. Members of the Alternative Technology Advisory Subcommittee at the June 16, 2005 meeting unanimously agreed that the short list of preferred MRFs for the first phase of development of a conversion facility should include:

- Del Norte Regional Recycling and Transfer Station (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)

- Perris MRF/TS (Riverside County)

The Community Recycling, Central Los Angeles and Santa Clarita MRF/TS should also be considered in the next phase of the project.

For the final selection of the most suitable combinations, a more detailed evaluation of MRF and technology suppliers is required, which can be included in the scope of work for the next phase of the study.

5. SUPPORTING DOCUMENTS

The following supporting documents were also included in the scope of work for this study:

Strategic Action Plan

The Strategic Action Plan prepared as part of this study considers the prospective steps the County, the Integrated Waste Management Task Force and its Alternative Technology Advisory Subcommittee should take over short (6-12 month), mid (1-5 years) and long-term to satisfy the objective of this study.

The Strategic Action Plan recommends a number of specific actions for development of a conversion facility in Southern California. The following issues are discussed in this Plan:

- Environmental Issues
- Technical Challenges
- Public Outreach Issues
- Legislative Issues
- Cost and Financing Issues

A preliminary implementation schedule is presented in the Strategic Action Plan, which indicates a possible commissioning date of mid 2008, assuming CIWMB involvement in the regulatory pathway.

Public Outreach Plan

The prepared Public Outreach Plan recommends specific actions the County and its Alternative Technology Advisory Subcommittee can take for conducting a public outreach program in connection with development of a conversion demonstration facility in Southern California. This Plan recognizes the unique nature of this project, including the need for public involvement and communication at the community level. This Plan emphasizes the following:

- Why Public Outreach Is Needed
- What Is Public Outreach With Regards to Conversion Facilities
- The Public Interest In A Conversion Facility
- A Strategic Approach to Public Outreach
- Communication Strategy
- Public Involvement Methods
- Specific Recommendations

Public acceptability is a major factor for implementation of a conversion demonstration facility. An early and comprehensive public outreach program will contribute to the success of this project.

Marketing Analysis

Conversion technologies produce marketable products and byproducts. The quality and quantity of these products depend on type and design of conversion systems, and feedstock composition. A preliminary marketing analysis for conversion products was performed as part of this study. The following issues are discussed:

- Primary End Products of Conversion Technologies
    - Electricity
    - Green Fuel
    - Compost and Soil Amendment

Other by-products such as carbon char, chemicals, inert material, and recyclable material may also be produced in small quantities. The type, quantity and quality of these by products depend on the type and design of the conversion systems, type and quality of preprocessing, MRF residual composition, and many other factors. Market analysis for these by products will be addressed in the second phase of this project.

- Market Assessment for Conversion Products
- Expected Market Prices and Volatility

Preliminary market analysis shows that electricity has the most reliable and stable local market. Green fuels are in a developing marketplace and compost market is uncertain and unpredictable. Markets for the other products can vary greatly.

Siting Analysis

A preliminary siting analysis for the development of a conversion demonstration facility was performed. The following issues are discussed in this analysis:

- Preferred Conversion Technologies
- Preferred MRF Locations
- Regulatory and Permitting Issues
  - CIWMB
  - Air Emissions for Thermal and Bioconversion Technologies
  - Air Permit Requirements
  - Water Discharges
  - Solid Waste
- Environmental Issues and Mitigation
  - CEQA
  - Air Quality
  - Nuisance (Traffic, Odor, Dust, and Noise)
  - Visual Impacts
  - Surrounding Land Use
- Public Acceptability

There are no currently commercial operating conversion facilities processing MSW or MRF residue in the United States. Preliminary data from Japan and Europe indicates that conversion facilities can operate within the regulatory framework in the U.S., and facilities with the most advanced environmental control systems would be able to meet regulatory requirements in California.

The actual environmental impacts of a specific conversion technology in a specific location will be evaluated as part of permitting process for the facility.

6. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The following conclusions are based on findings of this study:

I – The results of the technology evaluation indicated that the top ranking technologies are thermal technologies such as gasification and pyrolysis. The top four thermal technology suppliers according to their ranked scores are:

- Interstate Waste Technologies (IWT) – Pyrolysis/Gasification
- Primenergy LLC – Gasification
- Ntech Environmental – Gasification
- GEM America – Flash Pyrolysis

The second group of technologies includes anaerobic digestion. As discussed above and in Section 4 of this Report, anaerobic digestion vendors were not recommended for the next phase of this process.

The third group of technologies includes emerging technologies such as waste to green fuel technologies. These emerging technologies do not have commercial facilities processing MRF residue or MSW, therefore they ranked lower. However, the significantly increased development risk may be offset by the potential benefits offered by these technologies. The suppliers for these technologies are:

- Changing World Technologies (CWT) – Thermal Depolymerization
- BRI – Gasification/Fermentation to Ethanol

II – Analysis of the Southern California MRF/TS facilities concluded that the six MRF/TSs listed below are willing and capable of hosting a conversion technology demonstration facility.

- Del Norte Regional Recycling and Transfer Station operated by Republic Services (City of Oxnard, Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) operated by Burrtec Industries (City of Aqua Mansa, Riverside County)
- Perris MRF/TS operated by CR&R (City of Perris, Riverside County)
- Central Los Angeles Recycling Center and Transfer Station operated by the City of Los Angeles Bureau of Sanitation (City of Los Angeles, Los Angeles County)

- Community Recycling/Resource Recovery, Inc. MRF in Sun Valley operated by Community Recycling (City of Los Angeles, Los Angeles County)

Santa Clarita MRF/TS (Planned MRF to be built by Burrtec Industries, likely in or near the City of Santa Clarita, Los Angeles County)

III – Results of suitable technology/MRF combinations analysis concluded that the most suitable technologies are thermal conversion or waste to green fuel technologies and that any of the six MRF/TSs on the list of preferred facilities were suitable. Members of the Alternative Technology Advisory Subcommittee at the June 16, 2005 meeting unanimously agreed that the short list of preferred MRFs for the next phase of development of a conversion facility should include:

- Del Norte Regional Recycling and Transfer Station (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS (Riverside County)

The Community Recycling, Central Los Angeles and Santa Clarita MRF/TS should also be considered in the next phase of the project.

IV – The Strategic Action Plan provides a "road map" for implementation of this project. The schedule indicates a possible commissioning date of mid 2008.

V – A Public Outreach Plan, which was prepared by this study, emphasized the steps that have to be taken for public outreach and education on conversion facilities. This Public Outreach Plan concludes that public acceptability is a major factor for developing a conversion demonstration facility in Southern California. An early and comprehensive public outreach program will contribute to the success of this project.

VI – The preliminary market analysis shows that electricity has the most reliable and stable local market. Green fuels are in a developing marketplace where current demand outstrips supply in California. The compost market is uncertain and unpredictable.

VII – The siting analysis conducted as part of this study indicates that co-location of a conversion demonstration facility at an existing MRF in Southern California has several advantages over current practices of residue disposal. The actual environmental impacts of a specific conversion technology in a specific location will be evaluated as part of permitting process for the facility.

Recommendations

It is recommended to proceed with the following tasks for development of a conversion demonstration facility to process MRF residue in Southern California:

1. Acquire and confirm data provided by the top four technology suppliers in the thermal technology category through an official Request for Qualification (RFQ) or Request for Proposal (RFP). These suppliers are:

   - Interstate Waste Technologies (Pyrolysis/Gasification)
   - Primenergy LLC (Gasification)
   - Ntech Environmental (Gasification)
   - GEM America (Flash Pyrolysis)

2. Acquire and confirm data provided by the two emerging technology suppliers through an official RFQ or RFP. The suppliers for these technologies are:

   - Changing World Technologies (Thermal Depolymerization)
   - BRI (Gasification/Fermentation to Etanol)

   These technologies do not have a commercial facility processing MSW or MRF residue. Changing World Technologies has a demonstration facility processing turkey waste, and BRI has only a pilot facility. While these technologies demonstrate significant promise, the development risk is substantial.

3. Evaluate RFQ/RFP responses and select preferred supplier(s).
4. Clarify permitting pathways and requirements for each technology.
5. Visit preferred suppliers operating facilities.
6. Conduct a detailed evaluation of preferred MRF/TSs in the shortlist.
7. Pursue and negotiate a partnership between MRFs and technology suppliers.
8. Determine the most cost effective and technically feasible throughput for the proposed conversion facility.
9. Pursue funding mechanisms.
10. Start public outreach as early as possible for the implementation of this project.

Alternative Technology Advisory Subcommittee – Conclusions And Findings

Based on existing published studies of conversion technologies, the professional expertise of URS Corporation, as well as the findings of this conversion technology evaluation process, the Alternative Technology Advisory Subcommittee of the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force also adopted the following preliminary conclusions. These conclusions were adopted in support of the Subcommittee's decision to recommend the development of a demonstration conversion technology facility in Southern California, and it is the intent of the Subcommittee to confirm the validity of these conclusions through the next process:

1. Utilizing conversion technologies to process MRF residues and recover energy or green fuel with marketable byproducts will increase diversion from landfills and enhance Southern California's solid waste management and recycling programs.
2. Each of the technology groups evaluated (pyrolysis-gasification, gasification and waste to green fuel) appeared to be environmentally and technically feasible for processing MRF residue or MSW.
3. Available data from Japan and Europe indicates that conversion facilities can operate within the regulatory framework in the U.S. and that facilities with the most advanced environmental control systems would be able to meet regulatory requirements in California.
4. Conversion technologies have been in successful, long-term use around the world, although they typically use more homogeneous feedstocks such as coal and biomass. While technical challenges are expected with most of these technologies, because of their relatively short operating history using MSW as a feedstock and complexity of the process, these challenges are judged to be manageable.
5. Economically, these technologies appear to have the ability to compete favorably with other solid waste disposal methods in a commercial facility.

Conversion technologies offer a new and potentially ground-breaking approach in reducing the amount of solid waste disposed at landfills. Conversion technologies are a group of technologies that convert the organic or carbon-based portion of post recycling residual solid waste into useful products. These products, in turn can be used to produce electricity, green fuels, and/or marketable chemicals and fertilizers.

On the basis of their technical definitions, conversion technologies are divided into two types:

- Thermal conversion technologies: These technologies are characterized by higher temperatures (higher than 400°F) to process residual solid waste and produce useful products.
- Biological and chemical conversion technologies: These technologies proceed at lower temperatures (lower than 400°F) to convert residual solid waste into useful products.

The following is a brief description of thermal, biological, and chemical conversion technologies that were evaluated for the Alternative Technology Advisory Subcommittee.

1.1 THERMAL CONVERSION TECHNOLOGIES

1.1.1 Introduction

The thermal processes being considered for the Los Angeles County conversion technology evaluation project are technologies that thermally convert Material Recovery Facility (MRF) residue currently disposed of in a landfill to other useful products and by-products. Unlike incineration, they do not directly burn the MRF residue.

These technologies include:

- Pyrolysis
- Pyrolysis/gasification
- Pyrolysis/steam reforming
- Conventional gasification (fixed bed and fluid bed)
- Plasma gasification
- Thermal depolymerization

This evaluation does not include “conventional” mass-burn incineration technologies that are utilized throughout the U.S. in Waste-to-Energy (WTE) plants. The following section describes thermal conversion technologies currently used to process Municipal Solid Waste (MSW).

1.1.2 Pyrolysis

1.1.2.1 Conventional Pyrolysis

Pyrolysis has a long history of industrial use. Pyrolysis systems utilize a wide range of designs, temperatures, and pressures to initiate the pyrolysis reactions. Typically, pyrolysis systems use a drum, kiln-shaped structure, or pyrolysis tube, which is externally heated using either recycled syngas or another fuel or heat source to heat the pyrolysis tube/chamber. Essentially, the organic materials are "cooked" in an oven, with no air or oxygen present. No direct burning takes place.

Most organic compounds are thermally unstable. At high temperatures, larger (more complex) organic compounds are thermally broken down into gases and liquids composed of smaller molecules, including hydrocarbon gases and hydrogen gas. The temperature, pressure, reaction rates, and internal heat transfer rates are used to control specific pyrolytic reactions in order to produce specific products. At lower temperatures, liquid pyrolytic oils dominate; at higher temperatures, gaseous byproducts dominate. Pyrolysis reactions are endothermic, meaning that they require externally supplied heat to occur. Natural gas, propane or the Syngas produced by pyrolysis can be used as sources of external heat. If the feedstock has a high heating value (BTU/lb) the pyrolytic process becomes more self-sufficient and once the process starts uses very little fossil fuel.

The constituents of syngas produced by pyrolysis are: methane (CH_4), carbon monoxide (CO), and hydrogen (H_2), which are combustible gases. They also produce oxidized compounds (CO_2 and H_2O), which have no heating value and dilute the syngas.

Pyrolysis can be run as a batch or continuous process and can reduce the volume of MSW by as much as 90%. Pyrolysis produces gases and liquids, as well as residual solids including ash and a carbon char. Some common commercial products made through pyrolysis, depending on the nature of the feedstock, are charcoal (for barbecuing) and activated carbon (for absorption of liquid and gaseous emissions).

Municipal Solid Waste (MSW) is too heterogeneous for pyrolysis and other thermal conversion technologies and, therefore requires pre-processing in most cases. Since inorganic materials such as grit, glass, and metals, do not enter into the thermal conversion reactions, energy, which could be used to produce pyrolysis reactions, is expended in heating the inorganic materials to the pyrolysis reactor temperature. Then the inorganic materials are cooled in clean-up processes, and the heat is lost. Much of the pre-processing is required to remove inorganic materials and to enhance the homogeneity of the feedstock. Depending on the specific pyrolysis process, pre-processing may include sorting, separation, size reduction, densification, etc.

Since pyrolysis occurs in the absence of oxygen, the feed system and pyrolysis chamber are sealed and isolated from outside air during the processing. This is accomplished through the use of inlet and outlet knife-gates, with ram feeders to feed one “plug” of feedstock as the next plug is being fed into the sealed environment.

In the reactor, pyrolysis may occur over a period of time (several minutes in a pyrolysis or “degassing” chamber) or very quickly, as in the case of “flash” pyrolysis, where the feedstock encounters an extremely hot internal surface and volatilizes in less than a second. Slow pyrolysis is used to maximize the production of char, as in the case of producing charcoal or activated carbon. In those cases, the volatile fraction may be vented or used elsewhere. Slow pyrolysis is used to convert low volatile coal to metallurgical grade coke for steel making. Coke is a very pure carbon product, which is then used to initiate a reducing atmosphere for converting iron ore to molten iron. Following the pyrolysis reactor, the syngas may be:

- Burned directly in a thermal oxidizer or boiler, and its heat recovered for making steam for power generation; the exhaust gases then pass through emission control systems that may include fabric filters, wet and dry scrubbers, electrostatic precipitators, and activated carbon beds.
- Quench cooled, cleaned in emission control systems, and then burned in a boiler, reciprocating engine or gas turbine for power generation.
- Quench cooled, cleaned in emission control systems, and then utilized for producing organic chemicals.

The char can be used as a commercial product, such as charcoal or coke, manufactured into graphite rods for carbon arc steel making, or further processed in gasification reactions illustrated in Figure 1-1.

The inorganic materials in the feedstock are removed as a bottom ash. It is usually combined with the char, and can be separated out for disposal (if the char is to be utilized as noted above) or used in making block materials.

1.1.2.2 Pyrolysis/Steam Reforming

Since the pyrolysis reactions result in the formation of char, liquids, and gases, additional reactions can be initiated to further the thermal breakdown of these organic compounds. One of the common reactions to follow pyrolysis is steam reforming shown in Figure 1-2. Since the water-gas reaction is used to promote the reaction of carbon and water to form syngas. In this manner, the char produced in pyrolysis is reacted with steam that is injected into the process so that:

FIGURE 1-1
TYPICAL PYROLYSIS SYSTEM FOR POWER GENERATION

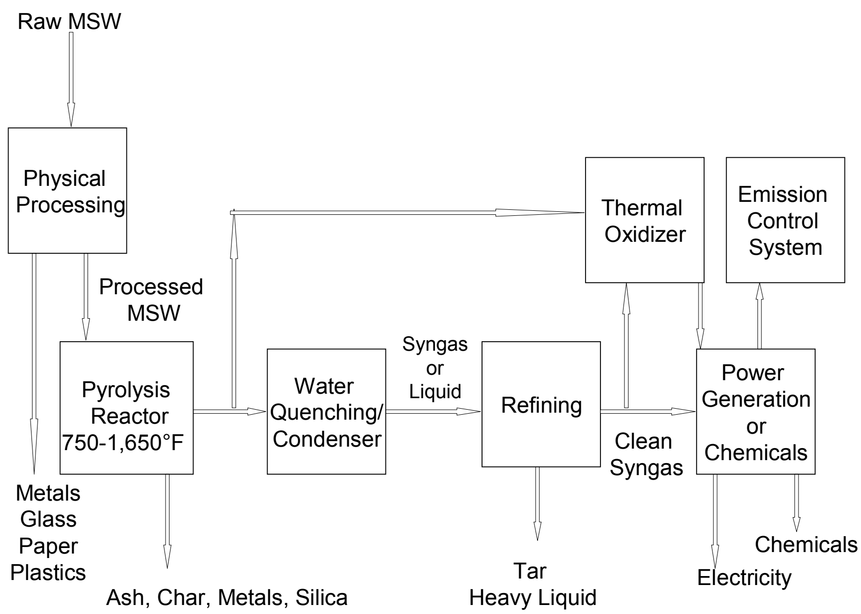
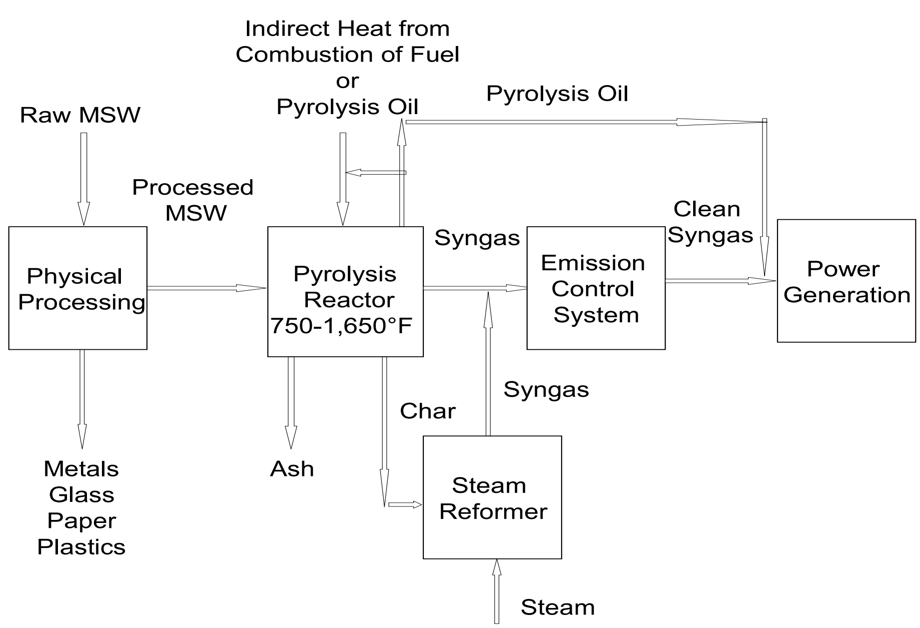


FIGURE 1-2
TYPICAL PYROLYSIS/STEAM REFORMING SYSTEM FOR POWER GENERATION



$C + H_2O \rightarrow CO + H_2$ (water-gas reaction)

This reaction is endothermic, using the heat provided by the steam (and from the external source used for pyrolysis) to further this reaction. In addition, steam reforming of the methane in the syngas stream can occur, resulting in additional production of hydrogen:

$CH_4 + H_2O \rightarrow CO + 3H_2$

The syngas stream is then cooled, cleaned, and used for power generation or chemical production.

1.1.2.3 Throughput

Existing pyrolysis systems treat up to 300 tons/day, with pyrolysis/steam reforming systems operating at up to 165 tons/day. Systems are modular, and can be installed in parallel to increase throughput.

1.1.2.4 Feedstock Characteristics

Pyrolysis systems can process a wide range of carbon-based materials. Any organic or thermally degradable material can be processed by pyrolysis. Historically, pyrolysis was used to make charcoal from wood. Pyrolysis also is used to process used tires and produce carbon black, steel and fuel to generate power. Currently, some manufacturers are using pyrolysis to make activated carbon using coconut shells or wood as feedstock. If a homogeneous feedstock is processed by pyrolysis, it produces high quality byproducts.

MSW is not a homogenous waste stream. In order to make the pyrolysis process more efficient, pre-processing of MSW is required. The pre-processing includes the separation of thermally non-degradable material like metals, glass, and concrete debris. Also, for some pyrolytic processes, size reduction and/or densification of the feedstock may be required. If MSW has high moisture content, a dryer may be added to the pre-processing stage to lower the moisture content of the MSW to 25% or lower. Lower moisture content of the feedstock increases its heating value and the system becomes more efficient. The waste heat or fuel produced by the system can be used to dry the MSW.

1.1.2.5 Byproducts

The solid byproducts from pyrolysis are mainly carbon char, silica, metals and non-thermally degradable material such as glass. In the case of low temperature pyrolysis, where liquid fuel is the byproduct, a tar or viscous material is also produced. The carbon char from processing MSW can be used as fuel, additives to construction materials or other industrial purposes. The carbon char produced by pyrolysis also can be activated using the steam generated by the pyrolysis system. The activated carbon can be used in wastewater treatment facilities or other manufacturing plants for water or air treatment and emission control. The metals can be separated and sold. The ash can be disposed of in a regular non-hazardous landfill.

1.1.2.6 Environmental Issues

In all thermal conversion technologies, air emissions are a major environmental issue to be addressed. Pyrolysis uses indirect heat with the absence of free air or oxygen to process MSW, therefore the air emissions are minimized. Pyrolysis, and gasification reactors typically are closed, pressurized systems, so that there are no direct air emission points. Contaminants are removed from the syngas and/or from the flue gases prior to being exhausted from a stack. Specific design and operation characteristics of thermal conversion systems also reduce air emission significantly. These include:

- Thermal conversion technologies often incorporate pre-processing subsystems in order to produce a more homogeneous feedstock; this provides the opportunity to remove chlorine-containing plastics (as recyclables), which could otherwise contribute to the formation of trace organic constituents.
- The volume of syngas produced in the conversion of the feedstock is considerably lower than the volume of flue gases formed in the combustion of MSW in a waste-to-energy facility. Smaller gas volumes are easier and less costly to treat.
- Pre-cleaning of the syngas is possible prior to combustion in a boiler, and is required when producing chemicals or prior to combustion in a reciprocating engine or gas turbine in order to reduce the potential for corrosion in this sensitive equipment. Syngas pre-cleaning serves to reduce overall air emissions.
- Syngas produced by thermal conversion technologies is much more homogeneous and cleaner-burning fuel than MSW.

Air emission control and processing systems that are likely to be required by South Coast Air Quality Management District (SCAQMD) include some or all of the following:

- When the syngas is combusted in a boiler, reciprocating engine, or gas turbine, automated combustion controls and furnace geometry (for boilers) designed to optimize residence time, temperature and turbulence to ensure complete combustion
- For combustion of syngas in a boiler, low-NO_x burners and/or a Selective Non-catalytic Reduction (SNCR) system for reduction of NO_x emissions. Selective Catalytic Reduction (SCR) is typical for exhaust gases from reciprocating engines and gas turbines.
- Baghouse (fabric filter) for removal of particulate matter from flue gases.
- Activated carbon injection (followed by a baghouse) for removal of trace metals (such as mercury).

- Wet scrubber for removal of chlorides/hydrochloric acid (may produce saleable HCl).
- Wet, dry, or semi-dry scrubber for sulfur dioxide (may produce saleable gypsum).
- Final baghouse for removal of fine particulate matter after dry or semi-dry scrubbers. Air emission control equipment to accomplish this syngas and/or flue gas cleanup is commercially available, and is able to reduce air emissions to levels well below regulatory limits in California.

It is likely that other issues will involve the following:

- Solid residual management – as stated above, pyrolysis can create several "residues", including char, silica, slag, or ash, depending upon the nature of the process. While many residues can be re-used, some small portion may be disposed in a landfill. These materials will be inert, however.
- Visual and Land Use – there may be impacts relating to the visual character of the facility, or issues relating to compatibility of the facility with surrounding land uses.
- As with other facilities handling MSW, there will be concerns about odors, litter, noise, traffic, and dust.

1.1.3 Gasification

1.1.3.1 Conventional Gasification

Conventional gasification involves the partial oxidation of carbon-based feedstock to generate a syngas, which can be used as a fuel or for the production of chemicals. Gasification has been used worldwide for making "town gas" for street lighting and cooking for over 150 years. It played a major role in the industrial development of Europe. Since then, many gasification technologies and designs have been developed, primarily in Europe. The Fischer-Tropsch process was developed to take syngas from gasification of coal and convert it to a wide range of hydrocarbon liquids, including diesel. After WWII, the use of gasification declined as oil and gasoline became cheaper and more available.

Syngas produced by gasification is presently used for making chemicals and electricity. Examples are the gasification of coal by Eastman Chemical in their Kingsport, Tennessee, plant to make chemicals that are the precursors for the manufacture of photographic film and other products, and the gasification of coal and petroleum coke by Tampa Electric to produce syngas, which is burned in place of natural gas in a large combustion turbine to make electricity.

The use of gasification for MSW began in the 1980s, in the U.S., Europe and Japan. In these initial units, the use of unprocessed MSW resulted in many technical problems, primarily due to the heterogeneous nature of MSW. This caused handling and feeding problems, as well as issues with temperature and process control, ash removal, and overall cost. Many of these facilities were shut down. With the worldwide success in coal and petroleum coke gasification, regulatory requirements in Europe and Japan for increased diversion of MSW from landfills, and difficulties in siting and permitting of conventional incineration, gasification become a major alternative treatment technology for MSW. Most of the development has occurred in Japan and Europe, at first utilizing MSW combined with other feedstocks, such as sewage sludge and industrial wastes. In order to feed the MSW by itself, development and use of preprocessing technologies became critical.

Prior to entering the gasifier, some preprocessing will likely be required, as described above in the section on pyrolysis. Some gasification technologies (primarily fixed-bed designs) may accept a minimum amount of preprocessing, such as removal of large appliances, shredding and sorting. Others may require a significant amount of removal of recyclables, sorting, shredding, and drying, in order to provide a homogeneous feedstock.

In the gasifier, the addition of air or oxygen for gasification of the MSW leads to a small amount of combustion, forming some CO_2 and releasing heat:

$C + O_2 \rightarrow CO_2$

Depending on the gasifier design, 10-30% of the heating value of the feedstock is used in this reaction. Utilizing that heat, the organic compounds in the feedstock begin to thermally degrade, forming the pyrolysis gases, oils, liquids and char. As these products move through the bed, or downstream through the gasifier, they encounter air, oxygen, and/or steam, which are injected to further the gasification reactions. The endothermic water-gas and Boudouard reactions occur:

$C + H_2O \rightarrow CO + H_2$ (water-gas reaction)

$C + CO_2 \rightarrow 2CO$ (Boudouard reaction)

Some of the carbon may react with the hydrogen, forming additional methane gas:

$C + 2H_2 \rightarrow CH_4$

Carbon monoxide, hydrogen, and methane, form the primary components of syngas. If air is used instead of oxygen, the syngas will include the nitrogen gas that enters with the air, diluting the syngas and lowering its overall heating value. Gasifier designs are optimized to feedstock and to specific reaction products. Additional water or steam can be injected to initiate the water-gas shift reaction, which converts the CO formed in the water-gas and Boudouard reactions to CO_2, also resulting in the production of a stream higher in hydrogen concentration.

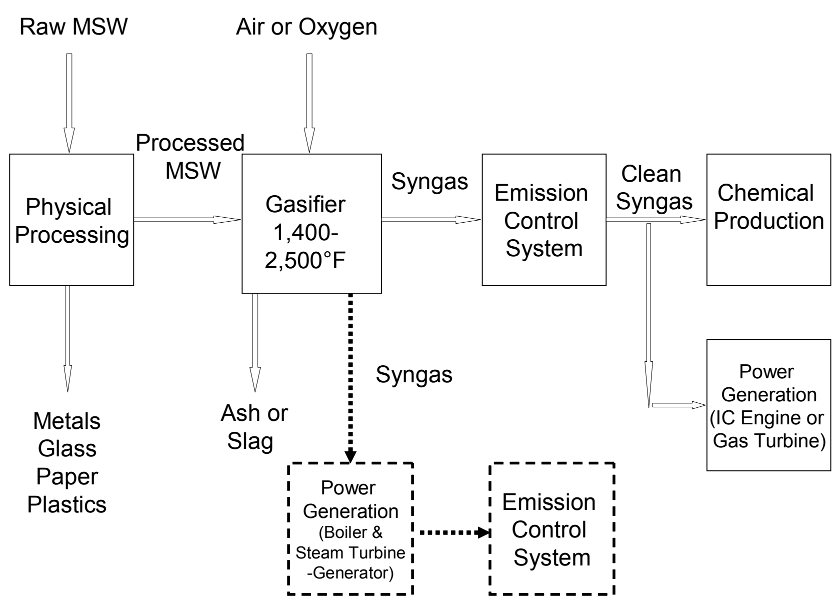
$CO + H_2O \rightarrow CO_2 + H_2$

The higher hydrogen concentration is important when the syngas will be used for chemical production. In that scenario, the CO_2 can be separated and removed through commercially available physical, chemical, membrane, or cryogenic processes.

Gasifiers are typically characterized as being horizontal or vertical, and utilize one of three specific reactor designs: 1) fixed-bed, 2) fluid bed, and 3) entrained bed. In fixed-bed gasifiers, the feedstock is usually fed through the system on a stationary or moving grate. The air or oxygen is injected either up, down, or cross draft flow. In an updraft gasifier, the air or oxygen is injected from the bottom and the syngas exits at the top.

In a downdraft design, the air enters at or near the top of the gasifier, and the syngas exits the bottom. In a fluid bed design, the gasifier is filled with inert particles (usually sand or alumina). The feedstock is fed either directly into or above the bed. High velocity oxygen, air, or other fluidizing medium is injected below the bed, causing the particles to be entrained in the flow and suspended. The feedstock and bed materials are continuously stirred, resulting in uniform temperatures, reactions, and heat transfer. Bubbling bed and circulating fluid bed designs are commonly used to enhance fluidization and turbulence. Figure 1-3 shows the process flow of typical gasification systems.

FIGURE 1-3
TYPICAL GASIFICATION SYSTEM FOR
POWER GENERATION (2 OPTIONS) OR CHEMICALS



Following the gasifier, the syngas may be:

- Burned directly in a thermal oxidizer or boiler, and its heat recovered for making steam for power generation; the exhaust gases then pass through emission control systems that may include fabric filters, wet and dry scrubbers, electrostatic precipitators, and activated carbon beds
- Quench cooled, cleaned in emission control systems, and then burned in a boiler reciprocating engine or gas turbine for power generation
- Quench cooled, clean in emission control systems, and then utilized for producing organic chemicals

If low temperature gasification is used, the inorganic materials in the feedstock will be recovered as a powdery to clinker-like bottom ash. This can be disposed of or used for the manufacture of block materials. If high-temperature gasification is used (above about 2,000°F), the inorganic materials will be subjected to temperatures above their melting points, forming a molten slag. The slag flows out a tap hole in the bottom of the gasifier, into a water bath. There, the slag is quench cooled, forming a glassy, non-hazardous slag material.

This can be disposed of safely, or used for the production of roofing tiles, sandblasting grit, or asphalt filler.

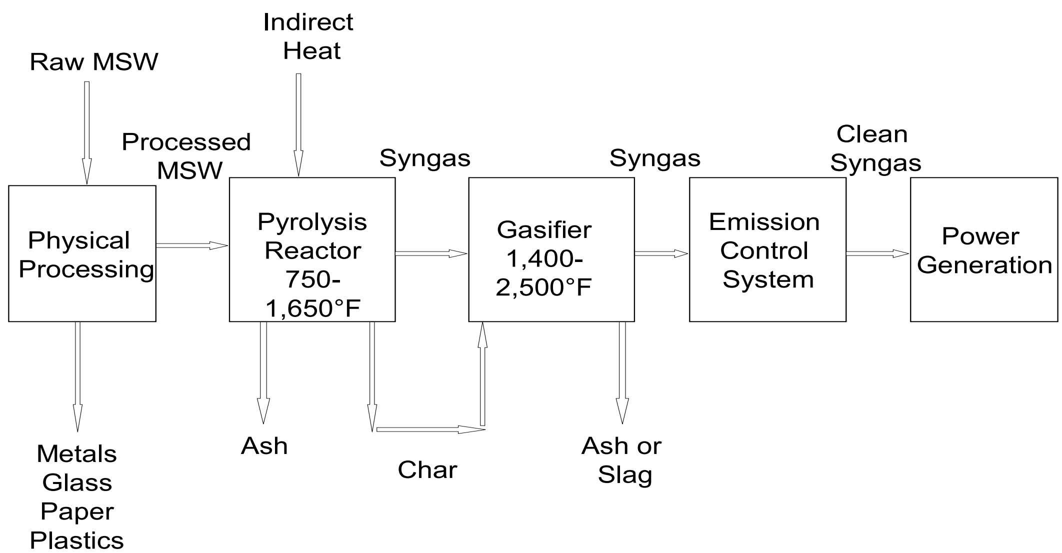
1.1.3.2 Pyrolysis/Gasification

Some technologies employ a pyrolysis system close-coupled to a follow-on gasification step or separate reactor, shown in Figure 1-4. The carbon char produced in the pyrolysis or "degassing" chamber is pushed through into the gasification chamber, where the char and any pyrolysis liquids are gasified by way of additional reactions in a gasification chamber. While the pyrolysis reactor operates without free oxygen, the gasification reactor may use air, oxygen, and/or steam to provide the oxygen needed for the gasification reactions. The gasification reactions are mostly exothermic, so that once the reactions initiate, they are self-sustaining.

1.1.3.3 Throughput

Existing gasification systems operate at throughputs up to 1,000 tons/day, with pyrolysis/ gasification systems operating at up to 800 tons/day. Gasifiers and the pre-processing, emission control, and power generation systems can be installed in parallel to increase throughput and power generation.

FIGURE 1-4
TYPICAL PYROLYSIS/GASIFICATION SYSTEM FOR POWER GENERATION



1.1.3.4 Feedstock Characteristics

Gasification systems utilize a wide range of feedstocks. As noted above, gasification has a long history with coal and petroleum coke. Gasification has also been commercially applied to biomass, such as rice hulls, wood waste, olive processing solids, and other agricultural wastes. They have the ability to tolerate very low quality feedstocks. Gasifiers are usually designed for a homogeneous feedstock, although they can utilize some variability. This can be an issue with gasifiers that use a slurry feed, since significant changes in the feedstock result in different slurry characteristics. This can lead to inefficient gasification, resulting in poor carbon conversion. When changes in the feedstock are anticipated, bench-scale or short-term testing can be used to optimize gasifier operation.

Due to the heterogeneous nature of MSW, significant pre-processing is often required. While some systems state that they can operate with little or no pre-processing, most include manual picking for large appliances, followed by primary and secondary rotary/stationary trommel screens, primary and secondary shredders, air classifiers, and magnetic and eddy-current separators to remove glass and metals and reduce the feedstock size. Sizing/shredding varies, with feedstocks ranging from 2 to 12 inches. Many systems incorporate an auger or ram feeder that compacts the processed MSW feed to as little as 1/10th of the original volume. In order to increase efficiency, many systems incorporate drying to 10-20% moisture content, using steam or engine exhaust. Depending on the supplier, as much as 2/3 of the raw MSW may be removed prior to being fed into the gasifier.

1.1.3.5 Byproducts

In low temperature gasification (below the melting point of most inorganic constituents), a powdery to clinker-type of bottom ash is formed. In high temperature gasification, the inorganic ash materials exit the bottom of the gasifier in a molten state, where the slag falls into a water bath, and is cooled and crystallized into a glassy, non-hazardous slag. The slag is crushed to form a grit that can be easily handled. Slag can be used in the manufacture of roofing tiles, sandblasting grit, and as asphalt filler. Bottom ash may require landfilling, although some suppliers have been able to manufacture ceramic-like bricks or paving stones. One system that utilizes oxygen injection creates extremely hot temperatures in the bottom of the gasifier, reaching the melting temperature of some metals. In that process, the metals can be recovered in "ingot" form.

1.1.3.6 Environmental Issues

In gasification, like most pyrolysis systems, the process itself has no outlet or stack. Pre-cleaning of the syngas is necessary prior to being utilized for production of chemicals, or as a fuel for gas turbines or reciprocating engines, which require clean fuels to minimize corrosion and emissions.

With regard to air emissions, the most important environmental issue for gasification, the discussion in Section 1.1.2.6 applies here as well.

Other environmental issues pertaining to gasification include:

- Solid residue management – As noted above, the inorganic constituents may be produced as bottom ash or slag, depending on the temperature in the reactor. Bottom ash will likely require disposal in a lined landfill. Slag, which is glassy and non-hazardous, is typically sold for the uses noted above. If markets are not available, it can be safely landfilled.
- Visual and Land Use – There may be impacts relating to the visual character of the facility or issues relating to compatibility of the facility with surrounding land uses.
- As with other facilities handling MSW, there will be concerns about odors, litter, noise, and dust.

1.1.4 Plasma Arc Gasification

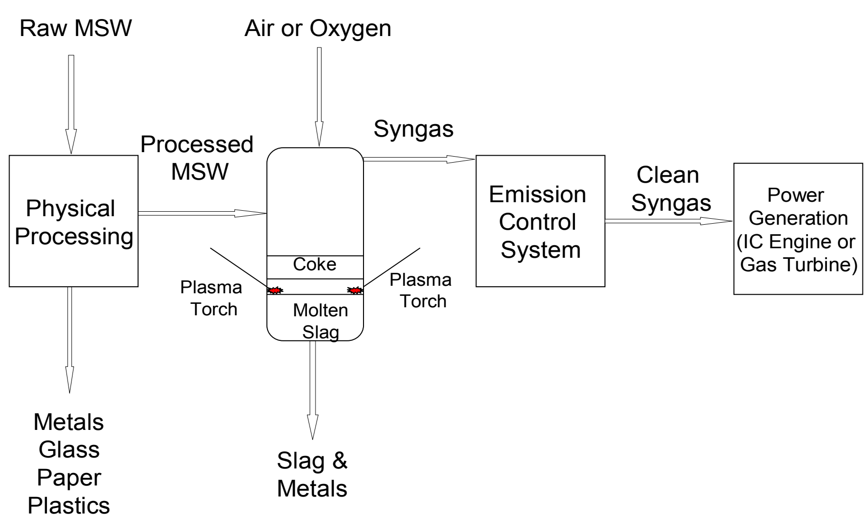
1.1.4.1 Process Description

Plasma gasification has been used for years to treat waste products and incinerator ash, converting them to a non-hazardous, glassy slag. While application to MSW is in its infancy, it has great potential to convert MSW to electricity more efficiently than conventional pyrolysis and gasification systems, due to its high heat flux, high temperature, almost complete conversion of carbon-based materials to syngas, and conversion of inorganic materials to a glassy, non-hazardous slag.

Most of the recent development and use of plasma arc technology has been for melting incinerator ash or for destroying hazardous or medical wastes. Only very recently has R&D occurred on using plasma technology integrated with gasification technologies to process MSW.

Plasma is a hot ionized gas resulting from an electrical discharge. Plasma technology uses an electrical discharge (some use AC, some DC) to heat a gas, typically air, oxygen, nitrogen, hydrogen or argon, or combinations of these gases, to temperatures above 7,000°F. The heated gas, or plasma, can then be used for welding, cutting, or treating waste materials. Plasma gasification typically occurs in a closed, pressurized reactor. The feedstock enters the reactor, where it comes into contact with the hot plasma gas. In some designs, several torches arranged circumferentially in the lower portion of the reactor help to provide a more homogeneous heat flux pictured in Figure 1-5. When used for gasification, the amount of air or oxygen used in the torch is controlled to promote gasification reactions. The inorganic constituents are converted to molten form, then quench-cooled to form a glassy, non-hazardous slag.

FIGURE 1-5
TYPICAL PLASMA GASIFICATION
SYSTEM FOR POWER GENERATION



There are two types of plasma torches, the transferred torch and the non-transferred torch. The transferred torch creates an electric arc between the tip of the torch and a metal bath or the conductive lining of the reactor wall. In the non-transferred torch, the arc is produced within the torch itself. The plasma gas is fed into the torch, heated, and then exits through the tip of the torch.

There are several approaches to the design of the plasma gasification reactors. In one approach, developed by Westinghouse Plasma Corporation (plasma torch manufacturer) and Hitachi Metals (plasma gasification system developer and user), a medium pressure gas (usually air or oxygen) flows through a water-cooled, non-transferred torch, outside of the reactor. The hot plasma gas then flows into the reactor to gasify the MSW and melt the inorganic materials.

Another design is an in-situ torch, where the plasma torch is placed inside the reactor. This torch can either be a transferred or non-transferred torch. When using a transferred torch, the electrode extends into the gasification reactor and the arc is generated between the tip of the torch and the molten metal and slag in the reactor bottom or a conducting wall. The low-pressure gas is heated in the external arc. Alternatively, a non-transferred torch can be used in which the plasma gas is created within the torch and is injected into the reactor.

Several suppliers utilize a completely different approach. In their designs, the reactor is heated by electric induction coils or a graphite arc, forming a molten metal and slag bath. The MSW enters the reactor, where it is subjected to high temperatures, resulting in partial gasification of the feedstock. From there, the syngas exits the reactor. The plasma torch is situated either in a secondary reactor or in a recycle line, which goes back to the first reactor, assuring complete gasification of the feedstock.

Proponents of the in-situ torch claim its advantages include better heat transfer to the MSW and a hotter reactor temperature, resulting in more complete conversion to syngas. The main disadvantage is the potential corrosive effect of the hot MSW and gases on the torch in the reactor. Proponents of the external torch point out that this approach protects the torch from the corrosive effects of the MSW and hot gas, and prolongs the mechanical integrity of the torches. Electrodes in all designs experience some wear and must be replaced. The disadvantage of the external torch is the possibility of a somewhat lower reactor temperature resulting in less MSW being gasified.

The first two approaches have been applied to small-scale commercial waste and medical waste processing units. The throughput of the largest external system is approximately 4 tons per hour and the throughput of the largest internal system is approximately 10 tons per day. The Westinghouse/Hitachi design has been scaled up to 83 tons per day per reactor at Utashinai, Japan, which treats a combination of MSW and auto shredder residue.

In the reactor, coke is often added to assure a reducing atmosphere in a portion of the reaction zone, initiating the pyrolysis reactions. Lime may also be added to the bed as a flux to lower the melting point of the inorganic components, and to stabilize the slag. Air, oxygen, or steam may be added through ports to provide the water and oxygen necessary to initiate the gasification reactions. Some designs include mechanical stirrers to keep the bed material agitated and promote efficient carbon conversion to syngas.

The syngas can either be burned immediately in a close-coupled combustion chamber or boiler, or cleaned of contaminants and used in a reciprocating engine or gas turbine. In the first approach, the exhaust gases are cleaned after combustion, in an emission control system similar to what is used in WTE plants. The hot gases flow through the boiler, crating steam used for power generation in a conventional steam turbine. In the second approach, the syngas is cleaned before it enters the engine or gas turbine.

As noted above, the primary solid output from plasma facilities is a glassy slag, the result of melting the inorganic fraction of the waste. Any waste disposal facility generating an ash or slag is required by the USEPA to subject it to a Toxicity Characteristic Leaching Procedure ("TCLP") test. The TCLP test is designed to measure the amount of eight elements that leach from the material being tested. Data from existing facilities, even those processing highly hazardous materials or medical waste, show results that are well below regulatory limits.

While there are only a few plasma torch manufacturers, there are over a dozen companies that are taking the plasma technology and are developing it for use in MSW gasification. This has led to several suppliers claiming the same experience, i.e., several suppliers that use Westinghouse plasma torches all claim the experience in the Hitachi Metals plants as being their own.

1.1.4.2 Throughput

Existing systems operate at throughputs of up to 83 tons/day on MSW/auto shredder residue combination, using two operating and one spare torch per reactor. Plasma torches can be added to the reactors, along with multiple reactors added to increase total capacity.

1.1.4.3 Feedstock

Feedstock preparation is similar to what is described above under conventional gasification.

1.1.4.4 Byproducts

Byproducts of plasma gasification are similar to those produced in high-temperature gasification, as noted above. Due to the very high temperatures produced in plasma gasification, carbon conversion nears 100%.

1.1.4.5 Environmental Issues

With regard to air emissions and other environmental issues for plasma gasification, the discussion in Section 1.1.2.6 applies here as well.

1.1.5 Thermal Depolymerization (TDP)

In this process, organics are subjected to five steps of high pressure-high temperature treatment:

1) Pulping and slurrying the organic feed with water
2) Heating the slurry under pressure to the desired temperature
3) Flashing the slurry to a lower pressure to release the gaseous products
4) Reheating the slurry to drive off water and light oils from the solid
5) Separating the light oil from the water

Before the fourth step, flashed liquids are separated by density in a liquid separator similar to that used in the petroleum industry. The high-value oil that is removed and is further processed in a post-processing loop such as distillation or solvent extraction. The quality and marketability of the products will derive the development of the separation process. With this process, the large molecules in the feed (usually waste product of various sorts, often known as biomass) are broken down into smaller ones (cracking), and the waste stream is converted into various products including a liquid fuel. The process has been proven at pilot scale and a full-scale (250 tons/day) facility has been built in Carthage, MO. This facility is in operation since September 2004 processing turkey waste and agricultural waste. We will not be able to provide a more detailed description of this technology because this process is quite unique and offered only by one vendor and the specifics related to process are deemed to be confidential.

1.2 BIOLOGICAL AND CHEMICAL CONVERSION TECHNOLOGIES

1.2.1 Introduction

Biological and chemical conversion technologies are focused on the conversion of organics in MRF residues. The MRF residue consists of dry matter and moisture. The dry matter further consists of organics (i.e., whose molecules are carbon-based), and minerals (also referred to as the ash fraction). The organics can be further subdivided into biodegradable organics (for example food waste) and non-biodegradables (for example plastics).

Biological technologies can only convert biodegradables, while chemical processes can potentially convert any organics. Preliminary analyses indicate that the Southern California

MRFs residues are dominated by paper and other biodegradable organics. So, there is much potential for biological and chemical technologies to reduce the amount of MRF residue going to the landfill.

Biological and chemical conversion technologies are treated together in this section because they are often intimately intertwined. Note that thermal and physical processes can be involved in biological and chemical process trains as well.

We will also touch on some other processes, but in less detail because each of these processes is quite unique and offered by very few vendors. These additional processes include syngas to ethanol, catalytic cracking of plastics, and aerobic digestion.

1.2.2 Anaerobic Digestion

Anaerobic digestion (AD) can be considered both a biological conversion technology and a composting technology because the digestate is a compostable residue. As a composting technology processing a source-separated municipal solid waste, the AD facility would qualify for diversion credit. Anaerobic digestion and ethanol production are included in this study because technically they convert MSW to a useful fuel. Also, there are a number of vendors offering these technologies, and many commercial scale anaerobic digestion facilities are in operation outside the U.S.

1.2.2.1 Process Description

In anaerobic digestion, biodegradable material is converted by a series of bacteria groups into methane and CO_2. A first group breaks down large organic molecules into small units like sugar; this step is referred to as hydrolysis. Another group of bacteria converts the resulting smaller molecules into volatile fatty acids, mainly acetate, but also hydrogen (H_2) and CO_2; this process is called acidification. The last group of bacteria, the methane producers or methanogens, produce biogas (methane and CO_2) from the acetate and hydrogen and CO_2. This biogas is a medium-Btu gas containing 50 to 70% methane. It can be used in boilers, and different types of generators with minimal pretreatment; it can also be upgraded to pipeline quality and used as a vehicular fuel.

Anaerobic digestion has been used for over a century to process sewage biosolids. If the MSW feed is processed in the solid phase, AD is often referred to as *anaerobic composting*. To distinguish AD from thermal gasification, as described earlier, it is also referred to as *biogasification*. In addition to biogas, AD generates a residue consisting of inorganics, non-degradable organics, non-degraded biodegradables, and bacterial biomass. If this material is sufficiently free of objectionable materials like colorful plastics, it can have market value as compost. Otherwise, it may be used as landfill cover.

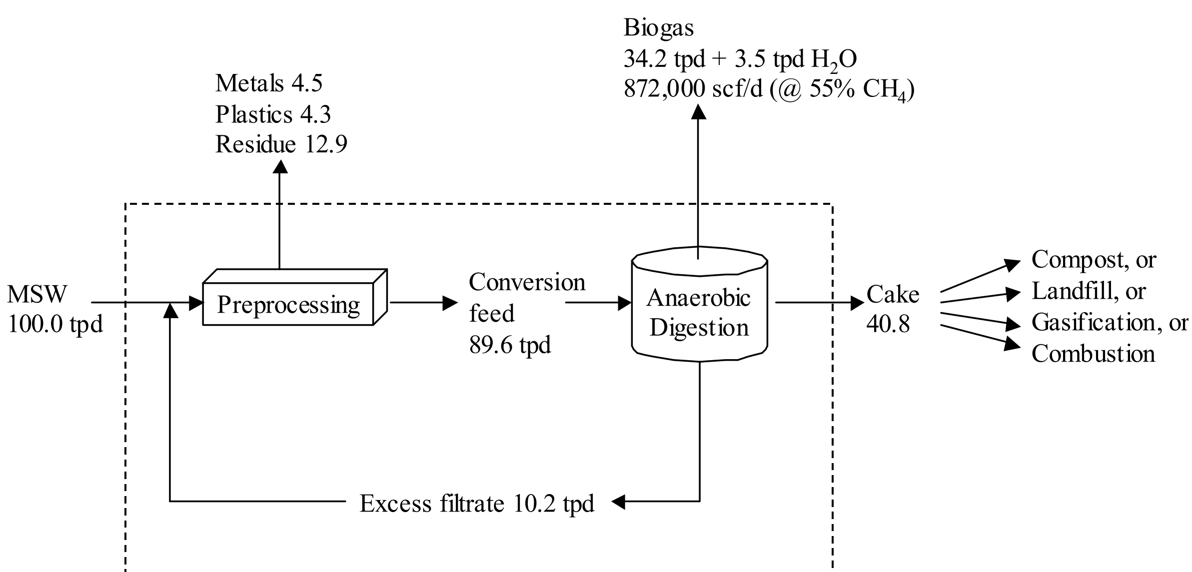
The contents of an anaerobic digester can be at different solids concentrations, ranging from a liquid slurry to a solid material. The material leaving the reactor can be dewatered in a press and the recovered filtrate liquid recirculated. In this manner, the moisture content of the feed material and that of the reactor contents are decoupled: a fairly dry feed can be digested as a liquid slurry without any significant net addition of water to the system. The dewatered material emerging from the press is referred to as filter cake or cake.

Some AD processes rely on a two-stage approach, in which the hydrolysis and acidification reactions are conducted in a first reactor and the methane fermentation itself in a second reactor. Most digesters are of the *continuous feed completely mixed* type (as opposed to batch or plug flow reactors). Mixing techniques include: large impellers; recirculation of effluent (e.g., Dranco process); or injection of pressurized biogas (e.g., Valorga process). The latter two approaches have the advantage that no moving parts are present inside the reactor.

The biogas produced can be used on site to generate electricity and heat using a generator (reciprocating engine, microturbine, conventional turbine, etc.). If a nearby industrial user exists, the biogas can be conveyed over short distances for such uses as boiler fuel. The biogas can also be purified extensively (dehydrating, H_2S removal, CO_2 removal) to pipeline quality and pressurized, for example to be used as compressed natural gas (CNG), a safe and clean vehicular fuel. Biogas can also be converted into methanol and/or used in fuel cells.

Figure 1-6 illustrates the mass balance and process diagram for an anaerobic digestion facility with MSW-derived feedstock.

FIGURE 1-6
SIMPLIFIED TYPICAL MSW ANAEROBIC DIGESTION PROCESS SCHEMATIC (after Legrand et al. 1989)



1.2.2.2 Throughput

AD facilities processing agricultural and solid industrial waste range up to 1300 tons per day (tpd) in capacity, while facilities processing MSW or MSW-derived streams range up to 800 tpd.

1.2.2.3 Feedstock Characteristics

Microorganisms convert biodegradable matter. They do not convert minerals or non-biodegradables like plastic. From the standpoint of the microorganisms that perform the conversion, it does not matter if those non-degradable materials are present in the fermenting mix. It does matter from a materials handling perspective, as some extraneous materials like metal debris, plastic stringers, etc. can wreak havoc on the fermentation equipment. Additionally, if the resulting compost has to be marketable, it is important that as much as possible of these extraneous materials be removed before entering the process. So, the ideal feedstock is nearly pure biodegradable material, with as few inorganics or plastics as possible.

1.2.2.4 Byproducts

The main byproduct is an effluent or filter cake consisting of undegraded organics and microbial biomass. If the material entering the AD process is sufficiently devoid of objectionable items like colorful plastics, the effluent can be formulated into a compost. The compost preparation may include a aeration and curing step, it also generally includes an additional screening step to remove undesirable elements in the filter cake. This compost is equally beneficial as a soil amendment as the compost produced in conventional aerobic facilities (windrow, static pile, etc.). Compared to these processes, AD has the advantage of requiring only a small footprint, and of being completely enclosed, which minimizes odor nuisances.

If the dewatered effluent is unmarketable as compost, it can still be burned or gasified in an appropriate facility; it can also be used as landfill daily cover, since it will not appreciably generate landfill gas or attract nuisance animals.

1.2.2.5 Environmental Issues

As with other MSW processing facilities, AD will have environmental issues, such as noise, dust, odor and litter nuisances at the receiving end of the plant. It may also produce some wastewater, which would need treatment and disposal. Proper process design and moisture management can minimize this stream to negligible levels or eliminate it altogether.

There are no air emissions or odor nuisances from the AD process proper, since it is fully enclosed. Combustion and flaring of the biogas has the same impacts as any natural gas combustion process and must be controlled with appropriate emission controls.

Depending upon the size of the facility, traffic and visual impacts may be an issue as well.

1.2.3 Hydrolysis – Ethanol Production

1.2.3.1 Process Description

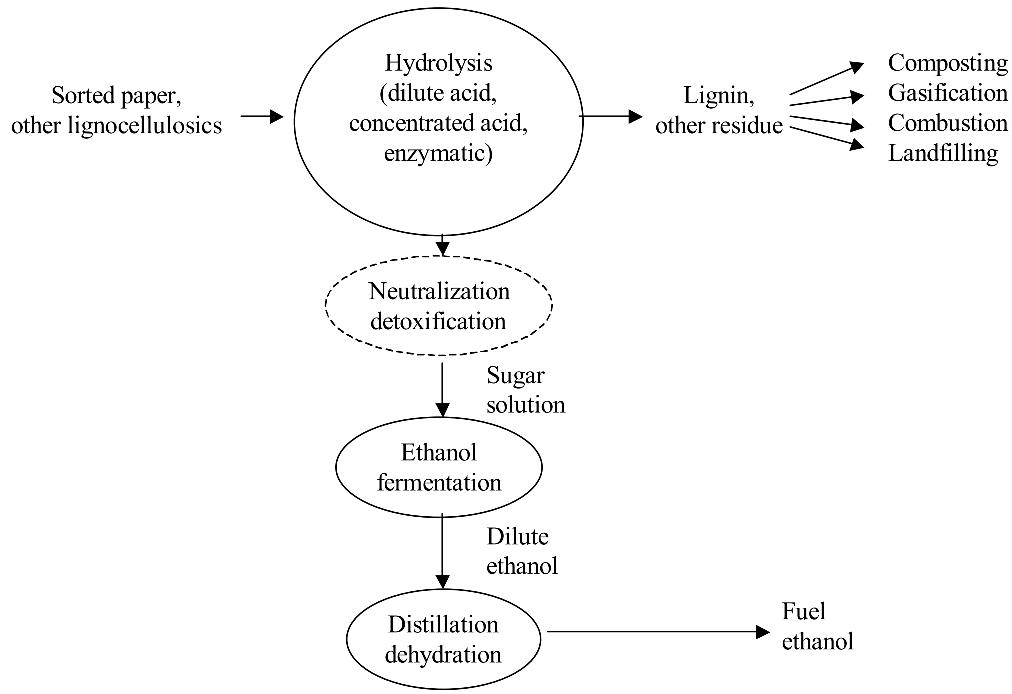
Sugar and starch can be fermented to ethanol. This process lies at the basis of the production of alcoholic beverages, but also of corn ethanol production. The latter process is used on a large scale in the US to produce fuel ethanol. Cellulose, the main constituent of most plants, is actually a polymer of glucose molecules. If the cellulose can be broken down into glucose, it can also be fermented to ethanol. However, the bonds between glucose molecules in cellulose are difficult to break; the process of breaking those bonds is known as hydrolysis. Additionally, cellulose can be encased in hard-to-degrade lignin, as in wood, making it less accessible for hydrolysis. Considerable effort has been devoted to cost-effectively hydrolyzing fibrous vegetable matter, referred to as "lignocellulosics."

Various hydrolysis processes have been developed (concentrated acid, dilute acid, enzymatic) and demonstrated at pilot scale, some of them at demonstration scale. They could be applied to paper and vegetable matter, including wood, in the MSW stream. A simplified process diagram is provided in Figure 1-7. A purified lignocellulosic material is chopped up and introduced into a hydrolysis reactor. The effluent of this reactor is mostly a sugar solution. It is prepared for fermentation, for example by neutralizing the pH if strong acid hydrolysis was used. This detoxified solution is introduced into the fermenter where microorganisms convert the sugar to ethanol and CO_2. The ethanol concentration in the fermenter must remain below 5% otherwise the microorganisms would be inhibited. This dilute fermenting liquid is referred to as a "beer." It is next introduced into a combined distillation and dehydration process to bring the ethanol concentration up to fuel grade (99% ethanol). The distillation process is particularly energy intensive. A solid residue of unfermented solids and microbial biomass is recovered (distiller's grain) and can be used as animal feed.

1.2.3.2 Throughput

Currently, corn ethanol facilities process thousands of tons of corn per day. However, there is at present no full-scale facility producing ethanol from lignocellulosics, although one such facility is in the startup phase in Canada. It processes exclusively agricultural crop residues.

FIGURE 1-7
SIMPLIFIED ETHANOL PRODUCTION PROCESS SCHEMATIC



1.2.3.3 Feedstock Characteristics

The ideal feedstock for ethanol production from MSW would be a stream containing only paper, wood, yard waste, and other purely vegetal biomass. Impurities like inert materials are a concern for two reasons. First, they could complicate materials handling by jamming pumps, clogging pipes, wrapping around mixers, etc. The second concern is that they could essentially render the solid residue worthless due to contamination.

1.2.3.4 Byproducts

Corn ethanol production yields CO_2 and a variety of other products such as distiller's grains, gluten, etc. If MSW is the source of the ethanol, the byproducts will not be acceptable for incorporation into human foodstuffs, including using CO_2 for beverage carbonation. Their marketability as animal feed is low. The marketability of the solid residue as compost depends on the purity of the feed stream and the resulting appearance of the compost. Of course, the solid residue could be burned or gasified. The CO_2 stream produced is relatively pure, and could have non-food industrial applications.

1.2.3.5 Environmental Issues

An ethanol plant is a chemical processing plant. By chemical processing standards, it is fairly benign from an environmental perspective. However, there will be air emissions, for example in the production of heat for the distillation step. Ethanol production can emit significant quantities of VOCs, NO_x, SO_2, CO, and particulate matter (PM, PM_{10}). The primary sources of these emissions are the dryers, carbon furnaces, fermentation units, boilers, and ethanol load-out systems. There will be some handling of hazardous chemicals in the hydrolysis process. The potential nuisances associated with the delivery of MSW streams (litter, odor, vermin, etc,) will have to be minimized via proper design and operation, as for all MSW processing facilities.

