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INTERRA ENERGY®

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August 26, 2013

Michael Tollstrup
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

RE: Comments on the California Air Resources Board (CARB) 2013 Update to AB 32 Scoping Plan - Kickoff Workshop Presentation 6/13/13: Comments of Interra Energy, Inc.

I. Introduction

Recently the California Air Resource Board held a workshop to discuss the 2013 update to the AB 32 scoping plan. Interra Energy, Inc. submits the following comments to that presentation.

Interra Energy has designed a distributed waste-to-energy solution that promises to minimize GHG emissions per ton of waste associated with current bioenergy technologies and maximize value creation through its ability to also create the valuable co-product biochar. Interra aims to provide a robust technology that can be deployed in rural communities across the United States and that can divert a waste stream from landfills, combat climate change, improve degraded agricultural soils, and create permenent high-paying jobs.

The innovative design of Interra's technology maximizes overall value creation by maximizing the *yield* of the most valuable product (biochar) and maximizing the *quality* of the next most valuable product (fuel gas). Through several innovations, the technology addresses many of the fundamental technical problems faced by existing bioenergy technologies that stand in the way of broad adoption of distributed bioenergy technology. Some innovations include, maximal thermal efficiency, continous operation, and a methane based fuel gas rather than syngas output.

II. General Comments:

CARB is administering the California Cap-and-Trade compliance offset market. Currently only four project types are allowed to generate compliance offsets, with two project types under consideration. Interra would encourage the program administrators to look into biochar offset projects. Currently the American Carbon Registry (ACR) is considering the biochar offset methodology. As of the time of this writing, the methodology is expected to be approved by ACR in early 2014. Due to the unique co-benefits associated with biochar and its carbon sequestration potential CARB should seriously consider adding biochar projects to the list of project types eligible for compliance offsets.

Further, as the cap is reduced in the coming years, investment in clean technologies will be required in order to generate the amount of offsets required by regulated entities. To encourage the development of such technologies CARB needs to support innovative projects that show the promise of generating emission reductions that can enter the compliance market. If supported by CARB, biochar projects, such as Interra's, can help reduce the cost of compliance, create jobs, and drastically cut emissions. A price on GHG is not enough to meet the goals of AB 32 if the funding generated by the cap and trade program does not go to technologies that will help California reach the goals of AB 32 and/or if important emission reduction projects are not allowed to enter the compliance market. CARB can go a long way to encourage market forces to spur investments in biochar technologies.

CARB support has currently gone primarily to a small segment of the bioenergy sector. Studies have estimated that only 11% of the available biomass resources in California are in the methane sector. However, a majority of CARB support has been focused on this small methane sector, primarily supporting landfill gas and anaerobic digestion projects. Interra would encourage a shift of support to projects that economically and sustainably address the remaining 89% of California's biomass resources. Interra's technology promises to convert these waste biomass resources into the highest value end products and generate the most emission reductions.

