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Filer:	Rick Moore
Organization:	Edgar & Associates
Submitter Role:	Other Interested Person
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CALIFORNIA COMPOST COALITION

Address:
1822 21st Street
Sacramento, CA 95811
Phone: (916) 739-1200
Fax: (916) 739-1216
Email:
neil@californiacompostcoaltion.org
Website:
www.californiacompostcoalition.org

Discussion of the California Air Resources Board Compost Emission Reduction Factor: Response to Interra Energy Submittal

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The comments provided by Interra Energy regarding the Compost Emission Reduction Factor (CERF) developed by the California Air Resources Board (CARB) in 2011 presents Interra Energy's case that the CERF is flawed. However, the assertion by Interra Energy that issues regarding the accuracy of the CERF have any bearing on the White Paper presented by the California Compost Coalition (CCC) are incorrect.

Although the principal objective of this comment letter is to clarify that the issues presented by Interra Energy (Interra) regarding the CARB CERF have no bearing on the White Paper submitted by the CCC, as Interra implied, there are also a number of assertions made by Interra regarding the CERF that are incorrect.

Note that links to all referenced documents are provided in the bibliography at the end of this comment letter.

The Interra Energy comment letter states that the CCC White Paper relies on the 2011 CERF developed by the California Air Resources Board, which is not the case. The CCC White Paper estimates of greenhouse gas benefits from anaerobic digestion applies the carbon intensity factor from the Low Carbon Fuel Standard (LCFS) High Solids Anaerobic Digestion (HSAD) Fuel Pathway, which was just recently re-adopted as being a minus 22.93 grams CO_2e/MJ. The manner in which the 2011 CERF value is incorporated into the LCFS HSAD Fuel Pathway is extremely conservative, as discussed in the CCC White Paper on Page 23, and is excerpted below:

> *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 CO2e/MJ.

Interra Energy's comments regarding the CERF focus principally on the soil carbon storage benefit estimated in CARB's CERF. However, the LCFS does not even include this component of the CERF in their fuel pathway. This is also discussed on Page 55 of the LCFS Fuel Pathway document for HSAD, a portion of which is excerpted below:

The solid residue that remains in the HSAD hydrolyzing units (digestate) contains organic nutrients that, when further composted, yield a high-quality compost material that is marketed as a soil amendment or a fertilizer. However, composting of the remaining digestate is fossil-fuel-energy-intensive. In addition, the estimated emissions from green waste composting could have a big impact on the overall contribution to GHG emissions. A portion of these emissions could, however, be considered to be of biogenic origin. The market impact of fully utilizing available resources by composting the digestate is the displacement of synthetically produced fertilizer. The magnitude of this displacement effect can be estimated by assuming that the nutrients in the composted digestate displace equal proportions of synthetically produced nitrogen, phosphorus, and potassium (NPK). The net GHG savings from the displacement of the synthetic fertilizer becomes the HSAD Pathway's co-product credit.

<u>Applicability of the CERF to Food and Yard Waste</u>

Interra states that the soil carbon storage emission factor of -0.256 MTCO2e/ton of feedstock is only applicable to food waste and should not be used for green waste or yard waste. The source of the emission factor is from a 2006 US EPA document entitled *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, in Chapter 4: Composting. This document describes in detail the origin of the emission factor, using the CENTURY Model, a soil-plant simulation model with a sub-module that simulates soil organic carbon pools.

The applicability of the methodology to both yard and food waste is clearly stated throughout the chapter. In the section entitled "Limitations Related to the Scope of the Report" (Page 62), it states:

> *EPA analyzed two types of compost feedstocks — yard trimmings and food discards—although sewage sludge, animal manure, and several other compost feedstocks also may have significant GHG implications.*

In a footnote on Page 58, the 2006 USEPA document states:

> *Very little information is available on the characteristics of compost derived from yard trimmings or food discards. However, Dr. Cole found that the composition of composts derived from other materials is broadly consistent, suggesting that his estimates may be reasonably applied to yard trimmings or food scrap compost.*

The table below is copied from Page 61 of the 2006 USEPA document:

Exhibit 4-6
Net GHG Emissions from Composting
(In MTCE Per Ton of Yard Trimmings Composted)

Emission/ Storage Factor (for 2010)					
Soil Carbon Restoration					
Unweighted	Proportion of C that is Not Passive	Weighted Estimate	Increased Humus Formation	Transportation Emissions	Net Carbon Flux
-0.04	48%	-0.02	-0.05	0.01	-0.05

Note that (-0.02 + -0.05)MTCE * (44/12) = -0.256 MTCO2E

Where 44/12 is the ratio of molecular weights of CO2 and carbon.

