CONSIDERATION OF STAFF RECOMMENDATION REGARDING FINANCING PROJECTS USING AN ACID HYDROLYSIS CONVERSION TECHNOLOGY PROCESS
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STAFF SUMMARY – CPCFA
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ISSUE: As a matter of policy, should the State allow tax-exempt bonds to be used for projects that use landfill diverted green waste and other cellulose debris in an acid hydrolysis conversion technology process for biomass fueled ethanol production?

BACKGROUND: There has been strong interest recently in finding ways to produce biomass fueled ethanol production using greenwaste and cellulose debris.

CPCFA has received a request from BlueFire Ethanol Lancaster, LLC (“Company”) to construct a three million gallons per year biomass fueled ethanol production facility which will process approximately 170 tons of landfill diverted greenwaste and other cellulose debris annually using an acid hydrolysis conversion technology process. The plant’s end product, ethanol, will serve as a volumetric extender for fossil fuel by virtue of being blended with conventional gasoline. Moreover, the plant process itself will consume about 70% less fuel than otherwise required through the use of a process by-product, lignin, to generate the facility’s thermal and electrical energy requirements. The facility will serve Southern California and aims to reduce petroleum dependence, generate greenhouse gas emissions reduction and preserve landfill space.

BlueFire Ethanol. At the December 3, 2007 meeting, the CPCFA Board approved an Initial Resolution (IR) for BlueFire. BlueFire is a publicly traded development-stage company focused on creating ethanol out of greenwaste and other cellulose debris through its patented Arkenol Process Technology. This landfill diverted material will be converted into renewable fuels and energy. The project will be constructed in Lancaster on a currently undeveloped 10-acre parcel and will involve site improvements, building construction and the installation of processing equipment. It will generate pollution control benefits by having greenwaste and other cellulose debris diverted from landfill and the increased use of ethanol versus conventional gasoline, which decreases greenhouse gas emissions (“GHG”) by about 85%. The Department of Energy (“DOE”) has awarded the Company 40 million dollars for a facility in Southern California that uses approximately 700 metric dry tons of greenwaste and wood waste currently disposed in the landfill to produce about 16.6 to 18 million gallons of ethanol annually.[1] This makes BlueFire one of only six companies awarded funding from the DOE. It is controlled by its Founder & CEO, Arnold Klann, who holds a 63% interest in the Company.

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[1] http://sec.gov/Archives/edgar/data/1370489/000091957408003225/d883450_10-q.htm

*Ethanol Technology - Arkenol Process Technology***.** This is an acid hydrolysis technology that converts lignocellulosic waste raw materials into value added end-products in fuels.[2] Simply put, the process separates the biomass into two main constituents: cellulose and hemicellulose (the main building blocks of plant life) and lignin (the "glue" that holds the building blocks together), which converts the cellulose and hemicellulose to sugars, ferments them and purifies the fermentation liquids into products. These unit operations require a series of material and energy inputs to produce the primary products of fermentation and the resultant by-products.[3]

Incoming biomass feedstocks are cleaned and ground to reduce the particle size for the process equipment. The pretreated material is then dried to a moisture content consistent with the acid concentration requirements for decrystallization (separation of the cellulose and hemicellulose from the lignin), then hydrolyzed (degrading the chemical bonds of the cellulose) to produce hexose and pentose sugars at the high concentrations necessary for commercial fermentation. Insoluble materials, principally the lignin portion of the biomass input, are separated from the hydrolyzate by filtering and pressing and further processed into fuel or other beneficial uses.

The remaining acid-sugar solution is separated into its acid and sugar components by means of the Company-developed technology that uses commercially available ion exchange resins to separate the components without diluting the sugar. The separated sulfuric acid is recirculated and reconcentrated to the level required by the decrystallization and hydrolysis steps. The small quantity of acid left in the sugar solution is neutralized with lime to make hydrated gypsum, an insoluble precipitate which is readily separated from the sugar solution and which also has beneficial use as an agricultural soil conditioner. At this point the process has produced a clean stream of mixed sugars (both C6 and C5) for fermentation.

