Appendix C

Additional Diversion Potential Analysis
(SMaRT Station Mixed Waste Diversion)

City Portion of SMaRT Station Tonnage

C&D Diversion	Tons		Additional Diversion Potential	Capture Rate
	Diverted	Available		
SMaRT Station C&D Diversion	3,290	996	0.4%	75%
Total Projected Additional Diversion		**498**	**0.2%**	**50%**

Small Organics	Tons		Additional Diversion Potential	Capture Rate
	Diverted	Available [1]		
Small Organics		16,000	6.2%	100%
Residue Percentage		25%		
Theoretical Maximum Tons		12,000	4.6%	100%
Current City Small Organics Diversion		3,000	1.2%	100%
Total Projected Additional Diversion		**9,000**	**3.5%**	**100%**

[1] Per City 02/23/12

Mixed Waste Residue	Tons		Additional Diversion Potential	Capture Rate
	Diverted	Available		
Recyclable Paper		9,547	3.7%	100%
Compostable Paper		47,883	18.5%	100%
Other Recyclables		6,922	2.7%	100%
Potentially Recyclable		4,800	1.9%	100%
Problem Materials		10,893	4.2%	100%
Total Tons		80,045		
Total Tons (w/o Problem Materials)		69,152	26.8%	100%
Additional Diversion Required to Achieve 75% [2]		**14,882**	**5.8%**	**100%**
% Recovery of Total Tons (w/o Problem Materials)		**21.5%**		

[2] With 5,300 tons additional Small Organics and 498 tons additional C&D Diversion = 20,680 tons (8% Additional Overall Diversion)

Gasification / Pyrolysis	Tons		Additional Diversion Potential	Capture Rate
	Diverted	Available		
		60,034	23.2%	100%
Theoretical Maximum Disposal Tonnage Reduction		60,034	23.2%	100%
Total Projected Additional Diversion		**54,030**	**20.9%**	**90%**

Appendix D

Conversion Technologies

- Conversion Technology Overview
- Conversion Technology Options for Sunnyvale SMaRT Station

R3

Conversion Technology Overview[1]

Conversion technologies refer to a wide array of state of the art technologies capable of converting organic materials, including the organic fraction of the municipal solid waste stream, into useful products, such as green fuels and renewable energy, in an environmentally beneficial way. Conversion technologies include both thermochemical and biochemical processes. A brief discussion of each of these technologies is provided below.

Thermochemical Conversion

Thermochemical conversion technologies include pyrolysis, gasification and plasma arc. Pyrolysis and gasification are not new technologies, having been used for coal since the early 20th century. The application of these technologies to solid waste feed stocks, however, is new and emerging.

Gasification

Gasification typically refers to the conversion of feedstock material by either direct or indirect heating, depending on the specific configuration of the gasification system. While gasification processes vary considerably, typical gasifiers operate from 1300^{0}F and higher and from atmospheric pressure to five atmospheres or higher. The process is optimized to produce fuel gases (methane and lighter hydrocarbons) and synthetic gases (carbon monoxide, hydrogen), hence the term gasification. The product fuels can be used in internal and external combustion engines and fuel cells. Synthetic gases can be used to produce methanol, ethanol and other fuel liquids and chemicals.

Pyrolysis

Pyrolysis is the process that produces pyrolytic oils and fuel gases that can be used directly as boiler fuel or refined for higher quality uses such as engine fuels, chemicals, adhesives and other products. Pyrolysis typically occurs at temperatures in the range of 750 – 1,500^{0}F and thermochemically degrades the feed stock without the addition of air or oxygen. Because air or oxygen is not intentionally introduced or used in the reaction, pyrolysis requires thermal energy, which is typically applied indirectly by thermal conduction through the walls of the containment reactor. The reactor is usually filled with an inert gas to aid in heat transfer from the reactor walls and to provide a transport medium for removal of the gaseous products.

Plasma Arc

Plasma Arc is a technology that can be used in both pyrolysis and gasification systems. The technology was developed for the metals industry in the late 19th century. Plasma is a collection of free-moving electrons and ions that is typically formed by applying a large voltage across a gas volume at reduced or atmospheric pressure. When the voltage is high enough and the gas pressure low enough, electrons in the gas molecules break away and flow towards the positive side of the applied voltage. The gas molecules become positively charged ions that are capable of transporting an electrical current and generating heat. This is the same phenomenon that creates lightening. Very high temperatures are created in the ionized plasma (i.e., 7,000^{0}F and above). For applications in processing solid waste the intense heat actually breaks up the molecular structure of the organic material to produce simpler gaseous molecules such as carbon monoxide (CO), hydrogen (H) and carbon dioxide (CO2).

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[1] Source: Conversion Technologies Report to the Legislature, CIWMB, February 2005

Biochemical Conversion

Biochemical conversion processes, such as anaerobic digestion and fermentation, occur at lower temperatures than thermochemical processes. Higher moisture feed stocks are generally better candidates for biochemical processes. Non-biodegradable feed stocks such as plastics and metals are not suitable for biochemical conversion and are not converted. Applying biochemical processes to solid waste as a pre-treatment prior to landfilling can reduce both the volume of material being landfilled and the production of leachate while at the same time extracting the embodied energy value from the feed stock. There are a large number of anaerobic digestion facilities operating in Europe and Canada that utilize unsorted municipal solid waste as feed stock.

Anaerobic Digestion

Anaerobic digestion is the bacterial breakdown of biodegradable organic material in the absence of oxygen and can occur over a wide temperature range from 50 – 160^{0}F. Anaerobic digestion produces a gas principally composed of methane (CH4) and carbon dioxide (CO2) but also has impurities such as hydrogen sulfide (H2S). This gas is produced from feed stocks such as sewage sludge, livestock manure and other wet organic wastes. Depending on the waste feed stock and the system design biogas is typically 55 to 75 percent pure methane, although state-of-the-art systems report producing biogas that is more than 95 percent pure methane. Biogas can be used as a fuel for engines, gas turbines, fuel cells, boilers, industrial heaters other processes and the manufacturing of chemicals.

Fermentation

Fermentation is an anaerobic process that is used to produce fuel liquids such as ethanol and other chemicals. Although fermentation and anaerobic digestion are commonly classified separately, both are fermentation methods designed to produce different products.

Status of Conversion Technologies

Conversion technologies are successfully used to manage solid waste throughout Europe, Israel, Japan and other countries in Asia, but are not yet in commercial operation in the United States. While there are and have been pilot demonstrations of conversion technologies in the United States, the absence of larger scale demonstration facilities and commercial facilities in this country is an obstacle to demonstrating the benefits these technologies can offer. In addition to lack of experience in the United States, specific development hurdles for conversion technologies in California may include: cost, especially when compared to the current, relatively inexpensive cost of landfill disposal; the lack of clear permitting and regulatory pathway; a lack of diversion credit, renewable energy credit, or other incentives for the development of emerging technologies; and misconceptions regarding the performance of these technologies.[2]

While there are no commercial scale conversion technologies in California or the United States, interest in conversion technologies has been growing. Attachment 1 provides a memorandum prepared by the City of San Jose that includes the status of municipalities pursuing conversion technologies in the United States and “lessons learned”. Within California a number of jurisdictions are actively pursuing the implementation of conversion technologies (including gasification), including:

- The County of Los Angeles;

[2] Los Angeles County Conversion Technology Evaluation Report; Phase II Assessment, October 2007 (pg ES-1).

- The County of Santa Barbara; and
- The Salinas Valley Solid Waste Authority.

Additional information on a status of those efforts is provided below.

Los Angeles County

After an extensive, multi-year evaluation process of Conversion Technologies for processing MSW (including gasification), which included facility site visits, stakeholder meetings and economic, environmental and technical feasibility assessments, the Los Angeles County Board of Supervisors on April 20, 1010 unanimously approved recommendations from the Los Angeles County Department of Public Works that included:

- Approval of Memorandums of Understanding (MOU) between the County and three different conversion technology project development teams (copies of the MOU's have been provided to the City under separate cover):
    - Arrow Ecology and Engineering & CR&R Incorporated proposing a 150 ton per day **anaerobic digestion process** in the City of Perris, to be located at the MRF/TS owned and operated by CR&R Incorporated.
    - International Environmental Solutions & Burrtec Waste Industries proposing a 184 ton per day **pyrolysis process** in unincorporated Riverside County, to be located at the MRF/TS owned and operated by Burrtec.
    - Entech Renewable Energy Solutions & Rainbow Disposal Company proposing a 360 ton per day **gasification process** in the City of Huntington Beach to be located at the MRF/TS owned and operated by Rainbow Disposal Company. The proposed Entech gasification technology has been in use since the first unit was installed in 1989. Since that time over 100 Entech gasification units have been installed with more than 20 of those installations fueled with municipal solid waste.[3]
- Approval of a four-year consultant contract with Alternative Resources Inc. (ARI) to provide technical, permitting, and funding procurement assistance to each of the demonstration projects and to assist with the technology evaluation and development of Phase IV commercial projects within LA County.