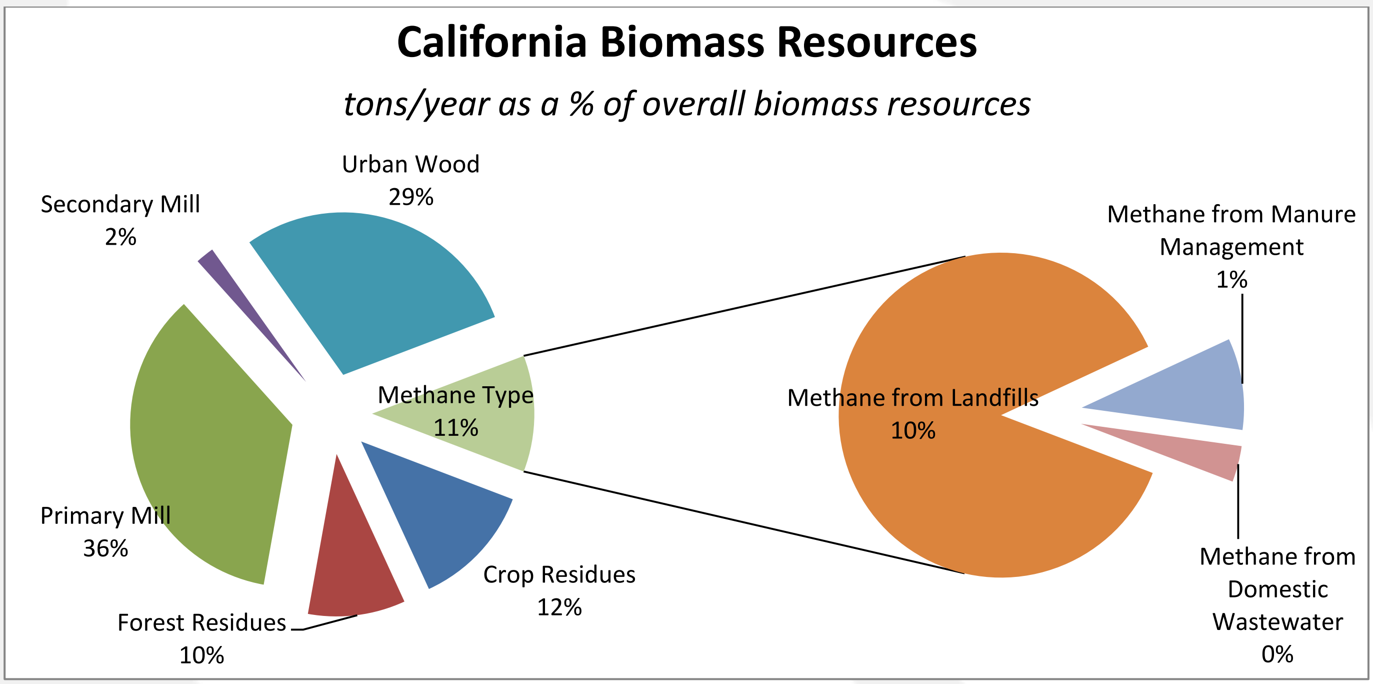

Figure 1: California Biomass Resources[1]

III. Comments on the Energy Sector Presentation:

The technology needed to reach the CARB 2050 goal of a sustainable bioenergy economy with low carbon generation is being developed today by start-up companies that do not have recognition, and the associated

[1] NREL Technical Report, NREL/TP-560-39181, *A Geographic Perspective on the Current Biomass Resource Availability in the United States*, A. Milbrandt, December 2005. *Available at* http://www.nrel.gov/docs/fy06osti/39181.pdf (last visited 8/26/13).

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funding and support, from state regulators. With the proper support, companies developing the appropriately disruptive technologies will be able to make the innovations necessary to meet the goals of CARB 2050 and AB 32.

In order to most effectively work on meeting the AB 32 goals in the Energy Sector, CARB and other state agencies should focus their efforts and funding on technologies that make leaps over the status quo instead of the current approach of funding marginal advancements for technologies that have been commercial for decades, such as anaerobic digestion and gasification. Other support mechanisms, such as loans, streamlined permitting, and contracts, can be focused on scaling up and marginally improving commercialized technologies. However, R&D and grant funding should predominately be distributed to entities, both public and private, that are developing energy technologies that have the potential to revolutionize the sector over the next 30 years. While the risk profile of each project will need to be evaluated and managed, the immense benefits that will come to the state if a technology is successfully commercialized more than make up for the risk in funding innovative R&D.

Bioenergy projects, especially those with valuable co-products and co-benefits, will play a large role in the state's energy future.

A. The Role of Bio-gas:

Bio-gas can play a large role in the state's energy sector. Interra believes that technologies that generate biomethane have the most commercial promise. This is because other bio-gas outputs, such as syngas, often require expensive upgrading prior to end use that makes commercial operations uneconomical. Interra's distinct pressurized pyrolysis technology was designed to take advantage of the beneficial shifting of gas composition pressure provides. This can be seen in Figure 2. Due to the thermal efficiency of the innovation design, air need not be let into the system for partial combustion, so the expected methane diluent gas is carbon dioxide rather than nitrogen. Nitrogen is very difficult to separate out, making the production of high purity methane cost prohibitive when there is high nitrogen contamination. CO_2, on the other hand, is capable of being separated using a pressurized water scrubbing method to separate out the CO_2 with very high efficiency. Pressurized water scrubbing is the least expensive on a $/scf final product produced metric and the most widely used CO_2 separation technology.

