Biomass: the next major business opportunity or continuing carbon conundrum?

Guest columnist – Jonathan Johns

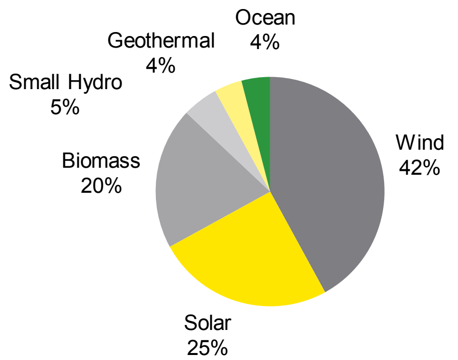
Ten to fifteen years ago, biomass for electricity (bio-power) was expected by many commentators to be a key player in the transition toward a more renewables-based electricity economy.

In 2000, in terms of dollars invested, biomass was easily the leading technology globally, equal to that in wind and solar combined, with Europe and Asia accounting for the bulk of activity.

At the turn of the century, the United States had by far the most capacity globally - driven by the 1978 Public Utility Regulatory Policies Act (PURPA) with just over 10GW of plants. These were mostly cogeneration (i.e., heat and power) primarily using forestry, pulp and other waste residues. In 2000, US biomass electricity production, due to its much higher capacity factors, far exceeded electricity produced from 4GW of wind and 30MW of on-grid solar (although, by this time, growth had slowed following electricity market deregulation).

The steadily declining cost curves of the wind and solar manufacturing industries, and their relatively simple project development business models, led many commentators to expect that initially wind, and then solar, would overtake biomass as the leading forms of renewables investment in the 10 years to 2010 - and this has proved to be correct. However, as Figure 1 shows, biomass was expected to remain a leading force in the industry, with 20% of investment and a greater share of electricity produced.

Figure 1 – Renewables investment (forecast 2000 - 2010)



Estimates were partly driven by anticipated growth in Asia and South America (due to resource availability), a strong market expected in Europe due to favorable incentives and further growth in biomass for heat, and an anticipated resurgence of growth in the US.

However, by 2010, the story was different, with wind and solar industries far outstripping biomass, becoming the technology of choice for many countries and industry players.

As shown by Table 1, biopower investment by the end of the decade had grown respectably - but its 8 times growth in annual investment was pedestrian compared with the 75 times growth in wind and 100 times growth in solar. Biomass power markets with the most potential simply did not grow at the speed anticipated.

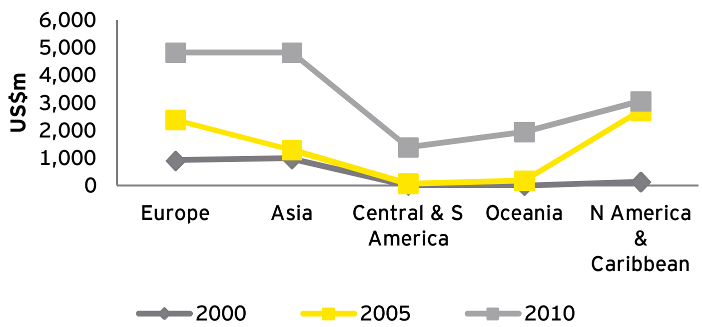
Table 1 – Investment levels for renewable sectors

Sector	2000	2005	2010
Wind	$1.2b	$24.0b	$90.0b
Solar	$0.8b	$3.7b	$79.0b
Biomass	$2.0b	$6.7b	$16.1b

Source: Bloomberg NEF

(Data does not include transactions that were undisclosed to the public)

Figure 2 - Investment levels for biomass by region



Source: Bloomberg NEF

In Asia, significant investment occurred more toward the latter half of the decade than at the start: India gradually grew to over 2.5GW of capacity as the Indian Renewable Energy Development Agency financed small - medium - scale rural projects, and in China, significant growth occurred toward the end of the decade, as it only just met its 5.5GW biopower installed capacity Five Year Plan target - whereas in wind and solar, targets were easily surpassed. In South America, a resurgence in investment did not occur until the end of the decade, when "green reserve" auctions in 2008 Brazil encouraged cogeneration (from bagasse for example).

In the US, investment in the early part of the decade was affected by the 'stop-start' nature of the Production Tax Credit (PTC) support mechanism and the exclusion of open loop biomass (i.e., forestry residues and other waste products) from support until 2005. In 2010, the US remained world leader in terms of capacity, but this was more due to pre-2000 capacity rather than its more modest recent investment.