The consultant contract with ARI is for a total not-to-exceed amount of $1,290,600. Each of the three demonstration projects will be financed by the respective project developer. Upon execution of the MOUs, for a term of 16 months, each project developer and the County will jointly attempt to obtain grants and/or loans to be applied against the cost of constructing and completing the project.

Santa Barbara County

The County of Santa Barbara and the cities of Santa Barbara, Goleta, Solvang and Buellton joined together to identify and evaluate the feasibility of various conversion technologies as alternatives to landfilling solid waste in southern Santa Barbara County. After a three year process including the development of a feasibility report, extensive public outreach and an extensive request for proposal (RFP) process, four companies submitted formal proposals to build and operate a conversion technology facility:

- International Environmental Solutions (**Pyrolysis**);

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[3] Los Angeles County Conversion Technology Evaluation Report; Phase II Assessment, October 2007.

- Mustang Renewable Power Ventures;[4]
- NRG Energy (**Plasma Gasification**); and
- Plasco Energy Group (**Plasma Gasification**).

The County is currently evaluating proposals and hopes to make that evaluation public early next year. A project representative reported that the project has cost approximately $1.0 million to date, with most of which have been internal costs, although approximately $300,000 has been paid to a consultant that has been providing project assistance since 2007.

Salinas Valley Solid Waste Authority

The Board of Directors of the Salinas Valley Solid Waste Authority (Authority) began investigating alternatives to landfill disposal of solid waste in February 2005 with a series of study sessions. In March 2007 a four-member Conversion Technology Commission (Commission) was formed to investigate viable conversion technologies. The Authority issued a request for Statement of Qualifications to more than 70 firms and selected nine (9) vendors to receive a Request for Proposals. Three proposals were received by the August 2008 deadline and were ranked from highest to lowest as follows:

- Plasco Energy Group (**Plasma Arc Gasification**);
- Urbaser, S.A. (**MRF/Anaerobic Digestion/Compost/WTE/Others**); and
- Interstate Technologies, Inc. (**Gasification**).

The Commission has recommended that the Authority negotiate with the top two ranked proposers. The cost associated with the technology evaluation and proposal process has been approximately $320,000. Staff anticipates support from consultants to negotiate with the vendors, and General Counsel time to complete the letter of intent will be an additional $30,000. The company that is ultimately selected will be required to reimburse the Authority for expenses related to the investigation of conversion technologies and waste treatment processes in the amount of $100,000.

Status of Conversion Technology Diversion Credit

Under the State's current 50 percent diversion requirement *" the most important aspect of compliance is program implementation. To evaluate compliance, CalRecycle will look at a jurisdiction's unique per capita disposal rate as an indicator of how well its programs are doing to keep disposal at or below a jurisdictions 50 percent equivalent per capital disposal target. But this number does not determine compliance. Compliance is based on CalRecycle evaluating that a jurisdiction is continuing to implement the programs it chose and is making progress in meeting its target."*[5]

The City's diversion rate was 45 percent in 2000 as compared to the State mandated 50 percent diversion rate. The City received Board Approved Time Extensions for 2000 through 2004 and a Board Approved Good Faith Effort[6] for 2005 and 2006, when its diversion rate was 47 and 48 percent respectively. Under the new disposal based reporting system, which became effective in 2007, the City exceeded CalRecycle's target per capita disposal amount in 2007 (6.3 pounds per

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[4] Mustang Renewable Power Ventures is run by a developer who has acquired licenses for anaerobic digestion, gasification and material recovery facility (MRF) technologies and is marketing packages based on a specific jurisdictions interest / needs.

resident per day (PPD) versus the 5.9 PPD target). The City's 2008 per capital disposal rate of 4.9 PPD, however, was below the 5.9 PPD target (i.e., the City's diversion level was above 50 percent). Data for 2009 has not yet been reported.

While gasification can result in 94 to 100 percent landfill diversion by weight,[7] CalRecycle staff report that any tonnage handled in a gasification facility would currently be considered disposed. There was proposed legislation (AB 222) that would have credited the diversion associated with a "Biorefinery"[8] for purposes of meeting a solid waste diversion level above 50 percent, provided that the Biorefinery satisfies certain criteria including: *"preprocesses the solid waste feedstock to remove, to the maximum extent feasible, all recyclable materials prior to the conversion process"*. That bill, however, died with the close of the most recent legislative session. AB 222 passed the Senate Environmental Quality Committee and was awaiting a hearing on the Senate floor. It previously passed the Senate Energy Utilities and Communications Committee, as well as the Assembly Policy and Fiscal Committees. While there are many parties that supported AB 222 there was also significant opposition.

Emissions from Conversion Technology Facilities

A report prepared by the University of California, Riverside in 2009 reported that pyrolysis and gasification facilities currently operating throughout the world with waste feed stocks meet each of their respective air quality emission limits. With few exceptions, most meet all of the current emission limits mandated in California, the United States, the European Union and Japan. In the case of toxic air contaminants (dioxins/furans and mercury), every process evaluated met the most stringent emission standards worldwide. Facilities with advanced environmental controls are most likely to meet regulatory requirements in California. The actual impacts of specific facilities will need to be evaluated on a case-by-case basis as part of a local permitting process.[9]

Local regulations for conversion technologies have not been established and it is important to note that any conversion technology facility constructed in the Bay Area will likely be subject to more stringent permitting requirements than those evaluated in the UC Riverside Study.

Attachment 2 provides a Fact Sheet for the LA County Conversion Technology Demonstration Project that includes the following findings:

- Conversion technologies are capable of meeting the most stringent air emission standards;
- Conversion technologies can actually make our air cleaner; and
- Conversion technologies can help address climate change.

Attachment 1

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Environmental Services
A Certified Green Business

M E M O R A N D U M

To: Michele Young
From: Jaqui Guzmán
Date: 1/6/2010
Re: Lessons Learned in Developing Municipal Conversion Technology Projects

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Conversion technologies (CT) use carbon-based waste to produce clean burning fuel to generate electricity or a renewable fuel. These technologies recover more energy than the capture of landfill gas, while diverting the residual carbon-based waste resulting from recycling and composting processes from landfills. Given the City's ambitious Zero Waste goal, the Environmental Services Department is exploring conversion technologies as a key strategy for reducing post-recycling and post-composting residuals.

This memo presents findings and lessons learned from research on municipal waste conversion projects and interviews with lead project staff. These lessons learned will help inform the City's own process as it pursues CT.

Scope

I conducted basic internet research to identify municipalities that were actively pursuing CT projects. This included browsing government websites and reviewing reports related to municipal waste conversion projects. In identifying municipalities, I limited my research to North America and focused particularly on California because these municipalities face similar environmental and political circumstances as San José. In addition, I looked only at projects that used municipal solid waste (MSW) as feedstock. Given that this technology is fairly new and has yet to be developed using MSW on a commercial scale in North America, we identified only 17 municipal conversion projects.

Of the 17 municipalities I contacted, I was able to conduct ten interviews with lead project staff. (See Appendix A for full contact information and Appendix B for interview questions.) The chart on the next page briefly describes the CT projects initiated by the 17 municipalities we identified for this lessons learned memo.

Findings

In researching municipal waste conversion projects, reviewing project reports, and interviewing project representatives, a number of key findings and recommendations emerged.

As you can see in the chart on the following page, every municipality has a unique project and is at a different stage of development; however, I also discovered many similarities in what they described as their motivations, process, and challenges. On page 3, I describe six key findings from my research and interviews with municipal government representatives.

Attachment 1

Municipalities Pursuing Conversion Technologies Project		
Municipality	**Project Description**	**Development Stage**
Interviewed		
City and County of Santa Barbara	Pursuing the development of a conversion facility at Tejiguas landfill. They are open to all conversion technologies.	RFP released
City of Los Angeles	Developing a plan to process MSW with waste-to-energy and conversion technologies.	Selecting vendor, Selecting project site
City of Sacramento	Abandoned plasma arc gasification project. Developing a strategic plan for a waste technology park that will feature multiple conversion technologies that convert MSW into energy.	First project abandoned, Strategic planning for second attempt
City of San Diego	Included a conversion technologies evaluation within Long Term Resource Management Options Strategic Plan. Taking a "watch and see others" approach before taking the next step toward developing a project.	Preliminary evaluation, No project planned
City of Tallahassee	Vendor approached municipality with a plasma arc gasification proposal for MSW. Power Purchase Agreement approved in 6.2007. Currently identifying sites, but estimating that facility will be operational in 2013.	Power Purchase Agreement signed, Selecting project site
City of Toronto	Anaerobic digestion facility using BTA as vendor.	Vendor selected
County of Santa Cruz	Approached by an interested vendor but negotiations fell apart because vendor lacked sufficient data on environmental impact and opposition from environmental groups.	Project abandoned
Lee County Solid Waste Division	Sought a public-private partnership to generate energy from fats, oils, and greases (FOG); however, the project was abandoned. Will possibly continue as private initiative.	Project abandoned
Los Angeles County	Developing demonstration projects with three short-listed vendors—IES (pyrolysis), EnTech (gasification), and Aerobio (anaerobic digestion)—with the goal of developing a commercial-scale project.	Shortlisted vendors, Selecting project site
New York City	Identifying a site for CT project through a siting task force. Planning to release an RFP in 12-18 months. Have yet to identify a technology.	Selecting project site
Saint Lucie County	Developing plasma arc gasification facility on landfill using GEOPLASMA as vendor.	Permitting
Salinas Valley Solid Waste Authority	Exploring projects with two vendors—Plasco Energy (gasification) and Urbaser (anaerobic digestion with gasification).	Initial vendor negotiations
Not Interviewed		
City of Huntsville	Developing plasma arc gasification project.	Unknown
City of Taunton	Developing conversion technology project to process 1,000 tons per day of MSW.	Unknown
East Bay MUD	Developing anaerobic digestion project.	Unknown
Orange County	Completed a comprehensive evaluation of conversion technologies.	Evaluation completed
City of Ottawa	Operating a 100 ton per day pilot plasma arc gasification facility since 2008.	Operational

