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See attached document: BIOMETHANE TRANSPORTATION FUEL POWERING THE SOLID WASTE INDUSTRY: Community-Scale Distributed Fuel Production Facilities

Additional submitted attachment is included below.

California Compost Coalition

WHITE PAPER BIOMETHANE TRANSPORTATION FUEL POWERING THE SOLID WASTE INDUSTRY: Community-Scale Distributed Fuel Production Facilities

CleanFleets.Net

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Biomethane Transportation Fuel Production Powering the Solid Waste Sector Community-Scale Distributed Transportation Fuel Production Facility

Executive Summary

A successful transportation biofuel project requires that several components be in place. In particular, the ability to be fully permitted, a reliable feedstock supply, a reliable demand for the fuel in line with storage capacity, the ability to deliver the fuel to users, and the ability to secure financing. California's solid waste management industry is structured in such a way as to have all of these necessary components in place and a high assurance that public investments will result in functioning facilities producing a renewable natural gas (RNG) which is a carbon negative fuel. This type of project provides the ability to site a dry fermentation anaerobic digestion facility with a purification system and vehicle fueling system on a very small footprint within the existing infrastructure. This is a perfect fit for existing waste management facilities, allowing the organic waste collected by the fleet to fuel the entire fleet of waste collection vehicles, which can fuel while being parked overnight. This approach not only avoids greenhouse gas emissions from displacing diesel, but is a well-suited method for managing a significant portion of the organic waste that will be diverted from landfill disposal over the next ten years.

Anaerobic Digestion (AD) is the biological decomposition of organic wastes with little or no oxygen. AD facilities that process organic waste produce biogas and digestate, the organic co-product remaining after anaerobic digestion. The AD system for source-separated co-collected organics waste and food waste would be a dry fermentation process where the digestate can be further processed into a clean compost. The generated biogas is purified and can be upgraded to a transportation fuel with compressed natural gas (CNG) quality. The fleet demand for the fuel on-site alleviates the need for a natural gas pipeline or pipeline injection, and avoids project delays with the major utilities.

This approach has been deemed a *Community-Scale Distributed Transportation Fuel Production Facility* where a population of 100,000 generate approximately 25,000 tons per year of organic waste which can fuel the entire fleet that serves that community. Project economics vary significantly from project to project due to site-specific factors. The economics can result in a positive cash flow, but the return on investment is not necessarily attractive to private sector investors, and state funding assistance is a desirable and appropriate way to commercialize and incentivize project implementation.

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The success of these programs will be anchored in having exclusive franchises in the community to collect source-separated organic waste to produce a clean compost. These exclusive franchises guarantee the organic tons to provide the revenue streams to finance the expensive compost and anaerobic digestion infrastructure. The City of Los Angeles recently endorsed ***"A Blueprint for Cities – Cleaning Up Waste and Recycling Management and Securing the Benefits***" dated July 2015 that have parlayed these concepts into a 78-page report that promotes the exclusive franchise and the source-separation of organics to get to zero waste by 2025.

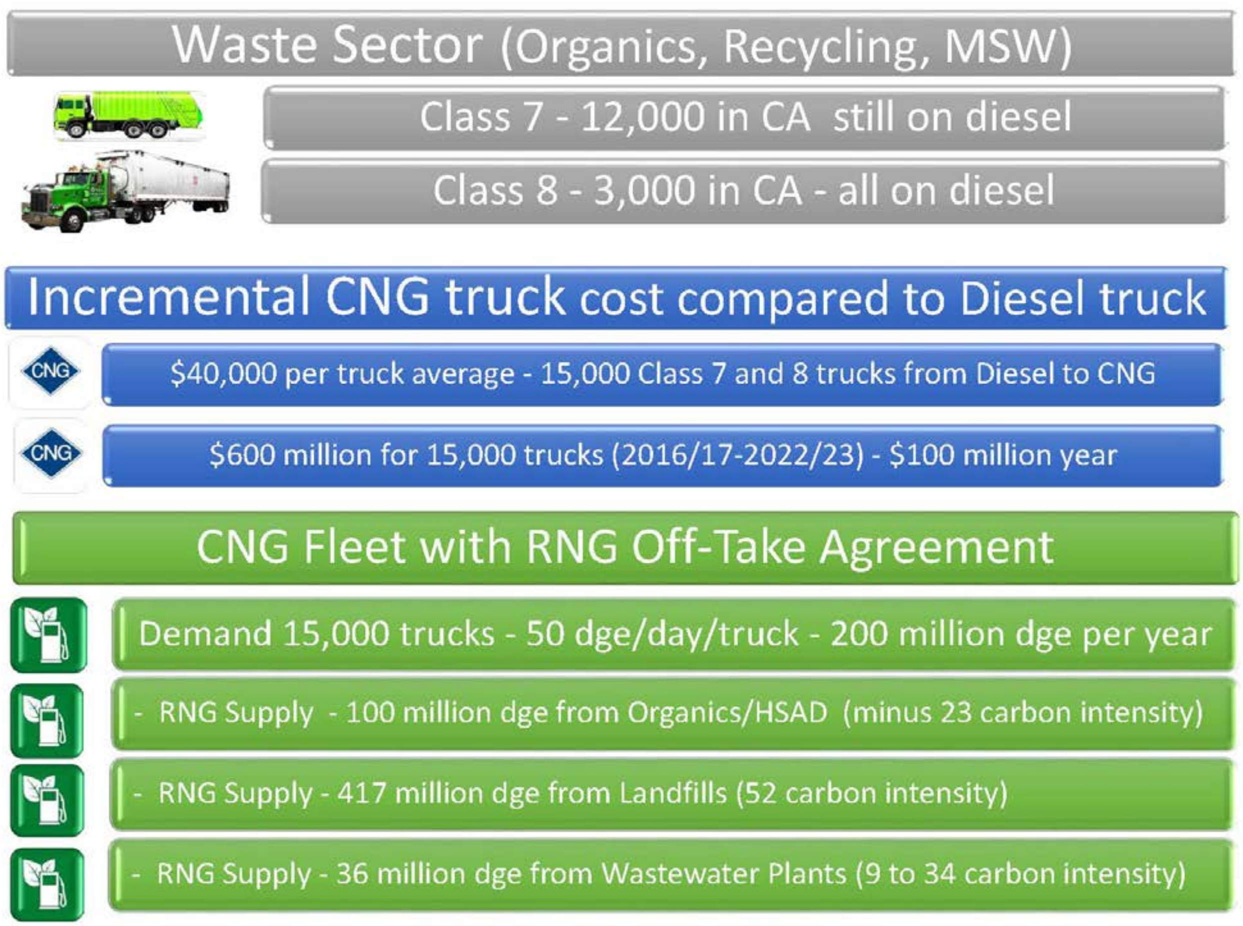
With the need to develop 100 anaerobic digestion facilities by 2020 to implement current state policies, the total capital costs is estimated to be $1.94 billion dollars and will produce 33 million diesel gallon equivalents (dge) of RNG transportation fuel that has been determined by the California Air Resources Board to be carbon negative. With a potential ban of all organics by 2025, there would need to be 255 facilities to manage 75% of the recovered food waste with AD, with capital costs estimated to be $4.95 billion producing 84 million dge of RNG transportation fuel per year.

There are approximately 12,000 waste collection vehicles and 3,000 transfer trucks still operating on diesel in California's solid waste management industry. With an average use of 50 dge per day, the demand within the solid waste sector is 200 million per year, where there would be adequate on-site fleet demand within the industry. Additional RNG could be procured from landfills with an estimated potential of 417 dge per year or wastewater treatment plants with an estimated production of 36 million dge per year, according to a recent UC Davis study (Williams, et al, 2014). Fueling stations blending RNG and CNG also provides additional fueling capacity for the fleet demand. Note that the incremental cost differential between diesel and CNG heavy-duty trucks is about $40,000, and both the California Energy Commission and the California Air Resources Board (CARB) have been requested to consider funding the difference following the Hybrid Voucher Incentive Program model.

In order transition from the fleet from diesel to CNG with RNG fuel, the 15,000 truck fleet at $40,000 additional cost per truck, will add up to be $600 million investment, or $100 million for 6 years (see Figure 1 on the next page). To reduce petroleum use by 50% by 2030, the Waste Sector can take the lead as a closed-loop system where the fleet that collects the organic wastes, get fueled by the anaerobic digestion of the organic waste that was collected. CARB can take a leadership position by investing $100 per year for 6 years of their $500 million proposed allocation from the Cap and Trade Expenditure Plan for Low Carbon Transportation & Fuels, which also meet the goals of the Air Quality Improvement Program. The industry is also excited about the upcoming availability of the near-zero NOx CNG engines coming out in 2016. The new Cummins Westport ISL G Near

Zero (NZ) NOx natural gas engine is the first MidRange engine in North America to receive emission certifications from both U.S. Environmental Protection Agency (EPA) and Air Resources Board (ARB) in California that meet the 0.02 g/bhp-hr optional Near Zero NOx Emissions standards for medium-duty truck, urban bus, school bus and refuse applications.

