McKinsey on Electric Power and Natural Gas

Perspectives on electric power and natural gas

Number 1,
Winter 2008

McKinsey&Company

Biomass: Fueling the next era of power generation in Europe

To achieve the European Union's renewable-energy goals, generators will have to take a more active role in mobilizing supplies and shaping the regulatory framework.

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Burning wood to produce electricity is hardly new. The use of biomass for power production, however, has so far been limited primarily to specific situations such as fueling a power plant in conjunction with a pulp-and-paper mill with fiber residues. That is changing. The need to reduce emissions to address climate change, concerns about the security of energy supply, and volatile oil and gas prices have created a more favorable environment for electricity production from renewable-energy sources and have generated a growing interest in biomass as a fuel for the power industry.

This article discusses why biomass will soon play a major role in the power and heat industry and then sets out some key questions to consider in the development of a successful biomass strategy for generators: How does biomass compare to other renewable-energy sources? What are its growth prospects? What is a winning strategy to capture the opportunity?

The power generators that succeed will be those that develop a thorough understanding of regulatory issues and that build a sophisticated biomass fuel sourcing structure. Winners in this sector will also benefit from making intelligent use of their existing portfolio of power generation assets to increase their capacity to produce electricity from biomass.

The state of the industry

There are three main applications of biomass for power (and heat) production today.

Solid biomass, such as wood and agricultural residues, can either be used in dedicated power plants that rely completely on this type of fuel or cofired in plants that also burn traditional fossil fuels with, for example, a mix of 20 percent biomass and 80 percent coal.

Liquid biomass, such as palm oil–based fuels, can be used to replace fuel oils.

Biogas, such as methane produced from biowaste, can be used to replace natural gas.

In all cases, biomass can be used both for condensing plants (power only) as well as for combined heat and power plants (CHP). CHP is expected to play a significant role in the production of energy from renewable-energy sources because EU targets for renewable-energy sources are defined in terms of final energy output, and CHP plants produce up to three times the energy of condensing plants for the same primary energy input (one unit of power for two units of heat is a typical ratio today).

Already a significant source of renewable-energy production

In 2006, the amount of electricity produced with biomass fuel was nearly equal to wind capacity in the European Union at around 80 terawatt hours (TWh), corresponding to 17 percent of the EU's total renewable electricity production. The installed capacity for biomass plants is already relatively high, especially in Northern Europe, with more than 5.0 gigawatts (GW) in Scandinavia, 1.0 GW in the United Kingdom, and 0.5 GW in Germany. In addition, many power generators are planning to build more capacity in the near future, with Scottish Power, E.ON, and the Drax Group all recently announcing biomass projects.

Cost competitive with other renewables

One of the factors explaining the different rates of development of biomass-based power production in different parts of the European Union is that the full generation cost depends on local supply conditions, such as the proximity of forests. In selected situations, biomass is already competitive against other renewable-energy sources. If a generator is able to source biomass at a price of 130 €/ton, electricity produced from a biomass-CHP plants will cost €70 to €80 per megawatt hour (€/MWh),[1] which is on a par with onshore wind farms (assuming that heat is sold for 30 €/MWh). In the case of biomass condensing plants, electricity will cost 100 to 110 €/MWh, below offshore wind farms whose full production cost is 120 to 160 €/MWh. In addition, power prices are starting to climb to these levels in many European countries, so biomass is also approaching competitiveness with conventional fuels.

An evolving regulatory framework in Europe

On the revenue side, as with most renewable-energy sources, electricity produced from biomass receives government support. In some countries the total remuneration can be considerable, making some projects potentially very attractive. For example, in Italy, given high electricity spot prices and the value of green certificates,[2] the total remuneration in 2007 has been 216 €/MWh, resulting in a project internal rate of return (IRR) of more than 20 percent for condensing plant-burning biomass fuels. Given the current regulatory environment, similar profitability could also be achieved in Belgium and the United Kingdom.

Most EU countries, however, are still in the process of developing regulatory regimes, particularly with regard to biomass-based CHP. In addition, while some countries offer very attractive support schemes, many countries have not decided how biomass-based energy will be supported.

[1] Assuming a heat content of ~5 megawatt hours per ton (MWh/ton) for the biomass.

[2] Tradable certificates proving that certain amounts of electricity is generated using renewable-energy sources.

