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California Air Resources Board
1001 I Street
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Re: Short Lived Climate Pollutant Concept Paper

Thank you for the opportunity to provide comments on the May 2015 *Short-Lived Climate Pollutant Reduction Strategy Concept Paper* (the Concept Paper). We fully support CARB's work to achieve deep reductions in the emissions of Short Lived Climate Pollutants (SLCPs). Covanta is a national leader in developing, owning and operating facilities that convert municipal solid waste ("MSW") into renewable energy (energy-from-waste or "EfW" facilities). These facilities are internationally recognized as a source of greenhouse gas mitigation, including by the U.S. EPA,[1] U.S. EPA scientists,[2] the Intergovernmental Panel on Climate Change ("IPCC"),[3] the World Economic Forum,[4] the European Union,[5,6] CalRecycle,[7] and the Center for American Progress.[8] This GHG mitigation is achieved by displacing grid connected fossil-fuel fired electricity, recovering metals from the waste stream for recycling, and most importantly, by avoiding landfill emissions of methane, a key SLCP.

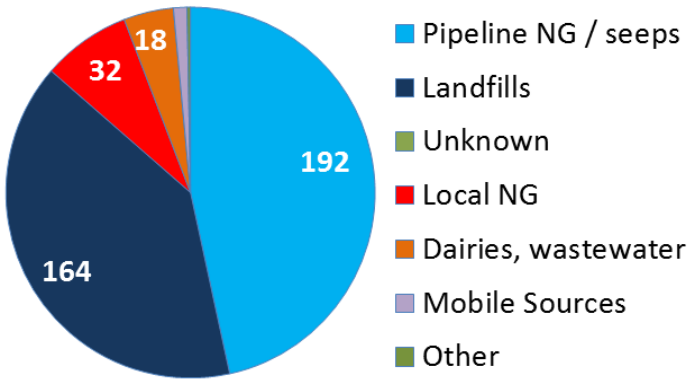
Recent research underscores the need for proactive steps to reduce California's methane emissions, which may be greater than previously thought. According to a 2013 report prepared for CARB and CalEPA, "California's CH_4 emissions are estimated to be 1.30 – 1.74 times larger than the current State total CH_4 emissions."[9] Two recently published manuscripts came to a similar conclusion for the L.A. area.[10,11] To combat landfills' 20% share of California's methane emissions, we fully support the diversion of organics to composting, anaerobic digestion, and energy recovery. To properly account for methane's impacts on the atmosphere, we recommend that CARB move forward with the global warming potentials outlined in the IPCC's 5th Assessment Report reflected the current scientific consensus. Lastly, in order to best account for the reductions achievable through landfill organics diversion, we support CARB's efforts to better quantify fugitive methane emissions from major sources, including landfills.

Organics Diversion

We fully support the diversion of organics materials from landfills to higher and better uses of this material, including anaerobic digestion, composting, and energy recovery. We believe all forms of energy recovery have a potential role to play, including fuels conversion, advanced technologies, and the California's existing EfW facilities.

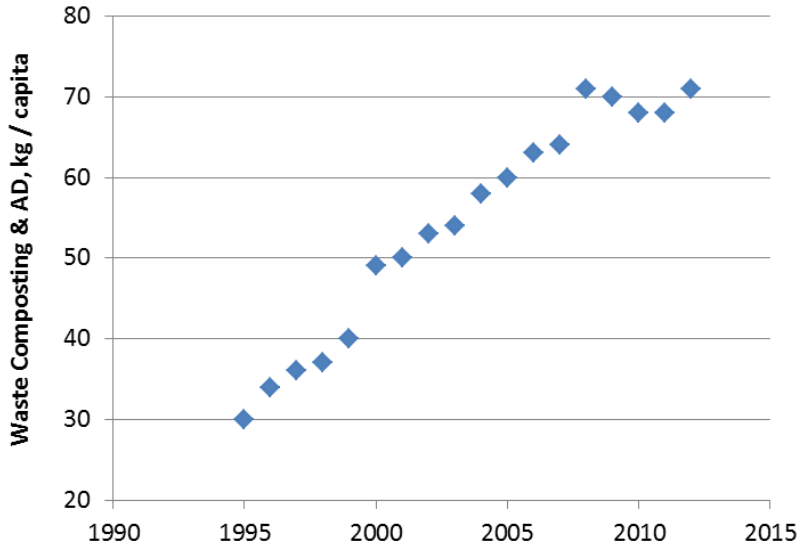
The benefits of organics diversion are clear. Despite the tremendous advancements made by CARB in regulating landfills, resulting in the most arduous standards in the nation, landfill emissions, at 20% of the state's inventory, are still significant. For example, a 2013 peer-reviewed paper authored by NOAA, UC-Davis, UC-Irvine, and Harvard scientists, confirmed CARB's inventory approach for estimating landfill emissions, predicated on a 75% collection efficiency.[12] So, despite well operated collection systems coupled with well-designed final caps, the most stringent regulatory regime in the country, and a dry climate, landfills are still only controlling about 75% of the gas under the best of conditions and remain a significant source of methane (Figure 1).

