Congressional Research Service
Informing the legislative debate since 1914

Biopower: Background and Federal Support

Kelsi Bracmort
Specialist in Agricultural Conservation and Natural Resources Policy

February 12, 2016

Congressional Research Service
7-5700
www.crs.gov
R41440

Summary

Biopower—a form of renewable energy—is the generation of electric power from biomass feedstocks. In 2014, Biopower comprised about 1.6% of total U.S. electricity generation and accounted for close to 12% of U.S. renewable electricity generation. Its advantages include a potential for baseload power production, greenhouse gas emission reduction, and use of renewable biomass feedstock, among other things. Its disadvantages include uncertain sustainable feedstock supply and infrastructure concerns, among other things.

Recent developments have prompted renewed interest in biopower. For instance, some stakeholders are concerned about the treatment of biopower by the U.S. Environmental Protection Agency (EPA) for the Clean Power Plan (CPP). The CPP—which was granted a stay by the Supreme Court on February 9, 2016—establishes regulations that would reduce carbon dioxide (CO_2) emissions from existing fossil fuel-fired electric power plants. . States are required to reach a state-specific emission reduction goal by 2030 using various options—including biopower—based on guidance provided by EPA. EPA has struggled with accounting for greenhouse gas emissions from bioenergy for various reasons, and it is not clear if this struggle will continue throughout the implementation of the CPP. Further, international demand for wood pellets—primarily to satisfy European Union renewable energy mandates—has increased significantly. This development has prompted environmental organizations and others to express concern about the harvest of increasing amounts of biomass and about possible increases in greenhouse gas emissions from the combustion of wood pellets to produce energy. By contrast, some in the forestry industry and the wood pellet industry argue that the international demand presents another market opportunity, that measures are in place to ensure a sustainable biomass feedstock supply, and that biopower can result in lower greenhouse gas emissions.

The future contribution of biopower to the U.S. electricity portfolio is uncertain. Challenges to biopower production include regulatory uncertainty (e.g., EPA's CPP), market fluctuation (e.g., natural gas prices), conversion technology development, and tax uncertainty (e.g., extension or termination of renewable energy tax credits), among other issues. Some argue that a comprehensive energy policy focused on renewables could boost biopower production efforts, especially if the policy includes a renewable portfolio standard—a mandate that requires increased production of energy from renewable sources. There is no federal renewable portfolio standard, and the last Congress to robustly debate the issue was the 111^{th} Congress. However, 29 states have established renewable portfolio standards, which vary dramatically from state to state. Current federal support for biopower exists in the form of loans, tax incentives, grant programs, and more.

Contents

Figures

Tables

Appendixes

Contacts

Introduction

Biopower—the production of electricity from biomass feedstocks—contributes to the U.S. electricity portfolio and has done so for more than a century. Biopower comprised approximately 1.6% of total U.S. electricity generation in 2014. By comparison, electricity generated from fossil fuels and nuclear electric power comprised 87% of total U.S. electricity generation in the same year.[1] When accounting solely for renewable energy sources, biopower constituted close to 12% of U.S. renewable electricity generation in 2014.[2]

As a renewable energy source, biopower has benefits and challenges. One of its primary benefits is that it can provide baseload or *firm* power. If an electric generation plant operates as a baseload plant, the plant can run continually except for maintenance and unexpected outages. In contrast, other renewable energy sources—such as wind and solar energy—are generated intermittently and require either a form of power storage, such as batteries, or another power source, such as natural gas turbines, to provide firm power. Additionally, biopower is not limited to a specific biomass feedstock and therefore is relatively flexible in terms of fuel suppliers. Challenges to biopower production involve infrastructure concerns, such as siting a biopower facility in close proximity to the biomass feedstock to reduce feedstock transportation costs. Moreover, it may be difficult to obtain a continuously available feedstock supply. Lastly, there is significant legislative and regulatory uncertainty surrounding incentives for biopower.

Congress may view biopower with new interest, especially given recent developments announced by the Obama Administration and mounting discourse between environmental groups and certain biopower feedstock groups (e.g., the forestry industry). For instance, biopower is likely to play a role in the Administration's state-specific rate-based goals for carbon dioxide emissions from the power sector (i.e., the Clean Power Plan).[3] Additionally, international demand for certain U.S. biomass feedstocks may be a part of any future legislative discussions (e.g., demand for wood pellets by European Union [EU] member countries to meet carbon goals using biopower).[4]

Congress may debate the future role for biopower in the U.S. electricity portfolio, and as such it may consider whether biopower requires new national policies or incentives to further encourage its use or if its use should be diminished. Congress also may explore biopower feedstock availability and accessibility, technological advancements, and new forms of economic support, along with other items such as environmental considerations. In considering congressional action to broaden or limit legislative authorities for biopower, an understanding of bioenergy, biopower, biomass feedstocks, federal incentives, and challenges to biopower production could be useful to policymakers. This report provides analyses on the aforementioned topics along with legislative issues.[5] The report begins with general summaries about bioenergy and biopower—including

[1] U.S. Energy Information Administration (EIA), *Monthly Energy Review*, June 2015. EIA collects data for facilities that generate at least 1 megawatt (MW) of electricity. Additional EIA biopower data is available in the EIA's *Electric Power Annual Report* and in databases for both survey form EIA-923, "Power Plant Operations Report," and form EIA-860, "Annual Electric Generator Report."

[2] The renewable energy sources include conventional hydroelectric power, biomass (wood and waste), geothermal, solar/PV, and wind.

[3] U.S. Environmental Protection Agency, *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, final rule, August 3, 2015.

[4] Tom Zeller Jr., "Wood Pellets Are Big Business (And for Some, a Big Worry)," *Forbes*, February 1, 2015.

[5] This report solely addresses the more technical aspects of biomass feedstock used for biopower. It does not address biopower environmental or health concerns. For information about the carbon status of biopower, see CRS Report R41603, *Is Biopower Carbon Neutral?*, by Kelsi Bracmort.

potential benefits and challenges, feedstocks, and biopower technologies. The report then delves into federal support available for biopower, followed by legislative concerns.

Bioenergy

Bioenergy is renewable energy derived from biomass.[6] It comes in three forms: biopower, biothermal, and biofuels. Essentially, biomass is used to produce electricity (biopower), heat (biothermal), and fuels (biofuel). Biomass also can be used to produce combined heat and power (CHP).

Using bioenergy has several advantages and several challenges. One advantage to using bioenergy is its classification as a renewable energy source because it uses biomass feedstocks, which may be replenishable in a short time frame relative to fossil fuels. Bioenergy also has the potential to contribute to rural economic development and to reduce greenhouse gas (GHG) emissions. The carbon status of most bioenergy types has thus far been treated as neutral or as having a low impact, although this assumption has been questioned.[7] Another benefit is the potential for the production of coproducts at bioenergy facilities, which may be of more value than the bioenergy being produced.

Challenges to bioenergy production include limited biomass feedstock availability and, in some cases, limited access to the feedstock. Further, certain biomass feedstocks (e.g., corn stover) may have to be harvested in a way that the soil and water nutrient value they provide to the landscape is not diminished. Moreover, the feedstock condition and arrangement may make it difficult and costly to transport and process for energy generation. In some instances, biomass feedstock storage can be an issue, especially during periods of peak demand. Lastly, biomass feedstocks on average have a lower energy content than fossil-fuel feedstocks, often requiring more feedstock to match the energy potential of fossil fuels.