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Meanwhile, in Europe, steady progress occurred in Germany (making it a top five global player) and steady growth occurred in Scandinavia. However, neither cogeneration nor electricity generation from biomass attracted the same attention as offshore wind or, indeed, solar PV - with landfill gas in the UK and Germany the area that attracted most infrastructure player investment. The disparate supply chain for biomass generally failed to create a sufficiently scaled biomass power market.

At under 10% of the renewables investment market in terms of dollars spent in 2010 (rather than the expected 20%), biopower has become to many observers the afterthought of the renewables industry - even though there remains huge underexploited resource in many prime markets, not only in terms of closed loop biomass but also in terms of open loop (i.e., residue- and waste- originated biomass). There are pressures on landfill in Western Europe that are increasing the flows of organic waste (such as kitchen waste and waste wood) available for energy recovery with gate fees (improved in the UK by avoided landfill tax and landfill trading allowance costs).

So why has biomass fallen so far behind in the investment race and does it deserve an upgrading from investors and policy - makers?

Certainly the contribution it makes to renewable energy production should not be overlooked. Its much higher capacity factors and base-load flexibility mean that, while it has fallen down the league tables in terms of nameplate capacity, it remains significant in many countries in terms of power contributed to the grid. For example, wind power only overtook biopower as the major producer of renewable electricity in the US in 2007 and still produced 38% of that country's renewable electricity in 2009. In Germany, in 2010, biopower produced only slightly less electricity than wind (33% compared with 37%) and nearly three times that generated by solar - even though Germany was by far the largest dollar investor in capacity in the solar sector.

Wind and solar have a number of advantages that explain their success, but that does not mean that the challenges posed by biomass business models cannot be overcome for adequate reward.

Wind and solar both benefit from free natural resources obtained by way of land or roof lease (with relatively modest royalties) rather than complex feedstock contracts. They also pose fewer issues concerning sustainability than biomass.

For wind and solar project development, risk relates primarily to permitting risk (e.g., dealing with the issue of noise, the effect on bird populations, and the remoteness of grid connections in the case of wind). By contrast, biomass tends to be reliant on complex feedstock supply chains often obtained at an input cost (or gate fee revenue where waste products are involved). Development risk for biomass plants is generally lower, as they commonly use brown-field sites, as opposed to green-field sites preferred for wind development.

Most biomass feedstocks come with an exposure to commodity (and shipping) prices that is difficult to avoid completely - with the economics of established plants at times adversely affected by rising input costs. On a local level, competition can emerge from a new plant within a fuel supply radius – analogous to reduction of wind quality due to neighboring project development. This has led to undersupply of feedstock in some markets where waste streams have declined due to lower levels of economic activity or increased recycling. Consequently, banks prefer projects to have sponsors who control feedstock and waste streams or for projects to have the benefit of long-term supply agreements for at least a significant proportion of the feedstock - for a period ideally exceeding the tenor of the loan and providing known parameters for price fluctuations.

Some utilities have responded to feedstock supply risk by physical ownership or control of the biomass source (usually forests) needed to supply their plants, in some cases on other continents. These utilities have often placed biopower plants at deep water ports to potentially reduce shipping costs.

Biomass can give rise to significant sustainability issues if it competes with food crops for land (an issue in common with the solar farm industry), or if energy crops lead to deforestation. It poses more of a carbon conundrum than free resource renewables and poses similar issues to first generation biofuels, such as far eastern palm oil.

In cases where biomass fuels are originated many miles from their use (for example, the use of biomass pellets from North America in large-scale European coal plants converted to biopower), not all environmentalists accept the argument that the net carbon savings justify conversion - instead preferring coal plants to be scrapped and replaced by biomass plants using local waste materials and energy crops satisfying the proximity principle. There is also a preference for heat to be recovered from new plants placed closer to population centers and for industry to use district heating networks.

Similar arguments have led to environmentalists opposing the cofiring of biomass in coal plants (as has occurred in Germany and the UK), arguing that it extends their life - although such practice has arguably allowed biomass fuel supply chains to become more developed. At the time of writing, Drax in the UK was suggesting that the forthcoming RO banding review should increase the subsidy for cofiring to allow it to use biomass for 50% of its 2GW capacity. (Drax has also stated that it needs improved RO incentives for two recently approved 299MW biomass-only plants to go ahead.) Certainly in countries such as China and India, where the drive to increased coal capacity is relentless, increased biomass cofiring from sustainable biomass offers the prospect of significant carbon reductions. Will regulation adapt to support co-firing or stay with pure-play?