In an ethanol production plant, naturally-occurring yeast, which the company has specifically cultured by a proprietary method to ferment the mixed sugar stream, is mixed with nutrients and added to the sugar solution where it efficiently converts both the C6 and C5 sugars to fermentation beer (an ethanol, yeast and water mixture) and carbon dioxide. The yeast culture is separated from the fermentation beer by a centrifuge and returned to the fermentation tanks for reuse. Ethanol is separated from the now clear fermentation beer by conventional distillation technology, dehydrated to 200 proof with conventional molecular sieve technology, and denatured with unleaded gasoline to produce the final fuel-grade ethanol product. Finally, the still bottoms, containing principally water and unfermented pentose sugar, is returned to the process for economic water use and for further conversion of the pentose sugars into ethanol.

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[2] http://www.bluefireethanol.com/pdf/Booz-Allen_Hamilton_Valuation_Report_for_Arkenol_051606.pdf
[3] http://www.bluefireethanol.com/technology/

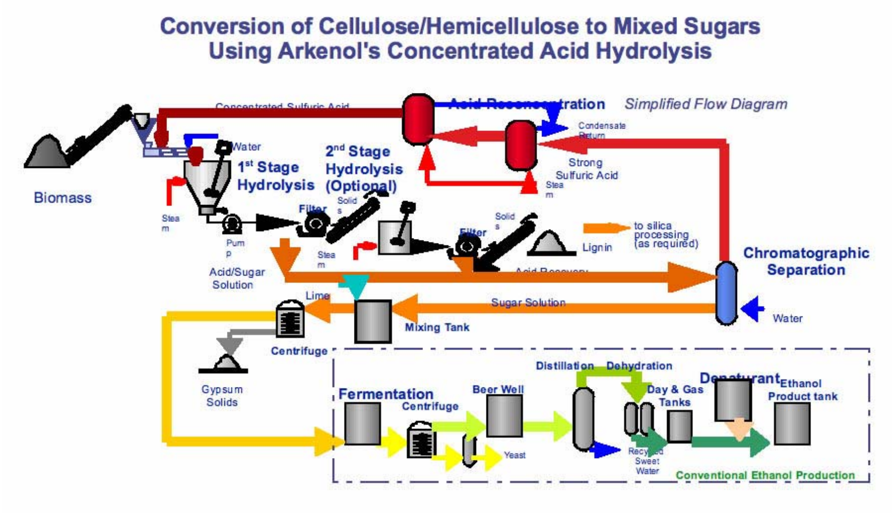

Figure 1 - http://www.bluefireethanol.com/images/ethanol-process.jpg

Ethanol Technology - Cellulosic Biomass Ethanol. The simplest process of producing ethanol is by fermenting sugar in sugar cane or beets, but ethanol can also be produced from starch in corn and other feedstocks by first converting the starch to sugar.[4] Ethanol can also be produced from complex carbohydrates, such as the cellulosic portion of plants or plant products. The cellulose is first converted to sugars (by hydrolysis); then the same fermentation process is used as for sugar to make ethanol.[5] Cellulosic feedstocks (composed of cellulose and hemicellulose) are currently more difficult and costly to convert to sugar than are starches. While the cost and difficulty are a disadvantage, the cellulosic process offers the advantage that a wider variety of feedstocks can be used. Ultimately with more feedstocks available from which to make ethanol more volume of ethanol can be produced. The Clean Air Act provides the definition of cellulosic biomass ethanol, which states: Cellulosic biomass ethanol means ethanol derived from any lignocellulosic or hemicellulosic matter that is available on a renewable or recurring basis, including:

(i) Dedicated energy crops and trees;
(ii) Wood and wood residues;
(iii) Plants;
(iv) Grasses;
(v) Agricultural residues;
(vi) Animal wastes and other waste materials, and
(viii) Municipal solid waste.

Examples of cellulosic biomass source material include rice straw, switch grass, and wood chips. Ethanol made from these materials would qualify under the definition as cellulosic ethanol. In addition to the above sources of feedstocks for cellulosic biomass ethanol, the Clean Air Act's definition also includes animal waste, municipal solid wastes, and other waste materials. Other waste materials generally include sewage sludge, waste candy, and waste starches from food

[4] http://www.cbsnews.com/stories/2007/03/04/ap/tech/mainD8NLISJ80.shtml
[5] Mosier N, Wyman C, Dale BE, Elander R, Lee YY, Holtzapple M, Ladisch M (2005) Features of promising technologies for pretreatment of lignocellulosic biomass. Bioresour Technol 96:673-686

production. Although the definitions of cellulosic biomass ethanol and waste derived ethanol both include animal wastes and municipal solid waste in their respective lists of covered feedstocks, there remains a distinction between these types of ethanol. If the animal wastes or municipal solid wastes contain cellulose or hemicellulose, the resulting ethanol can be termed cellulosic biomass ethanol. If the animal wastes or municipal solid wastes do not contain cellulose or hemicellulose, then the resulting ethanol is labeled "waste derived ethanol."[6]

