RELIABILITY OF RENEWABLE ENERGY: BIOMASS

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The Institute of Political Economy (IPE) at Utah State University seeks to promote a better understanding of the foundations of a free society by conducting research and disseminating findings through publications, classes, seminars, conferences, and lectures. By mentoring students and engaging them in research and writing projects, IPE creates diverse opportunities for students in graduate programs, internships, policy groups, and business.
As Americans have grown more concerned with fossil fuels, policymakers have responded to their constituencies by mandating and subsidizing renewable energy sources like biomass. Biomass is organic material that can be used for energy production. Environmentally-focused policies have helped the biomass market grow as an electricity source in the United States and internationally. In 2014, 1.7 percent of the United States’ electricity was generated from biomass, and as state governments mandate higher amounts of renewable energy, more electricity will be generated using biomass fuels. The Institute of Political Economy evaluated the environmental, economic, and physical reliability of biomass-generated electricity. To be considered reliable, biomass-generated electricity must be:

- Economically viable and profitable without government mandates, subsidies, or incentives.
- Less harmful to the environment than traditional forms of energy.
- Able to consistently meet energy demands without disruption.

**ECONOMIC RELIABILITY**

Biomass-generated electricity is, on average, slightly more expensive than coal power, so it is used less as an electricity source. Governments attempt to circumvent high costs of biomass by subsidizing and mandating biomass electricity production. Biomass incentives are effective, but the biomass industry has come to depend on incentives, making biomass economically unreliable.

**RELATIVE COST OF BIOMASS**

Although biomass fuels are more expensive than coal on average, the two fuels can be cost-competitive, making them more economically reliable than many renewable electricity sources. Researchers use what is called the “levelized cost of electricity” (LCOE) to estimate the lifetime costs associated with generating electricity. In 2015, the Energy Information Administration estimated that the LCOE from a conventional coal plant was $95.10 per megawatt-hour, and the LCOE from a biomass plant was $100.50 per megawatt-hour. Because biomass electricity is generally not a viable alternative to fossil fuel powered electricity, lawmakers in the United States have established mandates and subsidies to ensure that states explore options beyond fossil fuels.

**MANDATES**

Biomass is currently only mandated by state governments, not the federal government. Renewable Portfolio Standards (RPS), the most common type of renewable energy mandate, outline what portion of a state’s energy must come from renewable resources. Some states’ RPS have mandates for specific amounts of its energy come from a particular energy source. These mandates are called carve-outs.

Most carve-outs are for wind or solar power, but some states have carve-outs for biomass. While biomass has fewer carve-outs than wind or solar power, it is still eligible to satisfy the general renewable requirements for all twenty-nine states that have adopted RPS. Because biomass is one of the most reliable ways to meet RPS, these mandates drive the growth of the biomass energy industry.

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SUBSIDIES

In addition to mandates, governments use subsidies to impact the biomass industry. Biomass subsidies increase the cost of electricity for taxpayers and redistribute wealth to biomass producers. Taxpayers for Common Sense, a 501(c)(3) non-profit organization that acts as a budget watchdog, estimates that tax credits for biomass will cost taxpayers more than $2.2 billion over the next ten years.4

The Production Tax Credit (PTC) is a key government subsidy for most types of biomass.5 Electricity producers that use energy crops, called closed-loop biomass, receive a tax credit of 2.3 cents per kilowatt-hour. Electricity producers that use farm and forest waste, landfill gas, and other forms of waste biomass receive a smaller tax credit of 1.1 cents per kilowatt-hour.6 This is known as open-loop biomass.