To help the debate, sustainability criteria are increasingly being set - with the UK requiring a minimum saving of 60% of greenhouse gas emissions, and general restrictions on using materials sourced from land with high biodiversity value or high carbon stock.

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Biomass also faces competition for resource from biofuels, which have achieved greater levels of government support in many jurisdictions (such as the US), so that biofuels have diverted investment dollars and attention away from biomass for electricity production - even though energy conversion in terms of carbon tonnes saved can be less. Very strong biofuels industries have emerged: with the production of ethanol from sugar cane in Brazil, wheat in the US and maize in Europe, and biodiesel from vegetable oils and animal fats. Biofuels for aviation are likely to become a large new market, as are second and third generation biofuels derived from cellulosic materials and algae, for example. The emerging market for direct injection of cleaned-up biogas into the grid (as occurs in Germany) provides further forms of resource competition, albeit that complementary technologies are used.

The core wind and solar technologies are well established with a global supply chain, high levels of reliability and low levels of risk at construction and operating stages (with the possible exception of offshore wind).

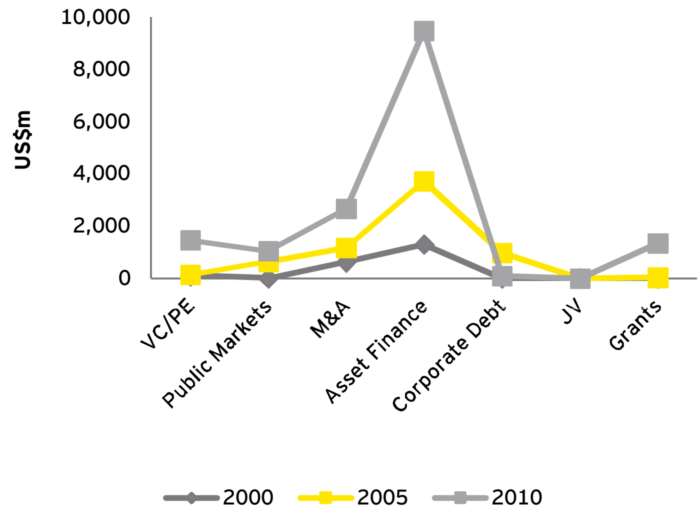
Wind turbine design has been largely settled for many years (with a trend from gearbox toward direct drive designs) and a well established pattern of cost reduction through increase in turbine size. This has allowed rapid globalization of the industry and the entry of significant competitors to Western players from India and China. It has also benefited from its ability to go offshore – albeit with attendant deployment risks in a much harsher and less accessible environment. In the case of solar, crystalline PV has dominated (with a degree of challenge from thin film), with an even more aggressive downward trajectory in costs due to technology improvements and manufacturing efficiencies, together with cost improvements by location of plants in Asia. Solar has benefited from its strong position in the built environment, where it is able to displace electricity at retail prices (often significantly higher than wholesale prices).

As a result, well-known wind and solar manufacturers have emerged that are able to offer warranty and maintenance support. By contrast, the biopower technology industry (other than in landfill gas) has no large players and is a collection of largely unrelated subsectors, each with many often locally or regionally based manufacturers. Technologies include direct combustion with steam cycle generation, and the more advanced technologies such as anaerobic digestion, gasification and pyrolysis, as well as liquefaction for biofuels. Moreover, as feedstocks vary by locality, there is an added degree of complexity as most technologies require relatively homogeneous inputs. This is resulting in a trend towards technologies that can run on a mixed feedstock supply.

Accordingly, each subsector tends to have its own supply chains with specifications varying according to plant size and fuel type, and often involving the integration of equipment provided by different providers - rather than the simple deployment of additional megawatts of identical units in a wind or solar farm. As a consequence of the disparate nature of the biopower supply chain, the pace of technology development has been slower.

Consequently, many biopower technology suppliers do not always have the financial strength required by banks and specialist investment funds for project financing, with construction contractors often required to provide turnkey wraps to absorb risk. Indeed, some banks (especially post 'credit crunch') have been reticent to lend to some technologies due to some early poor performing loans - in part due to optimism bias concerning availability and efficiency, as well as difficulties arising from system scale-up or integration risk. Difficulties have also emerged, for example, in the control of emissions. Careful selection of technology supplier is required with either whole equity financing or less aggressive debt structures.

Figure 3 - Investment levels for biomass by funding source



Source: Bloomberg NEF

The simplicity of wind and solar more readily gives them the characteristics of an infrastructure asset investment rather than a business investment.

