AB 32 AND THE WASTE MANAGEMENT SECTOR

California Recycling's Place in Greenhouse Gas Reduction

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Introduction

California's waste and air quality agencies, the California Department of Resources Recycling and Recovery (CalRecycle) and the California Air Resources Board (CARB), are collaborating on two significant pieces of environment law. One is a required 2013 update to the Scoping Plan of Global Warming Act Solutions Act of 2006, Assembly Bill (AB) 32, and the other is the AB 341 "Mandatory Commercial Recycling" implementation plan. Collaboration between agency staff has produced a series of Technical Papers, all available on-line and the subject of repeated stakeholder workshops. The agencies are rolling out a complex and crucial suite of multi-agency regulations and policies that are already having a profound impact on our state's social, environmental, and economic well-being.

This narrative is intended to explore the laws, regulations, and policies at the nexus of waste and air quality, at a moment when our oversight agencies are struggling with these issues and asking for stakeholder input. We provide a singular perspective, seeking a pathway through a virtual tangle of agency interpretations and policies while always returning to the underlying "letter of the law." This process of teasing apart the current status is necessary to establish a defensible oversight of California's waste management sector while facilitating its AB 32 greenhouse gas (GHG) reduction goals.

When Laws Collide

AB 32 crosses agency lines of purview, requiring each emissions-generating sector to find ways to reduce GHG emissions. the Waste Management Sector certainly provides ample opportunity for improvement. It requires a degree of coordination between laws, regulations, and policies to a degree seldom attempted by the state's regulatory bodies. The relationship between the AB 32 Scoping Plan revision, AB 341 implementation, the California Low Carbon Fuel Standard (LCFS) and the Cap and Trade program is indeed complex. When waste management and air quality standards collide, the underlying tenants provide a check-and-balance mechanism allowing us to test the validity of policies. Current "business as usual" practices do not pass the test:

- The legal definition of Recycling in California Public Resources Code (PRC) §40180 clearly identifies the steps necessary to complete the process of recycling: if a material sourced from waste is collected, sorted, cleaned, treated, and reconstituted into a raw material ready for reuse or remanufacturing, that material has been "recycled". Upon completion of this defined process, the material is removed from the legal onus of being considered a "waste" under state law. If no documentation is required by the regulators to prove where segregated materials have gone and that the recycling process has been completed, the material has not been "recycled" in accordance with California law.

- AB 341 requires Commercial Waste Generators (businesses, agencies, and multi-family residential) to "arrange for recycling services", presupposing that the outcome will actually be recycling as defined by code. Since no recycling process end-point can be proven in California's recycling industry, AB 341 requires commercial waste generators to adopt a deficient system with no assurance that the legally mandated outcome will result.

- PRC §40180 is a *technology neutral* statute defining the recycling process. The code does not state *how* the last step, "reconstituting", is to be accomplished, only that the result meets market specifications for remanufacturing. The lack of in-state examples of reconstituting approaches found in use globally does not justify placing artificial restrictions on the types of technologies that can be cleanly and economically deployed to expand California's legal recycling infrastructure.

- The reduction of GHG emissions mandated by AB 32 requires application of Life Cycle Assessment (LCA) methods using either direct documentation or demonstrably accurate modeling to judge which pathways provide the best hope of meeting GHG reduction goals. If emissions data are not available and/or cannot be defensibly extrapolated for *each step in a pathway*, LCA cannot be performed. When the Waste Management Sector collects, sorts, cleans, treats, and reconstitutes a material to accomplish recycling, GHGs generated for each step along the recycling pathway needs to be identified to meet the standards pertinent to updating the AB 32 Scoping Plan.

GHG Targets for the Waste Management Sector

California's intention is to develop "low-carbon, economically sustainable industries, technologies, and strategies that align with the state's long-term and integrated energy, waste, and environmental policy objectives." This is the ultimate metric against which to measure state implementation methods and policies for the Waste Management Sector. Moreover, these same goals reflect a global Circular Economy imperative to "close the loop" in waste management.

It is generally known how much of what waste is diverted from or disposed to landfills, yet less attention has been paid to how it gets from source to destination. For recyclable materials or "recyclates", the modes and distances of transport to reach destinations are even less clear. That reconstituting facility at recycling's end-point is too often out of state, or out of country. An LCA basis can clarify optimal pathways between waste generation through recyclate reprocessing, but must have reliable data and may require some form of manifest to be prepared and submitted to the state. Localization will drive down transport distances and incrementally reduce GHGs, but has to be measured against the current status quo. This management process can spur infrastructure investment by identifying local areas of specific recyclate abundance that lack sufficient reprocessing capacity and diversity. Repeated LCA tracking by state agency oversight constitutes a wise and appropriate use of funds.