Figure 1. South Coast Air Basin (SoCAB) CH_4 Inventory (Gg CH_4 / yr)[13]



The only sure way of reducing landfill methane emissions is to prevent their generation in the first place through landfill diversion. In fact, this approach has been followed with great success by the European Union, primarily through the Landfill Waste Directive, which calls for the reduction in landfilling of biodegradable wastes.[14] The European Environment Agency (EEA) attributes considerable reductions in waste management GHG emissions to increased levels of recycling, including composting, and EfW.[15] In fact, the proactive waste policies of the EU have been an overwhelming success in Europe's efforts to reduce GHG emissions: the waste sector achieved the largest relative reduction (34%) of any sector in the EU.[16] Both composting and AD have shown steady growth in the EU (Figure 2) as a result of policies.

Figure 2. Growth in EU-27 Per Capita Composting & Anaerobic Digestion



Effective organics diversion will take support. When market conditions make it economical to landfill, waste will naturally flow to landfills, which is the lowest cost option and the predominant market actor, taking 25 million tons of waste each year in California. Other waste management options, like recycling, anaerobic digestion and even EfW, cost significantly more to operate and have to compete against inexpensive landfill tip fees.

Methane Global Warming Potential

We are pleased to see the mention of the revised global warming potentials ("GWPs") in the IPCC 5th Assessment Report. As acknowledged in the Concept Paper, the latest scientific consensus finds methane to be more potent than previously thought. According to the IPCC's 5th Assessment Report, methane's contribution to climate change is equivalent to over 40% of the total net drivers of climate change.[17] This latest data on methane's contribution to the increase in radiative forcing, a measure of the atmosphere's additional uptake of energy relative to pre-industrial times, and hence global warming of the earth's climate system, is over 75% higher than previously reported.

The report updated the 100 year GWP to 34 CO_2 when climate-carbon feedbacks are included and 84 times more potent over 20 years.[18] This is 36% greater than the now outdated 100-year GWP of 25 from the IPCC's former report; the same outdated figure just recently adopted by the EPA's GHG reporting program. Although the continued use of this outdated number is

convenient, it doesn't reflect current scientific consensus. We encourage CARB to incorporate the latest science on the GWP of methane as it moves forward with its plans to combat SLCPs.

Measuring Fugitive Emissions of Methane

We support the efforts to better measure methane emissions from major sources, including landfills. For example, studying methane emissions from a top-down approach helps validate the GHG inventory (a bottom-up approach), which can be very uncertain, given challenges in estimating source emissions:

> "…there exists a large uncertainty in bottom-up emission inventory models that take natural and anthropogenic sources of CH_4 to produce emission estimates due to lack of understanding of emission processes and driving data."[19]

Recent studies have identified some significant shortcomings with regard to some estimates provided for landfill emissions. In 2013, Peischl *et al.* attributed the higher observed concentrations of methane than expected from bottom-up inventory data in the L.A. basin to fossil sources of methane (e.g. natural gas distribution, geologic seeps, local oil & gas industry). The study also validated the landfill emissions estimates of CARB's GHG inventory, calculated using a 75% collection efficiency default, through two methods: direct plume measurement by NOAA aircraft *and* light alkane (C2 – C5) measurements to quantify the relative contribution of methane sources in the basin.

Concurrently, a 2013 conference paper concluded that the three southern California landfills performed much better than indicated in CARB's inventory.[20] The study was based on results from flux boxes, a methodology widely criticized for small sample sizes; large uncertainty; omission of discreet point sources like cracks or system components; interference with methane transport mechanisms; and under-reporting emissions.[21,22,23,24,25,26,27] With regard to sample size, the flux box method at the largest of the three landfills studied, the Puente Hills landfill, sampled roughly 0.0003% of the landfill's surface.