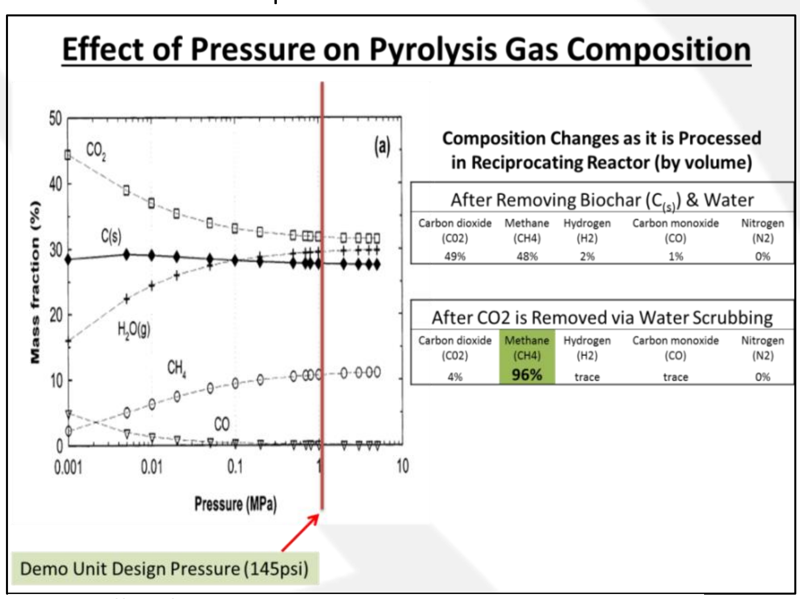

Figure 2: Effect of pressure on pyrolysis gas composition

Technologies, such as Interra's, that can efficiently and cost effectively turn waste biomass into biomethane and other co-products will play a large role in California's energy sector.

1. Biomethane for Electricity

On the electricity side, biomethane provides a domestic and renewable substitute for fossil fuels. Further, there are significant emission reductions, on a life-cycle basis, compared to other sources of energy such as natural gas and petroleum. Interra's technology goes one-step further by co-generating biochar, allowing the biomethane generation process to become carbon negative.

Indicative Emissions for the Interra Reciprocating Reactor									
		Emissions (Mg CO2e Mg-1 DM)						Net Emissions (Mg CO2e Mg-1 DM)	
		Baseline			Pyrolysis bioenergy & biochar				
Feedstock	**Baseline**	CH_4	N_20	Total	Replacing gas	Replacing coal	Biochar Carbon removal	Replacing gas	Replacing coal
Green Waste	Compost	0.25	0.18	0.43	-0.05	-0.11	-0.59	-1.07	-1.13

Positive values indicate emissions; negative values indicate avoided emissions, or removals.

Figure 3: Indicative Emissions for the Interra Reciprocating Reactor, developed by Carbon Consulting, LLC.

Interra's demonstration unit is projected to reduce emissions by 26,200 metric tons of CO_2e per year, every year (a full-scale unit is expected to reduce 45,500 metric tons CO_2e per year). To put that into perspective, if Interra's technology processed all of California's 80 million dry tons of *available* biomass[2] today, California's current annual emissions of 457.77 million tones $CO2_e$[3] would fall to 372.17 million. That rate of emissions is 15% *below* California's AB 32 target goal of reaching 1990 levels of 426.6 million tons.[4] To meet the AB 32 goals without contribution of any other activities it would take roughly 1,000 distributed installations of the technology. Of course, it is unrealistic to achieve that in the near future, but it should illustrate the scope of the potential that biochar production–especially with innovative technologies—can have on the climate change challenge.

Other co-benefits associated with Interra's technology will help it play a key role in the state's energy goals for 2020 and 2050. First, the technology will help divert waste from landfills. Second, the technology will create biochar, which can permanently improve degraded agricultural soils by increasing water and nutrient retention. Third, implementing and operating the technology will create high paying and high skill domestic jobs. Finally, the technology can create an added revenue source for large-scale agriculture facilities (similar to revenues gained from siting wind turbines on their land) or government run landfills.

2. Biomethane for Transportation

On the transportation side, Interra is conducting research into the ability to generate transportation grade biomethane with its technology. Modeling suggests that the technology can produce biomethane with the attributes required for transportation quality compressed natural gas. Should that be the results of the research, Interra's technology would be able to drastically reduce the emissions associated with transportation fuels.