Understanding the Recycling Pathway

Attention to terms helps: a recyclate is a material segregated from the waste stream for the purpose of recycling. Recyclates are materials that are at least *assumed* to be recyclable. To reconstitute a recyclate as the law requires for completion of the process is to "build up again from parts; reconstruct; to change the form, character, function or organization." California's recycling statute is *technology neutral*. It does not specify *how* reconstituting is to occur. PRC §40180 states:

> "Recycle" or "recycling" means the process of collecting, sorting, cleansing, treating, and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace. "Recycling" does not include transformation, as defined in Section 40201.

Is a *recyclate* a *waste*? After all, it was a waste before it was segregated from the waste stream to be recycled. This point in the law is confusing, but a strict reading of the code would indicate that a material's legal status changes once it has been reconstituted at the end of the recycling pathway. At this point, it has effectively been removed from the legally defined "waste" category. Whatever percentage of that recyclate that can be reconstituted into market-ready raw material becomes a "non-waste", while whatever residual generated from that last step remains *waste* to be either discarded or once again segregated for further recovery by the reconstituting facility. This iterative generation and reprocessing of discards is an underpinning of the "cradle to cradle" concept of a Circular Economy, and should be promoted.

At present, there is no requirement for documentation that tracks where recyclates go. Once they are sorted, measured, and the "recycled" bill sent to CalRecycle for payment, the trail ends. Without some form of manifest, there can be no proof that the legal process of recycling has actually been completed. We believe such tracking documentation should be submitted by waste management services operating as "recyclers", and certainly by *all* those intending to provide recycling services to Commercial Waste Generators in compliance with AB 341. For the state to not require proof of completion from recyclers, yet

require Commercial Waste Generators to *use* such services is to open the state to legal challenge, and may place waste generators in a very untenable risk position for their own enterprises.

Not all of the recyclable tonnage brokered as recycled can actually be recovered as raw material and made ready for remanufacturing: paper gets soiled and its fibers wear out; some kinds of plastic are not suited for type-to-type recycling; toxic cleaning products become mixed with food waste. If one hundred tons of "recyclates" are brokered from a materials recovery facility (MRF) to a reconstituting facility, and only 90 tons are actually reconstituted, then the amount recycled is 90 tons with 10 tons of waste remaining.

In addition, when we can't tell how much was recovered or how much was destroyed or determine how far recyclates were shipped, we cannot identify the GHGs being generated throughout the recycling pathway, and thus cannot with certainly manage that pathway to reduce GHGs over time.

Reconstituting vs. Remanufacturing

We have established that regardless the *technology used*, "reconstituting facilities" process recyclates that have been collected, sorted, cleaned, and pre-treated. Remanufacturing facilities use those non-waste, reconstituted raw materials; remanufacturing plants do not *process a waste feedstock* because that raw material has been "recycled" according to law. Lack of understanding in characterizing and separating operations that effect "reconstituting" from those designed for "remanufacturing" is a pervasive underlying problem, complicated by the fact that the entire processing pathway *including remanufacturing* can actually occur in one continuous processing train. More commonly, there are discrete stages and the plants that reconstitute are separate from the facilities that accomplish remanufacturing. Yet if different metrics (including GHG accounting by LCA) are to be applied to the different stages of the Circular Economy, it is imperative that we be able to tell those stages apart.

The agencies note that "…in general, there are a number of overarching challenges to increased recycling including: lack of sufficient domestic recycling infrastructure to remanufacture recycled materials, insufficient markets for recycled materials, and the relatively low cost of landfilling which adversely impacts the economics of recycling." Attending to this "lack of sufficient recycling infrastructure" should place the focus more on the need for operations designed to *reconstitute recyclates*, than on development of additional sorting and collecting operations or facilities that *remanufacture using recycled materials.* Were California to expedite development of the localized capacity for reconstituting recyclates to the receiving specifications for remanufacturing, the raw materials would readily enter the marketplace.

Composting and Anaerobic Digestion

The draft agency plans state that "GHG emissions reductions from these activities [referring to composting and anaerobic digestion, or AD, operations] would occur due to avoided landfill emissions, displacement of fossil fuel with biogas, and reduction in synthetic fertilizer and water use." Staff's premise here is that both composting and AD operations for conversion of organic recyclates to raw materials (organics recycling per code) will inherently generate less GHG impact than landfilling for any one amount of organic waste. This might seem sound if the emissions from a landfill are assumed to be less controllable than emissions from contained conversion systems.

Yet organics that provide an acceptable feedstock for composting and for all the various forms of digestion can arise from all sectors of our economy, encompassing urban wastes, agricultural and forest residuals, industrial by-products and virgin purpose-grown crops. It is unreasonable to simply assume everything going into a compost heap or a digester would have otherwise ended up in a landfill.