Bioenergy is unique among renewable energy sources because it can come in three diverse forms. Each form, thus far, has received a different amount of attention. However, there are some aspects of all bioenergy forms that could be addressed in tandem. For example, as biomass is the foundation of any form of bioenergy, the initial stages of the bioenergy pathway—feedstock production, harvest, and transport—all bear the same environmental and sustainability concerns. Although some stakeholders may voice their concerns more strongly for one bioenergy form than for another, often the concerns are transferable to other bioenergy forms (e.g., the impact of land use change on biofuel production). Congress, the executive branch, and others have tended to focus on one bioenergy form at a time, at the exclusion of others. For instance, in the last decade, legislative, research, and industrial attention have focused more on biofuels (e.g., corn-based ethanol) than on other bioenergy forms.[8] Such focus may occur due to the regulatory requirements necessary for the bioenergy end use as opposed to the bioenergy supply. One issue

[6] Biomass is organic matter that can be converted into energy. Biomass feedstocks encompass a wide range of material including agricultural crops, crop and forest residues, waste materials, and more. For more information on biomass, see CRS Report R40529, *Biomass: Comparison of Definitions in Legislation*, by Kelsi Bracmort.

[7] There is an ongoing discussion about the carbon status of bioenergy, particularly biopower. For more information, see CRS Report R41603, *Is Biopower Carbon Neutral?*, by Kelsi Bracmort.

[8] The Renewable Fuel Standard (RFS), a mandate to ensure that domestic transportation fuel contains a specified volume of biofuels, is one reason most legislative and administrative efforts have focused on development of biofuels for transportation. For more information, see CRS Report R40155, *Renewable Fuel Standard (RFS): Overview and Issues*, by Mark A. McMinimy and Kelsi Bracmort, and CRS Report R43325, *The Renewable Fuel Standard (RFS): In Brief*, by Kelsi Bracmort.

for Congress is that bioenergy can cross multiple committee jurisdictional boundaries, possibly making it harder to reach a consensus on a more comprehensive approach to bioenergy.

Biopower

Biopower was the third-largest renewable energy source for electricity generation in 2014, after conventional hydroelectric power and wind.[9] The top five states to contribute the largest amounts of net electricity generation from biomass year-to-date through December 2014 were California, Florida, Georgia, Virginia, and Maine.[10] The Energy Information Administration (EIA) projects that electricity generation from biomass will grow through 2030 by an average of 3.1% annually, led by co-firing at existing coal plants through 2030, and that after 2030 new dedicated biomass power plants will account for most of the growth in biopower.[11]

Woody biomass is the primary biomass feedstock used for biopower. In 2014, roughly two-thirds of biopower generation used wood and wood-derived fuels as its biomass feedstock. The remaining one-third came from municipal solid wastes from biogenic sources, landfill gas, and agricultural byproducts, among others.[12] EIA reports that biomass consumed as combustible fuel for electricity generation in 2014 was 723 trillion British thermal units (btu)—430 trillion btu from wood and wood-derived fuels, and 293 trillion btu from other biomass feedstocks.[13]

Like other power sources, biopower has its advantages and disadvantages. The intensity of those advantages and disadvantages varies based on the scenario under consideration. The sections below discuss some of these potential benefits and challenges.[14]

Potential Benefits

Baseload Power

Biopower can be a firm source of power for baseload power production. *Baseload power* is the minimum amount of electric power delivered or required over a given period of time at a steady rate.[15] Baseload plants produce electricity at a constant rate and generally run continuously

---

[9] Biopower constituted close to 12% of electricity generation from renewable energy sources in 2014, compared with conventional hydroelectric power and wind, which constituted roughly 48% and 34%, respectively. EIA, *Monthly Energy Review*, June 2015.

[10] EIA, *Electric Power Monthly with Data for December 2014*, February 2015.

[11] EIA, *Annual Energy Outlook 2015*, DOE/EIA-0383 (2015), April 2015. *Co-firing* is the combustion of supplementary fuel (e.g., biomass) and coal concurrently. EIA reports that the "AEO Reference case generally assumes that current laws and regulations affecting the energy sector remain unchanged throughout the projection (including the assumption that laws that include sunset dates do, in fact, expire at the time of those sunset dates). This assumption enables policy analysis with less uncertainty regarding unstated legal or regulatory assumptions."

[12] Biomass fuel types used for EIA statistical surveys include solid renewable biomass fuels (e.g., agricultural byproducts, municipal solid waste, other biomass solids, and wood/wood waste solids), liquid renewable biomass fuels (e.g., other biomass liquids, sludge waste, black liquor, and wood waste liquids excluding black liquor), and gaseous renewable biomass fuels (e.g., landfill gas and other biomass gas). EIA, *Form EIA-860M Monthly Update to Annual Electric Generator Report Instructions*, 2013.

[13] EIA, *Monthly Energy Review June 2015*.

[14] For more information, see U.S. Department of Energy (DOE), *Biopower Technical Strategy Workshop Summary Report*, December 2010, or the International Energy Agency, *Technology Roadmap: Bioenergy for Heat and Power*, 2012.

[15] Baseload should not be confused with peak load, which is the maximum electricity load during a specific period of time.

throughout the day. With sufficient feedstock supplies, among other things, a biopower plant can provide firm power for baseload needs. It is one of the few renewable energy sources that can provide consistent power.[16]

Renewable Biomass Feedstock Supply

Biopower originates from a feedstock—renewable biomass—that can be replenished in a short time frame relative to fossil fuels and may offer certain environmental benefits. *Renewable biomass*, or simply *biomass*, is organic matter that can be converted into energy. Biomass can come from food crops, dedicated energy crops, crop residues, trees, forestry residue, and reusable feedstocks that once were considered wastes (e.g., animal manure). Currently, woody biomass and wood wastes are the principal biomass feedstocks used for biopower generation. However, biopower generation is not limited to a specific feedstock and therefore is relatively flexible in terms of supply. Thus, each region of the country can pursue biomass feedstocks that are native, cost-effective, and readily available to generate biopower (e.g., food waste in urban areas).

Potential Challenges

Feedstock Availability and Cost

The amount of biopower that can be produced depends on the availability and cost of biomass feedstocks, both of which fluctuate given various conditions. Some biomass feedstock can be available at substantially lower costs than fossil fuels and integrated relatively easily into a bioenergy production process (e.g., yard waste). However, other biomass feedstocks have higher logistical and transaction costs associated with their removal and transport (e.g., forestry residues). An overarching concern is maintaining an environmentally and economically sustainable biomass feedstock supply.[17] Collecting or harvesting biomass without regard to replenishment, or in an otherwise unsustainable manner, may lead to the deterioration of certain natural resources, such as soil erosion or the depletion of forested land. Thus far, biomass used for biopower is not subject to the same constraints as biomass used for liquid transportation fuels under federal statute.[18] Additionally, feedstock diversity is a formidable challenge to biopower growth, because cultivation, harvest, storage, and transport vary according to the feedstock type and conventional agriculture is based on mass production of one crop. Another challenge is determining the amount of available feedstock due to market fluctuations and weather variability. Estimates of feedstock availability also differ depending on certain assumptions.[19] Further, it is

[16] Hydropower and geothermal electricity also provide baseload power. Historically, coal and nuclear are nonrenewable sources of energy that produce baseload power.

[17] Executive Order 13514 defines *sustainability* as the creation and maintenance of conditions that allow humans and animals to exist in productive harmony, and that permit fulfilling the social, economic, and other requirements of present and future generations. For more information, see CRS Report R40974, *Executive Order 13514: Sustainability and Greenhouse Gas Emissions Reduction*, by Richard J. Campbell and Anthony Andrews.