Figure 1. Waste Sector 6-Year Investment Plan



With AB 32 as a strong foundation, Governor Brown unveiled his ***Five Pillars*** (See Figure 2) vision in his 2015 inaugural address, stating that, by 2030, California will: (Pillar 1) reduce today's petroleum use in cars and trucks by up to 50 percent; (Pillar 2) increase from one-third to 50 percent our electricity derived from renewable sources; (Pillar 3) double the efficiency savings from existing buildings and make heating fuels cleaner; (Pillar 4) reduce the release of methane which includes eliminating organics from the landfill by 2025; and (Pillar 5) manage farms and rangelands, forests and wetlands so they can use compost and store carbon. The Governor's office is now hosting a series of Pillar Symposiums – 2030 Climate Change Commitments – to build all of the ***Five Pillars*** into the AB 32

Scoping Plan Update to 2030, which will be ready for adoption in fall 2016. Anaerobic digestion and composting weaves these pillars together. Eliminating organics from the landfills will mitigate methane generation as a short-lived climate pollutant (Pillar 4) and instead create biomethane at anaerobic digestion facilities to generate more renewable energy (Pillar 2) and carbon negative fuel for the CNG fleet that collects the organics (Pillar 1) to displace diesel fuel. The diverted food waste and digestate can be composted to sequester carbon and promote healthy soils (Pillar 5). Anaerobic digestion and composting is at the nexus of cost-effectively reducing GHGs while keeping it local at the community scale of implementing the Governor's distributed generation model for energy. The California Compost Coalition and CleanFleets.Net support the Governor's proposed budget for fiscal year 2016-2017 to implement:

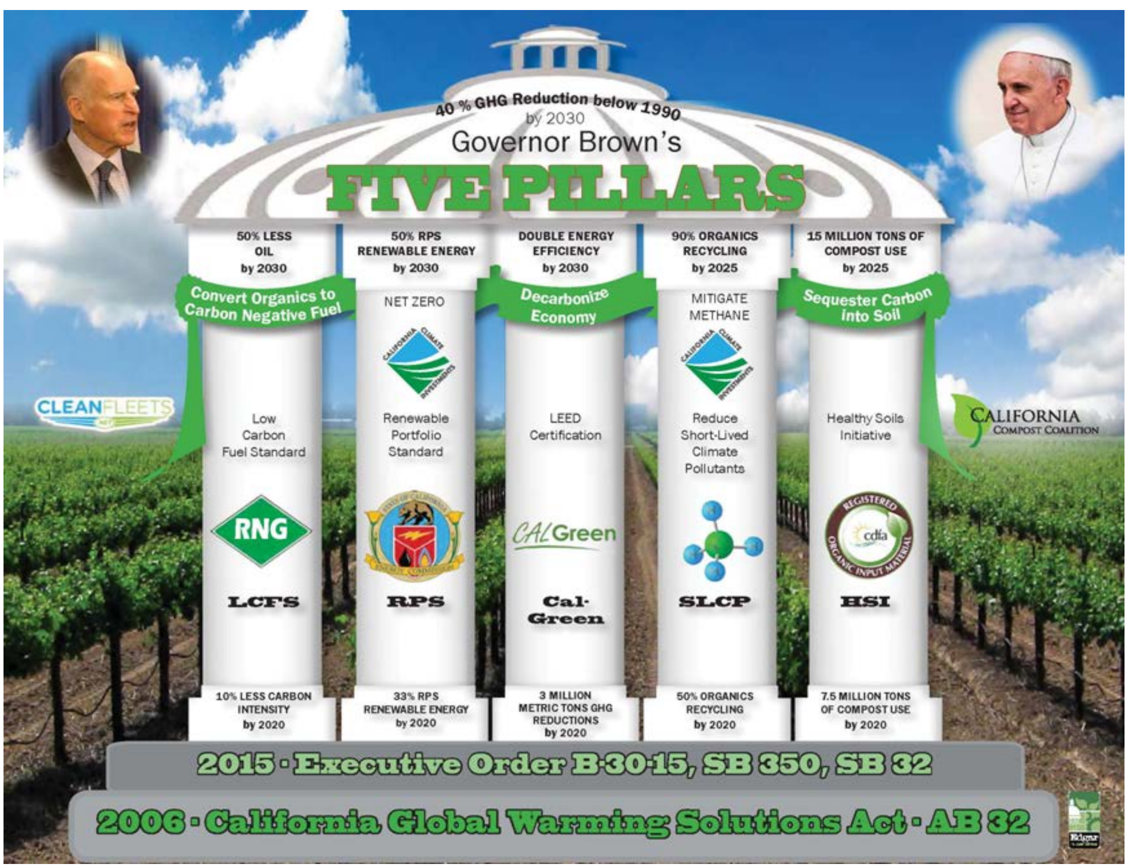
<u>Short-Lived Climate Pollutant:</u>

- CalRecycle Waste Diversion $100 million
- CDFA Healthy Soils $ 55 million

<u>50 Percent Reduction in Petroleum Use</u>

- Energy Commission Biofuel Facility $ 25 million
- Air Resources Board Low Carbon Transportation & Fuel $500 million

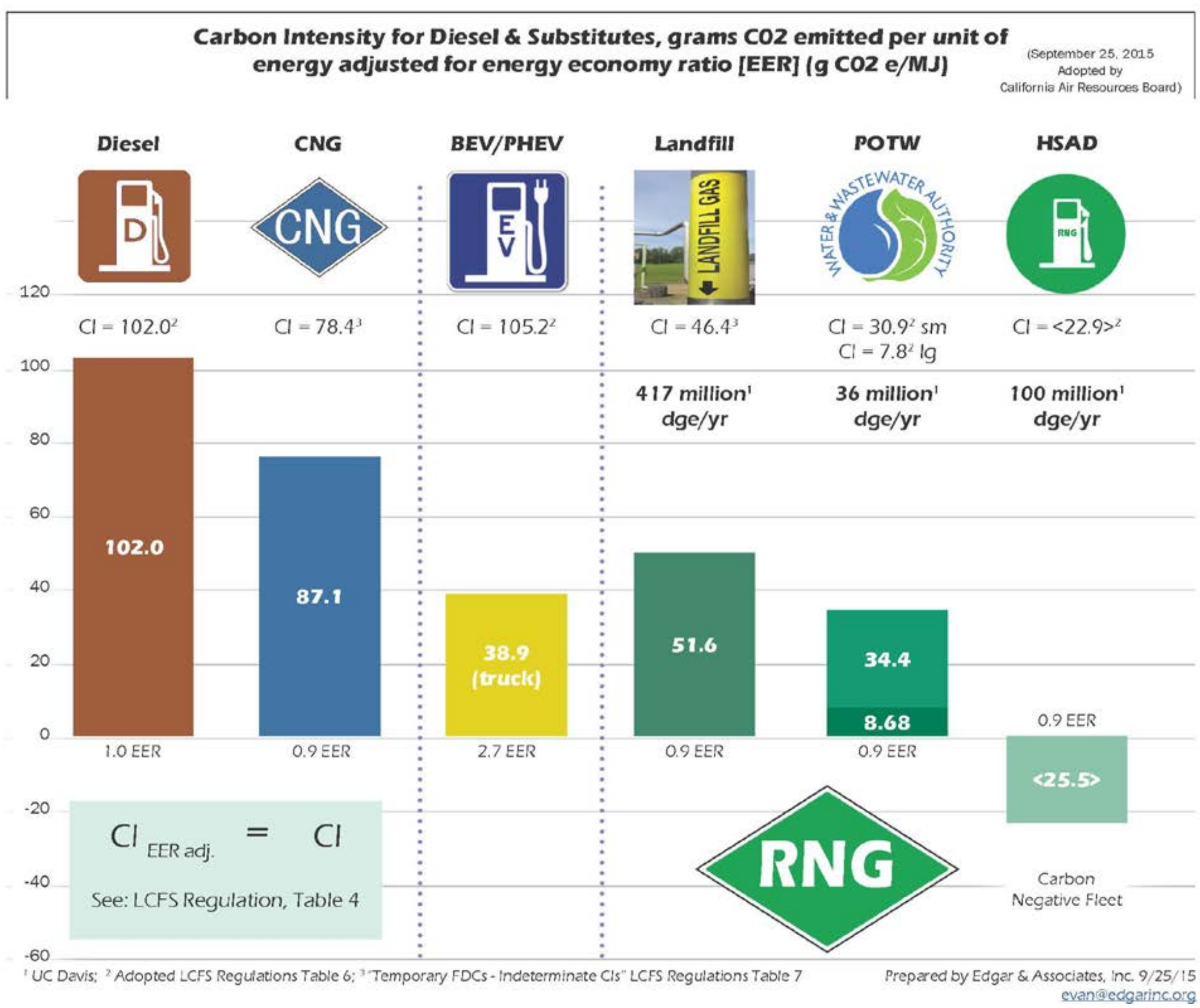
Figure 2. Governor's Five Pillars



Fuel Demand – Carbon Negative with Near-Zero NOx engines

California's waste sector (organics, recycling, municipal solid waste, etc.), has already gone a long way towards switching from a diesel-based to a CNG-based fleet and have recently started to produce their own carbon negative RNG. The South Coast Air Quality Management District adopted Rule 1193 in 2000, requiring solid waste collection fleets in their district to operate on alternative fuels, which are either CNG or LNG (liquefied natural gas). Due to the local nature of collection routes and fuel availability, CNG has become the fuel of choice as being cost-effective, lower carbon, and with less fleet noise in the community. With the deployment of community-scale technology, the waste sector has begun to produce RNG from the organic waste that their fleet collects. With the re-adoption of the Low Carbon Fuel Standard on September 25, 2015, CARB also adopted the carbon intensity of the transportation derived from the high-solids dry fermentation (HSAD) process to be a minus 22.9 g CO2e/MJ as shown in Figure 3 below.

Figure 3. CARB's Carbon Intensity for Transportation Fuels



In 2007, Cummins Westport made the ISL G engine available, which was a big improvement in power and efficiency over prior models, relieving many of the concerns that had been obstacles to replacing diesel trucks with CNG trucks. Within California's waste management sector, there are currently very efficient, well-performing CNG engines available for both Class 7 waste collection vehicles and Class 8 heavy-duty transfer vehicles and the industry has steadily converted their fleets to CNG where incentives and ratepayer support has been obtained.

The industry is also excited about the upcoming availability of the near-zero NOx CNG engines coming out in 2016. The new Cummins Westport ISL G Near Zero (NZ) NOx natural gas engine is the first MidRange engine in North America to receive emission certifications from both U.S. Environmental Protection Agency (EPA) and Air Resources Board (ARB) in California that meet the 0.02 g/bhp-hr optional Near Zero NOx Emissions standards for medium-duty truck, urban bus, school bus and refuse applications.

About 30% of the existing fleet of waste collection vehicles in California is CNG, and among new orders CNG vehicles are outpacing diesel. There are about 12,000 waste collection vehicles and 3,000 transfer trucks operating on diesel in California's solid waste management industry. Note that the incremental cost differential between diesel and CNG heavy-duty trucks is about $40,000, and both the California Energy Commission and the California Air Resources Board have been requested to consider funding the difference following a Hybrid Voucher Incentive Program model.

Using operational biomethane production and recovery rates, one waste collection vehicles delivering organic waste to an anaerobic digestion (AD) facility will provide enough renewable CNG (RNG) to operate seven CNG vehicles at 40 diesel gallon equivalents (DGE) per day. Essentially, the organic waste managed can provide sufficient RNG to fuel the entire waste collection fleet that is collecting organics, recycling, construction & demolition debris, and municipal waste.