Although closed-loop systems receive a greater tax credit than open-loop systems, they are not as widely used because energy crops are expensive to produce.7 Open-loop biomass material, however, is less expensive and easier for electricity companies to procure. Even without the PTC in effect, electricity companies use waste biomass to generate electricity. Incentivizing open-loop biomass provides additional profits to companies that are already generating a profit by using waste biomass to generate electricity.8

The Biomass Crop Assistance Program (BCAP) is another federal subsidy used to help the biomass industry. To incentivize farmers to harvest more agriculture and forest residues, the U.S. Department of Agriculture matches payments made to farmers by biomass energy companies through the BCAP. The BCAP provides matching payments up to $12.5 million per year.9 Many biomass energy plants have come to rely on the BCAP to stay in operation.10 Proposed BCAP cuts discourage farmers from entering the industry, showing that biomass suppliers are unconfident that the biomass industry could sustain itself if the industry were to lose government support.11

Biomass is economically reliable when it exists independently of government support, but when biomass is grown and used solely because of government intervention, as is often the case with animal waste and closed-loop biomass energy sources, biomass is not an economically reliable electricity source.

ENVIRONMENTAL RELIABILITY

Wood is the principal fuel used in biomass electricity generation.12 Biomass power plants can be reliably supplied from forest thinning operations and wood waste from construction and municipalities, but wood is often supplied by full scale logging operations. According to a 2011 article by the Partnership For Policy Integrity (PFPI), 55 million tons of wood (roughly 650,000 clear-cut acres of forest) are needed each year to provide enough fuel for predicted biomass facilities coming online over the next three years. That volume cannot be met by existing wood scrap and waste, power-of-association


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meaning forests will need to be harvested to meet demand.13

Logging and burning trees releases sequestered carbon into the atmosphere while diminishing forests’ future ability to sequester carbon.14 Carbon lost from burning trees will not be recaptured until trees have reached maturity, even if the trees are replanted after being harvested. Because climate change is an immediate concern, it is illogical for government to incentivize tree burning as a way to reduce carbon emissions. Net carbon emissions are positive in the short term because large numbers of trees that would absorb carbon dioxide in the future have been harvested and burned.15 By burning whole trees cut specifically for energy production, atmospheric carbon dioxide builds while carbon sequestering rates decrease.16

In addition to its immediate effects on carbon sequestration, burning woody biomass increases harmful emissions from energy production. A study done by the PFPI found that biomass combustion produces more carbon dioxide and nitrogen oxides than coal per megawatt-hour.17 The Massachusetts Environmental Energy Alliance states that biomass combustion emits 1.5 times more of both carbon monoxide and carbon dioxide than burning coal.18

Although biomass is dirtier than coal in terms of immediate emissions, biomass electricity plants are not held to the same emission standards as their fossil fuel counterparts. Biomass companies can emit two and a half times more of the same pollutants than fossil fuels before they are required by the Environmental Protection Agency to obtain Prevention of Significant Deterioration permits, which regulate emissions from energy generation.19 Most biomass facilities do not face any restrictions regarding hazardous air pollutants like hydrochloric acid, carcinogens, and heavy metals.20 Biomass plants are incentivized by both mandates and subsidies, yet they are often dirtier than fossil fuels.

Unlike trees, grasses do not have a significant time lag between releasing and sequestering carbon. Burning grass that will be regrown the next year has little impact on net carbon emissions.21 Compared to fossil fuels and wood harvesting, grasses have a minimal net carbon impact on the environment. Grasses do, however, require large amounts of land to produce enough grass to provide reliable power. The Union of Concerned Scientists suggest that if grasses are planted on a scale sufficient to meet increasing bioenergy demands, forestland would have to be cleared to make room for displaced food crops or energy grasses themselves.21

Clearing forests would release massive stores of carbon dioxide into the atmosphere, and the grasses that would replace forests would never be able to store the same amount of carbon that the removed trees did. Grasses’ ability to thrive in infertile areas indicates that unless market conditions change dramatically, grasses will fill marginal farmland before farmers clear-cut forests to make room for energy grass. Given current market conditions, grasses are unlikely to displace food crops and forestland enough to have significant negative impacts.