- ***Most Projects Driven by Diversion Goals.*** Of the twelve municipalities we contacted, ten either had ambitious diversion goals or sought CT for purposes of waste diversion. These municipalities were generally driven by landfill closings, long-term strategic planning, or vendor interest. Only two municipalities were driven by the desire to produce energy.

- ***Projects Generally Follow Same Development Process But Steps Vary Widely.*** Municipalities have generally followed the same path in pursuit of CT; however, the steps taken along that path have varied widely. Most began with a general review of available CT with some analysis of the feasibility of developing a CT project in their communities. They subsequently moved on to strategic planning and more extensive technical analyses, and then sought vendor proposals. However, municipalities varied in when and if they shortlisted vendors or released a request for information. Some municipalities included public outreach from the onset, while others waited until much later in the process. They also differed in when each identified a project site.

- ***Speeding the Development Process Led to Failure for Some.*** Two of the twelve municipalities interviewed, Lee County and Santa Cruz County, followed very different paths. Regrettably, their attempt to speed the process led to failure. In the case of Lee County, it applied for a grant to develop a CT facility for purposes of generating energy from FOG without carefully analyzing the feasibility of the project. Later staff found that the collection infrastructure did not exist, meaning the county would need to enter the hauling business to make the project work. This led to public outcry and ultimately the county removed itself from the project and instead provided seed money for a private initiative. Likewise, Santa Cruz tried to speed the process by moving straight to negotiations when approached by an interested vendor. When faced with public opposition from environmental groups, it had no CT literature, feasibility study, or data on emissions to quell the opposition and the project was abandoned.

- ***Biggest Challenges Related to Misinformation and Lack of Credible Information.*** The most cited challenge faced by the municipalities I interviewed was misinformation and lack of credible information. Many municipalities faced fierce opposition from anti-incineration groups that claim thermal technologies are "incineration in disguise." These groups mobilized to spread misinformation in communities considering CT. Some municipalities expressed frustration at not being able to counter claims that CT facilities would emit large amounts of dangerous emissions because good and reliable data on CT facilities is not readily available.

- ***UC Riverside Report Finds Acceptable Emissions.*** Better data on emissions is starting to emerge. UC Riverside recently released a report that found CT facilities worldwide are meeting emissions standards. They also found the vast majority of these facilities meet California's rigorous emissions standards. Thus, they conclude that CT facilities could be permitted in the state. This study will no doubt help municipalities pursuing CT.

- ***Everyone is Learning as They Go.*** Municipalities pursuing CT are at the forefront and are continuously learning as they go because there is no clear path to success. CT is a very new technology for North America. According to a UC Riverside report released in

2009, there are only a handful of operational CT facilities (operating under research permits) in North America using MSW as feedstock. Of the municipalities I interviewed, none had an operational CT facility. St. Lucie County and Toronto, now in the permitting phase, are furthest along.

Best Practices in Municipal Conversion Technology Project Development

In assessing the feedback I received from municipalities, four messages stood out as the most important lessons that San José should keep in mind as it develops its conversion technology project. Below, I describe these four best practices.

- ***Stakeholder Outreach.*** Most municipalities I interviewed emphasized the importance of educating and engaging the community when pursuing CT. Community involvement was particularly important for municipalities in California, given the concentration of environmental groups concerned with the impact CT could have on air quality and the waste hierarchy. Those municipalities that have been successfully moving forward—the City and County of Santa Barbara, Los Angeles County, and Saint Lucie County—credit their success in large part to their early outreach efforts. Conversely, those municipalities whose CT projects have been thwarted by opposition, like the City of Santa Cruz, lamented not implementing a robust public outreach effort early on in the process.

- ***Realistic and Flexible Timelines.*** Every municipality I interviewed has experienced setbacks in developing CT projects. These setbacks have caused municipalities to extend their timelines, which can cause frustration among stakeholders. Thus, they expressed the importance of developing realistic and flexible timelines, as well as processes for dealing with project problems and delays.

- ***Strong Group of Advisors.*** Several municipalities valued the advice and contributions of advisory groups formed to help guide the development of CT projects. Most advisory groups included technical experts, such as professors or consultants, that provided expert technical support. Some advisory groups also included municipal leadership that could help champion the project and lobby other decision-makers. The City of Los Angeles, in particular, credited a councilmember for keeping the project alive despite numerous delays.

- ***Learn From Other Municipalities.*** More than a few municipalities suggested learning from the experiences of other public entities pursuing CT. Moreover, they suggested using existing resources, like technical work, if feasible, particularly if using the same consultant and/or vendor as another municipality.

Recommendations

The City should consider the lessons learned and best practices gleaned from other municipalities as it moves forward with the development of CT in San José. With this memo, the City is already taking steps towards learning from the experiences of other municipalities and

taking stock of available resources. However, the City currently is moving forward on CT efforts with very limited stakeholder outreach and an undefined project development process, which can lead to difficulties as the City moves forward. Below, I present five recommendations to help the City avoid some of the pitfalls other municipalities have experienced in pursuing CT projects.

- ***Use Existing Negotiations and Planning to Begin Community Outreach.*** Understanding that the City has limited resources, the City should consider requiring Greenwaste Recovery to hire a public relations firm or fund a part-time community outreach position as part of the lease negotiations. This requirement should also be considered for any CT RFP. Additionally, the City should take advantage of the current Plant Master Plan process to educate the community on conversion technologies that could be located on the Plant in the future. To minimize efforts, the City could borrow from existing outreach campaigns from municipalities identified in this memo.

- ***Consider Forming a CT Committee.*** The City should also consider forming a CT Committee to help champion and guide the City's CT efforts. This committee should be composed of ESD staff, CMO staff, Councilmember staff, and technical experts in CT. Such an advisory committee could help the City face bureaucratic, political, and technical challenges.

- ***Further Develop the City's Conversion Technology Strategic Plan.*** Rather than move forward with grants and vendor negotiations, the City should step back and fully develop its Conversion Technologies Strategic Plan. While staff already has a draft, this could be the CT Committees first task. Having a well defined strategic plan backed by leadership will help facilitate stakeholder engagement and guide how the City pursues CT.

- ***Create a Project Development Manual for CT Projects.*** Prior to pursuing CT, the City should create a project development manual to help guide the development of CT projects. This manual should include step-by-step instructions, including local, state, and federal requirements for these types of projects. It also should link these requirements with appropriate lead departments. Such a manual will require substantial staff time and collaboration with relevant departments like the City Manager's Office, Attorney's Office, General Services (Real Estate), Planning, etc. This manual could be developed as the City navigates through the current 9-Par negotiations.

- ***Use Existing Technical Analyses, If Feasible.*** Extensive analysis of CT technologies, permitting issues, and other CT-related issues already exists. The City should avoid duplicating these existing resources. For example, many of the vendors submitting proposals for a CT project in San José may have submitted proposals to other municipalities. If a technical analysis of these vendors' technology already exists, there is no need to hire a consultant to duplicate that analysis. The City can simply review the existing analysis.