1.2.4 Other Processes

1.2.4.1 Syngas-ethanol

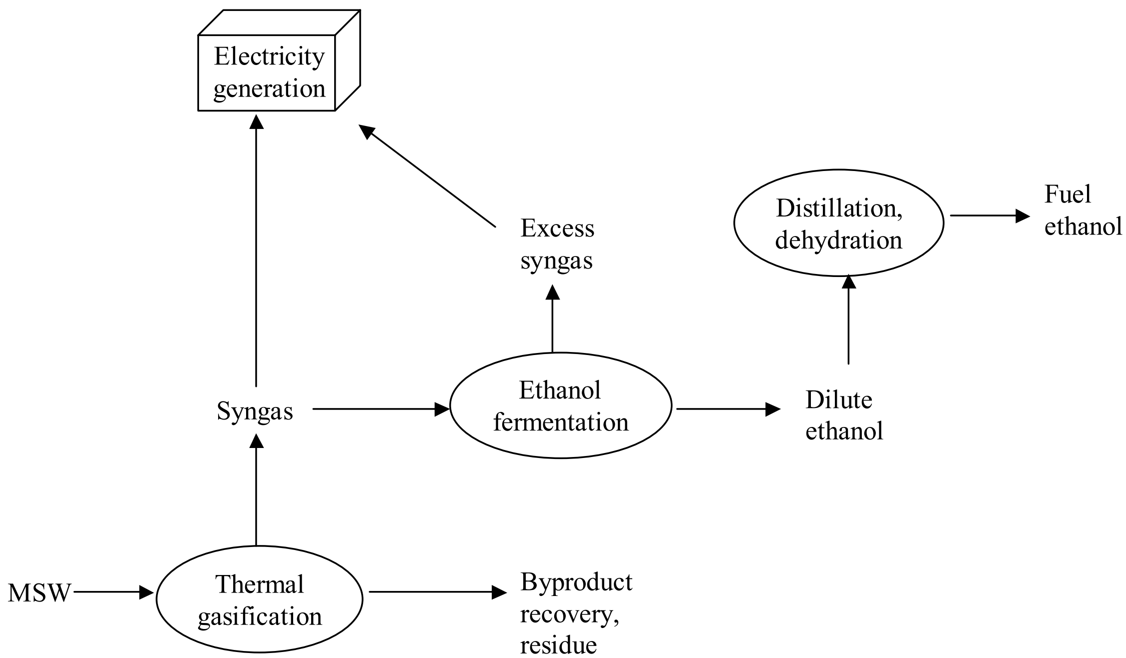
The syngas-ethanol process is illustrated in Figure 1-8. The organics in MSW are converted to syngas via thermal gasification (See Section 1.3, Gasification). The hot syngas is cooled, in the process generating steam, and it is introduced into a fermenter containing a specialized microbial population that converts the syngas into ethanol and CO_2. The resulting dilute ethanol is distilled and dehydrated to fuel grade ethanol, as described in the previous section. Unconverted syngas from the fermenter is used to generate electricity via a steam turbine. If desired, some of the syngas can bypass the fermenter and go directly to generation.

The main advantage of this process is that it makes all of the organics in MSW accessible to ethanol production, including plastics and hard-to-degrade woody materials. Therefore, the ethanol yield per ton of MSW feed should be significantly greater than it would be using the chemical or biochemical hydrolysis route to ethanol.

There would be little need for MSW sorting into hydrolyzable feed. Finally, this technology would minimize the landfilled residue to the same extent as gasification. Note also that there would be some flexibility in the quantity of electricity generated versus ethanol produced, so the facility could adapt to changing market conditions.

There is one vendor of syngas-ethanol technology; it has been developed to the pilot stage as of this writing.

FIGURE 1-8
SIMPLIFIED SYNGAS-ETHANOL PROCESS SCHEMATIC



1.2.4.2 Catalytic Cracking of Plastics

In this process, plastics are cracked into smaller molecules, and eventually converted to a diesel fuel. This is a purely chemical process. A facility using this process has been operating in Poland at commercial scale (260 tpd) for a number of years. There is one vendor in the U.S. This process can complement conventional plastics recycling, especially for low quality commingled plastics streams that often end up in the landfill. It would only make sense if applied to a plastics stream separated from the solid waste or separately collected.

1.2.4.3 Aerobic Digestion

This process applies mainly to food waste, agricultural waste, and sewage biosolids. The waste material is homogenized into a slurry, which is mixed with air in a bioreactor. Aerobic microorganisms in this reactor oxidize the easily biodegradable material, just like in an aerobic compost pile, producing substantial heat. The heat and retention time are enough to pasteurize the material, which is processed into several liquid and solid fertilizers. If MRF residues are the process feed, the marketability of the aerobic digestion products may be very low, considering the commingled nature of the MRF waste. Note that this process differs from anaerobic digestion in that no fuel is produced.

SECTION 2.0 EVALUATION, SCREENING, AND RANKING OF TECHNOLOGIES

2.1 INTRODUCTION

The main objective of this portion of the project was to evaluate conversion technologies that are capable of processing MRF/TS residue. This residue is being landfilled at the present time. The following steps were followed in order to evaluate conversion technologies and identify the most suitable technologies:

- Prepare a list of available conversion technologies
- Prepare a list of conversion technology suppliers
- Prepare a questionnaire and distribute it to conversion technology suppliers
- Summarize and evaluate responses from the technology suppliers
- Develop screening criteria to screen conversion technology suppliers
- Establish ranking criteria
- Rank technology suppliers
- Use this ranking process to identify the most suitable conversion technologies

The following sections explain each of the above steps.

2.2 LIST OF CONVERSION TECHNOLOGIES AND SUPPLIERS

2.2.1 List of Conversion Technologies

The Los Angeles County Alternative Technology Subcommittee goal is to develop a conversion demonstration facility to process MRF/TS residue in Southern California. The evaluation of conversion technologies began by creating a list of potential technologies. This list includes both thermal and bio-chemical conversion technologies.

Thermal conversion technologies include:

- Pyrolysis
- Pyrolysis/gasification
- Pyrolysis/steam reforming
- Conventional gasification (fixed bed and fluid bed)
- Plasma gasification
- Thermal depolymerization

Biological/Chemical conversion technologies include:

- Anaerobic Digestion
- Hydrolysis-Ethanol production
- Syngas Ethanol
- Catalytic cracking of plastics
- Aerobic Digestion

Descriptions of the conversion technologies are provided in Section 1.0 of this report.

2.2.2 List of Conversion Technology Suppliers

The conversion technology evaluation was conducted in part by issuing a questionnaire to technology suppliers. The list of conversion technology suppliers was prepared using lists from the the following existing sources:

- California Integrated Waste Management Board
- Santa Barbara County, CA
- Riverside County, CA
- City of Alameda, CA
- City of Honolulu, HI
- Collier County, FL
- City of Toronto, Canada
- City of York, Canada
- Juniper Consultants
- URS database (from recent conversion technology studies and evaluations)
- Southern California Association of Governments
- Other technologies/vendors known to Subcommittee members

The complete conversion technology suppliers list is shown in Table A-1 in Appendix A.

2.3 QUESTIONNAIRE FOR TECHNOLOGY SUPPLIERS

2.3.1 Supplier Requirements

A list of questions for conversion technology suppliers was prepared. The answers to these questions provided preliminary information to select suitable technologies. Some basic requirements were established for the technology suppliers to qualify them to receive the questionnaire. The following requirements were established for evaluating suppliers and their technologies. The supplier and their technology had to comply with all of these requirements to be considered further in this process.

1. **Waste Diversion Rate.** The supplier's technology must be able to reduce the amount of MRF/TS residuals going to the landfill by at least 50%.
2. **Demonstrated Processing Experience.** The supplier must have developed at least a demonstration scale facility, designed to process MSW or similar feedstock at a rate of approximately 5 short tons/day (1 short = 2,000 lbs), and that has operated for at least one year. Note: sewage sludge, black liquor solids, chemicals, plastics, or tires are not considered a "similar feedstock".
3. **Conversion to Useful Products and By-products.** The supplier's technology must demonstrate the capability to produce marketable products and by-products.
4. **Environmental Compliance.** The supplier's technology must comply with all regulatory requirements in the State of California.
5. **Responsiveness.** The supplier must reply to URS' requests for data within a timely manner (i.e., within the timeframe noted in the questionnaire).
6. **Ability to Partner with a MRF/TS.** The supplier must be willing and able to create a partnership with a MRF/TS in Southern California.
7. **Facility Size.** The supplier must exhibit the capability to develop a demonstration facility that will process approximately 100 short tons/day of MRF residuals.

2.3.2 Preparation of Questionnaire

The purpose of the questionnaire was to obtain information about the technology and to address specific technical and financial issues regarding the technologies. A copy of the questionnaire is included as Table A-2 in Appendix A.

2.3.3 Distribution of Questionnaire

The questionnaire was distributed to the technology suppliers on January 13, 2005. The Alternative Technology Advisory Subcommittee at its January 21, 2005 meeting decided to amend the questionnaire in order to encourage more technology suppliers to respond. The amendment to the questionnaire was sent to the technology suppliers on January 26, 2005. A copy of the amendment to the questionnaire is also provided as Table A-3 in Appendix A. Follow-up telephone calls were made to each of the technology suppliers to ensure that they received the questionnaire and the three amendments, which included:

- Item No. 2-Los Angeles County prefers a technology supplier that developed at least a pilot scale facility designed to process MSW or similar feedstock at a rate of 5 short tons/day, and operated for 1 year
- Item No. 4-the supplier must demonstrate a technology capable of meeting all regulatory requirements (e.g., air emissions)
- Schedule-responses must be received by 5:00 PM on February 28, 2005

2.3.4 Summary of Conversion Technology Suppliers Responses

Twenty-eight responses to the questionnaire were received. A list of the technology suppliers that responded to the questionnaire is shown in Table 2-1. The responses from the technology suppliers were reviewed, and a summary of the thermal technologies provided by technology suppliers is included in Table 2-2. A brief description of the biological/chemical technologies is included in Table 2-3. More detailed information regarding the technology suppliers for thermal conversion and biological/chemical conversion technologies is provided in Tables A-4, and A-5, in Appendix A.

Evaluating the conversion technologies and suppliers of the various technologies is a complex task, with multiple dimensions. There are significant differences in the technology groups being considered (i.e., thermal conversion and bioconversion), and the specific technologies offered by suppliers within the technology groups vary widely. Even suppliers of similar technologies, i.e., gasification, have very different designs for their gasifiers, such as fixed bed or fluid bed reactors, as well as differences in how they address pre-processing, cleaning of syngas, and power generation.

Data provided by the suppliers at this stage of the study is preliminary and subject to change. A formal RFQ and/or RFP process, utilizing a detailed engineering specification, would provide more certain and detailed technical, design, and costs information, including more accurate revenues from byproduct sales. A number of technical and economic assumptions were made to “normalize” the data submitted by the suppliers and to facilitate analysis. The preliminary nature of the data provided focused the evaluation on the data outliers, in order to identify fatal flaws or major technical or economic issues.

TABLE 2-1
CONVERSION TECHNOLOGY SUPPLIERS WHO RESPONDED TO THE QUESTIONNAIRE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Response Date
Gasification	Fixed bed	Omnifuel Technologies, Inc.	RDF Gasification	Organic wastes, tires, sewage sludge, biomass	03/01/05
Gasification	Fixed Bed	Primenergy, LLC	PRM Energy gasification	Biomass, RDF, rice hulls, olive waste	02/24/05
Gasification	Fixed Bed	Whitten Group International	Entech Renewable Energy System	MSW, medical, animal food wastes, dried sewage, hazardous wastes	03/01/05
Gasification	Fluid bed	Ebara Corporation/ Environmental Plants Division	Ebara Twin Rec TIFG (**T**win **I**nternally Circulating **F**luidized Bed **G**asification) and Ash Melting	MSW, RDF, ASR, sewage sludge, plastics	02/21/05
Other Thermal	Microwave	Molecular Waste Technologies, Inc.			02/28/05
Plasma Gasification		Geoplasma LLC (part of Jacoby Development, Inc.)	Plasma Direct Melting Reactor. Westinghouse Plasma torches.	MSW	03/01/05
Plasma Gasification		Plasma Environmental Technologies, Inc.	Plasma Assisted Gasifier	MSW	2/28/2005
Gasification	Fluid bed	Taylor Recycling Facility, LLC	FERCO SilvaGas	MSW, wood waste, agricultural waste and energy crops	02/28/05
Pyrolysis		Conrad Industries	121 Melhart Road Chehalis, WA, 98532	Plastics	03/01/05
Pyrolysis		Graveson Energy Management	GEM High-Speed Conversion Technology	MSW	02/28/05
Pyrolysis		Pan American Resources, Inc.	Lantz Converter	MSW	02/28/05
Pyrolysis		International Environmental Solution	Thermal Convertor	Mixed Waste	02/28/05
Pyrolysis/Gasification	Fixed bed	Interstate Waste Technologies	Thermoselect	MSW	02/28/05

TABLE 2-1 (CONTINUED)
CONVERSION TECHNOLOGY SUPPLIERS WHO RESPONDED

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Response Date
Thermal Depolymerization		Changing World Technologies	Heating under pressure, flash vaporization	Offall	02/28/05
Aerobic Composting		American Bio-Tech	Air Lance (in-vessel)		02/25/05
Aerobic Composting		HotRot Exports Ltd, or Outspoken Industries	HotRot		02/28/05
Aerobic Composting		Wright Environmental Management Inc.	In-Vessel		02/24/05
Aerobic Digestion		International Bio Recovery Corporation (IBR)	IBR		02/28/05
Anaerobic Digestion		Arrow Ecology Ltd	ArrowBio	MSW	02/28/05
Anaerobic Digestion		Canada Composting Inc. (CCI)	BTA		02/25/05
Anaerobic Digestion		Global Renewables	UR-3R, ISKA	MSW	02/28/05
Anaerobic Digestion		Organic Waste Systems nv	DRANCO		03/01/05
Anaerobic Digestion		Waste Recovery Systems, Inc.	Valorga		02/28/05
Syngas-Ethanol	BRI Energy, Inc.	Syngas - ethanol	BRI		02/28/05
Plasma Gasification		Rigel Resource Recovery and Conversion Company			02/28/05
Pyrolysis/Gasification	Fixed bed	Global Energy Solutions, Inc.	Thermal Converter	MSW	3/3/2005
Pyrolysis/Gasification		WasteGen (UK)	Pyrolysis/Gasification	MSW	2/28/05
Gasification		Green Energy Corp	Carbonaceous Waste to Electricity, Liquid Fuels, Synthetic Natural Gas and Liquid Natural Gas	Carbonaceous Waste	4/10/2005

TABLE 2-2
SUMMARY OF INFORMATION PROVIDED BY THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Supplier Name	Technology	Brief Description
Conrad Industries	Pyrolysis	Feed enters the pyrolysis unit, which includes the retort, process auger, outlet end bell, and furnace chamber. The retort is a horizontal cylindrical vessel and serves as a combined reactor, heat exchanger, and mixing device. The retort extends into the furnace. The auger mixes the feedstock and moves it through the reaction vessel. Surrounding the retort is the furnace chamber. Four propane burners provide pre-heat needed for start-up, then syngas is utilized. Hot pyrolyzed vapors that exit the retort are first condensed in the high temperature condensing unit. Pyrolysis occurs at ~1,400°F.
Ebara Corporation	Pyrolysis/ Gasification	A Circulating Fluidized-bed Gasifier (ICFG), using pyrolysis is coupled with char combustion. The conversion unit combines pyrolysis reactor and char oxidation chambers. Fluidizing sand provides heat source, with steam addition for fluidization and production of syngas at 1,560°F. Sand moves to char oxidation chamber, where air is added and combustion occurs. Energy production occurs when the syngas is cleaned and combusted in reciprocating engines.
Global Energy Solution, LC	Pyrolysis/ Gasification	A Pyrothermic Thermal Converter incorporates pyrolysis, along with medium and high-temperature gasification to convert MSW to syngas. The converter includes a pre-heat zone, degasification zone, pyrothermic zone, pre-molten zone, and molten layer.
Molecular Waste Technologies, Inc.	Microwave Technology	The technology uses magnetrons to induce microwaves into the feedstock, resulting in "molecular reduction of organics", breaking it down into oil and carbon char.
Omnifuel Technologies, Inc.	Gasification	An RDF is fed into the gasifier. Inside the gasifier, a bubbling bed of olivine sand is used to provide mixing and contact of the RDF with the gasifying air. The RDF is converted to syngas at 1,500°F, with some ash and tar remaining. The stream exits the top of the gasifier into a primary cyclone, where most of the particulate matter is removed and recycle to the gasifier. The syngas stream enters an air preheater, where heat from the syngas is used to preheat the fluidizing air. The cooled syngas stream enters a secondary cyclone for removal of remaining ash, then to a carbon adsorption bed for mercury removal and a wet scrubber for removal of ammonia. The clean syngas then is piped to a boiler for combustion, producing steam for power generation.
Pan American Resources	Pyrolysis	PAR's technology is the Lantz Converter using "Destructive Distillation", which is essentially a pyrolysis process. Metals are removed by electromagnets and eddy current separators, followed by a shredder. The shredded material is then dried to 5% moisture, using the off-gases produced from combustion of the syngas used to provide the indirect heat for pyrolysis. The prepared MSW is subjected to pyrolysis at 1,200°F, forming syngas and a carbon char. The syngas is cleaned of particulate matter, acid gases, and mercury, and is then combusted in a boiler to make steam for power generation. The indirect heat for pyrolysis is supplied by a portion of the syngas.

TABLE 2-2 (CONTINUED)
SUMMARY OF INFORMATION PROVIDED BY THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Supplier Name	Technology	Brief Description
Plasma Environmental Technologies	Plasma Gasification	No information addressing the questionnaire was provided. PET only provided a 2-page letter discussing a test program they are working on, and a 4 ton/day demo plant they are building.
Rigel Resource Recovery and Conversion Company	Autoclave/ Plasma Gasification	Rigel proposes to integrate autoclaving, MRF, plasma gasification, and power generation technologies. The MRF would utilize a Tempico Rotoclave, an autoclave that uses steam to physically reduce the volume of the MSW, and sterilize it. The output of the Rotoclave is then sent to a MRF for removal of metals and plastics. (Not known why Rigel has decided to put a MRF to treat MRF residuals). The MRF output, along with unsorted MSW, is sent to the plasma gasification system, supplied by Recovered Energy Inc., and using Westinghouse Plasma Corporation's plasma gasification technology. The syngas would be combusted in a gas turbine.
Taylor Biomass Energy LLC	Pyrolysis	Taylor proposes to use the FERC SilvaGas process, a unique fluid-bed pyrolysis technology that incorporates combustion of the syngas and the char remaining from pyrolysis.
WasteGen (UK) Ltd.	Pyrolysis/ Gasification	The shredded, dried MSW is fed to the 2 pyrolysis kilns, where it is thermally decomposed to syngas at 935ºF, leaving behind the inorganic components as ash, in a mixture with the unconverted carbon char. The char/ash mixture enters the carbon recovery unit, a rotary gasification kiln, where the carbon char is gasified, producing more syngas
Interstate Waste Technologies	Pyrolysis/ Gasification	Thermoselect high temperature gasification. This technology incorporates an initial degassing (pyrolysis) chamber, decomposing the MSW into volatile syngas and a carbon char mixed with inorganic components of the MSW. The carbon char enters the gasification chamber, where oxygen is added to complete the gasification of the carbon into more syngas. The syngas is then quench-cooled and cleaned; it can then be combusted in a boiler, reciprocating engine, or gas turbine for power generation.
Primenergy LLC	Gasification	Primenergy uses gasification technology developed by PRM Energy Systems, Inc. The fixed-bed gasifier operates at about 1,500°F, converting the MSW to syngas. The syngas enters a hot gas cyclone, where fly ash is removed. Bottom ash is removed from the bottom of the gasifier. The syngas is then combusted in a large combustion tube, and the hot gases flow through a waste heat boiler for steam production. The steam is piped to a steam turbine generator for production of electricity.
Ntech Environmental	Gasification	Ntech uses the ENTECH Renewable Energy System. The process utilizes low temperature, fixed-bed gasification with very low amounts of air, nearing pyrolysis, to convert MSW to syngas. The system has the following stages 1) a stepped-hearth designed pyrolytic gasification stage for conversion of MSW to syngas at 1,100°F, 2) a thermal reactor stage for immediate combustion of syngas at 2,200°F, 3) an energy utilization stage, including a heat recovery boiler for steam production and power generation.

TABLE 2-2 (CONTINUED)
SUMMARY OF INFORMATION PROVIDED BY
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Supplier Name	Technology	Brief Description
Geoplasma LLC	Plasma Gasification	Geoplasma uses Hitachi Metals' Plasma Direct Melting Reactor using Westinghouse plasma torches. Plasma torches (consuming about 20 kWh/ton MSW) heat air to 4,500°F. This gasifies organic portion of MSW and melts inorganics to form slag layer above molten metal layer. Hot flue gas flows through boiler to make steam; steam flows to steam turbine generator to produce electricity.
Changing World Technologies	Thermal Depolymerization	The Thermal Conversion Process consists of five main steps. 1) pulping and slurrying the organic feed with water; 2) heating the slurry under pressure to the desired temperature; 3) flashing the slurry to a lower pressure to release the biogas, 4) reheating the slurry (coking) to drive off water and light oils from the solids; and 5) separating the light oils from the water. The oil is further processed using distillation or solvent extraction. The biogas goes to electric and/or steam generation based upon the economics of on-site use.
GEM America	Flash Pyrolysis	The conversion unit uses flash pyrolysis at 1,500°F to produce syngas and char/ash mixture. Syngas is quenched in ½ second to 75°F. Chlorine compounds removed. Sulfur compounds are removed in wet scrubber. The syngas is combusted in reciprocating engines to produce electricity.
International Environmental Solution	Pyrolysis	The process utilizes a horizontal retort, with a proprietary rotating auger to move the feed through the system. The MSW is heated to 1,200-1,800°F, where thermal degradation of the organic portion of the MSW occurs. Syngas is produced, and a carbon char mixed with metals and glass is discharged by gravity onto a conveyor. The syngas is immediately combusted in a thermal oxidizer, creating flue gas at 2,250°F. The flue gases are routed through a heat recovery steam generator to produce steam. The steam is used to generate electricity.
Green Energy Corporation	Steam Reforming Pyrolysis	Green Energy Corp. acquired a Technology License Agreement from Bio-Conversion Technology, LLC. of Denver, Colorado to market the patented BCT Gasifier Technology and reactors based on this technology. The syngas is cleaned before combustion to generate electricity. It can also catalytically produce Ethanol from the syngas.

TABLE 2-3
SUMMARY OF INFORMATION PROVIDED BY BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Supplier Name	Technology	Brief Description
HotRot Composting System	Aerobic Composting	The HotRot system is an in-vessel aerobic composting process. Waste is slowly moved along a tunnel via tines on a longitudinal shaft; the tines double as air injectors.
Wright Tech System Inc.	Drying Biomass by biological Technology	Wright Environmental developed the Biodryer™ in-vessel biological drying technology based on its tunnel composting process. In the Biodryer, the processed material is dried to less than 15% moisture by using metabolic heat; the resulting dry material can be used as biomass fuel. Biological drying is an order of magnitude cheaper than conventional thermal drying, it does not require air pollution control equipment, and the air permitting is much simpler. The Biodryer can easily be retrofitted into a composter, should the client decide to produce compost rather than biomass fuel.
International Bio-Recovery Corp (IBR)	Aerobic Digestion	Food waste is slurried and aerobically digested with air injection inside a closed vessel using the EATAD process (Enhanced AutoThermal Aerobic Digestion); BRI has exclusive patent rights to its key components, the Shearator and the digester.
ABT-Haskell, LLC	Aerobic Composting	ABT has patented the AirLance™ in-vessel aerobic composting process. Air is injected and extracted via what is essentially a dense array of giant injection needles into a deep mass of composting sewage biosolids (sludge) and woodchips. The process occurs inside large 26-ft cubical composting cells with built-in screw conveyors. This system optimizes composting conditions, maximizing conversion rates and minimizing footprint. It is completely enclosed.
Organic Waste System (OWS)	Anaerobic Digestion	OWS has patented the DRANCO (Dry Anaerobic Composting) anaerobic digestion process. In this process, the digester feed is mixed with a large amount of recirculating digester effluent. The resulting mix is pumped to the top of the cylindrical digester where it is introduced into the digester. The contents have approximately 40 percent dry matter; they make their way down through the digester in a few days. Subsequently, most of the contents are recirculated to the top, so that the average residence time of the feed is 3 to 4 weeks. The fraction of the effluent removed from the digester (digestate) is aerobically matured using a static pile process and sold as compost. The products are biogas that can be used to generate electricity and compost.
Waste Recovery System (Valorga)	Anaerobic Digestion	Valorga international has patented the Valorga anaerobic digestion process. In this process, a solid or semi-solid waste feed is injected near the bottom of a cylindrical digester. The Valorga digesters have a vertical partition running from one wall across the center over approximately 2/3 of the diameter. The waste feed is introduced on one side of the partition and is removed from a port on the other side, to ensure a minimum residence time in the digester. During their transit, the contents are mixed via pulsed injections of pressurized biogas from the bottom of the digester. Typically, the waste resides in the digester for 3 to 4 weeks, at a dry solids content of 30 to 40%. The digester effluent is dewatered, aerobically matured, and marketed as compost. The products are biogas to generate electricity and compost.

TABLE 2-3 (CONTINUED)
SUMMARY OF INFORMATION PROVIDED BY BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Supplier Name	Technology	Brief Description
Global Renewable	Anaerobic Digestion	The conversion feed goes to an ISKA percolator where it is sprayed with hot process water. This generates a percolate solution, which is biogasified in a hybrid packed-bed low solids digester. Solid residue from the percolator is dewatered in a press; the filtrate liquid goes to the digester, while the cake is screened and the undersize fraction goes to aerobic composting. The products are biogas and compost.
Arrow Ecology	Anaerobic Digestion	Arrow Ecology has patented the ArrowBio process for anaerobic digestion of solid waste. The first preprocessing step consists of submerging the waste. The conversion feed resulting from this process goes into an acidogenic reactor for a brief time. The dissolved and suspended effluent from that reactor is led to a wastewater digester, of the UASB type (Upflow Anaerobic Sludge Blanket). Liquid effluent can be cleaned up to high quality irrigation water. The products are biogas and compost.
Canada Composting Inc. (BTA)	Anaerobic Digestion	CCI holds the exclusive license for the BTA process in Canada and the U.S. The BTA process is a solid waste AD process that was developed in Germany in the 1980's. Its particularities include the use of wet pulping to prepare the facility feed for anaerobic digestion. This converts the feed into slurry, which is pumped to the anaerobic digester. The latter is operated in the liquid phase; various digester designs are used. Generally, the digester effluent is dewatered, aerobically matured, and marketed as compost.
BRI	Gasification/ Fermentation	BRI gasifies MSW to produce synthesis gas, followed by fermentation of the synthesis gas to ethanol. Waste heat from the process is converted to steam and electricity. BRI has selected a two-stage gasifier that raises the syngas temperature to over 2000°F in the second stage to enable cracking of any heavy hydrocarbons to CO and H_2, maximizing ethanol yield. The hot gases are then cooled to 100°F and introduce into fermenter where ethanol is produced. Nutrients are added to provide for cell growth and automatic regeneration of the biocatalyst. A dilute, aqueous stream of ethanol is continuously removed through a membrane retain cells for recycle to maximize reaction rate.

2.4 SCREENING OF TECHNOLOGY SUPPLIERS

2.4.1 Screening Criteria

The following criteria were developed for the fatal flaw screening process:

1. **Incomplete Response** – Respondent did not respond directly to the questions in the questionnaire, or provided only sparse or general information on their basic technology, with no specific information related to the proposed system for Los Angeles County; Respondent provided no details or insufficient information on how they would develop an integrated conversion facility that incorporates the pre-processing, conversion unit, and products generation subsystems; respondent has experience on feedstocks other than MSW, and did not provide sufficient response to how the proposed facility would handle/treat MSW; Respondent's submittal had many technical and/or data errors.
2. **Only Generates RDF.** Respondent's technology provides only a physical change in the MSW, such as removal of recyclables, shredding and/or drying to produce a refuse-derived fuel (RDF) that would have to be utilized elsewhere, such as in an off-site boiler, as an alternative fuel or blended with coal or other fossil fuels.
3. **Only Generates Compost.** Respondent's technology only produces compost, with no utilization of biogas for power generation or other uses.
4. **No Pilot or Demonstration Units.** Respondent does not have any existing pilot or demonstration unit.
5. **Cost/Throughput is an Outlier.** Based on the economic information that the Respondent submitted (which may have been adjusted as part of the evaluation due to errors or incorrect assumptions), the capital cost of the proposed facility is >$100 million or the cost to treat/convert the MSW feed is >$300/ton of MSW. Due to the fact that the proposed facility would have a relatively small throughput, it will not likely be economical on a "per-ton" basis at these cost levels.
6. **Insufficient Cost Information.** Respondent did not provide capital and/or O&M cost information.

2.4.2 Screening Evaluation

The 28 respondents were evaluated on the basis of the fatal flaw screening criteria mentioned above. The respondents' submitted information was used for this screening process. Suppliers that failed one or more screening criteria were dropped from further evaluation. The suppliers that passed the screening criteria moved to the next step of the evaluation. Screening of conversion technology suppliers is shown in Table 2-4.

TABLE 2-4
SCREENING OF SUPPLIERS BY FATAL FLAW CRITERIA

Supplier	Incomplete Response	Only Generate RDF or Compost	No Pilot or Demonstration Units	Cost is an Outlier Capital cost is >$100 million or net cost is >$300/ton	Insufficient Cost Information
Changing World Technologies					
Conrad Industries	F				F
Ebara Corporation					
Geoplasma					
Global Energy Solutions	F				F
GEM America					
International Environmental Solutions					
Interstate Waste Technologies					
Molecular Waste Technologies	F				
Ntech Environmental					
Omnifuel Technologies	F		F		
Pan American Resources	F		F		
Plasma Environmental Technologies	F		F		F
Primenergy					
Rigel Resource Recovery and Conversion			F	F	
Taylor Recycling			F	F	
Green Energy Corporation					
WasteGen	F				
Arrow Ecology					
Wright Tech		F			
BRI Energy					
International Bio Recovery Corp. (IBR)	F	F			
Canada Composting Inc (CCI) BTA					
ABT-Haskell		F			F
HotRot		F			
Waste Recovery System (Valorga)					
Global Renewable (GR)					F
Organic Waste System (OWS)					

Note:
Blank cell = Technology Supplier Passed Fatal Flaw Criteria
F = Technology Supplier Failed Fatal Flaw Criteria

The explanation for the screening of conversion technology suppliers is shown in Table 2-5.

TABLE 2-5
EXPLANATION FOR SCREENING OF SUPPLIERS BASED ON FATAL FLAW CRITERIA

Supplier	Incomplete Response	Only Generate RDF or Compost	No Pilot or Demonstration Units	Cost is an Outlier >$100 million Capital or net cost >$300/ton	Insufficient Cost Information
Conrad Industries	Submittal provided general data on the technology treating tires, with little project-specific information No data on products and byproducts. Conrad states that equipment is provided by KleenAir Products; KleenAir brochure included did not show any pyrolysis equipment.				No cost data provided. Conrad stated, “we cannot calculate detailed and verifiable information asked for on Attachments 2 and 3.”
Global Energy Solutions	Submittal did not address questionnaire. Information related to general process and technology, and listed basic information on existing systems; nothing specific provided for the proposed project. Emission data (much of it illegible) provided for existing systems (some levels shown as above limits).				No cost data provided.
Molecular Waste Technologies	MWT provided a brief letter proposal and a brochure. Answers to questionnaire were vague and related to general technology discussion. Little to no information on the proposed facility. Throughput level was not specified. Very little pilot plant data on MSW. Process flow diagram was hand-drawn.				
Pan American Resources	Submittal contained general information with no specific responses to the questionnaire		No pilot or demonstration facilities.		

TABLE 2-5 (CONTINUED)
EXPLANATION FOR SCREENING OF SUPPLIERS BASED ON FATAL FLAW CRITERIA

Supplier	Incomplete Response	Only Generate RDF or Compost	No Pilot or Demonstration Units	Cost is an Outlier >$100 million Capital or net cost >$300/ton	Insufficient Cost Information
Omnifuel Technologies	Submittal was sparse, with many errors. Throughput data in one portion of the submittal did not match values shown in another portion, as much as a factor of 3. Submittal describes an extensive pre-processing system, treating MRF residuals; Omnifuel may not fully understand the feedstock, since much of their experience has been on industrial and wood wastes. Little understanding of overall facility integration.		No pilot or demonstration facilities. All operating have been shut down (mostly industrial wastes and wood waste).		
Plasma Environmental Technologies	Submittal was a 2-page letter with no technical or financial information.		No pilot or demonstration facilities.		No cost information was provided.
Rigel Resource Recovery and Conversion			No pilot or demonstration facilities using the proposed technology.	Capital cost of $800,000,000	
Taylor Recycling			Pilot and demonstration unit were shut down several years ago.	$348/ton	
WasteGen	Submittal was sparse. Much of data provided related to existing systems and a proposal for another project. Although WasteGen has significant, applicable experience, they were not particularly interested in developing a facility of this small size, since they have larger facilities already in operation.				

TABLE 2-5 (CONTINUED)
EXPLANATION FOR SCREENING OF SUPPLIERS BASED ON FATAL FLAW CRITERIA

Supplier	Incomplete Response	Only Generate RDF or Compost	No Pilot or Demonstration Units	Cost is an Outlier >$100 million Capital or net cost >$300/ton	Insufficient Cost Information
Wright Tech		Presents an aerobic in-vessel composting process, which is operated to minimize conversion but maximize drying (the Biodryer™ process, a drying process that does not rely on fossil fuels). The only product is refuse-derived fuel (RDF).			
ABT-Haskell		Presents an aerobic in-vessel composting process; its only product is compost.			Has selected to provide no cost or revenue information whatsoever "because of the proprietary nature of this information".
HotRot		Presents an aerobic in-vessel composting process; its only product is compost.			
Global Renewable					Has selected to provide no O& M cost and no revenue information
International Bio Recovery Corp. (IBR)	IBR presented an incomplete response based on an assumed feedstock composition that is fundamentally at odds with what is found at the MRFs in the county (e.g., IBR assumes 81% food waste and 5% bone and shell; total plastics is 2%, glass is 0.05%, metals 0.25%, etc.)	Presents an aerobic digestion process. This is not in-vessel composting, it occurs in slurry reactors. The output is a pelletized organic fertilizer and a liquid organic fertilizer marketed under the name Genica through an established network. These products are chemically similar to compost but not physically, so they occupy a different market niche.			

2.4.3 Screening Results

Results of the screening process showed that the following conversion technology suppliers failed one or more fatal flaw screening criteria and were excluded from further evaluation.

- Conrad Industries
- Global Energy Solution
- Molecular Waste Technologies
- Omnifuel Technologies
- Pan American Resources
- Plasma Environmental Technologies
- Rigel Resource Recovery and Conversion
- Wright Tech
- IBR Corporation
- ABT-Haskel
- Global Renewable (GR)
- HotRot
- Waste Gen
- Taylor Recycling

The following conversion technology suppliers passed the screening process and moved to the next step for further evaluation:

- Changing World Technologies — Thermal Depolymerization
- Ebara Corporation — Pyrolysis-Gasification
- Geoplasma — Plasma Gasification
- GEM America — Flash Pyrolysis
- International Environmental Solution — Pyrolysis
- Interstate Waste Technologies — Pyrolysis-Gasification
- Ntech Environmental — Gasification
- Primenergy — Gasification
- Green Energy Corporation — Steam Reforming Pyrolysis

• Arrow Ecology	Anaerobic Digestion
• BRI	Gasification/Fermentation
• Canada Composting Inc. (BTA)	Anaerobic Digestion
• Waste Recovery System (Valorga)	Anaerobic Digestion
• Organic Waste System (OWS)	Anaerobic Digestion

2.5 FURTHER EVALUATION AND RANKING OF TECHNOLOGY SUPPLIERS

A comparative evaluation was conducted for the technology suppliers that passed the screening process. Essential differences among technology suppliers and the main objective of this project were used to develop a set of ranking criteria. Conversion technology suppliers were ranked based upon technical and economic parameters. The results were used to identify a list of suitable technologies for consideration to develop a conversion facility demonstration project in Southern California.

2.5.1 Ranking Process

Ranking criteria were needed to evaluate the many conversion technologies represented by the suppliers. The process of developing these criteria consisted of the following steps:

1. Establish Ranking Criteria
2. Develop Performance Levels for each Criterion
3. Assign Ratings to each Performance Level
4. Assign Weights to the Criteria

Each of these steps is briefly discussed below.

2.5.1.1 Ranking Criteria

Ranking criteria were identified by considering the project objectives and subdividing them until specific, measurable criteria are found. By satisfying these criteria, the overall project objective is satisfied.

2.5.1.2 Performance Levels

Performance levels, or scales, must be developed for the criteria. These performance levels are shown on the criteria table, and derive from experience and the data supplied. However, the process to assign these levels involves looking at the criterion, comparing it with the overall objectives of the project, and determining the best and worst level based upon actual information about the technologies. Then intermediate levels are added as appropriate.

2.5.1.3 Ratings

Ratings are assigned to the performance levels to enable numeric scoring of the criteria. Certain rules are followed to make this process mathematically sound. For example, 100 points are assigned to the best performance level, and zero points to the worst level as a rule. Then the intermediate levels are assigned appropriate points based upon the relative position of the level with respect to the other levels.

2.5.1.4 Weights

Weights are assigned to the criteria based upon two issues: the intrinsic importance of the criterion (e.g., equipment scaling can introduce performance risk), and the range over which the criterion extends (i.e., if the range is wide, or there is a large difference between the lowest and highest level for the technologies, then the importance will be higher).

2.5.1.5 Scores

Finally, scores were calculated by multiplying the weights by the ratings and summing. The technology with the highest score is ranked number one and so forth. The group of technologies with the best scores will be advanced to the next step in the study.

2.5.2 Ranking of Technology Suppliers

The conversion technology suppliers that passed the screening process, moved to the next step for further evaluation. These technology suppliers were ranked according to the ranking criteria established for this project. This ranking is strictly based on information provided by the technology suppliers in the responses to questionnaire, and there was no independent verification of this information.

2.5.2.1 Ranking Criteria

The process for establishing ranking criteria included starting with the project objective and identifying criteria that would satisfy this objective.

We subdivided the overall objective of identifying a technology that can successfully process the residues from a MRF/TS facility into the following sub-objectives:

- Maximize Environmental Suitability
- Maximize Technical Performance
- Minimize Cost and Maximize Revenues

Environmental suitability is an important issue. However, at this early stage, there is insufficient environmental data regarding the technology designs to differentiate these designs among the alternatives. The only environmental criterion added at this point was Landfill Diversion, an indicator of the amount of residual that will still be landfilled. All of the technologies will be designed to meet the prevailing environmental regulations.

Technical performance, as an objective to maximize, was represented by several criteria:

- Equipment Scaling: if a design must be scaled up significantly in size, performance risks will be higher.
- Waste Suitability: if the technology supplier has limited experience with regard to processing MRF residuals, performance risk will be higher.
- Operational Experience: technology suppliers with a greater amount of experience operating their facilities will have lower performance risk.
- Engineering Design Experience: technology suppliers with more experience integrating the pre-processing system, conversion unit, and product generation systems will have less performance risk.

The objective of minimizing cost and maximizing the value of products generated was recognized as an important issue by including a criterion that addresses cost and revenues, as well as a criterion that addresses the capacity of the supplier to provide the necessary technical and financial resources to carry out a project for the Los Angeles County.

A brief description of the technology ranking criteria is listed in Table 2-6.

TABLE 2-6
BRIEF DESCRIPTIONS OF TECHNOLOGY SUPPLIER RANKING CRITERIA

Waste Suitability	Suppliers who have operating experience with MRF residuals or MSW will be ranked higher than suppliers who have processed other types of feedstocks similar to MRF residuals, such as biomass (e.g., green waste), plastics and tires. Lack of MSW processing experience introduces potential operational risks.
Need for Equipment Scaling to 100 TPD	When evaluating suppliers for a demonstration facility, many suppliers will have operating experience with systems far smaller than 100 TPD. Increasing throughput can be accomplished by designing larger modules or adding more modules. Designing larger modules introduces scaling risk.
Marketability of Conversion Products	We have defined a conversion facility to have the ability to convert MRF residuals to marketable products. Suppliers with products (e.g., electricity, ethanol, metals, compost, etc) that have existing strong market will score higher than those without market.
Engineering the Complete System	Some suppliers have expertise in only one technical area (e.g., preprocessing, conversion, or power production), while others have designed and built complete systems. Lack of expertise in one or more areas introduces design risks.
Existing Operational Experience	Suppliers with more operating experience will be ranked higher than those with less experience. More experience should result in smaller development risk.
Economics	The supplier must provide costs that are within reasonable ranges, and provide sufficient backup to understand the costs. Similarly, suppliers must demonstrate an understanding of product marketing. Suppliers that provide clear and reasonable costs and revenue projections will be rated higher.
Landfill Diversion	Suppliers who produce more marketable products, and thus less residuals, will be ranked higher. Larger amounts of residuals may lead to higher costs, and requires more landfill capacity.
Supplier Credibility	Suppliers must have organizations with the technical and financial resources to carry out design, construction and commissioning of a conversion facility. Suppliers with more resources will be rated higher.

TABLE 2-7
RANKING CRITERIA FOR TECHNOLOGY AND TECHNOLOGY SUPPLIER EVALUATION

Criterion	Attributes	Performance Levels	Ratings
Waste Suitability	Suitability is a function of the type of waste feedstock processing experience	1. Commercial experience with MRF Residuals or MSW	100
		2. Commercial experience with Refuse Derived Fuel (RDF)	75
		3. Pilot or demo scale experience with MRF residuals, MSW, or RDF	50
		4. Commercial experience with biomass (i.e., green waste)	25
		5. Experience with other wastes	0
Need to Scale Conversion Unit to 100 TPD Size	Scaling introduces potentially significant engineering hurdles	1. Scaling factor <=1	100
		2. Scaling factor >1, <=5	66
		3. Scaling factor >5, <=20	33
		4. Scaling >20X	0
Engineering the Complete System	Supplier/partner has experience/understanding, designing, and integrating entire system	1. Supplier/partner has designed/developed entire facilities/submitted designs complete	100
		2. Supplier/partner has developed only one facility, or has limited experience with one or more system components	75
		3. Technology has limited operational experience	50
		4. Lead firm has no development experience, but partners do	25
		5. Supplier/partner has not developed a complete system	0
Marketability of Conversion Products	Marketability of conversion products is desired	1. Electricity	100
		2. Electricity Plus Green Fuel (Ethanol, Others)	66
		3. Electricity Plus Compost	33
		4. No Products	0
Existing Operational Experience	What level of operating experience does the supplier have?	1. Multiple operating commercial units, >5 yrs	100
		2. One large operating facility, <1 year	75
		3. Small operating commercial unit, >1 yr	50
		4. Operating demonstration unit(s) or small commercial unit shut down	25
		5. Small pilot unit operating, or was operating	0

TABLE 2-7 (CONTINUED)
RANKING CRITERIA FOR TECHNOLOGY AND TECHNOLOGY SUPPLIER EVALUATION

Criterion	Attributes	Performance Levels	Ratings
Economics	Are the estimated costs and revenues within expected ranges? Are they substantiated?	1. Net costs are supported and are reasonable (between $20 - $100/ton)	100
		2. Net costs lack supporting and reasonable or supported and not reasonable	50
		3. Net cost are not supported and are not reasonable	0
Landfill Diversion	Percent by weight of feedstock sent to landfill	1. =< 10%	100
		2. 11-20%	66
		3. 21-40%	33
		4. >40%	0
Supplier Credibility	Suppliers must have organizations with sufficient technical and financial resources	1. Supplier organization has significant technical and financial resources	100
		2. Lead firm has few resources, but backed by other partners with significant resources	75
		3. Lead firm has limited resources, but backed by other firms with adequate resources	50
		4. Supplier has limited technical and financial resources, but has developed a small commercial unit or demo facility	25
		5. Supplier resources are limited, with no development record	0

2.5.2.2 Assignment of Performance Levels and Ratings

Using the data supplied, performance levels were developed, and appropriate ratings assigned to each performance level. The performance levels and ratings are shown in Table 2-7. Supporting data for this table can be found in Table A-6 in Appendix A.

2.5.2.3 Assignment of Weights

Weights were assigned to criteria by spreading a total of 100 points among the eight criteria. These weights were assigned by the members of the Los Angeles County Alternative Technology Subcommittee and averaged for each criterion.

The weight distribution is as follows:

1.	Waste Suitability	13
2.	Need to Scale Conversion Unit to 100 TPD Size	15
3.	Engineering the Complete System	12
4.	Marketability of Conversion products	13
5.	Existing Operation Experience	7
6.	Economics	12
7.	Landfill Diversion	17
8.	Supplier Credibility	11

The most critical criteria were judged to be Landfill Diversion, Need to Scale Conversion Unit to 100 TPD, Waste Suitability, and Marketability of Conversion Products. Economics, Engineering the Complete System, and Supplier Credibility also received relatively high weighting. These criteria related to the ability of the supplier to provide the resources necessary (both technical and financial) to implement this project in Southern California. Existing operational experience received the lowest weight because the Los Angeles County Alternative Technology Subcommittee did not want to exclude emerging conversion technologies from evaluation at this stage.

2.6 RESULTS

The results of the ranking process are presented in this section.

2.6.1 Scores

A performance level was assigned to the conversion technology suppliers for each criterion based on information received from suppliers in response to the questionnaire. A weight was assigned to each ranking criteria according to Section 2.5.2.3.

Ranking, assigned performance levels and their justification for each technology supplier are provided in Table A-6 of Appendix A.

The final scores for the conversion technology suppliers are shown in Table 2-8. The graphical results of the final scores are shown in Figure 2-1.

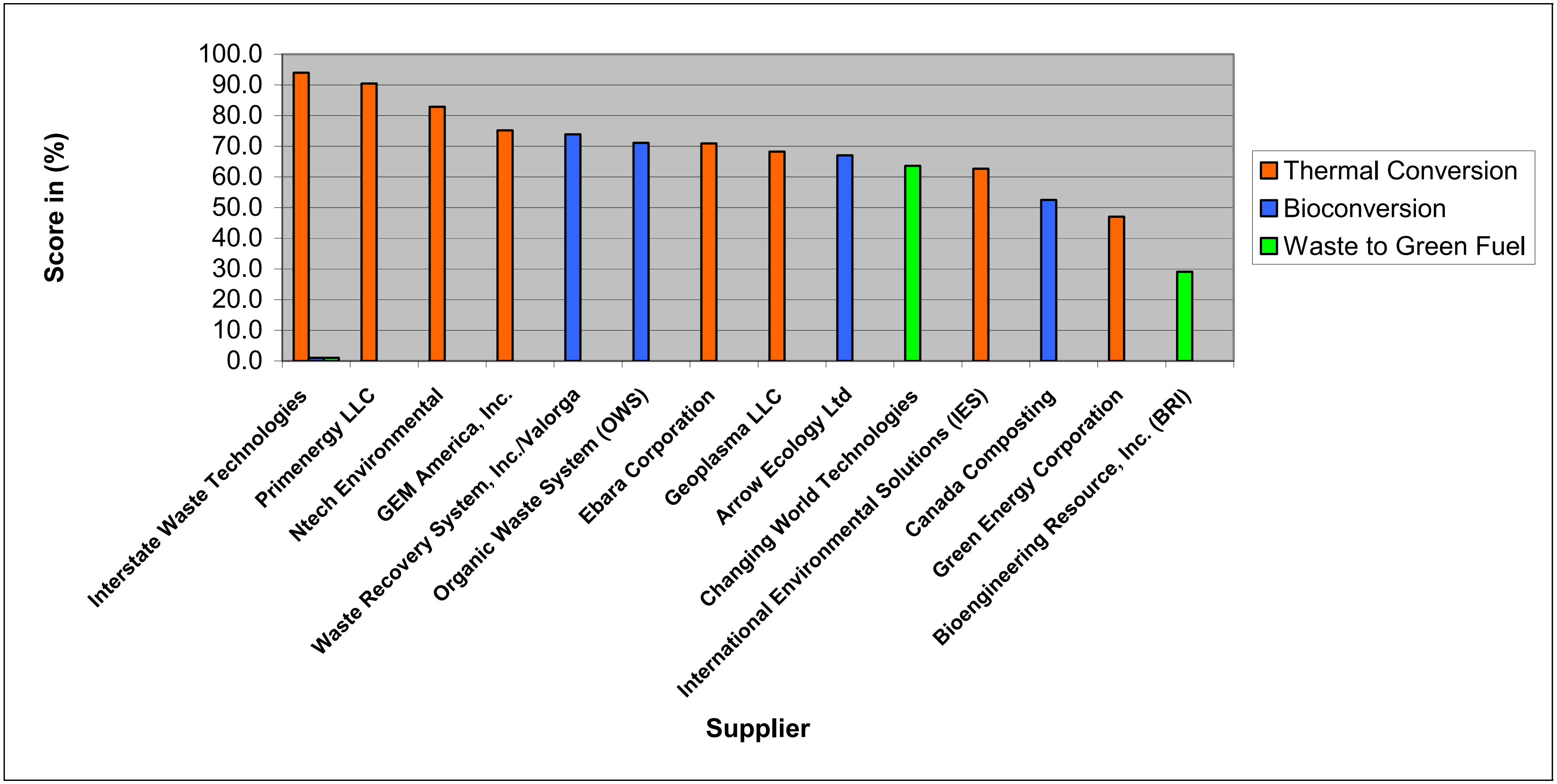
The following list shows conversion technology suppliers in order of their final scores received.

1. Interstate Waste Technologies
2. Primenergy LLC
3. Ntech Environmental
4. GEM America
5. Waste Recovery System (Valorga)
6. Organic Waste System (OWS)
7. Ebara Corporation
8. Geoplasma LLC
9. Arrow Ecology
10. Changing World Technologies
11. International Environmental Solutions
12. Canada Composting Inc. (BTA)
13. Green Energy Corporation
14. BRI

TABLE 2-8
SCORING OF THE CONVERSION TECHNOLOGY SUPPLIERS BY RANKING CRITERION

	Waste Suitability	Need to Scale to 100 TPD	Engineering the Complete System	Marketability of Conversion Products	Existing Operational Experience	Economics	Landfill Diversion	Supplier Credibility	Total Score
Weight	**13**	**15**	**12**	**13**	**7**	**12**	**17**	**11**	**100**
Interstate Waste Technologies	100	100	100	100	100	50	100	100	**94.0**
Primenergy LLC	50	100	75	100	100	100	100	100	**90.5**
Ntech Environmental	100	66	50	100	100	50	100	100	**82.9**
GEM America, Inc.	100	66	75	100	25	50	100	50	**75.2**
Waste Recovery System, Inc./Valorga	100	100	100	33	100	50	33	100	**73.9**
Organic Waste System (OWS)	100	100	100	33	100	50	33	75	**71.2**
Ebara Corporation	50	33	75	100	50	50	100	100	**71.0**
Geoplasma LLC	100	100	25	100	25	0	100	50	**68.3**
Arrow Ecology Ltd	100	66	100	33	75	50	33	100	**67.1**
Changing World Technologies	25	100	75	66	75	0	100	50	**63.6**
International Environmental Solutions (IES)	50	66	25	100	25	50	100	50	**62.7**
Canada Composting	25	100	100	33	100	0	0	100	**52.5**
Green Energy Corporation	50	0	0	100	25	50	100	25	**47.0**
Bioengineering Resource, Inc. (BRI)	50	0	0	66	0	0	66	25	**29.1**

FIGURE 2-1
SCORES OF CONVERSION TECHNOLOGY BY SUPPLIERS



2.6.2 Technical Comparison of Technologies

This section addresses a few important technical differences among the various technologies including:

- Gasification
- Pyrolysis
- Anaerobic Digestion
- Plasma Gasification
- Thermal Depolymerization

The fourteen suppliers on the "short-list" include thermal, and/or biological conversion technologies. These technologies produce different products, including:

- Syngas-to-electricity
- Biogas-to-electricity + compost or soil amendment
- Biodiesel + solid and liquid fertilizers
- Syngas-to-Ethanol or Biogas-to-Ethanol

The technologies represented on the short-list of suppliers have different levels of maturity in the marketplace. According to the final ranking scores established by this study, the technology suppliers were divided into the following three categories:

1. Technologies with ranking scores of 75% or higher
2. Technologies with ranking scores between 60% to 75%
3. Technologies with ranking scores of less than 60%

These categories are compared as follows:

1. The following conversion technology suppliers received final ranking scores of 75% or more:
   - Interstate Waste Technologies (Pyrolysis -Gasification)
   - Primenergy LLC (Gasification)
   - Ntech Environmental (Gasification)
   - GEM America (Flash Pyrolysis)

The technologies proposed by these suppliers are gasification and pyrolysis, which are the most mature technologies; there are many operating commercialized facilities using these technologies that process MSW in Europe and Japan.

A comparison of technical and operational characteristics of these technology suppliers is shown in Table 2-9.

2. Suppliers that received final ranking scores between 60% and 75% are:

- Geoplasma LLC (Plasma Gasification)
- Waste Recovery System (Valorga) (Anaerobic Digestion)
- Organic Waste System (OWS) (Anaerobic Digestion)
- Ebara Corporation (Pyrolysis-Gasification)
- Arrow Ecology (Anaerobic Digestion)
- Changing World Technologies (Thermal Depolymerization)
- International Environmental Solutions (Pyrolysis)

These supplier proposed technologies are: plasma gasification, anaerobic digestion, thermal depolymerization, and pyrolysis. Other than anaerobic digestion, these technologies are not as mature or commercialized at the same level as the first category.

TABLE 2-9
COMPARISON OF THE PREFERRED
CONVERSION TECHNOLOGY SUPPLIERS

Supplier	Advantages	Disadvantages
	Thermal Conversion	
The thermal conversion technologies that ranked higher are pyrolysis gasification, gasification, and flash pyrolysis. These conversion technologies are producing syngas as conversion products. Depending on the supplier design, the syngas can go through a quenching, cooling and cleaning process before combustion, or the syngas can be directly combusted to generate electricity. The following is a brief comparison of the thermal conversion technology suppliers. This comparison summarizes their advantages and disadvantages.		

TABLE 2-9 (CONTINUED) COMPARISON OF THE PREFERRED CONVERSION TECHNOLOGY SUPPLIERS

Supplier	Advantages	Disadvantages
Interstate Waste Technology (IWT) (Pyrolysis/ Gasification, Thermoselect)	1. The syngas produced by IWT gasification process is quenched-cooled and cleaned; it can then be combusted to generate electricity. The inorganic components are heated to >3,000 F, where they are converted to molten form. They flow into water bath and recovered as metals or slag aggregates, both of which are salable. 2. IWT has many years of experience processing MSW in Europe and Japan. IWT and its partners are large financially sound companies, which have implemented large projects worldwide.	1. IWT system capital cost, net cost and tipping fee are high. They suggest a 300-ton/day unit with a tipping fee of $186/ton. 2. IWT does not have operational experience in the USA.
Prime Energy LLC (Gasification)	1. Primenergy is part of Renewable Resource Alliances (RRA). Affiliates of RRA are CR&R, Community Recycling, Nexant Corporation (gasification technical support), Nixon Peabody (engineering contracting legal), CH2M Hill (engineering). RRA affiliates hold more than 30 municipal franchises for MSW; Community Recycling and CR&R are two large recycling facilities in California. Both are well capitalized and capable of obtaining financing for the project. 2. The RRA is USA based alliance and their experience is in the USA.	1. The syngas produced by Primenergy gasification process enters a hot gas cyclone, where solids and fly ash are removed. Bottom ash is removed from the bottom of the gasifier. The sygas is then combusted in a large combustion tube and the hot gases flow through a waste heat boiler for steam and power generation. The syngas is only partially cleaned before combustion. 2. Their primary experience is processing biomass. They have only tested MSW and RDF. 3. Primenergy has not designed, nor built a complete gasification and energy generation system processing MSW or MRF residue.
Ntech Environmental (Gasification)	1. Ntech Environmental has operational systems that process MSW. 2. Ntech Environmental and its partners have the credibility to successfully implement the project.	1. The syngas produced by Ntech system is immediately combusted to generate steam and electricity. 2. Ntech has operating units processing 67 tons/day. A 2X scale up is required to process 100 tons/day 3. Ntech has not designed a complete system to include power generation 4. Lack of backup for cost analysis. 5. No operational experience in the USA.

TABLE 2-9 (CONTINUED)
COMPARISON OF THE PREFERRED CONVERSION TECHNOLOGY SUPPLIERS

Supplier	Advantages	Disadvantages
GEM America (Flash Pyrolysis)	1. The syngas produced by GEM America system is going through a cleaning process and removal of chlorine and sulfur and then the clean syngas is used to generate electricity.	1. The GEM America system requires a specific feedstock. Shredding and drying may required. 2. It requires 1/16th in size and 8% moisture content. 3. The existing pilot plant has been shutdown for commercial reasons (not technical). It is waiting to restart. 4. No operational experience in the USA.
Ebara Corporation (Pyrolysis-Gasification)	1. The syngas produced by Ebara proposed system is cleaned and combusted in reciprocating engines 2. Ebara is a large engineering, environmental, construction and operation company with $1.8 billion per year in revenues	1. The hot flue gas from the char combustion section flows through a heat recovery boiler, where the steam is produced for the fluidizing process in the pyrolysis chamber. The cooled flue gas leaving the boiler passes through an air emission control system and then to a stack. 2. The Ebara Corporation proposed system is in pilot stage with one facility (4,950 tons/year capacity). 3. No operational experience in the USA.
Bioconversion		
Anaerobic digestion is ranked higher on the list of bioconversion technologies. It has essentially no air emissions. The conversion product is biogas that it can be processed and sold as industrial, commercial, or vehicular fuel. Also, anaerobic digestion generates a lot of solid matter, some of which can be processed into marketable compost. In the California market, it is unclear what amount of these solids can go to compost versus to the landfill (note that the landfilled material would be organically stabilized and usable as alternative daily cover). The following are advantages and disadvantages of anaerobic digestion suppliers.		
Waste Recovery Systems, Inc. Valorga (WRSI) (Anaerobic Digestion)	1. WRSI/Valorga has a proven technology and has built many commercial facilities since the 1980's. They have excellent operational records. 2. WRSI/Valorga has the financial and technical credibility to successfully implement the project. 3. WRSI/Valorga has Shaw-Emcon Group as a partner in the USA.	1. At this point, WRSI/Valorga indicates that 24% of the feed tonnage will go to the landfill, so the landfill diversion is only 76% (best case). 2. WRSI generates biogas plus compost. Marketing of the compost in California is questionable.
Organic Waste System (OWS) (Anaerobic Digestion)	1. OWS has technically sound process and operates large facilities processing MSW and MRF residue in Europe. 2. OWS has financial and technical credibility to successfully implement the project.	1. Landfill diversion is only 60%. 40% of the waste has to be disposed in a landfill. 2. OWS generates biogas plus compost. Marketing of the compost in California is questionable. 3. No operational experience in the USA.

3. Suppliers that received ranking scores of less than 60% are:

   - Green Energy Corporation (Steam Reforming Pyrolysis)
   - Canada Composting Inc. (BTA) (Anaerobic Digestion)

   BRI (Gasification-Fermentation)

   These suppliers are proposing technologies such as steam reforming pyrolysis and waste to green fuel, using MSW as feedstocks. These technologies are in the emerging category for processing MSW. The experience with these technologies is primarily at the pilot or demonstration stage.

To finalize the evaluation of technology suppliers, scoring was compiled by technology categories. The following pyrolysis and gasification technologies received ranking scores (more than 75%) greater than anaerobic digestion and other thermal technologies:

- Interstate Waste Technologies (Pyrolysis-Gasification)
- Primenergy LLC (Gasification)
- Ntech Environmental (Gasification)
- GEM America (Flash Pyrolysis)

These technologies are commercialized and have operating facilities. Other pyrolysis and gasification processes are in the pilot or testing stage and they ranked lower. They are:

- Ebara Corporation (Pyrolysis-Gasification)
- Geoplasma LLC (Plasma Gasification)
- International Environmental Solutions (Pyrolysis)

Ranking scores for pyrolysis-gasification, gasification, and pyrolysis are shown in Table 2-10.

