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A LOOK AT THE SOUTHERN CALIFORNIA CONVERSION TECHNOLOGY PROJECT

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ABSTRACT

This presentation provides an overview of conversion technologies, their potential benefits and applicability to solid waste management, and the efforts to develop conversion facilities around the country and specifically, California, including Los Angeles County's model for development. The Southern California Demonstration Project spearheaded by Los Angeles County is a unique project that proposes to develop up to four conversion technology demonstration facilities throughout Southern California, potentially the first of their kind anywhere in the U.S. These facilities will be collocated with material recovery facilities and will be designed specifically to process municipal solid waste residuals.

1. INTRODUCTION

1.1 What's the Problem?

Despite a 52 percent diversion rate, the County of Los Angeles continues to dispose of over 11 million tons of solid waste each year. Upcoming landfill closures, environmental concerns, and other solid waste issues have prompted the County to apply a diversified approach to solid waste management. In addition to expanding local capacity, seeking remote disposal capacity, and enhancing and expanding waste diversion and recycling activities, Los Angeles County has incorporated the development of conversion technologies as a means to accommodate our long-term solid waste management needs.

1.2 Introduction to Conversion Technologies

Spearheaded by Los Angeles County, the Southern California Conversion Technology Demonstration Project is a unique project that proposes to develop up to four conversion technology demonstration facilities in Southern California, potentially the first of their kind anywhere in the United States. Collocated with material recovery facilities, they will be designed specifically to process municipal solid waste (MSW) residuals. The commercialization of conversion technologies creates a realistic potential to achieve state diversion rates beyond 75 percent according to Martin [1]. Conversion technologies can revolutionize the way solid waste is managed in California, transforming waste that is currently an economic, environmental and political liability into a valuable commodity and resource.

2. WHAT ARE CONVERSION TECHNOLOGIES?

The term conversion technology refers to a variety of state of the art technologies including pyrolysis, gasification, anaerobic digestion, and ethanol fermentation, capable of converting residual solid waste into an array of high value, marketable materials and green fuels such as ethanol, biodiesel, biomethane, and hydrogen, that can produce clean, renewable energy.

Such facilities represent the most significant market opportunity for MSW to come along since passage of California's AB 939 in 1989, which requires municipalities to divert 50 percent of their waste stream from disposal. According to Public Resource Code section 40124 and the California Integrated Waste Management Board (CIWMB), "diversion" is defined as the quantity and type of solid waste material generated within a jurisdiction, which is not disposed at Board-permitted solid waste transformation and disposal facilities [2]. Jurisdictions are allowed to receive 10 percent diversion credit from transformation, which at this time only applies to existing waste-to-energy facilities. As discussed in Section 4, regulatory clarity is vital if conversion technologies are to be considered diversion thus providing another pathway for jurisdictions to meet State mandates.

Conversion technologies can also assist the state of California in meeting its Renewable Portfolio Standard (RPS) of 33 percent renewable energy consumption by 2020, which was discussed among other energy goals in the Scoping Plan adopted by the California Air Resources Board [3].

With fewer and fewer waste facilities being sited, permitted, or built locally, due to the heavily populated and urbanized landscape of Los Angeles County, many local planners, solid waste facility operators and municipalities are looking toward conversion technologies to manage residual solid waste. Approximately 130 conversion technology facilities currently process MSW in Western Europe and Japan, and have been reducing the amount of materials landfilled while generating energy and restoring valuable materials to the marketplace. However, efforts to successfully construct and operate a conversion technology facility within the United States have been delayed.