It is also off-target to think that there will be no significant increase in GHG emissions as the aggregation and transport routes and methods change. Feedstock sourcing will be dependent on availability and proximity. Even if the composting and / or digestion systems are literally located *at a landfill*, the types, sources and diversity of feedstock will not be the same as what was destined for disposal.

As California increases its reconstituting infrastructure, the distance may be expected to decrease from a source of materials suitable for reprocessing to a facility that can accept and reconstitute those recyclates. Discounting as irrelevant the GHG emissions associated with transport of materials during the recycling pathway by assuming the landfilling alternative was "more negative", produces an unsupportable basis for assessment..

Municipal Solid Waste Thermal Technologies

Nothing about California's recycling law dictates how each step in that pathway is to be accomplished. PRC §40180 establishes a *performance standard*, not a *prescriptive standard* and does not restrict methods as long as the results meet market specifications. Other statutes, regulations, and policies have been layered on the entire waste management sector, but what constitutes recycling remains relatively straightforward, and thermal technologies are one more way to complete recyclate reconstituting. Agency staff simply stating that one method or another of completing that legal pathway is not currently accepted as "recycling" does not change the underlying law.

Agency draft plans define "three main types of MSW Thermal systems being used worldwide", then provide only two systems examples (direct combustion and gasification), adding one additional refuse derived fuel (RDF) example for "the use of MSW (or components of MSW) as a supplemental along with conventional fossil fuel." This last example is not a "thermal system" at all, but simply a method for use of MSW in "manufacturing" energy.

The agency's plans neglect the simplest form of thermal energy application in commercial use in California; drying is a nearly-universal and crucial step in many recycling pathways when reclaiming benefit from waste. Drying is also one of the most energy-intensive and thus emissions-intensive stages. The plans also neglect thermal recovery of foundation chemicals in the form of gas, liquids, and/or solids. Thermochemical breakdown of MSW-sourced molecular structures into a lower molecular weight synthesis gas (syngas) in particular lends itself to recovery of constituents.

Lack of knowledge regarding technical options should *never* result in a blanket policy of curtailment of possibilities. The current CalRecycle stance seems to be, "We don't know enough about that approach to completing the recycling pathway, so we won't permit it." This is in stark contrast to the CARB's own approach, exemplified by the production methods assessment mechanism of the Low Carbon Fuel Standard (LCFS): "We don't know enough about that pathway to low carbon fuels, so please explain it in detail." Waste sourced feedstock certainly can be thermally converted to low carbon fuels, and each LCFS pathway of that nature that is certified then documents one more legal means of completing recycling using waste materials.

Thermally reconstituting recyclates is simply one more method of completing the series of processing stages within a recycling pathway. If and to the degree that that iterative processing pathway ends by producing a "raw material ready for reuse or remanufacturing," the technology-neutral language of the existing law deems this to be "recycling."

How that raw material is then put to use is only pertinent to the recycling pathway to the degree that *remanufacturing specifications* dictate reconstituting parameters. The recycling law similarly does not differentiate between types of remanufacturing, or even include remanufacturing in the recycling pathway. It therefore cannot set arbitrary prescriptive boundaries on how the reconstituting stage *meets* the market specifications of that next remanufacturing stage.

GHG reductions through improved cleanliness and energy efficiency of transport and processing incremental to recycling may prove more significant than any after-the-fact emissions management strategy. Assessment of process efficiency must incorporate infrastructure transport data. This point is being proven by example, as entire waste management fleets are converted to LNG and biomethane from older diesel fuel usage.

Below, we offer a more thorough breakdown of thermal processing methods, all of which are in some way represented within California and all of which find applicability in processing MSW fractions:

Table 1: **Thermal Processing Categories**

Category	Description	Result
Moisture Control	Drying through exposure to kinetic energy via grinding, compression / extrusion, radiant heat, forced air / steam or other energy source.	Recyclates are dried to meet the operational specifications of the next "reconstituting" process stage.
Microwave / RF	High-energy radiation excites molecular structure, progressively causing first drying then cellular breakdown. Includes Radio Frequency.	Recyclate materials are degraded and sterilized, increasing surface area and reducing resistance to reconstituting.
Torrefaction	Application of external or internal heat sufficient to cause off-gassing which may be used to power system, leaving a carbon char (Bio-Char, or Bio-Coal).	Biomass energy density is increased and volume decreased, improving transport cost/benefit, reconstituting to raw material for making biochar / bio-coal.
Pyrolysis	External heat source, little O2, no combustion: allothermic (requires outside force) & endothermic (absorbs energy); produces varying amounts of solid, liquid and gas.	Large molecules degraded to char, liquid and gaseous specifications for remanufacturing as alternatives to petroleum-sourced foundation chemicals.
Gasification	After start-up, driven by self-generating heat. Minimal (sub-stoichiometric) O2, minimal syngas combustion: autothermic & exothermic. Produces ash/char, gas.	Large molecules degraded to primarily gaseous raw materials, to specifications for remanufacturing as alternatives to petroleum-sourced foundation chemicals
Plasma	4th state of matter; all molecular structures dissociated. Extreme internal application of thermal / electrical energy source. Produces small molecular weight gases.	All molecular structures reduced to smallest gaseous constituents, ready for direct reuse and/or as raw material alternatives to petroleum-sourced foundation chemicals
Super-Critical Water Oxidation (SCWO)	Hydrothermal processing: water above critical temperature (374°C) and pressure (217 atm). Other liquids can be energy carrier; dissociates molecular structures.	Wet-environment thermal degradation of large organic molecules, ready for direct reuse and/or as raw material alternatives to petroleum-sourced foundation chemicals
Direct Combustion / FB	Excess oxygen present, exothermic (releases energy), allowed to proceed to full destruction, "render to ash". Includes Direct-Coupled Fluidized Bed gasification (FB).	Maximum conversion to heat for power production, rendering to ash all residual non-combustible fractions. Minimal molecular recovery.

