

Why 'Conversion Technologies' is a misleading term

Briefing Paper on 'Conversion Technologies' & Municipal Discards

Many in the recycling field have heard the term "conversion technologies" bandied about in the past few years by industry and the California Integrated Waste Management Board (CIWMB). Here are a few tips for navigating the technical jargon:

- The term "conversion technologies" refers to a wide array of very different technologies that claim to turn garbage or separated components into energy, fuels, and some other products.
- Some technologies dispose of garbage to air by heating mixed garbage or plastics at high temperatures, like gasification, pyrolysis and plasma. These are considered by some to be "incinerators in disguise" due to similarities in operating systems, toxic emissions and energy usage.
- Others of these technologies employ chemical and biological decomposition approaches. Anaerobic digestion is a form of composting.
- There is a range of materials being targeted for these various technologies, i.e. source-separated organics, mixed plastics, mixed garbage. Specifying discarded materials desired for each proposal is critical.
- While some of these currently treat other materials in the U.S., there are no existing U.S. commercial operations to dispose of mixed garbage.

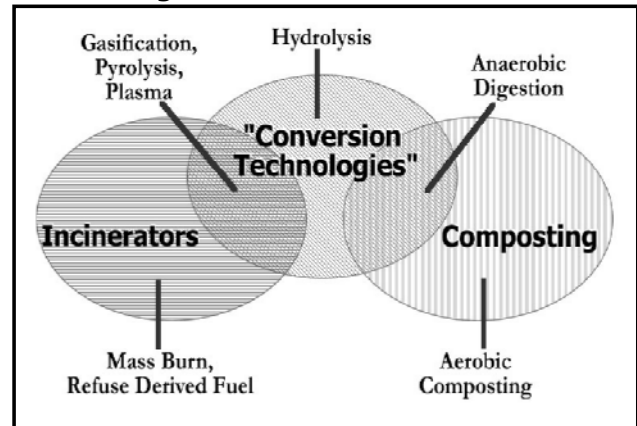
With such an array of temperatures and feedstocks, these technologies cannot be effectively addressed under one umbrella. Instead we recommend talking about specific technologies and desired discarded materials.

This briefing paper looks at gasification, pyrolysis, plasma, hydrolysis, and anaerobic digestion individually. The term "conversion technology" only refers to CIWMB research and regulatory efforts.

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Orwellian language: why "Conversion Technologies" is a misleading term



Hydrolysis

Hydrolysis uses acid or enzymatic processes to split chemical bonds. Resulting sugars can be fermented to make ethanol for fuel, and acids for industrial uses. Current proponents appear to desire only source separated green discards for this technology.

Industry claims: Many companies claim to process source separated green wastes. One claims to have "no waste streams."ⁱ A few claim to treat mixed garbageⁱⁱ and a different company says it "transforms MSW [municipal solid waste], wastewater and sewage sludge..."ⁱⁱⁱ

Concerns: Ethanol production may create volatile organic compounds (VOCs). Acid hydrolysis of mixed garbage may not work well because of toxic substances in the mix.^{iv}

Anaerobic Digestion

Anaerobic digestion is bacterial decomposition of organic materials without oxygen to produce gas, which can be combusted for energy.

Industry Claims: Most companies claim to process separated organics. Others claim to process mixed garbage into "high quality compost"^v in addition to gas.

Concerns: If compost is a desired output, contamination from plastics, glass, and other inorganics could be problematic if organics are not source separated. Systems need additional compost processing to create marketable compost. If a system processes mixed garbage, the resulting solids will be contaminated with plastics and other undesirable materials.

Gasification, Pyrolysis, Plasma: high temperature technologies

Technology description and claims

Gasification is heating of garbage with amounts of air or oxygen added. This creates a gas that the industry calls “syngas” to be combusted as fuel, as well as liquid and solid residues.

