

# Renewable Technologies and Environmental Injustice: Subsidizing Bioenergy, Promoting Inequity

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## ABSTRACT

Dozens of developed countries massively subsidize biomass-crop growing/incineration, touting it as clean, renewable, and helping to alleviate climate change. Using a case study of a contemporary, state-of-the-art facility to incinerate *Miscanthus-giganteus* biomass, this article shows that bioenergy projects are (1) not clean, given overwhelming particulate and nitrogen-oxide releases; (2) disproportionately sited in EIJ situations, near communities of color, tribal communities, or low-income communities who are harmed both medically and economically; (3) likely to impose ecological and environmental burdens on EIJ communities because of possible biomass-crop invasiveness; and (4) misrepresented by biomass promoters who take advantage of lucrative, taxpayer-funded federal and state biomass subsidies.

## INTRODUCTION

**W**HAT IS THE FUEL of the world's poor? In the developing world, at least three billion people burn domestic-biomass fuels such as leaves, wood, dung, and crop waste. This biomass-incineration causes two million deaths/year from indoor-air-pollution-caused problems like chronic obstructive respiratory disease. Nearly 50% of global, under-age-five pneumonia deaths are caused by biomass incineration.<sup>1,2</sup>

Have developed nations learned the developing-nation lesson about the obvious health harms from biomass incineration? No. Despite bioenergy threats to climate change,<sup>3,4</sup> and despite the World Bank, International Monetary Fund, World Trade Organization's food-security-based demands to end biomass-crop subsidies,<sup>5</sup> countries like Canada, Denmark, England, Germany, Greece, Ireland, Italy, Japan, Portugal, Spain, Sweden, Turkey, and the U.S. all subsidize biomass/biofuels like *Miscanthus giganteus* for electricity generation. Partly as a result, the International Energy Agency says that, between now and the year 2020, biomass-electricity gener-

ation will triple globally. Besides, in many developed countries, including the U.S., biomass-incineration is the largest single source of "renewable energy" and thus satisfies government renewable-energy credits and subsidies.<sup>4</sup> Developed nations offer biomass-crop, biomass-boiler-construction, and biomass-renewable-energy subsidies.<sup>3,6,7</sup> U.S.-taxpayer-biomass subsidies—\$3–5 billion/year (federal) + \$2–4 billion-per-plant/year (state)—help explain 255 existing, and 250 in-progress, U.S.-biomass plants.<sup>3</sup>

## DISCUSSION

Why do developed nations subsidize biomass? They say biomass crops are renewable, and promote energy independence. Even the U.S. government's Department of Energy (DOE) says biomass is a "clean" energy source.<sup>8</sup> They also say state-of-the-art, electricity-generating-biomass facilities are much cleaner than typical indoor stoves that cause massive harm in developing countries.<sup>4,9</sup>

### *A state-of-the-art biomass incinerator*

Are developed nations right about state-of-the-art, electricity-generating-biomass facilities being clean? If they are, biomass environmental-injustice (EIJ) problems seem less likely. If not, biomass EIJ seems more likely. To see who is more correct, consider a case study of a typical, state-of-the-art proposal to burn biomass (*Miscanthus giganteus*) in a Jasper, Indiana converted coal facility.

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Later paragraphs show Jasper's proposed biomass facility would create EIJ, especially for children, by increasing PM pollution having no safe dose. Annually PM kills 50,000–100,000 Americans, especially children, who are more sensitive to PM. These PM-caused premature deaths strike 6.4 percent of U.S. infants and toddlers.<sup>10</sup> Jasper's EIJ problems also are made worse by economic problems. These include the fact that, like hundreds of small towns across the globe, its outdated, aged, in-town, coal plant cannot pay for prohibitively-costly emissions-controls.

Given this nonperforming, coal-plant "asset," town leaders accepted the Twisted Oak Corporation (TOC) proposal to create a limited-liability corporation (LLC) that would convert the old coal boiler to combust biomass. TOC's 75-page LLC proposal promises Jasper lease payments and injecting \$200 million over 30 years (\$6.6 million/year) from the hybrid natural-gas/Miscanthus-giganteus-incineration facility. Most of the supposed \$200 million gross supposedly comes from growing Miscanthus. Partnering with Mendel Bioenergy, who would sell bio-engineered Miscanthus to local farmers, TOC's LLC would contract with them to grow roughly 100 tons/year of Mendel's cane-like Miscanthus.<sup>9</sup>