As a consequence, infrastructure funds have predominantly gone to the wind and solar sectors - with biopower not attracting the same level of committed funds from such investors. Indeed, it is possible that the flow of funds into biofuels and the poor performance of some of these investments (due to regulatory policy changes, rising commodity prices and sustainability issues) has led to biopower possibly suffering by association.

Perhaps due to its disparate and complex nature, the biopower industry has tended to be less well organized and less favored by policy-makers.

To deal with the diversity and localized nature of the biomass market, incentive mechanisms are often complex and vary considerably by jurisdiction, technology and feedstock.

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Table 2 – Biomass Support Mechanisms

Country	Biomass Support Mechanisms	Examples
US	Tax Credits (PTC or ITC until end 2013) or Treasury Grants until end 2011, and Renewable Energy Credits (RECs)	► Closed loop bioenergy (using dedicated energy crops) receive US$22/MWh and open loop bioenergy (farm and forest waste) receive US$11/MWh
China	FIT, PPA	► FIT for biomass of US$110/MWh
Brazil	Government regulated auctions, government subsidies	► US$98/MWh was set as the ceiling price in the last government auction
India	Renewable Energy Credits, Clean Energy Targets, government subsidies	► Government will provide up to 40% of development costs for biogas plants for electricity production ► US$87/MWh for RECs
UK	FIT or ROC, RHI	► FIT, anaerobic digestion 250kW ► 500kW receives £130/MWh ► ROC for schemes >5MW, £38.69 for 2011 (0.5 to 2 ROCs depending on biomass technology) ► RHI for biomass 200kWth - 1000kWth £47/MWh
Germany	FIT	► €77.9 – €296.7/MWh for installations less than 20MW, with 1% annual degression
Italy	FIT or Green Certificates	► FIT €180 – €280/MWh for schemes under 1MW. ► GC for schemes > 1MW. €87.38 for 2011. (0.8 to 1.8 GCs/MWh depending on technology)
Sweden	Green certificates, carbon tax	► Enacted a carbon tax on heat consumption from fossil fuels in 1991, which was €108 in 2009

Arguably there is less competitive pressure between countries in biopower compared to wind and solar where investors and developers routinely shift their attentions according to resource availability, permitting success, grid availability and easily compared tariff levels. Perhaps in response to better - organized single focus groups, legislators have tended to prefer the relatively easy build - out provided by wind and solar - especially if manufacturing gains have been on offer. This has most recently been seen in offshore wind, with the UK providing strong tariff support and earmarking of Green Investment Bank funds and Germany's recent announcement of €5b of KfW funding to potentially 10 offshore projects with up to 50% of offshore wind project costs, following on from an improvement in offshore tariffs. It is not certain that the difficulties in obtaining bank finance for some of the advanced biopower technologies are so well known or will lead to such a large level of state support. Certainly steps are needed to encourage broader engagement by more members of the banking sector.

In relation to regulatory support, it is to be hoped that the hiatus that occurred in the US in the last decade is avoided by policy - makers. In the UK, similar problems occurred in the initial period of the unbanded RO, when most biopower projects were uneconomic, and also in the last couple of years, when there was a reluctance to allow full grandfathering of biomass banded tariffs.

The strong tariffs put in place by Italy and Germany for smaller scale biomass have been helpful in setting support levels and developing a local supply chain, as has the UK's recently announced upward revision of small-scale feed in tariffs for anaerobic digestion.

In biomass, returns are possible in the high teens rather than low teens (for most wind and solar projects), with less exhaustion of available opportunities.

The good news for biomass is that the flow of funds to the wind and solar sectors has been such to drive down returns to very low levels – albeit adjusted upward post credit crunch. In many jurisdictions, the most attractive sites for wind and solar development are already taken, with only riskier markets such as offshore wind or new territories providing volume opportunities. In addition, pressure on landfill in many developed countries is creating new markets for biopower, particularly in the treatment of organic waste streams.

Biomass as a non - intermittent technology offers base load renewables with localized embedded generation and a relatively high capacity factor for its cost.

Table 3 - Typical technology costs (2010) and load factors in the UK

Technology	Capital Cost (£k/MW)	Operating Cost (£k/MW)	Levelized Cost (£/MWh)	Load Factor
Biomass >50MW	3,342	168	135	90%
Onshore Wind >5MW	1,524	57	91	29%
Offshore Wind >100MW	2,722	166	174	38%
Solar PV >50kW	2,710	21	282	11%
Geothermal	5,571	190	242	90%

Source: Ernst & Young and Arup (2011)

When cost per MW is compared to capacity factor and the relatively attractive embedded base load provided by biomass, it is arguable that regulators have favored both wind and solar disproportionately. As the challenges of moving economically to a low carbon environment become clear, the case for biopower and cogeneration will improve. Ironically, the provision of fixed feed - in tariffs and priority of dispatch in many jurisdictions – designed to assist intermittent renewable - removed some of the competitive advantage biomass had by way of its provision of quasi base load export profiles.

