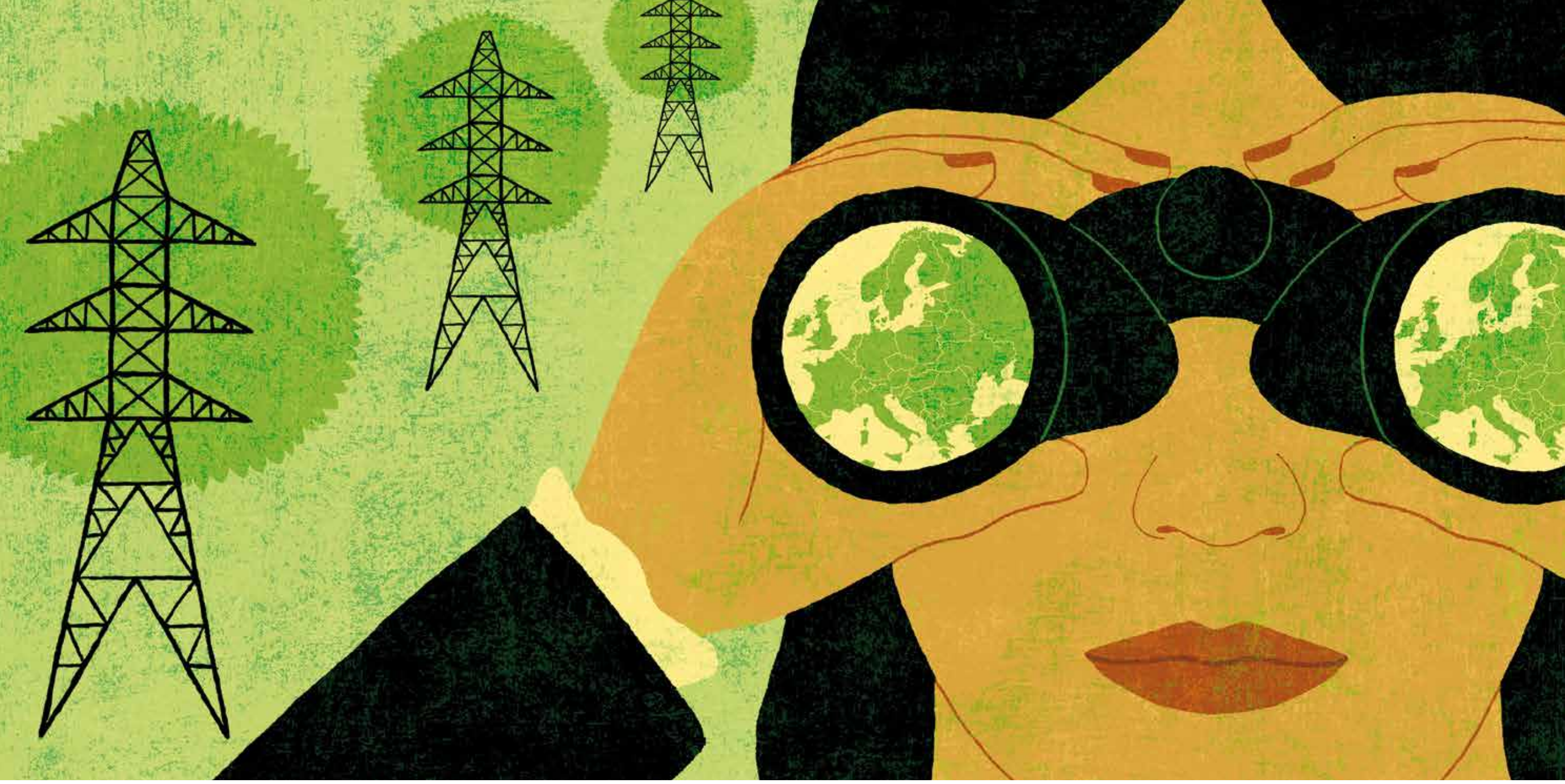

Illustration by James Steinberg

Bioenergy in Europe: A new beginning—or the end of the road?

Bioenergy faces challenges in Europe, but there is reason to believe it can make a comeback.

