Deloitte.

Knock on wood
Is biomass the answer to 2020?

Energy & Resources

Contents

Executive summary

The UK energy industry is facing a number of challenges. Among them energy security, decarbonisation and affordability rank the highest.

From an **energy security** perspective, the UK is increasingly relying on imported natural gas, several fossil fuel plants are shutting under the EU's *Industrial Emissions Directive (IED)* and the majority of nuclear plants will be retired by 2023.

To meet legally-binding EU targets and begin **decarbonising** the electricity sector, the UK has committed to generate 15 per cent of its energy from renewable sources by 2020. However, some of the technologies needed to achieve this goal are intermittent and therefore, to maintain security of supply the overall energy mix needs to be diverse.

With constrained government borrowing in a time of austerity, and the continuing squeeze on household incomes, a shift in energy mix needs to be delivered at an **affordable** cost to the consumer.

Could energy from biomass make a material contribution to meeting these challenges? Through the 2012 *Renewables Obligation Banding Review*, the Department of Energy and Climate Change (DECC) created a new band for conversion of fossil fuel power stations to biomass, reaffirming support at 1 Renewables Obligation Certificate (ROC), at a time when subsidies to other established renewable technologies were reduced. The 2011 *Renewables Obligation Banding Review* consultation document suggests that biomass could contribute up to 21 per cent of the 2020 renewable energy targets from a very low base today.

Deloitte has identified five obstacles that the biomass sector must overcome to achieve such success:

- **Regulation** – The sector needs to have long term confidence in the stability of the incentive regime.
- **Availability of fuel** – While the UK has some biomass fuel and the potential for more, this is unlikely to be sufficient to meet a 21 per cent contribution, and we expect the majority will be imported.
- **Sustainability credentials** – Biomass fuel must be sustainably sourced and its overall carbon footprint sufficiently lower than that of fossil fuel generation to remain credible.
- **Supply chain** – Investment in biomass handling, logistics, port and rail facilities will be critical.
- **Financing** – Conversion of existing coal-fired power stations requires considerable investment, for example in materials handling, boiler modifications and storage facilities. To secure funding, biomass projects must offer attractive returns to investors.

Our view is that the above obstacles can be overcome and biomass can play a key role in meeting the UK's energy challenges. The new emphasis on converting fossil fuel power stations to biomass in the Renewable Obligation (RO) banding proposals is a significant first step.

Deloitte has modelled the attractiveness of biomass projects to potential investors. Our findings indicate that full conversion of fossil fuel power plants, and conventional and enhanced co-firing offer the best return on capital invested. Our analysis also shows that these biomass plant types are competitive with other renewable technologies on a levelised cost basis. Considering the above, it therefore appears that biomass does have a part to play in addressing the challenges of energy security, decarbonisation and affordability. In which case, should we be targeting a greater role for biomass than a 21 per cent contribution to the 2020 renewable energy targets?

Clearly further economic and technical research needs to be undertaken, but it does raise an interesting question as to whether we may look back on the forced closure of our fossil fuel plants under the Large Combustion Plant Directive (LCPD) and its successor the EU's *IED* in years to come and see a missed opportunity when the alternative of converting them to run on high levels of sustainably-sourced biomass could have been considered.

Introduction

Biomass is our most diverse energy source. It differs from traditional fossil fuels in that it includes a wide variety of biomass fuel types and can involve a range of technologies for a number of end-uses. The term biomass usually refers to wood and agricultural residues, energy crops, and the biogenic part of waste such as solid municipal waste, landfill, sewage gas and farming waste.

In this report we focus on the role of agricultural and forestry residues, both domestic and imported, in UK power generation. Among the wide range of power generating technologies available for biomass, we mainly refer to coal-to-biomass conversions, co-firing and dedicated biomass plants for small and large-scale generation. Liquid biofuels, while they are also a biomass type, fall outside the scope of this report.

The 2011 *Renewables Obligation Banding Review* consultation document states that the new renewables bands and the Electricity Market Reform (EMR) will create the potential for between 32 and 52 TWh/year of biomass electricity generation by 2020. This is equivalent of up to 21 per cent of the government's 234 TWh/year 2020 target for renewable energy.