In return for unspecified amounts of lease payments from the LLC, Jasper would provide the facility "essential services," including double the water needed by the old coal facility, new electrical lines, and other infrastructure. However, lease-payment amounts were redacted from the proposal, as were lease terms, LLC taxes, financing, costs of water/sewer/new electrical lines/contaminated materials, and safety information about Mendel-bio-engineered Miscanthus. All redactions were marked "confidential materials."<sup>9</sup> Although the facility would sell its electricity on the open market, TOC promises to minimize health/environmental impacts with baghouse filters, biomass-boiler NOX/CO<sub>2</sub> best-available-control-technology limits, 560 ppmv CO limits, and "voluntary" 0.03 lb./million (MM)Btu PM limits.<sup>9,11</sup>

#### *Biomass-incineration nitrogen oxides (NOX) and particulates*

How serious are the air-pollution/potential EIJ problems caused by state-of-the-art, electricity-generating-biomass facilities—like that proposed for Jasper? Biomass-plant emissions in developed nations show biomass is generally dirtier than state-of-the-art coal, so it is hardly clean energy.<sup>4,12–14</sup> The main airborne-biomass pollutants are carbon monoxide (CO), hazardous air pollutants like mercury, nitrogen oxides (NOX), particulate matter (PM), and sulfur oxides (SOX). In developed-nation plants, all these biomass-pollutant harms are comparable to, or worse than, those from coal, except that biomass mercury and SOX releases < those from coal, and biomass CO/PM emissions > those from coal.<sup>4</sup> Biomass PM, for instance, is up to 25 times worse than coal PM—and PM causes most deaths from state-of-the-art-coal plants.<sup>15,16,17</sup> Just the PM from the proposed Jasper-Miscanthus plant likely would cause an additional 2–40 premature fatalities/year.<sup>3,4,12</sup>

How serious are biomass NOX and PM? Even Jasper-biomass-plant developers admit Miscanthus-NOX emis-

sions would be similar to those from burning wood, and Miscanthus-PM emissions would be worse than those from wood.<sup>11</sup> Yet PM has no safe dose,<sup>12,17</sup> and especially for children and those with respiratory problems, NOX also apparently has no safe dose;<sup>18</sup> NOX combines with atmospheric organic compounds to form ozone,<sup>19,20,21</sup> a major cause of human respiratory disease and death. Mainly because of NOX/PM releases, the American Lung Association and several medical associations have condemned biomass energy.<sup>13,14</sup>

Despite such condemnations, despite the apparent absence of safe NOX/PM doses, and despite the fact that ozone increases of only 0.01ppm/week cause increases of 0.5-percent-mortality/day and 0.64-percent-cardiovascular and respiratory mortality/day,<sup>22</sup> TOC's proposal fails to reveal how much ozone and PM the LLC facility will cause/release. Perhaps providing such figures would make Jasper-biomass-plant harms too obvious? The ozone problem occurs because TOC fails to provide plant in-stack NO<sub>2</sub>/NOX ratios needed to calculate resulting ozone levels.<sup>23</sup> Yet, utilities admit that even several ppb—parts per billion—of ozone causes lung damage,<sup>24</sup> and TOC says it will release up to 5 ppm—parts per million—NOX.<sup>10</sup> The PM problem occurs because, although TOC admits it will use up to 100 tons Miscanthus/year,<sup>9</sup> and release 0.03 pounds PM/million Btu,<sup>9</sup> it does not provide Miscanthus Btu, needed to calculate PM. Using Miscanthus Btu, however, calculations show Jasper-biomass-facility-PM releases = 25 tons PM/year—and there is no safe dose of PM, as already noted.

Moreover, NOX and PM releases are especially hazardous for children, one reason for U.S. childhood-respiratory-problem doubling in the last decade.<sup>10,25,26</sup> Increased child-respiratory problems occur at average NOX concentrations of 0.017 ppm/year,<sup>27</sup> roughly 300 times lower than 5 ppm/year NOX that TOC says the Jasper plant would release.<sup>9,11</sup> It thus might cause a local epidemic of child-respiratory disease—even if it meets the 5 ppm NOX pollution limits in its proposal. This NOX limit is also at least 50 times weaker than EPA's primary-standard NO<sub>2</sub> limit of 0.1 ppm/3 years.<sup>28</sup>