Because the fueling station is co-located at the waste management facility with the ability to leverage existing infrastructure to place stand-alone anaerobic digestion facilities, trucks are fueled on-site, typically on slow-fill while parked overnight, and there are no pipeline injection or leakage issues with which to contend. The concept is illustrated in Figure 4.

Figure 4. Community-Scale Distributed Transportation Fuel Production Facility

Facility Permitting

Waste management facilities, whether they are material recovery facilities, compost facilities or transfer stations, undergo a very extensive permitting process involving the local Planning Agency, several State agencies and the local air district. As such, the permitting required to construct and operate an anaerobic digestion and fueling facility, although challenging, is achievable and can be part of a cutting-edge industry. Because the project proponents work hand-in-hand with cities and counties and these types of projects are part of their sustainability and Climate Action Plans, the permit process is supported by client jurisdictions that are determined to comply with State Law.

Feedstock Supply

Companies and jurisdictions engaged in the waste management sector directly serve the waste management needs of the jurisdiction's population, and as such, have a very reliable and predictable source of organic feedstock. Since the passage of AB 939 in 1989, California has succeeded in achieving diversion rates of over 50%. However, only recently have recovery efforts targeted food waste, being driven by a number of legislative bills (See Attachment A will a detailed overview of each law) that will serve to increase the amount of organic material recovered, particularly food waste, by several million tons per year (tpy). For instance:

AB 341	Statewide 75% Recycling Goal by 2020
AB 1826	Mandated Commercial Organics Collection
SB 605	Reduction in Short-lived Climate Pollutants (note that the Draft Strategy calls for effectively eliminating the disposal of organics in landfills by 2025.)
AB 876	Local jurisdictions must identify 15 years of organic processing capacity

Anaerobic digestion, due to the fact that it is an enclosed and air-tight system, is very well-suited for the management of putrescible materials such as food waste. The solid waste management sector in California are typically not merchant facilities and have long-term contracts to secure feedstock for biofuel facilities, and are investing in biofuel facilities as a sustainable and well-suited response to managing the increasing quantities of putrescible waste being diverted from landfill disposal.

Financing

The management of solid waste is an on-going process, and because of high infrastructure costs, the Industry tends to have long-term contracts or franchises with renewal clauses. Solid waste facilities, whether they are material recovery facilities, compost facilities, transfer stations or a fleet of collection vehicles, require high levels of infrastructure investment. As such, agreements are structured with this in mind to assure that capital investments are recouped over the term of the agreement, thereby creating a positive basis for seeking financing for capital investments. The California Pollution Control Financing Authority (CPCFA) has issued tax-exempt bonds to finance the Waste Sector infrastructure for the past two decades by funding material recovery facilities and fleets to an amount of $150 million to $200 million per year and have a set aside reserve of over $1 billion available for projects. Anaerobic digestion and covered composting are considered best available control technologies and have been endorsed by CPCFA.

Business Model

The business model described above can provide RCNG production when incentivized to:

- Use the certainty of a long-term franchise agreement to leverage financing for capital improvements.

- Include anaerobic digestion and RNG production among CEQA entitlements and permitted activities levering existing infrastructure.
- Invest in CNG vehicles to replace diesel vehicles.
- Implement source-separation organic collection programs to divert materials, particularly food waste, from landfill disposal as mandated by state laws
- Construct and operate an anaerobic digestion facility and fueling station on-site.
- Fuel the trucks on-site overnight eliminating the need to wait in line for diesel fuel.
- Natural gas pipeline inter-connection is not needed reducing project delays caused by the major utilities
- Create a clean compost soil amendment product from the digestate, where the company can become a long-term compost operator

AB32 Scoping Plan Update

As part of the AB 32 Scoping Plan Update document from May 2014 (copy provided in Attachment B), it was assumed that new regulations would lead to the diversion of 5 million tons of organic material prior to 2020, and an additional 2.5 million tons after 2020 (i.e. 2020 – 2025). Of these amounts, it was also assumed that 50% of the diverted tons would be aerobically composted and 50% would go to anaerobic digestion, resulting in 2.5 million tons by 2020 and 3.75 million tons after 2020 being managed through anaerobic digestion. The AB 32 Scoping Plan Update also provides estimates of GHG emission reductions from these activities. The Governor's office is now hosting a series of Pillar Symposiums – 2030 Climate Change Commitments – to build all of the ***Five Pillars*** into the upcoming AB 32 Scoping Plan Update to 2030 which will be ready for adoption in fall 2016. Anaerobic digestion and composting weaves these pillars together. Anaerobic digestion and composting is also at the nexus of cost-effectively reducing GHGs while keeping it local at the community scale of implementing the Governor's distributed generation model for energy that can also occur for the production of transportation fuel.

Facility Costs

The cost estimates and fuel production capacity is based on a dry-fermentation type of anaerobic digestion of the type that is licensed by Zero Waste Energy, LLC. Zero Waste Energy. LLC currently has three operating facilities in California, ranging in capacity from 5,000 to 90,000 tpy. An 11,200 tpy facility at Blue Line Transfer in South San Francisco is producing RCNG from organic waste to operate their waste collection fleet, while the other two facilities are generating electricity from biogas.

An anaerobic digestion facility with a capacity of 25,000 tons per year is about the right size to serve a population of 100,000 people and is easy to site at an existing facility because of the small facility footprint of less than an acre. The City Council of Napa recently considered and supported a 25,000 ton-per-year anaerobic digestion project, which has been awarded $3 million in funding support from the California Energy Commission. The initial capital cost estimate for the facility is $15.5 million, which includes the anaerobic digestion bunkers, the biogas purification system, the fueling system and assorted ancillary equipment. Note that this did not include infrastructure costs for digestate management as the anaerobic digestion facility is being co-located at an existing composting facility. Constructing additional compost capacity for an estimated 20,000 tons per year of digestate using an aerated static pile (ASP) concrete bunker system is estimated at $2.5 million which is considered best available control technology by local air districts. As stated, this compost infrastructure cost is not included in the $15.5 million. The cost of building, operating and maintaining the AD facility is balanced against project benefits such as avoiding the cost of purchasing the fuel elsewhere, revenue from LCFS credits and RINs, and several other avoided costs.

Facility costs, and the approach to economic analysis, vary depending on the scenario for the facility. For instance, here are two possible scenarios:

- An AD facility is co-located with a compost facility under common ownership. The composting capacity may already be sufficient to handle the digestate, and would have been used for the raw feedstock if the AD system were not in place. In this case, the costs for composting capacity would generally not be allocated to the AD project, but neither would the tipping fees associated with accepting the organic material, or the revenue from compost sales.

- A facility that is not co-located with a compost facility will have to pay to take the digestate to a compost facility and would not realize revenue from compost sales. However, in this case it would be appropriate to allocate the tip fee at the gate to the AD facility.

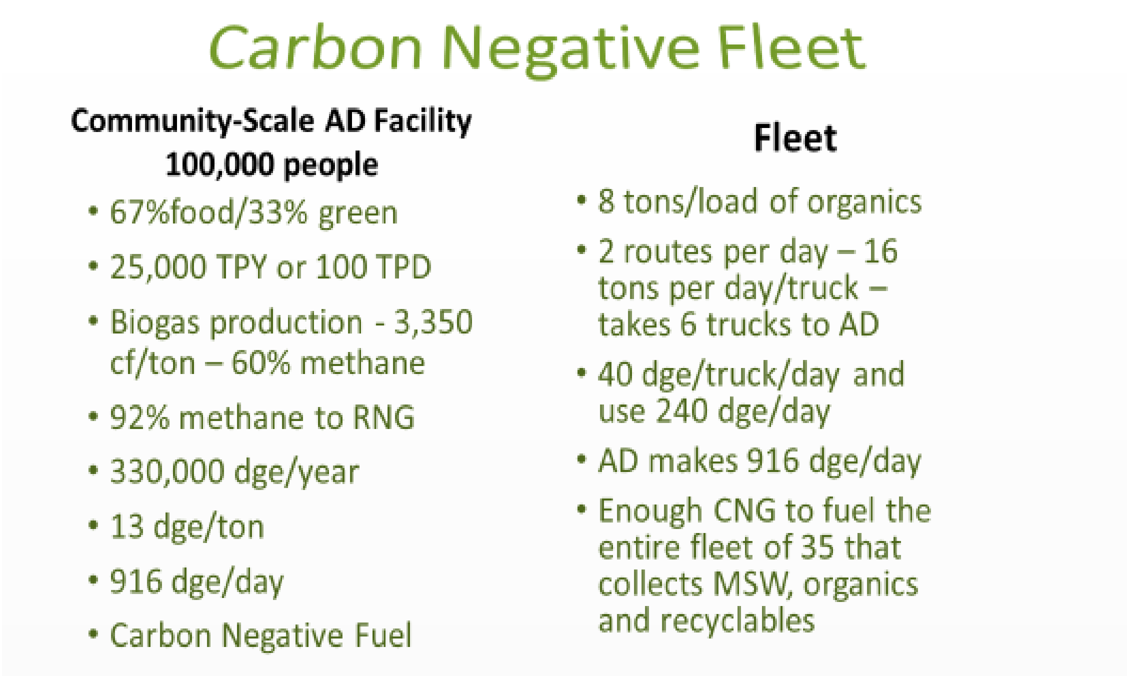
The Napa project is in the first category, where an AD facility is, in essence, being inserted into an existing facility between the gate and the compost area. The objective is to extract the biomethane from the putrescible waste before it is aerobically composted. Because there is an estimated 20% mass reduction during the anaerobic digestion process, only 20% of the revenue from the gate fee for the 25,000 tons per year was allocated to the AD Facility (5,000 tpy), and compost sales revenue is based on only 5,000 tpy of feedstock, reduced by 50% of the original mass. The idea is that the 25,000 tpy of feedstock could have gone directly to compost infrastructure, foregoing the methane energy benefit. By going through AD prior to composting, 20% of the mass is reduced, thereby increasing the amount of material that can be composted by 5,000 tpy.

A detailed pro forma was developed to analyze the project, which was amortized over a 20-year time horizon. On-going annual costs average $1.9 million, including debt service. Without the $3 million grant, the annualized project cost over 20 years, relative to no project and continuing to purchase fossil-based CNG at a local fueling station, is $320,000/year. Including the $3 million grant reduces the annualized cost to $170,000/year. To achieve a net present value of zero over a 20-year horizon, the grant amount would have had to be $6,250,000, or about 40% of the total estimated capital investment. The Napa City Council chose to support the project in spite of the cost increase over the status quo situation because it featured prominently in their sustainability and climate action programs and supported the food waste recovery programs that the City had put in place.