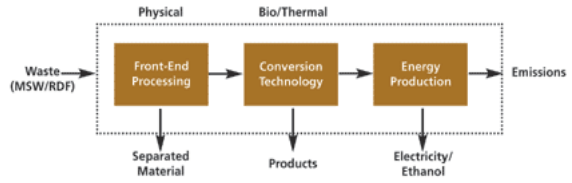
Although a wide array of diversion programs (including curbside recycling, composting, MRF sorting, and public education) have made possible considerable gains in the recovery and the beneficial reuse of resources, California still sends over half of its generated waste to disposal. According to the Biomass Collaborative, 45 million wet tons of MSW was disposed in landfills in 2006 (this includes 2.7 million tons of green waste used as alternative daily cover). The biomass component of MSW includes grass and greenwaste, paper, food waste, construction and demolition wood, and other organics excluding plastics and tires [4]. This fraction of the solid waste stream represents a significant amount of disposed recyclable material and can be a potential source of air and water contamination, creating leachate that can pollute groundwater if not managed properly as well as producing methane emissions. Conversion technologies would bypass these effects by requiring solid waste pre-processing, and removal of inert materials such as metal and glass. Because these materials cannot be utilized in the conversion process, otherwise landfilled commodities would be redirected to enhance the recycling market by extracting additional recyclables from the waste stream.

2.1 Conversion Processes Demystified

At present, conversion technologies are in varying stages of development, capitalization and commercial readiness. They range from small, modular processing units to large-scale refineries. Conversion technologies include biological processes such as aerobic and anaerobic digestion, thermal processes such as gasification, pyrolysis and plasma gasification, and chemical processes such as acid hydrolysis and distillation.

Most conversion technologies can be described as having three separate and distinct components: (1) front-end MSW preprocessing, (2) the conversion unit, and (3) the energy/chemicals production system. Front-end preprocessing is used to prepare MSW for treatment by helping to separate out any recyclables. The level of preprocessing varies depending on technology. Shredding, grinding, and/or drying the MSW may be required to create a more homogeneous feedstock for some of the thermal technologies. Alternatively, a water-based separation technique may be used in biological processes. The energy production module can be a gas turbine, boiler, or reciprocating engine for power production. Alternatively, ethanol or other chemicals could be produced. This type of system is portrayed by Predpall in Figure 1 [5].

Figure 1.



Most conversion technologies comprise these three components.

Although much attention nationwide has been centered on biotechnologies that convert cellulosic biomass, more focus is shifting toward the use of residual solid waste for various conversion processes. Unlike other sources, residual solid waste is the only feedstock that provides a steady supply of materials that can be delivered on a continuous basis with an existing collection and processing infrastructure in place [1].

2.2 Biological Conversion

Biological Conversion processes can utilize the substantial organic fraction of the MSW stream and typically involve natural metabolic functions of microorganisms (and sometimes larger organisms) that are exploited to treat the biodegradable fraction of the wastestream. “Examples of biological technologies include anaerobic digestion (similar to composting) which involves the biological conversion of biodegradable organic materials in the absence of oxygen at temperatures lower than 200°F. The process is carried out by anaerobic microorganisms that convert carbon-containing compounds to a biogas (primarily methane and carbon dioxide). The residue is a stabilized organic material that can be used as a soil amendment, and is suitable food wastes, yard wastes, animal wastes, and some paper fibers in the production of ethanol and biodiesel” [5].

2.3 Thermal Conversion

Thermal technologies differ from biological technologies by involving the thermal breakdown of solid materials into a gaseous constituent (often called *syngas*), and in some cases, a solid char residue and/or liquid (oil). The processed energy is provided in a reactor, either in the presence of some oxygen (gasification) or in the absence of oxygen (pyrolysis). Some technologies utilize both methods. "An advantage of these technologies is that the syngas produced can be utilized in boilers or low-profile reciprocating engines for generating electricity more cleanly and efficiently than conventional incinerators" [5]. Gasification, for example, is developed in the presence of heat at temperatures typically above 700°C and in a limited supply of oxygen to produce a syngas composed primarily of hydrogen and carbon monoxide, with inorganic materials converted to a solid, vitreous slag. According to the EPA:

> There are generally no direct emissions to the atmosphere from a gasification system. Emissions to the atmosphere from gasification activities are nearly always the result of using the synthesis gas as a fuel for the production of power or heat generation… [M]etal and chlorine emissions from the combustion of synthesis gas depend on the composition of the synthesis gas, which is dependent on the effectiveness of the synthesis gas cleanup system [6].