[18] The RFS, expanded under the Energy Independence and Security Act of 2007 (EISA; P.L. 110-140), mandates a minimum volume of biofuels to be used in the national transportation fuel supply each year. Under the RFS, biomass used for renewable fuel for transportation purposes cannot be removed from federal lands, and the law excludes crops from forested lands. For more information on the RFS, see CRS Report R43325, *The Renewable Fuel Standard (RFS): In Brief*, by Kelsi Bracmort. For more information on biomass definitions, see CRS Report R40529, *Biomass: Comparison of Definitions in Legislation*, by Kelsi Bracmort.

[19] Assumptions could include the existence and duration of certain policy drivers, tax incentives, market conditions, weather conditions, international demand, and more.

not clear if biomass supplies exist at a level that is palatable to the biomass-producing communities, the electricity industry, and the environmental community.

Infrastructure

Biopower infrastructure, especially plant siting and power transmission, may pose certain challenges. The current economic climate for biopower dictates that biopower plants should be located in close proximity to feedstocks to reduce transportation costs, which can be significant.[20] This high cost associated with transporting feedstocks for long distances is a result of nonexistent transportation infrastructure for biomass feedstocks compared with what is available for fossil fuels (e.g., a rail transportation system for coal). Permitting and transmission for any new or existing power facility also may be difficult given recent federal actions.[21] Financing and siting both a new facility and new transmission infrastructure could add uncertainty to a proposed project. However, it is possible to retrofit existing combustion plants for biopower production, and power from these plants could use existing transmission infrastructure.

Biomass Feedstock Types

There are several types of biomass feedstock available as a fuel source for electric power generation (see **Table 1**).[22] These sources include land- and water-based vegetation (e.g., trees, algae), as well as other organic wastes. The type, amount, and costs of biomass feedstocks will largely determine whether biopower can thrive as a major renewable energy alternative. Stakeholders differ on what are ideal feedstocks for biopower and what are feasible locations to grow and harvest feedstock. Biomass feedstock plays a critical role in biopower plant feasibility studies, especially feedstock storage and transport and other economic and environmental criteria. These issues contribute to uncertainty about the biopower market.

Comprehensive, national-level data on the current and future biomass feedstock supply is not available.[23] In the future, the potential inclusion of genetically modified dedicated energy crops or selective breeding for bioenergy purposes may alter the amount of biomass feedstock available for biopower production (and could impact water quantity and quality, air quality, and land use).

[20] Pew Center on Global Climate Change, *Biopower*, December 2009. Certain analysis indicates that feedstock supply should be located within a 50-mile radius to avoid excessive transportation costs: Marie E. Walsh, Robert L. Perlack, and Anthony Turhollow et al., *Biomass Feedstock Availability in the United States: 1999 State Level Analysis*, Oak Ridge National Laboratory, January 2000, at http://bioenergy.ornl.gov/resourcedata/index.html.

[21] For more information, see CRS Report R44341, *EPA's Clean Power Plan for Existing Power Plants: Frequently Asked Questions*, by James E. McCarthy et al.

[22] The following section, "Woody Biomass," discusses the primary biomass feedstock used for biopower. Although the other biomass types could be a primary feedstock source for biopower in the future, minimal information about their current contribution to biopower production is available.

[23] For more information on the amount of biomass feedstock available, see DOE, *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*, 2011; and Anthony Turhollow, Robert Perlack, and Laurence Eaton, et al., "The updated billion-ton resource assessment," *Biomass and Bioenergy*, vol. 70 (2014), pp. 149-164. Another source for biomass feedstock supply data is the Bioenergy Knowledge Discovery Framework, an online collaboration toolkit and data resource that provides access to the latest bioenergy research. Lastly, some states and regions have completed individual biomass resource assessments, such as the California Biomass Collaborative, *Summary of Current Biomass Energy Resources for Power and Fuel In California*, May 15, 2011.

Table 1. General Classification of Biomass

Biomass Groups	Biomass Subgroups, Varieties, and Species
Wood and Woody Biomass	Coniferous or deciduous (gymnosperm or angiosperm); stems, branches, foliage, bark, chips, lumps, pellets, briquettes, sawdust, sawmill, and other wastes from various woody species
Herbaceous and Agricultural Biomass	Annual or perennial and field-based or process-based such as grasses and flowers (alfalfa, arundo, bamboo, bana, brassica, cane, miscanthus, switchgrass, timothy, others); straws (barley, bean, flax, corn, mint, oat, rape, rice, rye, sesame, sunflower, wheat, others); other residues (fruits, shells, husks, hulls, pits, pips, grains, seeds, coir, stalks, cobs, kernels, bagasse, food, fodder, pulps, cakes, others)
Aquatic Biomass	Marine or freshwater algae and microalgae; macroalgae (blue, green, blue-green, brown, red); seaweed, kelp, lake weed, water hyacinth, others
Animal and Household/Commercial Biomass Wastes	Bones, meat-bone meal, chicken litter, various manures, others
Contaminated Biomass and Industrial Biomass Wastes (Semi-biomass)	Municipal solid waste, demolition wood, refuse-derived fuel, sewage sludge, hospital waste, paper-pulp sludge and liquors, waste papers, paperboard waste, chipboard, fiberboard, plywood, wood pallets and boxes, railway sleepers, tannery waste, others
Biomass Mixtures	Blends from the above varieties

Source: Stanislav V. Vassilev, David Baxter, and Lars K. Andersen et al., "An Overview of the Chemical Composition of Biomass," *Fuel*, vol. 89 (2010), pp. 913-933. Adapted by CRS.

Woody Biomass

Currently, woody biomass is the main feedstock used for biopower. However, woody biomass also is used in a variety of markets, including the timber market, the wood products market, and other energy markets. There are four primary energy markets for woody biomass: industrial, residential, electricity, and commercial. The electricity sector is responsible for 9% of wood consumed for energy, following the industrial (68%) and residential (20%) sectors.[24] Timber production data indicates that for 2011 close to 6% of timber production in the United States was used to generate electricity.[25]

Wood Pellets

Interest in one particular type of woody biomass feedstock—wood pellets—has increased over the last few years, mainly due to international demand for this commodity.[26] Wood pellets are small, compressed pieces of woodchips or sawdust that are used to heat homes and to produce electricity at power plants. The condensed, uniform size of wood pellets—about one inch in

[24] U.S. Forest Service (FS), *U.S. Forest Products Annual Market Review and Prospects, 2010-2014*, September 2014.

[25] FS, *U.S. Timber Production, Consumption and Price Statistics 1965-2011*, June 2013. Estimate calculated by dividing wood used for electric utilities by the total industrial roundwood production for 2011 (minus the fuelwood production and consumption).

[26] Christina Nunez, "The Energy Boom You Haven't Heard About: Wood Pellets," *National Geographic*, December 10, 2014.

length with the diameter roughly matching that of a pencil—makes them easy to transport and store. Wood pellet challenges include the potential to overheat and spontaneously combust when stored and the dust produced during pellet production, which has the potential to become a combustible fuel source.