The "Net Carbon Flux" value was not used in the CARB estimate of the soil carbon storage factor because estimates of transportation emissions are calculated separately in the CARB CERF methodology.

Interra states that the soil carbon storage factor includes out-dated emission reductions from reducing methane at landfills. This is not correct; the soil carbon storage factor contains no landfill-related emissions at all. It is based entirely on organic carbon accumulation in the soil.

Updated Compost Emission Factor – June 2014

Having gained knowledge about the process since 2006, the USEPA updated the Compost Chapter in June 2014 and in March 2015 provided an updated document to replace the entire 2006 document. The update includes emission sources and sinks that had not been considered in the 2006 document. For instance, fugitive GHG emissions from compost windrows on the positive emission side, and reduced emissions from enhanced productivity and a multiplier effect for carbon retention from crop residues. The Table below is copied from the updated document (Page 29-5).

Exhibit 29-7: Soil Carbon Effects as Modeled in Century Scenarios ($MTCO_2e$/Short Ton of Organics)

Scenario	Soil Carbon Restoration: Unweighted	Soil Carbon Restoration: Proportion of C that is Not Passive	Soil Carbon Restoration: Weighted estimate	Increased Humus Formation	Net Carbon Flux[a]
Annual application of 32 tons of compost per acre	-0.04	48%	-0.07	-0.17	-0.24

[a] The net carbon flux sums each of the carbon effects together and represents the net effect of composting a short ton of yard trimmings in $MTCO_2e$.

In the June 2014 update, the net compost emission factor, after the soil carbon storage benefit is reduced by fugitive emissions, transportation emissions and compost management emissions is -0.15 MTCO2E for food waste and -0.12 MTCO2E for yard waste.

Comparison to Landfilling and Combustion

Interra makes the point several times that the WARM model results show that composting yard trimmings produces more GHG emissions than landfilling them. This is true, but to understand why it is necessary to understand the way that WARM calculates landfill emissions.

Since many organic materials do not completely decompose in landfills, some of the biogenic carbon is stored there; thus, WARM credits landfilling as a biogenic carbon sink for such materials. WARM provides an estimate of the amount of biogenic carbon stored through landfilling organic material, and then subtracts the amount of stored biogenic carbon from the landfill GHG emissions to arrive at a "net" GHG emission generation. For yard trimmings, the result is that WARM GHG impacts are often negative, masking the GHG impacts of landfill emissions. In essence:

<u>Net WARM calculated landfill emissions =</u>

Landfill fugitive and operational emissions (positive) + ***biogenic carbon storage (negative)*** *+ avoided fossil fuel emissions from landfill gas energy generation (negative)*

Since carbon storage and avoided fossil fuel emissions are negative, the net emissions from WARM are negative for certain organics. During the first few years following the passage of AB 32, there was considerable debate regarding this issue. The result was a policy decision by the State that landfills would not be considered carbon sinks in GHG accounting.

The WARM documentation provides the biogenic carbon storage factors for different materials, allowing the effect of landfill biogenic carbon storage to be factored out. For yard waste, the factor is -0.54 MTCO2E/ton (Page 29-8 of the updated WARM documentation).

A comparison of management options for yard waste is shown in the Table below, with landfill emissions calculated by WARM with and without landfill carbon storage. The landfill scenarios are:

- Landfill Scenario 1 – dry area, landfill gas used to generate electricity, typical landfill gas recovery.

- Landfill Scenario 2 – dry area, landfill gas used to generate electricity, California Regulatory landfill gas recovery.

WARM Results for Yard Trimmings (MTCO2E/ton of as-received waste)

Landfill Scenario	Yard Waste Combustion	Yard Waste Composting	Yard Waste Landfilling (WARM unadjusted results)	WARM Yard Waste Carbon Storage Factor	Landfill Emissions with Carbon Storage Removed
LF Scenario 1	-0.08	-0.12	-0.34	-0.54	0.20
LF Scenario 2			-0.40	-0.54	0.14

It should be noted that the CARB CERF did not include any landfill emission impacts in the CERF value. The CARB methodology only considered a comparison between soil with and without compost application.

Compost Fugitive Emissions

Another issue cited by Interra is that the soil carbon storage factor, and by extension the CARB CERF, assumes that there are zero net emissions for composting. It is true that the soil carbon storage factor from the 2006 USEPA document did not include fugitive compost emissions. However, compost fugitive emissions of CH_4 and N_2O are included in the 2011 CARB document that describes the methodology for formulating the CERF and are accounted for in the net -0.42 $MTCO_2e$ CERF. The June 2014 update of WARM also includes fugitive emissions from composting, although the CARB CERF fugitive emission factor is about 40% higher than the WARM value.