Note that if the facility owner is a private entity, the economics can change substantially due to tax implications. In the case of Napa, property tax would amount to an additional $170,000 per year cost to a private operator. Additionally, grant funds are taxed as is any corporate revenue, reducing the "bang for the grant buck" for private companies.

A summary of some Napa system parameters is shown in Figure 5.

Figure 5. Summary of a 25,000 Ton-Per-Year AD Facility Parameters



Overall facility costs are shown in Table 1 for a 25,000 ton-per-year facility sited at an existing facility. Permitting consists of going through the CEQA process, revising the solid waste facility permit, and obtaining a Permit to Operate from the Air District.

Table 1. Overall Facility Costs – 25,000 TPY AD Facility

Cost Category	Cost
Permitting	$400,000
Design	$1,000,000
Construction – AD (includes biogas purification and fueling systems)	$15,500,000
Construction – Digestate composting capacity	$2,500,000
Total Capital Cost	**$19,400,000**
Annual Operations & Maintenance • Electricity $300,000 • Pipeline Natural Gas $75,000 • Biogas Cleanup Media $150,000 • Labor $400,000 • Fuel $35,000 • Other maintenance/repairs $50,000	$1,020,000
Annual debt service	$1,500,000
Total Annual On-going Costs	**$2,520,000**

Note that the costs for digestate transport to a compost facility and tipping fees at the compost facility are not included in the operations costs because the cost to develop composting capacity is included in the capital expenditures. If digestate must be transported to a compost facility, operating costs can increase substantially. For instance, 20,000 tons of digestate transported at $15/ton, plus a $45/ton tipping fee is $1,200,000 per year for a 25,000 ton-per-year facility.

Costs for processing equipment may or may not be allocated fully to the AD facility; this is a determination on a facility basis. In some cases for dry AD, very little pre-processing is needed. If there are large items in the feedstock (i.e. stumps or logs) they are simply removed. If an AD facility is co-located with a composting facility, then the processing equipment would have been needed in any case, even if the organics were composted without AD, and the AD feedstock may be a fraction of the total tonnage processed.

Cost estimates for processing equipment and a front-end loader are shown in Table 2. Potential revenue streams are presented in Table 3, and are calculated assuming a production of 330,000 DGE/year.

Table 2. Other Equipment Costs – 25,000 TPY AD Facility[1]

Cost Category	Cost
Sort line with disc screen	$1,000,000
Grinder	$500,000
Screen	$250,000
Front-end Loader	$250,000
Total Capital Cost	**$2,000,000**

1. Processing equipment capacity of 50 tons per hour.

Table 3. Potential Revenue Streams and Cost Savings for a 25,000 TPY AD Facility

Revenue or Savings	Unit Value	Annual Value	Comment
Tipping fee for accepting the feedstock material	$50/ton	$1,250,000	This can vary a lot statewide. There are various ways to apply fees for service, and tipping fees are easy to understand and apply.
Compost Sales[1]	$16/ton	$200,000	Assumes 50% reduction in mass during AD + composting.
LCFS Credits[2]	$40/credit Net of brokerage and other fees	$196,000	Based on 2016 average CI target for diesel of 96.8 g/CO_2e and -22.93 for HSAD, adjusted by the EER[3] of 0.9, which gives 4,900 LCFS credits. LCFS credit availability is uncertain going forward.
RINs[4]	$0.5/RIN Net of brokerage and other fees	$273,000	77,000 Btu/RIN. The future availability of RINs is also uncertain.
Fuel Savings[5]	$2.80/DGE of CNG	$918,000	CNG costs are currently very low
Labor Savings	$60/hour	$273,000	Assumes 30 minutes per weekday per truck= 4,550 hours/year
Total		**$3,110,000**	

1. Note that if the digestate is hauled to a compost facility under different ownership, the compost sales revenue disappears.
2. LCFS credits have ranged in value from $24 (Q2 2015) to $96 (Dec. 2015). In December 2015, prices ranged from $23 to $120. The LCFS sunsets in 2020, although CARB has indicated the intention to extend it to 2030. The carbon intensity of the fuel is also dependent on potential future revisions of the High Solids Anaerobic Digestion Fuel Pathway.
3. EER = energy economy ratio = 0.9 because CNG is less efficient than diesel.

4. D5 RINs are currently trading at about 70 cents, but have historically been below 50 cents at times. D3 RINs are trading at about $1.20. D5 RINs are for "Advanced Biofuels" and D3 RINs are for "Cellulosic Biofuels". By statute, food waste is not cellulosic, but yard waste is cellulosic, so it is anticipated that high food waste concentration feedstocks will trade as D5 RINs. RIN prices are uncertain, as can be the political future of the RFS. Political and price uncertainty mean these revenue streams are often not bankable.
5. Fuel savings are based on not having to purchase retail fossil fuel CNG.

Projected Waste Generation – Feedstock Availability

The AB 32 Scoping Plan update discusses 2.5 million tons going to AD facilities before 2020, and an additional 1.75 million tons between 2020 and 2025. Using the 25,000 ton per year model described, this would require 100 facilities by 2020 and an additional 70 facilities between 2020 and 2025.

Subsequent to the Scoping Plan Update, CalRecycle completed their *2014 Disposal – Facility - Based Characterization of Solid Waste in California*. The data from this characterization study can be used to better estimate the potential for waste diversion from landfill disposal in 2020 and 2025.

Population data (Department of Finance projections), annual disposal weights (CalRecycle Disposal Reporting System), and Waste Characterization by sector (CalRecycle) are used in the analysis below to project organics generation in 2020 and 2025.

CalRecycle's website indicates that 30,864,279 tons were disposed of in 2014. According to CalRecycle's update to the 2014 Waste Characterization, commercial waste constitutes 38.6% of the total waste stream, with residential and self-haul making up the remaining 47.0% and 14.4% respectively.

The 2014 Waste Characterization and CalRecycle's Disposal Reporting System can be used to obtain an estimate of overall statewide organics disposal, including alternative daily cover. These tonnages, adjusted by population projections from the Department of Finance, are used to calculate a 2020 and 2025 business-as-usual projection of organics disposal. Based on these projections, the 75% reduction in landfilled waste by 2020 and 90% by 2025 can be applied to assess the amount of diversion anticipated to occur.

A summary of the percent distribution of landfilled organics is shown in Table 4.

Table 4. CalRecycle 2014 Waste Characterization: Organic Portion of Waste Stream

CalRecycle 2014 Waste Characterization: Organic Portion of Waste Stream	
Food Waste	18%
Yard Waste	7%
Wood Waste	14%
Compostable Paper	4%
Manure	0.6%
	43%

Of the total organic portion of the waste stream, all of the components can be managed by anaerobic digestion or composting, with the exception of wood waste, which is typically used as biomass energy feedstock. Assembly Bill 1594 removed the diversion credit for beneficial use that green waste landfill alternative daily cover receives. AB 1826 requires that 50% of commercial organics be diverted from disposal form a 2014 base year. CARB proposes to eliminate all organics form the landfill by 2025 to mitigate methane, a short-lived climate pollutant. It is anticipated that commercial organics and green waste ADC use will be 50% of 2014 levels by 2020 and only 10% of 2014 levels by 2025.

The amount of yard waste ADC diversion is shown in Table 5.

Table 5. Green Waste ADC Use (tons)

	2014	2020	2025
Green Waste ADC Disposal Baseline	1,294,515	1,358,112	1,416,860
ADC Continued Use	1,294,515	659,026	129,452
ADC Diversion	**0**	**699,086**	**1,287,408**

The intent of this analysis of Projected Waste Generation – Feedstock Availability is the following:

- To estimate the amount of landfilled organics in 2020 and 2025 under a "business-as-usual" scenario. Using the disposal data from CalRecycle and the results of CalRecycle's Waste Characterization Study, projected population growth is used to estimate future landfilled organics tons assuming no increase in diversion. This is shown in Tables 6 to 8.

- To estimate the potential amount of compostable (or anaerobically digestable) organics assuming 75% recovery from disposal by 2020 and 90% by 2025. This is shown in Tables 9 and 10.

- To estimate the amount of food and yard waste allocated to AD given the Scoping Plan Update Measure of 2.5 million tons going through an AD process by 2020, and 3.75 million tons by 2025. A constraint is placed on the food/yard waste blend of 80% food waste, assumed to be the maximum food waste content for dry AD systems. Subsequently, to estimate the amount of food and yard waste remaining to be managed by other means, assumed to be aerobic composting, with a goal of a maximum food waste content in the blend of 30%. This is shown in Tables 11 and 12.

- Estimate the total amount of remaining recovered organics that would be treated by aerobic composting under the above scenarios. This is shown in Table 13.

- To repeat the above described scenarios for 2020 and 2025, but simply assuming that 75% of recovered food waste is directed towards AD prior to composting. The 75% is an arbitrary amount used for illustration. This is shown in Tables 14 and 15.

There are other means by which food waste can be reduced or managed, such as source reduction, food recovery programs, etc., but those are not included in this analysis.

Business-as-usual disposal, or baseline disposal tonnages, for 2020 and 2025 are shown in Tables 6-8.

Table 6. 2014 Compostable Organics Disposal By Sector (tons)

Material	Commercial	Residential	Self-Haul	Total
Food Waste	2,158,195	2,627,854	805,130	5,591,179
Yard Waste	824,182	1,003,538	307,467	2,135,187
Yard Waste ADC				1,294,515
Compostable Paper	469,345	571,482	175,092	1,215,919
Manure	67,476	82,160	25,172	174,808
TOTAL:	**3,519,198**	**4,285,034**	**1,312,861**	**9,117,093**

Table 7. 2020 Projected Business-as-Usual – Compostable Organics Disposal by Sector (tons)

Material	Commercial	Residential	Self-Haul	Total
Food Waste	2,264,223	2,756,955	844,684	5,865,862
Yard Waste	864,673	1,052,840	322,572	2,240,084
Yard Waste ADC				1,358,112
Compostable Paper	492,403	599,558	183,694	1,275,655
Manure	70,791	86,196	26,409	183,396
TOTAL:	**3,692,090**	**4,495,549**	**1,377,359**	**9,564,997**

Table 8. 2025 Projected Business-as-Usual – Compostable Organics Disposal by Sector (tons)

Material	Commercial	Residential	Self-Haul	Total
Food Waste	2,362,166	2,876,213	881,223	6,119,601
Yard Waste	902,076	1,098,382	336,526	2,336,984
Yard Waste ADC				1,416,860
Compostable Paper	513,703	625,493	191,640	1,330,836
Manure	73,853	89,925	27,551	191,329
TOTAL:	**3,851,798**	**4,690,013**	**1,436,940**	**9,978,750**

Potential diversion, based on a reduction in landfill disposal of 75% by 2020 and 90% by 2025, is shown in Tables 9 and 10.