Until recently, U.S. wood pellet production, consumption, and global trade data did not garner much attention, partly because wood pellets were used mostly at a small scale for domestic residential heating. Thus, wood pellet data collection had been disparate and opaque. However, today wood pellet production is on an upswing, with approximately half of U.S. wood pellets being exported for use at large power facilities. International policy, particularly the EU's 2009 Renewable Energy Directive (RED), has encouraged greater use of wood pellets. For a variety of reasons—economic, environmental, and more—better wood pellet data is now available to monitor the fuel's use and trade. The U.S. International Trade Commission (ITC) reports that domestic wood pellet production, which is concentrated in the southern United States, was approximately 5.5 million metric tons (Mt) in 2013, half of which was exported.[27] Further, the ITC reports that 99% of wood pellet exports in 2013 went to the EU.[28] Forisk Consulting reports that as of January 2015, there were at least 129 operating wood pellet plants in the United States.[29]

There are concerns about the sustainability and environmental impact of an expanding wood pellet market. For instance, some environmental groups argue that increased wood pellet production will destroy ecosystems and incentivize conversion of natural forests to plantations, among other things.[30] They contend that measures should be implemented to ensure more participation in rigorous forestry sustainability certification programs, prevent harvesting of whole trees, account for the future carbon storage capacity of a forest, and better regulate certain practices occurring in private forests. Some in the wood pellet industry disagree, asserting that they use low-grade wood, mill residues, tops and limbs, and thinnings. Further, they state that any use of whole trees is limited to certain situations and that their practices do not contribute to deforestation.[31] Additionally, several entities within the EU are in the midst of discussing sustainability criteria for biomass energy, including wood used for pellet production.[32] It is not yet known if such a development could result in a hardship for the U.S. wood pellet sector. Since several smaller forest owners provide the wood used for pellet production, it may be difficult for them to track some of the required measures and meet certification standards.

Currently, a viable market exists for wood pellets. However, it is not clear what future demands and policies could have on this market.[33] For instance, there could be market tension between the U.S. forest products sector and the U.S. wood pellet sector, which may compete for the same source material. Moreover, possible energy and environmental policy changes (e.g., any new

[27] 1 million metric tons (Mt) = 1000 kilograms = 2,204 pounds. Alberto Goetzl, *Developments in the Global Trade of Wood Pellets*, U.S. International Trade Commission, Working Paper no. ID-039, January 2015.

[28] The United Kingdom accounted for approximately 59% of U.S. wood pellet exports in 2013.

[29] Forisk Consulting, *Forisk Research Quarterly Q1 2015 Wood Bioenergy US*, February 2015.

[30] Natural Resources Defense Council, *The Truth About the Biomass Industry: How Wood Pellet Exports Pollute Our Climate and Damage Our Forests*, August 2014.

[31] U.S. Industrial Pellet Association, *Frequently Asked Questions*, 2013.

[32] One example of an EU biomass sustainability plan is the United Kingdom Department of Energy and Climate Change, *Timber Standard for Heat and Electricity: Woodfuel Used under the Renewable Heat Incentive and Renewables Obligation*, 2014.

[33] For more information, see FS, *Effect of Policies on Pellet Production and Forests in the US. South*, December 2014.

energy bill, the Environmental Protection Agency's [EPA's] Clean Power Plan [CPP], state renewable portfolio standards) could impact wood pellet production and export.[34]

Biopower Technologies

Biomass is converted to biopower via thermochemical and biochemical conversion processes. These processes include combustion (or firing), pyrolysis, gasification, and anaerobic digestion (see box below and **Figure 1**). Essentially, plants use photosynthesis to store energy (carbon-based molecules) within cell walls, and that energy is released, or converted, when the biomass undergoes a chemical process (such as combustion) or a biological process (such as anaerobic digestion). The type of conversion technology selected for a specific biomass feedstock results in differing amounts of useful energy recovered and forms for that energy.[35] The technologies are at varying stages of maturity, with combustion (e.g., co-firing) being the most established.

One critical factor in determining the potential generation of a biopower plant is determining the supply of biomass feedstock necessary to run the plant.[36] The amount of feedstock required depends on many things, including the feedstock's energy content—the less the energy value, the more feedstock that is needed. Further, the growing area needed to produce the biomass is contingent not only on the energy value of the feedstock but also on the power plant capacity and efficiency, as well as the feedstock yield.[37] In general, the higher the yield of the biomass feedstock, the less growing area is required to produce a megawatt of power. Also, less biomass is needed to support power plants with high efficiency rates.

Furthermore, the size of the biopower plant can range substantially. Small-scale systems (or modular units) may be an optimal choice for rural areas with limited electricity demand. Large-scale systems may be more economically suitable in urbanized areas or near grid connections if feedstocks are ample.

[34] Although there is no federal renewable portfolio standard, 29 states do have a renewable portfolio standard.

[35] Peter McKendry, "Energy Production from Biomass (Part 1): Overview of Biomass," *Bioresource Technology*, vol. 83 (2002), pp. 37-46.

[36] The federal government has studied biomass feedstock supply for bioenergy. For more information, see DOE, *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*, August 2011 and FS, Chapter 10, "Forest Biomass-Based Energy," in *The Southern Forest Futures Project: Technical Report*, August 2013.

[37] *Power plant capacity* is the maximum output of power, commonly expressed in millions of watts (megawatts, or MW), that generating equipment can supply over a certain time period. *Power plant efficiency* is the amount of electric energy produced per unit of feedstock input. For more information on power plant efficiency, see CRS Report R43343, *Increasing the Efficiency of Existing Coal-Fired Power Plants*, by Richard J. Campbell.

Selected Biopower Conversion Processes Defined

A. **Combustion** is the burning of biomass in a power plant. The biomass is burned to heat a boiler and create steam. The steam powers a turbine, which is connected to a generator to produce electricity. Existing plant efficiencies are in the low 20% range, although methods are available to advance efficiency to upwards of 40%. (*Efficiency* essentially describes the percentage of the energy in the feedstock processed that is actually converted to electricity.)

B. **Co-firing**, the simultaneous firing of biomass with coal in an existing power plant, is currently the most cost-effective biopower technology. Co-firing with biomass using existing equipment is less expensive than constructing a new biopower plant. The existing plant does require retrofitting to accept the biomass entering the plant. Certain air particulates associated with coal combustion are reduced with co-firing, as less coal is being burned. Co-firing has a generation efficiency in the 33%-37% range; coal-fired plants have efficiencies in the 33%-45% range.