The syngas generated can be utilized in boilers, gas turbines, or internal-combustion engines to create electricity or be further processed into organic chemicals. Pyrolysis, another type of thermal conversion technology, uses an indirect, external source of heat typically at temperatures greater than 925°F, in the absence or near complete absence of oxygen, to produce pyrolysis char, pyrolysis oil, and a syngas composed primarily of hydrogen, carbon monoxide, carbon dioxide, methane, and complex hydrocarbons. Plasma gasification differs from both gasification and pyrolysis by utilizing AC and/or DC electricity passed through graphite or carbon electrodes, with steam and/or oxygen/air injection, to produce an electrically conducting gas (a plasma) typically at greater than 7,000°F that converts organic materials, including tars, oils, and char, to a syngas composed primarily of hydrogen and carbon monoxide [5].

2.4 Dispelling Misconceptions

Recent California studies have concluded that conversion technologies can potentially produce more energy than landfilling and transformation, emit lower emissions of criteria air pollutants (including NO_x and SO_x) than from either landfilling or incineration, and increase recycling rates for glass, metal, and plastic due to the preprocessing required prior to conversion.

In their February 2008 Final Report, the Economic and Technology Advancement Advisory Committee [7] estimated conversion technologies have the potential to reduce greenhouse gas emissions by 0.5MMT- 4.7MMT assuming implementation ramps up from 10 percent by 2012 to 100 percent by 2050. These estimates are based solely on production of electricity, and do not include greenhouse gas reductions from reduced truck traffic or the avoidance of landfill disposal.

Unfortunately, opponents of conversion technologies sometimes misconstrue scientific studies, and have used extreme hyperbole in an effort to create fear regarding these relatively unknown yet largely benign processes. For instance, opponents of conversion have compared it to nuclear power plants and waste incinerators attempting to associate these new technologies with very different technologies that are politically unpopular.

The disconnection between nuclear power and conversion technologies couldn't be vaster. Even though they share a similar potential feedstock, conversion technologies differ greatly from direct combustion of solid waste (a.k.a. incineration). Assertions comparing the two technologies are based on a naïve understanding of the true nature of conversion, or are an effort to delay development of conversion technology by associating it with incineration, which despite significant advances in pollution control, are still strongly opposed by the public. Thermal conversion, such as pyrolysis and gasification, does not involve combustion and has a much cleaner and more manageable air emissions profiles. While incineration requires more oxygen to burn MSW (creating carbon dioxide as a waste gas that must be exhausted through a tall stack), pyrolysis and gasification both produce a syngas product, which has many further uses. Studies developed by the California Integrated Waste Management Board in conjunction with the Universities of California at Riverside and Davis have shown the lifecycle benefits of conversion technologies are far superior to landfilling and incineration as solid waste management options, and even fare well against composting and recycling in terms of potential resource utilization. The County is confident that when the benefits and impacts are analyzed on a life-cycle, scientific basis, conversion will be proven as a reliable, economical, and environmentally beneficial solid waste management option. To that end, the County has embarked on an effort to be among the first jurisdictions in the country to demonstrate the feasibility of utilizing conversion technologies to transform MSW into useful products, green fuels and energy.

3. THE COUNTY'S APPROACH

Los Angeles County, the most populous County in the United States understandably has the largest and most complex solid waste management system in California. Comprised of 88 cities and County unincorporated areas, it requires effective and responsible planning to protect the health, safety, and the local environment of its estimated 10 million residents. The residents and businesses of Los Angeles County dispose of approximately 11 million tons of trash each year. Like many other municipalities, the County is working to address this challenge of how to manage the portions of their municipal solid waste stream that cannot be diverted from landfills.