Advantages over other renewables

Biomass has some advantages over other renewable-energy sources: plants can be built at significant scale; they can be devoted to the production of base load supply; and biomass is the only renewable-energy source than can be used for heat production on a large scale. Over the past 30 years, the technology for biomass plants has substantially improved, with the average plant size increasing from 30 to 40 MW in the 1970s to more than 100 MW today and a 300 MW facility now under construction in the United Kingdom. This scale far exceeds that of other renewable-energy sources, which have maximum capacities ranging from 1 MW for solar photovoltaic (PV) units, 5 MW for single wind turbines, and up to around 50 MW for geothermal plants.

In addition, biomass is the only renewable source of electricity that can act as a base load supply, as its generating plants can reach up to 90 percent utilization, regardless of their location. They can produce energy on demand, which is quite different from other renewable-energy sources whose utilization rates range from around 15 percent for solar PV to 90 percent for geothermal. Moreover, with the exception of reservoir-based hydropower facilities, other renewable plants are not dispatchable—that is, they cannot be turned on and off to meet demand (Exhibit 1).

Finally, the EU renewable-energy sources targets have been defined for final energy not just in terms of electrical-power generation, but also for heating and cooling and for transportation fuels. Only biomass can be used in a significant way to address the heating/cooling part of the targets. This puts CHP production from biomass in a very central role.

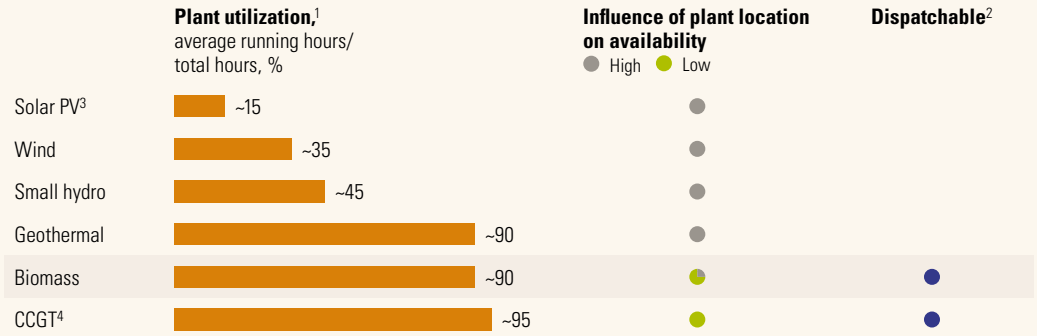
Capturing the biomass opportunity

The European Union has set a target to produce some 2,600 to 2,700 TWh of power and heat from renewable-energy sources by 2020. Given that we expect other renewable sources such as wind and solar to account for only about 1,000 TWh by then, that leaves about 1,700 TWh that will have to be filled by biomass sources. Of this, the share of power is estimated to be 400 to 600 TWh.

Exhibit 1

Biomass can act as base load supply

Biomass-generating plants can reach up to 90% utilization.



[1] Assuming: solar = 1,500 hours/year; wind = 3,000 hours/year; hydro = 4,000 hours/year; geothermal = 8,000 hours/year; biomass = 8,000 hours/year.
[2] "Dispatchable"—whether or not they can be turned on and off to meet demand.
[3] Photovoltaics.
[4] Combined cycle gas turbine.

In order to take advantage of these developments, power generators should base their plans around three imperatives: understand and shape the regulatory game; put in place a robust, global supply chain; and leverage their current portfolio of generation assets as an immediate next step.

Biomass is the only renewable-energy source that can be used for heat production on a large scale

Understand and shape the regulatory game

The volatility in the price of oil and gas in the past year reinforces the continued importance of favorable regulation in sustaining the economics of biomass-fueled power generation plants. Several mechanisms are currently in use: in early 2008, feed-in tariffs that secure the producer a fixed remuneration per MWh were in place in 14 EU countries; biomass energy quotas were applied by 7; direct investment subsidies existed in 4; and tax incentives were employed by 1 EU member state.

Generators investing in biomass should not only pay close attention to the regulatory environment of the country in which they operate, but also to how they can participate in *shaping* regulation. For example, many countries are starting to base the amount of remuneration on the type of biomass used. Power companies should make sure that regulators understand the differing conditions that apply to each type of biomass fuel—for example, imported biomass versus biomass from dedicated plantations—so that generators can earn a fair remuneration over time.