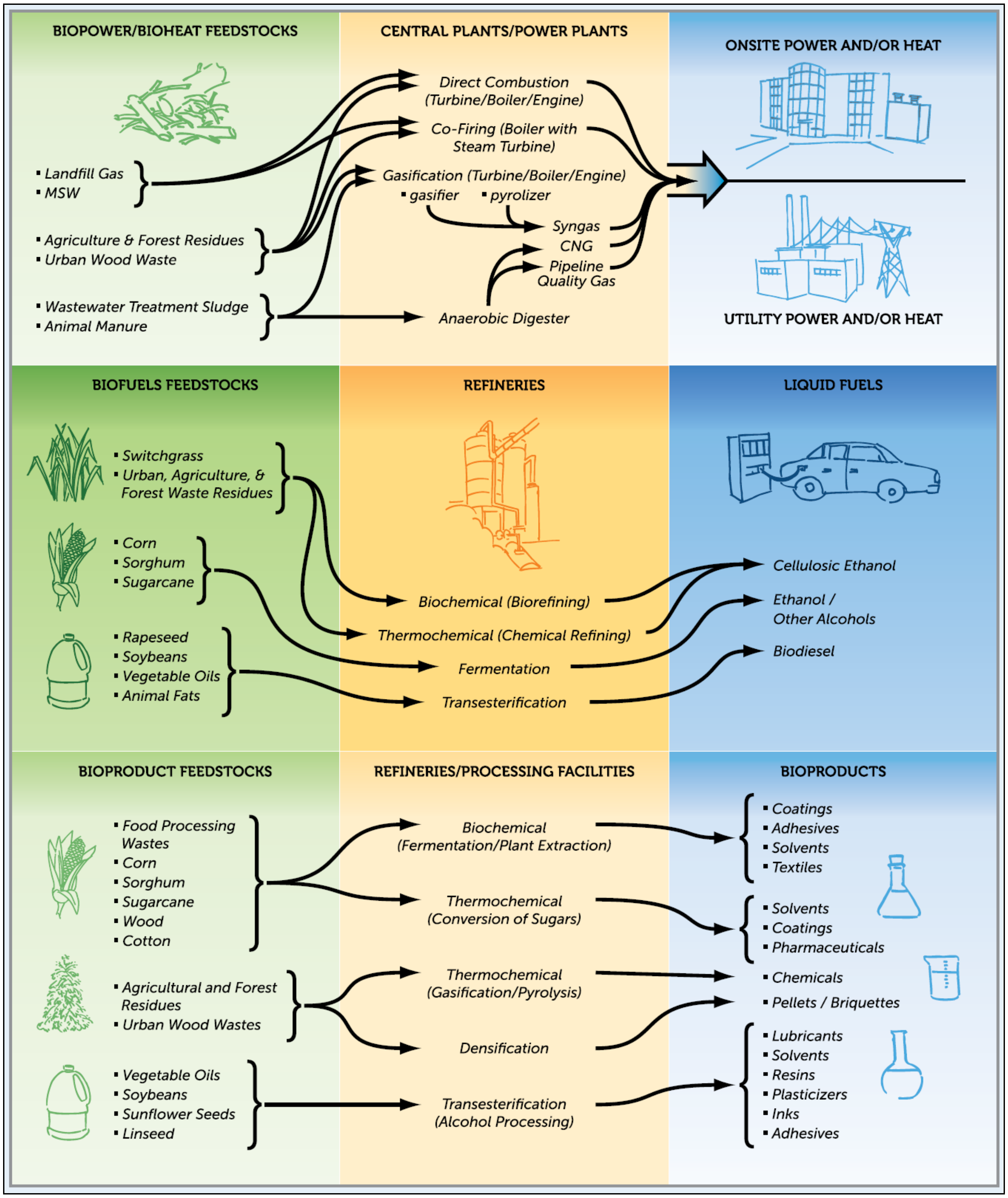
C. **Gasification** is the heating of biomass into synthesis gas (*syngas*, a mixture of hydrogen and carbon monoxide) in an environment with limited oxygen. The flammable syngas can be used in a combined gas and steam power plant to generate electricity. Generation efficiencies range from 40% to 50%. One challenge for gasification is feedstock logistics (e.g., cost to ship or transport the feedstock to the power plant). A wide variety of feedstocks could undergo gasification, including wood chips, sawdust, bark, agricultural residues, and waste.

D. **Pyrolysis** is the chemical breakdown of a substance under extremely high temperatures (400°C -500°C) in the absence of oxygen. There are fast and slow pyrolysis technologies. Fast pyrolysis technologies could be used to generate electricity. Fast pyrolysis of biomass produces a liquid product, *pyrolysis* oil or *bio-oil*, that can be readily stored and transported. The bio-oils produced from these technologies would be suitable for use in boilers for electricity generation. One of the challenges with pyrolysis is that the bio-oil produced tends to be low-quality relative to what is needed for power production. Commonly used feedstock types for pyrolysis include a variety of wood and agricultural resources.

E. **Anaerobic digestion** is a biological conversion process that breaks down a feedstock (e.g., manure, landfill waste) in the absence of oxygen to produce methane, among other outputs, that can be captured and used as an energy source to generate electricity. Anaerobic digestion systems historically have been used for comparatively smaller-scale energy generation in rural areas. Feedstocks suitable for digestion include brewery waste, cheese whey, manure, grass clippings, restaurant wastes, and the organic fraction of municipal solid waste, among others. Generation efficiency is roughly 20%-30%.

Sources: Oak Ridge National Laboratory, *Biomass Energy Data Book: Edition 2*, at ORNL/Tm-2009/098, December 2009, http://cta.ornl.gov/bedb/pdf/BEDB2_Full_Doc.pdf; International Energy Agency, *Biomass for Power Generation and CHP*, ETE03, January 2007, at http://www.iea.org/techno/essentials3.pdf; National Association of State Foresters, *A Strategy for Increasing the Use of Woody Biomass for Energy*, Portland, ME, September 2008, at http://www.stateforesters.org/files/NASF-biomass-strategy-FULL-REPORT-2009.pdf; Sally Brown, "Putting the Landfill Energy Myth to Rest," *BioCycle*, May 2010; John Balsam and Dave Ryan, *Anaerobic Digestion of Animal Wastes: Factors to Consider*, ATTRA—National Sustainable Agriculture Information Service, IP219, 2006, at http://attra.ncat.org/attra-pub/anaerobic.html; Jennifer Beddoes, Kelsi Bracmort, and Robert Burns et al., *An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities*, U.S. Department of Agriculture (USDA) Natural Resources Conservation Service, October 2007; personal communication with Robert Baldwin, National Renewable Energy Laboratory, 2010; personal communication with Lynn Wright, biomass consultant working with Oak Ridge National Laboratory. For more information on anaerobic digestion, see CRS Report R40667, *Anaerobic Digestion: Greenhouse Gas Emission Reduction and Energy Generation*, by Kelsi Bracmort.

Figure 1. Bioenergy and Bioproduct Conversion Processes



Source: U.S. Environmental Protection Agency, *State Bioenergy Primer*, 2009.

Federal Support

The federal government supports biopower with multiple initiatives including tax incentives, grant programs, research and development efforts, and more.[38] Additionally, there are state initiatives that support biopower.[39] Some of the federal biopower initiatives that have been available to industry are described below.

Tax Incentives

- Business Energy Investment Tax Credit (ITC): The business energy ITC is a 10% tax credit for expenditures on combined heat and power (CHP) systems, including biomass CHP.[40] The credit for biomass CHP is scheduled to expire December 31, 2016.
- Seven-year period for Modified Accelerated Cost-Recovery System (MACRS): The MACRS allows businesses to recover investments in certain property through depreciation deductions, including CHP property and biomass property used to create electricity.[41] There is no expiration date for the MACRS.
- Renewable Electricity Production Tax Credit (PTC): The renewable electricity PTC is a per-kilowatt-hour (kWh) tax credit for electricity generated using qualified energy resources, including biomass.[42] It expired in 2014 after being extended for one year as part of the Tax Increase Prevention Act of 2014 (P.L. 113-245).

Bonds

- New Clean Renewable Energy Bonds (CREBs): CREBs can be used by certain entities to finance renewable energy projects, including biomass. Federal tax credits in lieu of a portion of the traditional bond interest result in a lower effective interest rate for the borrower.[43]
- Qualified Energy Conservation Bonds (QECBs): A QECB allows qualified state, tribal, and local government issuers to borrow money at attractive rates to fund energy conservation projects. The U.S. Department of Energy (DOE) reports the bonds can be used to produce electricity from renewable energy sources, among other things.[44]

---

[38] For information on biopower research and development efforts and more, see the **Appendix**.

[39] For information about state incentives, see the Database of State Incentives for Renewables and Efficiency (DSIRE) and the DOE Office of Energy Efficiency & Renewable Energy, *Energy Incentive Program Funding by State*.

[40] For more information, see the DSIRE.

[41] Ibid.

[42] For more information, see CRS Report R43453, *The Renewable Electricity Production Tax Credit: In Brief*, by Molly F. Sherlock.