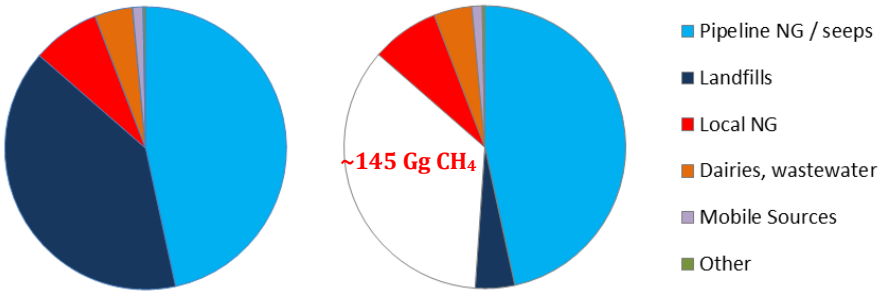
A comparison of the annual emissions flux from the Puente Hills landfill reported by the two studies and the 2008 CARB GHG inventory is presented in Table 1 below. The aforementioned conference paper study concludes emissions from the Puente Hills landfill are roughly 85-90% *below* the levels included in the state's 2008 GHG inventory. Applied to the other landfills in the South Coast Air Basin, this would result in a drop of landfill methane emissions from 164 Gg CH_4 to 18.6 Gg CH_4, as based on the CARB 2008 inventory.

Table 1. Comparison of Puente Hills Landfill Methane Emissions

Reference	Method	Year	% of Landfill Surface Measured	Annual CH_4 Flux (Mg / yr)	% difference from CARB 2008 Inventory
CARB 2008 Inventory	Modeled	2008	n/a	38.8	n/a
Peischl *et al.* (2013)	Plume measurement via NOAA aircraft	2010	100%	34.0 ± 9.9	-12.4%
Shan *et al.* (2013)	Static and dynamic flux boxes	2010-2011	0.0003%	4.4	-88.7%

If landfills indeed perform this well, there would be, once again, a significant unexplained discrepancy between the observed concentrations of methane in the SoCAB and the bottom up methane inventory of about 145 Gg CH_4 (Figure 3), or about 35%.

Figure 3.Impact of Purported lower Landfill GHG Emissions on South Coast Air Basin (SoCAB) CH_4 Inventory



SoCAB CH_4 Emissions sources, Peischl *et al.*

SoCAB CH_4 Emissions 85% lower LF emissions, per Shan *et al.* (2013)

Other methods have been used to estimate emissions from landfills with similar large disparities in results. For example, landfill surface methane concentrations and the U.S. EPA's Industrial Source Complex ("ISC") model have been used to develop landfill gas collection efficiencies approaching 95% or greater.[28] However, using this same approach, CARB has estimated that landfill methane emissions could be reasonably expected to achieve an instantaneous collection efficiency of 85%.[29]

Proper measurement of landfill emissions, instantaneous gas collection efficiencies, and development of corresponding realistic and science based estimates on the lifetime efficacy of landfill gas collection is critical: it informs the lifetime benefits of landfill organics diversion. The Peischl *et al.* paper represents a culmination of work on methane emissions in the South

Coast Air Basin, covering four peer reviewed journal articles written by scientists from very highly regarded academic and government institutions, including CARB, NOAA, NASA, Lawrence Berkeley National Laboratory, UC-Berkley, UC-Irvine, Jet Propulsion Laboratory, California Institute of Technology, University of Miami, University of Colorado Boulder, and Harvard. It also assessed the entire landfill surface through the direct measurement of the downwind methane plume. We are pleased to see this work continued as described in the Concept Paper.

Thank you very much for the opportunity to comment. Please let us know if you have any additional questions and thank you for your work on this important issue.

Sincerely,

Michael E. Van Brunt, P.E.

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[1] U.S. EPA Office of Solid Waste, Air Emissions from MSW Combustion Facilities, http://www.epa.gov/osw/nonhaz/municipal/wte/airem.htm#7

[2] Kaplan, P.O, J. DeCarolis, and S. Thorneloe, 2009, Is it better to burn or bury waste for clean electricity generation? *Environ. Sci. Technology* 43 (6) pp1711-1717. Available at: http://pubs.acs.org/doi/abs/10.1021/es802395e

[3] EfW identified as a "key mitigation measure" in IPCC, "Climate Change 2007: Synthesis Report. Contribution of Work Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. Available at: http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

[4] EfW identified as a key technology for a future low carbon energy system in World Economic Forum. *Green Investing: Towards a Clean Energy Infrastructure.* January 2009. Available at: http://www.weforum.org/pdf/climate/Green.pdf

[5] EU policies promoting EfW as part of an integrated waste management strategy have been an overwhelming success, reducing GHG emissions over 72 million metric tonnes per year, see European Environment Agency, *Greenhouse gas emission trends and projections in Europe 2009: Tracking progress towards Kyoto targets* *http://www.eea.europa.eu/publications/eea_report_2009_9*

[6] European Environmental Agency (2008) Better management of municipal waste will reduce greenhouse gas emissions. Available at: http://www.eea.europa.eu/publications/briefing_2008_1/EN_Briefing_01-2008.pdf

[7] CalRecycle. 2012. CalRecycle Review of Waste-to-Energy and Avoided Landfill Methane Emissions. Available at: http://www.calrecycle.ca.gov/Actions/PublicNoticeDetail.aspx?id=735&aiid=689

[8] Center for American Progress (2013) Energy from Waste Can Help Curb Greenhouse Gas Emissions http://www.americanprogress.org/wp-content/uploads/2013/04/EnergyFromWaste-PDF1.pdf.