3.1 History of Conversion in the County of Los Angeles

For nearly a decade, Los Angeles County has been a consistent supporter of conversion technologies because of their numerous environmental benefits. On July 27, 1999, the Los Angeles County Board of Supervisors formally adopted a series of recommendations that included support for the development of conversion technologies as an alternative to landfilling and incineration. Since then, the County has promoted Conversion Technologies in numerous ways including: securing funding for research; developing the Alternative Technology Advisory Subcommittee; supporting legislation seeking to advance the understanding of conversion within the state; and working with members of the CIWMB and other stakeholders to evaluate and promote conversion technologies.

The Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force is responsible for coordinating the development of all major solid waste planning documents prepared for the County of Los Angeles and its 88 cities. As an outgrowth of its commitment to conversion technologies, the Task Force established the Alternative Technology Advisory Subcommittee in 2004. The Subcommittee is comprised of a diverse group of professionals including representatives from local government, the CIWMB, facility operators, consultants and experts in the field of conversion technologies. Ultimately, the Subcommittee in coordination with the County would like to see the development of commercial-scale conversion technology facilities processing MSW, and believe that one or more demonstration facilities are the pathway achieving that goal. Implementation has taken a phased approach.

3.2 Phase I - Initial Technology Evaluation

Beginning in 2004, Public Works conducted a preliminary evaluation of a range of conversion technology suppliers, and initiated efforts to identify material recovery facilities and transfer stations in Southern California that could potentially host a conversion technology facility.

Technology suppliers were ranked and screened based on the goals of the Subcommittee, including maximizing diversion of solid waste from the landfill, and technical and economic capabilities to develop a facility in Southern California. The top ranking technologies included pyrolysis, gasification, plasma gasification and thermal depolymerization for thermal conversion; anaerobic digestion and gasification with fermentation to ethanol for biological/chemical conversion processes.

The County decided to proceed with conversion technology supplier – MRF/TS partnerships only in order to ensure a dedicated feedstock of preprocessed material that was otherwise destined for transformation and landfill disposal. Unlike other sources, residual solid waste is the only feedstock that provides a steady supply of materials that can be delivered on a continuous basis with an existing collection and processing infrastructure in place. Thus co-locating a conversion technology with a MRF would create a synergy that decreases transportation costs, provides continuous feedstock, and diverts material away from disposal.

This extensive research resulted in the County's *Conversion Technology Evaluation Report*, which was officially adopted by the Task Force in August 2005. This report identified a preliminary short list of technology suppliers and MRF/TS sites, along with a framework for development of a demonstration facility at one of these sites.

3.3 Phase II— Detailed Evaluation and Vetting Efforts towards Facilitation of One or More Demonstration Facilities

Phase II represents the County's continued efforts to facilitate development of a conversion technology demonstration facility in Southern California, including over a year of work by the County, the Subcommittee, and its technical consultants. Key Phase II activities included:

- an independent evaluation and verification of the qualifications of selected technology suppliers and the capabilities of their conversion technologies;
- an independent evaluation of candidate MRF/TS sites to determine suitability for integration with one or more technologies
- a review of permitting pathways;
- identification of funding opportunities and financing mechanisms;

- identification of potential County incentives (i.e. supporting benefits) to encourage facility development amongst potential project sponsors;

These activities are described in detail in the *Conversion Technology Evaluation Report: Phase II Assessment* adopted in October 2007. The Report summarized that tip fees needed to support a conversion technology project in the Los Angeles area may range from approximately $50 to $70 per ton. These tip fees compare favorably with projected costs for haul and disposal in the immediate future, and are expected to be cost competitive with landfill disposal within 5-10 years as Puente Hills Landfill, closes.