16 Ibid.
20 Ibid.

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A study conducted by the Vermont Grass Energy Partnership found that burning dried grass pellets releases more nitrogen, sulfur, and chlorine than burning wood. 22 Salts within plant material are difficult to combust and aid in the creation of toxic emissions. 23 To minimize toxic emissions from biomass, biomass materials can be co-fired with coal. Burning biomass materials with coal can reduce greenhouse gas emissions, particularly carbon dioxide and sulfur compounds.24

Methane, a greenhouse gas, is naturally emitted from landfills and livestock waste and can be collected and burned to generate electricity. 25 Burning methane positively affects the environment by converting methane into carbon dioxide, which is less damaging to the atmosphere.26 Collecting methane for electricity is reliable in multiple ways. Waste is readily and predictably available, and methane operations help lengthen the existence of landfills, delay additional landfill needs, and lower waste disposal effects and costs.27 Anaerobic digestion from microbial organisms naturally produces methane that can be burned like natural gas and the remaining waste can still be used as fertilizer for crops.28

Although biomass is renewable, it is not less harmful to the environment than traditional forms of energy. Biomass plants emit more emissions per unit of electricity produced than fossil fuel plants and are far less efficient. Because of mandates and subsidies, farmers may replace food crops with energy crops, causing an increase in the price of food. Although biomass power is a renewable electricity source, it is often more harmful to the environment than fossil fuels, so it cannot be considered an environmentally reliable electricity source overall.

PHYSICAL RELIABILITY

Biomass, unlike wind and solar power, is predictable and can be used for baseload power. Power plants that supply baseload power operate constantly to meet the majority of electricity demand, thus supplying a "base" of power that can be supplemented by other electricity sources when electricity demand fluctuates.29

Although biomass can provide baseload power, most solid biomass materials have a low energy density, meaning biomass has little energy potential per unit of material compared to other fuels, such as coal. Biomass’ low energy density is due largely to the high water content of biological materials. The water within biological materials cannot be burned for energy, so it does little more than weigh the material down. Biomass materials also have very low bulk density, meaning they have less weight per unit of volume that they take up.30 The combined effect of low bulk density and low energy density means that biomass materials take up more space and have more weight per unit of energy produced than other sources of energy. These factors make biomass material inefficient to transport and store because it takes up more space, weighs more, and generates less electricity than other fuels.31 Unless biomass materials are first processed to reduce their water content, it is generally inefficient to transport them more than 50-100 miles by truck.32

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Biomass producers can make biomass material more energy dense, making it more efficient to transport. Methods of increasing energy density include densifying the material by applying extreme pressure, or drying the material and turning it into charcoal.33,34 Treating biomass material, however, is often a very expensive process, and for smaller-scale operations, it is usually more economical to generate electricity with the biomass material close to the source it was harvested from.35

Biomass can provide renewable baseload power. Because supply is predictable, unlike wind or solar, biomass can meet energy demands without disruption. Therefore, biomass is physically reliable.

CONCLUSION

The popularity of biomass-generated electricity is growing because of government policies. In some cases, biomass facilities have become dependent on government support, such as the Drax Power Station in the United Kingdom. Governments mandate and incentivize biomass because of its supposed environmental benefits, but many forms of biomass energy production have negative environmental impacts. Woody biomass is dirtier than coal in terms of emissions, and harvesting it often damages forests. Producing electricity using methane, however, benefits the environment and is an efficient use of a resource that would have otherwise gone to waste.

Solid biomass fuels are an inefficient source of power due to their low energy and bulk densities. Although biomass materials can be densified, the costs are prohibitive for small-scale operations and obtaining sufficient amounts of biomass is difficult for large-scale operations.

Biomass can be a reliable source of energy when properly utilized. Animal and woody wastes are readily available and can provide an economically viable option when used close to their sources. Biomass energy initiatives can help maintain forest health and convert methane to less harmful carbon dioxide. Government mandates and subsidies, however, can incentivize unsustainable and environmentally harmful biomass practices. While biomass may have a place in the United States electricity market as a means of using waste products, it is an unreliable source of electricity at the grid-scale.


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