TOC says the LLC may control NOX using selective non-catalytic reduction (SNCR), a method of removing some NOX from flue gas.<sup>29</sup> However, the maximum efficiency of SNCR = 80–85 percent, at best, and average efficiencies are much lower.<sup>30,31</sup> This means that even with the best-available-control-technology (BACT) SNCR technology—which the proposal does not guarantee—the facility would remove, on average, only about 70 percent of NOX. Moreover, even if the facility released 3.5, not 5, ppm NOX, this still is about 350 times the NOX level that causes increased child-respiratory problems (3.5 ppm/0.01 = 350). Thus, even with BACT, the biomass-plant-pollution standards mean it could cause unacceptably high pollution and EIJ to children—likely minority/below-poverty-level children, as already noted. Yet, because the proposal contains no quantitative-human-health-risk assessment (QRA), and no admissions of its total PM/NOX releases, none of these problems is discussed. Instead, TOC's poor science begs the question of biomass-induced-air-pollution/EIJ harms.

### *Biomass plants and EIJ*

Who will bear most of this biomass pollution? As already noted, because children already bear disproportionate U.S. Jasper PM pollution, Jasper faces existing EIJ. Besides increased NOX/PM, would the proposed-biomass facility worsen EIJ in other ways?

Already, U.S. biomass facilities are disproportionately located in the South/Midwest and disproportionately located in communities where the county African-American population is either the majority population—or at least double that of other counties. Yet African-American children are five times more likely to die from asthma than are white children, and PM/NOX are major asthma contributors. One Georgia chapter of the National Association for the Advancement of Colored People (NAACP) thus argued that siting a biomass facility was a “clear cut example of environmental racism.” The Gainesville, Florida NAACP likewise opposes the local biomass plant. In richer, whiter communities—especially in the Northeast and West, however, biomass proposals often are rejected—while communities with already-existing EIJ tend to accept them.<sup>3,4,10</sup>

### *Biomass economic EIJ*

The EIJ imposed by biomass facilities is not merely medical, however, but also economic. Growing Miscanthus biomass crops is economically risky both for Jasper-area farmers and for taxpayers who would subsidize the plant. Why? Economists say farmers will not grow Miscanthus without price supports.<sup>36</sup> For instance, if non-irrigated Miscanthus operating costs/year = \$988.88/hectare and yield = 19.95 tons/hectare, if corn (soy) has operating costs/year = \$573.86(\$405.22)/hectare and yield = 9.10(3.14) ton/hectare, and if corn (soy) price = \$80.68(\$200.72)/ton,<sup>37</sup> then corn(soy) profit-per-hectare/year = \$160.33(\$255.04). Given these figures, for Miscanthus farmers to make the same profit-per-hectare as soy farmers, the Miscanthus price/ton must be \$61. However, current Miscanthus price/ton = \$38-40.<sup>38</sup> Thus, without price supports, Miscanthus farmers cannot even “break even” and would lose \$200/hectare/year; experts agree that growing Miscanthus is not economical.<sup>39</sup> However, if farmers are poor and desperate, massive federal/state biomass-crop subsidies might induce them to take risks they otherwise might not take.

Why is planting biomass-crop Miscanthus so risky? It typically requires planting “plantlets,” not rhizomes; cannot be planted/harvested with standard farm equipment; is drought intolerant; uses far more water (because of its more-than-eight-foot-dense-root mat) than typical local crops, like corn/soybeans; often requires irrigation (which is not cost-effective); and decreases local groundwater. Yet for years, Jasper has averaged 20 percent less rainfall than Miscanthus requires. Recently (2012), drought-prone Jasper has had summertime emergency-water-conservation rules.<sup>2,36,39</sup>

Local farmers, however, are unlikely to be the only ones hurt by Miscanthus, as Jasper must supply water,

electricity lines, and a plant-biomass lease. Preceding data suggest Jasper Miscanthus crops could fail. Also, Miscanthus has never been successfully grown commercially in the U.S., and TOC has never run a biomass facility. Given crop/facility failure, Jasper could be left with a bankrupt LLC, a dirty biomass plant, and bills for new water/electricity/biomass infrastructure. If so, giving federal/state/local taxpayer subsidies for growing/burning Miscanthus could be a bit like Nestlé’s initially “subsidizing” or giving free infant formula to developing-nation mothers. Once they use formula, causing their breast milk to dry up, the mothers cannot afford to buy formula, and they may lose their babies. Analogously, once subsidies entice farmers to grow Miscanthus, if drought and other problems occur, Miscanthus farmers and the LLC could go bankrupt, and the LLC might not obtain needed Miscanthus at a profitable price.