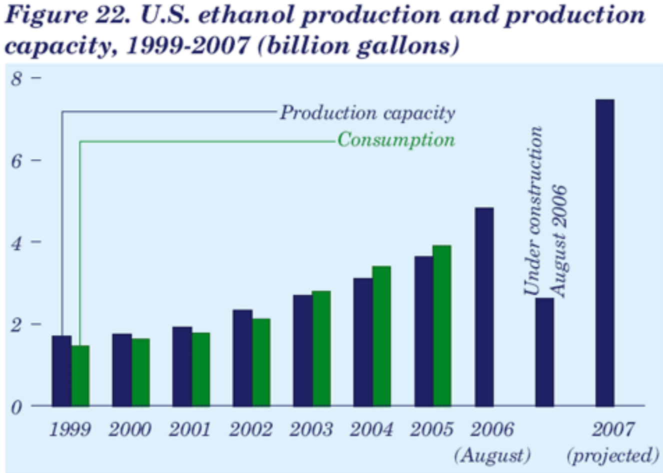

Figure 2 - EIA energy statistics Feb. 2007, http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

<u>SUPPORT FOR RENEWABLE ENERGY</u>: The 2005 Energy Act requires fuel suppliers to use 7.5 billion gallons of renewable fuels by 2012, with each gallon of cellulosic ethanol counting as 2.5 gallons toward the standard. The Energy Act also authorized more than $4.2 billion in grants, loan guarantees and production incentives for cellulosic ethanol over the next decade.[7] In a separate action, President Bush outlined in his 2007 State of the Union address that in order to reduce the dependency on foreign oil he is requiring the production of 35 billion gallons a year of renewable and alternative fuels by 2017.[8] Moreover, On May 15, 2008, Congress overwhelmingly passed the Farm Bill which gives a $1.01/gallon tax credit for cellulosic biofuel providing further support for the development of clean energy technologies.[9]

<u>PROS</u>: According to DOE studies, conducted by the Argonne Laboratories of the University of Chicago, cellulosic ethanol is shown to reduce GHG emissions by 85-86% over reformulated gasoline. Moreover, it has a five times better net energy balance than corn-based ethanol.[10] The DOE concludes that corn-based ethanol provides only 26% more energy than it requires for production, whereas cellulosic ehthanol provides 80% more. Another advantage of using cellulose is that it is not used for food and can be grown in all parts of the world. In addition, less land is needed, meaning less habitat fragmentation and biomass requiring fewer inputs (i.e.

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[6] EPA, Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program, May 2007
[7] EPA, May 2007, Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program; Final Rule,
[8] http://www.sciencedaily.com/releases/2007/02/070218140448.htm
[9] http://biz.yahoo.com/bw/080516/20080516005176.html?.v=1
[10] http://www.transportation.anl.gov/pdfs/TA/354.pdf

fetilizer, herbicides, natural gas, etc.) than corn which makes it cheaper to produce. Moreover, California produces more lignocellulosic biomass relative to other sources of biofuels, which means technologies that use the substance appear more beneficial for in-state production.[11]

This fuel process is also very beneficial since it uses materials that are not typically recycled extending the life of landfills. Green waste and cellulosic debris, that are not composted, are currently just thrown away like all other pieces of trash, which makes this piece of technology real intriguing. This cuts the cost of producing ethanol dramatically, while offering big pollution control benefits by preventing this waste from decomposing and creating methane gas (a GHG that is very damaging to the environment and many times more potent than carbon dioxide (CO_2)).