[43] For more information, see CRS Report R40523, *Tax Credit Bonds: Overview and Analysis*, by Steven Maguire; the DSIRE; and U.S. Internal Revenue Service (IRS), "IRS Announces New Clean Renewable Energy Bonds Supplemental Allocations for Cooperative Electric Companies," press release, January 15, 2015.

[44] For more information, see Energy Programs Consortium, *Qualified Energy Conservation Bonds (QECBS)*, December 2014, and Lawrence Berkeley National Laboratory, *Qualified Energy Conservation Bond (QECB) Update: New Guidance from the U.S. Department of Treasury and the Internal Revenue Service*, July 18, 2012.

Federal Loans

- U.S. Department of Agriculture (USDA) Rural Energy for America Program (REAP) Loan Guarantees and Grants: The program provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses to purchase, install, or construct renewable energy systems; make energy efficiency improvements to nonresidential buildings and facilities; use renewable technologies that reduce energy consumption; and participate in energy audits and renewable energy development assistance. The program receives mandatory funding and can receive discretionary funding through FY2018.[45]
- DOE Section 1703 Loan Guarantee Program: The program issues loan guarantees for projects with high technology risks that "avoid, reduce or sequester air pollutants or anthropogenic emissions of GHG; and employ new or significantly improved technologies as compared to commercial technologies in service in the United States at the time the guarantee is issued," including forestry waste-to-energy projects and co-firing.[46] The program is permanent, although the total amount of loans that may be guaranteed is capped in statute.

Grant Programs

- USDA Repowering Assistance Biorefinery Program: This program provides payments to eligible biorefineries to install renewable biomass systems for heating and power at their facilities, or to produce new energy from renewable biomass.[47]
- USDA High Energy Cost Grant Program: This program provides grants to assist power providers in lowering energy costs for families and individuals in areas with extremely high per-household energy costs. Grants may be awarded to finance the acquisition, construction, or improvement of facilities serving residential customers or communities, including biomass technologies used for electric power generation, among other things.[48]
- Tribal Energy Program Grant: This DOE program provides financial assistance, technical assistance, and education and training to tribes for the evaluation and development of renewable energy resources and energy efficiency measures, including co-firing, waste-to-energy, and CHP.[49]

---

[45] For more information, see CRS Report R43416, *Energy Provisions in the 2014 Farm Bill (P.L. 113-79)*, by Mark A. McMinimy.

[46] For more information, see DOE Loan Programs Office, Renewable Energy and Efficient Energy Projects Loan Guarantee Solicitation Announcement, July 3, 2014; and CRS Report R42152, *Loan Guarantees for Clean Energy Technologies: Goals, Concerns, and Policy Options*, by Phillip Brown.

[47] The 2014 farm bill (P.L. 113-79) provided mandatory funding of $12 million for FY2014 to remain available until expended. For FY2015, Congress reduced available funds by $8 million through the FY2015 Consolidated and Further Continuing Appropriations Act (P.L. 113-235). Discretionary funding of $10 million was authorized to be appropriated for FY2014-FY2018. For more information, see the Database of State Incentives for Renewables and Efficiency (DSIRE), and U.S. Department of Agriculture (USDA), "Vilsack Announces Farm Bill Funding for Bioenergy Research, Converting to Biomass Fuel Systems," press release, June 13, 2014.

[48] For more information, see the DSIRE and USDA, "USDA Announces Funding to Help Reduce Energy Costs in Remote Rural Areas," press release, April 8, 2014.

[49] For more information, see the DSIRE and the DOE, *Tribal Clean Energy Projects Awarded $6.5 Million from U.S. Energy Department*, February 16, 2012.

Regulatory Treatment

Biopower has received different attention and treatment than some other renewable electricity sources and conventional electricity sources. Although it generally is viewed as beneficial yet complicated, biopower often requires a high-level technical discussion that incorporates numerous facets to determine the best method to integrate it into whatever the immediate goal may be (e.g., environmental policy, energy policy). Further complications arise when considering the demands of the various stakeholders (e.g., agricultural and forestry producers, environmental organizations, energy sector, infrastructure development community, homeowners, business community, science community) and which prism to use for evaluating its contribution (e.g., GHG emission reduction, energy generation, market for agricultural or forestry or recyclable commodities).

Currently, from a federal regulatory perspective, the most pressing example of distinct treatment for biopower—specifically, its carbon status—is the EPA's CPP.[50] The CPP establishes regulations that would reduce carbon dioxide (CO_2) emissions from existing fossil fuel-fired electric power plants.[51] States are required to devise a plan that allows them to reach a state-specific CO_2 emission reduction goal by 2030. States have various options to reach this goal—including with the use of renewable energy (e.g., biopower)—based on guidance provided by the EPA. EPA specifies that "qualified biomass" may be included in a state's plan given certain conditions.[52]

Based on past support (see the **Appendix**), both Congress and the executive branch have decided that biopower has a role in the U.S. energy portfolio. Deciding what exactly that role should be, how substantial it should be, and what aspects should be accounted for is the focus of many of the present disagreements.

Biopower Perspectives

Biopower potentially straddles at least three policy areas: agriculture, energy, and the environment. Articulated perspectives on biopower thus far generally have focused on biopower's S. 1294 impact on one of the aforementioned policy areas. This section discusses, in general terms, some of the reasons for the support and opposition.

Support for Biopower

Some proponents of biopower argue that the agricultural and forestry communities benefit from biopower production because they will produce the required biomass feedstocks, potentially adding value to their farming or forestry operations. Further, the two communities have experience with implementing environmental and conservation measures that could lead to productive field conditions for biomass growth and harvest. Some in the energy industry, particularly technology companies and renewable energy companies, support biopower because

---

[50] For more information on the proposed CPP and biopower carbon neutrality, see CRS Report R44145, *EPA's Clean Power Plan: Highlights of the Final Rule*, by Jonathan L. Ramseur and James E. McCarthy and CRS Report R41603, *Is Biopower Carbon Neutral?*, by Kelsi Bracmort.

[51] On February 9, 2016, the Supreme Court granted a stay of EPA's Clean Power Plan (CPP), pending the Court's consideration of whether to hear the case.

[52] For more information, see CRS In Focus IF10280, *The Clean Power Plan (CPP): The Treatment of Biomass*, by Kelsi Bracmort.

of the potential to be at the leading edge of development and deployment of biopower technologies, especially if they receive federal financial assistance to do so. Given implementation of certain environmental standards for biomass feedstock cultivation and biopower plants, some in the environmental community might support certain forms of biopower, especially if there is monitoring of land-use, biodiversity, and GHG emission reduction impacts.

Legislative efforts are under way that could possibly further support the biopower industry. For example, would establish a bioheat and biopower initiative to provide grants to relevant projects, among other things. Additionally, 46 Senators and 154 Members of Congress sent a letter to the Secretaries of Agriculture and Energy and the EPA Administrator to express their support for the carbon neutrality of forest biomass.[53] Another relevant legislative effort is for the creation of a federal renewable electricity standard (RES) that would encourage renewable energy use and thus the production of renewable energy such as biopower. For example, an amendment was introduced in the 114th Congress that would establish an RES (S.Amdt. 77 to S. 1). Discussion of an RES has been minimal over the last few Congresses compared with the discussions that took place during the 111th Congress.[54] Many different state programs exist, which could create uncertainty as an RES is debated.