Attachment 1

Appendix A: Contact Information

Municipality	Contact	Phone	Email
City of Los Angeles	Miguel Zermeno	(213) 485-3611	miguel.zermeno@lacity.org
Los Angeles County	Coby Skye	(626) 458-5163	cskye@dpw.lacounty.gov
East Bay MUD	Sophia Skoda	(510) 287-1542	sskoda@ebmud.com
Salinas Valley Solid Waste Authority	Susan Warner	(831) 775-3002	susanw@svswa.org
City of Huntsville, AL	John "Doc" Holladay	(256) 880-6054	doc@swdahsv.org
Lee County Solid Waste Division	Keith Howard	(239) 533-8917	
City and County of Santa Barbara	Carlyle Johnston	(805) 882-3617	cjohnst@cosbpw.net
City of Sacramento	Edison Hicks	(916) 808-4949	EHicks@cityofsacramento.org
New York City	Venetia Lannon	(212) 312-4229	vlannon@nycedc.com
County of Santa Cruz	Melodye Serino	(831) 454-2160	
City of San Diego	Barbara Lamb	(619) 236-7789	BLamb@sandiego.gov
Orange County	Don Reeves	(714) 834-4000	
Saint Lucie County, FL	Ron Roberts	(772) 462-1768	robertsr@stlucieco.gov
City of Tallahassee, FL	Ben A. Cowart	(850) 891-6893	Ben.cowart@talgov.com
City of Taunton, MA	Steven Torres	(508) 821-1036	
City of Toronto	Brian Van Opstal		bvanops@toronto.ca

Appendix B: Questionnaire

Questions for Municipalities with Conversion Technology Projects:

Strategic Planning Process:

1. How did this project emerge? What were the goals/objectives of the program? (Was the main goal of this project to divert material from landfill or to create energy?)
    a. Would you share your planning documents with us (initial work plan)? Timeline?

2. Which, if any, consulting firms did you contract with to help devise or execute the project?
    a. What types of tasks were asked of your consultants?
    b. Would you share the scope of services with us?

Analyses Completed:

3. What types of feasibility or other analyses related to the project were conducted? (feedstock, diversion potential, energy generation potential, funding, etc)
    a. Would you share any analyses or other studies related to the project with us?

4. Was community input requested or a communication plan established as part of the pre-project work?

Lesson's Learned:

5. Did you release an RFI and/or RFP?
    a. Would you share your project description and/or RFI/RFP with us?
    b. Looking back, would you have made changes to the RFI/RFP?

6. What criteria did you use to evaluate the RFI and/or RFP responses?
    a. Would you share your evaluation criteria with us?

7. What worked well for you in the process?

8. What were your biggest challenges/obstacles?
    a. Looking back, how would you have approached these challenges/obstacles?

9. What advice do you have for cities who are contemplating a conversion technology project?

Attachment 2

Los Angeles County

Conversion Technology Demonstration Project

OVERVIEW: Conversion Technology Environmental Fact Sheet

Conversion technologies provide an opportunity to reduce our dependence on landfill disposal while reducing air emissions, including greenhouse gases. These are state-of-the-art processes capable of creating useful products, green fuels, and clean, renewable energy from solid waste. More than 130 commercial facilities operate in Europe and Asia as a safe and clean alternative to traditional waste management practices.

Following a decade of research, the County Los Angeles Department of Public Works has compiled this environmental fact sheet to summarize publicly available data, demonstrating that conversion technologies are a **superior option to traditional solid waste management practices** such as landfilling and waste-to-energy and **more than capable of meeting the most stringent air quality standards**.

Key Findings

Conversion technologies are capable of fully complying with the most stringent air emissions standards

Conversion technologies have been shown in actual operation to reduce dioxin and furan emissions in amounts **dramatically below the already low EPA limits** (see graph 1)

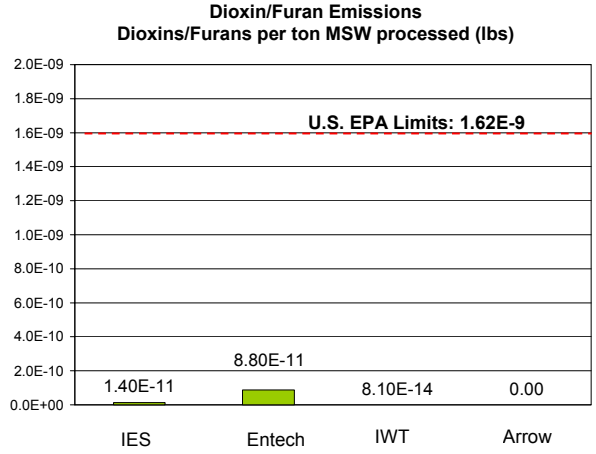
Conversion technologies actually make our air CLEANER

On a net-basis, conversion technologies can actually help **make our air cleaner** (see graph 2) by offsetting higher emissions from other sources, including greenhouse gas (GHG) emissions

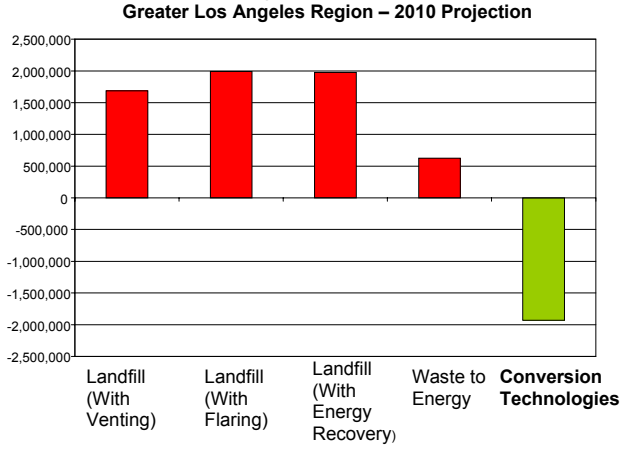
Conversion technologies can help us address climate change

Conversion technologies have the potential to **reduce GHG emissions each year by millions of tons of CO_2 equivalent** in California alone

Graph 1



Graph 2



*Attached is an environmental fact sheet summarizing public data that substantiates these findings. For more information, please visit: **www.SoCalConversion.org***

Los Angeles County

Conversion Technology Demonstration Project

Conversion Technologies: A Clean Solid Waste Alternative

The Los Angeles County Department of Public Works (County) is taking an active role in developing environmentally-sound alternatives to landfilling and waste-to-energy that would convert post-recycled residual solid waste into useful products, green fuels, and clean, renewable energy. These technologies may include biological, thermal, chemical, and mechanical processes; however they do not include waste-to-energy (combustion) as the trash is not actually burned. Public agencies and universities alike have studied air emissions from conversion technologies and concluded that they are capable of operating within regulatory limits. More than 130 commercial facilities, processing a wide variety of wastestreams, operate in Europe and Asia[1] as a safe and clean alternative to traditional waste management practices such as landfilling or waste-to-energy.

Sample Conversion Technologies From Around the World

Germany

Malaysia

Japan

Southern California

Independent, Peer-Reviewed Studies

Extensive studies have recently been completed by trusted California authorities. For example, a 2006 peer-reviewed study conducted by the University of California, Riverside, on behalf of the California Integrated Waste Management Board, analyzed third-party emissions data from three thermal technology facilities:

- ***International Environmental Solutions*** - Operates a pyrolysis facility in Romoland, California that utilizes solid waste
- ***BRI Energy*** - Operates a gasification facility in Fayetteville, Arkansas that was tested with solid waste from California
- ***Integrated Environmental Technologies*** - Operates a gasification process in Richland, Washington and other parts of the world that utilizes medical waste among other feedstocks

Additionally, Los Angeles County has been evaluating conversion technologies for more than a decade. After review of over 100 technology companies from around the world, the County is considering four technology companies to develop one or more demonstration facilities in Southern California. All four companies

participating in the process have demonstrated the ability to divert at least 87 percent of waste away from disposal, and in some cases 100 percent of the waste. The technology companies being considered by the County are the following:

- ***Arrow Ecology and Engineering (Arrow)*** - Operates anaerobic digestion facilities in Israel and Australia that process solid waste
- ***Entech*** – Operates a gasification facilities in Poland, England and Malaysia that process various forms of waste including solid waste, medical waste, and mixed plastics
- ***International Environmental Solutions (IES)*** - Operates a pyrolysis facility in Romoland, California that utilizes solid waste
- ***Interstate Waste Technologies (IWT)*** - Operates gasification/ pyrolysis facilities in Japan that process various forms of solid waste

The 2006 UC Riverside study, the County's conversion technology reports, and other key reports can be found online at www.SoCalConversion.org.

Conversion Technologies Meet Environmental Regulations

Since local regulations for conversion processes have not yet been established, UC Riverside researchers compared emissions data to similar known limits, including U.S. EPA limits for starved air solid waste combustors and German thermal conversion regulatory limits. **All three conversion facilities studied were, or will likely be, below these regulatory limits (see below).**

Air Emissions Comparison of Regulations and Three Thermal Technologies[2]

REGULATORY LIMITS	Particulate Matter	Nitrogen Oxides	Cadmium	Lead	Mercury
US EPA Limits	18.0	220	0.01500	0.15000	0.01500
German Limits	14.0	281	0.04200	0.70000	0.04200
ACTUAL FACILITY EMISSIONS[3]					
International Environmental Solutions	3.9	275[4]	0.000150	0.00028	0.00056
BRI Energy	2.0	10	0.005000	0.02000	0.00010
Integrated Environmental Technologies	<3.3	162	0.000027	0.01100	0.00067

(All limits normalized to mg/N-m^3 at 7% O_2)

Los Angeles County also analyzed dioxin/furan data from the four conversion processes currently under consideration in our process. Our research and review of emissions test results reveals that these conversion technologies should have no issues complying with U.S. EPA regulations. In fact, these conversion technologies have been shown in actual operation to produce dioxins and furans in amounts **dramatically lower than the already low U.S. EPA limits**, far less than many commonplace and natural activities such as a wood burning fireplace, and well within safe guidelines (see below).