Although TOC says it will work through local farm cooperatives to recruit/contract 150–200 growers necessary to produce 90,000–100,000 tons Miscanthus/year needed for the plant,<sup>10</sup> preceding economic data suggest such contracts are unlikely. If so, Jasper government officials must help protect local farmers and the city from Miscanthus agreements that could bankrupt both. Besides, if growing Miscanthus were profitable, TOC could have shown this through a cost-benefit analysis (CBA). It also could have done an ecological risk assessment (ERA) to try to show that growing Miscanthus in drought-prone Indiana was possible without irrigation. Instead, just as TOC’s proposal has no QRA (see above), it also has no CBA, no ERA, and begs the question of Miscanthus crop/incineration success. The only “success” may be federal/state/city biomass subsidies for TOC and TOC-partner Mendel Biotech—who hopes to sell local farmers Miscanthus plantlets. Thus Jasper may face economic EIJ—that is, EIJ that also causes economic harm. Moreover, because TOC’s proposal has no CBA/ERA/QRA, it virtually guarantees EIJ. Why? At a minimum, EJ requires both equitable risk distribution and equitable participation in risk decision making. But equitable risk decision-making participation requires risk consent, therefore risk disclosure. Therefore, given no Jasper-biomass-plant CBA/ERA/QRA, the plant poses threats to risk disclosure, therefore to consent, therefore to equitable risk decision making, and therefore to EJ.

### *Biomass ecological EIJ*

Besides economic and health threats, Miscanthus growing/incineration may cause ecological EIJ—EIJ that also causes harm to the local environment, threatening water and local-farming resources. Why? The new perennial hybrid Miscanthus giganteus could be invasive. Just in the U.S., invasive plants cause damage worth \$34 billion/year.<sup>40</sup> If this damage is prorated/square mile for only one of the two counties in which Jasper is located, it = \$400,000/year from invasive species.<sup>41,42</sup> On one hand, because Miscanthus giganteus has three, not the normal two, chromosomes,<sup>43</sup> TOC says Miscanthus is “sterile,” thus not invasive.<sup>10</sup>

On the other hand, scientists have shown that even triploid (three chromosomes instead of two) plants can reproduce and generate viable seeds; besides, one of the parent plants of *Miscanthus giganteus*—*Miscanthus sinensis*—is a triploid whose female fertility is reduced, but still up to 49 percent.<sup>44</sup> Yet triploid fertility of 49 percent suggests triploids are not sterile. Besides, this *Miscanthus giganteus*' parent (*Miscanthus sinensis*) is well known as a dangerous invasive. Moreover, because *Miscanthus* sprouts from root-like rhizomes (as potatoes do), it could spread throughout the environment during storms/floods/animal-assisted migration/plantlet transportation-distribution. Given that *Miscanthus giganteus* grows rapidly, once established, and has advantages from using the C<sub>4</sub>, not the normal C<sub>3</sub>, photosynthetic pathway,<sup>45</sup> scientists contradict TOC and say it could become invasive.<sup>46,47,48,49</sup>

Who is right on *Miscanthus* invasiveness potential, TOC or independent scientists? Interestingly, views of TOC-biomass-partner, Mendel, seem closer to what independent scientists say about *Miscanthus* invasiveness than what TOC says. In fact, TOC almost contradicts its partner, Mendel. In the proposal, Mendel repeatedly says it provides "low-risk" of invasiveness plants, not risk-free, sterile plants; Mendel says its plants have no "significant" invasiveness potential, but TOC says no potential; Mendel says that its "goal is functional sterility," but TOC claims *Miscanthus* is sterile.<sup>10</sup> Besides, if TOC really believed *Miscanthus* had no invasiveness potential, as it claims, the LLC could easily provide full-liability insurance for Jasper/Indiana against *Miscanthus* invasiveness. Regardless, TOC's behavior should be consistent with its claims. The fact that its invasiveness-liability behavior is not consistent—with its claims—suggests grounds for doubting TOC claims and fearing ecological EIJ. Again, TOC's non-disclosure (about *Miscanthus*' invasiveness potential) appears similar to its nondisclosures regarding biomass-caused PM/ozone and regarding its omissions of CBA/ERA/QRA. All these risk-disclosure problems threaten consent and thus EIJ.