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[2] http://biomass.ucdavis.edu/files/deliverables/2012-01-summary-of-current-biomass%20energy-resources.pdf
[3] http://www.arb.ca.gov/cc/inventory/inventory.htm
[4] http://www.arb.ca.gov/cc/inventory/1990level/1990level.htm

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Further, the technology would allow for synergies with waste haulers, as the waste disposal trucks that will be taking waste biomass to Interra's facilities can begin (or continue) to run on renewable natural gas, which can be provided by Interra's facilities.

Interra's biomethane output goal is the California Air Resources Board's quality specification for transportation quality compressed natural gas, which is laid out in Table 1.[5] Achieving this goal would transform the industry by offering the first thermally driven biomass process capable of cost-effectively producing transportation fuels.

Specifications for Compressed Natural Gas

Specification	Value	Test Method
	Hydrocarbons (expressed as mole percent)	
Methane	88.0% (min.)	ASTM D 1945-81
Ethane	6.0% (max.)	ASTM D 1945-81
C_3 and higher HC	3.0% (max.)	ASTM D 1945-81
C_6 and higher HC	0.2% (max.)	ASTM D 1945-81
	Other Species (expressed as mole percent unless otherwise indicated)	
Hydrogen	0.1% (max.)	ASTM D 2650-88
Carbon monoxide	0.1% (max.)	ASTM D 2650-88
Oxygen	1.0% (max.)	ASTM D 1945-81
Inert gases		
Sum of CO_2 and N_2	1.5-4.5 % (range)	ASTM D 1945-81
Water	The dew point at vehicle fuel storage container pressure shall be at least 10 degrees F below the 99.0% winter design temperature listed in Chapter 24, Table 1, Climatic Conditions	
Particulate matter	The compressed natural gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fueling station equipment or the vehicle being fueled.	
Odorant	The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.	
Sulfur	16 ppm by vol. (max.)	Title 17 CCR Section 94112

Table 1: CARB Transportation CNG Specification

B. What can be done in the Energy Sector Between 2014-2019:

With the proper incentives and support in place a lot can happen between 2014-2019 in the bio-gas sector. The following is a non-exclusive list of items that can help the sector grow: continue to support the commercialization and demonstration of technologies via grants, loans, and partnerships; develop policies for waste biomass diversion such that landfilling is no longer the default option and instead the materials are sourced to facilities that have lower emissions and can put the waste biomass to higher uses; develop streamlined permitting requirements and fast track applications for vetted projects that have demonstrated environmental and public health benefits; and include biochar projects as eligible projects in the compliance offset market administered by CARB.

With such policies in place Interra envisions tremendous growth in the bioenergy sector, benefitting many aspects of California's economy and helping the state meet the goals of AB 32.

Interra's technology can be used as an example to show the potential benefits and impacts that can occur in the sector between 2014-2019. Interra is currently building a demonstration unit projected to produce 1 MW (net) of electricity, or 16,000 gallons gas equivalent (GGE) of RNG, and 9,200 tons of biochar a year. The demonstration unit will enter full-time operation after demonstration, testing, and conducting a 1,000-1,500 hour commercialization readiness test. Interra's goal is 20 fully size units in operation by 2020, which modeling suggests will support 700 permanent operational clean energy jobs, create 900-2000 jobs in other economic

[5] Also available in California Admin. Code, tit. 13, § 2292.5.

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sectors, generate approximately 35 million GGEs of RNG, produce 318,000 tons of biochar, and sequester almost 1 million tons of CO_2e per year.

C. Challenges in the Energy Sector:

In regards to specific challenges mention in the presentation, Interra has the following comments:

1. Sustainable Feedstock:

Interra agrees that sustainable feedstock is a challenge if the bioenergy sector is going to drastically expand between now and 2050. Interra's technology was designed from the ground up to help solve the environmental challenges facing California. To this end the technology's size and scale was designed to process "waste" biomass not purpose grown crops. While this creates systems with limited output compared to large-scale biogas facilities, it creates sustainable systems that can work off of the local supply of waste cellulosic biomass. This helps to avoid land use change issues and other environmental concerns associated with the production of biomass for energy. Interra would encourage using the EPA's definition of clean cellulosic biomass (*see* 40 C.F.R. 241.2.). In California, it has been estimated that there is approximately 12,000,000 annual dry tons of waste biomass available without having to grow any new sources.[6]

2. Distance to Pipeline:

This issue stems from two problems with current bioenergy technologies. First, the bio-gas produced by current technologies often requires expensive upgrading at another facility. Second, current technologies are designed on such a large scale that they are forced to find remote regions that will allow siting and permitting of their facilities. Interra's technology solves both of these problems. The biomethane produced by Interra's technology has been modeled to be eligible to enter current turbine generators, without upgrading. Thus, the biomethane can be converted to electricity on site and fed into the local grid. In addition, the technology's scale was designed to fit within the ecological needs of local communities. As such, the technology can be located closer to feedstock and the local grid, as there are not the same permitting concerns that come with large operations.