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When the European Commission announced its long-term climate-change strategy in January 2014, it called for a higher target for the use of renewable-energy sources: 27 percent by 2030. This goal, combined with recent developments in the industry, could open a new and promising chapter for bioenergy in Europe.

In broad terms, the new plan is the natural follow-up to the "20-20-20" program of 2007 and the 2010 National Renewable Action Plans (NREAPs). The 20-20-20 plan called for a 20 percent reduction in greenhouse-gas emissions (compared with 1990), thereby increasing renewable energy to 20 percent of the power supply and improving energy efficiency by 20 percent. The NREAPs helped governments figure out the renewable-energy part of the puzzle.

At the time, the outlook was for the volume of biomass-based electricity—that is, power derived from wood and other organic materials, such as crops and agricultural residues—to double from 114 terawatt-hours[1] in 2010 to 232 terawatt-hours in 2020 (out of a total 3,346 terawatt-hours). As for heat, the goal was for biomass to grow from 685 terawatt-hours to just over 1,000 terawatt-hours. In both cases, biomass has fallen short; the European Union estimated it will reach only 83 percent of its target by 2020.[2]

What happened? Why has biomass-based energy been growing less than planned? Is there still a place for it in the European energy mix?

Like all renewable energy in the European Union, bioenergy has suffered from low-priced coal imports (a side effect of the rise of shale gas in the United States), low carbon dioxide (CO_2) prices in the emissions-trading system, and the economic and regulatory backlash against renewable-energy policies, including substantial cuts in government support. It has not delivered on declining unit costs and is often not competitive with wind and solar in the renewables sector.

In addition, biomass has to overcome hurdles of its own making, including the lack of industrialized fuel supply chains and continued skepticism over whether bioenergy is sustainable. Most important, because of the slow growth, biomass has not reached critical mass in the European energy mix. Given these issues, it is fair to question the future of bioenergy in Europe, even as the European Union prepares to increase its use of renewables.

However, there are two reasons to be optimistic. First, bioenergy offers one of the most capital-efficient transitions from coal to renewables. In 2011, the European Union produced about 850 terawatt-hours of electricity from coal and lignite; that accounted for about a quarter of energy production. Reducing the share of coal-fired power generation is an essential part of any decarbonization strategy. Biomass cofiring and coal-to-biomass conversions enable generators to use existing coal assets and infrastructure to produce renewable energy. This cannot be said of other renewable-energy sources.

Second, bioenergy offers a scalable opportunity for European utilities to take part in the second wave of renewable-energy-source growth. To date, European utilities have captured a limited share of these investments, mostly onshore wind and rooftop solar. Biomass has the significant advantages of being able to serve as a source of baseload power, which wind and solar cannot, and requires no major investments in the grid. With carbon capture and storage still far from happening, bioenergy offers a way for big utilities to comply with renewable targets while using their existing assets.

Drax, a UK generator, shows it can be done. In part because moving away from coal is a prerequisite for its license to operate, the company has begun an €800 million program to convert three of its six coal units, with a combined capacity of about 2,000 megawatts (enough to power up to 3.5 million British homes), to run on biomass.

Three challenges

A bioenergy comeback, however, will require specific barriers to growth to be addressed. There are three major challenges: affordability, efficiency, and acceptance.

Affordability: Making biomass-based energy cost competitive

Historically, biomass-based power has been generated from low-cost, low-grade waste-fuel streams, such as crop residues and wood chips. These have often been used in small-scale combined-heat-and-power plants that serve industrial sites or municipal-district heating networks.

The development of solar and onshore wind, however, followed a different trajectory. Both industries have seen an influx of Chinese and other non-European equipment makers; the ensuing competition sharply cut the price of the levelized cost of energy, or the cost per kilowatt-hour, in real terms, of building and operating a power plant. Lower costs in turn fueled more growth.

Bioenergy technology providers have not been exposed to similar competitive forces in their own segment, and they have so far not fully embraced the competition from other renewable energy technologies. Bioenergy trails onshore wind on cost competitiveness; in addition, the costs for most other renewable technologies are projected to keep falling faster.