[9] Fischer & Jeong (2013) *Inverse Modeling to Verify California's Greenhouse Gas Emission Inventory*, prepared for CARB and CalEPA.

[10] Wunch, D., *et al.* (2009) Emissions of greenhouse gases form a North American megacity, *Geophysical Research Letters*, **36**, L15810.

[11] Hsu, Y., *et al.* (2010) Methane emissions inventory verification in southern California, *Atmospheric Environment* **44** (2010) 1-7.

[12] Peischl *et al.* (2013) Quantifying sources of methane using light alkanes in the Los Angeles basin, California, *Journal of Geophysical Research: Atmospheres,* **118**: 4974-4990.

[13] Figure adapted from data presented in Figure 8 of Peischl *et al.*

[14] EU (European Union) (1999) Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. *Official Journal of the European Communities*. L182, 42, 1–19.

[15] European Environmental Agency (2008) Better management of municipal waste will reduce greenhouse gas emissions. Available at: http://www.eea.europa.eu/publications/briefing_2008_1/EN_Briefing_01-2008.pdf

[16] European Environment Agency, *Greenhouse gas emission trends and projections in Europe 2009: Tracking progress towards Kyoto targets http://www.eea.europa.eu/publications/eea_report_2009_9*

[17] Methane's contribution to the increase in radiative forcing relative to 1750 is 0.97 W / m^2, 42% of the total net increase in radiative forcing of 2.29 W / m^2. See Figure SPM.5 of IPCC WGI. 2013. *Working Group I Contribution to the IPCC Fifth Assessment Report Climate Change 2013: The Physical Science Basis Summary for Policymakers*.

[18] The IPCC concluded that "it is likely that including the climate-carbon feedback for non-CO2 gases as well as for CO2 provides a better estimate of the metric value than including it only for CO_2." See Table 8-7 of *IPCC WGI Fifth Assessment Report, Chapter 8: Anthropogenic and Natural Radiative Forcing*.

[19] See p10 of Fischer & Jeong (2013)

[20] Shan *et al.*(2012) Estimation of Landfill Gas Emissions and Collection System Efficiency Using Surface Flux Chamber Technology – A Case Study of Puente Hills Landfill, *Solid Waste Association of North America (SWANA) 35th Annual Landfill Gas Symposium*, Orlando, FL.

[21] See p16 of Solid Waste Industry for Climate Solutions (2012) *SWICS 2.2 Methane Oxidation Addendum 2012*. Addendum to SWICS (2009) *Current MSW Industry Position and State-of-the Practice on LFG Collection Efficiency, Methane Oxidation and Carbon Sequestration in Landfills, Version 2.2*.SWICS (2012)

[22] See p28 of SWANA (2013) *Practical Methods for Measuring Landfill Methane Emissions and Cover Soil Oxidation*.

[23] See p75 of EPA (2008) *Emission Factor Documentation for AP-42 Section 2.4 Municipal Solid Waste Landfills* EPA/600/R-08-116

[24] See p1-1 of EPA (2012) *Quantifying Methane Abatement Efficiency at Three Municipal Solid Waste Landfills* EPA/600/R-11/033

[25] Walker & Gin (2012) *CalRecycle Review of Waste-to-Energy and Avoided Landfill Methane Emissions*

[26] Amini, H.R., D.R. Reinhart, A. Niskanen (2013) Comparison of first-order-decay modeled and actual field measured municipal solid waste landfill methane data, *Waste Management,* **33** (12), 2720-2728.

[27] See p111 of Babilotte, A. (2011) *Field Comparison of Methods for Assessment of Methane Fugitive Emissions from Landfills*, Environmental Research & Education Foundation.

[28] Huitric & Kong (2006) Measuring Landfill Gas Collection Efficiency Using Surface Methane Concentrations

[29] California Air Resources Board (CARB 2009b), *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills, Appendix D: Evaluation of Landfill Gas Collection Efficiency,* May 2009. Available at: http://www.arb.ca.gov/regact/2009/landfills09/isor.pdf