Opposition to Biopower

Some opponents of biopower argue that the agriculture and forestry sectors cannot meet biomass feedstock demands for biopower without infringing upon current demands for food, feed, and energy needs (e.g., biofuels). There is concern that additional demand for these feedstocks for biopower could discourage production of feedstocks for other purposes, especially if market prices were to favor feedstocks for power production. Additionally, some express unease at the potential environmental impacts of producing feedstocks for biopower, especially if a few feedstocks become the dominant feedstock for biopower, requiring monolithic cultivation patterns that hamper biodiversity efforts. There also is concern that biopower is not technologically or economically feasible at a large scale relative to the fossil-fuel electricity sector. This concern may raise questions about the costs to provide assistance for feedstock production, technology build out, plant construction, and more. Lastly, some oppose biopower because it may not be viewed as a long-term solution to a persistent demand for electricity.

Legislative efforts that oppose increasing federal support of biopower have not been introduced thus far in the 114th Congress. However, various organizations have expressed opposition to biopower. For example, several environmental organizations are concerned about the use of forest biomass for biopower production, particularly the use of whole trees in pellet manufacturing facilities and utility-scale biomass projects.[55] Moreover, in 2012, the American Lung Association stated it "does not support biomass combustion for electricity production, a category that includes wood, wood products, agricultural residues or forest wastes, and potentially highly toxic feedstocks, such as construction and demolition waste. If biomass is combusted, state-of-the-art pollution controls must be required."[56]

---

53 Senator Susan Collins, "U.S. Senators Collins (R-ME) and Merkley (D-OR) Urge EPA, DOE, and USDA to Recognize Clear Benefits of Forest Bioenergy in Federal Policy," press release, July 1, 2015; U.S. Representative Reid Ribble, "Ribble to EPA: Don't Punish Sustainable Forestry," press release, August 3, 2015.

54 Several renewable electricity standard bills were introduced during the 111th Congress, including S. 1462, S. 433, S. 3021, H.R. 2454, and H.R. 890.

55 Dogwood Alliance, *Biomass Platform and Endorsers*, March 2015.

56 American Lung Association, "Public Policy Position: Energy," June 23, 2012.

Conclusion

Although significant challenges remain regarding any future large-scale development, biopower production could increase in the coming years to satisfy state renewable portfolio standards. Generation of electricity from biopower has some advantages over other renewable sources such as wind and solar. Biopower plants can function as baseload power plants, and multiple biomass feedstocks can be used to generate electricity. A sustainable supply of biomass feedstocks would be necessary for biopower growth. Some disadvantages of using biomass for electricity generation include the cost to transport the biomass to the biopower plant, less biomass being available for other purposes, and environmental tensions such as whether biomass combustion is carbon neutral.

Most biopower technologies, with the exception of combustion and co-firing systems, have yet to reach commercial status. Some have argued that regulatory uncertainty has contributed to the reluctance to develop biopower (e.g., EPA's CPP). In addition, there is no federal mandate requiring the production of biopower, although 29 states have implemented state renewable portfolio standards that include biopower. Furthermore, it is not clear how the agricultural and forestry communities would adapt to an increased demand for feedstock to be used at new biopower facilities. If there is a desire to increase biopower production, questions remain about what would be needed to simultaneously address technological, environmental, and agricultural concerns.

Appendix. Biopower R&D Authorizations

R&D Authorizations

Congress has enacted numerous provisions that authorize the Departments of Energy (DOE) and Agriculture (USDA) to conduct biopower research, development, and demonstration projects (RD&D) and to support biopower commercial application efforts.[57] At least eight public laws contain one or more biopower provisions:

- P.L. 95-620, Powerplants and Industrial Fuel Use Act of 1978
- P.L. 96-294, Energy Security Act of 1980
- P.L. 106-224, Biomass Research and Development Act of 2000
- P.L. 107-171, Farm Security and Rural Investment Act of 2002
- P.L. 108-148, Healthy Forest Restoration Act of 2003
- P.L. 109-58, Energy Policy Act of 2005
- P.L. 110-140, Energy Independence and Security Act of 2007
- P.L. 110-246, Food, Conservation, and Energy Act of 2008
- P.L. 113-79, Agricultural Act of 2014

The public laws discussed in this section are summaries of provisions at the time of enactment to illustrate the evolution of bioenergy policy in chronological order. Some provisions may have been amended since enactment.[58] A comprehensive legislative history of current law is beyond the scope of this report.

1978-1980: Biopower Legislative Origin

Both the Powerplant and Industrial Fuel Use Act of 1978 (P.L. 95-620) and the Energy Security Act of 1980 (P.L. 96-294) introduced the concept of biopower to the legislative arena. However, the enacted legislation emphasized the use of biomass as a liquid fuel to reduce dependence on imported petroleum and natural gas. Biomass used to generate electricity appears to have received less legislative support compared with biomass use as a liquid fuel, based on the report language and authorizations.

Powerplant and Industrial Fuel Use Act of 1978 (P.L. 95-620)

The legislative origin of the federal biopower definition stems from the Powerplant and Industrial Fuel Use Act of 1978. The act aimed to restrict the use of oil and natural gas as fuel in an attempt to mitigate the oil crisis of the mid-1970s by encouraging industries and utilities to reduce oil use. It required new power plants to operate using coal or alternate fuel sources. Otherwise, the act did not provide explicit support for biopower RD&D and commercial application.

[57] National Renewable Energy Laboratory, *Power Technologies Energy Data Book*, NREL/TP-620-39728, August 2006, at http://www.nrel.gov/analysis/power_databook/docs/pdf/39728_complete.pdf.

[58] Some provisions are renewed through multiple bills (e.g., the Farm Bill). In such cases, only notable updates to those provisions are included.

- §103(a)(6)—defines alternate fuel, in part, as electricity or any fuel, other than natural gas or petroleum, from sources such as biomass, municipal, industrial or agricultural wastes, wood, and renewable and geothermal energy sources.

Energy Security Act of 1980 (P.L. 96-294)

- §203(4)(B)—defines biomass energy, in part, as energy or steam derived from the direct combustion of biomass for the generation of electricity, mechanical power, or industrial process heat.
- §203(5)(B)—defines biomass energy project, in part, as any facility (or portion of a facility) located in the United States that is primarily for the combustion of biomass for generating industrial process heat, mechanical power, or electricity, including cogeneration.
- §203(19)—defines a small-scale biomass energy project as a biomass energy project with an anticipated annual production capacity of not more than 1 million gallons of ethanol per year, or its energy equivalent of other forms of biomass energy.
- §211(a)—requires DOE and USDA to collaborate on a biomass energy production and use plan and on providing financial assistance for biomass energy projects.
- §251(a)—indirect reference to biopower; stipulates the establishment of demonstration biomass energy facilities by the Secretary of Agriculture to exhibit the most advanced technology available for producing biomass energy.
- §252—indirect reference to biopower; modifies §1419 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (P.L. 95-113) to better address biomass energy for RD&D purposes; authorizes the Secretary of Agriculture to award grants for research related to, in part, the development of the most economical and commercially feasible means of producing, collecting, and transporting agricultural crops, wastes, residues, and byproducts for use as feedstocks for the production of alcohol and other forms of biomass energy.
- §255(a)—indirect reference to biopower; adds a Biomass Energy Educational and Technical Assistance Program to Subtitle B of P.L. 95-113 to provide technical assistance to producers for efficient use of biomass energy and disseminate research results to producers about biomass energy, among other things.

1981-1999: Biopower Legislation and Technology

Congress did not significantly address biopower during most of the 1980s and 1990s, partially due to stable conventional energy prices and supplies. Some biopower technologies emerged during this time period with low success rates due to poor design and inadequate management (e.g., anaerobic digestion systems). Other reliable biopower technologies were developed during this time period (e.g., biomass co-firing), but these could not compete economically with other energy sources.

