April 30, 1999

TO: Meredith Wingate, CRS
FROM: Steve Clemmer, UCS
RE: Comments on Green-E Standard for Co-firing Paper

Thank you for the opportunity to provide input on whether Green-E should develop a standard for renewable energy co-firing. Your paper presents an excellent discussion of most of the key issues that need to be addressed. Your openness in soliciting feedback from a wide range of viewpoints and on a range of options in reaching your decision is appreciated.

This decision has important implications for the environment, the renewables industry (particularly biomass) and the development of the green market. It may establish a precedent for future discussions on the role of co-firing in implementing state renewable portfolio standards and funds. It may also have an important impact on the public's and environmental community's perceptions of co-firing. Given CRS's limited resources available to address the broad and potentially controversial issues surrounding co-firing, a continued dialogue is needed.

Approach 5, "Include all co-firing except with MSW or in MSW incinerators," combined with elements of approach 4 requiring all co-firing options to meet standards that will result in meaningful environmental improvements, would appear to maximize potential environmental benefits from biomass co-firing. A wide variety of co-firing applications deserve consideration as being "green" as long as only the renewable portion of the electricity generated is counted, and its comes from a verifiable clean renewable energy source that is displacing a fossil or nuclear fuel that otherwise would have produced electricity. Perhaps most importantly, approach 5 would allow biomass co-firing in existing coal plants, which has the greatest potential for environmental improvement of all the co-firing options. Because of this potential, my comments will focus mainly on biomass co-firing.

Environmental Impacts

Biomass co-firing offers a number of environmental benefits. By directly displacing coal, arguably the most polluting energy source, biomass co-firing can reduce SO2, CO2 and even NOx emissions. Wood has essentially no sulfur content and nitrogen levels that are generally one-third to one-tenth those of coal. In addition, the moisture in wood can cool the coal combustion process, reducing the formation of thermal NOx. Test results by EPRI have shown that under a best case co-firing wood at 7 percent of the total heat input achieved NOx reductions up to 15 percent. Under a worst case, biomass co-firing had no impact on NOx emissions. NOx reductions of up to 50 percent may also be achieved by co-firing biomass as a reburn fuel, downstream from the primary combustion zone.[1]

[1] Raymond Costello (director of the DOE biomass power program), "Biomass Co-firing Offers Cleaner Future for Coal Plants," *Power Engineering*, January 1999.

Biomass co-firing would also displace some of the environmental impacts of mining and transporting coal to power plants. These benefits could be offset to the extent there are significant impacts due to environmental impacts associated with growing, harvesting and transporting biomass fuels to particular power plants. These impacts would best be addressed by environmental standards to ensure that biomass fuels are grown and harvested in a sustainable manner (see below).

Biomass co-firing can offer emissions and fuel cycle environmental advantages compared to stand-alone biomass plants using conventional technology, which are eligible for the Green-E standard in California. Co-firing in existing coal boilers is generally more efficient at converting the energy in biomass to electricity, with efficiencies of 33 percent, while stand-alone plants are typically around 20 percent efficient. By displacing coal directly, co-firing can reduce or at a minimum maintain NOx emissions, while stand-alone plants displace marginal fuels or new additions to the system, and may therefore actually displace oil, natural gas or even some nuclear, and therefore increase NOx emissions.

While it may seem counterintuitive, this assurance of displacing coal means that adding biomass co-firing may even decrease system emissions more than other renewable technologies such as wind and solar that have lower direct impacts.

Renewable Industry Impacts

A key objective of Green-E is to help support the renewables industry. Co-firing has important implications for the biomass industry. Over the past few years, electricity generation from the biomass industry has been declining. Some stand-alone plants have been shut down or idled in certain parts of the country (especially Maine and California) due to competitive pressures as they reach the end of their fixed price PURPA contracts or as contracts are bought out. Very few new stand-alone biomass plants are being built because they are too expensive compared to new natural gas plants and other renewable technologies. They also require a significant long-term capital investment, which utilities and independent power producers seem unwilling to make due to competitive risks. Furthermore, while biomass gasification is an attractive long-term option for reducing emissions and improving the efficiency of stand-alone biomass plants, this technology is still in the demonstration phase and has a number of technical obstacles to overcome before it becomes commercialized.