Rather than make a blanket statement that only "combustion and supplemental fuel systems are in commercial use in California" it should be recognized that *commercialization* itself represents a continuum. State resources would be well spent in documenting examples along the entire thermal and commercial continua of MSW recycling.

Disposal vs. Recovery

CalRecycle and CARB staff have adequately described in-state landfilling and accompanying GHG emissions at each landfill site, but the approach does not lend itself to LCA comparison of alternatives to

landfilling. Collection and conversion of methane-rich gases from a landfill certainly should be increased both in number and in technical efficacy. Yet to reduce emissions, it is the encompassing waste management infrastructure that needs full state attention; landfill site specific solutions only address one crucial aspect. Support for waste transport fleet conversion to clean-burning low-carbon fuels should be dramatically increased, especially where fuels can be generated from on-site emissions.

Recyclates must in some way be intercepted between generation and final disposal and diverted to localized reprocessing facilities. This will reduce the cumulative distance between waste generation sources, recycling infrastructure plants, and remanufacturing/reuse facilities for final re-entry into the marketplace.

If all MSW processing for materials recovery occurred at landfill sites, and if all materials collected, sorted, cleaned, and treated could indeed be matched with appropriate reconstituting technologies at each landfill-based complex, the GHG metrics would cancel out. Siting MRFs imbedded within the routing of the source-to-landfill routing heuristics and even at or near landfills has become a standard municipal / industrial practice. Plants necessary to reconstitute those collected, cleaned, and pre-treated recyclates must similarly be integrated within the existing waste management routing infrastructure to minimize transport GHGs.

Each GHG reduction comparison must stand on the merits of its own life cycle data, including transport related impacts. As an extreme example of this difficulty, consider the hypothetical GHG emissions resulting from local landfill disposal of low-grade, difficult-to-recycle waste plastics when compared to trans-oceanic shipment of those same polymers to Asian reprocessing facilities.

Parting Shots

California has worked long and hard to "de-industrialize" and now reaps the dubious results of pushing critical reconstituting and remanufacturing industrial development out of the state, and out of the country. With this on-going abhorrence of placing industry where we as a society have to actually acknowledge its existence comes lack of direct control over the industrial cleanliness and loss of the economic benefits such an infrastructure maintains. This is a trend we MUST reverse, and full recognition and accounting of the global costs of GHG generation is a good place to start. CalRecycle's stated mantra is that California must own its own waste. With ownership comes responsibility.

California has a relatively clear and concise legal description of how something we throw away can legally be turned into something we once again need. That encoded recycling pathway definition is clearly and intentionally based on *performance*, rather than reliance on prescriptive standards. There are constant and deeply lobbied attempts to overlay the existing law with such prescriptive criteria, to push the socio-economics of waste management and resource recovery to benefit one or another smaller minority, and to suit the arbitrary and unscientific assumptions of the current cadre of agency staff. Far enough: if you don't like a law, then work to change it. But until that law *is* changed, the agencies are under oath to uphold it. We need to hold our waste management and resource recovery agencies to this test: does the existing and proposed policy adhere to the letter and intent of the law?

CalRecycle and the CARB have a marvelous opportunity right now to shift California's Waste Management Sector from prescriptive, restrictive, and unscientific resource management to a wholly consistent, objective, and performance based approach. The CARB's implementation of the Low Carbon Fuel Standard uses just such an approach, and where low carbon fuels can be made from waste-sourced feedstock is a prime example of proper oversight and certification of recycling. Yet even this certification process has fallen to the unsupportable assumptions at the heart of CalRecycle's administrative guidance. Lack of knowledge or adequate data to allow proper Life Cycle Assessment is no excuse for passing off assumptions as fact.