TABLE 2-10
SCORING OF THE PYROLYSIS, GASIFICATION TECHNOLOGY SUPPLIERS BY RANKING CRITERIA

	Waste Suitability	Need to Scale to 100 TPD	Engineering the Complete System	Marketability of Conversion Products	Existing Operational Experience	Economics	Landfill Diversion	Supplier Credibility	Total Score
Weight	**13**	**15**	**12**	**13**	**7**	**12**	**17**	**11**	
Interstate Waste Technologies	100	100	100	100	100	50	100	100	**94.0**
Primenergy LLC	50	100	75	100	100	100	100	100	**90.5**
Ntech Environmental	100	66	50	100	100	50	100	100	**82.9**
GEM America, Inc.	100	66	75	100	25	50	100	50	**75.2**
Ebara Corporation	50	33	75	100	50	50	100	100	**71.0**
Geoplasma LLC	100	100	25	100	25	0	100	50	**68.3**
International Environmental Solutions (IES)	50	66	25	100	25	50	100	50	**62.7**
Green Energy Corporation	50	0	0	100	25	50	100	25	**47.0**

Ranking scores for anaerobic digestion technologies fall between 50 and 75%. These technology suppliers also have operating facilities processing MSW or biomass. They are:

- Waste Recovery System (Valorga)
- Organic Waste System (OWS)
- Arrow Ecology
- Canada Composting Inc. (BTA)

The ranking scores for anaerobic digestion suppliers are shown in Table 2-11.

TABLE 2-11
SCORING OF THE ANAEROBIC DIGESTION TECHNOLOGY SUPPLIERS BY RANKING CRITERIA

	Waste Suitability	Need to Scale to 100 TPD	Engineering the Complete System	Marketability of Conversion Products	Existing Operational Experience	Economics	Landfill Diversion	Supplier Credibility	Total Score
Weight	**13**	**15**	**12**	**13**	**7**	**12**	**17**	**11**	
Waste Recovery System, Inc./ Valorga	100	100	100	33	100	50	33	100	**73.9**
Organic Waste System (OWS)	100	100	100	33	100	50	33	75	**71.2**
Arrow Ecology Ltd	100	66	100	33	75	50	33	100	**67.1**
Canada Composting	25	100	100	33	100	0	0	100	**52.5**

Other emerging conversion technologies with green fuel production are ranked lower because they do not have substantiated data and/or long track records utilizing MSW as feedstock. They are:

- Changing World Technologies (Thermal Depolymerization)
- BRI (Gasification-Fermentation)

Ranking scores for the waste to green fuel conversion technologies are shown in Table 2-12.

TABLE 2-12
SCORING OF THE WASTE TO GREEN FUEL OR OTHER CONVERSION TECHNOLOGY SUPPLIERS BY RANKING CRITERION

	Waste Suitability	Need to Scale to 100 TPD	Engineering the Complete System	Marketability of Conversion Products	Existing Operational Experience	Economics	Landfill Diversion	Supplier Credibility	Total Score
Weight	**13**	**15**	**12**	**13**	**7**	**12**	**17**	**11**	
Changing World Technologies	25	100	75	66	75	0	100	50	**63.6**
Bioengineering Resource, Inc. (BRI)	50	0	0	66	0	0	66	25	**29.1**

2.6.3 Cost Summary of Conversion Technology Suppliers

The cost comparison of conversion technologies was made based on information provided by the suppliers. This information included the following items:

- Total capital cost
- Annualized capital cost
- Annual operation and maintenance (O&M) cost

In order to compare the economics for different technologies and suppliers, the following assumptions were made:

- Hauling and disposal of the final solid residue is $50 per ton.
- Power will be provided to the facility at $60 per Megawatt-hour.
- Operating and maintenance costs should be escalated at 3% per year.
- Buildings and site improvements are amortized at an annual interest rate of 6% over 20 years.
- All equipment are amortized at 6% over 7 years.
- Electricity generated by suppliers will be sold at $0.045 per kW-hour.

Table 2-13 shows the cost comparison of the conversion technology suppliers.

The graphical results for capital costs are shown in Figure 2-2.

The annual net costs (annual capital + annual O&M – annual revenue) are shown in Figure 2-3.

Annual revenue generated by conversion technology suppliers is shown in Figure 2-4.

It must be noted that the cost and revenue provided by the suppliers varied greatly. This large variation in the cost between suppliers resulted for the following reasons:

- Some suppliers did not follow the procedures provided by the questionnaire and did not submit clear and substantiated cost and revenue data.
- By requesting a demonstration-level facility size, cost for facilities that are commercial overseas became excessive because of lack of economies of scale. These costs will be much lower with higher throughput systems.
- Most of the “emerging technology” firms (those without commercial facilities) do not have strong cost and revenue data.

TABLE 2-13
COST COMPARISON OF CONVERSION TECHNOLOGY SUPPLIERS

	Throughput (TPD)	Capital Cost ($)	Annual Net Cost ($)	Annual Revenue ($)	Tipping Fee or Break Even Tipping Fee ($/Ton)
Interstate Waste Technologies	300	75,511,000	18,615,132	4,430,873	186.00
Primenergy LLC	100	15,500,000	3,072,100	1,067,900	87.00
Ntech Environmental	100	19,356,500	4,271,040	869,400	129.00
GEM America, Inc.	100	13,215,317	3,143,790	1,244,340	105.00
Waste Recovery System, Inc./Valorga	100	9,000,000	1,916,200	378,000	67.00
Organic Waste System (OWS)	100	23,600,000	4,925,000	660,000	197.00
Ebara	70	47,490,000	6,112,135	327,865	289.00
Geoplasma LLC	100	45,190,000	4,507,500	540,000	172.00
Changing World Technologies	100	15,000,000	136,192	5,136,848	4.00
Arrow Ecology Ltd	100	16,000,000	2,883,000	383,000	93.00
International Environmental Solution (IES)	147	23,225,500	3,297,594	3,004,282	61.00
Canada Composting	100	24,400,000	6,800,000	280,000	272.00
Green Energy Corporation	120	10,250,000	1,783,785	1,908,000	45.00
Bioengineering Resource, Inc. (BRI)	300	26,600,000	0	12,700,000	-49.00

*Some technology suppliers provided a tipping fee, while others did not. For those who did not provide tipping fee for MRF residue delivered to the conversion facility, a break even tipping fee was calculated by simply deducting annual revenue from annual cost and dividing the results by annual tonnage of residue processed by the facility.

FIGURE 2-2
CAPITAL COST BY SUPPLIER

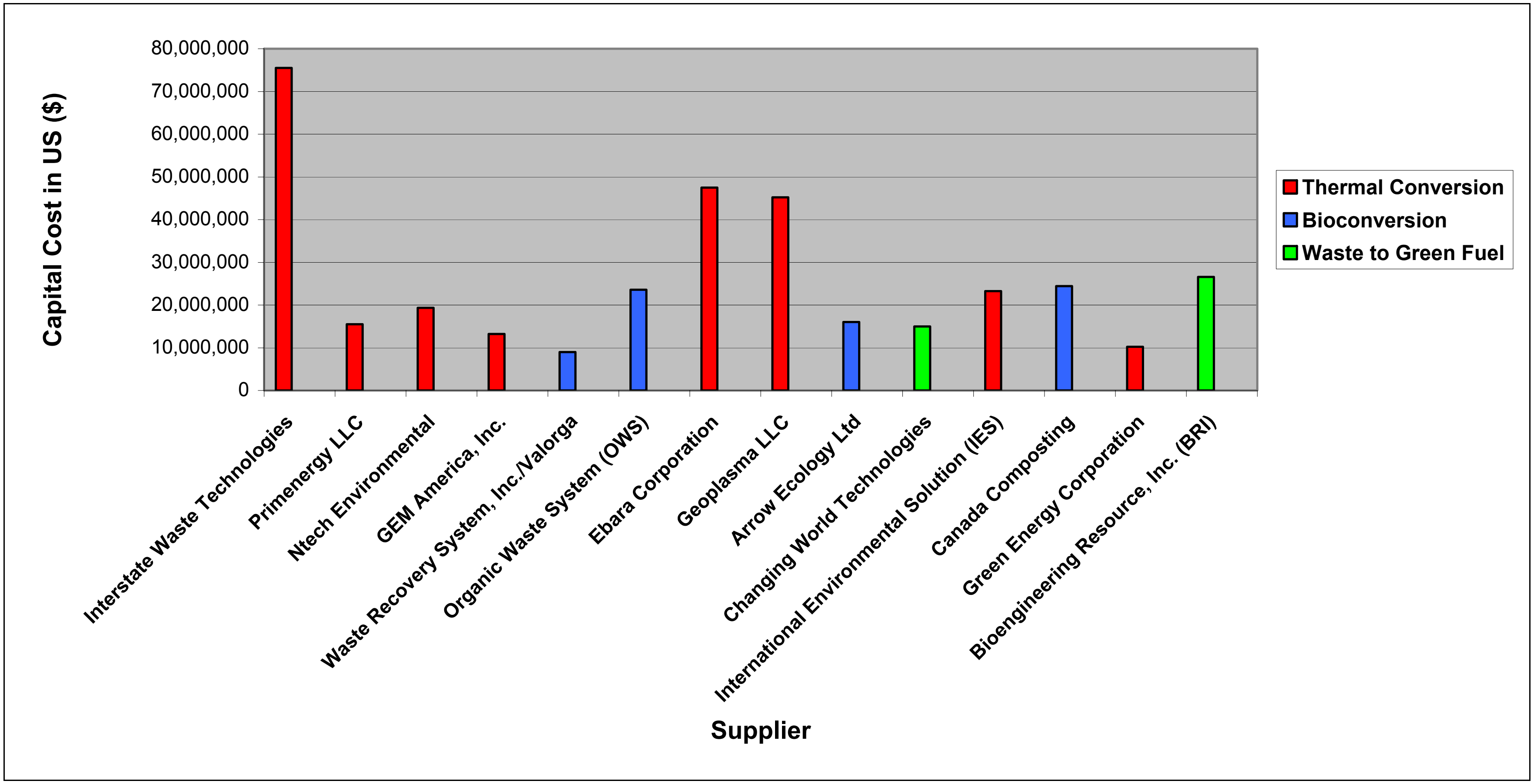


FIGURE 2-3
ANNUAL NET COST BY SUPPLIER

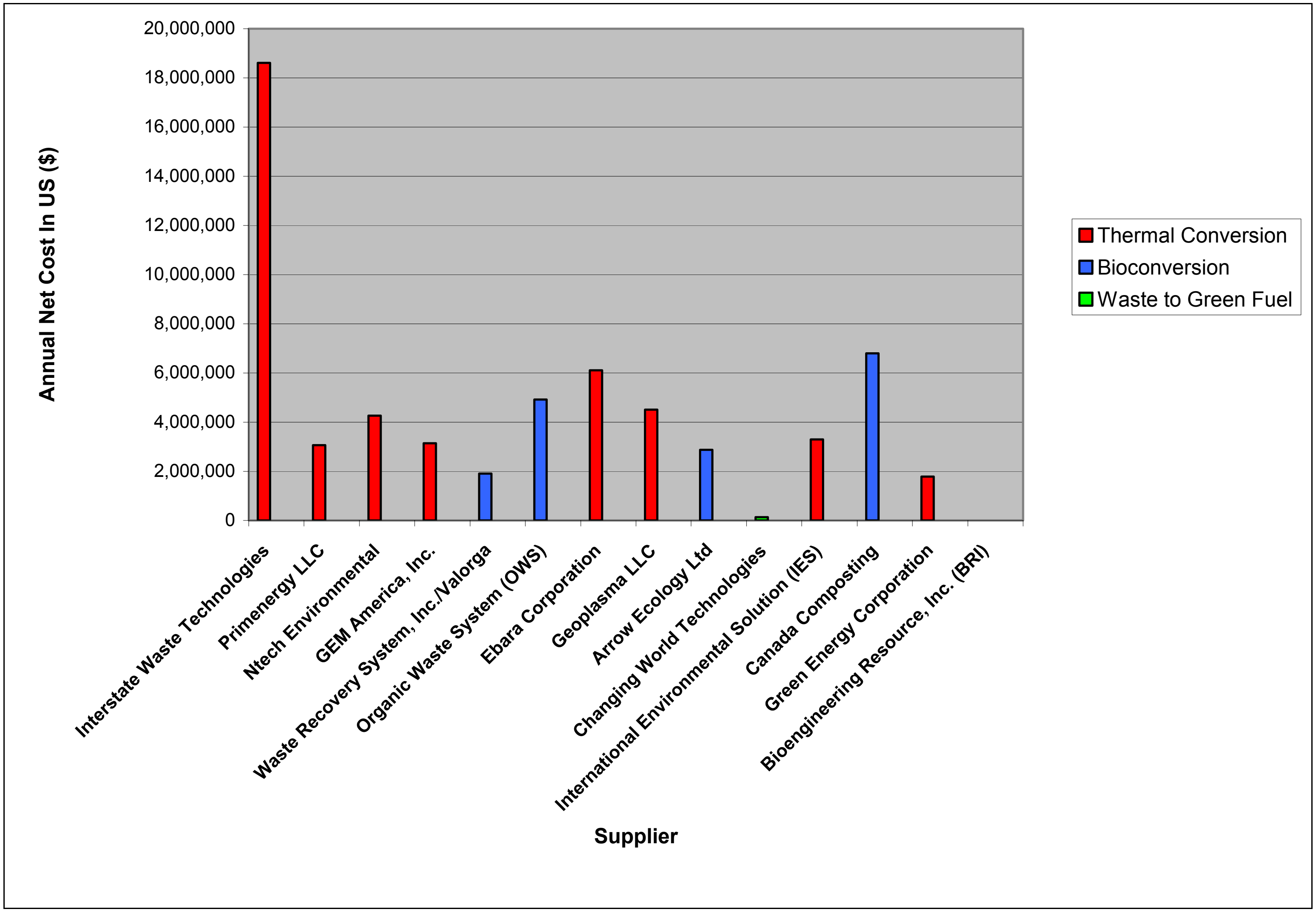
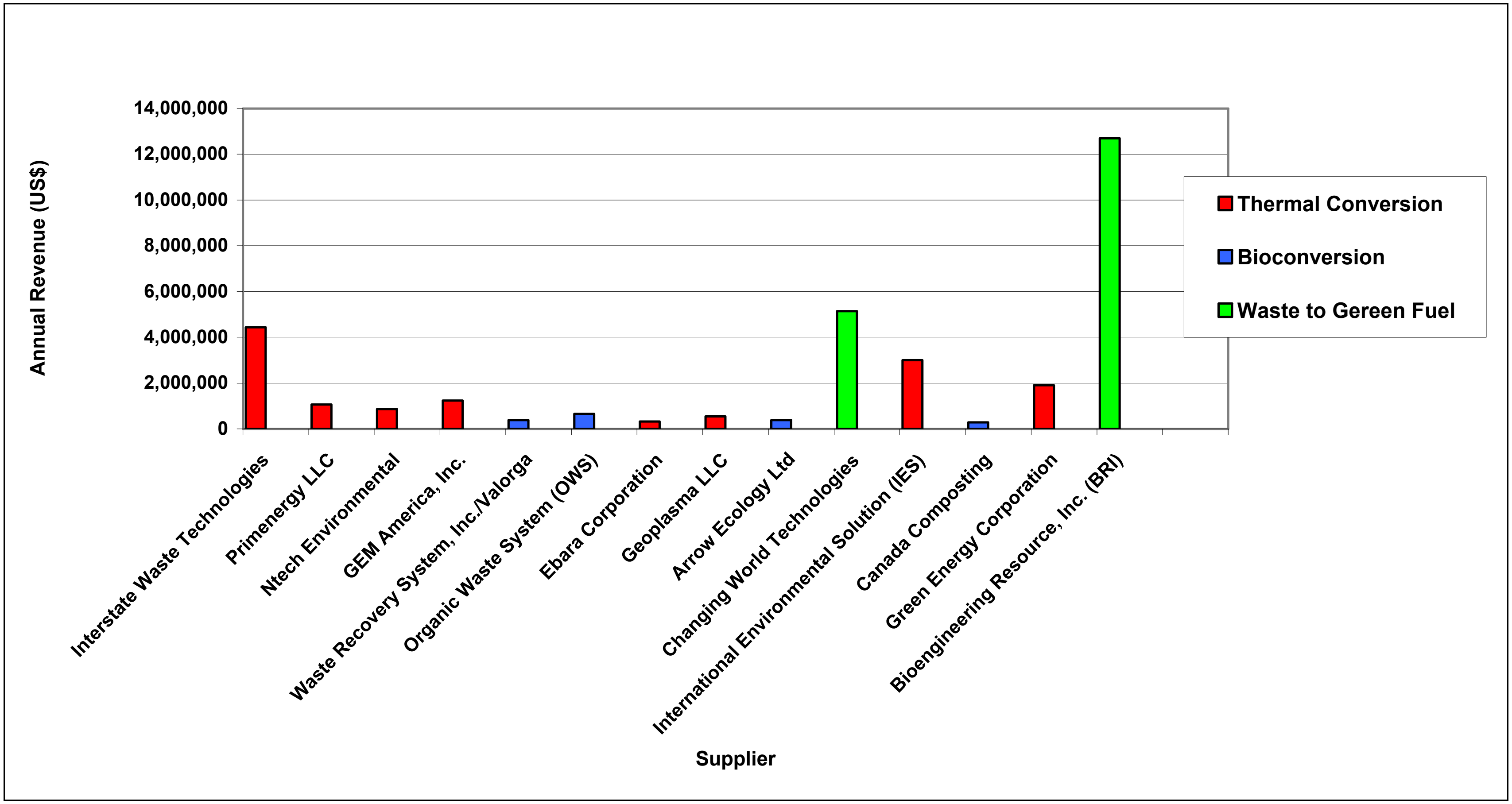


FIGURE 2-4
ANNUAL REVENUE BY SUPPLIER



Therefore, the costs for a demonstration facility should be evaluated in greater detail, along with a study of funding mechanisms and sources.

2.6.4 Conclusions

The top ranking technologies are pyrolysis-gasification, gasification, and pyrolysis. These technologies are well known, and have been widely used overseas for MSW processing. These technologies generate electricity as their primary product, and create only small quantities of residue. Four technology suppliers of this group ranked higher than any other technologies. These suppliers received total ranking scores of more than 75%. They are:

- Interstate Waste Technologies (IWT) – Pyrolysis/Gasification
- Primenergy LLC – Gasification
- Ntech Environmental – Gasification
- GEM America – Flash Pyrolysis

IWT, Ntech Environmental, and GEM America have operating facilities overseas. Primenergy has a facility in the United States processing rice hulls. Also, Primenergy has an alliance with CR&R MRF and Community Recycling and tested Refuse Derived Fuel (RDF).

The capital and operational costs for a demonstration facility using the Interstate Waste Technologies system are higher than other three pyrolysis and gasification technologies in this group ($186/ton processing 300 tons/day). However, IWT has many commercial operating facilities overseas processing MSW and submitted the most complete response to the questionnaire. Primenergy, Ntech Environmental, and GEM America costs are $87, $129, and $105 per ton respectively for processing 100 tons/day. These costs will be much lower with higher throughput in a commercial facility.

Other pyrolysis-gasification, plasma gasification, and pyrolysis suppliers ranked lower (47 to 75 %). These suppliers do not have commercial facilities processing MWS. They only have a pilot or test unit.

The second group of technologies includes anaerobic digestion. These technologies are also well known, and many facilities are operating overseas that process MSW or source separated organics. The primary product is compost, along with some electricity. A considerable quantity of residue is created that must be landfilled. In addition, the marketability of compost is uncertain and unpredictable. The following four suppliers from this group (all anaerobic digestion) are ranked between 50-75%:

- Waste Recovery System (Valorga)
- Organic Waste System (OWS)

- Arrow Ecology
- Canada Composting Inc. (BTA)

Despite second place in the ranking scores, anaerobic digestion was not recommended for the next phase of the process for the reasons provided in Section 4 of this Report.

The third group is waste to green fuel. This group of technologies includes thermal depolymerization and gasification with fermentation to ethanol. Although ethanol production from starch and sugar based material are commercialized processes, these technologies can be termed “emerging” since there are no commercial facilities processing MSW, and design data is limited. While these technologies demonstrate significant promise the development risk is substantial. The suppliers of these technologies are:

- Changing World Technologies (Thermal Depolymerization) – CWT has one operating demonstration/commercial facility using turkey waste as a feedstock.
- BRI (Gasification-Fermentation) – BRI has only a pilot facility.

If green fuel production becomes an objective of the proposed conversion facility, the syngas or biogas produced by the thermal or bioconversion technologies can be used to produce green fuel. In this case a combination of thermal, chemical and/or bioconversion technologies may be required, and such a combination can be evaluated in the next phase of this project.

The data presented in this report is preliminary, and subject to change when more detailed studies are conducted.

The main objective of this phase of the project is to evaluate Material Recovery Facilities and Transfer Stations (MRF/TSs) in Southern California and to find a MRF/TS that is willing to partner with conversion technology vendor, have adequate space, and can provide feedstock for a conversion facility. Partnership between a MRF/TS and conversion technology vendor will provide several advantages such as:

- Provide the processing capability of an existing MRF to produce the required composition of the feedstock for the conversion facility
- Reduce environmental impacts such as noise, odor, and traffic in comparison to a new facility
- Provide zoning and siting advantages for a conversion facility
- Provide financial incentive such as locating the facility in a Recycling Development Zone
- Make the permitting process easier compared to siting a new conversion facility
- Reduce overall project costs

URS evaluated Southern California MRF/TSs in order to identify MRF/TSs that are compatible for partnership with a conversion technology. The following procedure was followed to prepare a shortlist of MRF/TSs that exhibit the required features to facilitate a conversion system interface and be considered for further evaluation in this process:

- Prepare a long list of MRF/TSs
- Prepare and distribute a survey to identify interest in partnering with a conversion facility
- Identify a short list of MRF/TSs that are interested in partnering with a conversion facility
- Apply selection criteria to identify preferred MRF/TSs for continued evaluation

Each of these steps is described below.

3.1 EVALUATION OF MATERIAL RECOVERY FACILITIES AND TRANSFER STATIONS

3.1.1 Preparation of Long List of MRFs and Large TSs in Southern California

URS prepared a long list of MRFs and TSs in Southern California. The long list of MRF/TSs, which included 52 MRFs and TSs, was prepared using California Integrated Waste Management Board (CIWMB) database and Local Enforcement Agencies (LEA) data in Southern California. This list is presented in Table 3-1. Additional data about these facilities is shown in Table A-7 in Appendix A.

TABLE 3-1
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF)
AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Location County	Permitted Daily Throughput (tons/day)	Category	Operational Status
South Coast Recycling & Transfer Station	4430 Calle Real Santa Barbara, CA 93110	Santa Barbara	550	Transfer/ Processing	Active
Santa Ynez Valley Recycling & Transfer Station	4004 N. Foxen Canyon Road at Landfill Los Olivos, CA 93441	Santa Barbara	212	Transfer/ Processing	Active
MarBorg C and D Recycling/Transfer St.	119 North Quarantina Street Santa Barbara, CA 93101	Santa Barbara	750	Transfer/ Processing	Active
Tehachapi Recycling, Inc	416 North Dennison Road Tehachapi, CA 93561 Phone (661) 822-6421	Kern	850	Transfer/ Processing	Active
Mt. Vernon Metropolitan Recycling Center	2601 South Mt. Vernon Avenue Bakersfield, CA 93307	Kern	100	Transfer/ Processing	Active
Gold Coast Recycling Facility	5275 Colt Street Ventura, CA 93003	Ventura	440	Transfer/ Processing	Active
Del Norte Regional Recycling & Transfer	111 South Del Norte Blvd. Oxnard, CA 93030	Ventura	2779	Transfer/ Processing	Active
Santa Clarita MRF and Transfer Station	Proposed Site 26000 Springbrook Ave Santa Clarita, CA 91350	Los Angeles	1000	Transfer/ Processing	Planned
Rail Cycle Commerce Materials Recovery Facility	6300 E. 26th Street Commerce, CA 99999	Los Angeles	4200	Transfer/ Processing	Planned
Coastal Material Recovery Facility	357 W. Compton Blvd. Gardena, CA 90248	Los Angeles	500	Transfer/ Processing	Active
Angelus Western Paper Fibers, Inc.	2474 Porter Street Los Angeles, CA 90021	Los Angeles	650	Transfer/ Processing	Active
East Los Angeles Recycling and Transfer	1512 N. Bonnie Beach Place, City Terrace, CA 90063	Los Angeles	700	Transfer/ Processing	Active
Waste Management South Gate Transfer	4489 Ardine Street South Gate, CA 90280	Los Angeles	2000	Transfer/ Processing	Active
Athens Services	14048 E. Valley Blvd. Industry, CA 91746	Los Angeles	1920	Transfer/ Processing	Active
City Terrace Recycling Transfer Station	1525 Fishburn AvenueLos Angeles, CA 90063	Los Angeles	200	Transfer/ Processing	Active

TABLE 3-1 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Location County	Permitted Daily Throughput (tons/day)	Category	Operational Status
Puente Hills Materials Recovery	2800 Workman Mill Road, Whittier, CA 99999	Los Angeles	4400	Transfer/ Processing	Planned- Commence at the end of the year
Innovated Waste Control	4133 Bandini Blvd Vernon, CA 90023 Phone: (323) 264-0202	Los Angeles	1250	Transfer/ MRF	Active
Carson Transfer Station & MRF	321 West Francisco Street Carson, CA 90745	Los Angeles	5300	Transfer/ Processing	Active
American Waste Transfer	1449 W. Rosecrans Ave. Gardena, CA 90249	Los Angeles	2225	Transfer/ Processing	Active
South Gate Transfer	9530 Garfield Ave. South Gate, CA 90280	Los Angeles	1000	Transfer/ Processing	Active
Browing-Ferris Ind.	2509 W. Rosecrans Ave. Compton, CA 90220	Los Angeles	1500	Transfer/ Processing	Active
Culver City Transfer & Recycling Station	9255 W. Jefferson Blvd. Culver City, CA 90230	Los Angeles	500	Transfer/ Processing	Active
Downy Area Recycling and Transfer	9770 Washburn Road Downy, CA 90201	Los Angeles	5000	Transfer/ Processing	Active
Paramount Resources	7230 Patterson Lane Paramount, CA 90723	Los Angeles	1200	Transfer/ Processing	Active
Southern Cal. Disposal	1908 Frank Street Santa Monica, CA 90404	Los Angeles	1056	Transfer/ Processing	Active
Grand Central Recycling/Transfer	999 Hatcher Ave. Industry, CA 91744	Los Angeles	1500	Transfer/ Processing	Active
Bel-Art Waste	2501 East 68th Street Long Beach, CA 90805	Los Angeles	1500	Transfer/ Processing	Active
Community Recycling/Resource Recovery, Inc.	9147 De Garmo Ave. Sun Valley (In Los Angeles), CA 91352	City of Los Angeles	1700	Transfer/ Processing	Active
Central Los Angeles Recycling Center and Transfer Station	2201 Washington Blvd. Los Angeles (City), CA 90034	City of Los Angeles	1850	Transfer/ Processing	Active
Mission Road Recycling and Transfer Station	840 South Mission Road Los Angeles (City), CA 90023	City of Los Angeles	1500	Transfer/ Processing	Active

TABLE 3-1 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Location County	Permitted Daily Throughput (tons/day)	Category	Operational Status
West Valley Materials Recovery Facility	13373 Napa Street Fontana, CA 92335	San Bernardino	5000	Transfer/ Processing	Active
Victor Valley MRF & Transfer Station	NW Corner of Abby Lane & 'b' Street Victorville, CA 92307	San Bernardino	600	Transfer/ Processing	Active
Advance Disposal Transfer/ Processing Facility	17105 Mesa Street Hesperia, CA 92345	San Bernardino	600	Transfer/ Processing	Active
Inland Regional MRF & Transfer Station	2059 East Steel Road Colton, CA 92324	San Bernardino	1950	Transfer/ Processing	Active
Twentynine Palm Transfer Station	7501 Pinto Mountain Road Twentynine Palms, CA 92277	San Bernardino	200	Transfer/ Processing	Active
Big Bear Transfer Station	Holcomb Valley Road 1.5 Miles N of HWY 18 Big Bear City, CA 92314	San Bernardino	400	Transfer/ Processing	Active
Heap Peak Transfer Station	N Side of HWY 18; 3 Miles West of Running Springs Lake Arrowhead, CA 92407	San Bernardino	300	Transfer/ Processing	Active
Sheep Creek Transfer Station	10130 Buckwheat Road Phelan, CA 92371	San Bernardino	198	Transfer/ Processing	Active
Stanton Transfer and Recycling Center # 8	11232 Knott Ave. Stanton, CA 90680	Orange	1800	Transfer/ Processing	Active
Rainbow Recycling/ Transfer Station	17121 Nichols Ave. Huntington Beach, CA 92647	Orange	2800	Transfer/ Processing	Active
Consolidated Volume Transporters	1131 N. Blue Gum Street Anaheim, CA 92806	Orange	6000	Transfer/ Processing	Active
Sunset Envir Inc. Transfer Station/Resource Recovery Facility	16122 Construction Circle East Irvine, CA 92606	Orange	2050	Transfer/ Processing	Active
Waste Management of Orange/Transfer Station	2050 N. Glassell Street Orange, CA 92865	Orange	1500	Transfer/ Processing	Active
Moreno Valley Solid Waste Recycle & Transfer Facility	17700 Indian Street Moreno Valley, CA 92551	Riverside	2000	Transfer/ Processing	Active
Idyllwild Collection Station	28100 Saunders Meadow Road Idyllwild, CA 92549	Riverside	200	Transfer/ Processing	Active

TABLE 3-1 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Location County	Permitted Daily Throughput (tons/day)	Category	Operational Status
Robert A. Nelson (RANT) Transfer Station & MRF	1830 Agua Mansa Rd Rubidoux, CA 92509	Riverside	2700	Transfer/ Processing	Active
Perris Transfer Station and MRF	1706 Goetz Road Perris, CA 92570	Riverside	1800	Transfer/ Processing	Active
Escondido Resource Recovery	1044 W. Washington Avenue Escondido, CA 92033	San Diego	2500	Transfer/ Processing	Active
Ramona MRF And Transfer Station	324 Maple Street Ramona, CA 92065	San Diego	370	Transfer/ Processing	Active
Fallbrook Recycling Facility	550 W. Aviation Road Fallbrook, CA 92028	San Diego	500	Transfer/ Processing	Active
Edco Station	8152 Commercial Street La Mesa, CA 91942	San Diego	200	Transfer/ Processing	Active
Valley Environmental Services Recycling	702 East Heil Avenue El Centro, CA 92243	Imperial	200	Transfer/ Processing	Active

NA - Not Available

3.1.2 Prepare and Distribute a Survey

The County of Los Angeles Department of Public Works wrote a letter to each one of the facilities listed in Table 3-1 to introduce URS as County's contractor for the evaluation of the facility and to explain the purpose of this project. A copy of the County letter is included in this report Table A-8 in Appendix A. URS prepared a self-addressed stamped postcard with questions regarding the facility. The postcard included the following questions.

1. Are you interested in entering into partnership to develop a demonstration conversion facility to process residual feedstock that would otherwise be disposed?

   If yes, please specify the contact person (provide contact information).

2. Is space available at your facility to potentially develop a demonstration conversion technology operation?

   If yes, please specify facility name/address and maximum potential space available.

3. Additional Comments

The County introductory letter including URS' postcard with questions was sent to each of the 52 MRFs/TSs in Southern California. Follow up telephone calls were made to each facility to ensure that they received the letter and postcard.

3.1.3 Identify a Short List of MRF/TSs Interested in Conversion Facilities

URS received 13 positive responses from different MRF and large TSs in Southern California. These 13 MRF/TSs indicated that they are interested in conversion technology and may have space for a conversion demonstration facility. Table 3-2 shows the short list of MRF/TSs.

3.1.4 Select Preferred MRF/TSs

The process used to select the most appropriate of the remaining eleven MRF/TSs was the following:

- Develop selection criteria
- Collect data through letters and site visits
- Identify Preferred MRF/TSs

The selection criteria are shown in Table 3-3. These criteria represent the desired characteristics for MRF/TSs to be a satisfactory candidate for partnering with a conversion facility.

TABLE 3-2
SHORT LIST OF MRF/TS IN SOUTHERN CALIFORNIA INTERESTED IN CONVERSION FACILITY

Name	Location County	Operator/ Business Owner	Permitted Daily Throughput (Tons/Day)	Operational Type/ Pretreatment	Waste Type	Utility Availability
Mt. Vernon Metropolitan Recycling Center	Kern	Kern Refuse Inc. C/O 1501 Truxtun Avenue Bakersfield, CA 93301 Phone: (661) 326-3114	100	**MRF**	Construction/ demolition Mixed municipal	Water Gas Electricity Sewer Telephone
Gold Coast Recycling Facility	Ventura	Gold Coast Recycling Inc. 5275 Colt Street, Suite 2 Ventura, CA 93003 Phone: (805) 642-9236 Fax: (805) 642-9340	440	**MRF**	Mixed municipal	Water Gas Electricity Sewer Telephone
Del Norte Regional Recycling & Transfer	Ventura	BLT Enterprises of Oxnard, Inc. 511 Spectrum Circle Oxnard, CA 93030 Phone: (805) 278-8220	2779	**MRF**	Agricultural Construction/ demolition Industrial Mixed municipal	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes
Santa Clarita MRF and Transfer Station	Los Angeles	Burrtec Waste Industries, Inc. Eric Herbert 9890 Cherry Avenue Fontana, CA 92335 Phone: (909) 429-4200 Fax: (909) 355-7158	1000	**MRF**	Mixed municipal	Water Gas Electricity Sewer Telephone
Angelus Western Paper Fibers, Inc.	Los Angeles	Angelus Wester Paper Fibers, Inc. 2474 Porter Street Los Angeles, CA 90021 Phone: (213) 623-9221	650		Mixed Municipal	Water Gas Electricity Sewer Telephone

TABLE 3-2 (CONTINUED)
SHORT LIST OF MRF/TS IN SOUTHERN CALIFORNIA INTERESTED IN CONVERSION FACILITY

Name	Location County	Operator/ Business Owner	Permitted Daily Throughput (Tons/Day)	Operational Type/ Pretreatment	Waste Type	Utility Availability
Community Recycling/ Resource Recovery, Inc.	City of Los Angeles	Community Recycling and Resource Recover 9189 De Garmo Ave. Sun Valley, CA 91352 Phone: (818) 767-6000 Mr. John Richardson	1700	**MRF**	Commercial and Multifamily (Apartment/Condo) Mixed Municipal Waste	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes
Central Los Angeles Recycling Center and Transfer Station	City of Los Angeles	BLT Waste Systems of North America 2201 East Washington Blvd. Los Angeles, CA 90021 Phone: (213) 746-9700	1850		Construction/ demolition Industrial Mixed municipal	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes
West Valley Materials Recovery Facility	San Bernardino	West Valley Recycling and Transfer 9890 Cherry Avenue Fontana, CA 92335 Phone: NA	5000	**MRF**	Green Materials Mixed Municipal Wood Waste	Water Gas Electricity Sewer Telephone
Victor Valley MRF & Transfer Station	San Bernardino	Burrtec Waste Industries, Inc. 9890 Cherry Avenue Fontana, CA 92335 Phone: (909) 822-2396 Fax: (909) 355-7158	600	**MRF**	Mixed Municipal	Water Gas Electricity Sewer Telephone
Robert A. Nelson (RANT) Transfer Station & MRF	Riverside	Agua Mansa MRF, LLC 9890 Cherry Avenue Fontana, CA 92335 Phone: (909) 822-2397	2700	**MRF**	Mixed municipal	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes

TABLE 3-2 (CONTINUED)
SHORT LIST OF MRF/TS IN SOUTHERN CALIFORNIA INTERESTED IN CONVERSION FACILITY

Name	Location County	Operator/ Business Owner	Permitted Daily Throughput (Tons/Day)	Operational Type/ Pretreatment	Waste Type	Utility Availability
Perris Transfer Station and MRF	Riverside	CR&R Incorporated 11292 Western Avenue Stanton, CA 90680 Phone: (714) 826-9049	1800	**MRF**	Mixed municipal	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes
Edco Station	San Diego	Edco Disposal Corporation 6670 Federal Blvd Lemon Grove, CA 91945 Phone: (619) 287-3532	200	**MRF**	Construction/ demolition Green materials Industrial Mixed municipal	Water Gas Electricity Sewer Telephone
Valley Environmental Services Recycling	Imperial	Valley Environmental Services 3354 Dogwood Road Imperial, CA 92251 Phone: (760) 355-0004	200	**MRF**	Mixed municipal from the curb recycling with high percentage of residue	Water Gas Electricity Sewer Telephone

M-3 - Heavy Industrial Zone

TABLE 3-3
SELECTION CRITERIA FOR EVALUATION OF POTENTIAL FACILITY LOCATION

Criterion	Description
Ability and Willingness to Partner	Material Recovery Facility (MRF) or Transfer Station (TS) must have the ability (legal; financial etc.) and willingness to partner with conversion technology developer.
Availability of Adequate Space	MRF/TS must have adequate space adjacent to their facility to house a conversion technology facility.
Residual Quantity	MRF/TS must generate enough residue that is currently going to the landfill (TAD) to provide adequate feedstock for the conversion technology.
Residual Suitability	MRF/TS residue must have composition suitable to be used as feedstock for a conversion technology.
Pretreatment Capability	MRF/TS may have some pretreatment capabilities (sizing, sorting, etc.), which help the preparation of feedstock for conversion technology.
Flexibility in Residue Generation	MRF/TS may be designed/redesigned to generate a specific feedstock for a specific conversion technology.
Local Environmental Sensitivity	MRF/TS location (adjacent land use and zoning) must be suitable for development of conversion technology.
Utility Availability	MRF/TS must have adequate utility access including water, electricity, natural gas, and sewer.
Transportation Access	MRF/TS access to the rail or truck road, with consideration of traffic and land use along the road.
Site Specific Regulatory Issues	MRF/TS Site specific regulatory issues should not prevent the permitting of the conversion technology facility.
Financial Incentive	MRF/TS may have some financial incentive to develop conversion technology. For example recycling market development zone or partnership with other agencies or local governments.
Access to Local Market	MRF/TS may have access to local markets for products and byproducts of conversion technology. Steam, electricity, ethanol etc.

The next step was to collect data regarding these criteria so that the short list of MRF/TSs could be evaluated and preferred facilities identified. URS sent a letter to each short listed MRF requesting information related to the criteria in Table 3-3. A sample of URS' letter and the County letter sent to the short list of MRF/TSs is included in Appendix A. In addition, URS visited several MRF/TS facilities in Southern California to collect additional data.

If there were many facilities in the selection process, a formal ranking methodology, similar to that implemented to rank the technology suppliers would be used. However, because the list of MRF/TSs was short, a more informal selection process was applied.

When the data obtained from the short-listed facilities was compiled and evaluated, the following facilities satisfied the criteria and were identified as Preferred Facilities:

- Del Norte Regional Recycling and Transfer in the City of Oxnard
- Community Recycling/Resource Recovery, Inc in Sun Valley
- Central Los Angeles Recycling Center and Transfer Station in the City of Los Angeles
- Robert A. Nelson Transfer Station & MRF in Rubidoux (Riverside)

In addition, the Santa Clarita MRF/TS is planned to open in 2006 and they also indicated that they are very interested in a conversion facility and should be included in the short-list for a conversion technology demonstration facility. The Perris Transfer Station and MRF operated by CR&R is also very interested in conversion technology. Imperial County and San Diego County MRF/TSs were too small (200 tons/day incoming MSW), and therefore were not included in the final preferred list of MRFs/TSs.

Republic Services, Inc. and Burrtec Waste Industries, Inc., which operate the Del Norte Regional Recycling/Transfer Station and Robert A. Nelson Transfer Station & MRF, respectively indicated that these two MRF/TSs are the best for siting a conversion facility. However, they are operating many MRF/TSs in Southern California and willing to provide back-ups if these facilities are not satisfactory.

Table 3-4 shows data compiled for these facilities.

The composition of the MRF residue for four different MRFs in Southern California that are going to the landfill is provided in Figure 3-1. This composition was used as example for conversion technology evaluation.

The following is a brief description of the preferred Southern California MRF/TSs for development of a conversion facility.

3.2 PREFERRED MATERIAL RECOVERY FACILITIES

3.2.1 Del Norte Regional Recycling and Transfer Station in the City of Oxnard

Del Norte Regional Recycling and Transfer Station is located in 111 South Del Norte Boulevard, City of Oxnard (County of Ventura), California. The Facility is operating as a MRF and Transfer Station. The permitted daily throughput of this MRF/TS is 2,700 tons. The facility is accepting approximately 1,350 tons/day. The MRF and Transfer Station combined generate an average of approximately 890 tons/day residue.

TABLE 3-4
LIST OF PREFERRED MRF/TS IN SOUTHERN CALIFORNIA FOR POTENTIAL DEVELOPMENT OF CONVERSION FACILITY

Name/ Operational Status	Location County	Daily Throughput Permitted/ Actual (TPD)	Daily Residue Disposal (Tons/Day)	Availability of Residue Composition	Operational Waste/Type	Recycling Market Development Zone/Zoning	Utility Availability	Space Available	Remarks
Del Norte Regional Recycling & Transfer Active	Ventura	2700/1350	890 Average of 11 month.	Detail Waste and Residue Composition is Available	**MRF/** Agricultural Construction/ demolition Industrial Mixed municipal	**Yes/Industrial**	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes	**Yes.** **10 to 15 acres adjacent City owned space available** **Rail Access**	**Dr. Eugene Tseng is their consultant and very interested in conversion facility.** **URS visited the facility on December 7, 2004**
Santa Clarita MRF and Transfer Station Planned	Los Angeles	1000/NA	Not Available	Not Available	**MRF/** Mixed municipal	**Yes**	Water Gas Electricity Sewer Telephone	**Yes**	**This MRF is planned and will be built in 2005. They are very interested in conversion facility**

TABLE 3-4 (CONTINUED)
LIST OF PREFERRED MRF/TS IN SOUTHERN CALIFORNIA
FOR POTENTIAL DEVELOPMENT OF CONVERSION FACILITY

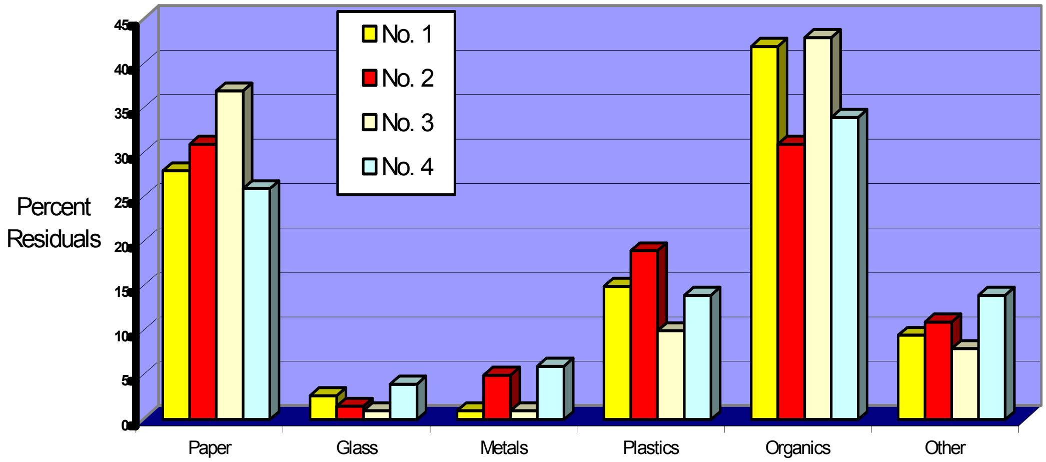
Name/ Operational Status	Location County	Daily Throughput Permitted/ Actual (TPD)	Daily Residue Disposal (Tons/Day)	Availability of Residue Composition	Operational Waste/Type	Recycling Market Development Zone/Zoning	Utility Availability	Space Available	Remarks
Community Recycling/ Resource Recovery, Inc. Active	City of Los Angeles	1700 (will be increased to 2400)/1500	1350	Not Available	**MRF/** Commercial and Multifamily (Apartment/ Condo) Mixed Municipal Waste	**Yes/M-3-G**	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes	**Yes- Approximately 3 acres of Land Available**	**URS visited the MRF on 11/16/04. They are very interested in conversion facility. Traffic congestion problem.**
Central Los Angeles Recycling Center and Transfer Station Active	City of Los Angeles	4025/3000	Approximately 3000. Only large Bulk items are separated.	This is the City of Los Angeles Black Bin waste supposedly with no recyclables. URS Performed an estimated and rough waste characterization in 2004.	**Transfer Station/** Construction/ demolition Industrial Mixed municipal	**Yes/M-3**	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes	**Yes. Have 9 acres on Washington Blvd Between Alameda and Santa Fe. Rail Access**	**URS visited the TS in October 2004. Los Angeles City owns the MRF. The City's Black Bin Waste (non recyclables) are transferred in this facility, which is going direct to the landfill.**

TABLE 3-4 (CONTINUED)
LIST OF PREFERRED MRF/TS IN SOUTHERN CALIFORNIA FOR POTENTIAL DEVELOPMENT OF CONVERSION FACILITY

Name/ Operational Status	Location County	Daily Throughput Permitted/ Actual (TPD)	Daily Residue Disposal (Tons/Day)	Availability of Residue Composition	Operational Waste/Type	Recycling Market Development Zone/Zoning	Utility Availability	Space Available	Remarks
Robert A. Nelson (RANT) Transfer Station & MRF Active	Riverside	2700/2300	2060	Not Available	**MRF/** Mixed municipal	**Yes**	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes	**Yes.** **5 acres of land is available beside the facility.**	**URS visited the MRF on 11/16/04. This is a Transfer Station and MRF. Very interested in conversion facility.**
Perris Transfer Station & MRF Active	Riverside	1800 (It will be expanded to 3600)/NA	Not Available	Not Available	**MRF/** Mixed municipal	**Yes**	Water Yes Gas Yes Electricity Yes Sewer Yes Telephone Yes	**Yes.** **MRF/TS comprising approximately 28 acres of land and 2 acres is reserved for conversion facility in the master plan.**	**This MRF will be undergoing an approximately $15 million redevelopment within one year.**

M-3 - Heavy Industrial Zone

FIGURE 3-1
EXAMPLES OF MRF RESIDUAL COMPOSITION



The MRF is located in an industrial zone in the City of Oxnard with a rail and truck road access to the facility. The MRF occupies approximately 27 acres, and the City of Oxnard owns approximately 10-15 acres of land adjacent to the property.

The MRF is owned by the City of Oxnard and operated by Republic Services, an example of Public-Private Partnership. They are very interested in conversion facility beside their MRF to process MRF residue.

3.2.2 Community Recycling/Resource Recovery, Inc. in Sun Valley

Community Recycling/Resource Recovery Inc. is located at 9147 De Garmo Ave, Sun Valley, California 91352. The permitted daily throughput of this MRF is 1,700 tons/day. At the present time it processes approximately 1,500 tons/day of MSW. Approximately 1,350 tons/day residue is going to the landfill from this facility. Community Recycling operates one of the largest composting facilities in California utilizing municipal green and food waste and it is also one of the largest C&D recyclers with a daily operating capacity of 2000 tons/day. A detailed waste characterization and composition of the MRF residue is not available. This MRF is very interested in developing a conversion system adjacent to their facility. They have approximately 3 acres of land adjacent to their facility, which at this time is used to process woodchip and green waste. This land would be made available for a conversion facility. Also, in addition to this, they have 3 acres of land across the street from the MRF facility. The traffic is very congested in the streets around the facility. The zoning of this facility is heavy industrial M-3-G according to their operators.

3.2.3 Central Los Angeles Recycling Center and Transfer Station

Central Los Angeles Recycling Center and Transfer Station located at 2201 Washington Boulevard in the City of Los Angeles, California 90034. This transfer station was operated by BLT until 2004. In 2004 the City of Los Angeles took over the operation of this facility. The City of Los Angeles black bin waste is coming to this facility (the City of Los Angeles provides its residents three bins. A blue bin is used for all recyclable items, green bins for all green waste and black bins for the remainder of MSW going to a transfer station. A very preliminary and rough waste characterization was performed by URS in 2004, which is included in Attachment 3. Daily permitted throughput for this facility is 4,025 ton/day. At the present time the facility receives approximately 3,000 ton/day. All 3,000 tons/day is going directly to the landfill because this facility is operating as a transfer station only. There is some equipment for material recovery but according to BLT operators this facility never operated as a MRF. The TS is located in a heavy industrial zone with approximately 9 acres of land available adjacent to this TS.

3.2.4 Robert A. Nelson Transfer Station and MRF (RANT)

The Robert A. Nelson Transfer Station and MRF is located at 1830 Aqua Mansa Road, Rubidoux, CA 92509 in the County of Riverside. Burrtec Waste Industries, Inc. operates the MRF. This MRF is permitted for 2,700 tons/day and receiving approximately 2,700 tons/day MSW. The amount of residue generated by this MRF and going to the landfill is approximately 2,060 tons/day. Part of the MRF is operating for material recovery and part is operating only as transfer station. This MRF is located in the Recycling Market Development Zone in a heavy industrial City zoning area. The land use surrounding this facility is suitable for a conversion facility and there are undeveloped land available adjacent to the MRF to locate a conversion facility.

3.2.5 Perris MRF/TS

The Perris Transfer Station and MRF is located in 1706 Goetz Road Perris, California 92570 in the County of Riverside and operated by CR&R. The daily permitted throughput of this facility is 1,800 tons/day, which will be expanded to 3,600 tons/day. This facility is going through $15 million renovation and CR&R Incorporated is in the process of designing a new state-of-the-art mixed MRF at Perris facility, which will be capable of producing an engineered fuel for gasification. CR&R already reserved 3 acres of land beside the MRF in the master plan for a conversion facility. CR&R is also very interested in conversion technology for processing its residue currently going to the landfill.

3.2.6 Santa Clarita MRF/TS

The Santa Clarita MRF/TS is planned to open in 2006. The proposed site for this MRF/TS is 26000 Springbrook Ave. Santa Clarita, California 91350. This location is in dispute at this time because of Rail Road crossing. The permitted throughput of this planned MRF/TS is 1,000 tons/day. Burrtec Waste Industries is designing this facility for the City of Santa Clarita. They also indicated that they are very interested in a conversion facility regardless of the location of this MRF because they are planning to have adequate space adjacent to it for a conversion facility and should be included in the short-list for a conversion technology demonstration facility. The Alternative Technology Advisory Subcommittee decided that the Del Norte, Robert A. Nelson and Perris MRF/TSs would be preferred for the first phase of the project.

4.1 INTRODUCTION

The Alternative Technology Advisory Subcommittee's goal is to develop a conversion technology demonstration facility in partnership with a Materials Recovery Facility and Transfer Station (MRF/TS) in Southern California. The main purpose of this phase of the project is to find the most suitable combinations of MRF/TSs and conversion technologies that can process the residue from the MRF/TS currently going to landfill. In order to evaluate the most suitable combinations, first MRF/TSs of Southern California were evaluated and a short list of MRF/TSs was established. Also, conversion technology suppliers were evaluated to identify suitable conversion technologies. The most suitable combinations of MRF/TSs and conversion technology are evaluated in this section.

4.2 PREFERRED MRF/TS

As discussed in previous sections, all MRF/TSs of Southern California were evaluated in order to find the most suitable MRF/TS that has the ability and willingness to partner with a conversion technology supplier. These MRF/TSs should be able to provide the following:

- Produce the required quantity and composition of the feedstock for a conversion facility
- Reduce environmental impacts such as noise, odor, and traffic in comparison to a new conversion facility
- Provide zoning and siting advantages for a conversion facility
- Provide synergies, such as the ability to provide the required feedstock quality so that preprocessing costs for the conversion facility can be avoided
- Provide financial incentive such as locating the facility in a Recycling Development Zone
- Willingness to create a partnership with a conversion technology supplier

A detailed evaluation of the Southern Californian MRF/TSs is provided in the MRF evaluation of Southern California section of this study. The MRF evaluation was based on a survey conducted by URS Corporation and site visits by the Los Angeles County Alternative Technology Subcommittee members to the selected MRF. The following MRFs made to the shortlist of preferred MRF/TSs to be considered for a conversion technology demonstration facility:

- Del Norte Regional Recycling and Transfer Station (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS (Riverside County)
- Santa Clarita MRF/TS (Planned MRF)

- Community Recycling/Resource Recovery, Inc. in Sun Valley (City of Los Angeles)
- Central Los Angeles Recycling Center and Transfer Station (City of Los Angeles)

Preferred MRF/TS information summary is provided in Table 4-1.

4.3 PREFERRED TECHNOLOGIES

Conversion technologies and their capabilities are described in Section 1.0 of this report. Conversion technology suppliers were screened and ranked by issuing a questionnaire to the suppliers and evaluating their responses to the questionnaire. The detailed description of screening and ranking of the technology and technology suppliers are described in Section 2.0. Preferred technologies were identified using the following general criteria:

- The technology must have the capability to process MRF/TS residue.
- The technology must divert at least 50 percent of the waste stream.
- The technology must be capable of processing 100 tons/day in a demonstration project.
- Costs and revenues must be "reasonable" for a demonstration project.

Based on the information received from the technology suppliers, the following technologies were selected to be considered by the County for development of conversion technology demonstration facility:

- Thermal Conversion:
    - Pyrolysis/gasification
    - Gasification
    - Plasma gasification
    - Thermal depolymerization
    - Pyrolysis including flash pyrolysis and steam reforming pyrolysis
- Biological/Chemical Conversion:
    - Anaerobic digestion
    - Gasification with fermentation to ethanol

TABLE 4-1
PREFERRED MATERIAL RECOVERY FACILITIES INFORMATION SUMMARY

MRF	Acres Available	Information
Del Norte Regional Recycling and Transfer Station	10-15 acres	Del Norte is located in the City of Oxnard County of Ventura, California. The facility is operating as a MRF and Transfer Station. The permitted daily throughput of this MRF/TS is 2,700 tons. The facility is accepting approximately 1,350 tons/day. The MRF and Transfer Station combined generate an average of approximately 890 tons/day residue. A detailed waste characterization for this facility is available. This MRF is located in the Recycling Market Development Zone and in a heavy industrial zone in Ventura County with a rail and truck road access to the facility. This MRF is occupying approximately 27 acres. The Subcommittee members visited this MRF as part of the evaluation.
The Robert A. Nelson (RANT) Transfer Station and MRF	3 – 5 acres	RANT is located in the County of Riverside. Burrtec Waste Industries, Inc. operates the MRF. This MRF is permitted for 2,700 tons/day and receiving approximately 2,700 tons/day MSW. The amount of residue generated by this MRF and going to the landfill is approximately 2060 tons/day. Part of the MRF is operating as a MRF and part is operating only as a transfer station. A detailed waste characterization and composition of the MRF residue for this facility is not available. This MRF is located in the Recycling Market Development Zone in a heavy industrial City zoning area. The land use surrounding this facility is suitable for a conversion facility and there are undeveloped land available adjacent to the MRF to locate a conversion facility. The Subcommittee members visited this MRF as part of the evaluation.
Perris Transfer Station and MRF	3 acres	Perris TS and MRF is located in the County of Riverside and operated by CR&R. The daily permitted throughput of this facility is 1800 tons/day, which will be expanded to 3600 tons/day. This facility is going through $15 million renovation and CR&R Incorporated is in the process of designing a new state-of-the-art mixed MRF at Perris facility, which will be capable of producing an engineered fuel for gasification. CR&R already reserved 3 acres of land beside the MRF in the master plan for a conversion facility. A detailed waste characterization and composition of the MRF residue for this facility is not available. This MRF is located in the Recycling Market Development Zone and heavy industrial City zoning area. CR&R is also part of Renewable Resource Alliance (RRA), which is a partnership between Primenergy, CR&R, and Community Recycling. This partnership is trying to develop a conversion facility in Southern California Mr. Paul Relis a principal of CR&R made a presentation at the Subcommittee meeting discussing their efforts for conversion facility development processing MRF residue at the Perris facility.

TABLE 4-1 (CONTINUED)
PREFERRED MATERIAL RECOVERY FACILITIES INFORMATION SUMMARY

MRF	Acres Available	Information
Community Recycling/ Resource Recovery Inc.	3 acres	Community Recycling is located in Sun Valley, California. Approximately 1,350 tons/day residue is going to the landfill from this facility. Community Recycling operates one of the largest composting facilities in California utilizing municipal green and food waste. This MRF is very interested in developing a conversion system adjacent to their facility. They have approximately 3 acres of land adjacent to their facility, which at this time is used to process woodchip and green waste. This land would be made available for a conversion facility. Also, in addition to this, the facility has 3 acres of land across the street from the MRF facility. A detailed waste characterization and composition of the MRF residue for this facility is not available. The traffic is congested in the streets around this facility. This MRF is located in the Recycling Market Development Zone in a heavy industrial (M-3-G) zone according to the operators. This facility is part of Renewable Resource Alliance, which is a partnership between Primenergy, CR&R, and Community Recycling. This facility indicated that they will help financially for a conversion facility development. The Subcommittee members visited this MRF as part of the evaluation.
Central Los Angeles Recycling Center and Transfer Station	9 acres (Questionable)	Central LA Transfer Station is located in the center of Los Angeles. This transfer station was operated by BLT until 2004. In 2004 the City of Los Angeles took over the operation of this facility. This facility is a transfer station for the City of Los Angeles black bin waste. Daily permitted throughput for this facility is 4,025 ton/day and at the present time the facility receives approximately 3,000 ton/day. All 3,000 tons/day is going directly to the landfill. A very preliminary and rough waste characterization was performed by URS in 2004. The TS is located in a heavy industrial zone with approximately 9 acres of land available adjacent to this TS. The long-term availability of this land is questionable. The City of Los Angeles (the operator of this facility) is also exploring options for alternative waste disposal facility.
The Santa Clarita MRF/TS	Planned	Santa Clarita MRF/TS is planned to open in 2006. The proposed site for this MRF/TS is 26000 Springbrook Ave. Santa Clarita, California 91350. This location is in dispute at this time because of Rail Road crossing. The permitted throughput of this planned MRF/TS is 1000 tons/day. Burrtec Waste Industries is designing this facility for the City of Santa Clarita. The City of Santa Clarita also indicated that they are very interested in a conversion facility regardless of the location of this MRF because they are planning to have adequate space adjacent to it for a conversion facility. Therefore, the facility should be included in the short-list for a conversion technology demonstration facility.

4.4 TECHNOLOGY/MRF COMBINATIONS

4.4.1 Thermal Conversion/MRF Combinations

Thermal conversion technologies were evaluated for the development of a conversion facility in Southern California with combination of a MRF. The following issues were considered for the thermal conversion and MRF combinations:

- Waste suitability
- Feedstock availability
- Preprocessing needs
- Space availability
- Environmental compatibility
- Infrastructure availability

4.4.1.1 Waste Suitability

Although a detailed and comprehensive waste characterization for the MRF residue was not available at this time, the available waste characterization data were used to evaluate the application of thermal conversion technologies. All thermal technologies evaluated in this study that made the shortlist are capable to treat carbon-based portion of the MRF residue.

The Perris MRF, which is owned and operated by CR&R is going through an extensive renovation. The Santa Clarita MRF/TS is planned and will be designed by Burrtec Industries. These two MRFs can be designed to generate a specific feedstock suitable for a thermal conversion unit. Also, each of the other four Southern Californian MRFs in the shortlist indicated that they are flexible enough to generate feedstock for a thermal conversion facility; therefore a combination of thermal conversion technology and MRF does not have a limitation on the basis of feedstock suitability.

4.4.1.2 Feedstock Availability

The Los Angeles County Alternative Technology Subcommittee is planning to develop a conversion technology demonstration facility adjacent to a MRF/TS in Southern California. This demonstration facility will process at a minimum of 100 tons/day MRF residue. All six MRF/TSs in the shortlist can generate at least 100 tons/day of residue.

4.4.1.3 Preprocessing

Thermal conversion technologies require specific preprocessing of MSW waste before processing in a conversion unit, such as size reduction, moisture content etc. MRF residue is going through resource recovery, but not necessarily preprocessing. The MRF residue may require additional equipment and processing to be prepared for treatment in a conversion unit. The Perris MRF operated by CR&R is undergoing an extensive renovation and Santa Clarita MRF/TS is planned by Burrtec Industries. Both MRFs can be designed to produce feedstock for a specific thermal conversion unit. The other four existing MRF facilities on the shortlist are willing to make changes to generate the specific feedstock for a thermal facility.

4.4.1.4 Space Availability

Thermal technologies evaluated in this study require 1-3 acres of land adjacent to the MRF facilities. The Perris MRF is going through a renovation and they indicated that they reserved 3 acres in the master plan for a conversion facility. The planned Santa Clarita MRF also will have enough space for a conversion facility. The four existing MRFs have space available for the development of a conversion facility.

4.4.1.5 Infrastructure Availability

Developing a conversion facility at a MRF/TS location will require additional infrastructure, such as electricity interconnect, water supply, sewer, and transportation access. The short-listed MRF/TS facilities are located in industrial areas that should have sufficient infrastructure to support a conversion facility.