Finally, obtaining the authorization for the realization of biomass power plants is not always straightforward (some obstacles, for example, include long processes or challenge from public opinion). Power generators, especially if already present in a country, should leverage their relationship with the relevant authorities, particularly at a local level, to ensure a prompt consideration of their biomass projects.

Put in place a robust, global supply chain

One of the key considerations when developing a biomass strategy will be to focus on the supply chain and the impact of feedstock sourcing on profitability. This requires an understanding of the supply-and-demand picture. On the demand side, it is important to consider the many other industries that compete for biomass fuel stocks—traditional forest industries, heat production, biofuels producers (especially when lignocellulosic technology enters the marketplace)—as well as other power generators. The overall volume of biomass demand for European power and heat production and for forestry products in 2020 is expected to reach the equivalent of more than 4,200 TWh of primary energy.

On the supply side, solid biomass can come from many different sources—traditional wood materials, recovered wood and paper, other type of wastes, food crops, energy crops, dedicated plantations, and agricultural residues. The technically and economically feasible supply in the European Union in 2020 is estimated to be around 3,500 TWh of primary energy, which is substantially less than expected demand. In addition, a large portion of the biomass supply potential for the European Union is not readily available today.

To close the supply gap, particularly in the short term when EU-origin supply has not yet been fully mobilized, cross-continent biomass trading will take place. For example, significant forest biomass volumes are expected to be exported from North America to Europe. The role of Africa, Russia, and South America as potential supply regions for Europe should also be recognized. In fact, at a global level, the biomass quantity demanded by all the relevant industries will be lower than the total supply achievable. Managing both the imported and local biomass sourcing will require power players to put in place and manage a complex, logistically challenging supply chain (Exhibit 2).

The rapid growth of the biomass demand and supply markets will also introduce more uncertainty into the cost of biomass, which further increases risk for generators. It is unlikely that a "global biomass price" will emerge quickly, as a sizeable share of the biomass is local, and the prices are set by local demand-supply balances. Looking at the recent price evolution in the different regions, it can be noted that in the European Union, where the market is tighter, the increase in demand has already translated into higher prices—a development that has not yet occurred in other regions.

In order to tackle the issue of price risk, power generators using biomass should carefully design their sourcing strategy. Several elements can be used to create a comprehensive price-risk mitigation strategy.

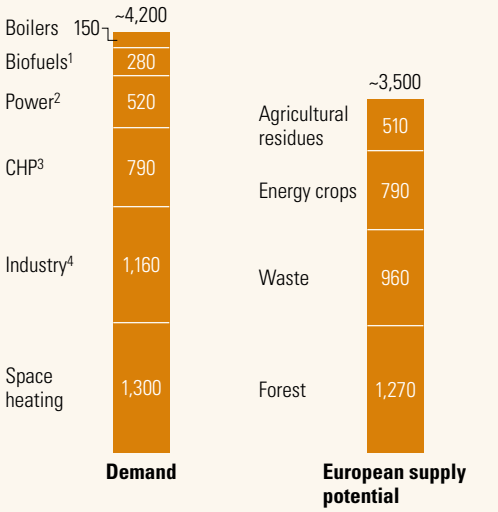
Partnerships with suppliers. Power generators can secure feedstock supply by seeking to make long-term agreements with biomass suppliers. So far this has not been easy to do, as very few suppliers have sufficient volumes to commit. Another challenge has been that suppliers have been unwill-

Exhibit 2

Power players will need to manage complex supply chains

Europe will be both short on biomass supply and have challenges in mobilizing the available resources.

Supply and demand for biomass in the EU in 2020, primary energy, terawatt hours (TWh)



Main mobilization challenges
- Collecting and transporting agricultural/forest residues
- Mobilizing Russian forest resources, given today's severe infrastructure shortages
- Introducing short-rotation forestry/energy crops on idle agricultural land in Europe
- Avoiding deforestation while securing new land

Imports to close gap to demand
- Biomass imports from North America likely to complement local supply, at least until full-scale mobilization of local resources has been achieved

[1]Excluding ~220 TWh food crops for 1st generation biofuels.
[2]Cofiring and condensing biomass.
[3]Combined heat and power plants.
[4]Forest/pulp and paper ~1,100 TWh; other industries 60 TWh.

ing to agree to prices for long periods, as they expect prices to increase rapidly. Real partnerships with profit-sharing formulas and joint risk taking will likely be needed if large volume, long-term contracts are to become a reality for generators.