Table 9. 2020 Recovered Compostable Organics Disposal by Sector (tons) With 75% of Organics Recovered

Material	Commercial	Residential	Self-Haul	Total
Food Waste	1,698,167	2,067,716	633,513	4,399,397
Yard Waste	648,505	789,630	241,929	1,680,063
Yard Waste ADC	-	-	-	699,086
Compostable Paper	369,302	449,669	137,771	956,741
Manure	53,093	64,647	19,807	137,547
TOTAL:	**2,769,068**	**3,371,662**	**1,033,019**	**7,872,834**

Table 10. 2025 Recovered Compostable Organics Disposal by Sector (tons) 90% of Organics Recovered

Material	Commercial	Residential	Self-Haul	Total
Food Waste	2,125,949	2,588,592	793,101	5,507,641
Yard Waste	811,868	988,544	302,873	2,103,286
Yard Waste ADC	-	-	-	1,287,408
Compostable Paper	462,333	562,944	172,476	1,197,752
Manure	66,468	80,933	24,796	172,196
TOTAL:	**3,466,618**	**4,221,012**	**1,293,246**	**10,268,283**

The AB 32 Scoping Plan Update projected that increased organic waste diversion would result in an additional 5 million tons of compostable organics diverted annually by 2020, with 50% being managed by anaerobic digestion and 50% by composting. By 2025, that amount is expected to be 7.5 million total tons, again split 50/50 between AD and composting. In an AD system, food waste is the principle generator of methane because green waste and compostable paper tend to breakdown much slower than food waste. To maximize methane content and biogas production, high solids anaerobic digestion systems have been observed to operate with food waste content as high as 67 to 80%, with a minimum of 20% yard waste needed for bulking and porosity.

The recovered organic waste streams are analyzed by combining food waste and compostable paper as the "food waste" category, combining yard waste with yard waste ADC as the Yard Waste" category, and splitting manure between the two categories.

In the following tables, the amount of food waste allocated to AD given the goals set forth in the Scoping Plan Update is presented, with the constraint that the blend for AD be 80% food waste content. Following that, the amount of yard waste needed to be blended with the remaining food waste so that it can be composted in an aerated static pile compost system is estimated. In an aerated static pile compost system, the maximum amount of food waste that can be composted without odor problems is about 40%.

In this analysis, the amount of yard waste needed to achieve a blend of 30% food waste in the ASP is estimated. The food waste not allocated to AD is assumed to be composted in an aerated static pile system, and the Yard Waste Supplement is the amount of already-diverted yard waste needed to achieve a ratio of food waste to yard waste of 30/70.

Table 11. Food and Yard Waste Allocated to Anaerobic Digestion and Composting Under the 2020 Scenario with 2.5 Million Tons per Year Allocated to AD

Material	New Tons to AD	Blend %	Remaining New Tons	Ratio of Remaining New Tons	Blend for ASP Compost (Tons)	ASP Blend Ratio %	Yard Waste Supplement (Tons)[1]
Food Waste	2,016,000	80	3,432,000	63	3,432,000	30	
Green Waste	494,000	20	1,977,000	37	8,000,000	70	6,023,000
Totals[2]	**2,510,000**		**5,409,000**		**11,432,000**		**6,023,000**

1. Note that if the AD blend was 67/33, the amount of supplemental yard waste would be 7,245,000 tons per year.
2. Tons to AD is slightly more than 2.5 million, but is negligible and meets the 80/20 blend constraint.

Table 12. Food and Yard Waste Allocated to Anaerobic Digestion and Composting Under the 2025 Scenario with 3.75 Million Tons per Year Allocated to AD

Material	New Tons to AD	Blend %	Remaining New Tons	Ratio of Remaining New Tons	Blend for ASP Compost (Tons)	ASP Blend Ratio %	Yard Waste Supplement (Tons)[1]
Food Waste	2,992,000	80	3,809,000	63	3,809,000	30	
Green Waste	767,000	20	2,719,000	37	9,000,000	70	6,280,000
Totals[2]	**3,759,000**		**5,409,000**		**12,809,000**		**6,280,000**

1. Note that if the AD blend was 67/33, the amount of supplemental yard waste would be 7,769,000 tons per year.
2. Tons to AD is slightly more than 2.5 million, but is negligible and meets the 80/20 blend constraint.

CalRecycle, in their document entitled *State of Recycling in California* (March, 2015), estimated that the current throughput for compost facilities is 6,200,000 tons per year, while there is existing compost capacity for up to 8,000,000 tons per year. Therefore, under the scenario represented by Tables 11 and 12, all of the currently composted material would need to be blended with the food waste for composting. The amount of compostable material currently being applied to land without composting is substantial but unknown, and could be made available for composting with food waste. Land application of post-consumer food waste is not allowed, so as the collection of comingled green waste and food waste becomes more common, material that is currently being land applied should be diverted to compost facilities.

To compost the high food waste content feedstock, windrow composting facilities will have to invest in aerated static pile compost systems. CalRecycle also estimates that there are currently 169 active permitted composting facilities in California and that the 12 largest composting facilities in California account for 50 percent of the current throughput, while roughly a third of active facilities manage 5,000 tons or less of organic material each year. The smaller facilities will probably not be able to make the investments needed to change composting methods to manage high food waste content feedstocks, and will continue to compost materials that can be managed in open windrows.

Compost capacity will be needed for the following feedstock sources, as shown in Table 13.

Table 13. Compost Capacity Required for Various Scenarios

Source of Material	2020 (Tons per Year)	2025 (Tons per Year)
Material that is currently being composted	6,200,000	6,200,000
Anaerobic digestion digestate, which is about 80% of the anaerobic digestion feedstock[1]	2,000,000	3,000,000
Yard waste to be diverted from landfill disposal and not going to AD	1,977,000	2,719,000
Food waste to be diverted from landfill disposal and not going to AD	3,432,000	3,809,000
Material that is currently being land applied but will contain food waste in the future	Unknown	Unknown
Totals	> 13,609,000	> 15,728,000

1. Note that the use of an in-vessel compost system for digestate for several days prior to going to a compost facility can reduce the digestate amount to about 50% of incoming feedstock, and can allow the digestate to enter the compost process in the curing phase and skip active composting. This analysis assumes that the digestate is composted in aerated static pile composting bunkers.

Alternatively, additional food waste could serve as AD feedstock, given that in both the 2020 and 2025 scenarios shown in Tables 10 and 11, the majority of food waste goes directly to composting. An alternative scenario is presented in Tables 14 and 15 assuming that 75% of food waste is anaerobically digested.

Table 14. Food and Yard Waste Allocated to Anaerobic Digestion and Composting Under the 2020 Scenario with 75% of Food Waste Allocated to AD

Material	Tons to AD	Blend %	Remaining New Tons	Ratio of Remaining New Tons	Blend for ASP Compost (Tons)	ASP Blend Ratio %	Yard Waste Supplement (Tons)[1]
Food Waste	4,086,000	80	1,362,000	48	1,362,000	30	
Green Waste	1,013,000	20	1,458,000	52	3,200,000	70	1,742,000
Totals	**5,099,000**		**2,820,000**		**4,562,000**		**1,742,000**

1. Note that if the AD blend was 67/33 rather than 80/20, the amount of supplemental yard waste would be 2,706,000 tons per year.

Table 15. Food and Yard Waste Allocated to Anaerobic Digestion and Composting Under the 2025 Scenario with 75% of Food Waste Allocated to AD

Material	Tons to AD	Blend %	Remaining New Tons	Ratio of Remaining New Tons	Blend for ASP Compost (Tons)	ASP Blend Ratio %	Yard Waste Supplement (Tons)[1]
Food Waste	5,101,000	80	1,700,000	44	1,700,000	30	
Green Waste	1,290,000	20	2,196,000	56	3,900,000	70	1,704,000
Totals	**6,391,000**		**3,896,000**		**5,600,000**		**1,704,000**

1. Note that if the AD blend was 67/33 rather than 80/20, the amount of supplemental yard waste would be 3,059,000 tons per year.

Overall Avoided Emissions and Costs

Avoided emissions are estimated using the carbon intensity (CI) of -22.93 g CO_2e/MJ and a diesel gallon CI of 102 g CO_2e/MJ. Applying this CI to an RCNG generation rate of 330,000 DGE/year, adjusting by the energy economy ratio of 0.9, the overall avoided GHG emissions are 4,900 $MTCO_2e$/year per facility. Statewide costs and avoided emissions are shown in Table 16.

Table 16. Overall Statewide Avoided Emissions and Costs for Various Scenarios

Scenario	Number of 25,000 TPY Facilities[1]	Annual Diesel Gallon Equivalents[2]	Annual MTCO2e Avoided[3]	Total Capital Cost
AB 32 Scoping Plan Update – 2.5 Million Tons by 2020	100	33,000,000	499,000	1,940,000,000
AB 32 Scoping Plan Update – 3.75 Million Tons by 2025	170	56,100,000	848,000	3,298,000,000
75% of Food Waste to AD in 2020	204	67,320,000	1,018,000	3,957,600,000
75% of Food Waste to AD in 2025	255	84,150,000	1,272,000	4,947,000,000

1. A 25,000 tpy facility is used as a basis, but there would certainly be larger facilities, as well, that would reduce the number of facilities and benefit from economies of scale. The number is arrived at by dividing the "Tons to AD" from previous tables by 25,000.
2. Assuming 330,000 DGEs per facility per year.
3. CI of -22.93 g CO2e/MJ for RCNG; 102 for diesel; EER = 0.9.

As noted previously, there are about 15,000 heavy-duty vehicles operating in the solid waste industry in California, creating a demand approaching 200 million diesel gallon equivalents annually. A significant fraction of that demand can be met by food and yard waste diverted from landfill disposal. Much, if not all of the balance, could be provided from legacy landfill gas and waste water treatment plant digesters (Williams, R.B., et al, 2014).