Industry Claims: Industry representatives convinced the California legislature during drafting of AB2770 that gasification would produce no discharges of air contaminants or emissions, and no hazardous waste.^{vi} One company claims to “process all types of waste,”^{vii} another claims it will increase recycling of glass and metals,^{viii} another claims to “transform your [municipal] waste into clean energy.”^{ix}

Pyrolysis is heating of garbage without additional oxygen. This creates gas and oils, and solid residues, which may be combusted as fuel.

Industry Claims: One company claims its technology has “no emissions”^x and that a major output is carbon black. Another claims to use a pyrolysis process called “catalytic cracking” to create diesel fuel from mixed waste plastics including PVC,^{xi} and a different company claims to make “high energy gas” from mixed municipal garbage.^{xii}

Plasma processes expose garbage to very high temperatures produced by a plasma-arc torch to create a gas that can be combusted for fuel. Other byproducts include slag.

Industry Claims: One company claims its process can “handle any waste,”^{xiii} and another claims to be able to process a “wide variety of waste streams, including hazardous, medical, radioactive, industrial, municipal and tire wastes” into “ultra-clean power generation using the hydrogen-rich gas.”^{xiv}

Some companies describe their technologies as combinations of the above, such as “plasma pyrolysis” and “pyrolytic gasification.”

Disposal to air means still no “away”

Although the volume of garbage appears to be greatly reduced by gasification and incineration, no technology can make anything actually disappear. Mass can neither be created nor destroyed, only changed.* *Solid materials entering a facility will have the same mass as the gas, smoke, and liquid and solid wastes that leave the facility.* Masses of gases and small particulates will go up the stack, toxic ashes and solid wastes will need to go to landfill, and liquid wastes will also need to be managed.

*Encyclopedia Britannica, www.britannica.com/eb/article?tocId=49377

Technology	Materials from municipal discard stream	Major outputs	Pollutants of concern	Temperature ranges – initial stage
Gasification	Mixed garbage	Gas, Liquids, Solids	Dioxin, heavy metals, others	932–1472° F
Pyrolysis	Mixed garbage, tires	Gas, Liquids, Solids	Dioxin, heavy metals, others	300-2192° F
Plasma	Mixed garbage, tires	Gas, Solids	Dioxin, heavy metals, others	1700-2200° F
Catalytic Cracking	Plastics	Gas, Solids Liquids,	Dioxin, heavy metals, others	550-800° F
Hydrolysis/ Fermentation	Biodegradables (green debris)	Ethanol, Chemicals Lignin solids	NOx, ammonia, others	Up to 450° F
Anaerobic Digestion	Biodegradables (food, green debris)	Gas Soil amendment	NOx, ammonia, others	50-160° F

Temperature ranges from scientific literature, vendors, CIWMB reports. Different vendors give varying temperature ranges.^{xv}

Concerns about high temperature technologies

When the California legislature passed AB2770 in 2001 to fund research about these technologies, it was clearly interested in non-polluting technologies. But gasification, pyrolysis and plasma are not pollution-free. Industry is now attempting to change California’s existing definition of gasification (which requires no emissions or hazardous wastes) to allow emissions. If the legislation is not changed, it could possibly prevent garbage gasification projects.

All proposed projects involve the combustion of gas created from heating garbage, resulting in the release of the same polluting combustion byproducts as standard incinerators. Studies in scientific journals show pollutants in solid and liquid residues, in addition to air emissions.^{xvi} Some company websites have pollution data.^{xvii} There are also many expected emissions for which companies do not provide data, such as brominated flame retardants.

The financial, technical, and energy feasibility of these high-temperature facilities for garbage is in question. Two of the most aggressive companies, Brightstar and Thermosteel, closed gasification facilities after only a few years of operation (in Australia and Germany respectively). We are not aware of any commercial-scale facilities treating garbage in the U.S; most facilities in operation are in Japan. These technologies require a great deal of energy to operate, and in some cases need more energy to operate than they can produce. Like existing garbage incinerators and landfills, the energy savings from recycling is greater than the energy produced by these facilities.