It should be noted that these fugitive emission factors are based on windrow composting, while aerated static pile composting is being increasingly implemented.

The table below is provided to provide a comparison between the CARB CERF and the updated version of the USEPA WARM values.

Compost Emission Factors ($MTCO_2E$/ton of feedstock)
Comparison of CARB CERF and US EPA WARM Values

	CARB CERF	US EPA WARM Food Waste	US EPA WARM Yard Waste
Transportation, Process and Fugitive Emissions	0.119	0.09	0.11
Increased Soil Carbon Storage	-0.26	-0.24	-0.24
Decreased Water Use	-0.02	0	0
Decreased Soil Erosion	-0.13	0	0
Decreased Fertilizer Use	-0.13	0	0
Decreased Herbicide Use	0	0	0
Total	-0.42	-0.15	-0.13[1]

1. Note that the value presented by WARM is -0.12, apparently due to rounding.

CERF Variability Analysis

The 2011 CARB document provides a variability analysis due to uncertainty in development of the CERF. The CARB document states on Page 17:

> *The studies used to calculate each variable that contributed to the CERF were spread over a wide range of values. For instance, the fugitive CH_4 emissions ranged from 0.172 to 11.9 gCH_4/kg (Table 3) and the fertilizer benefits ranged from 0.08-0.30 $MTCO_2E$/ton of compost (Table 5). This wide range illustrates the uncertainty associated with each of these factors due to variability in the*

compost processing and in the physical properties of the soil to which the compost is added.

And on Page 18:

Applying the values for each variable, the CERF range is -0.22 to 0.90 MTCO2E/ton of feedstock. In order to use the correct units for the soil carbon storage variable, the 0.26 MTCO2E/ton of feedstock value reported in Section 3.2.1 was multiplied by two to account for the feedstock to compost conversion for B_{totH} and the 0.002 MTCO2E/ton of feedstock (from Reference 16) was multiplied by two for B_{totL}. The average between $CERF_L$ and $CERF_H$ is 0.34 MTCO2E/ton of feedstock. This value is slightly lower than the CERF (0.42 MTCO2E/ton of feedstock).

The CARB CERF is not flawed, nor are there errors in calculation; however, it does include inherent uncertainty, which was understood and quantified by David Edwards, Ph.D., who conducted the 2011 analysis to develop the CERF. Interra states that CARB and CalRecycle are currently working on updating the CERF, which is a welcome effort. However, the CERF developed by CARB in 2011 is based on an in-depth, well-researched and well-documented analysis. The CARB CERF includes avoided emissions from compost use that the EPA WARM does not include which accounts for the difference from the US EPA value.

The California Compost Coalition is in full agreement with Interra Energy that the advice of Dr. Edwards regarding the CARB CERF should be followed:

As additional research is completed, the uncertainties will diminish. In the interim, it is important to understand the shortcomings of this quantification method and apply them in a judicious manner.

Bibliography – Links to Referenced Documents

Interra Energy, Inc. Comments: Current Compost Emission Reduction Factor is Flawed, Docketed on March 7, 2016.
http://docketpublic.energy.ca.gov/PublicDocuments/15-MISC-04/TN210630_20160307T111713_Kenny_Key_Comments_Current_Compost_Emission_Reduction_Factor_is.pdf

WHITE PAPER - BIOMETHANE TRANSPORTATION FUEL POWERING THE SOLID WASTE INDUSTRY: Community-Scale Distributed Fuel Production Facilities; California Compost Coalition and CleanFleets.Net, February 2016.

http://docketpublic.energy.ca.gov/PublicDocuments/15-ALT-01/TN210695-2_20160311T164823_BIOMETHANE_TRANSPORTATION_FUEL_POWERING_THE_SOLID_WASTE_INDUSTR.pdf

Method For Estimating Greenhouse Gas Emission Reductions From Compost From Commercial Organic Waste, CARB, November 14, 2011.
http://www.arb.ca.gov/cc/protocols/localgov/pubs/compost_method.pdf

Low Carbon Fuel Standard (LCFS) Pathway for the Production of Biomethane from High Solids Anaerobic Digestion (HSAD) of Organic (Food and Green) Wastes, CARB, December 2014.
http://www.arb.ca.gov/fuels/lcfs/121514hsad.pdf

Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, US EPA, 2006.
http://nepis.epa.gov/Exe/ZyNET.exe/60000AVO.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A\zyfiles\Index%20Data\06thru10\Txt\00000000\60000AVO.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h|-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p|f&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Prepared by ICF International for the U.S. Environmental Protection Agency, March 2015.
https://www3.epa.gov/warm/pdfs/WARM_Documentation.pdf

To obtain the excel version of WARM: https://www3.epa.gov/warm/index.html