CONS: Cellulosic ethanol is currently more expensive to produce than corn ethanol. The DOE estimates its cost of roughly $2.20 per gallon which is twice the cost of corn ethanol.[12] The main reason for this price differential is that the enzymes which destroy plant cell tissue cost 30-50 cents per gallon with cellulosic material while it only cost 3 cents per gallon with corn. In addition, if lignin is not used as fuel for the Arkenol process, then there is a waste disposal problem in regards to matter and NOX controls that are more costly than those required for natural gas.[13] However, BlueFire's technology looks to eliminate this cost by using lignin as its fuel source and by using a chemical process rather than the biological one which requires these costly enzymes. In addition, BlueFire's technology can use landfill diverted greenwaste rather than food crops, which, according to BlueFire, cuts the feedstock cost down to 0-$.20/gallon (0-$15/ton for transportation of waste) and brings the production cost down to $1.02/gallon.[14] BlueFire further drives down transportation costs by locating its bio-refinery near the energy intensive Los Angeles market. This differs from most ethanol production facilities that are located in remote areas requiring huge delivery costs and nullifying a lot of the benefits ethanol brings.[15]

GLOBAL CLIMATE CHANGE: The California Legislature and Governor Schwarzenegger approved Assembly Bill 32, the California Global Warming Solutions Act of 2006, which requires the State to cut total GHG emissions, such as CO_2 by 25 percent by 2020. Continuing California's long-standing tradition of innovation on environmental issues, Assembly Bill 32 has given The California Air Resources Board ("CARB") a leadership role working with other State agencies to forge new approaches to diminishing the State's carbon footprint. Processing landfill diverted greenwaste and other cellulose debris has shown through DOE studies, to potentially reduce GHG emissions by roughly 85%. This will help California meet the reduction goal. In addition, the waste material that will be diverted from landfills would otherwise have decomposed while creating methane gas, a pollutant which requires being captured and managed. BlueFire states that they are in full compliance with all applicable State and Federal environmental regulations governing solid waste disposal. The California Integrated Waste Management Act of 1989 (AB 939) and the United States Resource Conservation and Recovery

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[11] Economic and Technology Advancement Advisory Committee (ETAAC) Final report, February 11, 2008
[12] http://www.grist.org/news/maindish/2006/12/11/weeks/index.html
13 CARB, Air Resources Supervisor II, Dean Simeroth
[14] CFO, BlueFire Ethanol Fuels, Christopher Scott
[15] http://biz.yahoo.com/bw/080430/20080430005386.html?v=1

Act (RCRA) mandate the need to minimize the amount of material landfilled and maximize recycling opportunities, both of which this project will facilitate.

CONSIDERATIONS FOR CPCFA: There are several considerations with respect to financing projects using an acid hydrolysis conversion technology process. Funding a long-term project with an unproven technology that is just beginning to commercialize is always a risk. Moreover, it is unknown whether cellulosic ethanol will have a viable market 30+ years out since its viability largely depends on a high price for gasoline. Other competing uses for green waste may come about in the coming decades which could greatly affect the cost of using this technology since that is the main input in creating cellulosic ethanol.

CPCFA STATUTORY AUTHORITY: In general, CPCFA's statute permits financing of projects related to resource recovery and/or to reduce environmental pollution. Health & Safety Code Sections 44508(a), 44535 (a), 44535(b), 44535(c), and read, in part:

> 44508(a) "Project" and "pollution control facility", respectively mean any land, building, improvement thereto for processing or recovery of any natural resource or the generation of electricity, steam heat, or manufactured gas, together with the recovery, treatment, neutralizing, stabilizing, or cooling equipment.
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> 44535(a) The authority may separately approve financing for projects, the purpose of which is to prevent, remediate, or reduce environmental pollution resulting from the disposal of solid, hazardous, or liquid waste.
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> 44535(b) The following projects shall be considered for financing:
> (1) Projects utilizing recognized resource recovery or energy conversion processes.
> (2) Projects utilizing new technologies or processes for resource recovery or energy conversion.
> (7) Projects for the disposal of agricultural wastes.
>
> 44535(c) The projects specified in subdivision (b) may include elements that provide for energy conversion plants.

RECOMMENDATION: Staff finds that there is evidence of pollution control benefits to be derived from tax-exempt financing of qualifying projects using landfill diverted greenwaste and cellulose debris for producing biomass fueled ethanol. Therefore, staff recommends that the CPCFA Board direct staff to consider applications for tax-exempt financing of biomass fuels using landfill diverted greenwaste and to evaluate each application on its individual merits. Staff acknowledges that applications for cellulosic ethanol projects will be evaluated on their individual public and pollution control benefits (including climate change, air quality and water quality), financing structure, and legal status. Applications for cellulosic ethanol projects will be subject to the same degree of scrutiny by staff and by counsel, and subject to the same standards of documentation, as other applications received.