The avoided emissions from compost use from the CARB document *Method For Estimating Greenhouse Gas Emission Reductions From Compost From Commercial Organic Waste* (CARB, November 2011) are 0.54 MTCO2e/ton of compost feedstock, which includes avoided emissions from increased soil carbon storage, decreased water use, decreased soil erosion, decreased fertilizer use, and decreased herbicide use. The LCFS estimate of avoided emissions from composting uses only the decreased fertilizer use category and reduces the co-product emission reduction factor from compost use from the CARB document value of 0.13 MTCO2e/ton of feedstock to only 0.07 MTCO2e/ton of feedstock. Therefore, the CARB estimated emission benefit from compost use is 0.54 MTCO2e/ton of feedstock, but the LCFS fuel pathway document for High Solids Anaerobic Composting only uses 0.07 MTCO2e/ton of feedstock, a reduction by a factor of about 8. If a larger fraction of the potential benefit from this co-product use were used in the LCFS fuel pathway for high solids anaerobic digestion, the CI would be correspondingly lower than -22.93 g CO_2e/MJ.

Marginal Abatement Cost – Cost per $MTCO_2e$ Abated

Edgar and Associates conducted a marginal abatement cost analysis in June 2015, and analyzed both high solids anaerobic digestion and aerated static pile composting over a project time horizon of 20 years and found that both technologies have a marginal abatement cost of about \$50/$MTCO_2e$. The analysis is attached. In an effort to model a generic facility, the analysis for an AD facility is based on the parameters used in the LCFS fuel pathway for high solids anaerobic digestion, which differs from the 25,000 ton-per-year model described in this white paper. The ASP compost system does not produce transportation fuel, but was included as an alternative method of organics management.

To calculate avoided emissions, the anaerobic digestion for biomethane transportation fuel scenario is analyzed using the LCFS carbon intensity of -15.29 g CO2e/Mj, which has since been updated to -22.93. This carbon intensity value is intended to represent the life cycle emission impact, including emissions avoided by co-product use. The avoided emissions from the ASP compost system are estimated using the CARB document, *Method for Estimating Greenhouse Gas Emission Reductions from Compost from Commercial Organic Waste* (November, 2011). As discussed above, the LCFS only considers a fraction of the avoided emissions from the co-product compost use identified by CARB.

Conclusion

This technology provides the ability to site an anaerobic digestion facility with a purification system and vehicle fueling system on a very small footprint. This is perfect for existing waste management facilities, allowing the organic waste collected to fuel the entire fleet of waste collection vehicles, which can fuel while being parked overnight. This approach not only avoids greenhouse gas emissions from burning fossil fuels, but is a well-suited method for managing the putrescible waste that will be diverted from landfill disposal over the next ten years.

This approach has been deemed a *Community-Scale Distributed Transportation Fuel Production Facility*. Project economics vary significantly from project to project due to site-specific factors. The economics can result in a positive cash flow, but the return on investment is not necessarily attractive to private sector investors, and State funding assistance is a desirable and appropriate way to commercialize and incentivize project implementation.

References

California Air Resources Board, *Low Carbon Fuel Standard (LCFS) Pathway for the Production of Biomethane from High Solids Anaerobic Digestion (HSAD) of Organic (Food and Green) Wastes,* (updated December, 2014).

CalRecycle, *2014 Disposal – Facility - Based Characterization of Solid Waste in California*, (October, 2015).

California Air Resources Board, *Method For Estimating Greenhouse Gas Emission Reductions From Compost From Commercial Organic Waste* (CARB, November 2011)

Williams, R. B., B. M. Jenkins and S. Kaffka (California Biomass Collaborative). 2014. *An Assessment of Biomass Resources in California, 2012 – DRAFT*. Contractor Report to the California Energy Commission. PIER Contract 500-11-020.

ATTACHMENT A

AB 1826 ORGANIC WASTE RECYCLING PROGRAM AND SUPPORTING LEGISLATION

The purpose of this "Organic Waste Recycling Plan" is to provide the cities with an "Organic Waste Recycling Program" to comply with AB 1826, which mandates phased-in commercial organics recycling collection to 2020, which builds upon AB 341, which required mandatory commercial recycling in July 1, 2012. Other supporting legislation will also be addressed by identifying 15-years of organic waste processing capacity required of AB 876 and will address the Strategy Paper to mitigate methane as a Short-Lived Climate Pollutant by the California Air Resources Board (CARB) that would effectively eliminate organics from disposal by 2025.

With AB 1826 phase-in collection to 2020, AB 1594 phase-out green waste alternative daily cover (ADC) credits to 2020, 90% diversion of all organics by 2025 to mitigate methane, and identifying organic processing capacity to 2030, there will be over 14.5 million tons of organic waste coming onto the market statewide that needs organic waste processing capacity.

AB 341 "Mandatory Commercial Recycling" | Assembly Bill 341 was signed into law in 2012 in an effort to increase the amount of material diverted from landfills from the commercial sector. It states that businesses that generate four cubic yards or more of commercial solid waste per week shall arrange for recycling services. The same requirement is also applied to multifamily dwellings of five units or more. These multifamily homes and businesses can either self-haul the materials to an appropriate facility themselves, subscribe to an existing recycling service, or arrange for other pickup of recyclable materials.

Requirements of Local Government: Each jurisdiction shall implement a commercial solid waste recycling program that consists of education, outreach, and monitoring of businesses that is appropriate for that jurisdiction and is designed to divert commercial solid waste from businesses. These jurisdictions shall report the progress achieved in implementing its commercial recycling program, including education, outreach and monitoring, and if applicable, enforcement efforts and exemptions, by providing updates in its electronic annual report.

Enforcement: CalRecycle will review each jurisdiction's commercial recycling program that consists of education, outreach and monitoring. This will include an evaluation as part of its formal AB 939 review, conducted every two or four years of each jurisdiction's programs, which includes an annual jurisdiction site visit, review of the Electronic Annual Report, and other information a jurisdiction may deem relevant.

If the jurisdiction is found to have **not** made a good-faith effort in implementing its programs, possibly including its mandatory commercial recycling program, CalRecycle can place the jurisdiction on a compliance order as part of the AB 939 review, and if it then fails to adequately meet the conditions of the compliance order, then CalRecycle could consider a penalty hearing.

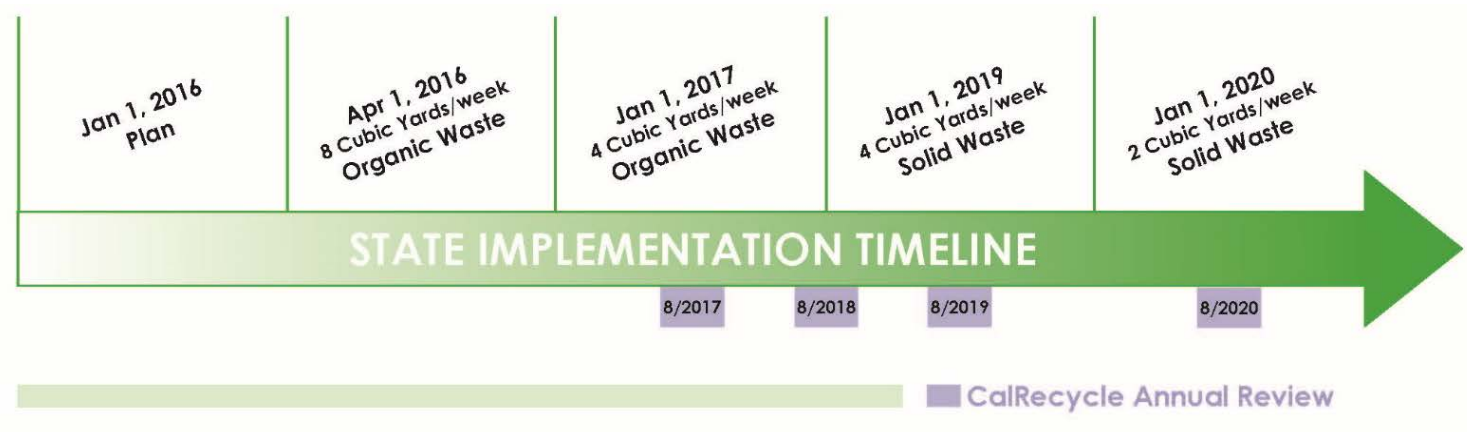
AB 1826 "Mandatory Commercial Organics Recycling" | In October of 2014 Governor Brown signed AB 1826 into law requiring businesses to recycle their organic waste on and after April 1, 2016, depending on the amount of waste they generate per week. This law also requires that on and after January 1, 2016, local jurisdictions across the state implement a commercial **Organic Waste Recycling Program** to divert organic waste generated by businesses. Jurisdictions must conduct outreach, education to inform businesses how to recycle organic waste in the jurisdiction, and monitoring to identify those not recycling and inform them of the law and how to recycle organic waste. Specific requirements for the Organic Waste Recycling Program include:

- ✓ Identification of the number of regulated businesses that generate organic waste
- ✓ Education, Outreach, and Monitoring following the AB 341 regulations
- ✓ Existing organic waste recycling facilities within a reasonable vicinity and the capacities available for materials to be accepted at each facility.
- ✓ Existing solid waste and organic waste recycling facilities within the jurisdiction that may be suitable for potential expansion or colocation of organic waste processing or recycling facilities.
- ✓ Efforts of which the jurisdiction is aware that are underway to develop new private or public regional organic waste recycling facilities that may serve some or all of the organic waste recycling needs of the commercial waste generators within the jurisdiction subject to this chapter, and the anticipated timeframe for completion of those facilities.
- ✓ Closed or abandoned sites that might be available for new organic waste recycling facilities.
- ✓ Other non-disposal opportunities and markets.
- ✓ Appropriate zoning and permit requirements for the location of new organic waste recycling facilities.
- ✓ Incentives available, if any, for developing new organic waste recycling facilities within the jurisdiction.
- ✓

AB 1826 phases in the mandatory recycling of commercial organics. The implementation schedule outlined is as follows:

- ✓ **January 1, 2016** | On and after this date, local jurisdictions must have an Organic Waste Recycling Program in place. Jurisdictions must identify regulated businesses and conduct outreach and education to inform those businesses how to recycle organic waste in the jurisdiction, and monitor to identify those not recycling and inform them of the law and how to recycle organic waste.
- ✓ **April 1, 2016** | Businesses that generate 8 cubic yards of organic waste per week must arrange for organic waste recycling services.
- ✓ **January 1, 2017** | Businesses that generate 4 cubic yards of organic waste per week must arrange for organic waste recycling services.
- ✓ **August 1, 2017 and ongoing** | Jurisdictions must provide information about their Organic Waste Recycling Program implementation in the annual report submitted to CalRecycle.
- ✓ **Fall 2018** | After receipt of the 2017 annual reports submitted on August 1, 2018, CalRecycle shall conduct its formal review of those jurisdictions that are on a two-year review cycle.
- ✓ **January 1, 2019** | Businesses that generate 4 cubic yards or more of commercial solid waste per week must arrange for organic waste recycling services.
- ✓ **January 1, 2020** | On or after January 1, 2020, if CalRecycle determines that the statewide disposal of organic waste has not been reduced by 50% of the level of disposal in 2014, the organic recycling requirements on businesses will expand to cover businesses that generate 2 cubic yards or more of commercial solid waste per week. Additionally, certain exemptions may no longer be available if the 2020 target is not met.
- ✓ **Fall 2020** | After receipt of the 2019 annual reports submitted on August 1, 2020, CalRecycle shall conduct its formal review of all jurisdictions. CalRecycle will continue to conduct the two- and four-year reviews after this cycle.