Where does biomass fit in? Our analysis suggests that there is an opportunity to reduce the levelized cost of energy for bioenergy by almost half by 2025. This would require significant efforts but no new technology breakthroughs. For instance, boiler efficiency in biomass plants today is often as little as 30 percent. Improvements, such as increasing steam parameters,[3] would reduce the volume of feedstock required and lower costs. The standardization of bioenergy-plant designs, boiler and plant modularization, and application of design to value could also push costs down. Finally, fuel costs could be lowered by applying lean techniques to remove unnecessary supply-chain costs. As suggested in Exhibit 1, getting this right could bring down the cost of bio-based electricity to levels that are competitive with coal.

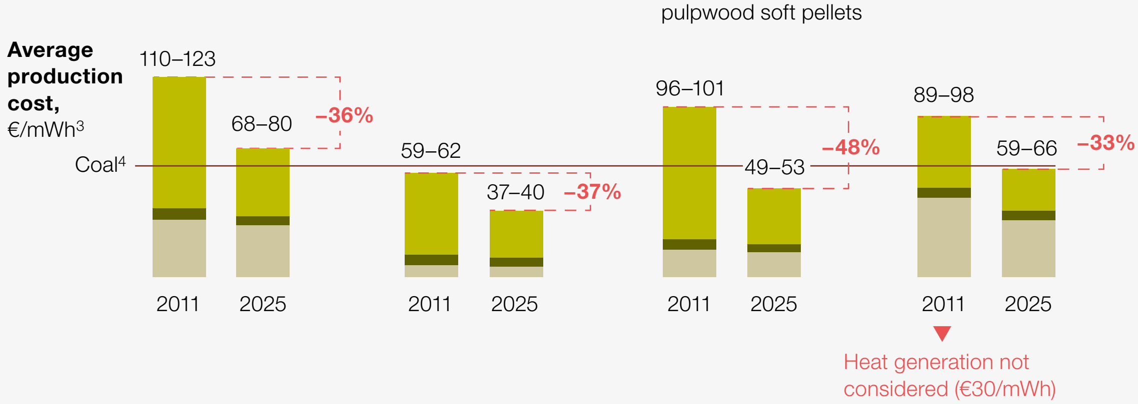
Efficiency: Industrializing the biomass supply chain

Bioenergy feedstocks are abundant, but their potential has not been maximized.[4] The use of biomass for energy is therefore well below the sustainable annual cut volumes of forests.

Exhibit 1 **Depending on the type of plant, biomass could make levelized-cost-of-energy improvements of up to 48 percent by 2025, making it close to competitive with coal.**

Fuel
Operations/maintenance
Capital expenditure

Plant type	**Large-scale greenfield**	**Cofiring**	**Converted from coal**	**Small/medium CHP[2]**
Description	200 mW[1] dedicated Fired with 100% imported US pulpwood soft pellets	200 mW plant Fired with 70% coal and 30% imported US pulpwood soft pellets	200 mW conversion including boiler of coal plant Fired with imported US pulpwood soft pellets	50 mW conversion of coal plant Fired with local waste-wood chips



[1]Megawatts.
[2]Combined heat and power.
[3]Megawatt-hour.
[4]Estimated cost of coal (€64/mWh, with carbon dioxide at €20/ton), which remains stable throughout 2025.

One reason is that the value chains of wood pellets and wood chips (the most common feedstocks) are not well established. Feedstock contracts today are done on a bilateral basis; there is no biomass market to provide price transparency or liquidity for buyers and sellers.

There is potential to develop more efficient, industrialized supply chains for biomass. To make this happen, there are two requirements: the use of long-term contracts and a breakthrough in fuel-treatment technology.

Long-term contracts with a duration of five to ten years would provide a basis for increasing supply investments, because they give investors a sense of security that this use of capital will pay off. Such contracts would also provide an incentive for removing waste along the supply chain. The much-needed operational improvements along the biomass supply chain include raising the utilization of pellet plants, optimizing inventories, improving the energy efficiency of pelletization, and maximizing shipload sizes.

Generators' largest concern with regard to long-term contracts has been regulatory uncertainty. If government policies change, so might their revenue streams. That is one reason that generators have not been willing to commit to contracts that fix their feedstock costs on a long-term basis.

On the supplier side, some providers have held back on long-term contracts, believing that increased demand for biomass could lead to higher prices; they therefore wanted to avoid getting locked in at lower ones. Our analysis suggests that this is not a valid assumption: increased demand does not necessarily lead to higher prices, as long as supply keeps up (Exhibit 2).