Besides invasiveness, ecological EIJ in Jasper also could arise from *Miscanthus*-induced-biodiversity losses. Non-native *Miscanthus giganteus* does not support local animal biodiversity,<sup>48</sup> and mature *Miscanthus* stands have lower bird/mammal numbers, often serving as impenetrable breeding traps for ground-nesting birds.<sup>48</sup> Because *Miscanthus* stands are dense, they drive out even local animals who cannot penetrate them. Yet such biodiversity threats are also threats to land values and ecosystem services such as providing food, water, natural-resource supplies, ecotourism opportunities, land, nutrient recycling, soil retention, climate regulation, and aesthetic quality.<sup>50</sup>

Because of *Miscanthus* threats to local biodiversity and ecosystem services, TOC's proposal should have quantified city/county land values and ecosystem services that could be lost because of growing *Miscanthus*. Globally, ecosystems provide humans services worth some \$33 trillion/year.<sup>51</sup> If U.S. land area = 7 percent of global, then U.S. ecosystem services are worth about  $(0.07)(33) = \$2$

trillion. But 2010 census data show U.S. land area = 3,531,905 square miles, and Jasper "micropolitan" land area (Dubois/Pike counties) = 972 square miles. Therefore, Jasper area =  $1/3634$  or .0275 percent of U.S. land area. But assuming U.S. average/prorated ecosystem services, Jasper-area ecosystem services =  $0.0275$  percent of \$2 trillion, or \$550 million/year. Clearly TOC should have quantified *Miscanthus*-biomass-facility threats to these \$550 million/year Jasper ecosystem services. However, with no CBA/ERA/QRA, TOC's proposal ignores these threats.

*Miscanthus*-induced biodiversity/ecosystem-services losses also can be calculated, based on the relative values of crop and pasture land.<sup>52,53</sup> TOC says Jasper-plant *Miscanthus* would be grown on 8,000–10,000 acres of uncultivated/pasture land.<sup>10</sup> However, the ecosystem-services value of uncultivated/pasture land is four times greater than that of already-biochemically-depleted crop land.<sup>53</sup> If so, then growing *Miscanthus* on 10,000 acres of Jasper land would reduce these acres' ecosystem-services values by 75 percent. Obviously such *Miscanthus*-decreased land values would negatively impact the local economy/environment and should have been disclosed in the Jasper-biomass proposal. Their nondisclosure thus threatens consent, therefore equitable risk decision making, therefore ecological EIJ.

#### *Biomass and scientific misrepresentation*

Why have Jasper local officials accepted the risky biomass-crop/plant proposal? One reason may be that the town wants income from its now-closed, 1960s-era, coal plant—and is willing to cover some infrastructure requirements for the proposed facility. Another reason may be that TOC has misled the town and county about *Miscanthus*/biomass/EIJ risks. The last reason is especially important because, as already mentioned, without full risk disclosure, there is no full consent, no fully equitable risk decision making, and no full EIJ. Again, as already noted, at a minimum, the Jasper-biomass proposal should have disclosed economic, ecological, and medical risks, as part of CBA/ERA/QRA. A full CBA would have included *Miscanthus* economic risks to farmers and taxpayers. A full ERA would have included biodiversity, drought, and invasiveness risks to the local area. A full QRA would have included NOX, ozone, and PM hazards that were largely missing from the proposal.

Instead, TOC's proposal encourages EIJ because its scientific deficiencies thwart risk disclosure and therefore cause ethical deficiencies, like lack of consent to the facility. Thus, the *Miscanthus*-biomass case may illustrate—as tobacco-industry "science" does—special-interest science (SIS), research whose conclusions are predetermined by profit interests rather than by empirical data.<sup>26</sup> Because the American Association for the Advancement of Science says that 75 percent of U.S. science is funded by special interests/corporations, not government or universities, this profit-oriented funding may contribute to problems such as special-interest science and resulting EIJ.<sup>26</sup>

## CONCLUSION

The Jasper-biomass proposal illustrates why NAACP chapters, across the country, have been so critical of alleged green, clean biomass. If the arguments here are correct, however, biomass does not threaten only the health of poor and minority citizens—through air pollutants like NOX—but also their economic and ecological and environmental welfare. That is, Miscanthus biomass crops/incineration poses invasiveness risks and threats to farm income, local water supplies, and biodiversity.

## AUTHORS' DISCLOSURE STATEMENT

The authors declare they have no competing financial interests.

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