AB 1826 State Implementation Timeline

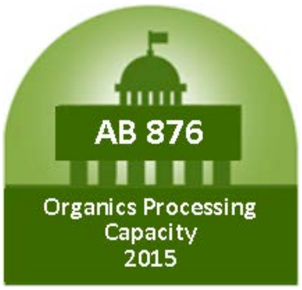


AB 1594 "Green Waste ADC Phase-out of Diversion Credits" | This bill was approved by the Governor on September 28, 2014 and states, commencing January 1, 2020, would provide that the use of green material, as defined, as alternative daily cover does not constitute diversion through recycling and would be considered disposal for purposes of the act. The bill, commencing August 1, 2018, would require a local jurisdiction to include information in an annual report on how the local jurisdiction intends to address these diversion requirements and divert green material that is being used as alternative daily cover. The bill would require a jurisdiction that does not meet certain diversion requirements as a result of not being able to claim diversion for the use of green material as alternative daily cover to identify and address, in an annual report, barriers to recycling green material and, if sufficient capacity at facilities that recycle green material is not expected to be operational before a certain date, to include a plan to address those barriers. The bill would impose a state-mandated local program by imposing new duties upon local agencies with regard to the diversion of solid waste.

SB 605 "Short Lived Climate Pollutants" | SB 605 was signed into law in 2014 and requires CARB to develop a comprehensive strategy by January 2016 to reduce emissions of short-lived climate pollutants such as methane. CARB has been busy in 2015 preparing the methane mitigation plan in concert with another AB 32 Scoping Plan action measure to effectively eliminate the disposal of organic materials at the landfill. Although not finalized, SB 605 is moving towards 90% organics diversion from landfill by 2025.

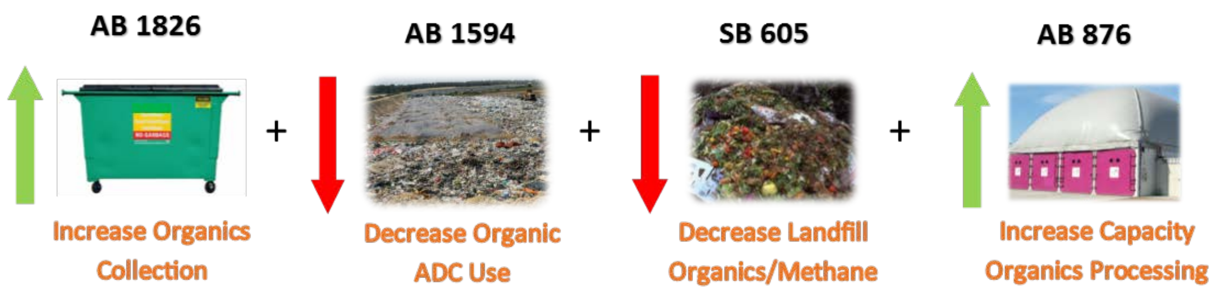
CARB released its Concept Paper "Short-Lived Climate Pollutant Reduction Strategy" on May 7, 2015. After a series of public workshops and input, CARB amended the paper and released their "Draft Strategy" on September 30, 2015. In their efforts, CARB identified Short-Lived Climate Pollutants (SLCP) such as methane, fluorinated gases, black carbon, and tropospheric ozone as priority targets for greenhouse gas abatement. Compared to carbon dioxide, these gases remain in the atmosphere for a much shorter period of time, and have a greater relative potency. CARB is Draft Strategy estimates that 40% of the global warming experienced to date may have occurred as a result of SLCP and recommends the following strategy for methane mitigation:

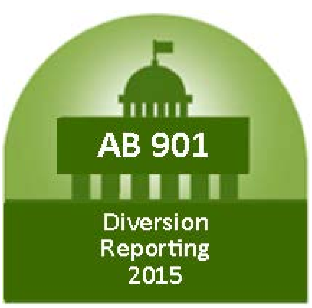
"For landfills, CARB will work with CalRecycle to develop a regulation by 2018 to progress towards existing State targets for landfill diversion by 2020, and effectively eliminate organic disposal in landfills by 2025"



AB 876 "15-Year Organic Processing Capacity" | AB 876 passed in 2015 and compliments AB 1826 by requiring, beginning August 1, 2017, cities to include in their annual reports to CalRecycle an estimate of the amount of organic waste that will be generated by the City over a 15-year period. In addition, it calls for an estimate of the additional organic waste capacity that will be needed to process that amount of waste, and areas identified by the City as potential locations for new or expanded organic waste recycling facilities capable of safely meeting that additional need.

How Organics Legislation Works Together





AB 901 "Reporting Requirements" | AB 901, which was passed in 2015, will require exporters, brokers, and transporters of recyclables or compost to submit periodic information to CalRecycle on the types, quantities, and destinations of materials that are disposed of, sold, or transferred inside or outside of the state, and would authorize the department to provide this information, on an aggregated basis, to jurisdictions, as specified. The bill would make the aggregated information, other than that aggregated by company. AB 901 regulations will be promulgated in 2016 where Tracy Disposal is poised to report the compost amounts to the state. The regulations will not be effective until after 2017, and could start as late as January 1, 2018.

ATTACHMENT B

AB 32 Scoping Plan Update - 2014 - Waste Sector

Table 2. Assessment of GHG Emission Benefits from Diverting Organics from Landfills

Process	**Organics Disposed in Landfills** (tons/year)	**Annual Tons Diverted** (50% of total disposed in years 2015 - 2020)	**Resulting GHG Emissions Benefits from 50% Diversion MMTCO2e per year** (2015 -2020)	**Annual Tons Diverted** (75% of total disposed in years 2020 and beyond)	**Resulting GHG Emissions Benefits from 75% Diversion MMTCO2e per year** (2020 and beyond)
Composting		2.5 million	1.65[1] – 2.38[2]	3.75 million	2.48[1] – 3.56[2]
Anaerobic Digestion		2.5 million	1.38[3]	3.75 million	2.06[3]
Total	10 million	5 million	3.03 - 3.76	7.5 million	4.54 – 5.62

[1] Estimated using Emission Reduction Factor (ERF) of 0.42 MTCO2e/ton material processed (ARB draft Mandatory Recycling Report) plus adjusted avoided landfill ERF of 0.24 MTCO2e/ton material processed (adjusted by ARB)

[2] Estimated using ERF of 0.42 MTCO2e/ton material processed (ARB draft Mandatory Recycling Report) plus avoided landfill ERF of 0.53 MTCO2e/ton material processed (CalRecycle)

[3] Estimated using ERF of 0.55 MTCO2e/ton material processed by HSAD (ARB LCFS report). As noted in the Follow Up Actions, additional work is on-going to include the downstream process emission benefits in the AD ERF in addition to the avoided landfill methane emissions benefits of AD that are included here.

ATTACHMENT C

UTILIZING MARGINAL ABATEMENT COSTS FOR MORE EFFICIENT CAP-AND-TRADE BUDGET ALLOCATION

Cap-and-Trade raised $850 million for the 2014-2015 Budget with $30 million allocated to recycling and composting, $200 million to low carbon transportation, and $20 million to improving agricultural efficiency. The allocation was based upon the investment priorities set by the Governor and his Climate Action Team which promoted three key sectors that reduce greenhouse gases: Sustainable Communities & Clean Transportation, Energy Efficiency & Clean Energy, and Natural Resources & Waste Diversion.

Anaerobic digestion with composting is the only program that intersects all three key sectors and should receive greater allocation in the future. On November 7, 2014, CARB held a public workshop on the development of the 2015-2016 budget to allocate the cap-and-trade proceeds towards low carbon transportation. This was the kick-off the to the Governor’s budget due in early January 2015 that will allocate an expected $3 billion to $5 billion in cap-and-trade revenue.

On January 1, 2015, the cap-and-trade program will expand to include transportation and natural gas suppliers, placing these fuels under the cap. With legal challenges to both the low carbon fuel standard (LCFS) and the cap-and-trade program being upheld, CARB will be re-adopting the LCFS in early 2015 and reaffirm their cap-and-trade program. The carbon intensity of transportation fuels needs to be 10% less in 2020 from a 2010 baseline, where allowances and carbon credits will need to be purchased starting in 2015 to comply with the LCFS. There will be at least $3 billion in proceeds coming soon.

The California Legislative Analyst Office (LAO) reviewed the $850 million 2014-2015 Budget and determined that it was important that proceeds be invested in a way that maximizes GHG emissions reduction given the level of spending, thereby putting downward pressure on the price of allowances and carbon credits. The LAO concluded that the budget lacked a coordinated approach with metrics and oversight in order to evaluate programs and their co-benefits. Plus, the LAO understood that there was no specific guidance on how to compare GHG emissions reductions, as each state department had their own process. The LOA recommended that the Governor may want to increase or decrease funding for specific programs in the future that will maximize GHG emission reductions.