Air Emissions Comparison of Dioxin/Furan Regulation[5]

REGULATORY LIMITS	Dioxin/Furan
US EPA Limits (for new sources)	0.000000001617131 (1.62 x10^{-9})
ACTUAL FACILITY EMISSIONS[6]	
International Environment Solutions	0.000000000014174 (1.42 x10^{-11})
Entech Environmental	0.000000000087715 (8.77 x10^{-11})
Interstate Waste Technologies	0.000000000000081 (8.10 x10^{-14})
Arrow Ecology and Engineering	This biological process does not produce dioxins or furans

(All limits normalized to lbs dioxins/furans per ton municipal solid waste)[7]

It's important to note that any conversion technology facility constructed in the South Coast Air Quality Management District (SCAQMD) will be subject to even more stringent permitting conditions than the limits above. SCAQMD is the air pollution control agency for Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. Because this region does not meet the Clean Air Act standard for healthy air, it is identified as a "non-attainment" area, requiring a "New Source Review"[8] for all new and modified sources in the area. Any facility or process that still produces emissions after the best available controls are implemented (above a very low threshold level) are required to offset those emissions in excess of the emissions generated, typically at a ratio of 1.2 to 1. After an extensive vetting process, the County is confident that the four technology companies under consideration by the County (i.e. Arrow, Entech, IES, and IWT) will operate within all regulatory guidelines.

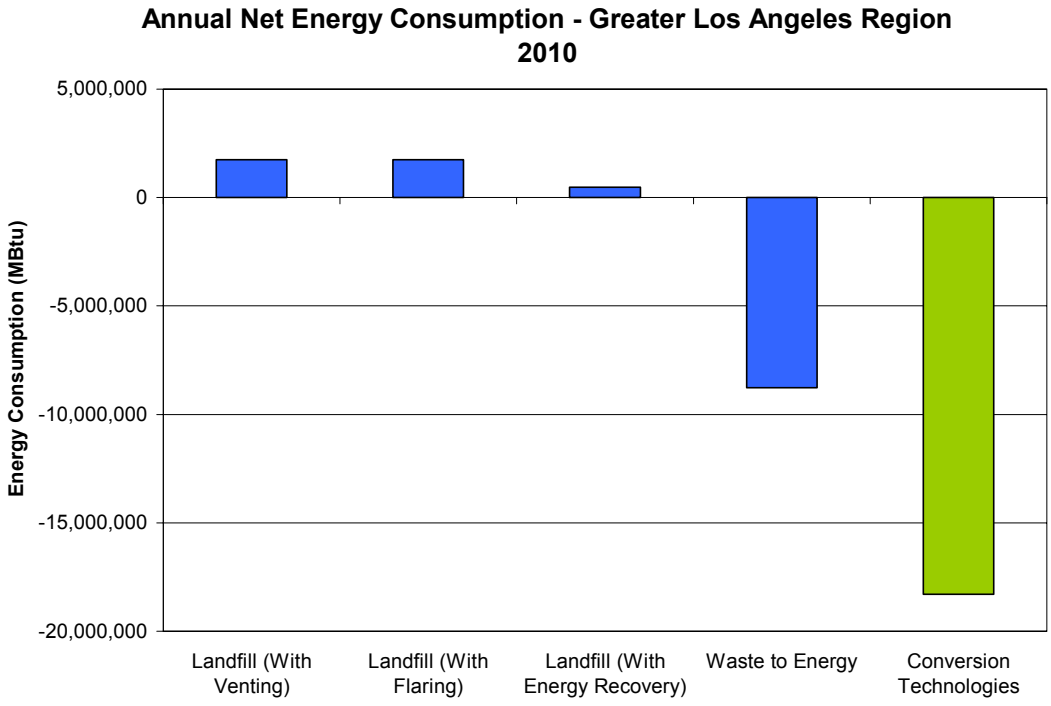
Conversion Technologies Are By Far The Most Energy-Efficient Waste Management Practices, And Can Reduce Net Air Emissions

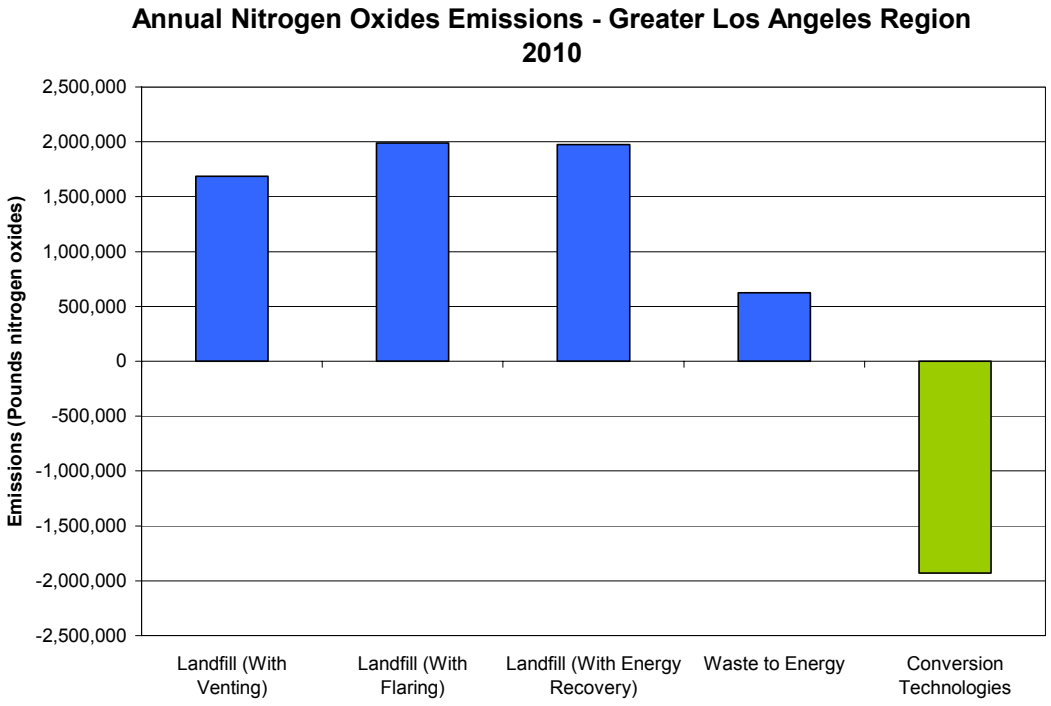
In the 2007 Staff Report to the Board entitled *New and Emerging Conversion Technologies*[9], the California Integrated Waste Management Board (CIWMB) developed several hypothetical waste management scenarios for a projected amount of waste generated in the year 2010. As noted in the CIWMB report, energy is an important factor when conducting a lifecycle analysis of a waste management scenario because air and water emissions are often a result of energy production. The report found that "as compared to the alternative management scenarios, the conversion technology scenario ranges from two times lower in net energy consumption when compared to the waste-to-energy scenario, to 11 times lower than the landfill without energy recovery scenarios[10]".

The CIWMB report attributes these conversion technology savings are to:

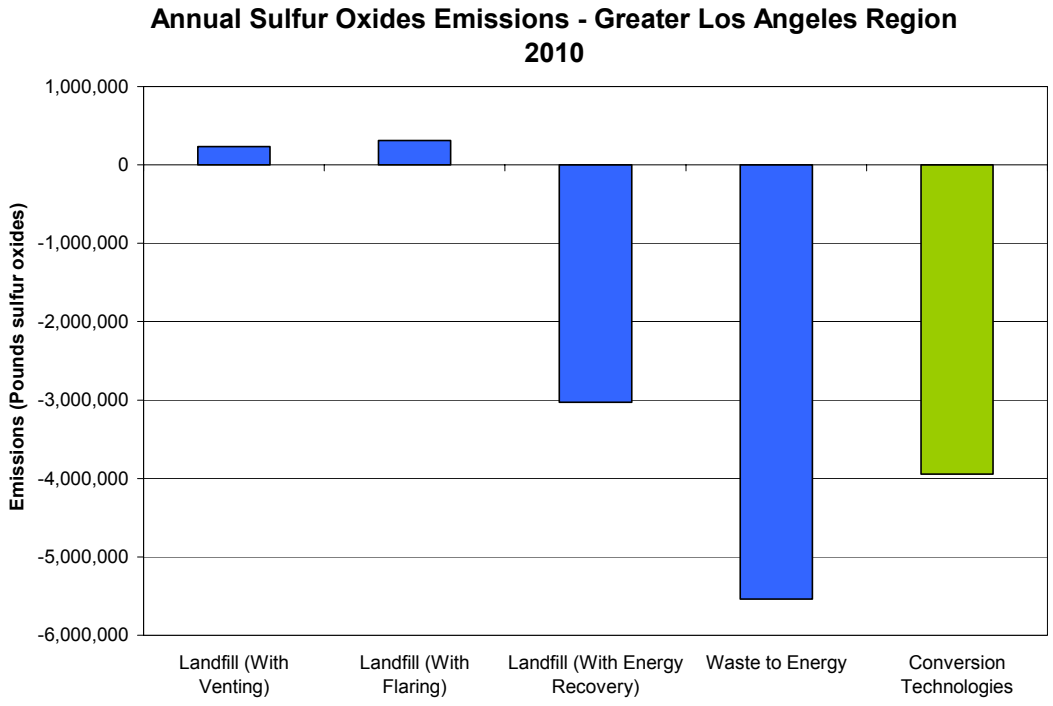
1) electricity production which offsets electricity produced by the utility sector;
2) biofuels production which offsets fuel production from fossil fuel sources; and
3) recyclable and reusable materials that are recovered, which offset the production of these products from virgin resources.