For more information about concerns with gasification, pyrolysis and plasma disposal of MSW, please visit www.ncrarecycles.org

Gasification, Pyrolysis, Plasma: high temperature technologies

The big picture

Even if gasification, pyrolysis, and plasma arc could be made safe, the question remains: could they be made sensible? Like incineration and landfilling, these approaches lead to exploiting more virgin resources, rather than resource conservation. Nearly 80% of materials disposed in California landfills is organic, including paper, wood, green waste, and food waste. Instead of continually seeking out more and more “back end” technologies, California could be implementing innovative strategies for capturing those organic materials and returning them to production cycles, as well as increased waste prevention.

What’s happening in California?

- After Hanford, CA residents raised concerns about a planned “catalytic cracking” pyrolysis facility for mixed discarded plastics, the facility’s permits were rescinded by the regional air pollution agency in August 2004. The company apparently never provided emissions data to acquire permits, and refused to provide emissions data to the public.
- After a two-year \$500,000 study of garbage gasification as a local energy source, members of the city of Alameda’s Public Utilities Board unanimously rejected gasification in late 2004.
- In 2003, Chowchilla, CA nearly granted North American Power Company a permit for a pyrolysis medical waste treatment facility. The company claimed to have no emissions but never provided data. Residents convinced the city to ask for data, but the company disappeared from Chowchilla without providing evidence for its claims.
- Other cities are still considering these incinerators in disguise, including Los Angeles, Santa Barbara, and Santa Cruz.

In March 2005 the CIWMB finalized a report for the CA legislature on “conversion technologies” including anaerobic digestion and hydrolysis. The report

- only examines mixed garbage, not separated organic discards
- contradicts existing studies regarding energy and emissions savings of recycling compared to burning
- downplays public health concerns about pollutants
- cites existing overseas facilities but does not mention severe problems at the two largest facilities listed, including closure and financial insolvency.

The term “conversion technologies” means different things within the CIWMB as well: the board’s draft “conversion technologies” regulations would not apply

to anaerobic digestion. The CIWMB’s report and draft regulations can be found on its website.

There are three pieces of pending California legislation that could undermine recycling and composting:

- AB 1090 (Matthews) would provide unlimited diversion for “conversion technologies” and places them on equal ground with composting and recycling in the state waste hierarchy.
- AB 727 (Bermudez) would move “conversion technologies” up in the hierarchy above direct combustion but below composting and recycling.
- AB 177 (Bogh) would provide unlimited diversion credit for incineration and “conversion technologies” and redefine “biomass” to all organics, including plastics.

What do we need to know about dioxins?

In incinerators (including gasification, pyrolysis and plasma incinerators), poisons called dioxins are formed when wastes containing chlorine (such as PVC) are exposed to high heat or catalysis in the presence of organic material.^{xviii} The EPA classifies dioxins as known carcinogens. Unlike some other poisons, there is no minimum level below which dioxin is safe.^{xix} The average daily dioxin intake of the American public exceeds federal exposure guidelines.^{xx}

ⁱ<http://www.arkenol.com/Arkenol%20Inc/tech01.html>

ⁱⁱ<http://www.westbioenergy.org/dec2003/02.htm>

ⁱⁱⁱ <http://www.masada.com/mocopro.html>

^{iv} Green, M., Shelef, G., 1989, Ethanol fermentation of acid hydrolysate of municipal solid waste. *Chem Eng Journal*, Volume 40, Issue 3, April 1989.

^v<http://www.canadacomposting.com>

^{vi} Text of this bill is available at http://www.leginfo.ca.gov/pub/01-02/bill/asm/ab_2751-2800/ab_2770_bill_20020920_chaptered.pdf

^{vii} <http://www.interstatewastetechnologies.com/benefits.htm>

^{viii} <http://www.brightstarensvironmental.com/html/Swerf.htm>

^{ix} http://www.downstreamsystems.com/downstreamsystems_wo_mtls003.htm

^x <http://www.napower.com/NAPCIntro4.03.pdf>

^{xi} *Plastics News*, “Ca. firm to make fuel from recycled resin,” May 24, 2004.