3. Lack of Commercialized Biogas Industry:

While it is up to the private sector to fully develop this industry, regulatory and policy signals will help advance the industry. State and local officials can support the biogas industry by continuing to integrate bioenergy in the long-term plans of the state, creating streamlined permitting requirements, helping to secure feedstock diversion from landfills, and continue grant funding for commercial demonstration projects. This industry in poised for tremendous growth and will be a large player in the state moving forward.

4. Better Understanding of Co-Benefits:

The beauty of new bioenergy systems is that they often create co-products that have added benefits on top of renewable energy production. Interra's technology has the co-product of biochar, which Interra agrees needs

[6] NREL Technical Report, NREL/TP-560-39181, *A Geographic Perspective on the Current Biomass Resource Availability in the United States*, A. Milbrandt, December 2005. Note: Estimate does not include resources from Switchgrass on CRP Lands, Methane from Landfills, Methane from Manure Management, or Methane from Domestic Wastewater. *Available at* http://www.nrel.gov/docs/fy06osti/39181.pdf (last visited 8/26/13).

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more recognition and understanding from regulatory agencies regarding its potential impact on climate change mitigation.

Interra's ongoing analysis suggests that its technology will have significant life-cycle benefits. Most uniquiely, due to biochar's ability to sequester atmospheric carbon for millennial time scales in agricultural soils, the fuels produced by the technology have a potential NET-NEGATIVE greenhouse gas emissions impact.[7, 8, 9, 10, 11, 12, 13]

The technology can claim net-negative emissions and superior environmential credentials in several categories because it was designed from the ground up to provide a solution to many contemporary environmental challenges. For example, Interra will utilize waste biomass feedstock that meets the EPA definition of clean cellulosic biomass,[14] and which will not contribute to increased emissions from land use changes. Also, the technology was designed for distributed community-scale applications that will reduce the environmental impact of feedstock procurement and delivery. Further, the biochar co-product is produced in a way to maximize the its ability to sequester carbon in the soil and its ability to aborb pollutants in water and gas cleanup applications.

The production of biochar integrates with the natural carbon cycle of photosynthesis and plant growth to capture and permanently store about 50% of the carbon that plants remove from the air and use the remaining 50% of carbon in the form of usable fuel. This process represents one of the few millennial-scale carbon sinks available

