SD-CAB SAN DIEGO CENTER FOR ALGAE BIOTECHNOLOGY

Additional comments to the California Energy Commission
Re: First 2010-2011 Advisory Committee Meeting for the Alternative and Renewable Fuel and Vehicle Technology Program (Docket #09-ALT-1), on February 11, 2009.

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On behalf of the San Diego Center for Algae Biotechnology, I am pleased to again be able to provide comment and observations on the CEC's deliberations with regard to its AB 118 investment plan for FY 2010-2011. Having had the opportunity to participate directly in one of CEC's earlier workshops on this topic (September 15, 2009) SD-CAB is already on the record as advocating for the CEC and the State of California to continue its leadership role in the field of sustainable biofuels development, by committing to a robust research plan for developing viable "drop-in" alternative transportation fuels, which would be compatible with existing fuel refinery and transmission infrastructure. SD-CAB is uniquely positioned to assist CEC in this regard – as we are one of the leading US research centers working to crack the fundamental research challenges inherent to production of algae-based biofuels. Our faculty and commercial sector partners have worked to identify and address the most relevant obstacles to commercialization of such fuels, while helping to create a jobs pipeline to meet the related workforce needs, and developing a comprehensive and state of the art life cycle analysis (LCA) for algae biofuels - all of which have already been identified as priorities by the CEC and its sister agencies.

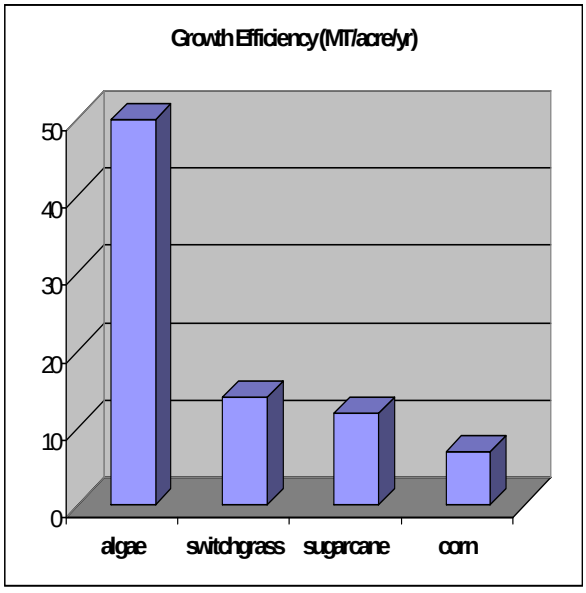
At this point, I think it is timely to also take note of several recent developments that may help to inform the CEC's decision-making process, and specifically the questions posed on page 68 of the draft report.

* Impact of related investments by the federal government/private sector –
Since the draft report was issued there have been several major investments in algae biofuels from the federal government, as well as continued private sector investments. Most notable of these was the several hundred million dollars provided by the US Departments of Energy and Agriculture to build algae biofuel refineries, all of which require a 20% to 50% cost share, meaning the total investment may reach well over $600 million dollars. While these are

significant investments, they are focused largely on building pilot facilities to demonstrate the viability of algae based fuels; by comparison, relatively little of this investment is devoted to creating the skilled work force needed to staff these and related facilities when they come on line, or to develop the next generation processes and strains that will make these facilities economically viable.

* Life cycle assessments - in December of 2009, a group of researchers at U-VA published a paper titled "Environmental Life Cycle Comparison of Algae to Other Bioenergy Feedstocks". This findings of this study reinforced several of the underlying factors that make algae so viable as an alternative transportation fuels feedstock:

"*algae tend to produce more biomass than terrestrial plant per unit area, and unlike terrestrial plants, they can be cultivated on otherwise marginal land using fresh water or salt water"*, and; *"(production of) algae does not compete directly with food crops."* The paper concludes with the authors anticipating that future analyses will "find algae easier to convert into liquid fuels than some of the other biomass sources...because of their inherently high lipid content, semi-steady state production, and suitability in a variety of climates."



Crop	Oil content	Biodiesel
Mustard	25-27	70
Safflower	42-48	146
Soy	20-22	55
Jatropha	32-35	202
Palm	48-52	635
Algae	2-40	> 5,000

Figure 1. Left. Biomass production from several potential energy crops (tons/acre/year). Right. Oil content (% of total biomass) and oil yield (gal/acre/year) of seven major oil producing crops.

However, the U-VA study has created something of a stir in biofuel circles, because of one of its conclusions - that switchgrass, canola and corn farming could have lower environmental impacts than algae in terms of energy use, greenhouse gas emissions, and water use. The fact is that this conclusion was based on an algae production process extrapolated from 1980s-era literature, but nevertheless, it came as a surprise to many in the academic and policy arenas who had become familiar with the positive aspects of algae. However, the authors also concluded that with a few obvious improvements in technology and production method, algae would be a far more environmentally favorable feedstock than any terrestrial plant.

The key aspect of any life cycle assessment on a biofuel feedstock is that it will identify the areas of production that have the greatest environmental impact. The two such areas identified by the UV-A paper - CO2 and nutrient sourcing - have already been recognized and incorporated by every modern-day commercial algae biofuel firm. Given this, then, the practical effect of the U-VA paper is that it clearly illustrates the potential of algae for the production of low carbon fuels in an environmentally favorable way. What the U-VA paper does do is underscore the need for a robust and comprehensive life cycle analysis for a range of algae production systems, so that the most environmentally and economically favorable systems can be identified and deployed. Such an LCA is presently under development by the SD-CAB. Indeed, elsewhere in its draft investment plan, the CEC acknowledges the need for additional support in establishing LCAs for "new and emerging fuel pathways". This is part and parcel of the aforementioned research efforts that remain to be undertaken on behalf of algae biofuel production, and on which the State of California should continue to lead. The State has never been short-sighted with regard to developing advances in public health and environmental protection, and its approach to advanced biofuels should be no different.

This focus on the importance of a robust life cycle analysis also calls attention to a larger philosophical point that bears careful consideration - the critical impact that innovation can have on developing any new process. Innovation, something in which California academia and industry have excelled since their inception, is what gives us an edge in national and even global competitiveness. This must be factored into the decision-making process with regard to any investment in research, rather than assuming a given scientific or technological environment will remain static. In short, the world is going to develop advanced biofuels, and we in California need to be at the cutting edge of this innovation if are going to remain a dominant economic power. To remain leaders we need to identify those technologies with the most potential and then invest in innovation around them to bring them to fruition. In its deliberations as to how best to include algae in its upcoming investment plan, the CEC should consider the potential for game-changing innovation within the field of algae biofuels research, and the subsequent potential to accelerate by orders of magnitude the timing for these related technologies to become economically viable and commercially available.

SD-CAB continues to believe that with the appropriate allocation of resources, alternative transportation fuels from algae will become a proverbial "game-changer" in the relative near term, due in large part to the potential to innovate within this technology by both our academic and industry partners. We look forward to continuing our collaborative working relationship with the CEC and State of California, and serving as a resource however we might be most useful.

2/25/10