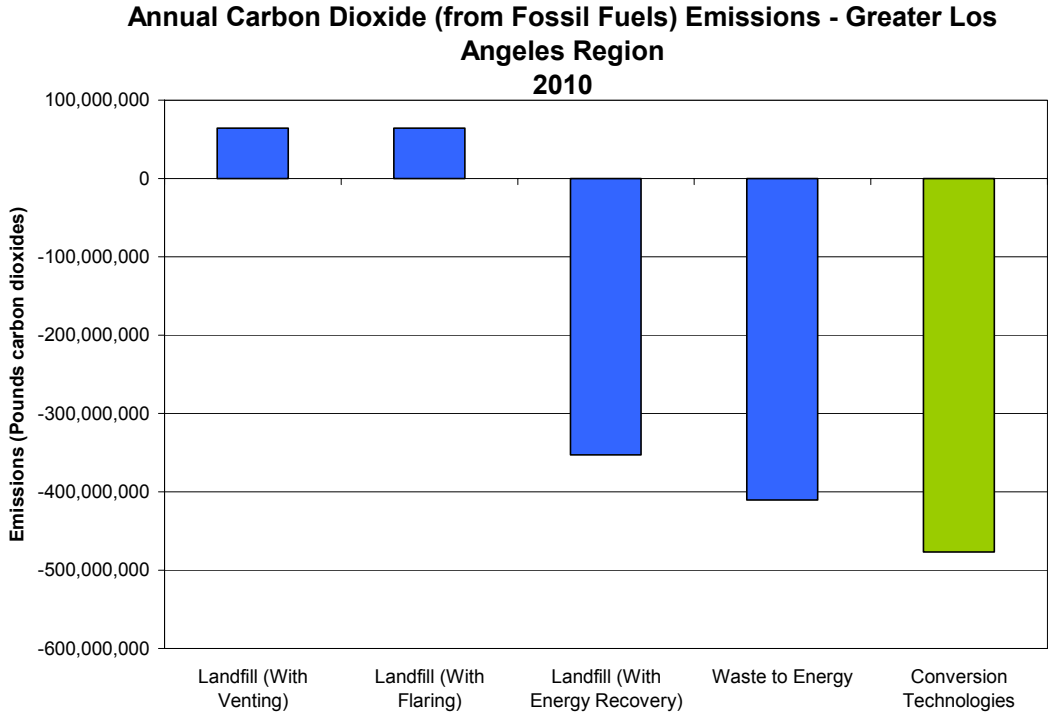
The CIWMB developed the following graphs, which compare emissions from landfills, waste-to-energy, and conversion technologies. The research indicates the **conversion technologies have the lowest net criteria air pollutant levels and GHG emissions**, and can actually help **make our air cleaner** by offsetting higher emissions from other sources:


Annual Net Energy Consumption - Greater Los Angeles Region
2010
Energy Consumption (MBtu)
5,000,000
0
-5,000,000
-10,000,000
-15,000,000
-20,000,000
Landfill (With Venting)
Landfill (With Flaring)
Landfill (With Energy Recovery)
Waste to Energy
Conversion Technologies


Annual Nitrogen Oxides Emissions - Greater Los Angeles Region
2010
Emissions (Pounds nitrogen oxides)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
-1,000,000
-1,500,000
-2,000,000
-2,500,000
Landfill (With Venting)
Landfill (With Flaring)
Landfill (With Energy Recovery)
Waste to Energy
Conversion Technologies

Attachment 2





Conversion Technologies Are An Integral Climate Change Solution

In February 2008, the California Air Resources Board's Economic and Technology Advancement Advisory Committee (ETAAC) released a report noting that *by conservative estimates,* conversion technologies have the potential to **reduce** annual GHG emissions by approximately **five million metric tons of CO_2 equivalent in California**.[11]

In fact, the potential GHG reduction of conversion technologies may be significantly greater, since conversion technologies have a simultaneous triple benefit to the environment: 1) reduction of transportation emissions resulting from long distance shipping of waste; 2) prevention of methane and other emissions from waste that would otherwise be landfilled; and 3) displacement of the use of fossil fuels from the energy (fuel and electricity) produced by conversion technologies. The ETAAC report only estimated reductions from this third benefit.

Conversion Technologies vs. Current Energy Production Practices

According to the U.S. Department of Energy and the California Energy Commission, approximately half of the electricity used in the United States and about one-sixth of California's electricity is generated by coal combustion[12]. Coal has the highest carbon intensity among fossil fuels, resulting in coal-fired plants having the highest output rate of carbon dioxide per kilowatt hour[13]. Emissions from coal combustion for electricity constitute 32 percent of total U.S. carbon dioxide emissions[14]. For comparison purposes, the following table illustrates the difference in emissions between a typical coal plant and a theoretical IES pyrolytic facility operating in Southern California. In all categories, the IES facility emits fewer pollutants including 67 percent less CO_2 than the coal plant.

Air Emissions Comparison of Equivalent-Sized Coal and Conversion Technology Facilities

POLLUTANT	10 MW COAL PLANT[15]	10 MW IES CONVERSION TECHNOLOGY FACILITY[16]
Sulfur Dioxide	400,000	230
Nitrogen Oxide	408,000	76,755
Carbon Dioxide	148,000,000	49,033,364
Small Particles	20,000	1,701
Hydrocarbons	8,800	1,555
Carbon Monoxide	28,800	0.00
Arsenic	4.50	0.03
Lead	2.28	0.01
Cadmium	0.08	0.01
Mercury	3.69	0.09

(All pollutants measured in pounds/year)

Conclusion

Managing our waste through the best available conversion technologies rather than relying on current disposal options can lead to a net reduction in air emissions. These technologies have been used successfully in other parts of the world. Any new facilities developed would be required to comply with the most stringent air emissions controls and standards in the U.S., and are capable of doing so. Conversion technologies have the potential to provide real benefits to our ability to address the energy, solid waste and climate change crises. For more information and to download copies of key reports, please visit: **www.SoCalConversion.org**

A Project of Los Angeles County Department of Public Works

"Communities where residents live and work in a safe, clean and sustainable environment"

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[1] California Integrated Waste Management Board, *Staff Report to the Board: New and Emerging Conversion Technologies,* 2007 pg 10

[2] Adapted from University of CA, Riverside "Evaluation of Environmental Impacts of Thermochemical Conversion Technologies Using Municipal Solid Waste Feedstocks: Final Summary Report", 2006

[3] Significant figures are provided for ease of comparison; however, the actual measurements may not be accurate to this level of detail.

[4] IES utilized selective non-catalytic reduction (SNCR) for controlling nitrogen oxide emissions. Typically SNCR control efficiency ranges from 10 - 40%. This control technology was utilized in source testing due to engineering and manufacturing time schedules. Additionally SNCR lowered the nitrogen oxide emissions below SCAQMD permit limit for 24/7 operation. Although the use of SNCR brought these emissions during source testing into compliance, future IES facilities are being designed to use selective catalytic reduction (SCR) for nitrogen oxide control. This technology is proven to reduce nitrogen oxide emissions from 65 - 90%. It is anticipated that the use of SCR will bring the nitrogen oxide emissions well within the EPA limit.

[5] Adapted from *Los Angeles County Conversion Technology Evaluation Report - Phase II Assessment,* prepared for Los Angeles County Department of Public Works by Alternative Resources, Inc, 2007

[6] Significant figures are provided for ease of comparison; however, the actual measurements may not be accurate to this level of detail.

[7] Dioxin and furan emissions listed herein are evaluated on a basis known as ITEQ (International Toxic Equivalents), which accounts for the relative toxicity of the individual compounds. In the United States, dioxin and furan emissions are often reported on a total mass basis, which does not account for the toxicity of the individual compounds. U.S. EPA published an equivalency between total mass and toxic equivalents, specifically for traditional waste-to-energy technology, in 60 FR 65396. The total mass statistics available in the United States were converted to ITEQ. For comparison, traditional waste-to-energy facilities in California, on average, generate 0.000000000540838 (5.41x 10-10) Lbs Dioxins/Furans per ton MSW processed, also well below the U.S. EPA limit for new sources.