Phase II identified four technology suppliers that have demonstrated the technical capabilities of their respective processes. Additionally four of the MRF/TSs sites evaluated were determined suitable for co-location with a conversion technology. County engineers, technical staff, and Subcommittee members personally visited an operating facility for each company on the short list. The following are the four technology suppliers continuing in the County's process:

- *Arrow Ecology and Engineering* - Operating anaerobic digestion facilities in Israel and Australia that process municipal solid waste
- *International Environmental Solutions* - Operating a pyrolysis facility in Romoland, California that utilizes post-recycled residual solid waste
- *Interstate Waste Technologies* - Operating gasification/pyrolysis facilities in Japan that process municipal solid waste
- *Entech* - Operating gasification facilities in Poland, England and Malaysia that process municipal solid waste, medical waste and mixed plastics

On January 17, 2008, a Request for Offers (RFO) was released to those technology suppliers and MRF/TS owners/operators vetted through the Phase II process. All shortlisted companies have submitted proposals and following a formal review process, the County will recommend one or more projects to the Board of Supervisors for approval.

3.4 Phase III/IV— Long Term Development of Conversion Technologies

The County has issued a Request for Proposals for technical consultant services to assist with the Phase III and Phase IV processes. Phase III will commence when the County's Board of Supervisors decides on which projects to pursue as well as which consultant will provide technical assistance. Phase III will build upon the efforts begun in Phase II by seeing through to completion the permitting process, design, construction, and operation of one or more demonstration facilities .

Whereas Phase III focuses on development of a demonstration facility in Southern California, Phase IV will pursue the siting of commercial scale conversion technology facilities in Los Angeles County capable of managing a portion of the County's wastestream. Due to the lag time between Phase I and Phase IV, the County will also reevaluate the conversion technology marketplace to validate the four recommended technologies in addition to investigating the progress and development of other technology suppliers.

Phase IV will also work to partner with local cities interested in siting a facility. In advance of Phase IV, four cities have already adopted resolutions expressing interest in partnering with the County: Calabasas; Glendale; Lancaster; and Long Beach; representatives from other cities have also expressed interest.

4. CALIFORNIA REGULATORY SYSTEM

Although various overseas governments employ conversion technologies as part of their hierarchy of waste management, the environment that would allow these technologies to flourish in California has been stifled by various constraints posed by law.

In order for the County's project and other similar endeavors to be successfully pursued within the state, it is essential for the CIWMB, California Energy Commission, and other relevant agencies to remove regulatory barriers. Many potential investors have expressed hesitation in investing in conversion technologies in California due to current regulatory uncertainty. This regulatory uncertainty is potentially more important for development of these advanced technologies than financial incentives. Specifically, there is a need for clarity regarding:

- *Definitions of what constitutes conversion technology* –PRC Section 40201 (definition of transformation) includes pyrolysis, distillation, biological conversion in the same category as incineration of MSW. None of these terms are well defined, leading to confusion since various thermal, chemical and biological conversion technologies may or may not fall under this definition. This is significant because a technology that is statutorily defined as "transformation" is considered a solid waste disposal facility and is subject to onerous permitting requirements at the State and local level, as well as significant regulatory disincentives.

- *Correction of technically inaccurate definitions* – PRC Section 40117 improperly defines gasification as a process that uses no air or oxygen in the conversion process. It also includes several unprecedented and overly restrictive requirements on such technologies, including prohibiting the facility from producing any (1) discharges of air contaminants or emissions; (2) discharges to surface or groundwaters of the state; or (3) hazardous waste. The statute even arbitrarily restricts the geographic origin of the waste feedstock the facility can accept.
    - Unfortunately, the same technically inaccurate definition of gasification, with the same burdensome restrictions, is included in PRC Section 25741, which forms the basis for the RPS guidebook definition of "solid waste conversion".
    - This is the only type of process utilizing MSW as a feedstock that is specifically listed as eligible for renewable energy (MSW combustion is limited to grandfathered facilities)
- *Clarity regarding definition of biomass* – Under the definition of biomass, (established in the Overall Renewable Energy Program Guidebook), MSW is neither specifically included nor excluded. Since a substantial portion of MSW is made up of "organic material not derived from fossil fuels", it should be possible for conversion technology facilities to be designated as renewable energy should they consider the biomass fraction of the feedstock they process.