In contrast, biomass co-firing has an enormous short-term potential. The technology is commercially proven and requires a relatively modest capital investment ($50-400/kW). The market for co-firing already exists (coal plants). Moreover, tapping into that market would allow the biomass feedstock supply infrastructure to develop, as we eventually make the transition to biomass gasification and increased use of combined heat and power. According to two recent studies by DOE and UCS, co-firing has the potential to reach 20-30 gigawatts of capacity in the US by 2020, by co-firing biomass up to 10-15 percent of the heat input in existing coal plants.[2] The UCS study also found that co-firing

[2] See Interlaboratory Working Group on Energy Efficiency and Low Carbon Technologies *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, 1997, and Steven

was one of the cheapest renewable technologies. Thus, developing a Green-E standard for co-firing could provide an important boost to the biomass industry, while helping to minimize the premium for purchasing renewable electricity. This is especially important for certain parts of the country that have significant quantities of coal generation but do not have good wind, solar or geothermal resources, like the industrial Midwest.

Public Perception

There are some public perception problems with co-firing, as well as biomass applications in general, that pose significant challenges to Green-E at this early stage of development. Some of these problems are real and stem from the poor performance of certain existing stand-alone biomass plants, as well as some bad experiences from the forest products industry and residential fireplaces and wood stoves. However, these public perceptions have often been unfairly extended to the biomass power industry as a whole, and to biomass co-firing projects in particular.

While it may be difficult for the public to understand how there can be environment benefits of co-firing biomass at a polluting coal plant, there are clear quantifiable benefits in most cases. Information and education based on sound science, along with standards for co-firing that insure meaningful environmental improvement, are desperately needed to overcome the public perception problems. Not developing a Green-E standard for biomass co-firing will only serve to perpetuate this problem. Furthermore, this education is needed so consumers can make informed choices about the resources and technologies they see as most desirable from an environmental and economic standpoint.

Given Green-E's limited resources for education, we would like to offer our assistance in developing and distributing materials to the public on co-firing.

Historic Relationships

Green-E obviously needs to be sensitive to efforts by environmental and public interest organizations to close heavily polluting fossil fuel power plants. UCS has been directly involved in some of those efforts and also supports closing the loophole for grandfathered plants. We also agree that in certain cases it may be more appropriate to shut down a certain plant, switch the entire plant to natural gas or install pollution controls. However, developing a Green-E standard for biomass co-firing should not preclude this from happening. Given the current plans to significantly expand generation from new natural gas plants to meet growing demand and replace nuclear capacity, it is highly unlikely and will be technically challenging to replace a significant portion of the nation's coal plants (which generate over half of US electricity) with natural gas. Doing so would require a significant expansion of pipeline capacity and would likely raise the price of natural gas to all gas consumers. Thus, biomass co-firing can be an attractive option to reduce coal use and help some coal plants meet new source performance standards.

Biomass co-firing is not likely to impact the decision of whether or not any individual coal plant will be shut down. A 1998 study by Synapse Energy Economics showed that

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Clemmer, Alan Nogee, and Michael Brower, *A Powerful Opportunity: Making Renewable Electricity the Standard*, Union of Concerned Scientists, 1999.

89% of the coal units, representing 94% of the total coal capacity in the US, would remain competitive even after paying for higher costs (averaging 0.8 cents/kWh) to eliminate the grandfathering of SO2 and NOx regulations.[3] The report further states that some of the at risk plants could stay open by renegotiating coal contracts and by cutting other costs.