[8] South Coast Air Quality Management District: "New Source Review" http://www.aqmd.gov/prdas/NSR/index.html

[9] California Integrated Waste Management Board, *Staff Report to the Board: New and Emerging Conversion Technologies,* 2007, pp 60-64

[10] Ibid, pg 60

[11] Economic and Technology Advancement Advisory Committee, "*Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California",* 2008

[12] Energy Information Administration (EIA) http://www.eia.doe.gov/fuelelectric.html

[13] US Dept. of Energy, *Carbon Dioxide Emissions from the Generation of Electric Power in the United States,* 2000

[14] Energy Information Administration (EIA) Annual energy outlook And EIA 2007 Emission of greenhouse gases in the U.S., 2008

[15] Union of Concerned Scientists, *"How Coal Works"* (values prorated from a 500 MW coal plant), http://www.ucsusa.org, 2008

[16] International Environmental Solutions (IES), 2006 Air Kinetics Report, values prorated from testing of 13.36 tpd MSW

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Memorandum

1796

TO: William Schoen, R3 Consulting Group

FROM: Jim Binder, Sue Higgins

DATE: July 5, 2011

SUBJECT: Conversion Technology Options for SMaRT Station®

Data provided to ARI in the SMaRT Station Residue Waste Composition File (June 9, 2011) shows that in 2010 the SMaRT Station received 179,230 tons of MSW for processing through the mixed MSW sorting lines. Approximately 15% of this MSW (26,799 tons) was recovered and diverted to recycling markets. The remaining material consisted of a fine fraction (minus 2" material) and residual waste. The data provided show that 30,276 tons of minus 2" material was generated in 2010, of which 7,357 tons were reported as being marketed. The unmarketed minus 2" material (22,919 tons) and the residual waste (122,155 tons) were delivered to the Kirby Canyon Landfill for disposal (145,074 tons disposed, in total).

ARI has reviewed the waste characterization data to determine the potential to process the residual waste and the minus 2" material from the SMaRT station using anaerobic digestion and thermal conversion technologies. Our findings are presented below, along with key information pertaining to energy/material outputs, residue requiring landfilling, and planning level tipping fees (cost).

Processing and Management of the Residue

In 2010, the SMaRT Station generated 122,155 tons of residual waste that was delivered to the Kirby Canyon Landfill for disposal. Based on the City of Sunnyvale Waste Characterization Study (2010) and the corresponding SMaRT Station Residue Waste Composition File (June 9, 2011), this residue is generally characterized as follows:

Material	Percent by Weight
Paper	52.4%
Plastic	11.7%
Glass	0.1%
Metal	1.7%
Organics	24.0%
Electronics	0.0%
Inerts	3.2%
HHW	0.3%
Special Waste	2.7%
Mixed Residue	3.9%
Total	100.0%

This material is most suitable for thermal treatment, such as pyrolysis or gasification, and less suitable for anaerobic digestion. Although the feedstock includes compostable paper and other compostable organics, there are processing limitations in separating these remaining compostable materials from the other inert and undigestable materials in the residue. As a result, a greater amount of contaminants would pass through the digestion process and end up in the compost material. There may be potential applications with wet anaerobic digestion technologies, such as those that employ water-based sorting and separation techniques, but the material appears best suited for thermal treatment.

A gasification facility designed to receive and process mixed residue from the SMaRT station would require minimal or no front-end processing, since processing is already accomplished at the SMaRT station. For some technologies, a limited amount of additional waste processing may be implemented, such as shredding and/or drying. The facility could be configured to generate electricity for sale or to produce other energy products. Based on the characteristics of the feedstock (i.e., predominantly paper, plastic and wood), gross electricity generation would be on the order of 720 kWh/ton of preprocessed feedstock, which in this application would be the MRF residue received from the SMaRT Station; actual output may vary, depending on the heating value of the feedstock material as well as the type of power generation equipment used. The process would generate a char or an ash residue that is assumed to be disposed of in a landfill; the residue generation rate could range from approximately 10-20% by weight of the feedstock received for processing. Certain thermal technologies, such as high temperature gasification and plasma gasification, produce less ash residue, replacing it in whole or part with a vitrified aggregate byproduct. However, these types of thermal technologies are more costly and have a higher capital and operating cost profile, generally making them less suitable for smaller-

scale applications (such as the SMaRT Station) and more suitable for larger-scale applications (i.e., 500-1000 tpd or larger plants).

A planning level estimated cost for a gasification facility designed to process approximately 122,000 tpy of mixed residue from the SMaRT Station ranges from approximately $69 (Case 1) to $133 (Case 2) per ton. This estimated planning level cost range is based on key assumptions including average capital and operating costs for a number of different thermal technologies, which individually can have different costs based on the technology employed and unique performance and cost profiles. Other key assumptions include the financing approach (public or private financing), the amount of electricity generated for sale and the value of the electricity sold, and the amount of residue requiring landfill disposal. The ability to obtain grant funding can also have a measurable, positive impact on costs. ARI's estimates are provided below, as two cases which frame the overall range:

- **Case 1.** The lower end of the cost range is based on the assumption that the technology minimizes residue requiring landfill disposal to 10% by weight of the feedstock received for processing. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The lower end of the cost range also assumes that the facility maximizes electricity output at 720 kWh/ton, with sale of the electricity at a levelized price of $0.142 per kWh. This assumed electricity sale price is based on a recent estimate by the municipal utility in Palo Alto for an anaerobic digestion facility feasibility study. It is inclusive of capacity payments and any and all renewable and environmental attributes, accounting for the impact of the Renewable Energy Act that was passed in April 2011. This renewable pricing is assumed to apply, based on recent determinations by CalRecycle and CEC that found certain thermal technologies eligible. However, future determination of renewable eligibility is not certain, and would be technology-dependent. It is assumed that all of the electricity generated is sold, with the facility purchasing electricity to meet its internal needs. The project is assumed to be publicly financed at a debt interest rate of 5%; other financing assumptions include amortization of the debt over a 20-year project period, and application of a 15% factor for financing soft costs and reserve fund. Public financing scenarios would accommodate project delivery methods such as design-build (DB) or design-build-operate (DBO). Based on these assumptions, the estimated cost is on the order of $82 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 1, a grant of $15 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $69 per ton.

- **Case 2.** The higher end of the cost range is based on the assumption that the facility generates residue requiring landfill disposal at a rate equal to 20% by weight of the feedstock received for processing. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The higher end of the cost range also assumes a more conservative net electricity output of 500 kWh/ton, with sale of the net electricity at a levelized price of $0.142 per kWh (inclusive of capacity payments and any and all renewable and environmental attributes, as discussed above). It is assumed that all of the electricity generated is

sold, with the facility purchasing electricity to meet its internal needs. The project is assumed to be privately financed and developed, with generally conservative financing assumptions (e.g., equity requirement of 30%; a return on equity of 25%; a 5.25% debt interest rate; debt service amortized over a 20-year project period, and a 15% factor for financing soft costs and reserve fund). Based on these assumptions, the estimated cost is on the order of $151 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 2, a grant of $15 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $133 per ton.

Processing and Management of the Minus 2" Material

In 2010, the SMaRT Station generated 30,276 tons of minus 2" material. The City of Sunnyvale Waste Characterization Study (2010) and the corresponding SMaRT Station Residue Waste Composition File (June 9, 2011) did not include sampling and characterization of the minus 2" material. However, the fine fraction resulting from similar sorting and separation of mixed MSW at other comparable facilities is typically an organically-rich stream, largely inclusive of food scraps along with other organic materials that have not been separately recovered. Although this material is also expected to include small pieces of glass, metal, plastic, rocks, dirt and other fine inerts, it can typically have an organic content of 75-90% by weight. Assuming the minus 2" material from the SMaRT Station is similarly organically rich, this material is suitable for anaerobic digestion, which performs well with organically rich feedstocks.

An anaerobic digestion facility designed to receive and process the organically-rich, minus 2" material (which would include the minus 2" material currently sold) would require minimal or no front-end processing, since the necessary processing is already accomplished at the SMaRT station. The facility could be configured to generate electricity or pipeline quality natural gas as the key energy output. Assuming the feedstock is approximately 85-90% organic in content, gross electricity generation could be on the order of 180 kWh/ton of received feedstock; gross output of pipeline-quality natural gas could be on the order of 118,000,000 scf per year. The process would generate compost that could be marketed for beneficial use. The amount of compost that would be generated could range from approximately 25-30% by weight of the feedstock received for processing. Residue requiring landfill disposal could range from 10-25% by weight of the feedstock received for processing, depending on the amount of inert or otherwise undigestible materials present in the feedstock and the specific technology employed, as well as the extent of post-processing required to meet market specifications for the compost (e.g., compost screening).