Lacking legislative clarity, the California Integrated Waste Management Board [8] developed a "Guidance Document" entitled *How Conversion Technologies Fit Current Board Regulatory Structure*. This guidance document identifies how the CIWMB would permit a facility based on the technology utilized, but more importantly, clarified what effect the feedstock utilized would have with regards to the way a facility might be permitted. Specifically, the CIWMB resolved that a conversion technology facility would be exempt from CIWMB permitting regulations if the facility meets the following 3-Part Test: (1) the site must be receiving material that has been source separated (by the generator) or separated for reuse (at a centralized facility – such as a MRF) prior to receipt at the site; (2) less than 1% of the material must be putrescible and not causing a nuisance; and, (3) less than 10% of the residual leaving the site is being sent to disposal.

If California hopes to successfully lure investment in green technologies, such regulatory clarity is vital so that companies wishing to develop facilities have an estimate of the feasibility and level of effort needed to successfully permit such a facility. The term "biomass" (for the purpose of determining eligibility for renewable energy/fuel designation), must be expanded to include MSW-derived organic materials which the CIWMB has designated are no longer waste materials.

4.1 Conversion Technologies Can Aid In Meeting State's Environmental Goals

With the passage of the Global Warming Solutions Act of 2006 (AB 32), and the subsequent approval of the Air Resources Board Scoping Plan, the State of California is on the road to reducing our carbon footprint and expanding our green economy. The County's proposed conversion technology demonstration facilities will aid the State in meeting many sustainability goals including limiting MSW landfill disposal, increasing local green-collar jobs, increasing local production of biofuels and renewable electricity, and reducing our dependence on foreign oil. Conversion technologies can help California achieve a number of statewide environmental goals, including:

AB 32/Climate Change – conversion technologies can significantly reduce GHG emissions;

Renewable Portfolio Standard – conversion technologies can increase in-State production of renewable energy;

Alternative Fuels/Low Carbon Fuel Standard – conversion technologies can increase in-State production of low carbon fuels;

Bioenergy Action Plan Goals – conversion technologies can significantly enhance our beneficial utilization of California's rich biomass resources in an environmentally friendly manner;

Energy Security/Independence – conversion technologies can diversify our energy supply from in-State sources, thereby reducing dependence on imported energy sources;

Hydrogen Highway – conversion technologies can not only be a sustainable source of hydrogen, but can generate it where potential demand is highest, thereby reducing transportation costs;

AB 939 / Solid Waste Disposal Capacity and Landfill Reduction – conversion technologies can significantly reduce the amount of MSW we send to landfills, and also give us the opportunity to adjust to fluctuating markets for recyclable materials;

Economic Investment and Job Creation – conversion technologies can create high quality

jobs (with good pay and benefits) in the construction and operation of facilities;
Because conversion technologies have the ability to produce transportation-grade fuels through a cleaning and refining of the syngas or biogas produced, they are a viable way to achieve California's alternative fuel goals such as Low Carbon Fuel Standard and Bioenergy Action Plans, allowing California to improve its energy independence while improving the environment.

5. CONCLUSION

Addressing conversion technologies requires lawmakers and the public to realistically analyze the net impacts of all waste management options, so that conversion technology can be examined in relation to other forms of waste management, including recycling and composting. Every year California landfills upwards of 40 million tons of trash, the majority of which is composed of economically unrecyclable material that could be put to better use. By continuing to landfill such large amounts of material, jurisdictions throw away a valuable resource which can be used to further save landfill space, reduce greenhouse gases, generate valuable products, electricity and green fuels, and help to create a less polluted, more sustainable world where plastic and unwanted material has a new life in preserving our children's future. The Southern California Conversion Technology Project will be a significant advance in demonstrating conversion of MSW, and a step toward a day when economics, sustainability, and environmental quality will be the driving factor in bringing us closer toward attaining a zero waste goal.

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