A key question is would co-firing provide enough of an economic incentive or environmental savings to allow the plants at risk to remain open? While the answer depends largely on site specific conditions, the most important factors are the relative cost of coal and biomass, the premium a co-firing project would be able to charge in the green market and the impact on emissions. The table below shows the average incremental cost of 10% biomass co-firing and the potential biomass supply at different biomass and coal prices, using data from EPRI and DOE.[4] The average incremental cost would range from -0.42 ¢/kWh using clean wood wastes (at $0.5/MMBtu) to 2 ¢/kWh using dedicated energy crops (at $2.84/MMBtu) assuming average US coal prices of $1.40/MMBtu. Incremental costs would be roughly 0.4 ¢/kWh higher using lower coal prices of $1.00/MMBtu, which are available in some parts of the country. This information shows that there's a large supply of biomass potentially available for co-firing below the range of premiums currently being offered by green marketers.

Average Incremental Cost of 10% Biomass Co-firing in Existing Coal Plants and US Biomass Supply at Different Biomass and Coal Fuel Prices

	Incremental Cofiring Cost (c/kWh)		US Biomass Supply	
Biomass Cost ($/MMBtu)	Coal @ $1.40/MMBtu	Coal @ $1.00/MMBtu	Trillion Btu	MW
0.50	-0.42	-0.04	21	335
1.00	0.08	0.49	103	1,653
1.50	0.61	1.02	1,005	16,084
2.84	2.02	2.40	5,636	90,181

To determine whether co-firing would provide a sufficient incentive to keep a grandfathered coal plant at risk of being shut down to stay open, consider the following relatively extreme example. Suppose the incremental cost of a particular 10% biomass co-firing project is zero, but the coal plant is able to sell the electricity to consumers at a premium of 2 ¢/kWh based on the premiums being offered by marketers for other renewable technologies, giving the coal plant 2 ¢/kWh profit on each biomass kWh.

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[3] Bruce Biewald, et. al. 1998. *Grandfathering and Environmental Comparability: An Economic Analysis of Air Emission Regulations and Electricity Market Distortions*. Prepared for the National Association of Regulatory Commissioners.

[4] Co-firing costs and performance are based on data from the Electric Power Research Institute and the Office of Utility Technologies, DOE, 1997. *Renewable Energy Technology Characterizations*, EPRI TR-109496, December, available on-line at www.eren.doe.gov/utilities/techchar.html. US biomass supply estimates are based on data from the Energy Information Administration, used in *Annual Energy Outlook—1999*.

However, this profit would only be worth 0.20 ¢/kWh spread across the entire output of the coal plant. Considering Synapse found that a difference of 0.8 ¢/kWh would produce minimal impacts on retirements, it is highly unlikely that the co-firing project would provide enough of an incentive for an at risk coal plant to stay open. In practice, it is also unlikely that there would not be sufficient competition from other renewables that would be available for less than a 2 cent generation premium.

In approach #4, Green-E proposes to require co-firing facilities to meet "stringent emission requirements," such as New Source Performance Standards (NSPS), to "recognize the environmental advantages of co-firing, but make certain exclusions to address public perception and credibility concerns." I am concerned that this approach may lead to missing some opportunities to reduce system emissions through co-firing. I understand, however, the concern that some groups may have that, without some additional emission requirement, the possibility cannot be ruled out that allowing co-firing could enable a specific coal plant to operate longer than it otherwise would have. While approach #4, therefore, does not seem ideal, it may be a reasonable vehicle for developing an interim compromise until better data is developed. If Green-e does takes this path, it would be worth considering whether it may be more appropriate to ensure that a portfolio of plants meet the NSPS requirements, rather than the specific plant in which co-firing is proposed. The portfolio approach would provide more certainty of net reductions, as well as more flexibility to generators.