A 2008 Study titled “*A Cost-effectiveness Analysis of AB 32”* authored by Stanford University offers a Greenhouse Gas Reduction Supply Curve which compares the marginal abatement costs of various programs in order to ascertain the cost-effectiveness of each. Such a study, if updated to incorporate relevant new technologies, would address the concerns brought forth by the LAO, and provide guidance in moving forward with budget allocation. Within the framework of this initial study, Edgar & Associates performed a marginal cost evaluation of anaerobic digestion and covered compost and determined both to be cost effective, and that both produce enough economic benefits as to actually be *socially cost negative* over time. A summary of these studies and their implications follows:

MARGINAL ABATEMENT COST ANALYSIS OF AB 32

Background

Definition of a MAC

Marginal Abatement Cost (MAC) is the incremental net social cost of reducing one unit of pollution. Its value is measured as the average *social cost* of any given pollution reduction method divided by the amount of pollution it abates. Displaying the marginal abatement costs of feasible technologies from most cost-effective to least cost-effective forms a *Marginal Abatement Cost Curve*.

Each technology has physical and economic limitations which constrain the amount of pollution the technology can remove before the next technology becomes more cost effective. As the most economically feasible opportunities for reducing pollution are exhausted, MACs increase. This is depicted on the Marginal Abatement Cost Curve by the width of each abatement option. This width represents the range at which any particular technology is the most efficient feasible option. Thusly, the curve allows us to see the most economically efficient approach to reaching a given level of abatement.

'A Cost-effectiveness Analysis of AB 32 Measures'

'A Cost-effectiveness Analysis of AB 32 Measures' authored by Stanford University in 2008, prepared one such Marginal Abatement Cost Curve for greenhouse gas reduction, measured in Metric Tons of Carbon Dioxide Equivalent Reduced ($MTCO_2E$). The study compared various programs in a marginal abatement cost analysis in order to assist CARB in adopting rules and regulations to achieve "*the maximum technologically feasible and cost-effective greenhouse gas emissions reductions"* as stated in AB 32. Over 40 programs with 175 million metric tons of GHG reductions were evaluated, producing MAC costs ranging from over $150/$MTCO_2E$ to technologies that are *cost negative.* Cost-negative technologies are those options which over their lifespans produced cost savings or revenue greater than their costs.

In the 2008 study, Anaerobic Digestion (AD) and Covered Aerated Static compost Piles (CASP) were not evaluated since those types of programs had not yet been developed at the time. With projects in place and the recent CalRecycle and CEC grant process providing GHG metrics, Edgar & Associates has been able to determine that anaerobic digestion and covered compost have a marginal abatement cost of negative $50/ton per $MTCO_2E$ (see insert).

Methodology

Stanford's assumptions

To maintain consistency with Stanford's study, all of the same assumptions were used to measure the cost-effectiveness of AD and CASP. The initial study used "social costs" to measure true economic costs of each technology. This entailed subtracting future diesel fuel savings (at $4/gallon in 2006 dollars) from the overall costs of the project (using a 5% discount rate). Several of the technologies investigated in the initial study, such as investments in fuel economy, reached cost negativity within their lifespans. The analysis of AD and CASP concludes that these technologies experience similar efficiencies.

Our assumptions

Based off the best available information for AD and CASP systems, an assumption of a 20 year lifespan for each technology is reasonable. This lifespan does incur regular operations and maintenance expenses which are factored into the final cost, consistent with the Stanford methodology. An assumption of 2% annual inflation was used. Additionally, the following parameters were used in the cost benefit analysis:

Costs and Benefits Assumptions

i. ***Tip fee: $50/ton***
ii. ***Compost price: $16/ton***
iii. ***AD Facility cost: $20,000,000***
iv. ***AD O&M costs: $2,000,000/year***
v. **CASP Facility cost $9,000,000**
vi. **CASP O&M costs $900,000/year**

GHG reductions Assumptions

vii. **GHG estimation methodology:** CARB's "Method for Estimating Greenhouse Gas Emission Reductions from Compost from Commercial Organic Waste" – 11/14/2011
viii. **$MTCO_2E$ reduction for AD = -15.29/MJ** from CARB's "Low Carbon Fuel Standards Staff Report" - 6/28/2012
ix. **AD & CASP: 25,000 TPY and 30,000 TPY processing capacity respectively**
x. **GWP of Methane: 21**

Results

Anaerobic Digestion:

Using the aforementioned assumptions, a typical 25,000 tons-per-year anaerobic digestion system would abate approximately 17,307 $MTCO_2E$ every year. At the end of its 20 years it would have avoided

90,500 $MTCO_2E$ worth of emissions. After approximately 18 years, the sale of compost, the avoided tipping fees, and the diesel gasoline savings would make such a project cost-neutral (even given a 5% discount rate, 2% inflation, and regular operating and maintenance costs.) By the end of 20 years, the marginal abatement costs of anaerobic digestion would be -$50/$MTCO_2E$.

Covered Aerated Static Pile:

Although Covered Aerated Static Pile Composting systems do not benefit from the fuel savings of anaerobic digestion, lower upfront costs and maintenance expenses make CASP systems comparable to AD in terms of Marginal Abatement Costs. Such systems could be expected to avoid 4525 $MTCO_2E$ each year throughout their 20 year lifespan. This ultimately results in a total GHG reduction of 90,500 $MTCO_2E$, leading to a marginal abatement cost of -$50/ton. CASP systems reach cost negativity after approximately 11 years.

Conclusion

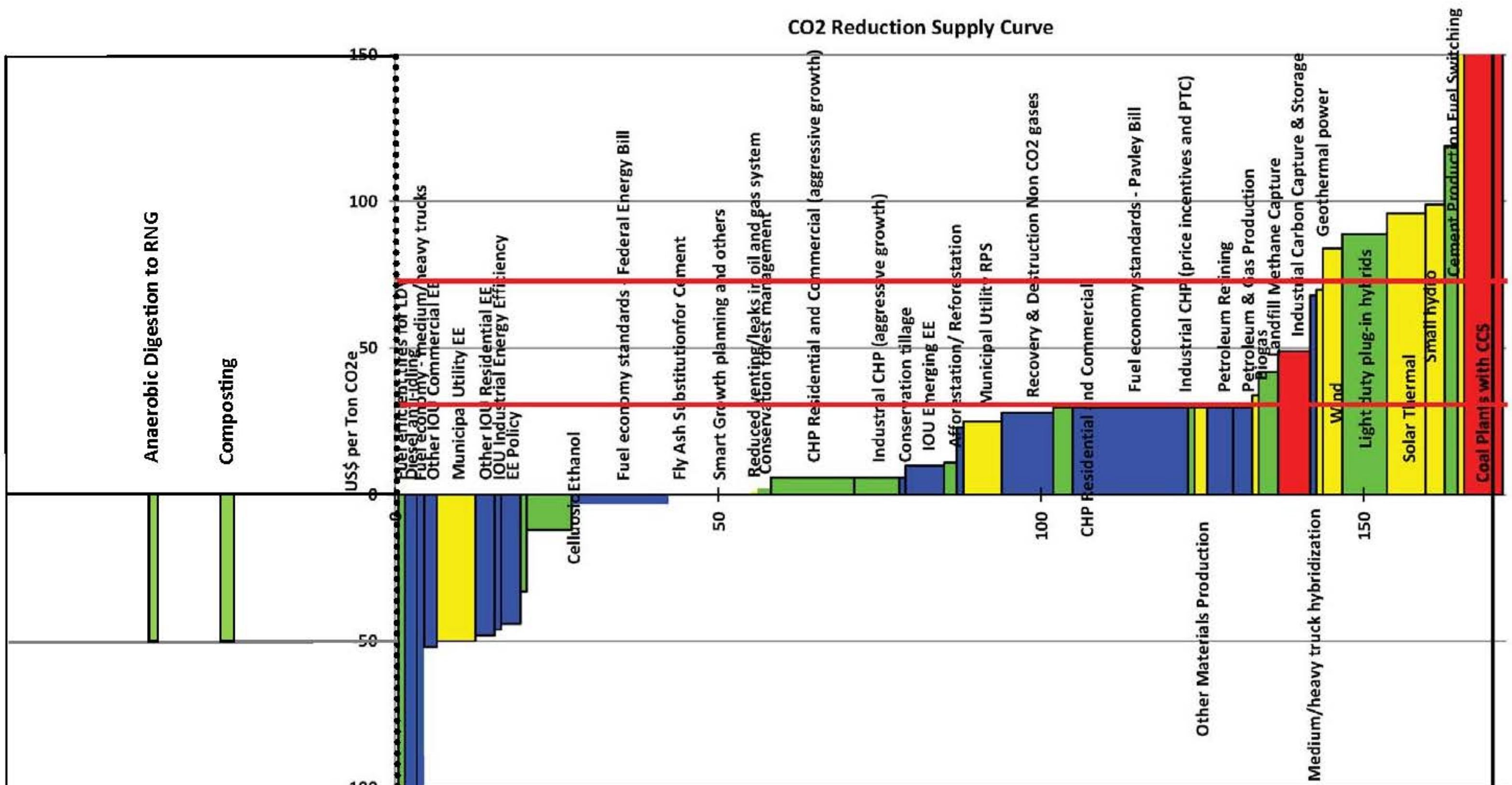
Analysis

Even in the brief period of time between this study's initial release and today, there have been substantial innovations that have improved the cost-effectiveness of greenhouse gas reduction. Identifying and implementing these improvements to achieve the goals of AB 32 will require new metrics that reflect the technological reality of 2015 and beyond. As the 2020 target date of AB 32 approaches, these new metrics will be essential for realizing the most greenhouse gas reduction per dollar spent.

Recommendations

It is our recommendation that the California Air Resources Board adopt, update, and amend a cost-effectiveness study of AB 32 like the one presented by Stanford University. Data from such a study will show that investments in emerging organics waste management technologies will make significant and efficient progress towards accomplishing AB 32's mandate.

In addition to using economic efficiency analysis to select the most efficacious GHG reduction measures, we believe that greater resources should be allotted to waste diversion. The current 3.5% of the 2014-2015 budget that is dedicated to waste diversion, should increase to 5% of the upcoming 2015-2016 budget. This $150 million would foster the investments necessary to bring the promising new innovations, such as anaerobic digestion and covered composting systems, to eliminate greenhouse gases at the lowest cost.



More Certain | Uncertain | Very Uncertain

AB 32 Scoping Plan First Update

(with respect to CO2 Reduction Supply Curve Model)

- 2MMTCO2 Anaerobic Digestion
- 5MMTCO2 Composting

Marginal Abatement Cost Analysis

by

Edgar & Associates, 2014

Source: Prof. James Sweeney, Precourt Institute for Energy Efficiency, Stanford University:

"Analysis of Measures to Meet the Requirements of California's AB 32 "