A planning level estimated cost for an anaerobic digestion facility designed to process approximately 30,000 tons per year of organically rich fines from the SMaRT Station ranges from approximately $62 (Case 1)to $96 (Case 2) per ton. This estimated planning level cost range is based on key assumptions including average capital and operating costs for a number of different anaerobic digestion technologies, which individually can have different costs based on the technology employed and unique performance and cost profiles. Other key assumptions include the financing approach (public or private financing), the amount of

electricity generated for sale and its sale price, the amount of compost generated and the value of the compost, and the amount of residue requiring landfill disposal. The ability to obtain grant funding can also have a measurable, positive impact on costs. ARI's estimates are provided below, as two cases which frame the overall range:

- **Case 1.** The lower end of the cost range is based on the assumption that the minus 2" fines are approximately 90% organic in content, resulting in approximately 10% residue requiring disposal. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. Compost is assumed to be generated at a rate of 30% by weight of the feedstock received for processing, and sold at a value of $5 per ton. The assumed electricity generation rate is 180 kWh/ton of feedstock. The total amount of electricity generated is assumed to be sold (i.e., with electricity purchased to meet internal project needs), at a levelized sale price of $0.142 per kWh. This assumed electricity sale price is based on a recent estimate by the municipal utility in Palo Alto for an anaerobic digestion facility feasibility study. It is inclusive of capacity payments and any and all renewable and environmental attributes, accounting for the impact of the Renewable Energy Act that was passed in April 2011. The project is assumed to be publicly financed at a debt interest rate of 5%; other financing assumptions include amortization of the debt over a 20-year project period, and application of a 15% factor for financing soft costs and reserve fund. Public financing scenarios would accommodate project delivery methods such as design-build (DB) or design-build-operate (DBO). Based on these assumptions, the estimated cost is on the order of $68 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 1, a grant of $2 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $62 per ton.

- **Case 2.** The higher end of the cost range is based on the assumption that the minus 2" fines are approximately 75% organic in content, resulting in approximately 25% residue requiring disposal and 25% compost. The residue is assumed to be disposed of at the Kirby Canyon Landfill, at a cost of $70 per ton for transport and disposal. The compost is assumed to be beneficially used, but at no net value (i.e., the compost is essentially given away or sold at a nominal price to offset the cost of transport to market). The assumed electricity generation rate is 150 kWh/ton of feedstock. The total amount of electricity generated is assumed to be sold at a levelized sale price of $0.142 per kWh (inclusive of capacity payments and any and all renewable and environmental attributes, as discussed above). The project is assumed to be privately financed and developed, with generally conservative financing assumptions (e.g., equity requirement of 30%, a return on equity of 25%, a 5.25% debt interest rate; debt service amortized over a 20-year project period; and a 15% factor for financing soft costs and reserve fund). Based on these assumptions, the estimated cost is on the order of $109 per ton. As noted above, grant funding can have a measurable, positive impact on costs. For this Case 2, a grant of $2 million, which is approximately 15% of total project planning, development and construction cost, would lower the estimated cost to approximately $96 per ton.

Summary

The waste characterization of the SMaRT Station indicates the residue remaining after recovery of recyclables and separation of the organically-rich fines fraction would be suitable for thermal processing. Based on key assumptions disclosed herein, a planning level estimated cost for a gasification facility designed to process approximately 122,000 tpy of this residue ranges from $69 (Case 1) to $133 (Case 2) per ton. The organically-rich fines fraction would be suitable for anaerobic digestion. Based on key assumptions disclosed herein, a planning level estimated cost for an anaerobic digestion facility designed to process approximately 30,000 tpy of the fines ranges from $62 (Case 1) to $96 (Case 2) per ton.

The estimated costs presented herein are based on information available from proposed projects in other California locations. The estimates, therefore, exclude any unique site-specific considerations, such as unique requirements associated with site development activities, and costs to purchase or lease land. The costs are representative of a stand-alone facility, and do not include any cost savings that could be realized from the use of existing infrastructure, including, for example, use (or partial use) of existing buildings, roadways, scalehouse, office areas, utility interconnections, and the like. A site specific analysis, beyond the scope of this study, would be required to evaluate the potential value of existing infrastructure.

Appendix E

Implementation Schedule

R3

Appendix E
Implemenation Schedule

		2012		2013		2014				2015				2016				2021		2022	
	Fiscal Year	FY 12-13				FY 13-14				FY 14-15				FY 15-16				FY 21-22			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	RESPONSIBLE ENTITY																				
CONTRACTUAL																					
SMaRT Station Agreement (Expires 12/31/14)	*Senior Management Team*											Current contract expires Dec 31, 2014									
Non-Franchised Haulers																					
Enforce Exclusive Franchise	*Senior Management Team*		X (Ongoing)																		
Permit Recycling Companies	*Senior Management Team*			X Ongoing																	
Solid Waste Collection Franchise (Expires 6/30/21)	*Senior Management Team*																				
Landfill Agreement (Expires 10/15/21)	*Senior Management Team*																				
CITY ZERO WASTE POLICY OBJECTIVES																					
1 Reduce Amount of Waste Disposed																					
SMaRT Station																					
a Improve Quality of Small Organics Fraction	*CalRecovery*																				
b Assess Potential for Additional Mixed Waste Diversion	*Recycling Mgr.* *SW Contract Administrator* *Bay Counties Waste Services*																				
Single-Family Residential																					
a Conduct residential curbside visual waste composition study	*Res Rec Coordinator*																				
b Evaluate policy options to maximize residential diversion through existing programs	*Senior Management Team*																				
c Explore cost/benefit of enhanced outreach	*Senior Management Team* *Res Rec Coordinator*																				
d Consider expanding material types collected through curbside recycling program	*Senior Management Team* *Res Rec Coordinator*																				
Multi-Family Residential																					
Assess additional diversion potential of MF yard waste collection program	*Res Rec Coordinator*																				
Commercial																					
a Visually characterize compactor waste stream. Pursue recovery where diversion potential exists.	*SW Contract Admin.* *Com Rec Coordinator*																				
b Assess additional diversion potential of Commercial yard waste collection program	*Com Rec Coordinator*																				
c Document current commercial business service levels by account	*Specialty Solid Waste and Recycling Company*	X	Update Annually																		
Construction and Demolition Debris																					
Identify and secure markets for materials that are not currently diverted	*SW Contract Admin.* *Bay Counties Waste Services*		Ongoing				Explore as requirement of New Agreement														
Other																					
a Pursue future CRV and other grant fundings	*Senior Management Team*							Ongoing as funding is available													
b Provide local no-cost low cost Pharmaceutical and Personal Care Products recycling options	*Senior Management Team Res Rec Coordinator*																				
c Develop means for gaging the effectiveness of various public education and outreach efforts and refine outreach accordingly.	*Senior Management Team*																				

Appendix E
Implemenation Schedule

		2012		2013		2014				2015				2016				2021		2022	
	Fiscal Year	FY 12-13				FY 13-14				FY 14-15				FY 15-16				FY 21-22			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	RESPONSIBLE ENTITY																				
2	**Encourage Residents and Busiensses and Agencies to Reduce, Reuse and Recycle Judisiously**																				
a	Develop enhanced outreach program																				
b	Develop Audit Protocol																				
c	Conduct Informational Audits																				
d	Coordinate with Chamber of Commerce																				
e	Conduct Zero Waste Audits / Green Business Audits																				
	All City Departments	*Recycling Manager Com Rec Coordinator*																			
	All Schools																				
	Large Venues																				
	All Commercial Businesses																X Ongoing				
3	**Empower Consumers to use their buying poer to demand non-toxic, easily reused, recycled or composted products**																				
a	Develop Residential Zero Waste "Shopping List"	*Recycling Manager Res Rec Coordinator*																			
b	Incorporate CalRecycle's Waste Reduction suggestions for specific industriles into proactive prioritized outreach to commercial sector	*Recycling Manager Com Rec Coordinator*	Ongoing in conjunction with commercial Zero Waste Audits (2a)																		
4	**Encourage manufacturers to produce and market less toxic and more durable, repairable, reusable, recycled and recyclable products**																				
a	Maintain CPSC and SCCPSC Memberships		Ongoing																		
b	Continue Lobbying Efforts	*Senior Management Team Com Rec Coordinator*	Ongoing																		
c	Actively promote existing EPR Programs		Ongoing																		
d	Encourage Local Businesses to Implement voluntary take back programs		Ongoing																		
5	**Lobby regional, state and federal legislators to implement laws, policies and regulations that promote Zero Waste**																				
a	Maintain CPSC and SCCPSC Memberships	*Senior Management Team*	Ongoing																		
b	Continue Lobbying Efforts		Ongoing																		
6	**Work locally and regionally to assist in Zero Waste planning**	*Senior Management Team*	Ongoing																		
7	**Lead by example and implement Zero Waste goals for all City buildings**																				
	Conduct Zero Waste Audits of all City Departments	*Recycling Manager Com Rec Coordinator*																			
8	**Put policies in place that favor environmentally sustainable practices**	*Senior Management Team*	In conjunction with Policy Objective #7																		
9	**Provide the community with information about Zero Waste that includes periodic reports that measure progress**	*Senior Management Team*	Ongoing																		