4.4.1.6 Environmental Compatibility

Environmental and regulatory issues relating to developing a conversion facility at one of the short-listed MRF/TSs are discussed in the Siting Plan.

4.4.2 Biological/Chemical Conversion/MRF Combinations

Biological conversion technologies were also evaluated using the technology supplier's response to the questionnaire and MRF/TS evaluation. The same issues that were evaluated for thermal technologies were used to analyze the biological technology/MRF combinations.

4.4.2.1 Waste Suitability

4.4.2.1.1 Anaerobic Digestion (AD). AD is using only the biodegradable portion of the MRF residue to generate biogas and compost or soil amendment material. Very extensive material preprocessing is required to generate the consistent composition of feedstock for AD units. The MRF residue may have to undergo another round of processing before it can be utilized by AD facility.

4.4.2.1.2 <u>Gasification with Ethanol Fermentation</u>. In this technology the carbon-based portion of MRF residue (including plastic) is treated in a gasifier to generate syngas. The syngas is fermented to produce ethanol.

Most MRF facilities prefer gasification with ethanol production over the biological conversion technologies. This preference is based on assumption that ethanol is a better product to market than compost.

4.4.2.2 Feedstock Availability

As mentioned above, AD can process only the biodegradable portion of MRF residue. The 100 tons/day only biodegradable residue may not be available after extensive resource recovery from some of the MRFs in Southern California. A very comprehensive waste characterization will be required for the development of an AD facility adjacent to a MRF.

With regard to gasification with ethanol production, all six MRFs can provide the required feedstock.

4.4.2.3 Preprocessing

AD technologies require extensive preprocessing of MSW waste, including separation of virtually all non-biodegradable material such as plastic, metals etc. MRF residue is not necessarily homogenous enough for AD processing. The MRF residue will require additional equipment and processing to be prepared for treatment in an AD conversion unit.

Gasification with ethanol production can process all carbon-based portion of MRF residue including plastic and may require little or no changes in MRF operation; therefore, all six MRF in the shortlist can accept this technology.

4.4.2.4 Space Availability

Some of the AD systems require large areas for processing MRF residue. For example Waste Recovery/Valorga, and Canada Compost require 7 and 6 acres of land, respectively. Most of the MRF in Southern California do not have large enough area available adjacent to their facilities.

Other bioconversion systems require smaller area and can be located adjacent to any one of the six MRF/TSs in the shortlist.

4.4.2.5 Infrastructure Availability

Developing a conversion facility at a MRF/TS location will require additional infrastructure, such as electricity interconnect, water supply, sewer, and transportation access. The short-listed MRF/TS facilities are located in industrial areas that should have sufficient infrastructure to support a conversion facility.

4.4.2.6 Environmental Compatibility

Environmental and regulatory issues relating to developing a conversion facility at one of the preferred MRF/TSs are discussed in the Siting Plan.

4.5 CONCLUSIONS

4.5.1 Most Suitable MRF

Preliminary analysis indicates that any of the six MRF/TSs are suitable for development of a conversion demonstration facility in Southern California. The Perris MRF will be renovated and can be designed for a specific conversion facility. The Santa Clarita MRF/TS is planned and also can be designed to facilitate a conversion unit. Del Norte, Community Recycling, Central Los Angeles, and Robert A. Nelson are also suitable for conversion technologies. Members of the Alternative Technology Advisory Subcommittee at the June 16, 2005 meeting unanimously agreed that the short list of preferred MRFs for the first phase of development of a conversion facility should include:

- Del Norte Regional Recycling and Transfer Station (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS (Riverside County)

The Community Recycling, Central Los Angeles and Santa Clarita MRF/TSs should also be considered in the next phase of the project.

4.5.2 Most Suitable Technology

Preliminary evaluation of conversion technology and conversion technology suppliers showed that the most suitable technologies for MRF/technology combinations are thermal conversion or waste to green fuel technologies. Anaerobic digestion (composting by CIWMB definition) was dropped from the list of most suitable technology processing MRF residue for the following reasons:

- Anaerobic digestion requires very extensive preprocessing of the feedstock. MRF residue may not be a suitable feedstock for anaerobic digestion.
- Anaerobic digestion requires larger area because of a larger footprint.
- Anaerobic digestion (WRSI/Valorga) is in the process of building a commercial facility in Southern California and, therefore, there is no need for a demonstration facility.
- Anaerobic digestion generates a larger percentage of residue, and therefore has a lower diversion rate.
- Anaerobic digestion generates mostly compost and soil amendment with small amount of biogas to generate electricity. The marketing of the compost is questionable.

4.5.3 Most Suitable MRF/Technology Combinations

Results of this study conclude that the most suitable MRF/technology combinations are the six MRF/TSs in list of preferred facilities and thermal conversion or waste to green fuel technologies. The Alternative Technology Advisory Subcommittee decided that the Del Norte, Robert A. Nelson and Perris MRF/TS would be included in the short list for the first phase of this project.

In order to select the final most suitable MRF/technology combinations, a more detailed evaluation of the MRF and technology supplier is required. This detailed evaluation can be accomplished by issuing an official RFQ or RFP to selected technology suppliers, and negotiating a partnership between MRF owners and technology suppliers. This can be included in the scope of work for the next phase of the study.

Several supporting documents were included in the scope of work for this project. A brief summary of these documents is presented below and the complete documents are included in appendices attached with this Report.

5.1 STRATEGIC ACTION PLAN

The Strategic Action Plan prepared as part of this study considers the prospective steps the County, the Integrated Waste Management Task Force, and its Alternative Technology Advisory Subcommittee may take over short (6-12 month), mid (1-5 years), and long-term to satisfy the objective of this study.

The Strategic Action Plan recommends a number of specific actions for development of a conversion facility in Southern California. The following issues are discussed in this Plan:

- Environmental Issues
- Technical Challenges
- Public Outreach Issues
- Legislative Issues
- Cost and Financing Issues

A preliminary implementation schedule is presented in the Strategic Action Plan, which indicates a possible commissioning date of mid 2008. The Strategic Action Plan is included in Appendix B.

5.2 PUBLIC OUTREACH PLAN

A Public Outreach Plan was prepared. This Public Outreach Plan recommends specific actions the County and its Alternative Technology Advisory Subcommittee can take for conducting a public outreach program in connection with development of a conversion demonstration facility in Southern California. This Plan recognizes the unique nature of this project, including the need for public involvement and communication at the community level. This Plan emphasizes the following:

- Why Public Outreach Is Needed
- What Is Public Outreach With Regards to Conversion Facilities
- The Public Interest In A Conversion Facility
- A Strategic Approach to Public Outreach
- Communication Strategy

- Suggested Public Involvement Techniques
- Specific Recommendations

Public acceptability is a major factor for implementation of a conversion demonstration facility. An early and aggressive public outreach program will contribute to the success of this project. The Public Outreach Plan is included in Appendix C.

5.3 MARKETING ANALYSIS

Conversion technologies produce marketable products and byproducts. The quality and quantity of these products depend on type and design of conversion systems, and feedstock composition. A preliminary marketing analysis for conversion products was performed as part of this study. The following issues are discussed:

- End Products of Conversion Technologies
    - Electricity
    - Green Fuel
    - Compost and Soil Amendment

Other by-products such as carbon char, chemicals, inert material, and recyclable material may also be produced in small quantities. The type, quantity and quality of these by products depend on the type and design of the conversion systems, type and quality of preprocessing, MRF residual composition, and many other factors. Market analysis for these by products will be addressed in the second phase of this project.

- Market Assessment for Conversion Products
- Expected Market Prices and Volatility

Preliminary market analysis shows that electricity has the most reliable and stable local market. Green fuels are in a developing marketplace and compost market is uncertain and unpredictable. The Market Analysis of conversion products is included in Appendix D.

5.4 SITING ANALYSIS

A preliminary siting analysis for the development of a conversion demonstration facility was performed. The following issues are discussed in this analysis:

- Preferred Conversion Technologies
- Preferred MRF Locations
- Regulatory and Permitting Issues

  - CIWMB
  - Air Emissions for Thermal and Bioconversion Technologies
  - Air Permit Requirements
  - Water Discharges
  - Solid Waste

- Environmental Issues and Mitigation
  - CEQA
  - Air Quality
  - Nuisance (Traffic, Odor, Dust, and Noise)
  - Visual Impacts
  - Surrounding Land Use
- Public Acceptability

There are no currently commercial operating conversion facilities processing MSW or MRF residue in the United States. Preliminary data from Japan and Europe indicates that conversion facilities can operate within regulatory framework in the U.S. Facilities with the most advanced environmental control systems would be able to meet regulatory requirements in California.

The actual environmental impacts of a specific conversion technology in a specific location will be evaluated as part of permitting process for the facility.

The Siting Analysis for the development of a conversion demonstration facility is included in Appendix E.

6.1 CONCLUSIONS

The following conclusions are based on finding of this study:

I – The results of the technology evaluation indicated that the top ranking technologies are pyrolysis-gasification, gasification, and pyrolysis. The top four suppliers according to their ranking scores for these technologies are:

- Interstate Waste Technologies (Pyrolysis-Gasification)
- Primenergy LLC (Gasification)
- Ntech Environmental (Gasification)
- GEM America (Flash Pyrolysis)

The second group of technologies is anaerobic digestion. Anaerobic digestion was dropped from the list of technologies for reasons provided in Section 4 of this Report.

The third group is waste to green fuel technologies. These emerging technologies do not have commercial facilities processing MRF residue or MSW, therefore they ranked lower. However, the significantly increased development risk may be offset by the potential benefits offered by these technologies. The suppliers for these technologies are:

- Changing World Technologies (Thermal Depolymerization)
- BRI (Gasification-Fermentation)

II – Analysis of the Southern California MRF facilities concluded that six MRF/TSs are preferred for a conversion technology demonstration facility development. They are:

- Del Norte Regional Recycling and Transfer Station operated by Republic Services (City of Oxnard, Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) operated by Burrtec Industries (City of Aqua Mansa, Riverside County)
- Perris MRF/TS operated by CR&R (City of Perris, Riverside County)
- Central Los Angeles Recycling Center and Transfer Station operated by the City of Los Angeles Bureau of Sanitation (City of Los Angeles, Los Angeles County)
- Community Recycling/Resource Recovery, Inc. MRF in Sun Valley operated by Community Recycling (City of Los Angeles, Los Angeles County)

Santa Clarita MRF/TS (Planned MRF to be built by Burrtec Industries, likely in or near the City of Santa Clarita, Los Angeles County)

III – Results of most suitable technology/MRF combinations analysis concluded that the suitable technologies are thermal conversion or waste to green fuel technologies. Anaerobic digestion (composting by CIWMB definition) was dropped from the list of suitable technology/MRF combinations for the reasons provided in Section 4 of this report. The most suitable MRF are six MRF/TSs on the list of preferred facilities. Members of the Alternative Technology Advisory Subcommittee at the June 16, 2005 meeting unanimously agreed that the short list of preferred MRF for the first phase of development a conversion facility should include:

- Del Norte Regional Recycling and Transfer Station (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS (Riverside County)

The Community Recycling, Central Los Angeles and Santa Clarita MRF/TS should be considered in the next phase of the project.

IV – The Strategic Action Plan provides a "road map" for project implementation. The schedule indicates a possible commissioning date of mid 2008.

V – A Public Outreach Plan, which was prepared by this study, emphasized the steps that have to be taken for public outreach and education on conversion facilities. This Public Outreach Plan concludes that public acceptability is a major factor for developing a conversion demonstration facility in Southern California. An early and comprehensive public outreach program will contribute to the success of this project.

VI – The preliminary market analysis shows that electricity has the most reliable and stable local market. Green fuels are in a developing marketplace where current demand outstrips supply in California. The compost market is uncertain and unpredictable.

VII – The siting analysis conducted as part of this study indicates that co-location of a conversion demonstration facility at an existing MRF in Southern California has several advantages over current practices of residue disposal. The actual environmental impacts of a specific conversion technology in a specific location will be evaluated as part of permitting process for the facility.

Alternative Technology Advisory Subcommittee – Conclusions And Findings

Based on existing published studies of conversion technologies, the professional expertise of URS Corporation, as well as the findings of this conversion technology evaluation process, the Alternative Technology Advisory Subcommittee of the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force also adopted the following preliminary conclusions. These conclusions were adopted in support of the

Subcommittee's decision to recommend the development of a demonstration conversion technology facility in Southern California, and it is the intent of the Subcommittee to confirm the validity of these conclusions through the next process:

1. Utilizing conversion technologies to process MRF residues and recover energy or green fuel with marketable byproducts will increase diversion from landfills and enhance Southern California's solid waste management and recycling programs.
2. Each of the technology groups evaluated (pyrolysis-gasification, gasification and waste to green fuel) appeared to be environmentally and technically feasible for processing MRF residue or MSW.
3. Available data from Japan and Europe indicates that conversion facilities can operate within regulatory framework in the U.S. and that facilities with the most advanced environmental control systems would be able to meet regulatory requirements in California.
4. Conversion technologies have been in successful, long-term use around the world, although they typically use more homogeneous feedstocks such as coal and biomass. While technical challenges are expected with most of these technologies, because of their relatively short operating history using MSW as a feedstock and complexity of the process, these challenges are judged to be manageable.
5. Economically, these technologies appear to have the ability to compete favorably with other solid waste disposal methods in a commercial facility.

6.2 RECOMMENDATIONS

It is recommended to proceed with the following tasks for development of a conversion demonstration facility to process MRF residue in Southern California:

1. Acquire and confirm and complete data provided by the top four thermal technology suppliers through an official Request for Qualification (RFQ) or Request for Proposal (RFP). These suppliers are:
   - Interstate Waste Technologies (IWT) – Pyrolysis/Gasification
   - Primenergy LLC – Gasification
   - Ntech Environmental – Gasification
   - GEM America – Flash Pyrolysis
2. Acquire and confirm and complete data provided by the two emerging technology suppliers through an official RFQ or RFP. The suppliers for these technologies are:
   - Changing World Technologies (CWT) – Thermal Depolymerization

- BRI – Gasification/Fermentation to Ethanol

These technologies do not have a commercial facility processing MSW or MRF residue. Changing World Technologies has a demonstration facility processing turkey waste, and BRI has a pilot facility. While these technologies demonstrate significant promise, the development risk is substantial.

3. Evaluate RFQ/RFP responses and select preferred supplier(s).
4. Clarify permitting pathways and requirements for each technology.
5. Visit preferred suppliers operating facilities.
6. Conduct a detailed evaluation of preferred MRF/TSs in the shortlist.
7. Pursue and negotiate a partnership between MRFs and technology suppliers.
8. Determine the most cost effective and technically feasible throughput for the proposed conversion facility.
9. Pursue funding mechanisms.
10. Start public outreach as early as possible for the implementation of this project.

Shapoor Hamid, PhD. Thermal Conversion Systems, Publication of International Materials Research Congress, Cancun, Mexico, 1998.

Evaluation of Gasification and Novel Thermal Processes for the Treatment of Municipal Solid Waste. Publication of National Renewable Energy Laboratory, Golden, Co, 1996.

Investigation of Municipal Solid Waste Gasification for Power Generation (URS technical report section), prepared for Alameda Power & Telecom, May, 2004

A Comparison of Gasification and Incineration of Hazardous Wastes, prepared for U.S. DOE by URS Corporation, March 2000.

Operating Experience – Commercial and Pilot Projects, Westinghouse Plasma Corporation presentation, 2003

Legrand, R., T.M. Masters, and G.W. Fallon, “A Systems Analysis of the Biological Gasification of MSW and an Assessment of Proven Technologies,” Energy from Biomass and Wastes XIII, IGT Symposium Papers (1989), D.L. Klass, Ed

CONVERSION TECHNOLOGY SUPPLIER INFORMATION

TABLE A-1
LIST OF CONVERSION TECHNOLOGY SUPPLIERS THAT RECEIVED THE QUESTIONNAIRE

TABLE A-1
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Gasification	Fixed bed	AmbientECO	Produces EnviroFuel, to gasification	MSW	ON, Canada	They license technology, but do not manufacture a gasifier. Patent submitted for WTE. Have used Simoneau Group close-coupled gasifier. Now talking with Emery. Syngas to boiler.	No operating plants	Small plant was at Caledon Landfill in Peel, Ontario, Canada. Can do testing.	Boiler
Gasification	Fixed Bed	Emery Energy Company	Emery Energy gasification process	Tires, RDF	Salt Lake City, UT	Pilot and demo units	1,200 TPY demo	Pilot and demo	Engines
Gasification	Fixed bed	Global Warming Prevention Technologies, Inc.	Natural State Reduction System (NSRS)	MSW, industrial, medical wastes	ON, Canada	Consortium of Thermogenics, Siemens Canada, Ltd., SENES Consulting, SK Precision Hydraulics, and Gardiner Roberts)	28 TPD	28 TPD demo plant in Anchorage, AK; 5 TPD demo plant in Kuala Lumpur. 64 ton batch process cells.	Boiler
Gasification	Fixed bed	Improved Converters, Inc.	Advanced Multi-Purpose Converter	MSW, RDF, tires, haz wastes	Sacramento, CA	Prototype to be tested within next 12 months		Commercial scale prototype, no throughput data	
Gasification	Fixed bed	Innovative Logistics Solutions, Inc.	Pyromex	MSW	Palm Desert, CA				

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Gasification	Fixed bed	Omnifuel Technologies, Inc.	RDF Gasification	Organic wastes, tires, sewage sludge, biomass	Folsom, CA	Omnifuel gasification	No plants	Plant in Ontario (1981) at 150 TPD on bark, sawmill residues, plywood trim. 25 TPD pilot plant ran 2,000 hours (including 24/7 for two 31-day runs) on RDF and other feedstocks in 1979.	CT
Gasification	Fixed Bed	Primenergy, LLC	PRM Energy gasification	Biomass, RDF, rice hulls, olive waste	Tulsa, Oklahoma	Main experience w/rice hulls and olive waste. Most have power generation.	200,000 TPY	18 gasifiers on biomass, up to 600 TPD	Boiler
Gasification	Fixed bed	Thermogenics, Inc.	Thermogenics Gasification System	Wood waste, MSW, lignin, tires	Albuquerque, NM	Pilot plant on tires		Plants planned for MSW in UAE, wood waste to ethanol in Mecca, CA, and lignin to syngas in Italy.	IC engines
Gasification	Fixed Bed	Whitten Group International	Entech Renewable Energy System	MSW, medical, animal food wastes, dried sewage, hazardous wastes	Longview, WA	Gasification at 1,040°F, close-coupled to combustion "thermal reactor"	30,000 TPY (Malaysia)	47 facilities in operation worldwide, 12 on MSW at 6-143 TPD. Taiwan facility at 30 TPD MSW (9,000 TPY)	Boiler
Gasification	Fluid bed	Ebara Corporation/ Environmental Plants Division	Ebara Twin Rec TIFG (Twin Internally Circulating Fluidized Bed Gasification) and Ash Melting	MSW, RDF, ASR, sewage sludge, plastics	Tokyo , Japan	Gasification at 1,100°F, w/close coupled combustion chamber at 2,500°F, w/ash melting	150,000 TPY	Plants in Japan, from 2,500-150,000 TPY. 461.5 TPD (150,000 TPYplant in Kawaguchi)	

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Gasification	Fluid bed	Energy Products of Idaho	Fluidized Bed Staged Gasification with Complete Combustion	MSW, RDF, biomass, wood chips, sawdust, paper mill sludge, industrial sludges, plastic, tires, coal	Coeur d'Alene, ID				Boiler
Gasification	Fluid bed	Enerkem Technologies, Inc. (part of KEMESTRIE Group, part of Univ. of Sherbrooke)	Biosyn Technology, Fluid bed w/alumina or silica	MSW, plastics, wood waste, RDF	Québec,Canada	PFBC at 1,832°F. Syngas produced at 1,472°F.	25,000 TPY		Engines
Gasification	Fluid Bed	Heuristic Engineering	EnvirOcycler	RDF, MSW, wood, biomass	Vancouver, Canada	Updraft gasifier with cyclonic combustion			
Gasification		United Recycling Technology, Inc.	Gasification	Medical, hazardous wastes	La Cresenta, CA				
Other Thermal	Microwave	Molecular Waste Technologies, Inc.			Marietta, GA				
Plasma Gasification		Geoplasma LLC (part of Jacoby Development, Inc.)	Plasma Direct Melting Reactor. Westinghouse Plasma torches.	MSW	Atlanta, GA	Works with Georgia Tech Research Institute	No plants.	No plants	NA
Plasma Gasification		Hitachi Metals, Inc.	Plasma Direct Melting Furnace (Westinghouse Plasma)	MSW	Tokyo, Japan				

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Plasma Gasification		Integrated Environmental Technologies, LLC	Plasma Enhanced Melter	MSW, hazardous, radioactive, medical, industrial, plastics	Richland, WA		3,650 TPY	1,460 TPY med waste facility in Hawaii; 3,650 TPY facility in construction at Fuji Kaihatsu's facility in Iizuka, Japan (near Fukuoka) to convert plastics and industrial waste into electricity.	
Plasma Gasification		MPM Technologies, Inc.	Skygas plasma gasification	MSW, industrial wastes, wood wastes	Parsippany, NJ			No plants	No plants
Plasma Gasification		Pearl Earth Sciences Corp.	Plasma Waste Converter		ON, Canada	Has agreement with Startech to supply plasma torches. Pearl acts as facility developer.	No plants.	Claims a 5 TPD plant, no location provided. Claims they are constructing 100 TPD tire gasification facility in Pickering, Durham Region, Ontario, Canada.	Boiler
Plasma Gasification		Phoenix Solutions Company		Ash vitrification, industrial, hazardous & medical wastes, PCBs, solvents	Crystal, MN			20 ash vitrification plants in Japan	
Plasma Gasification		Plasma Environmental Technologies,Inc.	Plasma Assisted Gasifier	MSW	Burlington, ON	Has 3 contracts in place to develop MSW gasification projects			

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Plasma Gasification		PyroGenesis, Inc.	Plasma Resource Recovery System (PRRS)	Hazardous wastes, incinerator ash	Montreal, Quebec, Canada	High temperature 2,732°F plasma gasification.	12 TPD	Two pilot systems at 11 TPD each in operation for 3 years. Scheduled to put on cruise ship in 2003 and U.S. Navy aircraft carrier in 2004/2005.	
Plasma Gasification		RCL Plasma, Inc. (formerly Resorption Canada Limited)	Phoenix Solutions or Europlasma	Biomedical and hazardous waste	ON, Canada	First commercial unit to be in Far East		Pilot plant near Ottawa for 15 years.	
Plasma Gasification		Recovered Energy, Inc.	Recovered Energy System	MSW	Pocatello, ID	Also uses "Nextpath Environmental"	No plants	No plants	
Plasma Gasification		Scientific Utilization, Inc.	Pyro-Electric Thermal Conversion (PETC)	Medical, hazardous wastes	Huntsville, AL	Molten slag at 2,900°F with induction heating (Allied Chemical ATGAS-PATGAS process). Syngas goes to AC Plasmatron.		Pilot plant under construction. Hazardous waste destruction plant in Taiwan at 15 TPD.	CT
Plasma Gasification		Solena Group	Plasma Gasification Vitrification	Industrial Waste/MSW	Washington, DC	Also partnered w/Europlasma	No plants	No plants	CT
Gasification	Fluid bed	Taylor Recycling Facility, LLC	FERCO SilvaGas	MSW, wood waste, agricultural waste and energy crops	Montgomery, New York,	Steam and hot sand at 1,800°F in gasifier. Close-coupled combustor.	3,650 TPY	10 TPD pilot at NcNeil Generating Plant in VT. Shut down. 300 TPD/23 MW plant in development using wood wates in Winkleigh, Devon, UK and 400 TPD wood waste/C&D debris in Forsyth County, Georgia.	Boiler

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Pyrolysis		Conrad Industries	121 Melhart Road Chehalis, WA, 98532	Plastics	Chehalis, WA				
Pyrolysis		Graveson Energy Management	GEM High-Speed Conversion Technology	MSW	Summit, NJ				
Pyrolysis		North American Power Company	Thermal Recovery Unit	MSW, industrial, medical, plastic	Las Vegas, NV				Boiler
Pyrolysis		Pan American Resources, Inc.	Lantz Converter	MSW	Pleasanton, CA				
Pyrolysis		International Environmental Solution	Thermal Convertor	Mixed Waste	Romoland, CA	The pyrolysis gases go directly to a thermal oxidizer and the heat from the thermal oxidizer routed to a boiler to generate electricity	Demo 50 tpd	No plants	Boiler
Pyrolysis		WasteGen UK Ltd	Materials and Energy Recovery Plant (MERP)	MSW	Gloucester, U.K.		110,000 TPY	Burgau - 40,000 TPY; Hamm - 110,000 TPY	Boiler
Pyrolysis		Utility Savings & Refund LLC	Rapid Thermal Process Producing Bio Oil	Carbon Based Material	Newport Beach, CA	Developer of renewable energy projects from biomass, including gasification, pyrolysis, and anaerobic digestion	150 tpdbiomass	Canada and California	BioOil

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Pyrolysis/ Gasification	Fixed bed	Global Energy Solutions, Inc.	Thermal Converter	MSW	Sarasota, FL	Pyrolysis chamber at 2,200°F. Pyro-Thermic reaction in gasifier at 3,000-3,100°F. Molten slag.		Claims 23 plants in operation around the world, 4 on MSW	Boiler
Pyrolysis/ Gasification	Fixed bed	Interstate Waste Technologies	Thermoselect	MSW	Malvern, PA	Pyrolysis at 572°F, oxygen-blown gasification at 2,200°F	289,000 TPY	Italy - 100 TPD, Japan - 330 TPD, Germany - 792 TPD	Boiler or IC
Pyrolysis/ Gasification		Compact Power Holdings PLC/ Compact Power Ltd		MSW	Bristol U.K.	Pyrolysis, steam reforming, gasification	8,000 TPY	Avonmouth, UK	Boiler
Pyrolysis/ Steam Reforming		Brightstar Environmental	Solid Waste Energy Recovery Facility (SWERF)	MSW	Rouge, LA	Pyrolysis followed by steam reforming	60,000 TPY	Wollongong, Australia	Engines
Steam Reforming/ Catalysis		ThermoChem Recovery International, Inc.	Pulse Enhanced Steam Reformer	Black liquor, bark, wood waste and other organic waste products	Baltimore, MD	Steam reforming using superheated steam. Catalysts enhance water gas shift rection to get more syngas.		New Bern, NC (45 TPD); Big Island, VA (200 TPD); Trenton, Ontario, Canada (125 TPD)	
Thermal Depolymer-ization		Changing World Technologies	Heating under pressure, flash vaporization	Offall	Hempstead, NY				
Aerobic Composting		American Bio-Tech	Air Lance (in-vessel)		Irvine, CA				
Aerobic Composting		Hatch/Stinnes Enerco	System 25.1		Mississauga, Ontario				

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Aerobic Composting		Horstmann Recyclingtechnik GmbH	Various		Oeynhausen, Germany				
Aerobic Composting		HotRot Exports Ltd, or Outspoken Industries	HotRot		Christchurch, NZ				
Aerobic Composting		Wright Environmental Management Inc.	In-Vessel		Ontario, Canada				
Aerobic Digestion		International Bio Recovery Corporation (IBR)	IBR		Vancouver, B.C.				
Anaerobic Digestion		Arrow Ecology Ltd	ArrowBio		Haifa, Israel	ArroBio license holder, responsive			
Anaerobic Digestion		Arrow Ecology Ltd	ArrowBio	MSW	Wheeling, WV	ArrowBio licensee, responsive			
Anaerobic Digestion		Canada Composting Inc. (CCI)	BTA		Newmarket, Ontario				
Anaerobic Digestion		Citec	Waasa process		Vaasa, Finland				
Anaerobic Digestion		Global Renewables	UR-3R, ISKA	MSW	Perth WA Australia	ISKA licensee, responsive			
Anaerobic Digestion		ISKA GmbH	ISKA		Ettlingen, Germany				
Anaerobic Digestion		Kompogas	Kompogas		Glattbrugg				
Anaerobic Digestion		McElvaney Associates Corporation			Santa Barbara, CA				
Anaerobic Digestion		Onsite Power Systems, Inc.	APS		Camarillo, CA				
Anaerobic Digestion		Orbit Waste-to-Energy Systems	HSAD						

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Anaerobic Digestion		Organic Waste Systems nv	DRANCO		Gent - Belgium				
Anaerobic Digestion		Orgaworld NV	BioCel	SSO	UDEN, Netherlands				
Anaerobic Digestion		SEBAC	SEBAC		Gainesville FL				
Anaerobic Digestion		Valorga International S.A.S.	Valorga		Montpellier, France	Valorga license holder, not responsive			
Anaerobic Digestion		Waste Recovery Systems, Inc.	Valorga		Monarch Beach, CA	Valorga licensee, responsive			
Ethanol Fermentation		BC International		MSW	Dedham MA				
Ethanol Fermentation		Arkenol		Agricultural/ biomass	Irvine, CA				
Ethanol Fermentation		Masada Resource Group LLC		MSW	Birmingham, AL				
Ethanol Fermentation	Genahol Hydrolysis & WTE Pyrolysis	Waste To Energy	Genahol	MSW fractions	Paso Robles, CA.	Waste to Energy uses Genahol Process as well as an internally developed pyrolysis for the residuals of the Genahol process			
Ethanol Fermentation		Genencor International, Inc.		Biomass	Palo Alto, CA				
Ethanol Fermentation		GeneSyst International		MSW	Hudson OH				

TABLE A-1 (CONTINUED)
LIST OF CONVERSION TECHNOLOGY SUPPLIERS
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE
ALTERNATIVE TECHNOLOGY SUBCOMMITTEE

Technology	Sub-Technology	Supplier Name	Process	Primary Feedstock Experience	Address	Comments	Largest Capacity	Plants	Syngas
Syngas-Ethanol		BRI Energy, Inc.	BRI		Studio City, CA				
Catalytic Cracking	Pyrolysis w/catalytic cracking	Plastic Energy LLC (SMUDA)	SMUDA	Plastics	Roseville, CA	Pyrolysis with Catalytic Cracking. The Company is planning to start construction of a facility to convert 26k to/year of non-recycled plastic to liquid fuel			
Plasma Gasification		Rigel Resource Recovery and Conversion Company			Baltimore, MD				

TABLE A-2
CONVERSION TECHNOLOGY SUPPLIERS QUESTIONNAIRE

Conversion Technologies Evaluation Services Project
Questionnaire for Conversion Technology Suppliers
January 2005

INTRODUCTION

Municipal Solid Waste (MSW) collected from residences and businesses in the County of Los Angeles (the County) is presently going to Material Recovery Facilities (MRFs) or Transfer Stations (TSs). After separation of some recyclable items, the residues left behind are disposed of in a landfill or incinerator. The goal of the County of Los Angeles Department of Public Works, Integrated Waste Management Task Force, is to divert some of the MRFs/TSs residues from traditional disposal.

The County has contracted with URS Corporation (URS) to evaluate a range of thermal, biological and chemical "conversion technologies" to treat the MRF/TS residues, create useful byproducts, and reduce the amount of MRF/TS residues going to the landfills. Also, URS is evaluating MRFs/TSs in Southern California for their willingness and ability to partner with a conversion technology supplier and to determine if they have adequate space and appropriate feedstock to develop a successful MSW conversion facility.

The County's goal is to select a supplier to develop a demonstration facility to treat the MRF/TS residues and produce usable products and by-products such as fuel, electricity, chemicals, and/or compost. This demonstration facility will be located adjacent to a MRF/TS in Southern California and will serve as a showcase for using MSW conversion technologies in the United States.

The purpose of this questionnaire is to obtain information about currently available technologies and to address specific technical and financial issues regarding these technologies and suppliers. Once responses from the questionnaire are evaluated, the County may select one or more suppliers with which to negotiate a contract for conversion technology facility development, or it may issue a Request for Qualification to a limited audience for development of the facility.

TECHNOLOGY/SUPPLIER REQUIREMENTS

The following requirements were established for evaluating suppliers and their technologies. The supplier and its technology must comply with all of these requirements to be considered further in this process.

1. **Waste Diversion Rate.** The supplier's technology must be able to reduce the amount of MRF/TS residuals going to the landfill by at least 50%.

2. **Demonstrated Processing Experience.** The supplier must have developed at least a pilot scale facility, designed to process MSW or similar feedstock at a rate of approximately 5 short tons/day, and that has operated for at least one year. During any one-year period, it must have processed at least 1,000 short tons of MSW (composition of the MSW close to that of post recycled MRF residual) or similar feedstock. Note: sewage sludge, black liquor solids, chemicals, plastics or tires are not considered a "similar feedstock".

3. **Conversion to Useful Products and By-products.** The supplier's technology must show capability to produce marketable products and by-products.

4. **Environmental Compliance.** The supplier's technology must comply with all regulatory requirements in the state of California (i.e., air emissions).

5. **Responsiveness.** Supplier must reply to URS requests for data within a timely manner (i.e. within the timeframe noted in this questionnaire).

6. **Ability to Partner with a MRF/TS**. Supplier must be willing and able to create a partnership with a MRF/TS in Southern California.

7. **Facility Size.** Supplier must exhibit the capability to develop a demonstration facility that will process approximately 100 short tons/day of MRF residuals.

RESPONSE PREPARATION

Respondents are solely responsible for the costs of responding to this questionnaire. All responses and the contents therein, will become the property of the County of Los Angeles Department of Public Works Integrated Waste Management Task Force and may be released to the public.

COMMITMENT

Response to this questionnaire does not commit the County of Los Angeles Department of Public Works, its Integrated Solid Waste Management Task Force or URS Corporation as their consultant to issue any subsequent Request for Qualification (RFQ) or Request for Proposal (RFP).

SUBMITTAL

All responses received by the county should include complete responses to each question contained in this questionnaire, regardless of previous responses or submittals to the County or to URS on other projects. Five hard copies of the response, and a CD or emailed copy, should be sent to the address provided in the contact section of this questionnaire.

SCHEDULE

The time frame for response to this questionnaire begins on January 13, 2005 with distribution of the questionnaire. The response must be received by 5:00 PM (Pacific Standard Time), February 14, 2005.

CONTACT

All inquiries regarding this questionnaire and submittal of the response should be directed to:

Mr. Shapoor Hamid, PhD, REA
URS Corporation
915 Wilshire Blvd., Suite 700
Los Angeles, CA 90017
shapoor_hamid@urscorp.com
Phone: (213) 996-2200
Fax: (213) 996-2290

Please provide complete answers to the following:

Question #1:

Name of Firm
Name of Technology
Principal Contact Person
Address
Telephone/Fax
E-mail

Question #2:

Please provide information about your firm and your technology. This can be available information in brochure format. Include firm history, location(s), accomplishments, personnel resources and ownership structure. Also, in order to show financial credibility to implement the project from development to operation, please provide an Annual Report for the most recent fiscal year (include parent corporation, if applicable).

Question #3:

Please provide the following information for up to three existing reference facilities.

- Name and location
- Owner/Operator
- Technology
- Feedstock
- Start-up date
- Capital cost
- Annual operation and maintenance cost
- Throughput (short tons/day and short tons/year)
- Area of facility, acres
- Types/quantities of products and by-products (for electricity, list gross and net kW)

- Amount of residuals sent to landfill
- Photos of the facility
- Air and water emissions
- Status of the facility, i.e. in operation, shut down

Question #4

For the facility the supplier is proposing for the County, describe the technology, including pre-processing systems, conversion unit, and product processing (e.g. electricity generation) appropriate for the type MRF residuals described in Attachment 1. List the number of processing lines and/or modules and the capacity of each in tons/day and tons/year. Describe the evolution of your technology with regard to timing and throughput capacity, including current commercial status.

Question #5:

For the facility the supplier is proposing for the County, discuss characteristics and composition of the anticipated products and byproducts. If available, provide analytical data for the end products and by-products. Also, provide assumptions used in estimates of selling prices of products and by-products, and describe your marketing experience with these products and by-products, particularly in California.

Question #6:

Briefly discuss the environmental impacts from your existing facilities, or issues that require permits. Include, as appropriate, air emissions, water emissions, solid waste residues, visual impacts, nuisances, and odor impacts. Also, where applicable, include a description of the syngas/biogas cleaning and air emission control systems, such as wet and dry scrubbers, cyclones, baghouses, activated carbon injection, etc., as well as other products and by-products processing proposed.

Question #7:

For the facility the supplier is proposing for the County, please provide a description of the feedstock requirements (i.e. size, moisture content, etc.) of your conversion unit, and indicate how your system would deal with the variability of MRF/TS residuals.

Question #8

For the facility the supplier is proposing for the County, please provide a site layout drawing showing area requirements and an equipment/building general arrangement.

Question #9

For the facility the supplier is proposing for the County, please provide information on the utility requirements (e.g. natural gas, fuel oil, water, electricity, and sewer), and staffing requirements.

Question #10:

For the facility the supplier is proposing for the County, please describe the composition, quality, and quantity of the hazardous and non-hazardous wastes generated by your system and whether they would have to be disposed of in a hazardous or regular landfill.

Question #11:

For the facility the supplier is proposing for the County, summarize the facility characteristics in a mass balance diagram that shows material delivered, recycled, disposed, and products generated/processed, on both a daily and annual basis. For electricity generation, list gross and net kW.

Question #12:

For the facility the supplier is proposing for the County, please provide information on the capital cost, operation and maintenance costs, and revenues generated. This information should be included in Attachments 2 and 3. Use the following assumptions:

- Exclude land cost
- Buildings and site improvements are amortized at an annual interest rate of 6% over 20 years
- All equipment is amortized at 6% over 7 years
- Hauling and disposal cost of the final solid residue is $50 per ton
- Power will be provided to the facility at $60 per Megawatt-hour
- Operating and maintenance costs should be escalated at 3% per year

Question #13:

Describe your ability/experience in providing financial guarantees and security arrangements, such as letters of credit or performance bonds.

Question #14:

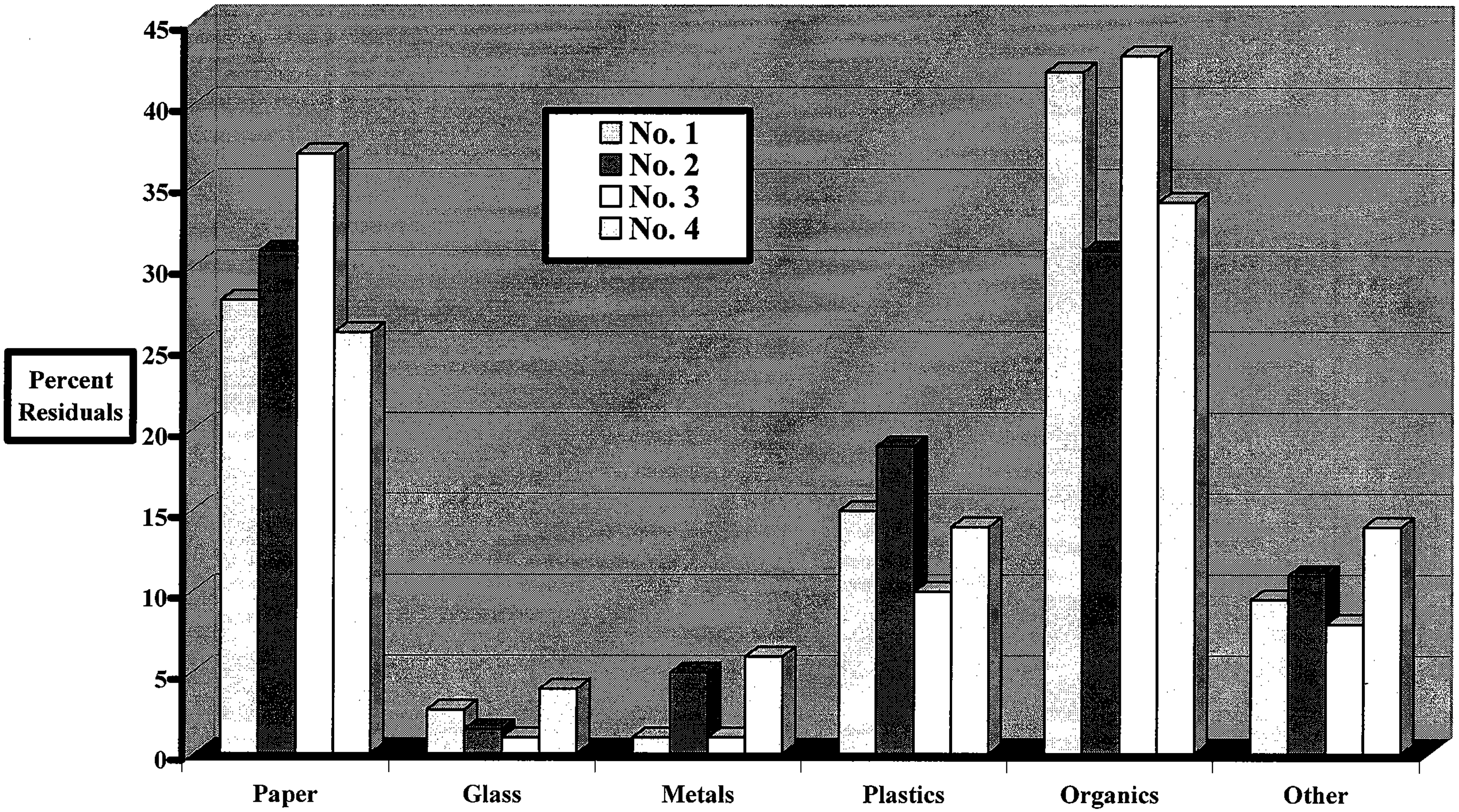
For the facility the supplier is proposing for the County, please provide a summary of the key advantages offered by your technology processing MRF/TS residues for the Southern California area. Compare those advantages with the key challenges you will encounter.

Responses must utilize the following customary U.S. units:

Parameter	Required Unit	Metric Equivalent
Area of Facility	Acres	1 acre = 0.4047 hectare
Length, size	Inches or feet	1 inch = 2.54 cm; 1 foot = 0.304 meter
Temperature	°F	Temperature in °F = (1.8 x (temp. in °C) + 32
Pressure	psi	1 psi = 6.895 kPa
MSW Heating Value	Btu/lb, LHV basis (LHV = lower heating value)	1 Btu = 1055 J = 252 cal; 1 lb = 1 pound = 0.454 kg; 1 kJ/kg x 0.43 = 1 Btu/lb
Syngas or biogas Heating Value	Btu/scf, LHV basis (LHV = lower heating value)	scf = standard cubic foot = 28.32 liter = 0.02832 m^3 (STP); 1 kJ/m^3 x 0.0268 = 1 Btu/scf
Syngas or biogas flow	scfh	scfm = scf per hour
Density	lb/ft^3	1 ft^3 = 28.32 liter
Weight	Pounds or short tons (2000 lbs. = 1 short ton)	1 short ton = 907 kg
Volume, liquids	U.S. gallons	1 US gallon = 3.7854 liter
Volume, gases	ft^3	1 ft^3 = 28.32 liter = 0.02832 m^3
Electric power	MW or kW	
Costs	$ U.S.	
Particle size	inches	1 inch = 2.54 cm

<u>Attachments:</u>
Attachment 1 – Examples of MRF Residue Composition
Attachment 2 – Cost Form
Attachment 3 – Revenue Form

Attachment 1. Examples of MRFs Residual Composition



ATTACHMENT 2

COST FORM (US$)

I. Capital Cost

- Building and site improvements $________________
- Equipment $________________
- Office equipment $________________
- Other (Specify) $________________

Total Capital Cost ***$________________***

Total Annualized Capital Cost ***$______________***

II. Annual Operation & Maintenance Costs:

- Operational labor and fringes $________________
- Other direct operational expenses $________________
    - Hauling and disposal of final solid residue
    - Hauling and disposal of other material
    - Equipment fuel
    - Property & liability insurance
    - Operating supplies and chemicals
    - Utilities (water, electricity, natural gas, fuel oil, etc.)
    - Other
- Direct Maintenance $________________
    - Parts and equipment
    - Shop supplies
    - Other
- General and Administrative and fringes $________________
- Miscellaneous General & Administrative $________________
    - Building Maintenance
    - Communications
    - Printing
    - Supplies
    - Legal
    - Travel
    - Public relations
    - Other

Total Annual Operation & Maintenance Costs **$____________**

Total Annual Costs (Capital + O&M) ***$_____________***

ATTACHMENT 3

Revenue Form

Material Type	Quantity Recovered (solids: tons/year; liquids: gallons/year; Electricity: MWh/year)	X Unit Value* (US$/ton for solids and US$/gallon for liquids)	Total Annual Revenue (US$)
Ferrous Metals			
Non-Ferrous Metals			
Carbon Char			
Bottom ash or Slag			
Activated Carbon			
Electricity		$0.045/kWhr	
Syngas			
Biogas			
Ethanol			
Biodiesel			
Compost			
Fertilizer			
Methanol			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
Others Specify			
TOTAL REVENUE			

* freight-on-board at MSW conversion facility

TABLE A-3
AMENDMENTS TO
CONVERSION TECHNOLOGY SUPPLIERS QUESTIONNAIRE

Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force	Alternative Technology Advisory Subcommittee

Conversion Technologies Evaluation Services Project
Amendments to Questionnaire for Conversion Technology Suppliers
January 2005

The Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force/Alternative Technology Advisory Subcommittee at its January 21, 2005 meeting decided to amend the questionnaire that was sent to the conversion technology suppliers on January 13, 2005, in order to encourage more potential technology vendors to respond to the questionnaire. The amendments are related to **Technology Suppliers Requirement** section and **Schedule** and are as follows:

Amendment No. 1

Item No.2 "Demonstrated Processing Experience" should read: The Los Angeles County prefers a technology supplier that developed at least a pilot scale facility, designed to process MSW or similar feedstock at a rate of approximately 5 short tons/day, and that has operated for about one year. During this period, it should have processed an MSW feedstock (composition of the MSW close to that of post recycled MRF residual) or similar feedstock. Note: sewage sludge, black liquor solids, chemicals, plastics or tires are not considered a "similar feedstock".

Amendment No. 2

Item No.4 " Environmental Compliance" should read: The supplier must demonstrate that the technology is capable of complying with all applicable regulatory requirements for an existing unit (e.g., air emissions).

Amendment No. 3

Schedule: The response must be received by 5:00 PM (Pacific Standard Time), February 28, 2005.

TABLE A-4
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

TABLE A-4
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Changing World Technologies, Inc.** West Hempstead, NY	
Brief Description of the Technology	The Thermal Conversion Process consists of five main steps: 1) pulping and slurrying the organic feed with water; 2) heating the slurry under pressure to the desired temperature; 3) flashing the slurry to a lower pressure to release the biogas; 4) reheating the slurry (coking) to drive off water and light oils from the solids; and 5) separating the light oils from the water. The oil is further processed using distillation or solvent extraction. The biogas goes to electric and/or steam generation based upon the economics of on-site use.	
Project Partners	None	
Technical and Financial Resources (Credibility)	CWT has sufficient technical and financial resources, proven in its development of its pilot plant ($13 million) and the commercial plant at ConAgra Foods ($25 million project). CWT states that it has raised $94 million in capital contributions and commitments. It also has a joint venture, Renewable Environmental Solutions, with ConAgra Foods, Inc., that operates the commercial facility. EPA and DOE have supported the development of the commercial plant.	
For the Existing Facilities		
Facility Name	TCP Pilot Plant	Carthage Plant
Location	Philadelphia, PA	Carthage, MO
Owner	Changing World Technologies, Inc.	Renewable Environmental Solutions, LLC
Technology	Thermal Conversion Process	Thermal Conversion Process
Throughput, TPY	Pilot plant rated 7 TPD	82,500
Feedstock	Various	Turkey offal, mechanically de-boned material, feathers, grease
Start-up Date	1999	2004
Capital Cost	$13,000,000	$25,000,000
Annual O & M Cost	Not available	$4,000,000
Products	Oil, biogas, carbon, fertilizer	Oil, biogas, carbon, fertilizer
By-products	None	None
Residuals	None	None

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	32,850 (100 TPD at 90%)
Description of Preprocessing System	CWT assumes that the MRF would provide the appropriate feedstock containing paper, plastics, organics, fats, oils, and greases. If any additional removal of glass or metals is required, CWT would include that equipment as needed. Costs are included in Attachment 2.
Description of Conversion Unit	The Thermal Conversion Process would be sized to treat 100 TPD of specific feedstock from the MRF residuals. The 5 main steps of the facility are as described above. Temperatures and pressures are proprietary to CWT. The general schematic block diagram provides an overall view of the subsystems in the conversion unit, including odor control, pulping and storage, reactors, gas treating, electric generation, water treatment, calciners, oil storage, and the thermal oxidizer feed.
Description of Energy Production Systems	CWT proposes to use a boiler which would combust the biogas produced from the system. All of the steam produced would be utilized within the CWT system.
Description of By-Products Processing & Handling Systems	There are no actual by-products, as the process creates only the primary products.
Feedstock Requirements	Composition: Paper, plastics, organics, fats, oils, and greases
	Size: No size specification
	Moisture Content: Moisture content is not an issue, since water is added for pulping.
Diversion Rate, %	Essentially 100% of processed MRF residuals.
Environmental Issues	Air: The closed, pressurized system has minimal requirements for environmental controls. Odors are piped to a thermal oxidizer for destruction. Commercial plant in Carthage qualified as *de minimis* emission source and did not require an individual air permit. Combustion of the biogas for steam production would result in air emissions; commercially available clean-up equipment would be utilized to meet applicable air emission standards. Produced oil could be combusted for power generation; this would be evaluated later.
	Water: Most process water is recycled. Vacuum/recompression system to be utilized to minimize wastewater discharge.
	Solid Residue: None identified.
	Odor: Any tanks or vessels that have a potential to generate or omit odors are piped to a thermal oxidizer. Tipping hall would likely utilize odor control system.
	Noise: Trucks
	Other: Planned installations in Colorado and Pennsylvania required Environmental Assessments; result in Finding of No Significant Impact is very positive.
Description of Products and By-Products	Products: Oil, biogas, carbon and fertilizers
	By-Products: None

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Products and By-Products, TPY	Products: Biodiesel: 9,113 Mineral Fertilizer: 2,488 Liquid Fertilizer: 8,240 Activated Carbon: 3,947 Metals: 242 Biogas: 4,568
	By-Products: None
Area Requirement, acres	3-5
Utility Requirements	Natural Gas: 14 MMBtu/hr
	Fuel Oil: None
	Water: Not specified
	Sewer: Domestic use
	Electricity: 1 MW from an external source, or about 7,884 MWh/year.
Composition of Residuals Generated by the Facility	Hazardous: N/A
	Non-Hazardous: N/A
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 32,850 (100 TPD at 90% availability)
	Material Recycled: Metals: 242
	Material Disposed: None identified
	Products Generated: 23,788 (does not include biogas, which is combusted for making steam for internal process use). Balance is water.
	By-Products Generated: None
Costs & Revenues	Capital: $15,000,000
	Annual O&M: $4,523,040
	Annual Capital Recovery: $750,000
	Annual Revenue Generated: $5,136,848
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $136,192
	Net cost/ton MSW delivered: $4/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Conrad Industries** Chehalis, WA	
Brief Description of the Technology	KleenAir Products Co. Advanced Recycling Technology (pyrolysis) Pre-processing: none described Conversion Unit: Feed enters the pyrolysis unit, which includes the retort, process auger, outlet end bell and furnace chamber. The retort is a horizontal cylindrical vessel and serves as a combined reactor, heat exchanger and mixing device. The retort extends into the furnace. The auger mixes the feedstock and moves it through the reaction vessel. Surrounding the retort is the furnace chamber. Four propane burners provide pre-heat needed for start-up, then syngas is utilized. Hot pyrolyzed vapors which exit the retort are first condensed in the high temperature condensing unit. Pyrolysis occurs at ~1,400 °F. Energy generation: not described.	
Project Partners	Pyrolysis equipment provided by KleenAir Products Co., but information brochure provided about KleenAir does not include any mention of pyrolysis equipment manufacture.	
Technical and Financial Resources (Credibility)	No technical or financial resources described. Supplier's prior experience is primarily with plastics and tires. Some testing on MSW shown in DVD provided. Supplier's submittal questions the need to provide financial guarantees and security arrangements.	
For the Existing Facilities		
Facility Name	Conrad Industries test facility	
Location	Chehalis, WA	
Owner	Conrad Industries, Inc.	
Technology	KleenAir Products Co. Advanced Recycling Technology of Pyrolysis	
Throughput, TPY	Demonstration Unit (KleenAir Products Model # 2977): 930	Commercial Unit: 7,440
Feedstock	Used for treating plastics and tires to produce petrochemical feedstocks which are sold.	
Start-up Date	1993	
Capital Cost	$6,500,000	
Annual O & M Cost	Not provided	
Products	Not described	
By-Products	Not described	
Residuals	Not described	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	30,000
Description of Preprocessing System	Recovery of glass, metals, other (C&D, white goods) fraction. Shredding, pelletizing or cubing for moisture reduction and sizing. No details provided.
Description of Conversion Unit	No details provided. See description above (note: proposed system may be different than existing commercial and demo units, since feedstocks are very different, i.e., MSW vs. plastics and tires). Conversion unit is designed as a 72 TPD module.
Description of Energy Production Systems	No energy production subsystem described. No prior experience with power generation is noted. Submittal notes that the proposed facility would be used to convert MSW to char, oil, and vapor gas (syngas). No use of syngas is noted.
Description of By-Products Processing & Handling Systems	Not provided.
Feedstock Requirements	Composition: Not provided.
	Size: Not provided (may be shredded, cubed or pelletized for sizing and moisture reduction)
	Moisture Content: 15% maximum
Diversion Rate, %	94
Environmental Issues	Air: Requires process stack exhaust, waste gas flare, carbon char silo baghouse. No details on power generation subsystem, so it is not known if syngas or flue gas cleanup will be utilized.
	Water: None determined
	Solid Residue: Disposal of carbon char/ash
	Odor: Likely to incorporate negative pressure maintained in tipping hall to reduce odors, with air routed to power generation subsystem for combustion and destruction of odor-causing compounds.
	Noise: Trucks
	Other: None determined.
Description of Products and By-Products	Products: Electricity, pyrolysis oil (similar to diesel or marine fuel)
	By-Products: Char/ash
Quantity of Products and By-Products, TPY	Products: Electricity: No information on generation provided
	By-Products: Pyrolysis oil: 8,400 (2.1 million gallons)
Area Requirement, acres	Not provided.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: No information
	Fuel Oil: No information
	Water: No information
	Sewer: No information
	Electricity: No information
Composition of Residuals Generated by the Facility	Hazardous: None
	Non-Hazardous: Char/ash
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: Char/ash: 1,680
Mass Balance, TPY	Material Delivered: 30,000
	Material Recycled: Glass and metals: 6,000
	Material Disposed: Char/ash: 1,680
	Products Generated: Electricity
	By-Products Generated: Oil: 8,400
Costs & Revenues	Capital: No information provided
	Annual O&M: No information provided
	Annual Capital Recovery: No information provided
	Annual Revenue Generated: No information provided
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : No information provided
	Net cost/ton MSW delivered: No information provided

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Ebara Corporation** Tokyo, Japan	
Brief Description of the Technology	Internally Circulating Fluidized-bed Gasifier (ICFG), using pyrolysis coupled with char combustion. Pre-processing: None required, other than removal of large items. Conversion unit: Combines pyrolysis reactor and char oxidation chambers. Fluidizing sand provides heat source, with steam addition for fluidization and production of syngas at 1,560 °F. Sand moves to char oxidation chamber, where air is added and combustion occurs. Energy production: syngas cleaned and combusted in reciprocating engines.	
Project Partners	No others.	
Technical and Financial Resources (Credibility)	Ebara is a global engineering, environmental, construction, and operations company. Ebara's Environmental Engineering Group alone does $1.8 billion per year in business. They have extensive environmental and engineering capabilities, and have experience in providing guarantees and letters of credit.	
For the Existing Facilities		
Facility Name	Sodegaura ICFG Pilot Plant #1 (now shut down)	Sodegaura ICFG Pilot Plant #2 (in operation)
Location	Nakasode 3-1, Sodegaura City, Chiba Prefecture	Nakasode 3-1, Sodegaura City, Chiba Prefecture
Owner	Ebara	Ebara
Technology	ICFG	ICFG
Throughput, TPY	6,600	4,950
Feedstock	Wood chips, plastic, RDF, Sewage sludge	MSW
Start-up Date	Jan. 2003	May 2004
Capital Cost	No data	No data
Annual O & M Cost	No data	No data
Products	No data	No data
By-products	No data	No data
Residuals	Bottom ash	Bottom ash

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	21,160 (70.5 TPD @ 300 days)
Description of Preprocessing System	None required. Manual picking of items > 12 inches.
Description of Conversion Unit	Reactor integrates a pyrolysis section and char oxidation section, using fluidizing sand that is moved between the two sections. In the pyrolysis section, steam is injected for fluidizing (fluidizing air cannot be used since the process is pyrolysis). The hot sand transfers heat to the MSW feedstock, resulting in thermal decomposition of the organic constituents. Unreacted carbon char and ash materials fall into the sand bed, and are transferred into the oxidation chamber for combustion. The combustion heats the sand, which is then moved to the pyrolysis section for providing heat. The syngas is cleaned in a water scrubber, and the cool, clean syngas is combusted in a reciprocating engine for power production. The hot exhaust gas goes through a heat recovery system, which heats up the air used in the oxidation/combustion chamber. The hot flue gas from the char combustion section flows through a heat recovery boiler, where steam is produced for the fluidizing process in the pyrolysis chamber. The cooled flue gas leaving the boiler enters a fabric filter, then a selective catalytic reduction (SCR) system, then to a stack.
Description of Energy Production Systems	The syngas is combusted in a reciprocating engine, producing 1.57 MW gross/992 kW net. The hot exhaust gas flows through a heat recovery system (no data on what it's used for), then through an SCR system, then to a stack.
Description of By-Products Processing & Handling Systems	Recovery of bottom ash and metals that are >1/8 inch. Metals removed from fluidizing sand. Fly ash and fabric filer ash are disposed of in landfill.
Feedstock Requirements	Composition: MSW
	Size: 12 inches
	Moisture Content: 43% per submittal.
Diversion Rate, %	95
Environmental Issues	Air: Flue gas from reciprocating engines is cooled and sent to SCR system for NO_x reduction. Hot flue gases from char oxidation are cooled; lime addition for removal of acid gases, then fly ash and reaction products removed in fabric filer, followed by SCR for NO_x reduction.
	Water: Blowdown from water treatment system to sewer.
	Solid Residue: Fly ash and reaction products to landfill.
	Odor: Trucks
	Noise: Tipping hall would likely be maintained under negative pressure, with air going to engines and char oxidation for combustion, destroying odor-causing compounds.
	Other: None identified

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Description of Products and By-Products	Products: Electricity
	By-Products: Bottom ash and metals
Quantity of Products and By-Products, TPY	Products: Electricity: 7,149 MWh/year
	By-Products: Metals/bottom ash: 288
Area Requirement, acres	2.5
Utility Requirements	Natural Gas: 135 TPY
	Fuel Oil: 450,000 gallons/year
	Water: 5,310,000 gallons/year
	Sewer: 4,854,000 gallons/year
	Electricity: Internal requirement of 575 kW = 4,140 MWh/year
Composition of Residuals Generated by the Facility	Hazardous: Fly ash and fabric filter reaction products
	Non-Hazardous: Bottom ash and metals
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 864 (fly ash to landfill)
	Non-Hazardous: 288 (bottom ash to landfill as daily cover)
Mass Balance, TPY	Material Delivered: 21,160
	Material Recycled: none
	Material Disposed: 1,152
	Products Generated: Electricity: 7,149 MWh/year
	By-Products Generated: Metals: 94
Costs & Revenues	Capital: $47,490,000 ($2,244/TPY)
	Annual O&M: $3,590,000
	Annual Capital Recovery: $2,850,000
	Annual Revenue Generated: $327,865
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $6,112,135
	Net cost/ton MSW delivered: $289/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**GEM America, Inc.** Summit, NJ
Brief Description of the Technology	Flash Pyrolysis Pre-processing: to remove inerts such as glass and metals. Shredding, granulating, and drying to produce feedstock at 8% moisture and 1/16th inch size. Conversion unit: flash pyrolysis at 1,500 °F. Produces syngas and char/ash mixture. Syngas is quenched in ½ second to 75 °F. Chlorine compounds removed. Sulfur compounds removed in wet scrubber. Syngas to power generation. Power generation: reciprocating engines.
Project Partners	ICC, Inc. (engineering firm)
Technical and Financial Resources (Credibility)	Sufficient technical resources. ICC, Inc. to provide complete EPC services and project insurance. GEM has already developed a pilot (1/3 scale) and commercial facility. GEM would guarantee facility at 75% of rate capacity, with sufficient funds in an escrow account to ensure performance
For the Existing Facilities	
Facility Name	Davies Brothers Waste (presently inactive, awaiting long-term MSW contract)
Location	Bridgend, South Wales, UK
Owner	Davies Brothers Waste
Technology	Graveson Energy Management Thermal Cracking Technology
Throughput	14,000 TPY (dried)
Feedstock	MSW
Start-up Date	April 2000
Capital Cost	No data
Operating Cost	No data
Products	Syngas for power generation in GE Jenbacher engine
By-products	None noted.
Residuals	30% char/70% ash mixture to landfill (10% of inlet feedstock)