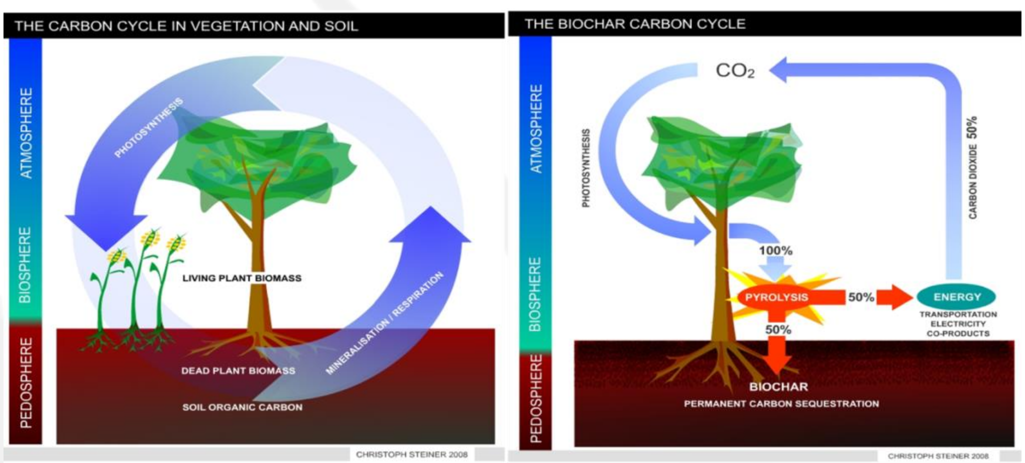

Figure 4: Regular Carbon Cycle v. Biochar Carbon Cycle

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[7] *See generally* Stewart, Zheng, Botte, and Cotrufo, Co-generated fast pyrolysis biochar mitigates greenhouse gas emissions and increases carbon sequestration in temperate soils, GCB Bioenergy (2012).
[8] Cowie, A.L. (2008), *Impact on GHG Balance of Utilizing Biochar as a Soil Amendment*, IEA Bioenergy Task 38, *available at* www.ieabioenergy-task38.org/projects/.
[9] Evelein, M. (2008), The Potential for Reducing Atmospheric Concentrations of CO2 through Biochar in the UK, MSc thesis, University of East London, UK.
[10] Gaunt, J. and Lehmann, J. (2008) 'Energy balance and emissions associated with biochar sequestration and pyrolysis bioenergy production', Environmental Science and Technology vol 42, at 4153-4158.
[11] Lehmann, J. (2007) 'A handful of carbon', *Nature*, vol 363, at 143-144.
[12] Lehmann, J. and Rondon, M. (2006) 'Bio-char soil management on highly weathered soils in the humid tropics', in N. Uphoff (ed) *Biological Approaches to Sustainable Soil Systems*, CRC Press, Boca Raton, FL, at 517-530.
[13] Rondon, M. and Lehmann, J. (2005) 'Charcoal additions reduce net emissions of greenhouse gases to the atmosphere', in *Proceedings of the Third USDA Symposium on Greenhouse Gases and Carbon Sequestration*, Baltimore, MD, 21-24 March 2005, at 208.
[14] *See* 40 C.F.R. 241.2.

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without large-scale geoengineering[15,16,17] (e.g. deep ocean injection, underground reservoir injection).

A study conducted by representatives from BiocharProtocol.org and Carbon Consulting, LLC on the potential Greenhouse Gas (GHG) mitigation of Interra's technology determined that for every dry metric ton of biomass processed by the system, 1.07 metric tons of CO2 equivalent (“$CO2_e$”) GHG emissions are avoided/removed compared to the baseline of green waste composting in California. Figure 3 offers the summary from that report.

Extrapolating from the calculations in Figure 3, a demonstration-sized unit would reduce emissions by 26,200 metric tons of $CO2_e$ per year (a full-scale unit would reduce emissions by 45,500 metric tons $CO2_e$ per year). To put that in perspective, each full-scale unit will reduce emissions that equate to the annual emissions from 9,479 passenger vehicles, the yearly electricity use of 6,811 homes, or the consumption of 5,100,897 gallons of gasoline.

5. Cost of Renewables:

The ability to generate valuable co-products will be a key factor driving down the cost of renewable bioenergy.

A key concept when evaluating the economic benefit Interra's technology can have on renewable fuel/energy consumers relates to the co-production of the higher value biochar and the ability to subsidize the fuel/gas production. The cost of producing biochar in a biomass conversion system can be set in terms of lost potential electricity revenue. Using this calculation method one group of researchers found the “cost” of biochar production to be $47 per metric ton of biochar.[18] Thus, to maximize profit, producers should make biochar and electricity instead of just electricity if the sale price of biochar is greater than $47/ton. The current lowest price of biochar is approximately $1,000/ton, resulting in a 20-fold difference in potential value. Technologies, such as Interra's, that optimize biochar production will have a competitive advantage for the foreseeable future. Further, if prices of biochar remain even close to their current mark, scenarios where a full-scale facility would be able to trade free renewable fuel/energy to the end user for controlled feedstock or land leases are easy to imagine

State regulators can encourage the continued reduction of renewable costs. First, they can continue, and increase, funding for commercialization demonstration projects. Providing capital at this phase will allow more technologies to reach commercial operations. Once commercial, the economies of scale will drive down the cost for other end users. Further, they can send strong market signals that this type of energy will play a large role in the state’s energy future. These policy initiatives will help developing technologies access capital markets that in the past few years have been hesitant to invest in the sector.