The cost competition between bioenergy and other renewable-energy sources limits biomass buyers' willingness to pay more; the cost pressure is downward. Thus, buyers and sellers need to find ways to make biomass a cost-competitive fuel. At this stage of development, long-term contracts are needed as a bridge before a transparent, liquid, and efficient biomass market can emerge.

Second, breakthroughs in fuel treatment, like pelletization and torrefaction, could markedly improve efficiency and also simplify transportation and storage. Recently, there has been significant progress in torrefaction, which is the removal of moisture and volatiles from the feedstock, leaving biocoal. Torrefied pellets not only have higher energy content but also have physical properties similar to coal, making them relatively simple to cofire with the same infrastructure. In late 2013, Topell Energy, a Dutch cleantech company, announced that it would produce torrefied pellets at commercial scale (six tons an hour). Valmet, a Finnish technology company, has developed a different method (steam explosion) for producing biocoal that is also ready for commercial-scale application.

Acceptance: Defining 'sustainable bioenergy'

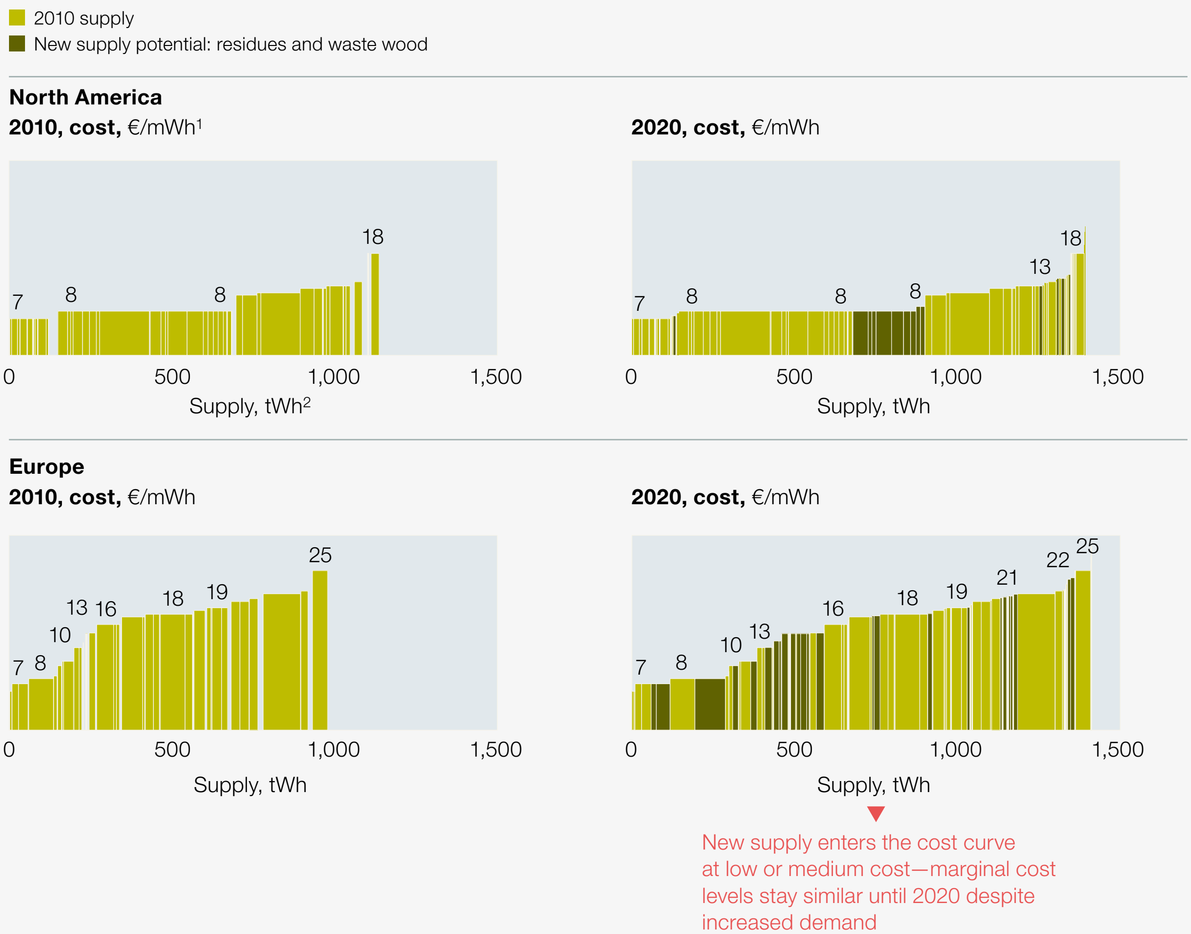
Opinions on the benefits of bioenergy vary widely. The main issues are the environmental standards of non-European biomass imports, and to what extent biomass leads to lower CO_2 emissions.