Multiple option contracts. Fuel demand volumes can easily outstrip the capacity of a single supplier, especially for large-scale plants. Power generators should negotiate multiple contracts in order to manage their risk and to hedge against shortages from any single source. Where possible, call options should also be considered to guarantee future supply and to limit investment exposures.

Exploitation of local opportunities. Local, temporary demand imbalances can be selectively exploited. Significant imbalances created by events like the closure of a pulp mill could create local opportunities that should be closely monitored to identify a potential increase in the supply.

Exploration of the feasibility of pass-through regulatory frameworks. Generators could also seek to promote regulatory frameworks that reduce their risk of investment, such as a remuneration scheme for electricity produced from biomass that is indexed to biomass prices.

Leverage existing asset generation portfolio as an immediate next step

Power generators interested in entering biomass-fueled energy production can exploit their current asset portfolio in two ways—through the adoption of cofiring technology for new power plants and by retrofitting existing coal- and oil-fired plants:

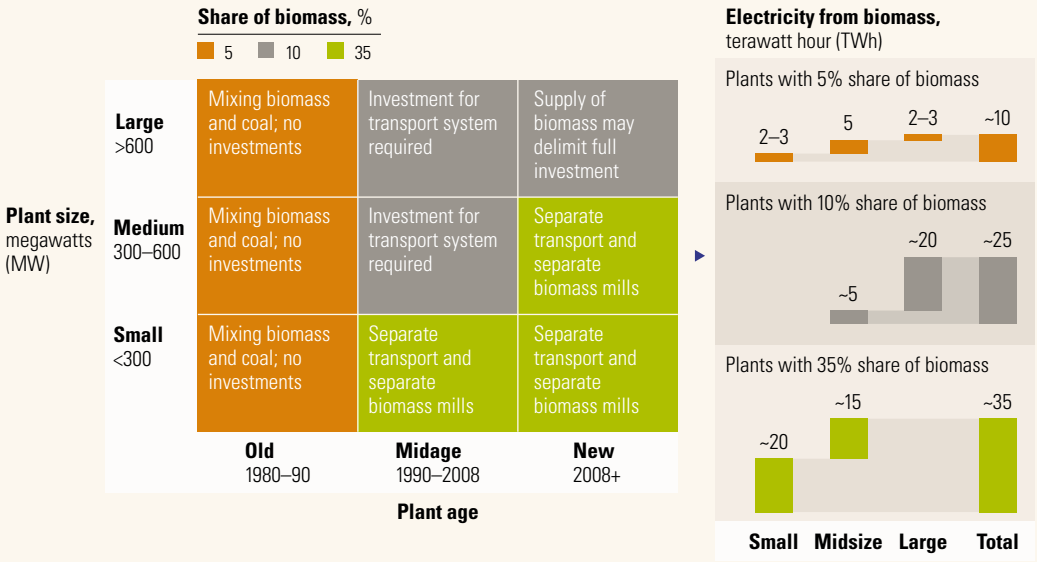
The total coal-fired generation in 2020 in the European Union is expected to reach 1,100 TWh. Taking into account differences

Exhibit 3

Top-down perspective

Power generators can exploit their existing asset portfolio

By 2020, biomass can substitute 5–35% of total energy supply in coal plants reaching a total of ~70 terawatt hours (TWh).



in plant size (very large plants cannot cofire more than 5 or 10 percent due to biomass logistics constraints) and plant age (new plants can cofire up to 35 percent due to separate transport and mills for biomass), the cofiring generating potential is approximately 70 TWh of electricity (Exhibit 3). However, changes in technology and a sharp change in economics (through higher CO_2 prices) could increase this figure.

Retrofitting current coal and oil plants, and turning them into biomass plants presents clear advantages for power generators:

- *The return on investment is higher and payback period shorter*, since the initial investment and fixed costs are reduced compared with greenfield plants and the lead time for conversion is lower than building greenfield plants from scratch.

- *Approvals by national governments and local authorities are easier to get*, as these projects can be positioned as a transition from "brown" power to "green" power.

Biomass-based power generation is already a sizable renewable-energy source, but a significant increase will be needed for the European Union to reach its 2020 renewable targets. For this to happen, generators of power and heat must take a very active role in mobilizing biomass supplies and shaping the regulatory framework for biomass power generation.

The authors wish to thank Peter Berg and Nicolas Denis for their contributions to this article.

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