^{xii} http://www.gem-ltd.co.uk/gen_proc.htm

^{xiii} <http://www.usplasma.com/technology.htm#Plasma%20Gasification%20-%20the%20Basic%20Process>

^{xiv} <http://www.inentec.com/pemprocess.html>

^{xv} Table Sources: Buekens, G., Huang, H., 1998. Catalytic plastics cracking for recovery of gasoline-range hydrocarbons from municipal plastic wastes. *Resources, Conservation and Recycling* Volume 23, Issue 3: 163-181; Malkow, Thomas, 2004. Novel and innovative pyrolysis and gasification technologies for energy efficient and environmentally sound MSW disposal. *Waste Mgmt*, Volume 24: 53-79; Porteous, A., 2001. Energy from waste incineration. *Applied Energy* 70: 157-167; CIWMB, www.ciwmb.ca.gov

^{xvi} Studies include: Porteous, A., 2001 (see table sources); Weber, R., Sakurai, T., 2001. Formation characteristics of PCDD and PCDF during pyrolysis processes. *Chemosphere* 45: 1111-1117.

^{xvii} <http://www.brightstarensvironmental.com/html/env.htm>

^{xviii} *The American People’s Dioxin Report, Technical Support Document*, Center for Health, Environment and Justice, page 11, 1999. <http://www.safealternatives.org/report.html>

^{xix} No evidence of dioxin cancer threshold. *Environmental Health Perspectives*, 2003;111(9):1145-1147.

^{xx} *The American People’s Dioxin Report*, page 10.

"Great, Green, Garbage-Eating Machine"

Local Governments Ask Vendors Some Questions

Are you being courted by a vendor claiming to create "energy from waste" or fuel from mixed garbage or municipal discards? These questions should help you get information that the vendor may not be upfront in providing.

Questions to ask all companies

- ✓ What is the name of this process, and how does it work?
- ✓ Do you have a facility like this in operation already? If so, where? Is this a research facility or a commercial facility?
- ✓ Do you have photos and diagrams?
- ✓ Would you require a put or pay contract?

Questions to ask anaerobic digestion or hydrolysis/fermentation companies

- ✓ What are the inputs to this process? Does it require a highly source-separated feedstock? Do you want mixed garbage?
- ✓ What pre-processing is performed to ensure the quality of the finished product?
- ✓ What are the by-products of the process? Are there any by-products that cannot be beneficially reused?
- ✓ What information about releases and emissions can you provide?
- ✓ Additional anaerobic digestion question: Are all components marketable as soil amendment or must they be processed further through composting or another method?



Questions to ask gasification, pyrolysis, and plasma companies

- ✓ What are the outputs and wastes created by this process?
- ✓ Do you have data about emissions to air as well as liquid and solid releases from all processing stages, including combustion of gases/fuels? Under what conditions were data obtained: test conditions or standard operating conditions? Are these from a research facility or a commercial facility?
- ✓ Do you have any data from operations during upset conditions and during start up and shut down of the facility?
- ✓ What are the waste streams to be treated with this process?
- ✓ If you have a plan to avoid all PVC, what is it? (High temperature treatment of PVC can create dioxins)
- ✓ How much energy would be required to heat the garbage? How much energy will be produced?
- ✓ What would happen in the facility if not enough waste were available to be processed? Will it be forced to shut down temporarily? How frequently might this happen?
- ✓ What kind of water treatment system would you have?
- ✓ Would solid wastes from the process be classified as hazardous waste? How would these wastes be disposed of?

The Northern California Recycling Assoc. (NCRA) prepared this Briefing Paper on "Conversion Technologies and Municipal Discards" in April 2005 for educational purposes. Monica Wilson and the "Conversion Technologies" Issues Committee compiled much of the information. NCRA looks forward to updating this Paper as pertinent data arises. Parts or all of this Paper may be cited so long as proper attribution is given to appropriate sources. For more information, contact NCRA (www.ncrarecycles.org) or mwilson@no-burn.org