2000-Present: Biopower Legislative Action

Described below are a variety of biopower provisions contained in public laws since 2000. Although many of the provisions focus primarily on the use of biomass for liquid transportation fuel, there also has been legislative support for biopower. Both DOE and USDA have the authority to conduct RD&D and support commercial application efforts for biopower. However, project summaries and financial allotments indicate the majority of resources in recent years were directed toward liquid fuels for transportation.[59]

Biomass Research and Development Act of 2000 (P.L. 106-224)

The Biomass Research and Development Act[60] established a partnership between USDA and DOE for RD&D on the production of biobased industrial products. (This act was amended by the Energy Policy Act of 2005, P.L. 109-58.) The original provisions included the following:

- §303(2)—defines biobased industrial products to include fuels, chemicals, building materials, or electric power or heat produced from biomass.
- §305—implicit reference to biopower; establishes the Biomass Research and Development Board to coordinate research and development activities relating to biobased industrial products; board membership includes a representative from DOE, USDA, Department of the Interior, the U.S. Environmental Protection Agency, the National Science Foundation, and the Office of Science and Technology Policy.
- §306—implicit reference to biopower; establishes the Biomass Research and Development Technical Advisory Committee to, in part, advise the Biomass Research and Development Board concerning the technical focus and direction of requests for proposals issued under the Biomass Research and Development Initiative.
- §307—implicit reference to biopower; authorizes the Secretaries of Agriculture and Energy to, in part, competitively award grants, contracts, and financial assistance to eligible entities that can perform research on biobased industrial products. For example, grants may be rendered to an entity conducting research on advanced biomass gasification and combustion to produce electricity (§307(d)(2)(e)); related research in advanced turbine and stationary fuel cell technology for production of electricity from biomass (§307(d)(2)(f)); biomass gasification and combustion to produce electricity (§307(d)(3)(A)(v)); and any research and development in technologies or processes determined by the Secretaries, acting through their respective points of contact and in consultation with the Biomass Research and Development Board (§307(d)(4)).

Farm Security and Rural Investment Act of 2002 (P.L. 107-171)

- §9003—authorizes the Secretary of Agriculture to award grants to assist in paying the development and construction costs of biorefineries in order to carry out projects that demonstrate their commercial viability for converting biomass to fuels or chemicals.
- §9003(b)(2)—defines biorefinery as equipment and processes that convert biomass into fuels and chemicals and may produce electricity.

---

[59] For information on biomass energy incentives, see CRS Report R40913, *Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs*, by Lynn J. Cunningham and Beth Cook.

[60] The Biomass Research and Development Act is Title III of the Agricultural Risk Protection Act of 2000 (P.L. 106-224).

Healthy Forest Restoration Act of 2003 (P.L. 108-148)

- §203—establishes the Biomass Commercial Utilization Grant Program; authorizes the Secretary of Agriculture to make grants to the owner or operator of a facility that uses biomass as a raw material to produce one or more of several outputs, including electric energy.

Energy Policy Act of 2005 (EPAct05; P.L. 109-58)

- §931(f)—authorizes the Secretary of Energy, in consultation with the Secretary of Agriculture, to implement rural demonstration projects that use renewable energy technologies to assist in delivering electricity to rural and remote locations from biomass.
- §932 (b)(1)—authorizes the Secretary of Energy to conduct a program of RD&D and commercial application for bioenergy including biopower energy systems.
- §932 (d)(B)(iv)—authorizes the Secretary of Energy to demonstrate the commercial application of integrated biorefineries from the commercial application of biomass technologies for energy in the form of electricity or useful heat.
- §941(a)—amends the definition for biobased product in P.L. 106-224 to mean an industrial product (including chemicals, materials, and polymers) produced from biomass, or a commercial or industrial product (including animal feed and electric power) derived in connection with the conversion of biomass to fuel.
- §941(d)(1)—modifies membership of the Biomass Research and Development Technical Advisory Committee (P.L. 106-224, §306); replaces an individual affiliated with the biobased industrial products industry with an individual affiliated with the biofuels industry; adds an individual affiliated with the biobased industrial and commercial products industry; requires committee members as described in P.L. 106-224, §306(b)(1)(C), (D), (G), and (I) to have expertise in "fuels and biobased products" whereas previously members were to have expertise in "biobased industrial products."
- §941(e)(1)—modifies the Biomass Research and Development Initiative (P.L. 106-224, §307(a)) to focus on "research on, and development and demonstration of, biobased fuels and biobased products, and the methods, practices and technologies, for their production." Previously the initiative focus was on "research on biobased industrial products."
- §941(e)(2)—adds to the Biomass Research and Development Initiative (P.L. 106-224, §307) an objectives section and a technical areas section, in addition to other sections, that specify biobased fuels as a priority. For example, the initiative is to support "product diversification through technologies relevant to production of a range of biobased products (including chemicals, animal feeds, and cogenerated power) that eventually can increase the feasibility of fuel production in a biorefinery."

Energy Independence and Security Act of 2007 (EISA; P.L. 110-140)

- §231(1)—modifies EPAct05 §931(b) by adding an authorization of $963 million for FY2010. Section 931 of EPAct05 authorizes the Secretary of Energy to conduct programs of renewable energy RD&D and commercial application.

- §231(2)—modifies EPAct05 §931(c)(2) to increase authorized funding for FY2008 from $251 million to $377 million; also modifies EPAct05 §931(c)(3) to increase authorized funding for FY2009 from $274 million to $398 million.

The Food, Conservation, and Energy Act of 2008 (2008 Farm Bill, P.L. 110-246)

- §7526—reauthorizes the Sun Grant program, which requires USDA to coordinate with DOE and land-grant colleges and universities to provide grants to the Sun Grant centers to enhance the efficiency of bioenergy and biomass research and development programs.
- §9001—defines biorefinery as a facility that converts renewable biomass into biofuels and biobased products and may produce electricity.
- §9008—defines biobased product as an industrial product (including chemicals, materials, and polymers) produced from biomass, or a commercial or industrial product (including animal feed and electric power) derived in connection with the conversion of biomass to fuel.
- §9011—establishes the Biomass Crop Assistance Program, which provides financial assistance to producers or entities that deliver eligible biomass material to designated biomass conversion facilities for use as heat, power, biobased products, or biofuels.
- §9012—authorizes the Secretary of Agriculture, acting through the Forest Service, to conduct a competitive R&D program to encourage use of forest biomass for energy.
- §9013(a)(2)—defines a community wood energy system as an energy system that primarily services public facilities owned or operated by state or local governments, including schools, town halls, libraries, and other public buildings; and uses woody biomass as the primary fuel. The term includes single facility central heating, district heating, combined heat and energy systems, and other related biomass energy systems.
- §9013(b)—establishes the Community Wood Energy Program and authorizes the Secretary of Agriculture, acting through the Forest Service, to provide grants of up to $50,000 for up to 50% of the cost for communities to plan and install wood energy systems in public buildings.

Agricultural Act of 2014 (2014 Farm Bill, P.L. 113-79)

- §7526—reauthorizes the Sun Grant program, which requires USDA to coordinate with other appropriate federal agencies and land-grant colleges and universities to provide grants to the Sun Grant centers to enhance the efficiency of bioenergy and biomass research and development programs.
- §9011—repeals the forest biomass for energy program.
- §11022—authorizes research and development regarding the use of biomass sorghum grown expressly for the purpose of producing a feedstock for renewable biofuel, renewable electricity, or biobased products.

Author Contact Information

Kelsi Bracmort
Specialist in Agricultural Conservation and Natural Resources Policy
kbracmort@crs.loc.gov, 7-7283