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	30,000 TPY
Description of Preprocessing Systems	Removal of all glass and metals. Shred Tech primary and secondary shredders; Scott Rotary dryer with Thermal Oxidizer, and Rapid Granulators – to achieve 8% moisture and 1/16th inch size.
Description of Conversion Unit	Two 50 TPD capacity thermal cracking reactors. Reactor is 20' high by 17' diameter, constructed of stainless steel, with a mechanical stirrer. Feedstock fed in and contacts hot stainless steel walls at 1,500 °F. Decomposition to syngas in < 1 second. 90% of carbon is converted. Ash and unconverted carbon char are removed at bottom of reactor.
Description of Energy Production Systems	A GE Jenbacher reciprocating engine will be used to generate 3 net MW, for a conversion of 1,060 net kWh/ton feedstock.
Description of By-products Processing & Handling Systems	No by-products noted, only residuals.
Feedstock Requirements	Composition: MSW
	Size: 1/16th inch
	Moisture Content: 8%
Diversion Rate	100% if char/ash found to be non-hazardous. 83% if it is hazardous.
Environmental Issues	Air: Syngas cleaning provides extensive cooling and cleaning prior to combustion in engine.
	Water: No wastewater identified.
	Solid Residue: Char/ash likely to be non-hazardous, but will need to be tested for assurance.
	Odor: Tipping hall would likely be maintained under negative pressure, with air going to engines for combustion, destroying odor-causing compounds.
	Noise: Trucks, engines.
	Other: None
Description of Products and By-Products	Products: Electricity
	By-Products: Char/ash may be recyclable.
Quantity of Products and By-Products	Products: Electricity: 23,652 MWh
	By-Products: Char/ash: 5,045 (if not shown to be hazardous)
Area Requirement	½ acre

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: Only on start-up for heating; no quantity specified.
	Fuel Oil: None
	Water: Not specified
	Sewer: Not specified
	Electricity: Uses 0.3 MW internal load.
Composition of Waste Generated by the Facility	Hazardous: None
	Non-Hazardous: Char/ash mixture (testing needed to confirm)
Quantity of Waste Generated by the Facility	Hazardous: 0
	Non-Hazardous: 5,054 TPY char/ash mixture (testing needed to confirm)
Mass Balance	Material Delivered: 30,000 TPY
	Material Recycled: 1,800 TPY
	Material Disposed: 0 (unless char/ash is found to be hazardous; 5,054 if hazardous)
	Product Generated: Syngas
Cost	Capital: $13,215,317 ($440/TPY)
	Annual O &M: $2,071,450
	Annual Capital Recovery: $2,316,680
	Annual Revenue Generated: $1,244,340
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $3,143,790
	Net cost/ton MSW delivered: $105/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	Geoplasma, LLC Atlanta, GA	
Brief Description of the Technology	Pre-processing: Shredding to 6 inch size may be required. Conversion unit: uses Hitachi Metals' Plasma Direct Melting Reactor using Westinghouse plasma torches. MSW fed with coke at a rate of 7% of MSW feed (provides for a porous bed at the bottom of the reactor that acts as a heat reservoir and assures even distribution of the plasma gases and free flow of the vitrified residue) and limestone (for lowering fusion temperature of melt to keep it in molten form). Plasma torches (consuming about 20 kWh/ton MSW) heat air to 4,500 °F. This gasifies organic portion of MSW and melts inorganics to form slag layer above molten metal layer. Use of coke contributes to about 13% of the syngas produced. Slag and metals removed in molten form and cooled. Forms glassy aggregate and metal nodules. Syngas combusted in adjacent combustor. Hot flue gas flows through boiler to make steam; steam flows to steam turbine generator. Flue gases go through emission control system with caustic scrubber to remove acid gases, and activated carbon injection, then to stack.	
Project Partners	Geoplasma is subsidiary of JDI, Inc., which re-develops environmentally sensitive or impaired sites into industrial parks and malls. Hitachi Metals Corp. (process design, process equipment design and supply, facility design and construction oversight), Westinghouse Plasma Corp. (plasma torches), Energy Systems Group LLC (subsidiary of Vectren, to operate facility and provide guarantees), SPF Group and UBS (financial), MACTEC (engineering, siting, and permitting) and Georgia Institute of Technology (technological oversight and permitting assistance).	
Technical and Financial Resources (Credibility)	Sufficient to implement project. See partner descriptions above.	
For the Existing Facilities		
Facility Name	Mihama-Mikata	Utashinai
Location	Mihama-Mikata, Japan	Utashinai, Japan (near Hokkaido)
Owner	Cities of Mihama and Mikata	City of Utashinai
Technology	Hitachi Metals Plasma Direct Melting Furnace	Hitachi Metals Plasma Direct Melting Furnace
Throughput, TPY	8,000	65,700
Feedstock	MSW and sewage sludge	2/3 MSW and 1/3 Auto Shredder Residue
Start-up Date	December 2002	July 2002
Capital Cost	$18,000,000 ($2,250/TPY)	$65,000,000 ($989/TPY)
Annual O & M Cost	$700,000 ($84/ton)	$5,500,000 ($84/ton)
Products	Hot water for district heating	Electricity (7.9 MW steam turbine generator)
By-products	Slag aggregate, metals	Slag aggregate, metals

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Residuals	None	None
For the Proposed Facility		
Throughput, TPY	29,200	
Description of Preprocessing System	Shredding to 6 inch size.	
Description of Conversion Unit	Uses a single Hitachi Metals' Plasma Direct Melting Reactor using Westinghouse plasma torches. MSW fed with coke and limestone. Plasma torches heat air to 4,500 °F. This gasifies organic portion of MSW and melts inorganics to form slag layer above molten metal layer. Slag and metals removed in molten form and cooled. Forms glassy aggregate and metal nodules. Syngas combusted in adjacent combustor. Hot flue gas flows through boiler to make steam; steam to steam turbine generator. Flue gases go through emission control system (caustic scrubber to remove acid gases, then activated carbon injection and baghouse) to stack.	
Description of Energy Production Systems	Syngas burned in combustor to produce hot flue gas; hot flue gas flows through boiler to produce steam; steam to steam turbine generator to generate 2.8 MW gross/1.375 MW net.	
Description of By-Products Processing & Handling Systems	Conveyor to remove slag aggregate and metal nodules and send to pit for transfer to trucks for removal to sale.	
Feedstock Requirements	Composition: Unsorted MSW, with some shredding	
	Size: Not stated	
	Moisture Content: 30% desirable - water turns to steam, which promotes steam reforming of carbon to syngas)	
Diversion Rate, %	~100%	
Environmental Issues	Air: emission control system, using caustic scrubber for removing acid gases, followed by activated carbon injection and baghouse, removes pollutants. Fly ash and other compounds from the emission control system are re-injected into the reactor and become part of the vitreous slag when it solidifies.	
	Water: Water and wastewater streams are injected into reactor, where contaminants become mixed into molten slag layer and are captured into the vitreous granulate when it solidifies.	
	Solid Residue: No residuals	
	Odor: Negative pressure maintained in tipping hall to reduce odors – air is routed to reactor and combustor, destroying odor-causing compounds.	
	Noise: Trucks	
	Other: Not determined	
Description of Products and By-Products	Products: Electricity sold on grid.	
	By-Products: Slag aggregate sold for cement-making; metals have existing market.	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Products and By-Products, TPY	Products: Electricity: 9,900 MWh
	By-Products: Metals: 1,168 TPY Slag: 3,504 TPY
Area Requirement, acres	3-4
Utility Requirements	Natural Gas: only on start-up for heating
	Fuel Oil: None
	Water: 91,600,000 for cooling tower; 290,000 for sanitary
	Sewer: Sanitary use.
	Electricity: Internally generated
Composition of Residuals Generated by the Facility	Hazardous: None
	Non-Hazardous: None
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 29,200 MSW/2,000 coke/200 limestone
	Material Recycled: 0
	Material Disposed: 0
	Product Generated: 0
	By-products Generated (metals and slag aggregate): 4,678
Costs & Revenues	Capital: $45,190,000 ($1,548/TPY)
	Annual O&M: $2,668,000
	Annual Capital Recovery: $2,380,000
	Annual Revenue Generated: $540,500
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $4,507,500
	Net cost/ton MSW delivered: $172/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Global Energy Solutions, LC** Sarasota, FL
Brief Description of the Technology	Pre-processing: shredding to 3 inch size. Conversion unit: Pyrothermic Thermal Converter incorporates pyrolysis, along with medium and high-temperature gasification to convert MSW to syngas. The converter includes a pre-heat zone, degasification zone, pyro-thermic zone, pre-molten zone, and molten layer. MSW enters through airtight, interlocked doors mounted above the upper chamber. A portion of the converter is internally rotated for mixing purposes. MSW comes into direct contact with preheated air at 660-840 °F, and falls into primary conversion chamber. There, water is evaporated, and some of the gases are liberated. It is subjected to indirect heat from gases at 2,192-2,460 °F, and the MSW is converted to syngas. Material falling into secondary conversion chamber subjected to temperatures of 3,000-3,300 °F. At the center of this chamber is a 6" thick bed of molten slag. Combustion of fuel oil or natural gas is used to maintain the slag in molten form. All produced gases must first pass through the molten bed before exiting through the bottom of the converter. Apparently, GES expects that contaminants are in some way filtered by the molten layer. The syngas is then mixed with air and combusted within the bottom chamber. The molten slag enters a heat recovery chamber, then falls into the quench tank where the temperature is reduced to 122-140 °F. The slag droplets solidify into a granulate form, and are removed by a conveyor. GES claims that the granulate residue is sterile and inert, and can be used as fill for road construction and/or lightweight building blocks.
Project Partners	GES has listed a team of attorneys, environmental consultants, architects, and technology solutions companies.
Technical and Financial Resources (Credibility)	GES has developed 20 other facilities worldwide, and with their team partners, is likely to be able to develop a facility for the County. GES proposes to develop the facility at no capital cost to the County, and O&M, capital recovery and profit would be funded by tipping fees (level not stated).

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Existing Facilities	
Facility Name	GES provided a list of 20 existing facilities worldwide that utilize the Thermal Converter, treating MSW, industrial wastes, and auto wastes at throughputs of 72-420 TPD. They list a 180 TPD unit in Tokyo treating MSW, and one at Japan Gas Co. with 8 converters that treats MSW. One system in Germany uses the heat from the process to produce steam, which is piped to a steam turbine for generation of electricity.
Location	Most of the units are in Japan, Germany, Belgium, and the UK.
Owner	Various cities and industrial companies.
Technology	Pyrothermic Thermal Converter.
Throughput, TPY	23,000-125,000
Feedstock	MSW, industrial wastes, auto wastes
Start-up Date	Not provided
Capital Cost	Not provided
Annual O & M Cost	Not provided
Products	Not provided
By-products	Slag at approximately 3% of inlet waste
Residuals	Not provided
For the Proposed Facility	
Throughput, TPY	33,000
Description of Preprocessing System	MSW is run though a shredder to reduce size to 3 inches. No removal/recovery of recyclables is noted.
Description of Conversion Unit	See discussion above. GES proposes to use two model 150S Pyrothermic Thermal Converters, each rated at 72 TPD, for a total capacity of 144 TPD, to handle the 100 TPD. They state that the excess capacity allows for maintenance and assures that the entire system will never be completely shut down. The Pyrothermic Thermal Converter uses a multi-zone pyrolysis and gasification system to convert MSW to syngas. The syngas is combusted in an integrated chamber within the converter, and the hot flue gases and hot air are internally recirculated, subjecting the inlet MSW to temperatures up to 3,100 °F. Some of the heat is applied indirectly (for pyrolysis to occur) and some is direct heat exchange with the MSW and converted gases. No emission control system is noted. (see discussion below)
Description of Energy Production Systems	Each converter will have a waste heat boiler and a steam turbine rated at 3 MW. Total output will be 5.45 MW. Internal load is 0.25 MW, for a net output of 5.2 MW.
Description of By-Products Processing & Handling Systems	No description provided.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Feedstock Requirements	Composition: MSW
	Size: No data provided
	Moisture Content: No data provided
Diversion Rate, %	No information provided. Submittal states that a slag granulate is produced at approximately 3% of inlet MSW; diversion could therefore be 97%.
Environmental Issues	Air: No information on emission controls is provided. Apparently, GES expects that all contaminants in the syngas are removed as the syngas passes through the molten slag bed. GES states that "there is no smoke emitted into the air and the clean exhaust gasses that are allowed to leave the unit are constantly monitored so that they will not release any toxic or harmful gasses into the atmosphere." GES provided some monitoring results, which show cases where emissions are above applicable standards, and notes "while the units are developing heir operating temperatures (at start-up and after shutdown) some of the emission results may be above standard until the units reach optimum operating temperatures." This would not be acceptable in the LA area.
	Water: No information on water or wastewater treatment is provided.
	Solid Residue: No information on solid residues is provided; slag granulate may be marketable, so that there are no residues.
	Odor: Tipping hall would likely be maintained under negative pressure, with air going to engines and char oxidation for combustion, destroying odor-causing compounds.
	Noise: Trucks
	Other: Insufficient information in submittal to determine.
Description of Products and By-Products	Products: Not specified.
	By-Products: Slag granulate
Quantity of Products and By-Products, TPY	Products: No information provided
	By-Products: Slag granulate may be produced at 3% of inlet MSW, but no inlet MSW feed was proposed. System may also produce steam and/or desalinate water, but actual by-products were not described.
Area Requirement, acres	No information provided
Utility Requirements	Natural Gas: No information provided
	Fuel Oil: No information provided
	Water: No information provided
	Sewer: No information provided
	Electricity: No information provided
Composition of Residuals Generated by the Facility	Hazardous: No information provided
	Non-Hazardous: No information provided

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Residuals Generated by the Facility, TPY	Hazardous: No information provided
	Non-Hazardous: Slag granulate produced at approximately 3% of inlet MSW feed, but no inlet MSW feed was proposed.
Mass Balance, TPY	Material Delivered: No information provided
	Material Recycled: No pre-sorting required
	Material Disposed: No information provided
	Products Generated: No information provided
	By-Products Generated: Slag granulate produced at approximately 3% of inlet MSW feed, but no inlet MSW feed was proposed. Steam and/or desalinated water might also be produced, but GES did not propose anything specific for the County.
Costs & Revenues	Capital: No information provided. GES proposes to develop a facility at no capital cost to the County.
	Annual O&M: No information provided
	Annual Capital Recovery: No information provided
	Annual Revenue Generated: No information provided
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : No information provided
	Net cost/ton MSW delivered: No information provided. GES proposes that the facility (no throughput specified) would be built and operated at no cost to the County other than a tipping fee to be negotiated between GES and the County. However, since GES provided no financial information, it is impossible to evaluate the economic implications of a GES facility. No tipping fee (or range of tipping fees) can be determined for comparison with existing landfill disposal costs or for comparison with other technology submittals. The fact that GES's submittal states that "At this time, there is not enough data to determine exact capital cost requirements" is a concern. Given that GES has apparently provided over 20 other Thermal Converter facilities, it is surprising that they are not able to prepare even a conceptual cost estimate for the facility for the county.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**International Environmental Solutions Corporation** Romoland, CA
Brief Description of the Technology	Advanced Pyrolytic Technology, utilizing pyrolysis.
Project Partners	H. West Equipment (design of conveyors and MRFs), Northern Power Systems (provided feasibility study and designs power plants), DeVere Construction Company (develops and engineers power plant designs), Advanced Energy Strategies (energy project development and regulatory issues), Manit Systems (automated controls)
Technical and Financial Resources (Credibility)	The overall team that IES has proposed has significant technical capabilities and experience in MSW management, MRF and power plants design, and energy sales; together, they provide financial strength and ability to develop and guarantee the project. DeVere has the capability to bond projects up to $100 million.
For the Existing Facilities	
Facility Name	International Environmental Solutions test facility
Location	Romoland, CA
Owner	International Environmental Solutions
Technology	Advanced Pyrolytic Technology (pyrolysis)
Throughput, TPY	Rated at 50 TPD. TPY not appropriate for a test facility. (A 147 TPD system has been designed and will be constructed)
Feedstock	Various feedstocks for tests, including post-MRF residuals, infested wood bark, industrial waste, industrial sludge, pharmaceuticals, auto shredder residue.
Start-up Date	Not provided
Capital Cost	$8,000,000 for test facility
Annual O & M Cost	Not provided – test facility
Products	Test facility
By-products	Carbon char, glass and metals (ferrous and non-ferrous)
Residuals	None

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	53,655
Description of Preprocessing System	MRF residuals at inlet conveyor to dryer are sized at ≤ 2 inches (if MRF residuals do not meet this size, an additional stage will be required). Feed enters dryer where moisture is reduced from 25% to 10%. Feed system uses patented valve that seals out air (since pyrolysis is used).
Description of Conversion Unit	The process utilizes a horizontal retort, with a proprietary rotating auger to move the feed through the system. The chamber is a three-arch, triangular design, using the upper portion to transport the syngas to the thermal oxidizer, with the two bottom arches conveying the MSW through the retort for pyrolysis. Hot gases from combustion of natural gas provide the indirect heat needed for pyrolysis. The MSW is heated to 1,200-1,800 °F, where thermal degradation of the organic portion of the MSW occurs. Syngas is produced, and a carbon char mixed with metals and glass is discharged by gravity onto a conveyor. The syngas is immediately combusted in a thermal oxidizer, creating flue gas at 2,250 °F. The flue gases are routed through a heat recovery steam generator to produce steam, then through a fabric filter, wet scrubber, and activated carbon filter, and are then exhausted through a stack. The steam is piped to a steam turbine generator.
Description of Energy Production Systems	The steam from the boiler is piped to a steam turbine generator, producing electricity at 8 MW gross/7.6 MW net.
Description of By-Products Processing & Handling Systems	No description, but video showed magnetic separator and eddy-current separator for metals. Glass will also be recovered.
Feedstock Requirements	Composition: MSW from MRF
	Size: ≤ 2 inches
	Moisture Content: 25% (will dry to 10% moisture)
Diversion Rate, %	99
Environmental Issues	Air: Flue gases from combustion chamber will be treated by fabric filter, wet scrubber, and activated carbon filter, and are then exhausted through a stack.
	Water: No discharge noted. Water is recovered from the system for re-use.
	Solid Residue: Wet scrubber produces small amount of by-product, but no quantities are noted. This may or may not be commercially usable.
	Odor: Tipping hall would likely be maintained under negative pressure, with air going to engines and char oxidation for combustion, destroying odor-causing compounds.
	Noise: Trucks
	Other: None determined.
Description of Products and By-Products	Products: Electricity:
	By-Products: Carbon char, metals and glass.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Products and By-Products, TPY	Products: Electricity: 60,793 MWh
	By-Products: Char: 1,073 Metals: 805 Glass: 5,365
Area Requirement, acres	0.2 acre (no area for MSW delivery and storage)
Utility Requirements	Natural Gas: Used for providing indirect heat for pyrolysis
	Fuel Oil: None used
	Water: Used in the process for steam generation; reclaimed from water recovered within the process.
	Sewer: For employee use only
	Electricity: Internal load of 3,504 MWh
Composition of Residuals Generated by the Facility	Hazardous: None
	Non-Hazardous: Wet scrubber by-product and fabric filter ash
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: 91
Mass Balance, TPY	Material Delivered: 53,655
	Material Recycled: 805
	Material Disposed: 91
	Products Generated: Electricity: 60,793 MWh
	By-Products Generated: Char: 1,073 Metals: 805 Glass: 5,365
Costs & Revenues	Capital: $23,225,500 ($433/TPY)
	Annual O&M: $2,328,650
	Annual Capital Recovery: $3,973,226
	Annual Revenue Generated: $3,004,282
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $3,297,594
	Net cost/ton MSW delivered: $61/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Interstate Waste Technologies, Inc.** Malvern, PA		
Brief Description of the Technology	Thermoselect high temperature gasification. This technology incorporates an initial degassing (pyrolysis) chamber, decomposing the MSW into volatile syngas and a carbon char mixed with inorganic components of the MSW. The carbon char enters the gasification chamber, where oxygen is added to complete the gasification of the carbon into more syngas. The syngas is then quench-cooled and cleaned; it can then be combusted in a boiler, reciprocating engine, or gas turbine for power generation. The inorganic components are heated in the bottom of the reactor, where oxygen is added, to >3,000 °F, where they are converted to molten form. They flow into a water bath and are recovered as a metal shot and a slag aggregate, both of which are saleable. Some of the syngas cleaning system byproducts are marketable.		
Project Partners	Thermoselect S.A. (gasification technology), HDR Engineering, Inc. (engineering), H.B. Zachry (construction), Montenay Power Corporation (facility O&M)		
Technical and Financial Resources (Credibility)	IWT has developed the Interstate Waste Management Alliance, composed of IWT and its partners listed above. These are large, financially sound companies which have implemented large projects worldwide. HDR/Zachry have prior experience in providing financial guarantees, letters of credit and performance bonds in their work. They would provide a 100% payment and performance bond for the design and construction of the facility. Montenay Power would provide appropriate guarantees for the O&M of the facility.		
For the Existing Facilities			
Facility Name	Thermoselect Sudwest	Chiba Facility	Mutsu Facility
Location	Karlsruhe, Germany	Chiba, Japan	Shimokita, Japan
Owner	EnBW (electric utility)	JFE (formerly Kawasaki Steel)	Mitsubishi Materials Corp.
Technology	Thermoselect	Thermoselect	Thermoselect
Throughput, TPY	246,500	103,500	47,850
Feedstock	MSW	MSW	MSW
Start-up Date	1999	1999	2003
Capital Cost	$120,000,000	$80,000,000	Not available
Annual O & M Cost	$19,500,000	$13,000,000	Not available
Products	Electricity, steam	Electricity	Electricity
By-products	Slag aggregate, metal shot, sulfur, mineral salts, zinc concentrate (hydroxide)	Slag aggregate, metal shot, sulfur, mineral salts, zinc concentrate (hydroxide)	Slag aggregate, metal shot, sulfur, mineral salts, zinc concentrate (hydroxide)
Residuals	Mineral salts may or may not be saleable		

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	100,000
Description of Preprocessing System	No preprocessing is required with the Thermoselect technology, other than removal of large objects.
Description of Conversion Unit	The proposed facility would use one Thermoselect module rated at 13.3 tons/hour, or 319 tons/day. The system layout is as described above.
Description of Energy Production Systems	The syngas would be combusted in two B&V Pielstick reciprocating engines, each rated at about 8 MW, for a total of 16.125 MW gross/11.142 MW net.
Description of By-Products Processing & Handling Systems	The slag and metal exit the bottom of the gasifier reactor in molten form, and fall into a water batch. The metals cool, forming small metal nodules. The molten slag cools, forming a glassy, non-hazardous slag, which is crushed into a fine aggregate. Both are conveyed to outdoor pits for temporary storage prior to being loaded into trucks for sale. The water treatment system removes other metals in the process in a concentrated hydroxide form. These may be marketable. Sulfur in the MSW is eventually removed as a pure sulfur product, which is salable.
Feedstock Requirements	Composition: MSW
	Size: Very large white goods, engines, etc. are removed manually
	Moisture Content: No requirement
Diversion Rate, %	>99%. If mineral salts can be sold, diversion is essentially 100%.
Environmental Issues	Air: Extensive cleaning system removes solid and gaseous contaminants from syngas prior to combustion. Low-NO_x burners in reciprocating engines, followed by SCR, further reduce NO_x emissions.
	Water: No discharges.
	Solid Residue: Mineral salts may or may not be saleable.
	Odor: Tipping hall would likely be maintained under negative pressure, with air going to engines for combustion, destroying odor-causing compounds.
	Noise: Trucks
	Other: None determined
Description of Products and By-Products	Products: Electricity
	By-Products: Slag aggregate, sulfur, metal shot, mineral salts, zinc concentrate
Quantity of Products and By-Products, TPY	Products: Electricity: 83,700 MWh
	By-Products: Slag: 15,024 Metal shot: 2,567 Mineral salts: 2,723 Sulfur: 125 Zinc concentrate: 845
Area Requirement, acres	3.4

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: 110 million scf/year
	Fuel Oil: 187,800 gallons/year
	Water: 75 million gallons/year
	Sewer: 829,450 gallons/year
	Electricity: Internal load of 5 MW, or 37 million kWh/year
Composition of Residuals Generated by the Facility	Hazardous: Mineral salts, if not saleable, will require appropriate disposal in hazardous landfill
	Non-Hazardous: None
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 3,175 of mineral salts, if not saleable
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 100,000
	Material Recycled: None in preprocessing
	Material Disposed: possible 3,175 of mineral salts, if not saleable
	Products Generated: Electricity: 83,700 MWh
	By-Products: Slag: 15,024 Metal shot: 2,567 Mineral salts: 2,723 Sulfur: 125 Zinc concentrate: 845
Costs & Revenues	Capital: $75,511,000 ($755/TPY)
	Annual O&M: $10,787,432
	Annual Capital Recovery: $12,258,573
	Annual Revenue Generated: $4,430,873
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $18,615,132
	Net cost/ton MSW delivered: $186/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Molecular Waste Technologies, Inc.** Marietta, GA
Brief Description of the Technology	Uses magnetrons to induce microwaves into the feedstock, resulting in "molecular reduction of organics", breaking it down into oil and carbon char.
Project Partners	Lockwood Greene would design and construct the facility.
Technical and Financial Resources (Credibility)	MWT's business plan is to design, research and license the technology. MWT may have sufficient technical resources with Lockwood Greene on the project. They have questionable financial resources to implement the project. MWT states that they have "no appreciable assets except equipment". The submittal states that Lockwood Greene would provide performance bonds.
For the Existing Facilities	
Facility Name	None in operation. Had pilot plant at Georgia Tech.
Location	Georgia Tech, Atlanta, GA
Owner	MWT
Technology	Microwave-induced breakdown of organic compounds
Throughput, TPY	No data
Feedstock	No data
Start-up Date	No data
Capital Cost	No data
Annual O & M Cost	No data
Products	Oil and carbon char
By-products	None
Residuals	No data

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	
Description of Preprocessing System	Removal of glass and metals is required, but no description provided. MWT presented no information on prior experience in pre-processing of MSW.
Description of Conversion Unit	No information provided. Chart shows that for every ton of MSW, the system would produce 922 lbs carbon, 370 lbs oil, 50 pounds off-gases, 70 lbs metals, 46 lbs glass, and 42 lbs other materials (total =1,500 lbs, with balance being water). No information on off-gases is provided, i.e., whether or not they are combustible. Brochure states that 1 ton of MSW produces 1.1 barrels of oil and 882 lbs of carbon (slightly different values).
Description of Energy Production Systems	None.
Description of By-Products Processing & Handling Systems	No information provided.
Feedstock Requirements	Composition: MSW from MRF
	Size: No information provided
	Moisture Content: 25%
Diversion Rate, %	Insufficient data to calculate
Environmental Issues	Air: MWT states that it would include a fabric filter and scrubber.
	Water: Produces water; no discharge
	Solid Residue: Insufficient information
	Odor: Tipping hall would likely be maintained under negative pressure, with air going to engines and char oxidation for combustion, destroying odor-causing compounds.
	Noise: Trucks
	Other: None determined
Description of Products and By-Products	Products: Oil and carbon black
	By-Products: No information
Quantity of Products and By-Products, TPY	Products: Oil: 1,009,008 gallons/year Char: 10,833 TPY
	By-Products: No information
Area Requirement, acres	4-5
Utility Requirements	Natural Gas: None
	Fuel Oil: None
	Water: None (produces water from moisture in MSW)
	Sewer: Domestic use only
	Electricity: 1 MW at rate of 85 TPD/26,208 TPY

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Composition of Residuals Generated by the Facility	Hazardous: None identified
	Non-Hazardous: None identified
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None identified
	Non-Hazardous: None identified
Mass Balance, TPY	Material Delivered: 26,208
	Material Recycled: 1,267
	Material Disposed: 0
	Products Generated: Oil: 1,009,008 gallons/year Carbon char: 10,833
	By-Products Generated: None identified
Costs & Revenues	Capital: $2,008,500 ($101/TPY)
	Annual O&M: $1,222,950
	Annual Capital Recovery: $448,140
	Annual Revenue Generated: $2,042,287
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : -$371,197
	Net cost/ton MSW delivered:$0/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Ntech Environmental** Longview, WA		
Brief Description of the Technology	Ntech uses the ENTECH Renewable Energy System. The process utilizes low temperature, fixed-bed gasification with very low amounts of air, nearing pyrolysis, to convert MSW to syngas. Since MRF residuals are the feedstock, no pre-processing is required. The technology includes: 1) a stepped-hearth designed pyrolytic gasification stage for conversion of MSW to syngas at 1,100 °F, 2) a thermal reactor stage for immediate combustion of syngas at 2,200 °F, 3) an energy utilization stage, including a heat recovery boiler for steam production and power generation, 4) an air quality control stage with emission controls, and 5) a flow control stage with blowers to exhaust the flue gases to stack.		
Project Partners	Whitten Group International, located in the U.S., would provide the project development and management services, while NTech Environmental, which licenses the ENTECH technology, will provide the engineering services for the ENTECH technology. The gasification technology itself is provided by ENTECH.		
Technical and Financial Resources (Credibility)	Whitten Group International (Whitten) is a project management and development company founded in 1984 to provide construction services to project developers world wide. Whitten holds proprietary intellectual properties and equipment patents. Its clients and partners are international construction developers, gas & oil companies, and local and federal governments. ENTECH as the technology provider would make available a number of bonds and guarantees. Whitten, as the project developer, would incorporate these bonds in the facility construction, through Allianz, its financial partner. Allianz underwrites projects up to $100 million.		
For the Existing Facilities			
Facility Name	Genting	Chung Gung	Hong Kong
Location	Sri Layang, Malaysia	Chung Gung, Taiwan	Lantau Island, Hong Kong
Owner	Genting Corporation	City of Chung Gung	Government of Hong Kong
Technology	ENTECH	ENTECH	ENTECH
Throughput, TPY	22,000	11,000	22,000
Feedstock	MSW	Wet MSW	Industrial wastes
Start-up Date	1998	1991	1988
Capital Cost	Not available	Not available	Not available
Annual O & M Cost	Not available	Not available	Not available
Products	Steam	Steam	Steam
By-products	Bottom ash	Bottom ash	Bottom ash
Residuals	Fly ash, emission control system reaction products	Fly ash, emission control system reaction products	Fly ash, emission control system reaction products

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	33,000
Description of Preprocessing System	No pre-processing would be required for this application.
Description of Conversion Unit	Ntech/Whitten propose two operating Pyrolytic Gasification Chambers (PGCs), plus one spare, each rated at 50 TPD. The MSW is fed into the refractory-lined PGC, which operates with little air to initiate pyrolysis and then gasification reactions. The PGC uses a stepped hearth design, where the feedstock is moved by ram feeders or gravity fed down a series of steps in the PGC, providing mixing of the feedstock to ensure that all of it is subjected to sufficient thermal decomposition and gasification. The inorganic components of the feedstockare converted to ash and move to the end of the PGC for collection. Metals and glass are recovered later from the ash. The syngas from both operating PGCs is then combusted immediately in one Thermal Reactor (a combustion chamber) at 2,200 °F, and the hot flue gases flow to the single heat recovery boiler for generation of steam. Flue gases exit the boiler and enter the air quality control system, which includes lime injection to a spray dryer absorber, for removal of acid gases. Following the spray dryer absorber, activated carbon is injected to mix with the flue gas for the removal of heavy metals, such as mercury. The byproducts of the emission controls are captured in a fabric filter.
Description of Energy Production Systems	Heat recovery boiler produces steam. Steam flows to steam turbine generator, producing 2.56 MW gross/2.44 MW net.
Description of By-Products Processing & Handling Systems	Magnetic separator and eddy-current separator for removal of ferrous and non-ferrous metals from bottom ash.
Feedstock Requirements	Composition: MSW
	Size: 80 inch max, i.e., furniture, carpets, but not a solid block.
	Moisture Content: variable
Diversion Rate, %	99
Environmental Issues	Air: Emission controls for acid gases include lime spray dryer followed by pulverized activated carbon injection. Fly ash, reaction products and spent carbon are captured in a fabric filter.
	Water: No discharges noted.
	Solid Residue: Fly ash and spent reactants are disposed of in a landfill.
	Odor: The MSW storage building will be maintained under negative pressure and this air used for combustion. Odor-causing compounds will be destroyed.
	Noise: Trucks
	Other: None identified.
Description of Products and By-Products	Products: Electricity
	By-Products: Glass and bottom ash

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Products and By-Products, TPY	Products: Electricity: 19,320 MWh
	By-Products: Glass: 990 Bottom ash: 4,479
Area Requirement, acres	<1 acre
Utility Requirements	Natural Gas: None
	Fuel Oil: 145,371 gallons/year
	Water: 7,166,833 gallons/year
	Sewer: Employee use only
	Electricity: 992 MWh/year
Composition of Residuals Generated by the Facility	Hazardous: Fly ash and spent reaction products
	Non-Hazardous: None
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 358
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 33,000
	Material Recycled: 990
	Material Disposed: 358 (spent lime and activated carbon)
	Products Generated: electricity: 19,320 MWh
	By-Products Generated: Glass: 990 Bottom ash: 4,479
Costs & Revenues	Capital: $19,356,500 ($587/TPY)
	Annual O&M: $1,783,960
	Annual Capital Recovery: $3,356,480
	Annual Revenue Generated: $869,400
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $4,271,040
	Net cost/ton MSW delivered: $129/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Omnifuel Technologies, Inc.** Citrus Heights, CA
Brief Description of the Technology	The Omnifuel technology uses fluid bed gasification. Following pre-processing to remove recyclables or size the feed, lime is added to the refuse-derived fuel (RDF) for absorption of sulfur and chlorine compounds in the syngas. The RDF is fed into the gasifier. Inside the gasifier, a bubbling bed of olivine sand is used to provide mixing and contact of the RDF with the gasifying air. The RDF is converted to syngas at 1,500 °F, with some ash and tar remaining. The stream exits the top of the gasifier into a primary cyclone, where most of the particulate matter is removed and recycle to the gasifier. The syngas stream enters an air preheater, where heat from the syngas is used to preheat the fluidizing air. The cooled syngas stream enters a secondary cyclone for removal of remaining ash, then to a carbon adsorption bed for mercury removal and a wet scrubber for removal of ammonia. The clean syngas then is piped to a boiler for combustion, producing steam for power generation.
Project Partners	None noted.
Technical and Financial Resources (Credibility)	The principals of Omnifuel have long-term experience with MSW pre-processing and recovery of recyclables, as well as with gasification. Omnifuel states "Company principals are experienced in commercial relationships. Most system components are proven, commercially available and carry vendor warranties. Providing suitable fuel supply and energy purchase commitments are provided, and the project has a favorable return, debt and equity funds are expected to be available." No financial information is available, and financial credibility is questionable.
For the Existing Facilities	
Facility Name	There are no facilities in operation. All prior Omnifuel gasification facilities have been shut down.
Location	
Owner	
Technology	
Throughput, TPY	
Feedstock	
Start-up Date	
Capital Cost	
Annual O & M Cost	
Products	
By-products	
Residuals	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	26,883 from MRF, then through pre-processing to create 20,700 of RDF
Description of Preprocessing System	Minor modifications to the existing MRF will be needed to provide for removal of 23% of the existing MRF residuals to produce the RDF.
Description of Conversion Unit	The Omnifuel technology uses fluid bed gasification. The RDF is fed directly into the 10' diameter, refractory-lined gasifier. Lime is added for absorption/removal of sulfur and chlorine compounds. Inside the gasifier, a bubbling bed of olivine sand is used to provide mixing and contact of the RDF with the hot gasifying air. The RDF is converted to syngas at 1,500 °F, with some ash and tar remaining. The syngas stream exits the top of the gasifier into a primary cyclone, where most of the particulate matter is removed and recycled to the gasifier. The syngas is expected to contain nitrogen, sulfur and chlorine compounds, as well as heavy metals. The lime added to the RDF will capture and remove a large portion of the sulfur and chlorine compounds. The chlorine compounds are not converted to dioxins during gasification. The syngas stream enters an air preheater, where heat from the syngas is used to preheat the fluidizing air. The cooled syngas stream enters a secondary cyclone for removal of remaining ash, then to a carbon adsorption bed for mercury removal and a wet scrubber for removal of ammonia. The clean syngas flows to the boiler for combustion, producing steam for power generation.
Description of Energy Production Systems	The boiler generates steam at 750 psi and 850 °F. It is piped to a 2.5 MW steam turbine for power generation. Net generation is 2.3 MW.
Description of By-Products Processing & Handling Systems	None required.
Feedstock Requirements	Composition: treated MRF residuals
	Size: 3 inches
	Moisture Content: Not specified
Diversion Rate, %	70

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: The syngas is treated and cleaned prior to combustion, using lime addition to the RDF feed for capture and removal of sulfur and chlorine compounds. Ash removal is accomplished by the secondary cyclone. Mercury removal is accomplished with a carbon adsorption bed, and ammonia is removed in a wet scrubber. NO_x is controlled by removal o ammonia (which would be converted to NO_x during combustion) and low-NO_x burners in the boiler.
	Water: No discharge noted.
	Solid Residue: Additional MRF residues and ash from the process (until a market can be found)
	Odor: A negative pressure in the building will be used, and the air will be routed either through the gasifier or an in-ground biological filter.
	Noise: Trucks
	Other: Not identified
Description of Products and By-Products	Products: Electricity
	By-Products: None
Quantity of Products and By-Products, TPY	Products: Electricity: 19,000 MWh
	By-Products: None
Area Requirement, acres	<1
Utility Requirements	Natural Gas: Needed for start-up. No amount specified.
	Fuel Oil: Not required.
	Water: Needed for employee use, boiler make-up, and cooling tower. Volume not specified.
	Sewer: Employee use only.
	Electricity: 1,656 MWh
Composition of Residuals Generated by the Facility	Hazardous: Cyclone ash
	Non-Hazardous: Additional MRF residues
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 2,070
	Non-Hazardous: 6,183
Mass Balance, TPY	Material Delivered: 26,883
	Material Recycled: 0
	Material Disposed: 8,253
	Products Generated: electricity: 19,000 MWh
	By-Products Generated: None

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Costs & Revenues	Capital: $7,000,000 ($260/TPY)
	Annual O&M: $750,000
	Annual Capital Recovery: $1,040,000
	Annual Revenue Generated: $857,000
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $933,000
	Net cost/ton MSW delivered: $35/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Pan American Resources** Pleasanton, CA
Brief Description of the Technology	PAR's technology is the Lantz Converter using "Destructive Distillation", which is essentially a pyrolysis process. Metals are removed by electromagnets and eddy current separators, followed by a shredder. The shredded material is then dried to 5% moisture, using the off-gases produced from combustion of the syngas used to provide the indirect heat for pyrolysis. The prepared MSW is subjected to pyrolysis at 1,200 °F, forming syngas and a carbon char. The syngas is cleaned of particulate matter, acid gases, and mercury, and is then combusted in a boiler to make steam for power generation. The indirect heat for pyrolysis is supplied by a portion of the syngas.
Project Partners	M3 Engineering & Technical Corp. (facility design), Schuff Steel (fabrication of the converter), Oxford Research Institute (risk analysis and ergonomic solutions for industrial facilities)
Technical and Financial Resources (Credibility)	The team likely has the technical capabilities for pre-processing and the conversion unit. Capabilities for power generation are not specified. PAR is the developer/owner of the technology, and has only one employee (John Toman) and no operating capital. PAR's technical and cost proposal is based on a proposal submitted to Alameda County several years ago for a 500 TPD facility. PAR would require a put or pay MSW contract with the County in order to finance the project. PAR states that "Since PAR has no commercial operating facilities, the current management has no experience with financial guarantees and security arrangements other than that which residues with PAR's partners."
For the Existing Facilities	
Facility Name	While PAR has had several facilities in the past (up to 100 TPD), there are no operating facilities at this time.
Location	
Owner	
Technology	
Throughput, TPY	
Feedstock	
Start-up Date	
Capital Cost	
Annual O & M Cost	
Products	
By-products	
Residuals	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	54,860
Description of Preprocessing System	PAR proposes to locate its facility at a transfer station, instead of at a MRF. The preprocessing system includes an electromagnet for recovery of ferrous metals and an eddy current separator for non-ferrous metals, as well as a shredder. The shredded feedstock is dried from 25% to 5% moisture prior to being fed into the converter. The water evaporated in the converter is sent to a cyclone to remove any particulate matter, then it passes through a condenser and a charcoal filter to produce makeup water for the entire process.
Description of Conversion Unit	The single Lantz Converter is rated at 100 TPD. It incorporates a rotating horizontal retort with burners to provide the indirect heat needed for pyrolysis. The dried feedstock from the dryer is ram-fed into the converter, where pyrolysis occurs over a period of 15 minutes at 1,200 °F. A portion of the syngas is combusted to provide this indirect heat. The syngas is combusted in a boiler at up to 3,000 °F. A char ash mixture is removed from the converter by a Holo-Flite tube, which uses a screw inside a cool water heat exchanger (to keep the mixture from auto-igniting when it contact outside air) for disposal.
Description of Energy Production Systems	The syngas is combusted in a boiler, producing steam for power generation. PAR proposes to use a steam turbine generator, producing 2 MW net. Flue gas from the boiler flows to a Hydrosonic scrubber, which is used to remove non-condensable vapors, particulate matter and acid gases.
Description of By-Products Processing & Handling Systems	No post-processing is described.
Feedstock Requirements	Composition: MSW
	Size: Shredded to 1 inch size prior to entering dryer.
	Moisture Content: 25% in MSW is reduced to 5% after dryer
Diversion Rate, %	86
Environmental Issues	Air: Based on PAR's testing, 90% of chlorine from plastics and 30% of sulfur compounds are chemically bound to the carbon char. In addition, flue gas from the boiler and non-condensable gases from the process are sent through a Hydrosonic wet scrubber for removal of air toxics, particulate matter, and acid gases. The system incorporates an 18 inch diameter flare stack, which would be a permitting issue.
	Water: The system has no water discharge.
	Solid Residue: Char/ash mixture
	Odor: Tipping hall will be kept under negative pressure, with air flow through deodorizing filter system.
	Noise: Trucks
	Other: None determined

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Description of Products and By-Products	Products: Electricity
	By-Products: Metals
Quantity of Products and By-Products, TPY	Products: Electricity: 17,082 MWh
	By-Products: None
Area Requirement, acres	5
Utility Requirements	Natural Gas: For start-up. Quantity not provided
	Fuel Oil: None
	Water: For start-up only, then water recovery system provided make-up.
	Sewer: Domestic use only
	Electricity: Internal load of 833 kW, or total of 6,567 MWh
Composition of Residuals Generated by the Facility	Hazardous: None
	Non-Hazardous: Char/ash mixture
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: Char/ash: 7,884
Mass Balance, TPY (assume 90% availability)	Material Delivered: 54,860
	Material Recycled: 5,486
	Material Disposed: 7,884
	Products Generated: Electricity: 17,082 MWh
	By-Products Generated: None
Costs & Revenues	Capital: $9,936,167 ($181/TPY)
	Annual O&M: $2,526,681
	Annual Capital Recovery: $859,716
	Annual Revenue Generated: $821,065
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $2,565,332
	Net cost/ton MSW delivered: $47/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Plasma Environmental Technologies** Burlington, ON
Brief Description of the Technology	Plasma gasification - No information addressing the questionnaire was provided. PET only provided a 2 page letter discussing a test program they are working on, and a 4 ton/day demo plant they are building.
Project Partners	None
Technical and Financial Resources (Credibility)	No data provided
For the Existing Facilities	
Facility Name	
Location	
Owner	
Technology	
Throughput, TPY	
Feedstock	
Start-up Date	
Capital Cost	
Annual O & M Cost	
Products	
By-products	
Residuals	
For the Proposed Facility	
Throughput, TPY	
Description of Preprocessing System	
Description of Conversion Unit	
Description of Energy Production Systems	
Description of By-Products Processing & Handling Systems	
Feedstock Requirements	Composition:
	Size:
	Moisture Content:
Diversion Rate, %	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air:
	Water:
	Solid Residue:
	Odor:
	Noise:
	Other:
Description of Products and By-Products	Products:
	By-Products:
Quantity of Products and By-Products, TPY	Products:
	By-Products:
Area Requirement, acres	
Utility Requirements	Natural Gas:
	Fuel Oil:
	Water:
	Sewer:
	Electricity:
Composition of Residuals Generated by the Facility	Hazardous:
	Non-Hazardous:
Quantity of Residuals Generated by the Facility, TPY	Hazardous:
	Non-Hazardous:
Mass Balance, TPY	Material Delivered:
	Material Recycled:
	Material Disposed:
	Products Generated:
	By-Products Generated:
Costs & Revenues	Capital:
	Annual O&M:
	Annual Capital Recovery:
	Annual Revenue Generated:
	Net annual cost: [(O&M + Capital Recovery) - Revenues] :
	Net cost/ton MSW delivered:

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Primenergy, LLC** Tulsa, OK		**Renewable** Resources Alliance, LLC Paul Relis
Brief Description of the Technology	Pre-processing is used to prepare a refuse-derived fuel called Post-Recycled Municipal Biomass (PRMB™). The PRMB system includes mechanical and manual systems for removal of paper, glass, metals, and plastics. The PRMB feedstock is metered into the gasifier. Primenergy uses gasification technology developed by PRM Energy Systems, Inc. The fixed-bed gasifier operates at about 1,500 °F, converting the MSW to syngas. The syngas enters a hot gas cyclone, where fly ash is removed. Bottom ash is removed from the bottom of the gasifier. The syngas is then combusted in a large combustion tube, and the hot gases flow through a waste heat boiler for steam production. The steam is piped to a steam turbine generator for production of electricity. Flue gases are treated with injection of lime and activated carbon, with spent materials removed in a fabric filter, followed by a Selective Catalytic Reduction (SCR) system.		
Project Partners	Affiliates of RRA (CR&R, Community Recycling), Nexant Corp. (gasification technical support), Nixon Peabody (energy contracting legal), CH2M Hill (engineering).		
Technical and Financial Resources (Credibility)	RRA's affiliates hold more than 30 municipal franchises for MSW; they form one of the largest waste and recycling companies in California. Community Recycling has the largest composting facility in California. Both are well capitalized. RRA is capable of obtaining financing for the project. CR&R has 1,000 employees, and provides much of the design for its facilities in-house. It has developed the PRMB system. Primenergy is a large equipment manufacturer, with almost 20 gasifiers in operation worldwide. It has in-house technical expertise for design of gasification facilities, including associated material handling equipment. The partnership has extensive technical and financial capabilities. CR&R has raised >$25,000,000 in bond financing from the California Pollution Control Finance Authority and has an available credit line of $105,000,000, which is guaranteed by the underlying municipal waste franchises.		
For the Existing Facilities			
Facility Name	CR Transfer	Gasification and Thermal Energy Conversion System	Sewage Sludge Gasification and Drying Plant
Location	Stanton, CA	Stuttgart, AR	Philadelphia, PA
Owner	CR&R Inc.	Riceland Foods, Inc.	EcoTechnology, Inc.
Technology	MSW separation system including trommels and screens, material floating devices, grinding equipment to produce PRMB.	PRM Energy Systems, Inc. gasification	PRM Energy Systems, Inc. gasification
Throughput, TPY	500,000	180,000	84,000

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Feedstock	MSW	Rice hulls	75% moisture sewage sludge
Start-up Date	1990	1996	March 2005
Capital Cost	$14,000,000	$22,000,000	$6,500,000
Annual O & M Cost	$4,800,000	~$1,500,000	$600,000
Products	Recyclables: metals, fibers, glass, C&D materials, PRMB, wood waste fuel	Steam and electricity (12.8 MW gross/11.6 MW net) for milling rice plant	90% reduction and thermal degradation of sewage sludge. Ash is returned to compost made from sewage sludge.
By-products	N/A	None	None
Residuals	50% sent to landfill	28% of feed is sent to landfill (25% of rice hull is high silica ash). Ash is now being marketed.	None
For the Proposed Facility			
Throughput, TPY	35,000		
Description of Preprocessing System	CR&R (RRA's affiliate) is designing its new MRF (and PRMB production facility) for installation at the Perris Facility in Riverside County, and proposes that the Primenergy conversion and power generation system be located there. Pre-processing involves preparation/sorting of MSW to recover ~30% of raw MSW for recycling. Steel and aluminum would be recovered at nearly 100% and additional paper, plastics and organic materials would be sorted for recycling. Recyclables would be returned to recycling centers. Remaining material, mostly marginal paper and mixed plastics, would be refined and processed into PRMB.		
Description of Conversion Unit	4.16 TPH of PRMB is fed into a single KC-16 gasifier, where gasification of the feedstock occurs at about 1,500 °F, producing syngas. The syngas from the gasifiers flows through a hot gas cyclone for removal of fly ash. The cleaned syngas is then combusted in the combustion tube at 2,400 °F. The hot flue gas flows through the waste heat boiler, where steam is produced for power generation. The cooled flue gases are treated in an extensive emission control system. Lime is injected into the flue gases for removal of acid gases, including SO_2 and HCl. Activated carbon is injected for adsorption of heavy metals, including vaporized mercury. The reaction products and particulate matter in the flue gas stream are then removed in a fabric filter. NO_x emissions are controlled by using Selective Catalytic Reduction (SCR). The cleaned flue gases are exhausted through a stack.		
Description of Energy Production Systems	The hot flue gases enter the waste heat boiler, where steam is produced. The steam is piped to a steam turbine generator, producing 3.08 MW gross/2.57 MW net.		

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Description of By-Products Processing & Handling Systems	No post-processing required.
Feedstock Requirements	Composition: MSW converted to PRMB (mostly paper and plastic)
	Size: -3/8 inch
	Moisture Content: 25%
Diversion Rate, %	99
Environmental Issues	Air: The combustion tube incorporates staged combustion for NO_x control. Air emission control system includes injection of lime for removal of acid gases, and activated carbon for removal of mercury and other contaminants. Spent materials and fly ash are collected in a fabric filter. The cleaned gases then flow through the SCR system for NO_x removal.
	Water: Cooling tower blowdown (if wet cooling tower is used).
	Solid Residue: Fly ash and reacted by-products from emission control system. Bottom ash assumed to be marketable (testing needed to confirm).
	Odor: CR&R incorporates an extensive biofilter and deodorizer misting system into its facilities for odor control. It has designed and installed the largest biofilter in California.
	Noise: Trucks
	Other: None identified.
Description of Products and By-Products	Products: Electricity
	By-Products: Bottom ash
Quantity of Products and By-Products, TPY	Products: Electricity: 21,580 MWh
	By-Products: Bottom ash: 3,872
Area Requirement, acres	1 (does not include PRMB facility already planned for construction)
Utility Requirements	Natural Gas: for building heat and start-up. Quantity not specified.
	Fuel Oil: Not required.
	Water: Potable water for boiler feedwater make-up, cooling tower make-up (if wet cooling tower used), employee usage. Quantity not specified.
	Sewer: Domestic use.
	Electricity: 4,276 MWh
Composition of Residuals Generated by the Facility	Hazardous: Fly ash and spent reactants from emission control system.
	Non-Hazardous: Bottom ash, if it is not saleable.
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 151
	Non-Hazardous: 0 if bottom ash is saleable; 3,872 if bottom ash is not saleable and goes to landfill

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Mass Balance, TPY	Material Delivered: 35,000 (PRMB)
	Material Recycled: 0 (recyclables from PRMB production facility not included here)
	Material Disposed: 151
	Products Generated: Electricity; 21,580 MWh
	By-Products Generated: Bottom ash: 3,872
Costs & Revenues	Capital: $15,500,000
	Annual O&M: $1,557,000
	Annual Capital Recovery: $2,583,000
	Annual Revenue Generated: $1,067,900
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $3,072,100
	Net cost/ton MSW delivered: $87/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Rigel Resource Recovery and Conversion Company** Baltimore, MD
Brief Description of the Technology	Rigel proposes to integrate autoclaving, MRF, plasma gasification, and power generation technologies. The MRF would utilize a Tempico Rotoclave, an autoclave that uses steam to physically reduce the volume of the MSW, and sterilize it. The output of the Rotoclave is then sent to a MRF for removal of metals and plastics. (Not known why Rigel has decided to put a MRF to treat MRF residuals). The MRF output, along with unsorted MSW, is sent to the plasma gasification system, supplied by Recovered Energy Inc., and using Westinghouse Plasma Corporation's plasma gasification technology. The syngas would be combusted in a gas turbine, and steam production in the process and from a heat recovery steam generator would drive a steam turbine. Rigel has not developed this type of facility before. Other integrated facilities (which may be added later) may include a glass plant using the recovered glass from the process, as well as a paper manufacturing plant using pulp recovered from the MSW treated in the Rotoclave.
Project Partners	Tempico (Rotoclave facility), Recovered Energy, Inc. (plasma gasification facility), Westinghouse Plasma Corporation (plasma torch design).
Technical and Financial Resources (Credibility)	Rigel is a start-up management company, which is being set up as an LLC. Its shareholders are the individuals who have come together to promote and develop this combination of technologies. Many of the individuals are former employees of Orion Power Holdings, a company that developed gas-fired combined cycle power plants in the U.S. Orion was acquired by Reliant Resources in 2002. At this time, Rigel has no assets, and has developed no projects. Rigel and its partners likely have the technical expertise to develop this project. While the ex-Orion staff has significant experience in obtaining financing for power projects (over $1 billion of projects), Rigel itself has no track record or financial history.
For the Existing Facilities	
Facility Name	No facilities using this combination of technologies exist. Rigel has not developed any projects.
Location	
Owner	
Technology	
Throughput, TPY	
Feedstock	
Start-up Date	
Capital Cost	
Annual O & M Cost	
Products	
By-products	

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Residuals	
	For the Proposed Facility
Throughput, TPY	1,095,000 (3,000 TPD is the minimum economical size for this facility, according to Rigel)
Description of Preprocessing System	The facility would use two Rotoclaves to process 350 TPD of MSW. The Rotoclaves use steam at 275-300 °F to treat 350 TPD of the incoming MSW for about 2 hours, reducing its volume by up to 2/3 and sterilizing it. The output from the Rotoclaves is sent to a MRF for recovery of ferrous and non-ferrous metals, and high-value plastics. The output is then conveyed to the plasma gasification system, where it is mixed with unprocessed MSW.
Description of Conversion Unit	Rigel proposes to use the Recovered Energy Inc.'s plasma gasification system. This incorporates Westinghouse Plasma Corporation plasma torches (number of torches not specified) and reactor design. To treat the 3,000 TPD, there are six 500 TPD reactors. In the reactor, the plasma torches create a hot gas at up to 8,000 °F. The MSW is heated to over 3,000 °F, and the organic portion of the MSW is converted to syngas. The metals and inorganic components form molten metal and molten slag, respectively. These molten components are tapped from the bottom of the reactor, cooled in a water bath, and recovered in solid form. The metals can be sold to metal processors. The slag forms a glassy, non-hazardous granulate which can be sold for use in making sandblasting grit, roofing tiles, and cement. The hot syngas is cooled in a heat exchanger, producing steam for power generation. The syngas is cleaned of particulates in hot gas cyclone, then to a Turbosonic wet scrubber for removal of HCL (this is concentrated for sale). The syngas then goes through a Turbosonic wet electrostatic precipitator to remove fine particulate, heavy metals, acid gases, and any remaining dioxins and furans. The syngas is combusted in a gas turbine. Flue gases are treated by a SCONOX system to remove NO_x, CO, and non-methane volatile compounds. Sulfur compounds are removed either pre- or post-combustion (to be determined). The hot flue gases from the combustion turbine pass through a heat recovery steam generator, producing additional steam for power generation in the steam turbine.
Description of Energy Production Systems	Hot syngas flows through a heat exchanger, producing steam that flows to a steam turbine. Following clean-up, the cooled, clean syngas is combusted in a gas turbine. The hot exhaust gas flows through a heat recovery steam generator, producing more steam for the steam turbine. Total power generation is listed as 280 MW gross. The net generation is not specified; Rigel expects to be able to export 1 MWh/ton MSW. This equates to a net generation of 125 MW on the basis of 3,000 TPD.
Description of By-Products Processing & Handling Systems	Not required.
Feedstock Requirements	Composition: MSW and MSW from Rotoclave/MRF
	Size: 1 meter maximum
	Moisture Content: No maximum specified.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Diversion Rate, %	~100%, assuming slag is saleable. Rigel notes that about 1% of the original MSW feed needs to be landfilled, but provides no detail on the composition or quantity of that stream.
Environmental Issues	Air: Volatiles from the Rotoclave are condensed and removed. Additional treatment with a charcoal filter may be added if needed. In the conversion unit, extensive syngas cleaning and flue gas cleaning systems are proposed. A hot gas cyclone is used to remove particulates from the syngas. Rigel proposes a Turbosonic emission control system, incorporating particulate controls, acid gas removal (HCL and sulfur compounds, with recovery of concentrated HCl for sale), a wet electrostatic precipitator for removal of fine particulates, liquid particles, heavy metals, acid mists, and any remaining dioxins and furans. After combustion in the gas turbine, the flue gas is treated by the SCONOX process for removal of NO_x, CO and VOCs.
	Water: The Rotoclave/MRF facility would have a wastewater residual (volume not specified). The plasma gasification system actually recovers water from the MSW. This would be cleaned and re-used, allowing for zero-discharge portion in this portion of the facility.
	Solid Residue: Rigel notes that about 1% of the original MSW feed needs to be landfilled, but provides no detail on the composition or quantity of that stream.
	Odor: Rigel proposes to maintain a negative pressure in the tipping building. The air removed is used in the process, destroying odor-causing compounds. Volatiles from the Rotoclave are condensed and removed. Further treatment in a charcoal filter may be added if needed.
	Noise: Trucks
	Other: None identified.
Description of Products and By-Products	Products: Electricity
	By-Products: metals and plastics from pre-processing; slag and metals from gasifier.
Quantity of Products and By-Products, TPY	Products: Electricity: 1,200,000 MWh
	By-Products: Metals: 5,475 Plastics: 7,300 Slag: not specified Metals from gasifier: 125
Area Requirement, acres	35
Utility Requirements	Natural Gas: Needed for gas turbine start-up at rate of 1,600 mmBtu/hour until syngas is available.
	Fuel Oil: None required.
	Water: 29 million gallons/year (Rotoclave requires 1 ton water per ton MSW, in the form of steam)
	Sewer: Not specified
	Electricity: 1,357,800 MWh