Verification

Mechanisms do exist for tracking the electric output and emissions from biomass co-firing projects. The fraction of the electric output from biomass co-firing could be measured by requiring the power plant to track the quantity of fuel used, the chemical composition of the fuel (to determine the average heating value and make sure the fuel is clean), and the heat rate of the power plant with and without co-firing. Most of this information is already tracked by power plant owners and reported to the Energy Information Administration. SO_2, NOx, CO_2 and other emissions are also closely monitored at these plants and reported to the Environmental Protection Agency. This data would allow an independent auditor to calculate emission rates on a pounds per megawatt-hour or some equivalent basis, with and without co-firing, which could then be used to calculate the biomass emissions rate. Similar mechanisms could be employed for other co-firing technologies as well.

Developing a meaningful standard for biomass co-firing

Green-e will be more credible with many in the environmental community, and ultimately the public, if it includes a verifiable standard for biomass fuels to ensure they are uncontaminated with toxic chemicals and that they are grown and harvested in a sustainable manner. Developing a biomass fuel standard that meets this broad definition is likely to be complex and possibly controversial. However, as a biomass advocate, I am concerned that failure to address these issues will lead marketers to avoid biomass fuels, rather than risk the credibility of their products. This result will not serve green markets, biomass developers, or the environment well. Green-E is well placed to consider initiating a multi-stakeholder consensus process to determine such a standard.

One tricky issue is how to evaluate NOx emissions from biomass co-firing, if Green-e adopts a biomass emission standard, as advocated by some participants in the New England group. While biomass co-firing will generate some NOx emissions, they are likely to be the same or lower than the NOx emissions from the coal plant without the biomass. As mentioned above, co-firing could be more effective at reducing NOx emissions than a wind or solar project that displaces the marginal fuel on the system, which may be new natural gas or nuclear generation with no NOx emissions. If Green-e were to look at the emissions profile of each resource in the determining whether the overall emissions from the product are lower than the system average, biomass co-firing could be unfairly penalized. While it may difficult to track which conventional resources are being displaced from a renewable technology added to the system, we believe there is some justification for giving biomass co-firing some credit in cases where NOx emission reductions can be verified. At this point, we do not have specific suggestions for how this would be done, but would offer our assistance in developing a method.

Other renewable co-firing options

While the potential market for other renewable co-firing options may be more limited, as long as the renewable portion of the electricity generated can be verified and results in environmental improvement to the existing system, there does not appear to be a good rationale for allowing certain types of renewable co-firing and not others. Also, there does not appear to be sufficient evidence on dioxin emissions to exclude landfill gas projects from being an eligible co-firing option. However, allowing MSW, or any fraction of it, to be included as a renewable fuel under Green-e would not ensure environmental improvement and would certainly undermine the credibility of Green-e.

Additional Issues

Should co-fired power be able to comprise the entire renewable percentage for any Green-e product? Should co-firing be considered a "new renewable."

There does not appear to be a good rationale for treating co-firing differently from other renewables in terms of an allowable percentage of Green-E products. Co-firing should be considered a new renewable if it can be verified that the fuel being co-fired represents development of a feedstock not previously used to generate electricity. This rationale would also apply to eligible biomass waste products, as long as new renewable electricity was being added to the system. The market can determine whether such products would be more or less preferred to others.

Should the Green-E co-firing decision be consistent with state disclosure laws?

We are not aware of any reason why Green-E standard for co-firing would be inconsistent with state disclosure laws. The output from the renewable portion of the plant should be allocated to the section of the disclosure label describing fuel sources that includes the contribution of that renewable to the overall generation mix.

References on Biomass Co-firing

For additional information on environmental impacts, economics and technical aspects of actual biomass co-firing projects, I recommend the following three sources:

Electric Power Research Institute and the Office of Utility Technologies, DOE, 1997. *Renewable Energy Technology Characterizations*, EPRI TR-109496, December, available on-line at www.eren.doe.gov/utilities/techchar.html.

Raymond Costello (director of the DOE biomass power program) "Biomass Co-firing Offers Cleaner Future for Coal Plants," *Power Engineering*, January 1999.

A series of papers on co-firing is available from *Expanding BioEnergy Partnerships*, Proceedings of the BioEnergy 98 Conference, Madison, Wisconsin, October 4-8, 1998.