The lack of clear standards makes it difficult for market participants to trust that the biomass they source will be considered sustainable in the long term. This uncertainty inhibits growth. There are high-level discussions about how to create EU-wide sustainability criteria but no official conclusions yet.

The question of how much actual CO_2 reduction can be achieved through biomass cannot be answered in a straightforward manner. According to the broadest definition, bioenergy should be considered sustainable from a greenhouse-gas perspective as

Exhibit 2 **The marginal cost of biomass does not necessarily increase significantly when demand increases, assuming residues and waste wood can be captured.**

Woody-biomass-supply cost curve



[1]Megawatt-hour.
[2]Terawatt-hour.

Source: US Department of Energy

long as its fossil CO_2 emissions are lower than if the same amount of energy was generated with fossil fuels. At the time of combustion, bioenergy-related carbon emissions may be higher than comparable emissions from burning fossil fuels because of the lower energy density of biomass. But, unlike fossil fuels, the recultivation of the area from which biomass is removed can return it to its former carbon-stock level and thus offset the emissions. In the case of wood or crops cultivated specifically for energy use, the CO_2 has already been absorbed in advance. Hence, in a steady state, net emissions from fossil fuels will always exceed those of bioenergy.

A stricter approach—the closed-CO_2-loop perspective—considers bioenergy carbon neutral as long as its emissions (including those from harvesting, transport, and replanting) are offset by new biomass growth. As such, the growth of new biomass must always surpass harvest to cover these additional emissions. In the United States, for example, harvest rates have been lower than carbon-stock growth in recent years. It is important to note that the speed at which forests sequester carbon varies significantly depending on climate conditions. For example, Brazilian eucalyptus plantations close their CO_2 loop faster than Nordic softwood forests.

A much stricter school of thought considers bioenergy sustainable only if it is close to 100 percent carbon neutral at any time. That is, bioenergy emissions should never be higher than the emissions that would have occurred had the biomass not been burned, including the foregone carbon sequestration from the land where biomass fuels have been produced. This approach, however, is complex to put into practice. It requires assumptions about the biomass-fuel mix that will be used—for example, what fraction of biomass will come from harvest residues (tops and branches of trees cut for use by the forest industry), instead of whole trees that would have not been otherwise cut.

It also requires understanding how bioenergy demand will affect the land-management decisions of a dispersed base of biomass suppliers. More active management, if done well, can improve the economic and ecological services of many forested landscapes without reducing the carbon they store. Finally, even unmanaged forests are at risk of carbon loss from unforeseen insect infestation or large fires. These risks need to be taken into account.

The industry would benefit from a clear definition of sustainability so that participants can understand what is expected of them.

■ ■ ■

Europe's climate goals provide a new opportunity to revive the bioenergy industry, with great potential to step up as a fast and capital-efficient replacement for coal. But while these policies might be helpful, the industry itself must act to make the case for its existence—something it has failed to do in the past. A comeback requires that the industry lower total costs, create more efficient value chains, and define a credible sustainability story. Without a renewed sense of urgency to deliver improvements in both cost and performance, there will be no place for bioenergy in Europe's future energy mix. ■

1 A terawatt-hour is a unit of energy equivalent to a million megawatt-hours, or 588,440 barrels of oil.

2 *Renewable Energy Progress Report*, Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions, March 2013, ec.europa.eu.

3 For example, pressure, temperature, and energy efficiency.

4 Bill Caesar et al.,"Biomass: Mobilizing a sustainable resource," *Sustainable Bioenergy*, Environmental Finance Publications, 2010.

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