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Composition of Residuals Generated by the Facility	Hazardous: None. Rigel notes that about 1% of the original MSW feed needs to be landfilled, but provides no detail on the composition or quantity of that stream.
	Non-Hazardous: None. Rigel notes that about 1% of the original MSW feed needs to be landfilled, but provides no detail on the composition or quantity of that stream.
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 1,095,000
	Material Recycled: 12,900
	Material Disposed: 0
	Products Generated: Electricity: 1,200,000 MWh
	By-Products Generated: Metals: 5,475 Plastics: 7,300 Slag: not specified Metals from gasifier: 125
Costs & Revenues	Capital: $800,000,000
	Annual O&M: $73,050,000
	Annual Capital Recovery: $32,000,000
	Annual Revenue Generated: $56,272,000
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $48,778,000
	Net cost/ton MSW delivered: $44/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Taylor Biomass Energy LLC** Montgomery, NY
Brief Description of the Technology	Pre-processing: not required for removal of recyclables from MRF residuals, but used to protect the process from undesirable feed or tramp material. Conversion technology: Taylor proposes to use the FERC SilvaGas process, a unique fluid-bed pyrolysis technology that incorporates combustion of the syngas and the char remaining from pyrolysis. The MSW feedstock enters the reactor though an airlock (oxygen must be kept out for pyrolysis), where it comes into contact with hot fluidizing sand at 1,800 °F and low-pressure steam. The MSW is converted to syngas at 1,545 °F. The hot syngas exits the top of the reactor, and flows through a hot gas cyclone for removal of particulates, sand and pyrolysis char. From there, the syngas goes to the boiler for combustion. The sand, ash and pyrolysis char flow by gravity to the bottom of the combustor, where the char is combusted with air. The hot flue gas exits the top of the combustor at 1,845 °F and flows through another hot gas cyclone, where additional particulates and sand are removed; they are recycled to the bottom of the reactor. This hot sand provides the indirect heat needed for pyrolysis in the reactor. The flue gas enters the heat recovery steam generator for more steam production. Flue gases from the combustor and the boiler are treated in a fabric filer and Selective Catalytic Reaction (SCR) system. Energy Production: Hot flue gases from the boiler and heat recovery steam generator create steam, which is piped to a steam turbine generator for producing electricity.
Project Partners	FERCO (technology license and process design)
Technical and Financial Resources (Credibility)	Taylor Biomass is a small company that is part of the Taylor Holdings Group, Ltd. Their expertise is in recycling and recovery from construction and demolition wastes (see facility descriptions below). Taylor Biomass was set up to market and develop the FERCO SilvaGas technology. While Taylor itself has limited technical capabilities or experience with MSW or MSW conversion technologies, Taylor has provided resumes of other project participants that have significant technical expertise in design and development of power plants and other energy and industrial facilities. While they have technical credibility, Taylor states that "Taylor Biomass Energy, LLC is a small business and does not possess the financial capabilities to complete the design and construction of the Taylor Pre-Processing and gasification plants without access to external funds. Taylor welcomes LA's resources to accelerate proving the model. Taylor is not in a position to provide a financial guarantee." Therefore, without outside funding, Taylor is not likely to be able to financially implement the proposed project.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Existing Facilities			
Facility Name	Taylor C&D facility	Battelle Pilot Scale FERCO Process (shut down)	Vermont Gasification Project (shut down in 2001)
Location	Montgomery, NY	West Jefferson, OH	Burlington Electric McNeil Station, Burlington, VT
Owner	Taylor Holdings Group, Ltd.	Battelle	FERCO
Technology	Screens, conveyors, mills, magnets for recovery of recyclables from C&D waste	FERCO SilvaGas fluid bed pyrolysis	FERCO SilvaGas fluid bed pyrolysis
Throughput, TPY	60,000	10-12 dry TPD pilot plant. Annual throughput not known.	Designed for about 300 tons/day, operated at up to 500 tons/day. Commercial-scale test program of the SilvaGas
Feedstock	C&D waste	Wood, switch grass, source-separated MSW, waste wood, logging residue, paper mill sludges	Woody biomass, wood pellets, chopped pallets, crop residues.
Start-up Date	Early 1990s	Late 1970s (operated >20,000 hours)	1999
Capital Cost	$2,000,000	$2,500,000	$14,000,000
Annual O & M Cost	$1,500,000	Not known	Not known
Products	Wood, metal, aggregates, wallboard, cardboard	Syngas at 450-500 Btu/scf, electricity from Solar gas turbine.	Syngas at 470 Btu/scf piped to power plant's boiler
By-products	Waste rejects used as alternative daily cover for landfill	Cyclone ash at 2-3% of inlet	Cyclone ash at 3% of inlet
Residuals	<5% of inlet goes to landfill	None identified	None identified

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	33,930
Description of Preprocessing System	Since MRF residuals are the feedstock, Taylor does not intend to install a system for recovery of recyclables. Pre-processing will include a mill to reduce the size of the inlet MSW, and magnets and eddy current separators to remove tramp metals.
Description of Conversion Unit	Taylor proposes to use one SilvaGas system rated at 5.2 TPH. The processed MSW enters the reactor though two rotary airlocks, lock hoppers and a feed metering bin. The MSW contacts the hot fluidizing sand and undergoes pyrolysis at 1,545 °F, converting the organic portion to syngas. The syngas stream, with char and ash, exits the top of the reactor and flows through the hot gas cyclone. Char, sand, and fly ash are removed and sent to the combustor. The cleaned syngas is combusted in a boiler, where steam is produced. The cooled exhaust gas is sent to a fabric filter for removal of particulates, then through the SCR system for NO_x removal. The char is combusted in the combustor, and the flue gas exits the top of the combustor. Sand and ash are removed in a hot gas cyclone; the hot sand is returned to the bottom of the reactor to provide the heat needed for pyrolysis of the MSW. The flue gas then flows through another cyclone, where the ash is removed. This ash can be used for construction materials. The flue gas then flows through a heat recovery steam generator, producing steam for power generation. The flue gas from the boiler and the combustor flow through the fabric filter to remove particulate matter and the SCR system for NO_x removal. All cleaned flue gases exit through a stack.
Description of Energy Production Systems	Taylor proposes to use a package boiler to produce steam from the combustion of the syngas, a heat recovery steam generator to produce steam from the combustion of the char, and a steam turbine generator sized to produce 4 MW net. Taylor proposes to utilize some of the low pressure steam to drive a package chiller plant. Since the site is not selected, a user of the chilled water is not identified; this system may not be included.
Description of By-Products Processing & Handling Systems	Not required.
Feedstock Requirements	Composition: MSW
	Size: 4 inches
	Moisture Content: 25%
Diversion Rate, %	99
Environmental Issues	Air: Cyclones and a fabric filter are used to remove particulate matter from syngas and the flue gas. Following the fabric filter, the gas flows through the SCR system for NO_x removal.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**WasteGen (UK) Ltd.** Gloucester, U.K.
Brief Description of the Technology	WasteGen licenses TechTrade's rotary kiln pyrolysis technology. The MSW is shredded to 12 inch size, and is fed by screw feeder to the pyrolysis kilns. Indirect heat for pyrolysis is supplied by the recycle of a portion of the hot flue gases combusted downstream in the process. Calcium hydroxide is added into the kiln to bind some of the acid gases such as SO_2 and HCl. Pyrolysis occurs at about 935 °F, producing syngas and leaving behind the inorganic components of the MSW (ash), mixed with unconverted carbon char. The char/ash solids are removed through a water bath system and a wet slag removal system. The mixture is then conveyed from the system, and metals are removed by magnetic and eddy current separators. The char is conveyed into a rotary kiln gasifier, producing syngas and a potentially marketable bottom ash. The syngas is cleaned of its particulate matter, and combusted in the combustion chamber at 2,300 °F. The hot flue gases flow through a boiler, where steam is produced. The steam is piped to a steam turbine generator for the generation of electricity. A portion of the hot flue gases are routed back to the outer jacket of the kiln, in order to provide the indirect heat needed for pyrolysis of the MSW. After the cooled flue gases leave the boiler, sodium bicarbonate and calcium hydroxide are injected into the flue gas stream to capture acid gases such as SO_2 and HCl. Activated carbon is also injected, to adsorb heavy metals, such as vaporized mercury. The particulates and reaction products are removed in a fabric filter, and the cleaned flue gases are exhausted through a stack.
Project Partners	TechTrade GmbH (technology license and pyrolysis system design) and Shaw Stone & Webster (overall facility design and construction)
Technical and Financial Resources (Credibility)	WasteGen licenses the technology from Tech Trade, and relies on TechTrade for its technical capabilities. TechTrade staff are the original inventors of the technology and have provided the detailed design for all WasteGen facilities. Together with Shaw Stone & Webster, there are sufficient design and engineering capabilities to implement the project. WasteGen states that "It should be noted that any supply contract would be with Shaw Stone & Webster of Baton Rouge, Louisiana who will provide the EPC Contract for the plant. They will be the prime contracting party with Los Angeles for the supply of our technology." Shaw Stone & Webster would be responsible for providing the project guarantees. Together, the team has the ability to provide the technical and financial resources to implement the project.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Existing Facilities			
Facility Name	Municipal Pyrolysis Plant	RWE Pyrolysis Unit	Herne Soil Treatment BRZ Herne
Location	Burgau, Germany	Hamm-Uentrop, Germany	Bochum, Germany
Owner	Günzburg Council	RWE Energie GmbH	SITA
Technology	TechTrade rotary kiln pyrolysis with power generation	TechTrade rotary kiln pyrolysis – syngas goes to existing power plant boiler and is co-fired with coal	TechTrade rotary kiln pyrolysis
Throughput, TPY	40,000	110,000	75,000
Feedstock	MSW	MSW	Dioxin/furan contaminated soils
Start-up Date	1984	2001	1992
Capital Cost	Not known	$31,250,000	$25,000,000
Annual O & M Cost	$3,750,000	$2,500,000	$5,000,000
Products	Electricity (2 MW) and steam to greenhouse	Electricity (12 MW) - syngas is co-fired in power plant boiler for producing electricity	75,000 TPY usable soil
By-products	None	None	None
Residuals	Char/ash mixture (20,000 TPY) and fabric filter ash	8,000 (bottom ash)	None

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	100,000
Description of Preprocessing System	The MSW is shredded to 12 inch size, and is fed by screw feeder to dryers to reduce the moisture to <20%. Drying is accomplished using process steam.
Description of Conversion Unit	WasteGen proposes to use 2 rotary kilns rated at ~8 TPH each. Calcium hydroxide is added to the MSW to capture acid gases later in the process. The shredded, dried MSW is fed to the 2 pyrolysis kilns, where it is thermally decomposed to syngas at 935 °F, leaving behind the inorganic components as ash, in a mixture with the unconverted carbon char. The char/ash mixture enters the carbon recovery unit, a rotary gasification kiln, where the carbon char is gasified, producing more syngas (this is a new process addition to the basic WasteGen pyrolysis technology, although the technology is commercially available). Bottom ash is produced, which is likely to be saleable/usable since it will no longer contain char. The syngas is cleaned of particulate matter in a hot gas cyclone, then combusted in the combustion chamber at 2,300 °F. A portion of the hot flue gas is routed back to the outer annuli of both of the kilns, providing the indirect heat required for pyrolysis. Urea is injected to convert a portion of the NO_x to nitrogen. The hot flue gases flow through the boiler, and steam is produced for power generation. After leaving the boiler, the cooled flue gas is injected with calcium hydroxide and sodium bicarbonate slurries in order to capture acid gases in the flue gas, such as SO_2 and HCl. Activated carbon is also injected to adsorb heavy metals, such as vaporized mercury. The flue gases then flow through a fabric filter, where particulate matter and byproducts from reaction with the acid gases are captured and removed. The cooled, cleaned flue gases are exhausted through a stack.
Description of Energy Production Systems	The steam is piped to the single steam turbine generator, producing 12 MW gross, and 9 MW net of electricity.
Description of By-Products Processing & Handling Systems	Magnetic and eddy current separators will recover ferrous and non-ferrous metals from the bottom ash for recycling.
Feedstock Requirements	Composition: MSW
	Size: Shredded to 12 inch size
	Moisture Content: Dried to 20% maximum moisture
Diversion Rate, %	99

TABLE A-4 (CONTINUED) SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: the process includes an extensive air emission control system, including urea injection in the boiler for reduction of NO_x emissions, lime and sodium bicarbonate injection for control of acid gases, a fabric filter for removal of particulate matter and reaction products, and activated carbon injection for removal of mercury and other heavy metals.
	Water: No wastewater discharge identified.
	Solid Residue: Fly ash from the fabric filter.
	Odor: The tipping hall is maintained under negative pressure, with the air used in the combustor, where odor-causing compounds are destroyed.
	Noise: Trucks
	Other: None identified
Description of Products and By-Products	Products: Electricity
	By-Products: Bottom ash, metals. WasteGen lists steam export for sale; since the site is not selected, no user is confirmed, so this data is not included in the evaluation.
Quantity of Products and By-Products, TPY	Products: Electricity: 67,500 MWh
	By-Products: Bottom ash: 30,000 Metals recovered from bottom ash: 2,200
Area Requirement, acres	5
Utility Requirements	Natural Gas:
	Fuel Oil: Required for heating the kilns at start-up. Rate of 1.75 gallons oil/ton MSW, or ~25 gallons/hour
	Water: 4.8 million gallons/year for boiler water make-up
	Sewer: Employee use only
	Electricity: 21,600 MWh
Composition of Residuals Generated by the Facility	Hazardous: Fabric filter ash
	Non-Hazardous: None
Quantity of Residuals Generated by the Facility, TPY	Hazardous: 1,031
	Non-Hazardous: None
Mass Balance, TPY	Material Delivered: 100,000
	Material Recycled: Metals: 2,200
	Material Disposed: 1,031
	Products Generated: Electricity: 67,500 MWh
	By-Products Generated: Bottom ash: 30,000

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Costs & Revenues	Capital: $60,000,000 ($600/TPY)
	Annual O&M: $3,427,000
	Annual Capital Recovery: $7,300,000
	Annual Revenue Generated: $3,037,500
	Net annual cost: [(O&M + Capital Recovery) - Revenues] : $7,689,500
	Net cost/ton MSW delivered: $77/ton

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE
THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Green Energy Corporation** Englewood, CO
Brief Description of the Technology	The technology is designed for commercial applications to produce fuels and chemicals from feed stocks normally considered negative or low-value waste. Preprocessing consists of grinding the feedstock to one inch or less. An added benefit is that the volume of most "waste" feed stocks will be reduced by 95% or more leaving only a benign clay-like ash. The BCT reactor produces green, or alternative, energy in the form of synthesis gas that can be catalytically converted to ethanol or can be used to fuel an internal combustion engine or micro-turbine to generate electricity. The BCT process offers additional environmental benefits as it promises to use as feed stock large volumes of waste products such as bio-solids, agricultural waste products, municipal solid waste, sewage sludge, and many other carbonaceous wastes. The gasification process converts any carbon-containing material into synthesis gas composed primarily of carbon monoxide, hydrogen and methane, which can be used as a fuel to generate electricity when combined with a turbine or internal combustion engine generator unit, or used as a basic chemical building block for a large number of applications in the automotive fuels, petrochemical and refining industries. The BCT steam reforming gasification process is a form of thermal decomposition in an environment with limited or no oxygen. The technology has the ability to treat a wide variety of gaseous, liquid and solid feedstock. Gasification customarily adds value to low or negative-value feedstock by converting it to marketable fuels and products. Conventional fuels such as coal and oil, as well as low or negative-value materials and waste such as petroleum coke, heavy refinery residuals, secondary oil-bearing refinery materials, municipal sewage sludge, hydrocarbon contaminated soils and chlorinated hydrocarbon products have all been used in gasification operations. The syngas can also be processed using commercially available technologies to produce products such as fuels, chemicals, fertilizer or industrial gases. The ability to produce ethanol cheaply and quickly from synthesis gas is of equal and perhaps even greater significance than the breakthroughs represented by the gasifier. The proprietary Biomass Conversion System ("System") is comprised of the BCT Gasifier mated to our proprietary ethanol reactor. The System features a proprietary catalyst, and other trade secret elements. The System is highly efficient and can generate up to 20,000 GPD of ethanol from 400 wet (200 dry) tons per day of any kind of carbonaceous material.
Project Partners	Zambrana Engineering, Inc. headquartered in St Louis Missouri Bioconversion Technologies, LLC
Technical and Financial Resources (Credibility)	No technical or resource describe except the resume of key management personnel. Green Energy processed different carbonaceous material and tested MSW.

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Existing Facilities			
Facility Name	BCT Bioconversion Technology	BCT Bioconversion Technology	BCT Bioconversion Technology
Location	6535 North Washington Street Denver, Colorado 80202	6535 North Washington Street Denver, Colorado 80202	6535 North Washington Street Denver, Colorado 80202
Owner	Bioconversion Technologies, LLC.	Bioconversion Technologies, LLC.	Bioconversion Technologies, LLC.
Technology	Staged Temperature Reaction Process Gasifier	Staged Temperature Reaction Process Gasifier	Staged Temperature Reaction Process Gasifier
Throughput, TPY	1 ton/day Test and Pilot System	5 ton/day Permanent Test/Demonstration System	15 tons/day SAS System-staged for delivery to client
Feedstock	Various Carbonaceous feedstock	Various Carbonaceous feedstock	Wood waste System
Start-up Date	1988		
Capital Cost	3,000,000		
Annual O & M Cost			
Products	Electricity/Gas/Syngas		
By-products			
Residuals	10% to the landfill		

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Throughput, TPY	39,600
Description of Preprocessing System	The MSW is shredded to one-inch minus size, and containing a maximum of 40% moisture. Variability of the different types of carbonaceous material have little impact on the systems operation.
Description of Conversion Unit	Green Energy Corp. acquired a Technology License Agreement from Bio-Conversion Technology, LLC. of Denver, Colorado to market the patented BCT Gasifier Technology and reactors based on this technology (Steam Reforming Pyrolysis). Green Energy will design and staff its own marketing and sales department to develop, own and operate gasification units for company-owned projects or the sale of BCT Gasifier machines to third parties. The BCT reactor produces green, or alternative, energy in the form of synthesis gas that can be catalytically converted to ethanol or can be used to fuel an internal combustion engine or micro-turbine to generate electricity. The BCT process offers additional environmental benefits as it promises to use as feed stock large volumes of waste products such as bio-solids, agricultural waste products and sewage sludge. The BCT Gasification Reactor is more efficient than competing processes as it produces fewer residues and eliminates the discharge of noxious emissions. The BCT Technology has been field tested and demonstrated to work outside of the laboratory. Green Energy Corp will seek to sell and install its products in order to solve environmental problems resulting from society's ever-increasing generation of waste. The ability of Green Energy to process a wide variety of waste materials and to produce a product (energy) that is in ever-increasing demand provides a solid foundation for the building of a successful business.
Description of Energy Production Systems	The proposed facility will produce sygas, a mixture of hydrogen, carbon monoxide, and methane. This gas can be used as is, to fuel an internal combustion engine or micro-turbine that can power an electricity generator set. Or the gas can be catalytically converted to farm ethanol if the gasifier connected to alcohol plant.
Description of By-Products Processing & Handling Systems	The small solid residue is benign, with trace minerals that in some cases are suitable for use as fertilizer or animal feed supplement.
Feedstock Requirements	Composition: Carbonaceous material or MSW
	Size: Shredded to one-inch minus
	Moisture Content: Maximum 40%
Diversion Rate, %	90

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: the process is a completely closed process except for the negligible emissions of the gasifier heat source. The syngas is going through a Cyclone, Quench and Cooling, Final Chilling, Sygas Compression, and Excess Hydrogen Removal. This process cleans the syngas.
	Water: Negligible amount of non-hazardous. Can be disposed in a regular sanitary sewer.
	Solid Residue: Approximately 10% or less non-hazardous ash.
	Odor: The system is a closed process, which eliminate odorous discharge.
	Noise: Trucks
	Other: None identified
Description of Products and By-Products	Products: Syngas, Electricity, and/or ethanol
	By-Products: Bottom ash, metals.
Quantity of Products and By-Products, TPY	Products: Electricity: 42,400 MWh
	By-Products: Bottom ash: 2,040
Area Requirement, acres	2 acres
Utility Requirements	Natural Gas: 5000 therms/hour (for initial start up only)
	Oil: None
	Water: up to 150 gallon/day (make-up)
	Sewer: Negligible
	Electricity: kW
Composition of Residuals Generated by the Facility	Hazardous: None
	Non-Hazardous: Ash can be disposed in a regular landfill
Quantity of Residuals Generated by the Facility, TPY	Hazardous: None
	Non-Hazardous: Ash 2040
Mass Balance, TPY	Material Delivered: 39,600
	Material Recycled: Metals: 2,160
	Material Disposed: 30,000
	Products Generated: Electricity: 42,400 MWh
	By-Products Generated: Bottom ash: 2,040

TABLE A-4 (CONTINUED)
SUMMARY OF RESPONSES FROM THE THERMAL CONVERSION TECHNOLOGY SUPPLIERS

Costs & Revenues	Capital: $10,250,000 ($258/TPY)
	Annual O&M: $1,510,000
	Annual Capital Recovery: $2,181,785
	Annual Revenue Generated: $ 1,908,000 (Only from electricity)
	Net annual cost: [(O&M + Capital Recovery) - Revenues]: $1,783,785
	Net cost/ton MSW delivered: $45/ton

TABLE A-5
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

TABLE A-5
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Arrow Ecology & Engineering Overseas Ltd.** Wheeling, WV
Brief Description of the Technology	Arrow Ecology has patented the ArrowBio process for anaerobic digestion of solid waste. The waste first goes through a wet preprocessing chain to remove recyclables and undesirable compounds. In fact, the first preprocessing step consists of submerging the waste. The conversion feed resulting from this process goes into an acidogenic reactor for a brief time. The dissolved and suspended effluent from that reactor is led to a wastewater digester, of the UASB type (Upflow Anaerobic Sludge Blanket). Liquid effluent can be cleaned up to high quality irrigation water.
Technical and Financial Resources (Credibility)	Arrow Ecology Ltd., the parent company, is a professional environmental services and contracting/implementation company providing a comprehensive full service approach to environmental problems and regulatory compliance. The company offers a wide range of environmental and industrial services. The company's financial condition is good; a supportive statement from Bank Leumi was provided.
For the Existing Facilities	
Facility Name	Tel Aviv ArrowBio facility
Location	Tel Aviv, Israel
Owner	Arrow Ecology & Engineering Dan Ltd.
Technology	ArrowBio process
Throughput	31,000 tpy
Feedstock	Mixed unsorted MSW
Start-up Date	December 2002
Capital Cost	$10 million
Operating Cost	$385,000/year
Products	Biogas, electricity (700-800 kW net), organic soil amendment (10-15 tpd), water (2500 gal/day)
By-products	Metals, plastics, glass, stones
Residuals	25 tpd

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	31,000 tpy
Description of Preprocessing Systems	The black bin waste is dropped onto a tipping floor, from where it is pushed into a vat of recirculated water. MSW components are separated gravitationally in the vat. From then on, most of the preprocessing occurs in water. During preprocessing, some recyclables are recovered, and undesirable residue is removed.
Description of Conversion Unit	The resulting conversion feed is introduced into an acidogenic reactor where it spends a few hours. From there, it is pumped to the UASB digesters to be biogasified. The digester operates at approximately 4% dry matter. A large inventory of water is recirculated between the various processes
Description of Energy Production Systems	Biogas from the UASB digester fuels generators with appropriate emissions controls
Description of By- products Processing & Handling Systems	The solid residue from the acidogenic and UASB reactors is very stable and requires very little curing
Feedstock Requirements	Composition: MSW
	Size: no limits
	Moisture Content: no limits
Diversion Rate	79%
Environmental Issues	Air: will comply with local regulations
	Water: 1500-2000 gallons per day to the sewer
	Solid Residue: will be landfilled
	Odor: controlled by largely submerged pretreatment
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: Electricity
	By-Products: Metals, mixed plastics, glass, soil amendment, water
Quantity of Products and By-Products	Products: 6.4 million kWh/yr
	By-Products (tpy): metals (800), mixed plastics (3300), glass (500), soil amendment (10,300), water (2800)
Area Requirement	3 ac

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: not needed
	Fuel Oil: not needed
	Water: some dilution water may be needed
	Sewer: 1500-2000 gpd
	Electricity: not needed
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 6500 tpy
Mass Balance	Material Delivered: 31,000 tpy
	Material Recycled: 4600 tpy
	Material Disposed: 6500 tpy
	Product Generated: 800 kW; 10,000 tpy organic soil amendment
Cost	Capital: $16 million, excluding land
	O&M: $1.0 million/year
	Revenue Generated: $383,000/year

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Bioengineering Resources, Inc. (BRI)** Emmaus Road, Fayetteville
Brief Description of the Technology	Gasification/Fermentation (Gasification of MSW to produce synthesis gas, followed by fermentation of the synthesis gas to ethanol. Waste heat from the process is converted to steam and electricity.)
Technical and Financial Resources (Credibility)	Audited statement of income provided for the year 2000 shows $3.3 million operating income, and $1.0 million net operating income. BRI is working with engineering companies (Parsons, etc.) that routinely provide equipment guarantees and performance bonds.
For the Existing Facilities	
Facility Name	BRI pilot facility
Location	Fayetteville, AR
Owner	BRI
Technology	Gasification/fermentation pilot demonstration
Throughput	1.5 US tpd
Feedstock	Wood, corn stover, tires, RDF
Start-up Date	Thermal gasifier – 2003; fermenter – 1991
Capital Cost	$4.5 million
Operating Cost	$1.5 million/year
Products	Ethanol, steam
By-products	None listed.
Residuals	None listed. Probably include gasifier residues (ash, slag), and fermenter excess solids

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	96,500 tpy
Description of Preprocessing Systems	"Some size reduction"; suggest drying using process steam.
Description of Conversion Unit	BRI has selected a two-stage gasifier that raises the syngas temperature to over 2000°F in the second stage to enable cracking of any heavy hydrocarbons to CO and H_2, maximizing the ethanol yield. There are hundreds of these units in operation with a demonstrated reliability of 95 percent. The hot gases are then cooled to 100° F and introduced into the fermenter where ethanol is produced. Nutrients are added to provide for cell growth and automatic regeneration of the biocatalyst. A dilute, aqueous stream of ethanol is continuously removed through a membrane that retains cells for recycle to maximize reaction rates. Anhydrous ethanol is produced by conventional distillation followed by a molecular sieve, using the waste heat from the process. Water, with nutrients, is recycled from the distillation bottoms back to the fermenter. The selected gasifier (maximum unit size 125 tons/day) is capable of handling RDF as produced at the County's MRFs with no additional sorting. Metals and glass simply pass through the gasifier, along with the ash, while the organic fractions are converted to carbon monoxide and hydrogen, and thus serve as the raw materials for ethanol production. Multiple trains of gasification and fermentation are used to achieve the desired capacity. Two modules are proposed for the initial demonstration in Los Angeles to provide operating flexibility. Additional modules will be added later to improve the economic feasibility.
Description of Energy Production Systems	There are two sources of waste heat in this process: a) the cooling of the hot syngas and b) the combustion of the unconverted CO, H_2 and hydrocarbons in the exhaust gases from the fermenter. Steam can be generated from these waste heat sources and introduced into a turbine to generate electricity. The turbine exhaust steam can then be used as a source of heat for ethanol purification, feedstock drying, air pre-heating, etc. Alternatively, the unused syngas may be burned in an engine / generator to produce power with exhaust heat available for process needs. This syngas may be supplemented with natural gas to raise the heating value, where necessary.
Description of By- products Processing & Handling Systems	Anhydrous ethanol is produced by conventional distillation followed by a molecular sieve, using the waste heat from the process. Water, with nutrients, is recycled from the distillation bottoms back to the fermenter.
Feedstock Requirements	Composition: Not specified, but the constraints should be similar to those of any thermal gasification process
	Size: same comment
	Moisture Content: same comment
Diversion Rate	85%

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: typical emissions of syngas combustion with air pollution controls
	Water: 65 gpm ((94,000 gal/day)
	Solid Residue: It is assumed that unsorted MSW would be fed to the gasifier, therefore, all ash, metal, glass (15-20% of the MSW) that is unconverted in the gasifier would be landfilled.
	Odor: not listed, probably not significant
	Noise: not listed, probably not significant
	Other: not listed
Description of Products and By-Products	Products: Fuel ethanol, electricity
	By-Products: steam (if not used in power generation)
Quantity of Products and By-Products	Products: 8.2 million gal ethanol/year, 9.3 million kWh/year (1.2 MW) net
	By-Products:
Area Requirement	2.2 ac
Utility Requirements	Natural Gas: none
	Fuel Oil: none
	Water: 190 gpm
	Sewer: 65 gpm wastewater
	Electricity: none
Composition of Waste Generated by the Facility	Hazardous: not listed
	Non-Hazardous: not listed
Quantity of Waste Generated by the Facility	Hazardous: not listed
	Non-Hazardous: 43 tpd
Mass Balance	Material Delivered: 96500 tpy
	Material Recycled: none
	Material Disposed: 14,400 tpy
	Product Generated: 8.2 million gal ethanol/year, 9.3 million kWh/year (1.2 MW) net
Cost	Capital: $26.6 million
	Operational: $3.9 million
	Revenue Generated: $12.7 million, mainly from the sale of ethanol at $1.50/gal

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name,	**Canada Composting Inc.** Ontario, Canada
Brief Description of the Technology	CCI holds the exclusive license for the BTA process in Canada and the U.S. The BTA process is a solid waste AD process that was developed in Germany in the 1980's. Its particularities include the use of wet pulping to prepare the facility feed for anaerobic digestion. This converts the feed into a slurry, which is pumped to the anaerobic digester. The latter is operated in the liquid phase; various digester designs are used. Generally, the digester effluent is dewatered, aerobically matured, and marketed as compost.
Technical and Financial Resources (Credibility)	CCI is a privately held company, with approximately 45 shareholders having invested $8 Million Canadian since it was founded in 1992. Specific financial statements are confidential. The company is solvent and continues to grow the revenue base that will support expansion into the marketplace. Current operations are supported by revenue generated with existing operations and support contracts, license fees and from global consulting activities. The company has never had to defend (or settle) a lawsuit, forfeit a bond, or had a contract cancelled.
For the Existing Facilities	
Facility Name	City of Toronto/Dufferin pilot plant
Location	Toronto, Ontario
Owner	City of Toronto
Technology	BTA process
Throughput	28,000 tpy
Feedstock	Source-separated organics
Start-up Date	2001
Capital Cost	$13 million
Operating Cost	NA
Products	Biogas, currently flared
By-products	Compost
Residuals	4100 tpy

TABLE A-5 (CONTINUED) SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	25,000tpy (per RFQ request, CCI considers this a pilot plant)
Description of Preprocessing Systems	The tipping floor operator will first remove large non-processable objects. Then the waste is subjected to dry pretreatment. It is first loaded on a trommel screen. Garbage bags are broken up, and the majority of the organics report to the undersize fraction, from which ferrous metals and aluminum are removed using magnetic removal and an eddy current generator. At this point, the waste enters the wet pretreatment phase; it is conveyed to one of the pulpers, which separates the waste into: a) a light fraction (plastic textiles, etc.); b) a heavy fraction (stones, glass, metal, batteries, etc.); and c) an organic suspension. The latter is degritted in a hydrocyclone. The resulting conversion feed goes to buffer storage and is then fed to a digester operating in the liquid phase, where it is biogasified.
Description of Conversion Unit	Several digester designs have been used. They have in common that they operate in the liquid phase and are completely mixed.
Description of Energy Production Systems	The biogas will be converted to electricity in typical IC engine generators.
Description of By- products Processing & Handling Systems	For this application, CCI typically partners with an experienced producer and marketer of compost products and the approach applied is outdoor piles. This approach is relatively easy to manage and has the advantage of using standard excavation machinery. Using this approach, CCI can annually compost about 20,000 tons of waste per hectare of platform; a higher output than normally obtained by windrow composting systems.
Feedstock Requirements	Composition: MSW
	Size: no limits
	Moisture Content: no limits
Diversion Rate	56%
Environmental Issues	Air: will comply with local regulations
	Water: 6200 tpy
	Solid Residue: will be landfilled
	Odor: controlled by operating inside a negative pressure building
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: Electricity
	By-Products: Compost, recyclables
Quantity of Products and By-Products	Products: 3.4 million kWh/yr
	By-Products (tpy): compost (4600)
Area Requirement	NA (The 130,000 tpy Newmarket, ON, CCI facility takes up less than 6 ac)

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: for startup/backup
	Fuel Oil: for rolling stock; at Dufferin/Toronto: $900/month
	Water: 800 gpd, primarily for mixing in flocculants
	Sewer: 1.2 million gal/year
	Electricity: for startup/backup
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 11,000 tpy
Mass Balance	Material Delivered: 25,000 tpy (per RFQ: 100 tpd, 5 days/week)
	Material Recycled: 2700 tpy
	Material Disposed: 11,000 tpy
	Product Generated: 400 kW; 4600 tpy compost
Cost	Capital: $24.4 million, excluding land
	O&M: $2.6 million/year
	Revenue Generated: $280,000/year

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**GRL Investments Pty Limited (Global Renewables)** Australia
Brief Description of the Technology	Global Renewables' Urban Resource-Reduction, Recovery and Recycling (UR-3R) process contains 4 basic elements: • Mechanical Separation; • ISKA percolation; • Composting and refining using the SCT process; and • Renewable energy recovery in the form of biogas. In the UR-3R Process® waste resources become cleaner at every stage of the process. Shredding and mixing are minimized; separation processes are maximized using both mechanical and natural biological technologies. Waste is treated gently to enhance recovery of resources such as glass and paper, and to avoid mixing contaminants into the organics or turning high value materials (e.g. plastics) into comparatively low value materials (e.g. fuel). Resources that have a higher recovery cost than their current net value are inerted for either safe landfill disposal or separate storage.
Technical and Financial Resources (Credibility)	Global Renewables was formed in 2000 and is wholly owned by GRD Limited (GRD), which is listed on the Australian and New Zealand Stock exchanges and has a market capitalization of $380 million. Besides Global Renewables, GRD wholly owns GRD Minproc, a leading Australian resource and process engineering company, which has completed over 200 projects in 30 countries ranging in value from $4 million to $200 million with a total value exceeding $12 billion. GRD Minproc carries out the detailed design, construction management, and commissioning of Global Renewables' facilities. GRD also owns a 56% share in OceanaGold, a major gold producer. Global Renewables' UR-3R process includes anaerobic digestion using the German ISKA process, for which they hold the license in Australasia and Asia. Global Renewables also has an alliance with Sorain Cecchini Tecno SRL (SCT) from Italy, which has expertise in the separation and aerobic composting of MSW. In the UR-3R process, the SCT process is used for the aerobic treatment that follows AD; Global Renewables has the SCT license for the Asia-Pacific region.

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Existing Facilities	
Facility Name	Eastern Creek UR-3R Facility
Location	Eastern Creek, NSW, Australia
Owner	GRL Investments Pty Limited (Global Renewables)
Technology	UR-3R process
Throughput	Designed for 190,000 tpy (in start-up)
Feedstock	Residual mixed MSW
Start-up Date	September 2004
Capital Cost	$55 million
Operating Cost	Confidential
Products	Biogas, electricity (17 million kWh/yr estimated), organic growth media (40,000 tpy estimated)
By-products	Metals, plastics, glass, paper, mixed plastic
Residuals	28,000 tpy estimated
For the Proposed Facility	
Capacity	250,000 tpy
Description of Preprocessing Systems	Not specified, but uses current preprocessing technology and excludes shredding
Description of Conversion Unit	The conversion feed goes to an ISKA percolator where it is sprayed with hot process water. This generates a percolate solution, which is biogasified in a hybrid packed-bed low solids digester. Solid residue from the percolator is dewatered in a press; the filtrate liquid goes to the digester, while the cake is screened and the undersize fraction goes to aerobic composting
Description of Energy Production Systems	Biogas from the ISKA system fuels generators with appropriate emissions controls
Description of By- products Processing & Handling Systems	Composting occurs in a large mixed compost bay inside a building under negative pressure. The initial 2-week intensive composting phase is followed by 8 weeks of windrow maturation. The final product is screened before being marketed
Feedstock Requirements	Composition: MSW
	Size: no limits
	Moisture Content: no limits
Diversion Rate	75%

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: will comply with local regulations
	Water: no discharge
	Solid Residue: will be landfilled
	Odor: controlled by operating buildings at negative pressure and treating exhaust with biofilter
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: Electricity
	By-Products: Hard recyclables (paper, cardboard, glass, PET, HDPE, mixed plastic, film plastic, ferrous & non-ferrous metals) and high grade compost
Quantity of Products and By-Products	Products: 2.8 MW (based on attached brochure)
	By-Products (tpy): Glass: 2500; PET & HDPE: 6750; plastic, film & mixed: 16,500; metals: 6750; paper & cardboard: 43,000; alternative daily cover: 44,750; OGM (compost): 21,000.
Area Requirement	Not provided. Existing facility takes up 11 ac and is designed to process 190,000 US tpd, so the Los Angeles facility may take up 14 acres
Utility Requirements	Natural Gas: not needed
	Fuel Oil: not needed
	Water: not needed
	Sewer: not needed
	Electricity: not needed
Composition of Waste Generated by the Facility	Hazardous: none, because will it be separated in preprocessing
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous:
	Non-Hazardous: 17,500 tpy of rejects, 44,750 tpy of alternative daily cover (ADC) as listed under byproducts
Mass Balance	Material Delivered: 250,000
	Material Recycled: 120,000 tpy, including ADC
	Material Disposed: 17,500 tpy of rejects, not including ADC
	Product Generated: 2.8 MW; 21,000 tpy OGM (compost)
Cost	Capital: $50 to 70 million, excluding land
	Operational: not provided, but tipping fee estimated at US$50 to 63 per US ton including profit but not residue landfilling, which would add $10 to these numbers (assuming landfilling costs at $40/ton and no ADC accepted)
	Revenue Generated: not provided

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Organic Waste Systems** Belgium
Brief Description of the Technology	OWS has patented the DRANCO (Dry Anaerobic Composting) anaerobic digestion process. In this process, the digester feed is mixed with a large amount of recirculating digester effluent. The resulting mix is pumped to the top of the cylindrical digester where it is introduced into the digester. The contents have approximately 40 percent dry matter; they make their way down through the digester in a few days. Subsequently, most of the contents are recirculated to the top, so that the average residence time of the feed is 3 to 4 weeks. The fraction of the effluent removed from the digester (digestate) is aerobically matured using a static pile process and sold as compost
Technical and Financial Resources (Credibility)	Organic Waste Systems (OWS) is a stock company under Belgian law, constituted in 1988 with a capital of 1.2 million Euros, and specialized in biological treatment of solid and semisolid wastes. OWS has 40 employees and historical revenue of about 10 million Euros per year, although revenues are expected to rise to 15 to 18 million Euros (20 to 25 million U.S. Dollars) in 2004 and 2005 due to the construction of several new facilities. OWS developed the DRANCO process. OWS has constructed several commercial DRANCO plants worldwide, and has a significant backlog of facilities in the design and construction stages. A copy of the 2003 annual report was provided.
For the Existing Facilities	
Facility Name	Brecht II
Location	Brecht, Belgium
Owner	IGEAN (a regional association of municipalities)
Technology	DRANCO process
Throughput	53,000 tpy
Feedstock	Source-separated organics, some industrial waste
Start-up Date	2000
Capital Cost	$20 million
Operating Cost	NA
Products	Biogas, electricity (850 kW net)
By-products	Compost (28,000 tpy)
Residuals	9,000 tpy

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	25,000 tpy (per RFQ request, 100 tpd, 5 d/wk)
Description of Preprocessing Systems	Delivered waste is conveyed to a hammer mill, then subjected to magnetic separation, 40 mm rotating screen, and non-ferrous magnet. The resulting feed goes to the dosing unit, where it is mixed with recirculated digester contents and heated with low pressure steam to 120-130 °F; some ferric chloride is added to reduce the H_2S content of the biogas.
Description of Conversion Unit	The resulting mix is pumped into the top of the digester using a cement pump. As the material works its way down the digester, it is subjected to intense anaerobic digestion at 120°-130° F at a dry matter content of approximately 40 percent. It takes about 3-4 days for the material to arrive at the bottom of the digester. There, it is withdrawn, and a small part is removed and sent to post-processing, while most of it is recirculated after being mixed with fresh feed, iron chloride, etc. As a result, the conversion feed spends an average of 25 days in the digester. There will be one 56,000-ft^3 steel digester, approximately 35 feet in diameter.
Description of Energy Production Systems	The biogas flows into a buffer storage tank, and then it is sent to blowers, which convey it to the IC engine generators with appropriate emissions controls. Some of the heat of the exhaust gases is used to generate steam to preheat conversion feed in the mixing chamber.
Description of By- products Processing & Handling Systems	The digestate is wet screened, then dewatered in a centrifuge; the centrate liquid is recycled. The cake is aerobically cured using an enclosed static pile process. OWS offers an option to install further wet separation to recover marketable fibers and sand.
Feedstock Requirements	Composition: MSW; C/N ratio >25, no high salt wastes; avoid high sulfur materials like drywall; no stringers.
	Size: no limits, but <4" preferred
	Moisture Content: preferably less than 70% moisture
Diversion Rate	61%
Environmental Issues	Air: will comply with local regulations
	Water: no significant amount of wastewater expected
	Solid Residue: will be landfilled
	Odor: controlled by operating inside a negative pressure building and treating the exhausted air.
	Noise: no issue expected; 60 dB expected outside the DRANCO process buildings.
	Other: none identified
Description of Products and By-Products	Products: Electricity
	By-Products: Compost, recyclables

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Quantity of Products and By-Products	Products: 4.5 million kWh/yr
	By-Products (tpy): compost (10,000), ferrous metals (1000)
Area Requirement	1 ac
Utility Requirements	Natural Gas: not listed
	Diesel: 1650 gal/yr
	Water: 2000 m3/yr (2000 gpd)
	Sewer: no significant wastewater discharge
	Electricity: for startup/backup
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 10,000 tpy
Mass Balance	Material Delivered: 25,000 tpy (per RFQ: 100 tpd, 5 days/week)
	Material Recycled: 1000 tpy (more if wete sorting implelemted)
	Material Disposed: 10,000 tpy
	Product Generated: 500 kW; 10,000 tpy compost
Cost	Capital: $23.6 million, excluding land (wet separation option: $0.5 million)
	O&M: $1.95 million/year
	Revenue Generated: $660,000/year

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name, Contact, Address, Telephone, Email	**Waste Recovery Systems, Inc./Valorga** Monarch Beach,
Brief Description of the Technology	Valorga international has patented the Valorga anaerobic digestion process. In this process, a solid or semi-solid waste feed is injected near the bottom of a cylindrical digester. The Valorga digesters have a vertical partition running from one wall across the center over approximately 2/3 of the diameter. The waste feed is introduced on one side of the partition and is removed from a port on the other side, to ensure a minimum residence time in the digester. During their transit, the contents are mixed via pulsed injections of pressurized biogas from the bottom of the digester. Typically, the waste resides in the digester for 3 to 4 weeks, at a dry solids content of 30 to 40%. The digester effluent is dewatered, aerobically matured, and marketed as compost.
Technical and Financial Resources (Credibility)	WRSI successfully secured commitments for financing for both private and public municipal projects ranging in value from $5.0 million to $110 million, upon favorable terms and conditions. Relationships established over many years with Wall Street investment banking firms have enabled WRSI to secure financial commitments for the construction of a 450 TPD Valorga facility in Southern California within the last year. WRSI has received notification that the WRSI/Valorga International/Shaw-Emcon group has been selected by a major waste management firm to build, own, and operate a facility to process a significant daily quantity of MSW in the Western US for a period of 20 years. Shaw-Emcon will be the EPC contractor for the project, guaranteeing a fixed price construction contract and mechanical completion. Valorga International will provide a guarantee for the process. WRSI will operate the facility with the technical support of Valorga International and one of its shareholder companies, URBASER, a major Spanish construction and solid waste processing firm.
For the Existing Facilities	
Facility Name	Ecoparc 2
Location	Barcelona, Spain
Owner	Ecoparc del Besos.
Technology	Valorga process
Throughput	132,000 tpy
Feedstock	Source-separated organics + MSW
Start-up Date	2004
Capital Cost	$70 million
Operating Cost	NA
Products	Biogas, electricity (3750 kW net), compost (65,000 tpy), water (15,500 tpy)
By-products	Recyclables
Residuals	65,000 tpy

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	28,600 tpy (per RFQ request, a larger size would be more cost-effective, according to WRSI/Valorga)
Description of Preprocessing Systems	A combination of mechanical sorting /screening equipment and hand-picking, followed by low-speed shredding of the purified digester feed. The conversion feed is delivered to a mixing chamber where process water can be added as needed, steam is injected to heat the feed, and some amount of digester effluent is added. The resulting slurry is pumped into the digester during operating hours using a robust piston pump.
Description of Conversion Unit	As discussed above, the digester contents are mixed with injections of pressurized biogas On average, waste feed spends approximately 30 days in the digester, where it is subjected to intense anaerobic digestion. There will be one 110,000-ft^3 concrete digester, approximately 57 feet high and 50 feet in diameter.
Description of Energy Production Systems	The biogas flows into a buffer storage tank, and then it is sent to blowers, which convey it to the IC engine generators with appropriate emissions controls. Other than chilling and condensate collection, no further treatment of the gas is needed. Some of the heat of the exhaust gases is used to generate steam to preheat conversion feed in the mixing chamber.
Description of By- products Processing & Handling Systems	The digestate will be aerobically cured using an in-vessel process.
Feedstock Requirements	Composition: MSW
	Size: no limits
	Moisture Content: no limits
Diversion Rate	76%
Environmental Issues	Air: will comply with local regulations
	Water: 8300 tpy
	Solid Residue: will be landfilled
	Odor: controlled by operting inside a negative pressure building
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: Electricity
	By-Products: Compost, recyclables
Quantity of Products and By-Products	Products: 2.8 million kWh/yr
	By-Products (tpy): compost (6400), recyclables (4900)
Area Requirement	7 ac

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Utility Requirements	Natural Gas: for startup/backup
	Fuel Oil: not needed
	Water: washdown, sanitary
	Sewer: 5000 gpd
	Electricity: for startup/backup
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 6800 tpy
Mass Balance	Material Delivered: 29,000 tpy (per RFQ: 100 tpd, 5.5 days/week)
	Material Recycled: 4900 tpy
	Material Disposed: 6800 tpy
	Product Generated: 320 kW; 6400 tpy organic soil amendment
Cost	Capital: $9 million, excluding land
	O&M: $1.14 million/year
	Revenue Generated: $378,000/year

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**ABT-Haskell, LLC.** Saint Augustine, Florida
Brief Description of the Technology	ABT has patented the AirLance™ in-vessel aerobic composting process. Air is injected and extracted via what is essentially a dense array of giant injection needles into a deep mass of composting sewage biosolids (sludge) and woodchips. The process occurs inside large 26-ft cubical composting cells with built-in screw conveyors. This system optimizes composting conditions, maximizing conversion rates and minimizing footprint. It is completely enclosed.
Technical and Financial Resources (Credibility)	ABT-Haskell LLC is a joint venture of American Bio Tech (ABT) and The Haskell Company (Haskell) that utilizes ABT's AirLance™ composting technology and The Haskell Company's recognized design-build expertise. The AirLance™ Enclosed in-vessel composting technology has been utilized for more than 17 years. The Haskell Company's (THC) role in the project is to secure permitting, financing, design-build the facilities, and provide project and construction management. As an integrated design-build contractor this is THC's core business, in support of which it may utilize local services and businesses as required. Founded in 1965, The Haskell Company ranks among the foremost design-build organizations in the U.S. With more than 1,250 employees and annual sales that exceed $650 million, The Haskell Company provides complete architectural, engineering, construction, real estate and facility management services on a single-responsibility basis. The geographical scope of Haskell's work spans the Western Hemisphere, including Canada, the Caribbean and Latin America.
For the Existing Facilities	
Facility Name	Schenectady biosolids composting project
Location	Schenectady, NY
Owner	City of Schenectady
Technology	AirLance
Throughput	70 tpd biosolids + 35 tpd waste wood (38,000 tpy total assuming 7d/wk)
Feedstock	Biosolids + waste wood
Start-up Date	1987
Capital Cost	$5.5 million
Operating Cost	NA
Products	Compost (62 tpd; 23,000 tpy assuming 7d/wk)
By-products	none
Residuals	NA

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	100,000 tpy (274 tpd, 7 d/wk))
Description of Preprocessing Systems	The MRF will supply organic waste and waste wood that are relatively free of inerts, plastics, etc. The organics will be macerated into a slurry, while the waste wood will be shredded into chips. The two will be judiciously mixed and fed to the composting system.
Description of Conversion Unit	On a daily basis, a layer of composted material is removed from the bottom of the reactor cells and a fresh layer of proportioned and mixed feed material is placed on the top, allowing the vertical, plug flow operation. The plug flow concept assures compost material cannot short circuit and maintains uniform thermophilic decomposition sustained by the AirLance™ system. The internal temperature of the composting biomass is consistently maintained between 55°C and 70°C during the entire process. In each of the compost cells, a series of alternating pressure and vacuum AirLances™ are installed to provide the necessary air supply and waste product removal to sustain the efficient, high rate thermophilic decomposition of the organic matter. Air supply is monitored and metered into the pressure AirLances™ and likewise out of the vacuum AirLances™. More air is removed from the cell than is injected to keep odors and emissions from leaving the building enclosure before scrubbing.
Description of Energy Production Systems	There is no energy production in aerobic composting
Description of By- products Processing & Handling Systems	In a daily operation that runs concurrently with the infeed sequence, a traveling screw reclaimer that operates on a parallel rail system, undercuts and removes a layer of the composted material at the bottom of the reactor cells, discharging onto the reactor outfeed belt conveyor. The compost is loaded onto trucks and distributed.
Feedstock Requirements	The proposed AirLance™ Composting Facility requires organic wastes and carbonaceous wastes that are relatively free of metals, glass and other inert particles.
	Size: not specified
	Moisture Content: not specified
Diversion Rate	Not specified, assumes all residue removal will occur at the MRF, no compost post-treatment assumed. Counting the residuals separated at the MRF, the diversion rate should be in the 60 to 80% range.
Environmental Issues	Air: will comply with local regulations
	Water: 20 - 40 gpm
	Solid Residue: not specified
	Odor: controlled by operating inside a negative pressure building and treating the exhausted air.
	Noise: no issue expected
	Other: none identified

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Description of Products and By-Products	Products: Compost
	By-Products: none
Quantity of Products and By-Products	Products: Compost (83,000 tpy/227 tpd)
	By-Products: NA
Area Requirement	6.5 ac
Utility Requirements	Natural Gas: not needed
	Diesel: for moving equipment
	Water: 10 gpm (14,000 gpd)
	Sewer: 20-40 gpm (30,000 to 55,000 gpd)
	Electricity: not listed, but should be substantial
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: negligible after MRF (separation occurs at MRF)
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: negligible
Mass Balance	Material Delivered: 100,000 tpy organics + 50,000 tpy wood waste = 150,000 tpy
	Material Recycled: no recycling
	Material Disposed: no solid material after MRF; 67,000 tpy of condensate
	Product Generated: 83,000 tpy compost
Cost	Capital: NA
	O&M: NA
	Revenue Generated: NA

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**HotRot Composting Systems** Santa Barbara, CA
Brief Description of the Technology	The HotRot system is an in-vessel aerobic composting process. Waste is slowly moved along a tunnel via tines on a longitudinal shaft; the tines double as air injectors.
Technical and Financial Resources (Credibility)	HotRot provided financial reports indicating over $4 million in sales in the first quarter of 2005. They have substantial major shareholders.
For the Existing Facilities	
Facility Name	Seamer Carr landfill site
Location	Scarborough, England
Owner	HotRot Composting Systems Limited/Wastec Waste Separation
Technology	HotRot
Throughput	15 tpd, 5400 tpy
Feedstock	Organics from MRF
Start-up Date	2004
Capital Cost	$1.3 million
Operating Cost	NA
Products	Compost (7.5 tpd; "gray" compost suitable for landfill cover and restoration)
By-products	None
Residuals	Zero
For the Proposed Facility	
Capacity	100 tpd
Description of Preprocessing Systems	The MRF will supply organic waste that is relatively free of inerts, plastics, etc.
Description of Conversion Unit	The process is continuous, with a residence time of 14-20 days. HotRot provides a complete suite of processing equipment.
Description of Energy Production Systems	There is no energy production in aerobic composting
Description of By- products Processing & Handling Systems	Screening and curing are optional but probably required to generate marketable compost.
Feedstock Requirements	pH 6-8; C/N ratio 8-40 to 1; no CCA-treated wood; no liquids.
	Size: 2" or less for yard waste, 10"or less for paper and cardboard
	Moisture Content: 40-60% in the resulting feed blend
Diversion Rate	90 to 95% after MRF.

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: will comply with local regulations
	Water: not expected
	Solid Residue: landfill refuse
	Odor: completely controlled, exhausted air treated in biofilter.
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: Compost
	By-Products: none
Quantity of Products and By-Products	Products: Compost (40-50 tpd)
	By-Products: NA
Area Requirement	2.5 ac
Utility Requirements	Natural Gas: not needed
	Diesel: for moving equipment
	Water: washdown and sanitary
	Sewer: some need for washdown and condensate traps
	Electricity: 1200 kW
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: landfill refuse
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 5-10 tpd
Mass Balance	Material Delivered: 100 tpd
	Material Recycled: no recycling after MRF
	Material Disposed: 5-10 tpd
	Product Generated: 40 to 50 tpd compost
Cost	Capital: 7.7 million
	O&M: $670,000/yr
	Revenue Generated: $280,000 (assuming $20/ton compost)

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**International Bio-Recovery Corp. (IBR)** North Vancouver, Canada
Brief Description of the Technology	Food waste is slurried and aerobically digested with air injection inside a closed vessel using the EATAD process (Enhanced AutoThermal Aerobic Digestion); BRI has exclusive patent rights to its key components, the Shearator and the digester. The resulting biooxidation is exothermic and the resulting heat raises the slurry temperature to pasteurizing levels (> 160 °F). The digested effluent is formulated into a) a dry pelletized fertilizer, and b) a liquid fertilizer; both are marketed under the name Genica.
Technical and Financial Resources (Credibility)	IBR has been operating their North Vancouver plant since 1997. In their SOQ, they offer a $200,000 bid bond, a bank letter of guarantee, and surety.
For the Existing Facilities	
Facility Name	North Vancouver facility
Location	North Vancouver, BC, Canada
Owner	IBR
Technology	EATAD process
Throughput	Design: 120 tpd; actual: 30 tpd?
Feedstock	Food waste
Start-up Date	1997
Capital Cost	NA
Operating Cost	NA
Products	Solid and liquid fertilizer
By-products	None
Residuals	NA

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	100,000 tpy
Description of Preprocessing Systems	Maceration to prepare slurry; pH adjustment if necessary
Description of Conversion Unit	Feed first goes to startup digesters where it is aerated to 140°F and pH-stabilized, then inoculated with recirculated effluent. Next it goes to the main digesters. Effluent is screened, flocculant added, and mechanically dewatered, pelletized, and bagged. The filtrate is clarified, concentrated and decanted into totes as liquid fertilizer. The whole process takes 6 days. Condensate is recycled. If the feed contains more than 70% water, there will be a net wastewater discharge.
Description of Energy Production Systems	There is no energy production
Description of By- products Processing & Handling Systems	See description of conversion unit
Feedstock Requirements	Composition: food waste or similar
	Size: no limits
	Moisture Content: no limits, but >70% will generate net wastewater
Diversion Rate	NA
Environmental Issues	Air: will comply with local regulations
	Water: no discharge if feed <70% moisture
	Solid Residue: will be landfilled
	Odor: controlled by operating buildings at negative pressure and treating exhaust with biofilter
	Noise: no issue expected
	Other: none identified
Description of Products and By-Products	Products: pelletized and liquid fertilizers
	By-Products: NA
Quantity of Products and By-Products	Products: 36,000 to 56,000 tpy (estimated from rest of mass balance)
	By-Products (tpy): NA
Area Requirement	4-5 ac
Utility Requirements	Natural Gas: 57,000 MMBtu/yr or 57 million scf/yr
	Fuel Oil: NA
	Water: NA
	Sewer: 8000 to 13,000 gpd
	Electricity: 1200 kW

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: non-putrescible landfill material
Quantity of Waste Generated by the Facility	Hazardous: NA
	Non-Hazardous: 14,000 tpy
Mass Balance	Material Delivered: 100,000 tpy
	Material Recycled: NA
	Material Disposed: 14,000 tpy of rejects
	Product Generated: 36,000 to 56,000 tpy of liquid and pelletized fertilizer
Cost	Capital: NA
	Operational: not provided, but tipping fee estimated at $25 to $55 per US ton
	Revenue Generated: not provided

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Firm Name	**Wright Tech Systems Inc.** Canada
Brief Description of the Technology	Wright Environmental developed the Biodryer™ in-vessel biological drying technology based on its tunnel composting process. In the Biodryer, the processed material is dried to less than 15% moisture by using metabolic heat; the resulting dry material can be used as biomass fuel. Biological drying is an order of magnitude cheaper than conventional thermal drying, it does not require air pollution control equipment, and the air permitting is much simpler. The Biodryer can easily be retrofitted into a composter, should the client decide to produce compost rather than biomass fuel.
Technical and Financial Resources (Credibility)	Wright Environmental Management, Inc. (project lead) was incorporated in 1992, and has installed dozens of its patented tunnel composting systems across North America and Europe. Canadian Commercial Corporation (CCC) (prime contractor) is a Crown corporation established by the Government of Canada, which acts as the prime contractor when the client prefers a commitment from the Government of Canada. It will provide the contract guarantees and assurances. Machinex (subcontractor) designs and manufactures preprocessing equipment; it has installed over 200 turnkey installations throughout North America and Europe. It will provide the conveyor system. The SHAW Group (sub-contractor) will provide the necessary engineering, construction and permitting services and if required by the City, the operation and maintenance of the organic waste facility as well. Lundell Manufacturing Inc. (sub-contractor) is a leading manufacturer of pelletization and material handling systems for fuel applications. They would provide the air classifier and shredder for the back end.
For the Existing Facilities	
Facility Name	Inverboyndie facility
Location	Inverboyndie, Nr Banff, Scotland
Owner	Aberdeenshire Council
Technology	Wright in-vessel composting
Throughput	100 tpd/36,500 tpy
Feedstock	MSW
Start-up Date	2001
Capital Cost	$2.0 million
Operating Cost	$ 743,000/year
Products	Compost, used for landfill restoration
By-products	none
Residuals	Up to 60% of input

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

For the Proposed Facility	
Capacity	26,000 tpy (100 tpd, 5 d/wk)
Description of Preprocessing Systems	Assumes all necessary separations will be conducted by the MRF. Preprocessing will be limited to blending, moisture control, and conveying.
Description of Conversion Unit	The Biodryer is an in-vessel tunnel system that is fully enclosed. It has automated controls to ensure the ideal conditions are in place to optimize decompositions and thus provide the heat for the drying process. The waste material remains in the biodryer for a 14-day cycle. It moves continuously through the tunnel during the eight operating hours of each shift. The floor trays in the tunnel are cycled through the tunnels and are advanced as a new clean tray is added. Exhaust fans remove water vapor and gases from the decomposing mass. This airflow is sent to an external biofilter, which cleans the air and water. The reduction of moisture content is the process of bio-drying by microbial exothermic reaction. The heat from aerobic decomposition in the first stage is used to dry the mass in the second stage of the biodryer. The heat is transferred between the stages by a heat exchanger. There are neither fossil fuels required nor any emissions that require permits. No NO_x nor SO_x are generated.
Description of Energy Production Systems	There is no energy production in aerobic composting
Description of By- products Processing & Handling Systems	As the dried material is discharged from the tunnels it falls onto a reclaim conveyor that is in line with the discharge of all tunnels. This material is then transferred by conveyor to the final processing stages. A shredder breaks up the dried mulch. The mulch is then passed through an air classifier. Here, the metal, glass, plastic and "other" components are separated from the remaining dry organic material. The final cleaned dry biomass fuel is then stored in piles in a bunker until delivered to market. It does not emit an odor since there is no moisture content to promote decomposition nor bacterial growth. Ferrous metals can be separated mechanically by a magnetic separator and recycled as scrap metal; this would generate an additional revenue stream. The fuel may be pelletized as an option as well depending on the needs of the market.
Feedstock Requirements	No limits
	Size: shorter than conveyor belt width
	Moisture Content: flexible
Diversion Rate	90% post-MRF

TABLE A-5 (CONTINUED)
SUMMARY OF RESPONSES FROM THE BIOLOGICAL/CHEMICAL CONVERSION TECHNOLOGY SUPPLIERS

Environmental Issues	Air: will comply with local regulations
	Water: low-strength condensate
	Solid Residue: 10 tpd (10% of input)
	Odor: controlled by operating inside a negative pressure building and treating the exhausted air.
	Noise: well defined; no issue expected
	Other: none identified
Description of Products and By-Products	Products: RDF
	By-Products: none
Quantity of Products and By-Products	Products: RDF (10,000 tpy/39 tpd)
	By-Products: NA
Area Requirement	1.5 ac for process equipment, need to add parking, roads, etc.
Utility Requirements	Natural Gas: not needed
	Diesel: not used, propane used for moving equipment because of indoor operation
	Water: washdown, sanitary, dust control
	Sewer: 12,000 gpd
	Electricity: not specified, but should be substantial
Composition of Waste Generated by the Facility	Hazardous: none
	Non-Hazardous: dried landfill refuse
Quantity of Waste Generated by the Facility	Hazardous: not applicable
	Non-Hazardous: 10 tpd of dried waste
Mass Balance	Material Delivered: 26,000 tpy
	Material Recycled: no recycling
	Material Disposed: 10 tpd
	Product Generated: 10,000 tpy compost
Cost	Capital: $6.9 million
	O&M: $546,000/year
	Revenue Generated: $446,000/year

TABLE A-6
RANKING OF THE TECHNOLOGY SUPPLIERS AND JUSTIFICATION OF PERFORMANCE LEVELS ASSIGNED

CHANGING WORLD TECHNOLOGIES, INC.