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From a policy perspective, biomass provides greater local economic stimulus and more cleantech jobs than transient construction - oriented employment.

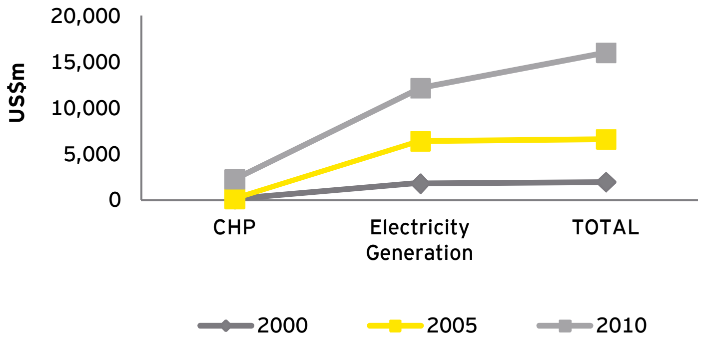
Biomass businesses create much higher numbers of ongoing local jobs - to manage feedstock supply, operate the plant and interface with customers, and in some cases, sell by-products. Manufacturers tend to be more regionally based and subcontract greater proportions of the plant infrastructure to local fabricators.

When combined with district heating, biomass offers very high levels of energy conversion .

Other than in Scandinavia and Denmark (and to a lesser extent Germany), insufficient support has on the whole been provided for district heating, with the consequence that there has been less emphasis on the location of plants near to heat users – which would optimize overall efficiency. (This has notably been the case in the UK, and it is uncertain whether the pioneering Renewable Heat Incentive has fully addressed the issue.) In most jurisdictions, the funding of pipe networks for heat remains a significant issue, as does the quality of the heat offtaker, with many banks discounting heat from their debt - sizing calculations.

Arguably, the focus of biomass on cogeneration or combined heat and power remains one of the most challenging areas for regulators, with the consequence that large - scale biopower-only plants could, in the relatively short term, come under pressure due to their relative inefficiency in energy conversion terms.

Figure 4 – Investment levels for biomass CHP and electricity generation



Source: Bloomberg NEF

While it is unlikely that biomass will achieve the levels of growth in investment achieved by wind and solar in the last decade, some commentators are expecting the global market to at least double to 120GW by 2020 - which would represent a significant outperformance of the last 10 years.

There are a number of challenges, not least the need for policy - makers to ensure that tariff support and bank and equity finance flow through to the sector. The danger still remains that biomass is swamped by the various glamor sectors: offshore wind in Northern Europe, and onshore wind and solar elsewhere.

Certainly, regulators need to think carefully about their desired position in the bioenergy market as a whole: whether they favor large - scale stand-alone, or cogeneration, or more localized biopower. They also need to consider the extent to which they wish to engage in the biofuels, biogas and bioheat markets, and the degree of interaction needed with the waste market. The role of energy crops also needs careful consideration.

As financial pressures mount on the cost of decarbonization, the high capacity factors afforded by biopower relative to the cost of nameplate capacity ought to lead to a renewed focus on the sector. This may not occur if the biomass industry does not become more adept at presenting its case and providing a lobby as strong as that of the competing technologies. With many countries reducing emphasis on nuclear, there is a lot of power to fight for.

There are some early encouraging signs in the renewables roadmaps set out by EU Member States to 2020, indicating a significantly increased contribution from biomass (albeit that some targets appear stretched). China is widely expected to accelerate its development of biopower and biofuel facilities. Even in the US, biopower grabbed a higher level of federal support at US$1.1b (€762.2m), (up eight-fold from that in the previous year) and similar to that provided to the solar sector - with biofuels by far the largest recipient at US$6b (€4.2b) followed by wind at US$5b (€3.5b).

Indeed, there is the possibility that, by the end of the decade, the distinction between biofuels and biopower (and indeed biogas and bioheat) could have melted away. Bioenergy may become regarded as a single market with different points of delivery: by which measure, in some markets, it already eclipses wind and solar in its contribution to the new low carbon economy. Perhaps the industry should think that way now.

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