It should be noted that most analysis of the cost of renewable energy technologies versus the status quo is incomplete. Many metrics do not factor in the full cost of current energy technologies, including externalities. If California implemented the social cost of carbon into its analysis, then the true cost of current technologies would be compared to the true cost of renewables. Under this type of analysis Interra is confident that the true cost of

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[15] Batjes, N.H., Total Carbon and Nitrogen in the Soils of the World, European Journal of Soil Science, June 1996, 47, 151-163

[16] Gaunt, J and Cowie, A. (2009) *Biochar, Greenhouse Gas Accounting and Emissions Trading* in J. Lehmann and S. Joseph (eds) Biochar for environmental management: science and technology. Earthscan. UK

[17] Lehmann, J., Gaunt, J., Rondon, M. (2006). Bio-Char sequestration in terrestrial ecosystems – A review. Mitigation and Adaptation Strategies for Global Change, 11:403-427.

[18] Gaunt, J. and Lehmann J., Energy Balance and Emissions Associated with Biochar Sequestration and Pyrolysis Bioenergy Production, 42 Env. Science and Tech. 4152, (2008).

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renewable energy would more than justify its benefits to the state, and would likely be less costly than the status quo reliance on fossil fuels.

IV. Comments on the Waste Sector Presentation:

As Interra's technology is a waste-to-energy technology, Interra has a few comments on the waste section of the presentation as well. As the state works towards the 2050 goals it will be beneficial to encourage new technologies that not only divert waste, but that also recycle the waste and convert it into valuable products. Interra's technology generates biochar as a co-product. Besides the environmental benefits mentioned above, biochar has many economic benefits in the agricultural sector (e.g. increasing soil fertility, nutrient retention, and water retention) and the water and air purification industries (e.g. creating a cheap and environmentally friendly alternative to fossil fuel derived activate carbon).

Regulatory action can be effective in helping to reduce California's waste problem and helping to ensure the highest end use of waste materials. For example, regulations could encourage waste biomass diversion from landfills to bioenergy facilities or require the landfills to implement new technologies, such as Interra's, that reduce emissions associate with waste biomass disposal and processing and generate valuable co-products.

To encourage the transition to low carbon waste processing it could be beneficial to place landfills under the Cap and Trade regulations. This could encourage the transition to new technologies that reduce the emissions associated with landfilling and/or composting biomass. As new processing technologies are ideally co-located at waste disposal sites, it makes financial and environmental sense for all parties involved to encourage the implementation and demonstration of new technologies. If the landfills do not integrate new lower emission technologies, then the funds they will be required to pay will go towards implementing those technological solutions elsewhere.

A. The Role of Thermal Processes and Energy Recovery:

New thermal processing technologies will play a key role in phasing organics out of landfills. Interra's thermal conversion technology seeks to be maximally efficient in terms of energy recovery by utilizing an innovative configuration of standard industrial equipment. The novel design characteristics have been modeled to suggest that the technology will be the most efficient, most cost effective, and most environmentally friendly way to process waste biomass. Technologies such as this will be instrumental in a low carbon economy that aims to minimize the amount of waste generated and the emissions associated with waste processing.

B. Funding for Biomethane Projects:

Interra strongly encourages the recommendations to increase funding for biomethane projects. A lot of R&D is still required to optimize biomethane technologies. In the short term, commercial demonstration funding would have the most direct benefits. Biomethane technologies, such as Interra's, are available but they still need funding to demonstrate at commercial scales prior to widespread adoption. Regulators should focus on creating funding opportunities to allow companies to work with local governments on co-locating the technology at current waste facilities in order to divert organics from landfills and provide the co-benefits mentioned above.

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This will help speed up the commercial applications of new technologies and help the state meet the AB 32 waste goals.

A focus should be on biomethane projects that also generate co-products. In the long term the co-products will be required to make the projects economically feasible and the co-products can also help to subsidize the biomethane production. Co-products, such as biochar, that can also help the state meet other AB 32 goals should be given priority.

It should be noted that funding does not have to be cash. Supplying companies with feedstock supply contracts, land for demonstration projects, or biomethane purchase agreements can be just as, if not more, beneficial.

V. Conclusion

Interra Energy welcomes the opportunity to meet with CARB staff to discuss these important topics.

Sincerely,

/s/

Kenny S. Key
VP, General Counsel

/s/

Thomas Del Monte
President, CTO

CC: La Ronda Bowen by email (lbowen@arb.ca.gov)