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	CWT has tested many different biomass feedstocks, including food wastes, mixed plastics, tires, oil residual, waste grease, but not straight MRF residuals or unsorted MSW.	25	
Need to Scale Conversion Unit to 100 TPD Size	Present operating unit in Carthage, MO has a throughput of 250 TPD. No scale-up is required.	100	
Engineering the Complete System	CWT has designed, constructed, and now operates one commercial scale facility using its technology.	75	
Marketability of Conversion Products	CWT's proposed facility would primarily produce liquid fuels, and will combust some of the fuels for internal steam use, with some potential generation of electricity as needed.	66	
Existing Operational Experience	CWT has had a demo plant in operation for over 5 years; its commercial plant has been in operation for 6 months.	75	
Economics	Capital and O&M costs, as well as product revenues, are based on 6 years of pilot plant experience and full-scale commercial facility. Capital costs on a $/TPY are greater than for the larger commercial plant, which would be expected. Details of Attachment 2 not provided. CWT failed to include significant costs for purchase off the grid of 1 MW of power to run the facility, but net costs are still low once they are added in. The cost is based on commercial unit processing other feedstock.	0	
Landfill Diversion	The process converts essentially 100% of the feedstock to marketable products. If additional equipment is required to remove metals and glass from the MRF residuals, that would provide additional marketable by-products.	100	
Supplier Credibility	CWT has proven its technical and financial capabilities through its development of one commercial-scale facility at more than twice the throughput proposed for the County. It has received significant (non-monetary) support from the U.S. EPA, U.S. DOE, and members of Congress. The commercial plant was financed with equity capital.	50	

EBARA CORPORATION

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Ebara has a 4950 tons/day demonstration facility processing MSW.	50	
Need to Scale Conversion Unit to 100 TPD Size	The unit that Ebara operates has 15 tons/day capacity a scale up of 6X is required to process 100 tons/day.	33	
Engineering the Complete System	Ebara is operating a demonstration complete system.	75	
Marketability of Conversion Products	Ebara proposed facility will produce electricity.	100	
Existing Operational Experience	For the system that Ebara suggest they have limited operational experience.	50	
Economics	Net costs are supported and is not reasonable ($289/ton).	50	
Landfill Diversion	Ebara Corporation described their diversion rate at > 95% or more.	100	
Supplier Credibility	Ebara is a large corporation with annual business of $1.8 billion. They have extensive environmental and engineering capability.	100	

GEM AMERICA, INC.

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	GEM has a pilot plant and a commercial operating plant (shut down for now, but awaiting re-start) treating MSW.	100	
Need to Scale Conversion Unit to 100 TPD Size	GEM's commercial-size modules are rated at about 40-50 TPD. The 100 TPD throughput could be accomplished with 2-3 modules, or scale-up of two is required.	66	
Engineering the Complete System	GEM has developed a small demonstration facility and a 14,000 TPY commercial-scale facility. It has also signed a contract to develop a commercial facility in Spain, using auto shredder residue. GEM has partnered with ICC, Inc., a large engineering firm in the U.S. for a complete EPC package. The submittal contained complete data, including a mass and energy balance for the proposed facility and environmental data on the syngas and by-product char.	75	
Marketability of Conversion Products	GEM's proposed facility would produce electricity.	100	
Existing Operational Experience	GEM's pilot plant has been in operation for 8 years. The commercial plant in South Wales was in operation for >1 year, until the owner/operator shut it down for commercial (not technical) reasons. It is awaiting a waste contract so that it can re-start.	25	
Economics	Net costs are supported and is not reasonable range ($105/ton). Details provided on Attachment 2. Additional revenues may be possible from sale of char and ash, if testing shows them to be marketable.	50	
Landfill Diversion	Based on testing to date, the char/ash mixture has not been found to be hazardous. Therefore, it can likely be used for cement making, providing a diversion rate of ~100%.	100	
Supplier Credibility	GEM America is owned by Mr. Weltz and GEM International, Ltd. GEM International is staffed by personnel including the GEM process inventor and senior managing director. GEM is partnering with ICC, Inc., an engineering firm, for offering an EPC package. GEM offers to warrant its system at 75% of rated capacity, and would put money in escrow to insure performance. Together, the team offers credible, but somewhat limited technical and financial resources compared to others.	50	

GEOPLASMA LLC

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	One of Geoplasma's partners, Hitachi Metals, has had direct experience with this technology using MSW.	100	
Need to Scale Conversion Unit to 100 TPD Size	The existing facilities in Japan are rated at 100 TPD per module, so no scale-up is required.	100	
Engineering the Complete System	Geoplasma's partner, Hitachi Metals, has designed and built three facilities using its plasma gasification technology. The submittal contained extensive information on the commercial systems, the technology, pre-processing and power generation subsystems, facility integration concepts, and the roles of the partners for the proposed facility. Lead firm has no development experience but the partner does.	25	
Marketability of Conversion Products	Geoplasma's proposed facility would produce electricity.	100	
Existing Operational Experience	The proposed technology has been used at pilot scale for 6 years, at commercial scale at 24 TPD for 2 years, and at commercial scale at 200 TPD for almost 3 years. One operating demonstration facility.	25	
Economics	The proposed system is very capital intensive and has a very high cost in $/TPY. The larger commercial systems have a much lower than $172/T cost, which would be expected. Net costs are on the high side, but not the highest of all suppliers. Geoplasma provided some details on Attachment 2 but not complete. Values for products and by-products look reasonable.	0	
Landfill Diversion	Since the system operates at very high temperatures, the inorganics are recovered as a vitreous, non-hazardous slag which is marketable. Diversion rate is ~100%.	100	
Supplier Credibility	Geoplasma itself has few resources, but it has put together a very strong technical and development team, including JDI, Inc. (owns shopping malls and re-develops environmentally impaired sites into industrial parks and malls), Hitachi Metals Corp. (process design, process equipment design and supply, facility design and construction oversight), Westinghouse Plasma Corp. (plasma torches), Energy Systems Group LLC (subsidiary of Vectren, to operate facility and provide operating guarantees), SPF Group and UBS (financial), MACTEC (engineering, siting, and permitting) and Georgia Institute of Technology (technological oversight and permitting assistance). This team provides extensive technical and financial resources and credibility. JDI has over 25 years of experience in providing financial guarantees and security arrangements, such as letters of credit and performance bonds.	50	

INTERNATIONAL ENVIRONMENTAL SOLUTIONS

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	IES has conducted numerous tests of its 50 TPD unit with MSW and many other feedstocks, but has no commercial experience.	50	
Need to Scale Conversion Unit to 100 TPD Size	Existing system is operating at 50 TPD. 2X scale-up is required.	66	
Engineering the Complete System	IES has already designed and developed a demonstration facility rated at 50 TPD for testing different feed stock (undergoing its air permitting tests), and has designed and will be constructing a 147 TPD sized unit. It has supplemented its technical resources by partnering with engineering and equipment supply companies. Although they have developed the pre-processing and conversion subsystems, IES itself has not developed a complete facility with power generation. The original submittal lacked some important details, but they were provided in response to a Request for Additional Information. IES provided energy and mass balances, facility layouts, and considerable information on its partners and their services/equipment.	25	
Marketability of Conversion Products	IES's proposed facility would produce electricity.	100	
Existing Operational Experience	IES's demonstration unit has been in operation for a short time testing various feedstock and is undergoing air emission compliance testing.	25	
Economics	Costs are based on development of a 50 TPD pilot unit that has tested only small amounts of MSW and is within acceptable range.	50	
Landfill Diversion	Recovery of metals and glass; carbon char may be able to be used as landfill cover, but would not need to be disposed of in a landfill at a cost. Diversion rate is ~99%.	100	
Supplier Credibility	IES itself is a small, privately held company, but has partnered with other companies such as H. West Equipment (design of conveyors and MRFs), Northern Power Systems (provided feasibility study and designs power plants), DeVere Construction Company (develops and engineers power plant designs), Advanced Energy Strategies (energy project development and regulatory issues), and Manit Systems (automated controls). IES has developed its existing facilities solely with equity capital, although it is still a small company. Once commercial operation of the 50 TPD facility begins in Spring 2005, treating industrial wastes and other feedstocks for its customers, it expects to have an income stream. The EPC contractor will provide overall insurance and performance bonds.	50	

INTERSTATE WASTE TECHNOLOGIES, INC.

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	IWT's Thermoselect technology has significant experience on MSW, with throughputs up to 250,000 TPY.	100	
Need to Scale Conversion Unit to 100 TPD Size	Thermoselect technology modules have a throughput of over 250 TPD, so no scale-up is required.	100	
Engineering the Complete System	The Thermoselect technology has been developed at several full-scale facilities, integrating the conversion technology with power generation (both steam turbine generators and reciprocating engines). IWT's submittal was complete, with extensive information on existing facilities, energy and mass balances for the proposed facility, samples of by-products, and information on their project partners.	100	
Marketability of Conversion Products	IWT 's proposed facility would produce electricity.	100	
Existing Operational Experience	The Thermoselect technology has been in operation in Karlsruhe, Germany for 5 years (recently shut down for economic reasons), in Chiba, Japan for 5 years, and at Mutsu, Japan for 2 years. There are five facilities planned to go into operation in Japan in the 2005-2006 period.	100	
Economics	IWT provided significant detail for the cost information in Attachment 2. Attachment 3 also provided detail on all of the expected by-products and market rates. The units costs are substantiated. The Thermoselect technology is very capital intensive, and netl costs in $/T ($186 ton)are higher than all other pyrolysis and conventional gasification systems. With high capital recovery, interest, and O&M to run the proposed plant, net costs are the highest of all suppliers.	50	
Landfill Diversion	The Thermoselect technology incorporates extensive syngas cleanup and recovery of by-products from the emission control systems and gasifier. Essentially all by-products are marketable or can be marketable. Diversion is ~99%.	100	
Supplier Credibility	IWT has partnered with large, financially sound companies which have implemented large projects worldwide. HDR/Zachry have experience in providing financial guarantees, letters of credit and performance bonds in their work. They would provide a 100 % payment and performance bond for the design and construction of the facility. Montenay Power would provide appropriate guarantees for the O&M of the facility. The team provides significant technical and financial resources.	100	

NTECH ENVIRONMENTAL

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	There are 46 ENTECH systems worldwide, with 10 treating MSW.	100	
Need to Scale Conversion Unit to 100 TPD Size	There are ENTECH systems operating at 67 TPD on MSW. With two modules, the 100 TPD throughput would be satisfied or 2X scale up is required.	66	
Engineering the Complete System	NTech has designed facilities with the ENTECH Renewable Energy System, which incorporates combustion of the syngas in a thermal reactor, followed by recovery of the heat in a boiler and steam production for external use. They have not yet designed a plant which incorporates pre-processing of MSW or power generation. NTech's submittal was complete, with extensive information on the technology and the process, a mass flow diagram, and project descriptions.	50	
Marketability of Conversion Products	NTech's proposed facility would produce electricity.	100	
Existing Operational Experience	There are 46 commercial-scale ENTECH systems in operation. The largest throughput is 67 TPD of MSW. The oldest has been in operation for over 15 years.	100	
Economics	Costs are supported by dozens of existing systems in operation. The capital cost of the system, in $/TPY, is close to the average of all of the pyrolysis and conventional gasification suppliers' costs. Some details were provided in Attachment 2, but information presented in Attachment 3 showed a lack of experience with pre-processing and post-processing for recovery of recyclables.	50	
Landfill Diversion	Recovery of metals and glass from bottom ash creates marketable by-products. Diversion is ~99%.	100	
Supplier Credibility	NTech is represented in the U.S. by Whitten Group International (Whitten), a project management and development company. Whitten holds proprietary intellectual properties and equipment patents. Its clients and partners are international construction developers, gas & oil companies, and local and federal governments. ENTECH as the technology provider would make available a number of bonds and guarantees. Whitten, as the project developer, would incorporate these bonds in the facility construction, through Allianz, its financial partner. Allianz underwrites projects up to $100 million. Together, the team provides extensive technical and financial resources.	100	

PRIMENERGY, LLC/RENEWABLE RESOURCES ALLIANCE, LLC

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Primenergy has extensive experience on gasification of a wide range of biomass feedstocks. In their partnership with RRA, they have tested RRA's refuse-derived fuel, called PRMB, at pilot scale.	50	
Need to Scale Conversion Unit to 100 TPD Size	Primenergy has designed and built facilities using their technology with modules treating 200 TPD. RRA has facilities that handle MSW at several thousand TPD. No scale-up is required.	100	
Engineering the Complete System	Both Primenergy and RRA have extensive resources in their specific areas of expertise. RRA has developed and built large pre-processing facilities. Primenergy has built facilities that incorporate biomass gasification with steam generation and power production. However, they have not yet integrated the three subsystems. The Primenergy/RRA proposal was complete, with mass and energy balances and process flow diagrams.	75	
Marketability of Conversion Products	RRA's proposed facility would produce electricity.	100	
Existing Operational Experience	RRA and its affiliates have been in operation for over 20 years, and make up one of the largest recovery and recycling companies in California. They operate the largest composting facility in the state, rated at 3,600 TPD. They are constructing a PRMB facility rated at 3,600 TPD. Primenergy has 18 gasifiers in operation, with the oldest in operation for over 15 years.	100	
Economics	Primenergy and RRA have proposed a system that has a capital cost, in $/TPY, very close to the average of all of the pyrolysis and gasification technologies. They provided fairly detailed information on Attachments 2 and 3. Capital and O&M costs are based on many operating systems (both Primenergy and RRA). Net costs are in the acceptable range, and are lower than most of the other suppliers.	100	
Landfill Diversion	Extensive pre-processing to produce the PRMB feedstock, plus isolation of bottom ash from fly ash and emission control system by-products to make bottom ash marketable provides for 99% diversion.	100	
Supplier Credibility	RRA and its affiliates hold more than 30 MSW franchises, forming one of the largest waste/recycling companies in California. They have the largest composting facility in California. RRA is capable of obtaining financing for the project. Its affiliate, CR&R has 1,000 employees, and provides much of the design for its facilities in-house. It has developed the PRMB system. Primenergy is a large equipment manufacturer, with 18 gasifiers in operation worldwide. It has in-house technical expertise for design of gasification facilities, including associated material handling, emission control, and power generation equipment. The partnership has extensive technical and financial capabilities. CR&R has raised >$25,000,000 in bond financing from the California Pollution Control Finance Authority and has an available credit line of $105,000,000, which is guaranteed by the underlying municipal waste franchises.	100	

GREEN ENERGY CORPORATION

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Green Energy has experience on gasification of a wide range of carbonaceous material. They tested MSW.	50	
Need to Scale Conversion Unit to 100 TPD Size	Green Energy has designed and built units to process one ton per day and 5 tons per day. They are in the process of building a 15 tons/day unit for a customer to process wood waste	0	
Engineering the Complete System	Green Energy did not put together a complete MSW treatment facility.	0	
Marketability of Conversion Products	Green Energy proposed facility would produce electricity.	100	
Existing Operational Experience	The proposed technology has been used at pilot scale. One and 5 TPD units operated for a year	25	
Economics	Green Energy does not have current commercial facility. Their cost is based on the pilot and test units.	50	
Landfill Diversion	Green Energy Technology described their diversion rate at 90% or more.	100	
Supplier Credibility	Green Energy was incorporated October 14, 2003. A financial statement dated June 30, 2004 is included in their response.	25	

ARROW ECOLOGY AND ENGINEERING OVERSEAS LTD

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Processing MSW	100	
Need to Scale Conversion Unit to 100 TPD Size	Operating since Dec 2002 at 90 tpd	66	
Engineering the Complete System	Are operating a complete facility	100	
Marketability of Conversion Products	Electricity is very marketable; the marketability of compost is questionable	33	
Existing Operational Experience	Commercial unit operating for 2 years	75	
Economics	Cost elements are provided, and backed up in a general sense	50	
Landfill Diversion	79%	33	
Supplier Credibility	Extensive financial and technical resources	100	

BIOENGINEERING RESOURCES, INC (BRI)

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Pilot scale experience with RDF	50	
Need to Scale Conversion Unit to 100 TPD Size	Presently operating at 1.5 tpd, so scaling factor is 67	0	
Engineering the Complete System	Submitted a complete concept, but has not been developed in any detail	0	
Marketability of Conversion Products	Ethanol and electricity are marketable products	66	
Existing Operational Experience	The facility in Fayetteville, AR, can only be described as a pilot plant	0	
Economics	Cost elements are provided and is not reasonable ($0.00/ton), but there isn't any backup to speak of	0	
Landfill Diversion	15% is sent to the landfill	66	
Supplier Credibility	Income statement provided is from 2000.	25	

CANADA COMPOSTING INC.

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Commercial experience with source-separated organics	25	
Need to Scale Conversion Unit to 100 TPD Size	Operating at larger scales	100	
Engineering the Complete System	Are operating complete facilities	100	
Marketability of Conversion Products	Electricity is marketable; the marketability of compost is questionable	33	
Existing Operational Experience	Commercial units operating for 20 years	100	
Economics	Cost elements are provided and not reasonable ($172/ton), and backed up in a general sense	0	
Landfill Diversion	56%	0	
Supplier Credibility	Adequate financial and technical resources	100	

ORGANIC WASTE SYSTEMS (OWS)

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Are processing MRF residuals at commercial scale	100	
Need to Scale Conversion Unit to 100 TPD Size	No scale-up needed	100	
Engineering the Complete System	Have built complete systems that are in commercial operation	100	
Marketability of Conversion Products	Electricity is marketable; the marketability of compost is questionable	33	
Existing Operational Experience	Many commercial facilities, operating for up to 12 years	100	
Economics	Costs supported, not reasonable range ($197/ton) for 100 tons/day. For larger system the cost will be less.	50	
Landfill Diversion	About 60%	33	
Supplier Credibility	Extensive technical resources, adequate financial resources.	75	

WASTE RECOVERY SYSTEMS, INC./VALORGA

Ranking Criterion	Assigned Performance Levels and Justification	Rating	Weight
Waste Suitability	Processing MSW at commercial scale	100	
Need to Scale Conversion Unit to 100 TPD Size	Operating at larger scales	100	
Engineering the Complete System	Are operating complete facilities	100	
Marketability of Conversion Products	Electricity is marketable; the marketability of compost is questionable	33	
Existing Operational Experience	Commercial units operating for 20 years	100	
Economics	Cost elements are provided in the reasonable range, and backed up in a general sense	50	
Landfill Diversion	76%	33	
Supplier Credibility	Extensive financial and technical resources	100	

TABLE A-7
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

TABLE A-7
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
South Coast Recycling & Transfer Station	4430 Calle Real Santa Barbara, CA 93110	County of Santa Barbara Transfer Station 123 East Anapamu Street Santa Barbara, CA 93101	NA/ Construction/ demolition Agricultural Mixed municipal Tires	130 East Victoria Street Santa Barbara, CA 93101	**Yes**	**Yes. Do not have space.**
Santa Ynez Valley Recycling & Transfer Station	4004 N. Foxen Canyon Road at Landfill Los Olivos, CA 93441	County of Santa Barbara Public Works Solid Waste and Utilities Division 109 East Victoria Street Santa Barbara, CA 93101	NA/ Construction/ demolition Green Material Inert Mixed municipal Tires Wood Waste	130 East Victoria Street Santa Barbara, CA 93101	**Yes**	**Yes. Do not have space.**
MarBorg C and D Recycling/Transfer St.	119 North Quarantina Street Santa Barbara, CA 93101	MarBorg Industries Mario A. Morgatello 136 North Quarantina Street Santa Barbara, CA 93103	NA/ Construction/ demolition Agricultural, Ash, Green Materials, Inert, Metals Mixed municipal	136 North Quarantina Street Santa Barbara, CA 93103	**Yes**	**Not Interested.**

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Tehachapi Recycling, Inc	416 North Dennison Road Tehachapi, CA 93561	Tehachapi Recycling, Inc. P.O. Box 1750 Tehachapi, CA 93581	**MRF/** Construction/ demolition Green Material Industrial Inert Mixed municipal	416 North Dennison Rd Tehachapi, CA 93561	**Yes**	**Not Interested.**
Mt. Vernon Metropolitan Recycling Center	2601 South Mt. Vernon Avenue Bakersfield, CA 93307	Kern Refuse Inc. C/O 1501 Truxtun Avenue Bakersfield, CA 93301	**MRF/** Construction/ demolition Mixed municipal	City of Bakersfield Solid Waste Department 4101 Truxtun Ave Bakersfield, CA 93309	**Yes**	**Yes.** **They have space.** **Too Small.**
Gold Coast Recycling Facility	5275 Colt Street Ventura, CA 93003	Gold Coast Recycling Inc. 5275 Colt Street, Suite 2 Ventura, CA 93003	**MRF/** Mixed municipal	5275 Colt Street Ventura, CA 93003	**Yes**	**Yes.** **Do not have a lot of room. Are willing to do what they can.**
Del Norte Regional Recycling & Transfer	111 South Del Norte Blvd. Oxnard, CA 93030	BLT Enterprises of Oxnard, Inc. 511 Spectrum Circle Oxnard, CA 93030	**MRF/** Agricultural Construction/ demolition Industrial Mixed municipal	111 South Del Norte Blvd. Oxnard, CA 93030	**Yes**	**Yes.** **Eugene Tseng is the consultant. Space available and very interested.**

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Santa Clarita MRF and Transfer Station	Proposed Site 26000 Springbrook Ave Santa Clarita, CA 91350	Burrtec Waste Industries, Inc. Eric Herbert 9890 Cherry Avenue Fontana, CA 92335	**MRF/** Mixed municipal	City of Santa Clarita 23920 Valencia Boulevard Suite 300 Santa Clarita, CA 91355	**Yes**	**Yes**
Rail Cycle Commerce Materials Recovery Facility	6300 E. 26th Street Commerce, CA 99999	Waste Management Incorporated 18500 Van Karmen Ave., Suite 900 Irvine, CA 92175	**MRF/** Construction/ demolition Industrial Mixed municipal	16122 Construction Circle East Irvine, CA 92606		No Response
Coastal Material Recovery Facility	357 W. Compton Blvd. Gardena, CA 90248	Si-Nor Inc. 357 W. Compton Blvd. Gardena, CA 90248	**NA/** Construction/ demolition Inert Mixed municipal Tires Wood waste	357 W. Compton Blvd. Gardena, CA 90248		No Response
Angelus Western Paper Fibers, Inc.	2474 Porter Street Los Angeles, CA 90021	Angelus Wester Paper Fibers, Inc. 2474 Porter Street Los Angeles, CA 90021	**NA/** Mixed Municipal	2474 Porter Street Los Angeles, CA 90021	**Yes**	**Only Yes on the 1st question. No further information.**

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
East Los Angeles Recycling and Transfer	1512 N. Bonnie Beach Place, City Terrace, CA 90063	Permodo/Blt Ent. L.L.C. C/O Cons.Sv., Inc 12949 Telegraph Road Santa Fe Springs, CA 90670	**MRF/** Construction/ demolition Mixed municipal	12949 Telegraph Road Santa Fe Springs, CA 90670		No Response
Waste Management South Gate Transfer	4489 Ardine Street South Gate, CA 90280	H.B.J.J. Inc. Subsidiary of USA Waste 4489 Ardine St. South Gate, CA 90280	**MRF/** Construction/ demolition Green material Industrial Inert Mixed municipal	321 Francisco St. Carson, CA 90745		No Response
		Si-Nor Inc. DBA: Coastal MRF & TS 357 W. Compton Blvd. Gardena, CA 90247				
Athens Services	14048 E. Valley Blvd. Industry, CA 91746	Athens Services Ron Arakelian Jr. P.O. Box 60009 Industry, CA 91716-0009	**MRF/** Industrial Mixed municipal	P.O. Box 60009 Industry, CA 91716-0009		No Response
City Terrace Recycling Transfer Station	1525 Fishburn Avenue Los Angeles, CA 90063	PJB Disposal Company 1525 Fishburn Avenue Los Angeles, CA 90063	**MRF/** Industrial Mixed municipal	1525 Fishburn Ave Los Angeles, CA 90063		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Puente Hills Materials Recovery	2800 Workman Mill Road, Whittier, CA 99999	County of Los Angeles Sanitation Dist 1955 Workman Mill Road Whittier, CA 90601	**MRF/** Construction/ demolition Industrial Mixed municipal	1955 Workman Mill Rd. Whittier, CA 90601		No Response
Innovated Waste Control	4133 Bandini Blvd Vernon, CA 90023	Innovated Waste Control Inc. 1300 Bristol Street North Suite 100 Newport Beach, CA 92660	**MRF/** Mixed municipal	4133 Bandini Blvd Vernon, CA 90023		No Response
Carson Transfer Station & MRF	321 West Francisco Street Carson, CA 90745	U.S.A. Waste Of Ca, Inc. 321 West Francisco Street Carson, CA 90745	NA/ Construction/ demolition Industrial Mixed municipal	321 Francisco St. Carson, CA 90745		No Response
American Waste Transfer	1449 W. Rosecrans Ave. Gardena, CA 90249	Republic Industries 1449 W. Rosecrans Ave Gardena, Ca 90249	NA/ Construction/ demolition Industrial Green Material Inert, Manure Mixed municipal	1449 W. Rosecrans Ave Gardena, CA 90249		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
South Gate Transfer	9530 Garfield Ave. South Gate, CA 90280	Los Angeles County Sanitation District	NA/ Construction/ demolition Green Material Inert Mixed municipal	1955 Workman Mill Rd. Whittier, CA 90601		No Response
Browing-Ferris Ind.	2509 W. Rosecrans Ave. Compton, CA 90220	BFI 2509 W. Rosecrans Ave. Los Angeles, CA 90059	NA/ Construction/ demolition Green Material Industrial Mixed municipal	2509 W. Rosecrans Ave Gardena, CA 90249		No Response
Culver City Transfer & Recycling Station	9255 W. Jefferson Blvd. Culver City, CA 90230	City of Culver City Sanitation Div. Of P.W.D 9770 Culver Blvd. Culver City, CA 90232	NA/ Construction/ demolition Green Material Inert, Tires Mixed municipal	PO Box 507 Culver City, CA 90232		No Response
Downy Area Recycling and Transfer	9770 Washburn Road Downy, CA 90201	Los Angeles County Sanitation Dis. And Downy Area Recycling Transfer Inc. P.O. Box 4998 Whittier, CA 90601	NA/ Construction/ demolition Green Material Industrial Mixed municipal	1955 Workman Mill Rd Whittier, CA 90601		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Paramount Resources	7230 Patterson Lane Paramount, CA 90723	Paramount Recycle Resource 7230 Patterson Lane Paramount, CA 90723	NA/ Construction/ demolition Industrial Mixed municipal	7230 Patterson Lane Paramount, CA 90723		No Response
Southern Cal. Disposal	1908 Frank Street Santa Monica, CA 90404	Southern Cal. Disposal Co. P.O. Box 25666 West Los Angeles, 90025	NA/ Construction/ demolition Green Material Mixed municipal	P.O. Box 25666 West Los Angeles, 90025		No Response
Grand Central Recycling/Transfer	999 Hatcher Ave. Industry, CA 91744	Grand Central Inc. 999 Hatcher Ave Industry, CA 91744	NA/ Construction/ demolition Green Material Inert Mixed municipal	999 Hatcher Ave Industry, CA 91744		No Response
Bel-Art Waste	2501 East 68th Street Long Beach, CA 90805	Republic Industries 1449 Rosecrans Ave Gardena, Ca 90249	NA/ Construction/ demolition Green Material Inert Mixed municipal	1449 W. Rosecrans Ave Gardena, CA 90249		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Community Recycling/Resource Recovery, Inc.	9147 De Garmo Ave. Sun Valley (In Los Angeles), CA 91352	Community Recycling and Resource Recover 9189 De Garmo Ave. Sun Valley, CA 91352	NA/ Construction/ demolition Industrial Mixed municipal	9189 De Garmo Ave. Sunvalley, CA 91352	**Yes**	**Yes. They are very interested.**
Central Los Angeles Recycling Center and Transfer Station	2201 Washington Blvd. Los Angeles (City), CA 90034	BLT Waste Systems of North America 2201 East Washington Blvd. Los Angeles, CA 90021	NA/ Construction/ demolition Industrial Mixed municipal	2201 East Washington Blvd. Los Angeles, CA 90021	**Yes**	**Yes. Have 9 acres on Washington Blvd Between Alameda and Santa Fe. M3 Heavy Industrial Full Utilities, Rail Access**
Mission Road Recycling and Transfer Station	840 South Mission Road Los Angeles (City), CA 90023	Waste Management Incorporated-Bradley LF & Miss 9081 Tujunga Ave. Sun Valley, CA 91352	NA/ Construction/ demolition Mixed municipal	9081 Tujunga Ave. Sun Valley, CA 91352		No Response
West Valley Materials Recovery Facility	13373 Napa Street Fontana, CA 92335	West Valley Recycling and Transfer 9890 Cherry Avenue Fontana, CA 92335	**MRF/** Green Materials Mixed Municipal Wood Waste	9890 Cherry Avenue Fontana, CA 92335	**Yes**	**Yes**

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Victor Valley MRF & Transfer Station	NW Corner of Abby Lane & 'b' Street Victorville, CA 92307	Burrtec Waste Industries, Inc. 9890 Cherry Avenue Fontana, CA 92335	**MRF/** Mixed Municipal	9890 Cherry Avenue Fontana, CA 92335	**Yes**	**Yes**
Advance Disposal Transfer/Processing Facility	17105 Mesa Street Hesperia, CA 92345	Advance Disposal Company P.O. Box 400997 Hesperia, CA 92340	**MRF/** Mixed municipal	P.O. Box 400997 Hesperia, CA 92340		No Response
Inland Regional MRF & Transfer Station	2059 East Steel Road Colton, CA 92324	Taormina Industries, LLC 1131 N. Blue Gum Street P.O. Box 309 Anaheim, CA 92806	**MRF/** Construction/ demolition Green materials Industrial Mixed municipal Wood waste	1131 N. Blue Gum Street P.O. Box 309 Anaheim, CA 92806		No Response
Twentynine Palm Transfer Station	7501 Pinto Mountain Road Twentynine Palms, CA 92277	County of San Bernardino Solid Waste Mgt Div. Art Rivera Solid Waste Div. 222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415-0017	NA/ Construction/ demolition Industrial Mixed municipal Tires	222 West Hospitality Lane 2nd Floor San Bernardino, CA 92415-0017		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Big Bear Transfer Station	Holcomb Valley Road 1.5 Miles N of HWY 18 Big Bear City, CA 92314	County of San Bernardino Solid Waste Mgt Div. Art Rivera Solid Waste Div. 222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415	NA/ Construction/ demolition Dead Animals Green Material Mixed municipal	222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415-0017		No Response
Heap Peak Transfer Station	N Side of HWY 18; 3 Miles West of Running Springs Lake Arrowhead, CA 92407	County of San Bernardino Solid Waste Mgt Div. Art Rivera Solid Waste Div. 222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415	NA/ Mixed municipal	222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415-0017		No Response
Sheep Creek Transfer Station	10130 Buckwheat Road Phelan, CA 92371	County of San Bernardino Solid Waste Mgt Div. Art Rivera Solid Waste Div. 222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415	NA/ Mixed municipal	222 West Hospitality Lane, 2nd Floor San Bernardino, CA 92415-0017		No Response
Stanton Transfer and Recycling Center # 8	11232 Knott Ave. Stanton, CA 90680	CR Transfer Inc. 11292 Western Avenue Stanton, CA 90680	**MRF/** Mixed municipal	11292 Western Avenue Stanton, CA 90680		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Rainbow Recycling/Transfer Station	17121 Nichols Ave. Huntington Beach, CA 92647	Rainbow Transfer/Recycling Inc. 17121 Nichols Ave. Huntington Beach, CA 92647	NA/ Construction/ demolition Industrial Mixed municipal Wood Waste	PO Box 1026 Huntington Beach, CA 92647		No Response
Consolidated Volume Transporters	1131 N. Blue Gum Street Anaheim, CA 92806	Taormina Industries, LLC 1131 N. Blue Gum Street P.O. Box 309 Anaheim, CA 92806	NA/ Industrial Mixed municipal Tires	1131 N. Blue Gum Street P.O. Box 309 Anaheim, CA 92806		No Response
Sunset Envir Inc. Transfer Station/Resource Recovery Facility	16122 Construction Circle East Irvine, CA 92606	Sunset Environmental 16122 Construction Circle East Irvine, CA 92606	NA/ Construction/ demolition Industrial Mixed municipal	16122 Construction Circle East Irvine, CA 92606		No Response
Waste Management of Orange/Transfer Station	2050 N. Glassell Street Orange, CA 92865	USA Waste of California, Inc. 2050 N. Glassell Street Orange, CA 92865	NA/ Construction/ demolition Mixed municipal	1800 S. Grand Santa Ana, CA 92705		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Moreno Valley Solid Waste Recycle & Transfer Facility	17700 Indian Street Moreno Valley, CA 92551	Waste Management of the Desert 41575 Eclectic Street Palm Desert, CA 92260	NA/ Construction/ demolition Green Material Metals Inert Mixed municipal	41575 Eclectic Street Palm Desert, CA 92260		No Response
Idyllwild Collection Station	28100 Saunders Meadow Road Idyllwild, CA 92549	County of Riverside Waste Management Department 14310 Frederick Street Moreno Valley, CA 92553	NA/ Ash Green Material Mixed municipal	14310 Frederick Street Moreno Valley, CA 92553		No Response
Robert A Nelson (RANT) Transfer Station & MRF	1830 Agua Mansa Rd Rubidoux, CA 92509	Agua Mansa MRF, LLC 9890 Cherry Avenue Fontana, CA 92335	**MRF/** Mixed municipal	9890 Cherry Avenue Fontana, CA 92335	**Yes**	**Yes.** **They have 5 acres of land beside the facility.**
Perris Transfer Station and MRF	1706 Goetz Road Perris, CA 92570	CR&R Incorporated 11292 Western Avenue Stanton, CA 90680	**MRF/** Mixed municipal	1706 Goetz Road Perris, CA 92570	**Yes**	**Yes.** **They have 27 acres adjacent to their property.**
Escondido Resource Recovery	1044 W. Washington Avenue Escondido, CA 92033	Jemco Equipment Corporation P.O. Box 1187 Ramona, CA 92065	**MRF/** Construction/ demolition Green materials Mixed municipal	1044 W. Washington Avenue Escondido, CA 92033		No Response

TABLE A-7 (CONTINUED)
LONG LIST OF MATERIAL RECOVERY FACILITIES (MRF) AND LARGE TRANSFER STATIONS (TS) OF SOUTHERN CALIFORNIA

Name	Address	Operator/Business Owner	Operational/Waste Type	Mailing Address	Recycling Market Development Zone	Interest in Conversion Technology
Ramona MRF And Transfer Station	324 Maple Street Ramona, CA 92065	Ramona Disposal Service P.O. Box 1187, 324 Maple Street Ramona, CA 92065	**MRF/** Construction/ demolition Green materials Mixed municipal	P.O. Box 1187 Ramona, CA 92065		No Response
Fallbrook Recycling Facility	550 W. Aviation Road Fallbrook, CA 92028	Fallbrook Refuse Service 550 W. Aviation Road, Fallbrook, CA 92028	**MRF/** Construction/ demolition Mixed municipal	550 W. Aviation Road, Fallbrook, CA 92028		No Response
Edco Station	8152 Commercial Street La Mesa, CA 91942	Edco Disposal Corporation 6670 Federal Blvd Lemon Grove, CA 91945	**MRF/** Construction/ Demolition Green materials Industrial Mixed municipal	6750 Federal Blvd. Lemon Grove, CA 91945	**Yes**	**Yes**
Valley Environmental Services Recycling	702 East Heil Avenue El Centro, CA 92243	Valley Environmental Services 3354 Dogwood Road Imperial, CA 92251	**MRF/** Mixed municipal from the curb recycling with high percentage of residue	3354 Dogwood Rd Imperial, CA 92251	**Yes**	**Yes. Possibly space availability depending on the need.**

LOS ANGELES COUNTY INTRODUCTORY LETTER TO THE MRFs/TSs

LOS ANGELES COUNTY
SOLID WASTE MANAGEMENT COMMITTEE/
INTEGRATED WASTE MANAGEMENT TASK FORCE
900 SOUTH FREMONT AVENUE, ALHAMBRA, CALIFORNIA 91803-1331
P.O. BOX 1460, ALHAMBRA, CALIFORNIA 91802-1460
www.lacountyiswmtf.org

DONALD L. WOLFE
CHAIRMAN

REQUEST FOR INTEREST
SOLID WASTE MANAGEMENT ALTERNATIVE TECHNOLOGY PROJECTS
SOUTHERN CALIFORNIA REGION

The Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force (Task Force) in concert with the County of Los Angeles is currently researching and promoting the development of conversion technologies as alternatives to traditional solid waste disposal methods. As a part of these efforts, we have an opportunity to partner with solid waste management facilities in order to develop and test these state-of-the-art solid waste management technologies. We are excited about the potential of these technologies to significantly increase the amount of solid waste diverted from disposal and create marketable and valuable products and fuels.

Our aim is to develop a demonstration facility in Southern California that utilizes new technology(ies) to manage solid waste, testing the feasibility of such facilities and gaining real data on their operation in California. This may well be the first facility of its kind in Southern California and the operation of the facility will be widely publicized well beyond California and the Nation.

The Task Force, and more specifically its Alternative Technology Advisory Subcommittee (Subcommittee), represents a diverse array of public and private entities committed to exploring conversion technologies as a potentially viable solid waste management alternative. Members of the Subcommittee include representatives from the Task Force, the County of Los Angeles, the City of Los Angeles, the County Sanitation Districts of Los Angeles County, private consultants, and members of the public. Each member has interest, knowledge, and experience in the field of conversion technologies and all have committed their resources to help make this endeavor a success.

We are contacting operators of solid waste management facilities, especially Materials Recovery Facilities, as to their interest to partner with the Task Force in development of a demonstration conversion technology facility. **It is requested that you fill out and return the enclosed postage-paid postcard in order to convey your interest to us**. The postcards are being compiled by URS Corporation under contract with the County of Los Angeles Department of Public Works, and a representative from URS will be in touch with you soon to follow up on this letter. Please note that we will assume you are not interested in participating if we do not hear back from you by September 30, 2004.

We want to emphasize that facility operators interested in a partnership can look forward to the support of the County of Los Angeles, the Sanitation Districts of Los Angeles County, the Task Force, and other representative members. This includes technical and material support as well as assurances of confidentiality. The Subcommittee's representative members are determined to pursue the development of a facility in the next few years. We look forward to your positive response and working together in achieving this endeavor.

Should you have any questions regarding this matter, please contact Mr. Shapoor Hamid of URS Corporation at (213) 996-2200, who is coordinating our data collection and research efforts under contract with the County, or you may contact Ms. Shari Afshari of the County of Los Angeles Department of Public Works at (626) 458-3500, if you would like information regarding the County's efforts to promote Conversion Technology.

Very truly yours,

Michael Miller, Vice-Chair
Los Angeles County Solid Waste Management Committee/
Integrated Waste Management Task Force and
Mayor, City of West Covina

CS:my
Letter2MRFs

Enc.

cc: Each Member of the Los Angeles County Board of Supervisors
Each Member of the County Sanitation Districts Board of Directors
Chief Engineer & General Manager of the County Sanitation Districts
Each Member of the County of Los Angeles Regional Planning Commission
Interim Director of the County of Los Angeles Department of Public Works
Each Member of the Los Angeles County Integrated Waste Management Task Force
Each Member of the Alternative Technology Advisory Subcommittee

SAMPLE OF URS' LETTERS SENT TO THE MRFs/TSs

November 2, 2004

MRF Address

Re: MRF/TS

Dear Sir/Mam:

The County of Los Angeles Department of Public Works (CLADPW) Integrated Waste Management Task Force has engaged URS Corporation to perform a conversion technology study and to facilitate the development of a conversion facility in Southern California. This study will exclusively prioritize residue from a Material Recovery Facility (MRF) and Transfer Station (TS) as the feedstock for a potential conversion facility. A Los Angeles County letter introducing URS as the contractor for this job and County's purpose for this project was sent to the Southern California MRF/TS on September 30, 2004.

The County letter also included a postcard with questions regarding willingness to partner with a conversion technology supplier and space availability. Your initial positive response prompted URS to pursue this issue further and to start evaluation of your facility for this purpose. To this end, URS will need your assistance in providing some basic data regarding your facility and the residues that are currently disposed of in a landfill. The following information will help to expedite MRFs/TSs evaluation process:

- The daily tonnage of the MSW delivered to the facility
- Types of waste (single family residential, apartment buildings, commercial or industrial)
- Is MSW going through any type of separation before coming to the facility?
- Daily tonnage of the MRF/TS residue disposed of in a landfill
- Composition (existing data) of the MRF/TS residue going to the landfill
- Space available adjacent to the facility, zoning and transportation access
- Pretreatment capability and availability of utilities (electricity, water sewage).

Also, URS representatives would like to visit your facility. The above-mentioned information can be given to URS during our visit. Please provide us the name and phone number of a contact person with dates and times that are convenient for this visit.

We appreciate your assistance and if you have any questions, please do not hesitate to call me.

Best Regards,

Shapoor Hamid, PhD, REA
Senior Scientist/Project Manager
Email: shapoor_hamid@urscorp.com

STRATEGIC ACTION PLAN

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EXECUTIVE SUMMARY

Conversion Technologies offer a new and potentially groundbreaking approach to reducing the amount of solid waste disposed at landfills. Conversion Technologies refers to an array of emerging technologies capable of converting the organic, or carbon-containing materials portion of post recycling residual solid waste into useful products, including renewable and environmentally benign fuels, chemicals, and other sources of clean energy. These products, in turn, can be utilized in the same facility to produce electricity or marketable chemicals and fertilizers. These technologies are a reflection of our technological advances to bring about improvements to our quality of life and the environment while complying with strict environmental standards and up-front recovery of recyclable materials prior to the conversion process.

Benefits

The California Integrated Waste Management Board recently released two reports on conversion technologies. The first report addressed the various technologies available, and the second included a life cycle assessment and market assessment. Both of these reports concluded that conversion technologies offer substantial benefits over existing solid waste management options, including landfilling and incineration. Examples of these benefits are:

- Beneficial use of solid waste
- Reduced landfill impacts
- Increased diversion of materials from landfill disposal
- Increased recycling
- Significant life cycle advantages
- Societal and economic benefits due to job creation, etc.

Challenges

Implementation of a conversion facility requires the successful completion of a series of steps, however as with any new industrial facility some challenges will need to be remedied or surmounted prior to development. These obstacles include existing regulations that are too restrictive and unworkable, the lack of a regulatory framework to allow permitting of a facility, and economic considerations (i.e., capital cost, operation and maintenance costs, and potential revenue streams). There will be challenges with regard to environmental and technical issues, but these issues can be largely addressed by analyzing existing data from operating conversion facilities abroad. It is expected that these facilities will comply with all Federal, State and local environmental laws and regulations.

Recommendations

This Strategic Plan recommends a number of actions to further the development of a conversion technology facility in Southern California. A summary of these actions follows:

- Environmental Issues:
  - Identify potential sites early and involve the public
  - Evaluate environmental challenges with solid science and utilize independent and academic experts
  - Collect and analyze available conversion technology data, and present it in context with conventional solid waste management options currently in use in California
  - Address mitigation of environmental impacts clearly and aggressively
  - Emphasize that all environmental regulatory limits will be met or exceeded; Consider over-controlling air emissions if cost-effective
- Technical Challenges:
  - Adopt a conservative design approach
  - Only consider conversion technology vendors with excellent credentials (technical and financial)
  - Inspect existing facilities of short-listed technology vendors
  - Emphasize the technical issues discussed in this Plan and the importance of overcoming them in the Request for Proposal (RFP) instructions
- Public Outreach Issues:
  - Educate political and influential officials using real data
  - Engage stakeholders early and often
  - Engage independent experts
  - Consider forming a "Stakeholder Outreach Steering Committee" to guide an outreach program for the project
- Legislative Issues:
  - Participate in the development of regulations and promote modifications to statutes to allow for impartial study and analysis of the potential capabilities of these technologies

  - Seek political support to adopt prudent regulations
  - Promote and participate in relevant technical and economic studies

- Cost and Financing Issues:
  - Explore other (outside) funding mechanisms
  - Engage multiple jurisdictions
  - Seek assistance from the state (e.g., CIWMB, CEC) and other levels of government
  - Investigate partnering with technology suppliers or other public and/or private agencies
  - Identify the markets for electricity, fuel, compost and other products and byproducts in Southern California

1.0 INTRODUCTION AND OBJECTIVES

The County of Los Angeles and the Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force have adopted a goal to reduce landfilling of solid waste residuals remaining after all appropriate recycling and composting activities have been completed through the beneficial use of the remaining residuals. This goal can be achieved by utilizing non-combustion thermal, chemical and biological processes (commonly known as conversion technologies), which are currently being used in Europe, Japan, and other countries. However, use of such technologies in California for management of solid waste residuals is virtually non-existent due to current legislative obstacles and economic constraints.

The objectives of the County and the Task Force are to:

- Evaluate various conversion technologies and identify those that are most suitable for Southern California
- Create a partnership between a Materials Recovery Facility/Transfer Station (MRF/TS) and a conversion technology vendor to develop a demonstration/small commercial project at one or more MRFs and/or TSs in Southern California
- Support the development and adoption of legislative proposals to remove existing legislative obstacles utilizing the results of the California Integrated Waste Management Board (CIWMB) studies conducted pursuant to AB 2770 and technical data from existing conversion technology facilities and those that will gathered from the operation of the demonstration/pilot facility

This Strategic Action Plan considers the prospective steps the County and the Task Force may take over the short- (6-12 months), mid- (1-5 years) and long- term to satisfy the above-mentioned objectives.

The County and the Task Force set out to further these objectives by developing a pilot/demonstration facility that utilizes a conversion technology somewhere in Southern California, and co-locate it at a Materials Recovery Facility (MRF) or Transfer Station (TS) to utilize the available solid waste residuals that would otherwise be sent to disposal. This approach offers several advantages, such as:

- Provides the processing capability of an existing MRF to produce the required composition of the feedstock for the conversion facility
- Reduces environmental impacts such as noise, odor, and traffic in comparison to a new facility
- Provides zoning and siting advantages for a conversion facility

- Provides financial incentives such as locating in a Recycling Market Development Zone
- Makes the permitting process easier compared to siting a new conversion facility

The County and Task Force focused on developing a demonstration-scale facility with a throughput of approximately 100 tons per day. This direction was chosen because it would allow for a more rapid development of a facility than a full commercial unit. The California Integrated Waste Management Board's (CIWMB) Conversion Technology Evaluation Report concluded that the lack of locally relevant data was a hindrance to future development. A demonstration facility will provide valuable real-world data to support further conversion facilities in California and will provide an opportunity to test approaches to siting, permitting, public response, air emissions and other environmental issues, economics, and technical challenges.

Implementing such a project is a complex task that involves many challenges, including:

- Technical feasibility
- Siting
- Risk management
- Legal (including contractual), legislative, regulatory and permitting issues
- Financial and cost issues
- Public acceptability
- Environmental impact mitigation
- Ability and willingness of a MSW Facility (MRF/TS) and conversion technology vendor to create a partnership
- End product markets and market impacts

These challenges are addressed in this Plan, and an overall implementation schedule is proposed.

2.0 BENEFITS OF CONVERSION TECHNOLOGIES

According to extensive preliminary research (including the CIWMB's Life Cycle and Market Assessment Report), conversion technologies have the potential to provide substantial environmental benefits over other solid waste management options, such as landfilling or incineration. These benefits include increased landfill diversion, reduce landfill impacts, the beneficial use of solid waste, reduce green house gas emissions and other air pollutants, as well as socio-economic, economic and other market benefits. These benefits are briefly described below.

2.1 Increased Landfill Diversion

Material currently sent to landfills represents a substantial resource that contains chemical energy available for conversion to useful products. According to the CIWMB's Conversion Technology Market Analysis Report, converting MRF residues into useful products and byproducts will significantly increase landfill diversion while complementing and potentially enhancing the recycling market. Some materials, which are not currently recycled (e.g., some plastics, contaminated organic material, etc.), can serve as excellent feedstocks for conversion technologies.

2.2 Reduced Landfill Impacts

Diverting biodegradable materials from landfills also reduces the environmental impacts and operating costs of landfilling.

2.3 Beneficial Use of Solid Waste

Thermal and chemical/biological conversion technologies can convert solid waste, including the organic portion of MRF residuals, into many types of products, such as electricity, fuels, or chemical feedstocks. In addition, some of the residuals (byproducts) from conversion technologies, such as metals and slag, can be recycled, or used productively. Most of these products can be sold, creating an important revenue stream for the facility.

Power produced by conversion technologies will likely qualify for credit under the Renewable Portfolio Standard (RPS) in California. This will increase the attractiveness, and perhaps pricing, of electricity generated by a conversion facility.

2.4 Increased Recycling

Use of conversion technologies will enhance the recycling industry by providing additional material for recycling through the pre-processing component of the conversion facility. Pre-processing will both remove materials that are inappropriate for conversion, and separate any materials that can be recycled. As noted above, some un-recyclable materials that would otherwise be disposed are likely to be excellent feedstocks for conversion technologies.

2.5 Greenhouse Gas Emissions and Air Pollution

Converting biodegradable material into energy, or other useful products, in a controlled fashion , will lead to reduce greenhouse gas creation. This benefit arises from:

- The prevention of methane emissions from landfills, since solid waste is converted to usable syngas (even if the syngas is used for power generation, the resulting carbon dioxide has a lower global warming potential than methane)
- The displacement of fossil fuels for creating the same power or chemicals, preventing the introduction of new carbon into the atmosphere
- The displacement of chemical fertilizers and the related fossils fuel consumption

Thermal conversion technologies are often compared to existing solid waste incinerators, or mass burn systems. However, with regard to air emissions, thermal conversion facilities differ significantly from incineration:

- The volume of gases from a pyrolysis reactor or gasifier is much smaller per ton of feedstock, which greatly simplifies gas clean-up and allows for a greater variety of control technologies to be applied.
- Output gases from thermal conversion technologies are typically in a reducing environment, also enabling a greater variety of control technologies to be used.

Most biological/chemical conversion technologies have the potential to generate little or no greenhouse gases, and with existing air emission control systems, the air emissions from these technologies can meet regulatory limits (including those imposed by the Southern California Air Quality Management District) with regard to other air pollutants such as heavy metals and Volatile Organic Compounds (VOCs).

2.6 Socioeconomic Benefits

Conversion technologies that are processing MRF/TS residuals or other solid waste feedstocks, result in a number of benefits, the magnitude of which will depend upon how many facilities are ultimately built:

- Reduces in the need for disposal capacity
- Reduces environmental impacts and operation & maintenance costs of landfills
- Reduces traffic and air emissions currently generated by hauling residuals from MRFs and TSs to landfills or incineration facilities

- Displaces petroleum use for production of chemicals and generation of electricity
- Generates distributed energy which not only reduces the need for oil and natural gas but also helps in stabilizing California's power supply
- Creates jobs from conversion facility construction and operation
- Brings new products to market, with resulting local economic multiplier effects

2.7 Life Cycle Benefits

The CIWMB recently released a report that evaluated the life cycle impacts of conversion technologies. Key findings of this report include:

- The amount of energy produced by the conversion technology scenario analyzed in the report is larger than all other solid waste management scenarios studied, which includes landfilling, incineration, and even recycling.
- For criteria air pollutants, the conversion technology scenario is better when compared to all other solid waste management scenarios studied, again including recycling.
- Carbon emissions contribute to the greenhouse gas effect. The use of conversion technologies creates carbon emission offsets resulting from the displacement of fossil fuels, material recycling, and the diversion of organic materials from landfills. Thus, conversion technologies exhibit the lowest overall carbon emissions of all solid waste management options studied.
- Conversion technologies will reduce the amount of waste disposed of in landfills.

2.8 Economic and Market Benefits

The CIWMB recently released a report that evaluated the impact of conversion technologies on the recycling, composting, and landfill markets. Key findings of this study include:

- There will be a net positive impact on glass, metal, and plastic recycling if conversion facilities are introduced as another solid waste management option.
- Conversion technologies will create additional recycling-related jobs as well as jobs at the conversion facilities.
- The potential threat to the recycling industry from conversion technologies is unfounded.

3.0 ISSUES AFFECTING PROJECT IMPLEMENTATION

The key issues affecting implementation of a conversion technology facility in southern California are discussed in this section. These issues can be viewed both as challenges to development and as potential benefits to the community. Overall, the most important issues affecting implementation of a conversion facility are likely to be legislative/regulatory barriers and economics. While a number of technical and environmental issues are discussed here, it is anticipated that careful attention to facility design, and aggressive impact mitigation will be adequate to ensure that those issues are successfully addressed.

3.1 Legislation, Policy, and Regulations Affecting the Development of Conversion Technologies

The legal and regulatory environments surrounding conversion technology development in California is complex, confusing, and in a state of flux. Legislative and policy issues affecting conversion technologies involve several regulations, including AB 2770, AB 1038, SB 1078. Regulations promulgated by new legislation are now under development by both the CIWMB and the California Energy Commission.

Since 1999, Los Angeles County and the Task Force have been actively investigating and promoting the development of conversion technologies as alternatives to traditional disposal methods. For example, Los Angeles County introduced Assembly Bill 1939 in 2000 which would have provided a diversion credit incentive for the development of conversion technologies. However, despite strong bipartisan support, AB 1939 was held in the Natural Resources Committee. Subsequently, the CIWMB began investigating the potential of conversion technologies to increase landfill diversion. In September 2002, encoding of AB 2770 and SB 1038 created the first legal definition of waste conversion of solid waste for the production of a "clean-burning synthetic gas" to be used in generating renewable energy. "Solid waste conversion technologies" eligible for renewable energy support as described in SB 1038 were more narrowly defined as "gasification" in AB 2770, legally equating this broad technical capability to one specific form of conversion. Purview over "gasification" of solid waste was placed under CIWMB, and defined for purposes of permitting and enforcement as the newest type of Solid Waste Disposal Facility.

3.1.1 <u>Definitions</u>

The definitions created by AB 2770 are both too restrictive and unworkable as written. Issues surrounding AB 2770 and Public Resources Code Section 40117 include:

- AB 2770 applies to a "non-combustion thermal process to covert solid waste to a clean burning fuel for the purpose of generating electricity", using the term "gasification". Clearly, this definition is too restrictive, and needs to expand in the new law to include not only energy generation, but also the production of fuels, chemicals, and other renewable products.

- It is unclear how the thermal processes are differentiated, such as gasification, pyrolysis, and gasification/pyrolysis systems, as well as technologies that employ both thermal and biological processes. The law should be based upon performance, not individual technologies.
- Biological conversion and chemical conversion are not addressed. However, biological conversion is included in the definition of "transformation" (gasification is not). A broader list of conversion technologies needs to be legally recognized, based upon performance rather than technology.
- Gasification cannot simply be defined according to the "use air or oxygen in the conversion process". This definition is unworkable, and too restrictive. Again, a performance-based approach would be more inclusive.

Conversion facility definitions within AB 2770, SB 1038 and SB 1078 must be modified by the legislature so that workable regulations can be developed and promulgated. These definitions should be revised to be broader in context, more flexible to innovation, and in conformity with scientific classifications of conversion technologies.

3.1.2 Diversion Credit

The development of conversion technologies have been hampered by obsolete provisions in the law that classify these conversion technologies identically to incineration, however the regulatory hurdles imposed by statute are more severe for conversion technologies, and do not have access to grandfathered diversion credit that existing transformation facilities currently enjoy. Diversion credit should be awarded based on good science and a rational and comprehensive analysis of the impacts and benefits of conversion technologies in relation to the spectrum of other solid waste management options, especially as compared to composting and recycling. Allowing conversion technologies to be eligible for diversion credit would spur the development of conversion technologies since it would provide an incentive for local governments to take their solid waste to those facilities in return for diversion credit.

Diversion credit *can* presently be counted by a municipality for materials diverted from the waste stream toward an approved conversion technology, *provided that feedstock never enters the waste stream in the first place.* "Sole source segregation" at the point of generation would accomplish what can not now legally be claimed by post-recycling aggregation: (a) tonnage decrease from a known waste generation source can be quantified based on existing records, and counted as diversion by the Municipality; (b) material never entering the "waste stream" is not legally "waste" under state or federal law, and (c) long-term feedstock contracts for sole-source segregated materials could stipulate quality, including any provisions for pre-sorting and resource recovery that might be deemed acceptable.

This method of industrial sole-source segregated feedstock acquisition has long been utilized by California's existing Biomass Energy industry, although no apparent attempt to justify municipal diversion credit has been made by the industrial facilities. The legal foundation lies with determination of exactly when a material becomes a waste, a subject addressed piece-meal in a variety of state and federal code sections.

Recognition, quantification and acceptance of the contractual value and municipal diversion benefit would create a sound basis for one approach to assigning municipal diversion credit for resource materials diverted as feedstock for approved conversion technology facilities.

3.1.3 Relationship to Renewable Energy

The California Energy Commission (CEC) administers programs to promote renewable energy technologies through SB 1038. This legislation includes parallel language with respect to conversion technologies to AB 2770. SB 1038 allows solid waste conversion technology as a renewable technology eligible under the Renewable Portfolio Standard (RPS). However, the CEC has deferred to the CIWMB for determination of when thermal conversion technologies meet the definition of renewable power. Eligibility for RPS would be a benefit for conversion technologies; however, it is unclear when the CEC and CIWMB will clarify how conversion technologies will qualify under the RPS.

3.1.4 Solid Waste Versus Material Reuse

Equally important to conversion technology implementation is the question of when a material, once classified as a "waste" can be determined to no longer fit that category: when, and under what processing conditions, is management of a waste derived feedstock no longer legally considered "disposal"?

The CIWMB currently regulates residue from a Material Recovery Facility, and interprets this residue as a solid waste. This approach appears contradictory when compared to industries that use recycled materials for manufacturing new products. In addition, businesses receiving materials that meet the so-called "three-part test" (separated for reuse, less than 10% residual, and less than 1% putrescible) currently qualify as "Recycling Centers," under CCR 17402.5 and are exempt from the Board's regulatory framework. Therefore, there appears to be potential for a regulatory pathway whereas MRF residuals would be classified as "reuse material". Alternatively, CCR 17402.5 defines "manufacturer" as "*a business entity that uses new or separated for reuse materials as a raw material*".

3.2 Permitting and Other Requirements

The process of securing permits for a conversion facility will be similar to obtaining permits for other industrial facilities. However, one challenge is that there are no operating conversion facilities in California (or in any other state for that matter). This will complicate the permitting process because various permitting schemes (e.g., air quality) do not include conversion facilities as a source type. Finally, the CIWMB must develop a permitting framework for conversion facilities.

The timing of permit approvals is dependent upon the regulatory framework (which is not yet present), and the nature of any significant or adverse impacts. The expected timing is discussed in Section 4.7.

Aside from the regulations that will need to be developed for conversion technologies by the CIWMB, developing a conversion facility will require many permits and/or other entitlements. Several of the key permits are discussed below, with comments regarding the status of conversion technology regulations, and how this situation may affect the permitting process.

- **Land use permit and/or zoning.** An amendment to the General Plan comes under consideration. If the CT is a "Disposal facility", then it must be also be shown in the "Countywide Siting Element", which requires amendment of the Plan. As this is the first time a proposed project becomes "public knowledge", it is also the first time a project may be challenged. Accepting the premise that conversion technologies are disposal facilities also creates the opportunity to challenge by those who would categorically oppose a new "disposal facility" in their region.
- **California Environmental Quality Act (CEQA) process.** The CEQA process will require preparation of an environmental assessment document and appropriate mitigation measures. Because this is likely to be the first CEQA document for a conversion facility, it is important that the evaluation of environmental issues be comprehensive.
- **Air emissions (AQMD) and water discharge permits (RWQCB).** As applicable, these permits will be important determinants of overall facility acceptance to the regulators and the public.
- **Solid waste facility permit.** Under current regulations, the conversion facility will be viewed as a disposal facility. The comment under land use above, also applies here.
- **Regulating compost as a byproduct.** If compost is produced, it will have to be certified as compliant with US EPA (e.g., 503 rules) and State regulations. A larger issue is that current regulation under AB 2770 requires that all compostable materials be removed from the feedstock before conversion.

3.3 Environmental Issues

Environmental issues are an important consideration in the implementation of a conversion facility from both the permitting and public acceptability perspectives. When discussing these issues, it should be recognized that different technologies would exhibit different impacts; therefore, all of the issues discussed below may not apply to a specific facility design.

3.3.1 Air Emissions

One advantage of conversion technologies is that the core conversion equipment of most of them does not release air emissions. Typically, a synthetic gas (syngas) and/or liquid fuel is produced, which after cleaning and refining, can be used as a fuel to generate power or for producing chemicals. Air emissions may occur as stack gas releases from the power production system using refined syngas or liquid fuel.

Air emissions of concern include the "conventional pollutants" covered by air permits (NO_x, CO, PM, VOCs, SO_x), as well as air toxics (e.g., dioxins/furans, metals, HCl, H_2SO_4). The conventional pollutant releases will be similar to those from gas-fired power plants. Thermal conversion technologies, unlike incinerators, treat solid waste in the absence of oxygen or with limited oxygen in a reducing environment, which significantly reduces the formation of air toxics. These processes thermally convert (without combustion) the solid waste to a syngas, which can then be used for power production or for making chemicals and alternative fuels. There is some potential for air toxics to be present in the feedstock due to small amounts of chlorinated materials. In addition, there is a potential for air toxics formation. However the concentration of these air toxics using thermal conversion technologies is much lower than "mass burn" incinerators and typical recycling technologies such as metal smelting and paper recycling. Proper design and operation of these facilities, control of temperatures, use of a reducing atmosphere, and use of appropriate emission control technologies minimize these emissions.

Also, biological conversion technologies can have emissions like Volatile Organic Compounds (VOCs) and ammonia from their digestion units. These emissions should be taken under consideration and can be dealt with by an appropriate emission control system.

A key issue with regard to air emissions is the lack of comparable data. While some air emissions data is available for conversion facilities located abroad, these facilities were designed to different standards than would be applied in Southern California, and their air emission regulations are also different. "Apples to apples" comparisons of existing conversion technology data with conventional solid waste management options will be important when discussing the environmental performance of conversion technologies. While this problem is not viewed as a technical barrier to development, it is important to public acceptability of these facilities.

3.3.2 Water Discharges

Thermal, biological and chemical conversion technologies will produce some water and/or wastewater, either from the processes themselves, or from various emission control systems. If need be, the processed water can be treated with conventional technologies before release to sewer systems or otherwise disposed. Some of these technologies can produce reusable water.

3.3.3 Solid Waste

All conversion facilities will create quantities of solid wastes because of the presence of inorganic materials in the feedstock, and residue from various emission control systems. Some of these residues, such as carbon char, slag, and ferrous and non-ferrous metals, may be marketable. Conversion facilities that generate small quantities of unmarketable solid residues can dispose of those materials in a standard Class III landfill, depending on their physical and chemical characteristics.

3.3.4 Other Impacts

If byproducts are generated for land application, such as compost, there is a possibility of spreading heavy metals and other persistent toxic to levels exceeding regulatory limits. Also, conversion facilities will be potential sources of odor, dust, traffic, and other nuisance impacts because solid waste may be delivered to and handled in the facility. These impacts can be minimized or eliminated through good housekeeping practices, intelligent design, co-location with a Materials Recovery Facility (MRF) or Transfer Station (TS), and other measures. Biological systems can create nuisance odor problems; however, negative air pressure systems (commonly used in some existing MRFs and TSs) control this problem. Since this effort proposes to co-locate any facility with a MRF/TS, some of these impacts will be reduced compared to a new facility at a greenfield location.

In summary, while environmental issues will play an important role in conversion facility development, these issues are manageable on a technical level. As stated in CIWMB's Conversion Technology Evaluation Report, current understanding of conversion technologies suggests that environmental permits can be obtained for these facilities.

Public outreach can address key environmental issues, educate the public about conversion technologies, and distinguish conversion technologies from conventional mass burn (incineration) facilities and their air emissions, in order to reinforce the environmental benefits of conversion technologies.

3.4 Technical Issues

As will any new industrial development, there are technical challenges that must be evaluated prior to technology, technology vendor, and conversion facility selection. These challenges arise primarily because most conversion facilities have been built and operated overseas. Since we have no design experience to draw from in this country, additional efforts will be necessary to ensure that the facility design will meet the highest standards. These challenges are manageable, with the end results being that these conversion technologies will bring significant improvements to solid waste management in southern California.

Key technical challenges include the following:

- Feedstock Composition and Availability
- Design and Equipment Scaling
- Subsystem Integration
- Pre-processing System Reliability/Functionality
- Conversion Unit Performance/Reliability
- Unit Process and Systems Performance Guarantees
- Emission Control Systems
- Products and Byproducts Quality
- Reference Plants and Available Data

Each of these challenges is briefly discussed below.

3.4.1 Design and Equipment Scaling

Many conversion technology vendors being considered as candidates for a demonstration facility have relatively small pilot facilities operating at rates of 5-20 tons per day. These firms claim to be able to scale these facilities to the 100 tons per day level or higher. There are two primary methods of accomplishing this:

- Scaling up the size of the conversion unit, i.e., reactor
- Adding more conversion units, i.e., modules

Adding more modules of a proven design or throughput may be an acceptable way of increasing throughput, up to the point where a large number of modules may actually inhibit effective operation and maintenance or create excessive cost. However, scaling up a proven size to one not yet proven, especially over a short period of time, may present significant technical challenges. Careful design review will avoid these issues.

3.4.2 Subsystem Integration

Conversion facilities typically are comprised of at least three subsystems: pre-processing, conversion, and energy production. Conversion technology vendors often have strong expertise and experience in only one of the three areas. A conversion technology vendor may establish a partnership with a firm with strong capabilities in material separation, for example. As a result, a key concern is the ability of the vendor and partners to successfully integrate (and optimize) the three subsystems. Ensuring that the vendor has partners who can adequately address integration issues can mitigate this issue.

3.4.3 Pre-processing System Reliability/Functionality

Conversion technologies require differing type and quality of feedstock in order to operate efficiently and reliably. Some designs operate well on heterogeneous feedstocks, and some require as homogeneous a feedstock as possible in order to assure constant operating conditions. The ideal feedstock varies by technology or design. Conversion technology vendors may use many different material separation and/or processing techniques, including shredding, crushing, drying, and agglomerating to prepare the feedstock for conversion. The MRF/TS may be able to avoid some of these issues by effectively pre-processing the feedstock. This issue is managed by ensuring that the pre-processing equipment is designed to provide the required feedstock (with a design basis linked to the composition of MRF residuals).

3.4.4 Conversion Unit Performance/Reliability

A key concern is the performance of the conversion technology, independently and as part of the larger facility/complex. For the most part, the individual subsystems that make up conversion facilities have been commercially proven worldwide on a wide range of feedstocks, including MSW. However, most of these conversion technologies have not yet been applied in this country for MSW or as part of an integrated MSW facility. The conversion facilities in Europe, Japan and Australia were designed to different standards, and are subject to different regulations. Additionally, the feedstock composition of the existing foreign or domestic conversion facility may be different from that expected in Southern California, with resulting differences in conversion efficiency, fuel quality, emission, byproduct composition, etc. These issues are precisely why a demonstration facility is being proposed.

3.4.5 Air and Water Emission Control Systems

Environmental impacts from conversion technologies must be properly managed and mitigated in order to obtain the required permits, and more importantly, to gain the public's support for these projects. Therefore, emission control systems proposed by the conversion technology vendors must be carefully evaluated to insure that the impacts are acceptable and that they can comply with federal, state, and local emission regulations. The technology to control emissions within regulatory limits and protect the public health is commercially available.

3.4.6 Products and Byproducts Quality

The product and byproduct quality from processing MSW using conversion technologies vary depending on the feedstock composition. There is information available from existing conversion facilities in other countries, and from pilot plant and demonstration-sized facilities in the North America that can be used to predict product quality with reasonable certainty. However, an aggressive materials testing program will be required to ensure that the products meet standards, and that residuals can be safely disposed.

3.4.7 Reference Plants and Available Data

There are no commercial-sized MSW conversion facilities operating in the U.S. Therefore, plants operating abroad will provide operating and emissions data needed to evaluate how these technologies would work in California. Because of the limited number of these facilities, the limited data available for these plants, and the different design bases used, we are presented with a challenge in terms of identifying the operational characteristics and impacts of these facilities were they to be built in California. Designs will be developed for use in a California plant, along with proposed gas clean-up systems and emission control systems, to show how emissions will be controlled to comply with federal, state, and local limits. These designs, for a demonstration facility, may be more conservative than normal to ensure safe operation.

3.5 Financing Issues

The ability to attract financing for a conversion facility will be a key determinant of project success. Obtaining funding for any new industrial project is difficult; however, it is even more challenging when considering an innovative type of technology that has not been built in this country on a commercial scale. A public-private partnership may be an attractive way to proceed, given the desire to develop a demonstration project (not a fully commercial project).

3.5.1 Sources of Funding and Support

The ultimate goal of this effort is to develop a demonstration-size conversion facility with a throughput of approximately 100 tons per day. This facility may not be of sufficient size to be profitable, or even support its operation (breakeven). Therefore, attracting sources of funding to support such a project will be critical to project success. It will be important to look for funding support early in the development phase. Possible options include:

- California Pollution Control Financing Authority (CPCFA)
- California Energy Commission, Public Interest Energy Research Program (PIER)
- CIWMB, Recycling Market Development Zone (RMDZ) Program
- Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE)
- DOE's National Competitiveness through Energy, Environment and Economics ($NICE^3$)
- U.S. Department of Agriculture grants programs

3.5.2 Conversion Technology Vendor Financial Capability

For development of a 100 ton per day facility, the conversion technology vendor's financial condition and ability to work with the investment banking community will be important factors with regard to sources of both equity and debt. This firm must have the financial staying power to carry this project from the early development phases through operation, which will require resources over several years. Developing a power purchase agreement with a potential purchaser, a part of the project financing, is routine in the power industry. Such an agreement may provide the financial community with additional security needed to fund the project.

3.5.3 Capital and Operating Costs

Capital and operating costs are central to how the facility will "pencil out". These costs are difficult to obtain, especially in early development stages, because we have no opportunities for direct comparison. In addition, each conversion technology vendor will make different costing assumptions, which makes comparisons between conversion technology vendors difficult. Issues such as whom will acquire/own the land (County, MRF/TS or vendor) will have significant impacts on overall facility cost. The integration with the MRFs need for heat or electricity would improve energy efficiency, and reduce cost. Locating the facility adjacent to an industrial plant could provide opportunities for a synergistic relationship that also could reduce costs.

3.5.4 Revenue Streams

The potential revenue streams form an important aspect of the overall plant economics. These revenues are difficult to estimate early in the project, prior to any negotiations with power purchasers, materials brokers, or solid waste feedstock suppliers (MRF/TS). Each will make its own assumptions about the value of various products and byproducts. The unit revenue from products and byproducts will vary based upon market conditions and the quality of the products and byproducts from the conversion process. Operating and financing costs will be partially or fully offset by revenues from products and byproducts sales, electricity sales, and tipping fees from the management of solid waste residue that would otherwise be disposed.

3.6 Public Acceptability

Public acceptability will be one of the most important determinants of project success. Siting, permitting and developing a new technology will lead to many questions from the public with regard to environmental impacts and public health issues. The key is to consider the public as a partner and present the facts and benefits throughout the process while being responsive to their concerns at all times. Developing early relationships with key stakeholder groups is essential.

4.0 PROJECT IMPLEMENTATION STEPS

Table B-1 presents a suggested conversion facility implementation process and schedule. This process is separated into six phases, or steps:

- Phase 1 – Screening of Technologies & Host MSW Facilities
- Phase 2 – Detailed Evaluation of Technology Vendors & Host MSW Facilities
- Phase 3 – Technology Vendor & Host MSW Facility Selection
- Phase 4 – Vendor & Host Facility Agreements
- Phase 5 – Permitting
- Phase 6 – Design & Construction, and Start-up

4.1 Project Phasing

Each of the project phases is described in this section.

4.1.1 Phase 1 – Screening of Technologies & Host Facilities

This first phase is underway, and is scheduled for completion early in 2005. The result of this phase is a short list of several facilities/locations under consideration for conversion technology implementation, and a short list of conversion technology suppliers that meet the screening and ranking criteria.

4.1.2 Phase 2 - Detailed Evaluation of Technology Vendors & Host MSW Facilities

At the conclusion of Phase 1, the County will have identified several possible technology solutions and sites for a conversion facility development. However, there will be additional work to be completed before a Request for Proposal (RFP) can be prepared. Examples are:

- Data Gap Assessment
- Evaluation of the data and follow up with interview and additional questions for conversion technology vendors
- Additional assessment of the host facility

At the conclusion of Phase 2, one or more technology-host facility combinations will be identified.

TABLE B-1
LOS ANGELES COUNTY INTEGRATED WASTE MANAGEMENT TASK FORCE ALTERNATIVE TECHNOLOGY ADVISORY SUBCOMMITTEE IMPLEMENTATION PLAN AND SCHEDULE

Task		Projected Completion
Phase I – Screening of Technologies/Host Facilities		
1	Submit Strategic Plan/Outreach Plan	10/04
2	Submit Preferred Host Facility(ies)	12/04
3	Submit Preferred Technologies/Vendors	02/05
Phase II – Detailed Evaluation of Technology Vendor & Host Facility		
4	Data Gap Assessment	03/05
5	Conduct Interviews with Preferred Vendors	04/05
6	Conduct Interviews with Host Facilities	04/05
7	Select Preferred Vendor/Host Facility(ies)	05/05
Phase III – Vendor Selection		
8	Develop a Request for Proposals (RFP)	07/05
9	Finalize and Approve the RFP	9/05
10	Distribute to Preferred Vendors	10/05
11	Review Responses	12/05
12	Select Vendor	12/05
Phase IV - Vendor & Host Facility Agreements		
13	Negotiate Vendor Agreement	02/06
14	Negotiate Host Facility Agreement	02/06
15	Negotiate Power Purchase Agreement and Product Stream Contracts	03/06
Phase V - Permitting		
16	Develop Technical Documents (CEQA, Conceptual Design, etc.)	05/06
17	Complete and Submit Permit Applications	08/06
18	Agency Review/Public Meetings	06/07
19	Acquire Permits	07/07
Phase VI - Construction		
20	Complete Detailed Design	07/07
21	Start Construction	08/07
22	Complete Construction	05/08
23	Start Operation	07/08

4.1.3 Phase 3 - Vendor & Host MSW Facility Selection

In Phase 3, a conversion technology vendor and host facility will be selected based upon a Request for Proposal (RFP) process. This process may be conducted through a public-private partnership.

The following steps will be required:

- Develop a Request for Proposal (RFP)
- Distribute to Short List of Suppliers
- Review RFP responses
- Select supplier(s)
- Select MSW host facility(ies)
- Intensify public outreach

4.1.4 Phase 4 – Conversion Technology Vendor & Host Facility Agreements

Once a supplier and host facility have been selected, agreements must be put in place as a first step in financing and development of the project. If a public-private partnership approach was selected, this structure must be finalized during this phase as well.

In addition to the vendor and host agreements, a power purchase agreement and contracts for sale of products must be completed.

4.1.5 Phase 5 – Permitting

With the conversion technology vendor and host agreements in place, and funding available, permitting will begin. The key permitting tasks are:

- Develop technical documents (CEQA, Conceptual Design)
- Complete and submit permit applications
- Agency reviews
- Public meetings/hearings as necessary
- Receive permits

4.1.6 Phase 6 – Design, Construction, and Start-up

With permits in hand, the detailed design process can begin, followed by construction as follows:

- Conduct detailed design
- Construction
- Construction compliance monitoring
- Performance compliance testing and start-up

4.2 Project Implementation Schedule

A preliminary implementation schedule is presented in Table 1. This schedule assumes that the regulatory pathway involves CIWMB. The schedule indicates a commissioning date of mid 2008. The following comments are made with regard to this schedule:

- The six phases include all major tasks that are necessary to develop and implement a conversion facility.
- Funding this project may require more time than is provided in this schedule.
- All of the tasks are shown in sequence. It is possible to overlap some of these tasks to shorten the overall schedule; however, this will entail additional financial risk.
- The need for a workable regulatory framework and permit process is critical to achieving this schedule.

An alternative schedule could look at MRF residuals as reuse material, not subject to CIWMB regulations. While there is significant uncertainty about this regulatory pathway, it is possible that the implementation could be expedited under this scenario.

5.0 RECOMMENDATIONS FOR MOVING FORWARD

Based upon the information presented in the previous three sections of this document, the following recommendations are offered with regard to moving forward with implementation of a demonstration conversion facility in Southern California.

5.1 Legislative/Regulatory Framework and Permitting Issues

As described in Section 3.1 and 3.2, the regulatory status pertaining to conversion technologies is emerging. Once these issues are resolved, it will be important to recognize the unique character of this project in regulatory documents. The following actions are suggested:

- Participate in regulation development at the state level, including needed modifications to statutes
- Seek political support
- Participate in technical and economic studies, as well as regulatory development, with the CIWMB

5.2 Environmental Issues

As indicated in Section 3.3, environmental issues present a number of important, though surmountable challenges to conversion technology development. Actions recommended are:

- Identify potential sites early and involve the public
- Evaluate environmental risks with solid science and utilize independent and academic experts
- Identify the air emissions of greatest concern early on and focus on these during the conversion technology vendor selection process
- Collect and analyze available conversion technology emission data, and present it on a comparable basis with conventional MSW treatment technologies, i.e., mass-burn incineration for thermal conversion
- Address mitigation of environmental impacts clearly and aggressively
- Emphasize that all environmental regulatory limits will be met or exceeded. Consider over-controlling air emissions if cost-effective
- Identify the compost/fertilizer application limits applicable in Southern California, compare with expected compost/fertilizer, identify any problem compounds and address those early

5.3 Technical Challenges

Section 3.4 describes a number of specific technical challenges that will be faced during this project. The following recommendations are suggested to mitigate these issues:

- Adopt a conservative design approach
- Only consider conversion technology vendors with excellent credentials (technical and financial)
- Inspect existing facilities of short-listed technology vendors
- Emphasize these technical issues and the importance of overcoming them in the RFP instructions

5.4 Cost and Financing Issues

Section 3.5 addresses financing and cost related risks. A financing arrangement needs to be decided. Options include:

- Build-Operate-Own-Maintain (BOOM) by developer
- Build-Operate-Own-Transfer (BOOT), developer to County or Sanitation Districts
- Build-Own-Operate by County or Sanitation Districts (BOO)
- Public-private partnerships

The risk profile is quite different for these options. While the BOOM approach offers the lowest development risk overall, it may not be appropriate for a demonstration facility. A public-private partnership (P3) may be an attractive approach for such a project.

A P3 will involve the following processes:

- Convene a group of parties interested in a P3 structure
- List all responsibilities of the P3, including:
  - Landowner
  - Waste stream commitment
  - Permitting
  - Utilities and site development
  - Project assets (design, build, finance, operate)
  - Product marketing and sales

- Residual disposal

- Assign roles to responsibilities
- Assignment of risks
- Assignment of capital and operating costs
- Holder of major permits
- P3 structure (who owns what, operates what)
- Establish contractual arrangements
- Procurement

Based upon the above, these recommendations are suggested:

- Explore other (outside) funding mechanisms
- Engage multiple jurisdictions
- Seek assistance from the state (e.g., CIWMB, CEC)
- Investigate partnering with technology suppliers or other public and/or private agencies (P3)
- Identify the markets for electricity, fuel gas, compost and other products and byproducts in Southern California

5.5 Public Outreach

As discussed in Section 3.6, public outreach is an essential step in the conversion facility development process. The public must be educated about these technologies before sites are selected. Then the sites must be brought to the public before final decisions are made. The best approach to public outreach is to establish two-way communication channels such that stakeholders see their influence reflected in the siting and development of the conversion facility. This is accomplished by:

- Identifying and contacting key stakeholders early
- Developing clear and understandable informational materials that educate and offer the opportunity to participate in the process
- Identifying and addressing "Environmental Justice" issues
- Provide easy access to information
- Emphasizing the benefits of using conversion technologies

- Communicating the purpose of the project – to provide a cost-effective and environmentally superior conversion facility for the benefit of Southern California

In summary, the following are key suggestions:

- Educate political and influential officials using real data, using some of the following methods:
  - Flyers
  - Websites
  - Fact sheets
  - Presentations
  - Media coordination
  - Newsletters
  - Telephone hotline
  - Booth days
- Engage stakeholders early, including:
  - Elected officials
  - Public Works Department
  - Business organizations and major employers
  - Citizen groups
  - Special interest organizations
  - CIWMB
  - CE-CERT
  - UC Davis
  - Local enforcement agencies
  - Media
- Engage independent experts
- Consider forming a "Stakeholder Outreach Steering Committee" to guide an outreach program for the project

PUBLIC OUTREACH PLAN

TABLE OF CONTENTS

1.0 INTRODUCTION

This document addresses various plans of action recommended for conducting a public outreach program related to the promotion and development of alternative technologies in general, and a pilot/demonstration facility in Los Angeles County or other counties in Southern California. Alternative technology is the most technologically and environmentally beneficial way to deal with waste. It offers substantial benefits over existing solid waste management options such as landfilling and incineration, and has the potential to increase recycling, divert thousands of tons of waste from valuable landfill space, hinder the release of damaging greenhouse gases into the atmosphere, generate jobs and produce useable energy. Alternative technology can save measurable natural resources such as various fossil fuels by using fuel from converted residual waste, further reducing our need for foreign products.

The development of a pilot facility reflects an ongoing need to improve the quality of life for Southern Californians. However, citizens are rightfully concerned about the potential construction of a facility in their backyard, as many assume alternative technology poses a threat to the health and safety of residents and the environment. This misconception, based on older combustion/incineration technology, has hindered development within Southern California and the United States; concurrently, alternative technology is being explored and developed as a viable, technologically advanced alternative to options posed by traditional waste management throughout Western Europe and Japan.

The general misconception, that alternative technology is another form of incineration, is the biggest hindrance to development. Because the public is not familiar with these technologies or their potential impact on the environment and community, educating residents and other stakeholder groups is pivotal if we are to make alternative technology a reality in Southern California. Public outreach is needed to explain and dispel misconceptions based on older combustion/incineration technologies.

This Plan begins by providing background as to why the public will be interested in a project of this nature and which aspects will create the most interest and concern for local residents. The plan then discusses the best approach to public outreach, followed by a more detailed discussion related to the outreach process as well as specific recommendations for executing a successful plan of action.

2.0 WHY PUBLIC OUTREACH IS NEEDED

Development of an alternative technology facility within Southern California may be controversial. Many residents are not familiar with alternative technologies, or the potential benefits and impacts expected. There are environmental groups, groups who support landfills, and recycling organizations who may raise concerns related to alternative technologies either because they believe the environmental impacts may be unacceptable, or they see it as a threat to existing landfills or the health of the recycling industry.

Public outreach is crucial when educating the public. It provides various ways to address concerns voiced by opposing groups, and seek community support. By presenting a public outreach plan, we can help to minimize potential misunderstandings that may arise from miscommunication about a potential facility. By involving residents and elected officials in the decision making process, project proponents can lay out the potential benefits of alternative technologies and address questions or concerns as they arise. The benefits of this approach include:

- Residents can understand the need for the project
- Residents will be educated about the technology and project potential
- Potential issues of contention are identified early and are addressed
- A collaborative process engenders participation, support, and promotes ownership
- Public involvement reduces the possibility of litigation or other barriers to implementation
- Interaction improves the relationship between project proponents and the public
- Public participation will result in better decisions, more efficient use of resources, and improved planning and engineering practices.

3.0 WHAT IS PUBLIC OUTREACH WITH REGARD TO ALTERNATIVE FACILITY DEVELOPMENT?

Public outreach includes many elements of both public information and public relations, and adds a fundamentally important dimension to a successful public outreach process: a dynamic two-way communication. This step promotes public feedback, which can transform the development process and outcome. Ideally, a public outreach plan informs citizens about various options relating to the project; a good plan provides various opportunities for citizens to make their voices heard and mediate any differences between opposing viewpoints. Public outreach is a continuous process which begins early, before a site is selected, and continues throughout the development process.

Prior to involving the public with the particulars of the conversion facility plan, efforts must be made to disseminate information to the regulatory community about the intended plan of action. Initially targeting the regulatory community will lessen the chances of miscommunication between concerned stakeholders and governmental bodies. Because regulatory agencies most likely do not have a set of coordinated regulatory frameworks in place regarding a conversion facility, familiarizing them with the specifics of a conversion plan will allow for a unified consensus, eliminating any possible inconsistencies about the proposed facility.

Los Angeles County agencies and other partners in this process must provide leadership in their outreach. Their responsibility includes insuring the outreach process has no predetermined outcomes, and assuring that adequate resources are available for implementing the outreach plan.

4.0 PUBLIC INTEREST IN AN ALTERNATIVE FACILITY

Residents and governmental officials will display strong interest in a prospective alternative facility. We must identify and anticipate any potential concerns so that an open discussion can ensue. The public will want to know about the project including:

- Where will the project be located?
- What are, if any, the potential health and safety risks connected to a alternative facility?
- What actions will the county take in response to risks?
- Are there any environmental impacts?
- How will the project be funded?
- How can an alternative facility benefit the community?
- How will information be disseminated? (process concerns)
- What are the alternatives to the project? Are there any potential benefits and negative impacts to these alternatives?

Based upon previous experience, the following factors may be of concern to residents and may result in potential criticism including:

- Pollution generated by the facility (real or assumed)
- Proximity to residential communities
- Proximity to important scenic, cultural or environmental sites
- Lack of comparison models employing similar technology
- Lack of adequate data to satisfy risk concerns

These factors highlight the areas that should be addressed via the public outreach plan.

5.0 A STRATEGIC APPROACH TO PUBLIC OUTREACH

A strategic approach to public outreach is depicted in Figure C-1. The ultimate goal is approval by the public for an alternative facility; it is only when the public accepts the project it can then move forward. Public acceptance will depend largely upon the level of trust established early between the project partners and residents and other stakeholders, including:

FIGURE C-1
PUBLIC OUTREACH PARTHENON

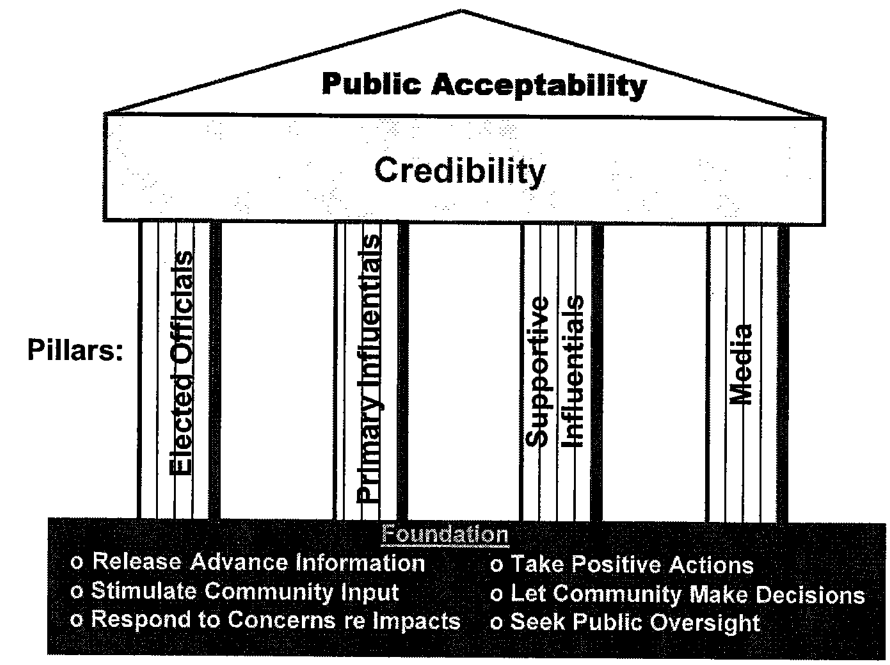

Figure 1. Public Outreach Parthenon
LA County Conversion Technology Study

- Government representatives, including elected officials, the regulatory community, and appointed agency personnel. Their support and leadership is needed to help establish rapport with the community and assist with regulatory constraints and requirements.
- Community stakeholders, including people most impacted by the facility, or who may have concerns regarding an alternative facility, such as residents who live in close proximity to a potential site, environmental activists or interest groups who may see the project as threatening to industry (e.g., those businesses who depend on landfill operation).

- People who support an alternative facility, including those who may benefit directly or indirectly from the project, such as business and civic groups.

The media is an important component of the communication strategy; they have an enormous impact on the eventual implementation of an alternative facility. The media should be used to present information, and to introduce the public to the developer of the project. We must present the progressive, rational and environmentally oriented policies of the project's developer.

Each of these audiences must be included in a public outreach strategy; however, once a location and technology is identified, communicating with the community stakeholders receives top priority. The communication strategy must be based upon a core group of positive, proactive fundamental concepts, as shown in Figure 1. This foundation supports the entire public outreach structure. The key elements comprising the foundation include:

- Notify the Regulatory Community: It is important to familiarize regulatory agencies about the intended plan of action early on in the process. Doing so will pave the way for future efforts.
- Advance information: Once a site location and technology are identified, it is critical that information about the project originates from the developers/agencies and be directed towards community stakeholders.
- Take action: straightforward, positive action will influence the public, especially individuals who may be opposed to the project. Project proponents should continually release information highlighting the benefits of alternative technologies, such as eliminating waste and generating much needed energy.
- Stimulate community input: getting feedback from the public is vital to understanding and responding to concerns. Input should be encouraged by asking questions and prompting participation.
- The community must make decisions: providing opportunities for the public to participate in decision-making, such as contributing information or data, will display the project proponents' reliability when addressing public concerns. One of the best mechanisms for doing this is through advisory committees.
- Respond to concerns: it will be continually important to address concerns raised by the public. A lack of response may lead to skepticism and apprehension. Answers to concerns are addressed with understanding, be solution orientated; include supporting facts, and a show a commitment to obtaining additional information if needed.
- Seek public oversight: oversight by independent stakeholders, especially those with relevant and credible knowledge, can increase project standing among residents. Oversight can be provided by academics, public officials, well known community

members, and the media. Oversight and accountability can help to subside any potential debate.

Essentially, when a public outreach plan addresses these foundational ideas, it will be more successful. The converse can also be true.

6.0 COMMUNICATIONS STRATEGY

The communications strategy is comprised of the following steps:

- **Define goals and objectives**
  - What outcomes are desired?
  - Educating the public.
  - Earning trust.
  - Obtaining acceptance.
  - Disseminating information.
  - Resolving conflict.
  - Reviewing a specific proposal.
  - How will success be measured?
  - Key objective: to make the regulatory committee aware of the objectives and specifics of the conversion project prior to eliciting community input.
- **Identify the Public Outreach Team**
  - Identify the agency staff, consultants, and public relations staff/firms who will develop and implement the plan.
  - Determine the roles of team members.
- **Identify and prioritize the audiences**
  - Define the audiences (e.g., general public, residences near project site(s), public officials, regulatory agencies, environmental organizations, and opposing groups).
  - Obtain information about each audience (e.g., their concerns, core values, knowledge level, interest level, and prior reaction to projects).
  - A priority is to reach out to opposing groups (especially environmental and humanitarian groups) early, before the project goes public.
  - Familiarize the regulatory community with the proposed project/facility

- **Select communication channels**
  - Which channels are most appropriate for reaching the target audiences (e.g., mass media, face-to-face)?
  - Which formats will best suit the channels and messages (e.g., videos, slide shows, pamphlets)?
- **Develop the message**
  - What are the different ways the message can be delivered?
  - Modify the message in order to best reach the level of understanding among the public.
  - Determine the appropriate level of technical detail.
  - Who should deliver the message (e.g., technical consultant, public relations personnel, and agency personnel)?
  - Develop messages for each dominant culture in the community.
- **Identify concerns**
  - What concerns are voiced by the community?
- **Reply to these concerns promptly**
  - Respond with clear, supportive answers.
  - Obtain additional information where needed.
- **Establish two-way communication (dialog) as follow-up**
  - Two-way communication is essential to promoting understanding.
- **Assess the effectiveness of the program and make adjustments**
  - Are objectives being met?
  - What improvements can be made in the program?
- **Communicate continuously**

A communications/outreach plan should be designed around these steps.

7.0 SUGGESTED PUBLIC INVOLVEMENT TECHNIQUES

There are many techniques that can be effectively utilized to promote an alternative facility project. These techniques can be direct or indirect in terms of how they communicate the message:

- Direct Public Outreach Techniques
  - Brochures/flyers
  - Direct mailings
  - Surveys/Focus groups
  - Neighborhood canvassing (door hangars, etc)
  - Evening news spots
  - Fact sheets, briefing packets
  - Meetings with community leaders
  - Piggyback on other County events
  - Popular spokesman
  - Information hotline
  - Newsletters
  - Newspaper/periodical inserts
  - Videos
  - Neighborhood meetings
  - Advisory committees
  - Public forums
  - Study circles
- Indirect Public Outreach Techniques
  - Editorial briefings
  - Op ed pieces
  - News releases
  - Press conferences
  - Feature stories
  - Web sites (piggyback on County sites)

These techniques should be evaluated with regard to the targeted audiences and objectives to determine the most effective techniques for an alternative project.

8.0 RECOMMENDATIONS

The following plan will need to be refined once the project is initiated and more information is collected regarding the geographical coverage related to the outreach program, location of the project, and the key outreach groups and their characteristics. It is useful to use existing outreach channels available through project proponents and partners.

Step 1: Define Goals and Objectives

The primary purpose of the outreach program is to educate the public with regard to the following:

- Provide the public with accurate and current information about alternative technologies (how they work, how they affect the environment)
- A measurable level of knowledge among the general public concerning alternative technology
- Illustrate the benefits of alternative technologies within the solid waste management system
- Show how this project will be developed (sequence of steps)
- Explain how the public will be involved

Later in the process, other objectives will be important, such as siting input, project review, and information dissemination.

Step 2: Assemble the Public Outreach Team

The public outreach team must be identified. Typical members include:

- Supporting agencies' technical staff (including County of Los Angeles Department of Public Works, Integrated Waste Management Task Force, Alternative Technology Advisory Subcommittee)
- Consultants (e.g., URS)
- Public relations staff from project proponents
- Public relations firm(s) engaged for this effort (may require different firms for different geographical areas or different cultures)

Step 3: Identify and Prioritize the Audiences

In the initial stages of public outreach, the site location may not be known. If this is the case, public outreach should be used to educate the general public about alternative technologies.

The priority audiences should include:

- The general public in Southern California
- Elected officials
- Regulatory agencies
- Interest groups who may support the projects
- Environmental groups

Step 4: Select Communication Channels

Outreach should begin by educating key audiences about alternative technologies and the various sites that will be under consideration. Suggested communication channels include:

- Op ed articles or editorial briefings with Wave Group newspapers, La Opinion, and/or similar newspaper groups.
- Evening news spots with David Cruz and/or similar TV news personalities (e.g., a piece showing where garbage goes).
- Direct mail to areas near MRFs under consideration (e.g., door hangars).
- Surveys/focus groups to ascertain current awareness, attitudes and biases regarding alternative technologies, develop wording and phrasing, fine tune outreach campaign.
- Meetings with environmental groups such as Heal the Bay, Environment Now.
- Meet with neighborhood associations.
- Briefing packets to elected officials.
- Local radio interviews on talk/public affairs channels.
- A Citizen's Advisory Committee with members from opposition groups, supporting organizations, CIWMB, LA County DPW, Chamber of Commerce, etc. Members should be located in areas with sites under consideration.
- Follow up surveys to determine effectiveness of campaign and measure changes in awareness, attitudes, etc.

Step 5: Develop the Message

The message begins with education about alternative technologies: what they are, how they operate, environmental impacts, and most importantly, their benefits. This message will need to be focused more on siting considerations, and be adjusted as the sites are narrowed and the key audience becomes more focused on a specific community most directly impacted. The message may need to be distributed in multiple languages to reach critical audiences.

Step 6: Identify Concerns and Reply

Once the program is underway, it is crucial to listen carefully to the community's concerns, respond to these concerns promptly, and provide feedback to residents in the proper format.

Step 7: Assess Effectiveness and Modify Plan

As the program evolves, changes will be made to improve performance. Several progress criteria will be developed, and effectiveness may be measured based on:

- Number and substance of comments received on web pages
- Number of hits on web site
- Number of participants at meetings
- Number and substance of comments received at meetings
- Attendance at Advisory Committee meetings

MARKET ANALYSIS

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1.0 INTRODUCTION

Conversion technology facilities are capable of converting Material Recovery Facility (MRF) residue of Southern California into useful products. In this study the most suitable conversion technologies that can process MRF residue were identified. These facilities also enhance recycling because they require more homogeneous feedstock. In this section, a preliminary market analysis is presented for conversion products that are produced by most suitable technologies. The market analysis for recyclable items is not included in this study.

2.0 PRODUCTS OF CONVERSION

The following conversion technologies were short-listed, and are evaluated by this study:

- Thermal Conversion:
  - Pyrolysis/gasification
  - Gasification
  - Plasma gasification
  - Thermal depolymerization
  - Pyrolysis including flash pyrolysis and steam reforming pyrolysis
- Biological Conversion:
  - Anaerobic digestion
  - Gasification and fermentation to ethanol

Each of these technologies convert MRF residue into useful products. The following sections describe the characteristics of products produced by these conversion facilities processing MRF residue.

2.1 Product Characteristics

Conversion technologies produce marketable products and byproducts. The quality and quantity of these products depend on process type, operating conditions, design of the conversion systems, and feedstock composition and characteristics.

2.1.1 Thermal Conversion Products

The products of thermal conversion technologies are typically syngas, fuel gas, fuel oil, or heat that can be used to generate electricity. Different thermal conversion technologies or different designs of the same technology can produce different products. A brief description of the technologies and their products are as follows:

- Gasification produces syngas (CO, CH_4, H_2) and heat that can be transformed into electricity. They also may produce tar and other condensibles, char or ash.
- Prolysis produces syngas (CO_2, CO, CH_4, H_2). This syngas has less energy (Btu/ft^3) than syngas produced by gasification. Pyrolysis may also produce heat, tar, liquid fuel, and char or ash.
- Plasma gasification produces syngas, slag aggregates and metal nodules.
- Thermal depolymerization produces fuel oil, biodiesel, biogas, carbon, and fertilizer.

2.1.2 Bioconversion Products

Bioconversion uses low temperature to convert MRF residue into useful products. Bioconversion technologies depending on the technology and design can produce different products. These products are:

- Biogas (a mixture of methane and carbon dioxide). Biogas usually has less energy (Btu/ft^3) than syngas produced by thermal conversion systems.
- Green fuel (ethanol, biodiesel, fuel oil, etc.).
- Residue that can be used for compost, soil amendment or fertilizer.

3.0 END PRODUCTS OF CONVERSION

In this study, conversion technology and conversion technology suppliers were evaluated. These conversion technology suppliers generate different products and by products processing MRF residue in Southern California. Only the main products of a demonstration conversion facility are included in this market analysis and they are described in the following sections. Other by-products such as carbon char, chemicals, inert material, and recyclable material may also be produced in small quantities. The type, quantity and quality of these by products depend on the type and design of the conversion systems, type and quality of preprocessing, MRF residual composition, and many other factors. Market analysis for these by products will be addressed in the second phase of this project.

3.1 Electricity

The carbon based portion of the MRF residue can be processed by a conversion facility to produce

syngas, biogas, fuel gas, heat and fuel oil. If the conversion products are used as fuel to generate electricity, the conversion facility may then be certified as an eligible generator of "renewable energy" for sale under the provisions of California's Renewable Portfolio Standard (RPS), as authorized by the Renewable Energy Program overseen by the CEC.

The amount of electricity generated by a conversion facility depends on many factors. These factors include:

- Conversion technology type
- Design of conversion system
- Heating value of the syngas (Btu/ft^3)
- Efficiency of the electricity generating system
- Composition and characteristics of the feedstock such as heating value of the material (Btu/lb), moisture content, etc.

The respondents of different technology suppliers showed different amounts of electricity generated by their systems. The amount of electricity generated by suppliers of conversion technology is shown in Table D-1.

Table D-1 shows that thermal conversion technologies generate larger amounts of electricity than bioconversion technologies.

3.2 Green Fuel

Some conversion technologies are producing green fuel with or without electricity such as ethanol, fuel oil, biogas etc. The suppliers of these technologies suggest that the green fuel can be used to generate different chemical products or as additives to the gasoline or other types of fuel. The conversion technology suppliers that produce green fuel are shown in Table D-2.

TABLE D-1
CONVERSION TECHNOLOGY FACILITIES ELECTRICITY GENERATION

Conversion Technology Suppliers	Type of Technology	Throughput Tons/year	Electricity Generated MWh/year
Interstate Waste Technologies	Pyrolysis/gasification	100,000	83,700
Bioengineering Resource Inc. (BRI)	Gasification/fermentation	96,500	9,300
International Environmental Solution (EIS)	Pyrolysis	53,655	60,793
Green Energy Corporation	Steam Reforming Pyrolysis	39,600	42,400
Primenergy LLC	Gasification	35,000	21,580
Ntech Environmental	Gasification/pyrolysis	33,000	19,320
Arrow Ecology Ltd.	Anaerobic Digestion	31,000	6,400
GEM America	Flash Pyrolysis	30,000	23,650
Geoplasma LLC	Plasma gasification	29,200	9,900
Organic Waste System (OWS)	Anaerobic Digestion	25,000	4,500
Canada Composting	Anaerobic Digestion	25,000	3,400
Waste Recovery System/Valorga	Anaerobic Digestion	25,000	2,800
Ebara Corporation	Pyrolysis/gasification	21,160	7,149

TABLE D-2
CONVERSION TECHNOLOGY FACILITIES GREEN FUEL PRODUCTS

Conversion Technology Suppliers	Type of Technology	Products	Throughput/year	Quantity of Products Per Year
Bioengineering Resource Inc. (BRI)	Gasification/fermentation	Ethanol	96,500	8,200,000 gallons
Changing World Technologies	Thermal Depolimerization	Fuel Oil (Biodiesel)	32,850	9,113 tons

3.3 Compost, Soil Amendments

Anaerobic digesters (AD) produce a biogas, which can be combusted in reciprocating engines to produce electricity. In addition, compost, soil amendment, or fertilizer byproducts are created from the residuals. Table D-3 lists the technology suppliers that produce compost.

TABLE D-3
CONVERSION TECHNOLOGY FACILITIES COMPOST OR SOIL AMENDMENT PRODUCTS

Conversion Technology Suppliers	Type of Technology	Compost, Soil Amendment, or Liquid Fertilizer	Throughput/year	Quantity of Products tons/year
Arrow Ecology Ltd.	Anaerobic Digestion	Soil Amendment	31,000	10,300
Organic Waste System (OWS)	Anaerobic Digestion	Compost	25,000	10,000
Waste Recovery System Inc./ Valorga	Anaerobic Digestion	Compost	25,000	6400
Canada Composting	Anaerobic Digestion	Compost	25,000	4600

4.0 MARKET ASSESSMENT FOR THE PRODUCT

4.1 Market Description

4.1.1 Electricity

The potential buyers of electricity are electric utilities, such as Southern California Edison, or municipal utilities such as Department of Water and Power (DWP). A Power Purchase Agreement (PPA) with the utility will be required to guarantee a revenue stream for an agreed upon period (typically 20 years).

As mentioned above, the Renewable Portfolio Standard should provide a strong market for renewable energy for the foreseeable future in California.

4.1.2 Green Fuel

Green fuel generated by the conversion technology also can be used as fossil fuel for boilers to generate steam for any manufacturing facility. Ethanol can be used as an oxygenate for gasoline to produce high-octane gasoline. Since the gubernatorially mandated phase-out of MTBE (Methyl Tertiary Butyl Ether) as an oxygenate as of December 2003, ethanol has become the choice oxygenate. This requirement has created a strong demand for ethanol in California (over a billion gallons this year). The state imports most of the ethanol needed for gasoline additive (5.7% of gasoline in California is ethanol).

Demand for ethanol should increase with time because the Federal government and the state are supporting renewable energy and biomass initiatives (e.g., Governor's Ethanol Coalition).

If the production of green fuel or other chemicals becomes the objective of the conversion technology facility, the syngas or biogas produced by the thermal or bioconversion technologies can be used to produce green fuel or other chemicals. In this case a combination of thermal, chemical and/or bioconversion technologies is required. Some emerging conversion technology suppliers listed in this study provide combined gasification/ fermentation to ethanol technologies producing green fuel.

4.1.3 Compost, Soil Amendment

Compost or soil amendment is produced by Anaerobic Digestion systems. The marketability of these products depends on their quality and composition (heavy metal content, contamination, etc.). These products have to go through a permitting process with State and local regulatory agencies for their use in California. It is difficult at this early stage to identify a market for these products.

4.2 Expected Market Price and Volatility

4.2.1 Electricity

The market price for electricity can be negotiated with an electricity distributor in Southern California. A long term PPA has to be signed. The City of Commerce waste-to-energy facility currently is selling their electricity for \$0.045/kWh. A PPA in the price range of \$0.04 to \$0.05/kWh is likely to be the price of renewable electricity generated by a conversion facility in the next year. The price of renewable energy may increase with time based upon increased consumer demand for green power.

The availability of long-term power purchase agreements ensures reasonable price stability.

4.2.2 Green Fuels

Changing World Technology is pricing the biodiesel generated by their system at $231/ton. Ethanol was priced by conversion technology suppliers at $1.50 to $1.75/gallon.

The California market price for ethanol has varied from $2.00/gal to the current $1.30/gal. This relatively high price volatility is expected to continue until such a time that California can establish its own ethanol production.

Biodiesel production in the U.S. in 2004 was only about 30 million gallons. The price of biodiesel is linked to the price of vegetable oil, and tends to be about $0.20 higher than diesel per gallon.

4.2.3 Compost, Soil Amendment

The market price for compost and soil amendment form conversion technologies is unknown. The price will depend on the quality of the compost, which, in turn, depends on the composition of the feedstock. The market price for compost also will depend upon the receptivity of the public for this material. Potential suppliers have estimated prices of about $5.00 per ton.

5.0 CONCLUSIONS

A wide range of conversion technologies and conversion technology suppliers were evaluated by this study. The technologies that were included on the short-list can process MRF residue and generate useful products. Depending on the technology selection the following products can be generated:

- Electricity
- Green fuel with or without electricity
- Electricity plus compost

The preliminary market analysis shows that electricity has the most reliable and stable local market. Green fuels are in a developing marketplace where current demand outstrips supply in California. The compost market is uncertain and unpredictable.

SITING ANALYSIS

Section **Page**

1.0 INTRODUCTION

The Los Angeles County Alternative Technology Advisory Subcommittee goal is to co-locate a conversion technology at an existing Material Recovery Facility and Transfer Station (MRF/TS) in Southern California. This conversion facility will process MRF residue currently disposed in a landfill. The MRF/TSs in Southern California were evaluated in this study to determine which MRF will be suitable and willing to create a partnership with a conversion technology supplier and which technology is the most suitable to process the MRF residues. This siting analysis is targeting only preferred MRF locations and conversion technologies selected by this study.

This report addresses the siting requirements, such as anticipated permits, CEQA compliance, and public concerns. General strategies are suggested to mitigate permitting constraints.

2.0 PREFERRED TECHNOLOGY/MRF LOCATIONS

A preliminary technology/MRF analysis was performed to identify the most suitable technology/MRF combinations for development of a conversion demonstration facility in Southern California.

2.1 Preferred Technology

Based on the conversion technology evaluation, the following technologies were selected for consideration by the County to develop a demonstration conversion facility:

- Thermal Conversion:
  - Pyrolysis/gasification
  - Gasification
  - Plasma gasification
  - Thermal depolymerization
  - Pyrolysis including flash pyrolysis and steam reforming pyrolysis
- Biological Conversion:
  - Anaerobic digestion
  - Gasification and fermentation to ethanol

2.2 Preferred MRF/TS Locations

A detailed evaluation of the Southern California MRF/TSs was performed by this study. The following MRF/TSs were selected for consideration of a conversion demonstration facility:

- Del Norte Regional Recycling and Transfer Station in the City of Oxnard (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS Operated by CR&R (Riverside County)
- Community Recycling/Resource Recovery, Inc. in Sun Valley (City of Los Angeles)
- Central Los Angeles Recycling Center and Transfer Station (City of Los Angeles)
- Santa Clarita MRF/TS (Planned MRF will be built by Burrtec Industries)

Each one of these MRFs can be considered for a conversion facility location. Members of the Alternative Technology Advisory Subcommittee at the June 16, 2005 meeting unanimously agreed that the short list of preferred MRF for the first phase of development a conversion facility should include:

- Del Norte Regional Recycling and Transfer Station in the City of Oxnard (Ventura County)
- Robert A. Nelson Transfer Station and MRF (RANT) (Riverside County)
- Perris MRF/TS Operated by CR&R (Riverside County)

The Community Recycling, Central Los Angeles and Santa Clarita MRF/TS should be considered later perhaps in the next phase of the project.

3.0 REGULATORY AND PERMITTING ISSUES

The regulatory framework for waste-to-energy facilities, as well as other existing types of solid waste facilities, is well established in California. However, the regulatory framework for conversion facilities is emerging. This section provides a brief discussion of regulations pertaining to siting a conversion facility in California.

3.1 Applicable State Regulations

This section presents a summary of the regulations governing permitting of conversion technologies in California.

It is assumed that this facility will be co-located at an existing MRF/TS in Southern California, which is already operating under a Solid Waste Facility permit. This could simplify the permitting process for a conversion facility at State and local levels.

3.1.1 CIWMB Regulations

The California Integrated Waste Management Board (CIWMB) under the Integrated Waste Management Act authorized local control for state waste management permitting and enforcement, establishing a network of "Local Enforcement Agencies" (LEA) at the municipal level. The Board's Permitting and Inspection Branch, in conjunction with the LEA, administer Solid Waste Facilities permitting and enforcement programs.

A facility that manages solid waste in California is called a "Solid Waste Facility," under the jurisdiction of the CIWMB. In compliance with AB 2770, the list of "Solid Waste Facility" types now includes a facility employing "gasification" for conversion of solid waste to fuel (Public Resources Code 40194). However, the definition of gasification (Public Resources Code 40117) is flawed. The legislature is considering several proposed regulations that will correct these definitions, and establish a permitting pathway for conversion technologies in California. At this time these facilities are under existing Transfer/Processing regulations.

If the conversion product is a fuel used for generation of electricity, the conversion facility may be certified as an eligible generator of "renewable energy" for sale under the provisions of California's Renewable Portfolio Standard (RPS), as authorized by the Renewable Energy Program overseen by the CEC. Anaerobic digestion would be considered composting by CIWMB definition.

In 2004, CIWMB conducted an evaluation of conversion technology processes and products. The Board conversion technology evaluation in conjunction with different State wide solid waste organizations and committees, and Board members effort resulted in CIWMB recommendations to the legislatures. This recommendation supports correcting conversion technology definitions.

3.1.2 Air Emissions

Air emissions will be a major issue when a conversion facility is in the siting and permitting process. The air emissions are different for thermal conversion and bioconversion technologies.

3.1.2.1 Thermal Conversion. Due to the nature of thermal conversion technologies, they have inherently lower air emissions and offer significant environmental benefits when compared to waste-to-energy facilities. These design and operation characteristics include:

- Since pyrolysis and gasification processes occur in a reducing environment, typically using indirect heat, and without free air or oxygen, or with a limited amount of air or oxygen, the formation of unwanted organic compounds or trace constituents is minimized.
- Pyrolysis and gasification reactors typically are closed, pressurized systems, so that there are no direct air emission points. Contaminants are removed from the syngas and/or from the flue gases prior to being exhausted from a stack.
- Thermal conversion technologies often incorporate pre-processing subsystems in order to produce a more homogeneous feedstock; this provides the opportunity to remove chlorine-containing plastics (as recyclables), which could otherwise contribute to the formation of organic compounds or trace constituents.
- The volume of syngas produced in the conversion of the feedstock is considerably lower than the volume of flue gases formed in the combustion of MSW in a waste-to-energy facility. Smaller gas volumes are easier and less costly to treat.
- Pre-cleaning of the syngas is possible prior to combustion in a boiler, and is required when producing chemicals or prior to combustion in a reciprocating engine or gas turbine in order to reduce the potential for corrosion in this sensitive equipment. Syngas pre-cleaning serves to reduce overall air emissions.
- Syngas produced by thermal conversion technologies is much more homogeneous and cleaner-burning fuel than MSW or MRF residue.

Air emission control and processing systems that are likely to be required by South Coast Air Quality Management District (SCAQMD) include some or all of the following:

- When the syngas is combusted in a boiler, reciprocating engine, or gas turbine, automated combustion controls and furnace geometry (for boilers) designed to optimize residence time, temperature and turbulence to ensure complete combustion.
- For combustion of syngas in a boiler, low-NO_x burners and/or a Selective Non-catalytic Reduction (SNCR) system for reduction of NO_x emissions. Selective Catalytic Reduction (SCR) is typical for exhaust gases from reciprocating engines and gas turbines.
- Baghouse (fabric filter) for removal of particulate matter from flue gases.
- Activated carbon injection (followed by a baghouse) for removal of trace metals (such as mercury).
- Wet scrubber for removal of chlorides/hydrochloric acid (may produce saleable HCl).

- Wet, dry, or semi-dry scrubber for sulfur dioxide (may produce saleable gypsum).
- Final baghouse for removal of fine particulate matter after dry or semi-dry scrubbers.

Air emission control equipment to accomplish the syngas and/or flue gas cleanup is commercially available, and is able to reduce air emissions to levels well below regulatory limits in California.

3.1.2.2 **Bioconversion.** Assuming that all process vents are completely leak-free, there would be no air emissions from the AD process, since it is fully enclosed. Combustion and flaring of the biogas would result in emissions of NO_x, CO, VOC, PM_{10}, $PM_{2.5}$, and SO_2. Typical combustion and post-combustion process controls (such as SNCR or SCR) may be required. It is likely that flaring would only be allowed on an emergency upset basis and that adequate process provisions would need to be in place to ensure distribution of the gas to conventional combustion equipment that can be adequately controlled.

Air emissions from an ethanol plant would include the gasification emission or combustion emissions (NO_x, CO, PM_{10}, $PM_{2.5}$, and SO_2) associated with the fuel combustion for the generation of process heat or steam to support the distillation process. In addition to process vents, storage of intermediate products, raw ethanol and gasoline (required to denature the ethanol), and ethanol loading for shipment would be sources of VOC emissions. Process vents, storage, and loading equipment would require vapor recovery equipment with subsequent control, using combustion in onsite heaters or boilers, a thermal oxidizer, or an activated carbon adsorption system.

3.1.2.3 **Air Permit Requirements.** The key (SCAQMD) air permits that likely will be required are:

- Permit to Construct/Operate (Rule 201)
- Title V Operating Permit (Reg. X)
- Toxic Contaminants/Health Risk Assessment (Rule 1401)
- NESHAPS – Hazardous Air Pollutants (Reg. IX)

3.1.3 Water Discharge

Most thermal conversion technologies will generate small amounts of non-hazardous wastewater that can be disposed into a regular sanitary sewer system. Some inject the wastewater into the gasifier or use to make steam for the system.

Bioconversion facilities may also produce some wastewater, which would need treatment and disposal. Proper process design and moisture management can minimize this stream to negligible levels or eliminate it altogether.

If the facility will have a wastewater discharge, a discharge permit will be required. In addition, a Stormwater Pollution Prevention Plan will be needed.

3.1.4 Solid Waste

In thermal conversion facilities, the inorganic constituents of MRF residue may be produced as bottom ash or slag, depending on the temperature in the reactor. Bottom ash will likely require disposal in a lined landfill. Slag, which is glassy and non-hazardous, is typically sold for use as construction material or road base. If markets are not available, it can be safely landfilled in a regular landfill.

In anaerobic digestion (AD), impurities like colorful pieces of plastic can render the effluent unmarketable as compost, even with post-processing. In that case, it can still be burned or gasified in an appropriate facility; it can also be used as landfill cover, since it will not appreciably generate landfill gas.

Ethanol production also can generate solid material such as distiller's grains, gluten, etc. If MRF residue is the source of the ethanol, the byproducts may not be acceptable for human consumption, including using CO_2 for beverage carbonation. The marketability of the solid residue as compost depends on the purity of the feed stream and the resulting appearance of the compost. Of course, the solid residue could be burned or gasified. The CO_2 stream produced is relatively pure, and could have industrial applications.

4.0 ENVIRONMENTAL ISSUES

Siting a demonstration conversion facility adjacent to a MRF in Southern California is a project that can have an impact on surrounding areas and may need preparation of many environmental documents and permits. The following sections discuss the important siting issues.

4.1 California Environmental Quality Act (CEQA)

Before implementation of a conversion demonstration project, all environmental issues for a specific location and technology have to be identified and lead regulatory agencies have to be consulted. After the determination of CEQA requirements an Environmental Impact Report (EIR) for this project will likely be required. The EIR must address the following major topics:

- Description of the Project

- Environmental Setting
- Environmental Impacts
- Significant Environmental Effects
- Mitigation Measures
- Alternatives to the Project

Environmental issues that will be important for permitting a conversion technology will vary depending upon the site selected; however, it is expected that air impacts, "quality of life" impacts to the local community, visual impacts, and land use compatibility will receive the greatest interest.

4.2 Environmental Issues and Mitigation

There are many environmental issues that may relate to a conversion facility development. When compared to long-term environmental issues related to landfilling, these issues are well manageable. Some of these issues are:

4.2.1 Air Quality

Air quality impacts will be an important issue, particularly with regard to potential release of toxic constituents. The purpose of the Health Risk Assessment is to describe the potential for impacts from toxics.

4.2.2 Nuisance (Traffic, Odor, Dust, and Noise)

The proposed conversion facility will be co-located at an existing MRF in Southern California, and it should not result in any increased traffic because the existing transportation infrastructure will continue to be used for MSW delivery to the MRF. The MRF residue can be transported to the conversion unit via conveyor belts; therefore, the traffic impact may be reduced by the construction of a conversion facility because of the reduction in the number of trucks currently hauling residue from the MRF to the landfill.

Conversion processes generally occur in an enclosed vessel and operate at a slight negative pressure. Assuming that the system is designed properly, there would be no odor, fugitive dust, and litter from a conversion facility.

The use of engines, turbines, and generators to produce electricity may results in increased noise, but this is commonly mitigated by enclosing the power generating equipment in sound isolating enclosures. The conversion facilities will be designed in accordance with State and local regulations with respect to noise abatement.

In general, the nuisance impacts would not be expected to increase, and possibly reduced when compared to what is experienced at existing MRFs.

4.2.3 Visual Impacts

Conversion facilities do not have a very large footprint, and the proposed facility is not expected to have a height requirement that will exceed the height of the existing MRF building. In addition, within an industrial zone, there are no aesthetic restrictions that apply to conversion facilities.

4.2.4 Surrounding Area Land Use

The MRF/TSs in Southern California that are on the short-list for development of a conversion facility are located in heavy industrial zones. All six MRF/TS locations are suitable for a conversion facility. There are no sensitive land uses in close proximity of these MRF/TSs.

5.0 PUBLIC ACCEPTABILITY

Development of a conversion facility will be controversial. Public acceptability is one of the major elements for development of a conversion demonstration facility. Citizens in Southern California and specifically in the County, where a conversion facility will be located, should be made aware and educated as to the benefits and impacts of conversion facilities.

An aggressive public outreach program is needed to educate the public, political officials, regulatory agencies, and all stakeholders about conversion technologies, their advantages and disadvantages, and seek their advice and consent. A comprehensive Public Outreach Plan is prepared as part of this study. The implementation of the Public Outreach Plan should start in the early stages of this project to ensure public acceptability.

6.0 CONCLUSIONS

Analysis of the most suitable combinations of MRF locations and technology conducted as part of this study indicate that co-location of a conversion demonstration facility at an existing MRF in Southern California has several advantages over current practices of residue disposal. The preliminary evaluation of data submitted by many conversion technology suppliers in Europe and Japan shows that conversion facilities can operate within the California regulatory framework. Facilities with the most advanced environmental control systems would very likely to be able to meet all regulatory requirements in California.

Public acceptability is a major factor for siting a conversion facility. An early and comprehensive public outreach program will contribute to the success of this project.

The actual environmental impacts of a specific conversion technology in a specific location will be evaluated as part of permitting process of the facility.