Our research suggests that the UK power sector could deliver this contribution from biomass, but the industry, and in some areas government, has to overcome a number of challenges to realise this potential. These hurdles are associated with regulation, feedstock availability, sustainability requirements, supply chain issues and access to financing.

The aim of this report is to consider each of these challenges from the perspective of both project developers and investors. As part of the research, Deloitte constructed a model to assess the financial viability of biomass projects.

Challenges facing the UK energy industry

The UK energy industry is facing its greatest challenges for at least a generation. The sector is expected to provide reliable, secure, affordable, low carbon energy to customers. Depending on the choice of technology and the fuel source it displaces, biomass can provide part of the solution to some of these challenges.

- **Weakening UK energy security** – Under the EU's *IED*, a large number of coal and gas plants are scheduled to be closed down. Further, the majority of the UK's ageing nuclear power stations will be decommissioned in the coming decade. However, the government's plans for the private sector to replace this ageing nuclear generating capacity have been jeopardised due to a combination of factors. These include the Fukushima accident in Japan, Germany's decision to close its nuclear power plants and the continuing impact of the global financial crisis. All of this is against the backdrop of reduced production in the North Sea Continental Shelf and a growing reliance on imported natural gas.

- **Carbon commitment** – Under the EU's *Renewable Energy Directive*, the government agreed to provide 15 per cent of the country's annual energy consumption from renewable sources by 2020. In addition, the government's Committee on Climate Change advised that UK-wide emissions should be cut by around 60 per cent by 2030. In the same period, renewable sources should provide 45 per cent of all energy consumed.

To support the government's low carbon targets, the role of intermittent technologies, such as wind, is expected to increase within the UK electricity mix. National Grid estimates that intermittent technologies could potentially make up 28 per cent of transmission-connected generation by 2020, up from five per cent in 2010.[1] The government's projected electricity mix represents a clear shift in the provision of predictable electricity supply to unpredictable, intermittent and seasonal generation. This will require the remaining electricity generation capacity to operate more reliably and flexibly.

- Investment in a time of austerity – DECC estimates that around £110 billion investment is required in low carbon generation and network infrastructure by 2020.[2] The vast majority of this funding must be committed up front and it will take years before investments can be recovered from customers. With government spending constrained, and household energy bills reaching an all time high, the private sector is expected to bear the brunt of the funding burden in the medium term.

Can biomass be part of the answer?

Biomass has the potential to address all three of the UK's key energy challenges. Depending on the choice of technology, the green credentials of biomass power and heat generation can make it a significant contributor to the UK's energy mix and help achieve the country's 2020 targets.

The Energy Technologies Institute (ETI) built a model of the UK energy system which is able to show the impact of removing a key energy source, such as biomass or nuclear, from the system. The model indicates that the removal of biomass would add about £44 billion a year to the UK's energy costs within the constraints imposed by the emissions target.[3]

Electricity cannot be stored in quantity and the share of intermittent technologies will continue to increase within the power generating capacity for the foreseeable future. Cost-effective flexible fuel sources that provide robust and predictable electricity supplies will therefore become increasingly valuable. Biomass has the potential to provide this much needed flexible generation.

The industry has to overcome a number of challenges to realise this potential. These hurdles are associated with regulation, feedstock availability, sustainability requirements, supply chain issues and access to financing.

Regulation

The clarity of the regulatory regime is crucial for a sector where government subsidies are an integral part of the revenue stream. Government support will therefore shape the future of biomass and its potential to contribute to the UK's 2020 targets to reduce carbon emissions in a cost effective manner.

The 2012 *Renewables Obligation Banding Review* contains the details of government subsidies available for renewables operations that come online by 31 March 2017. For plants that become operational after 2017, EMR and its key mechanism of a Feed in Tariff with Contracts for Difference (FiT CfD) will replace the RO over time.

Government support

Recent DECC statements reveal substantial government support for biomass.

The 2011 *UK Renewable Energy Roadmap* counts biomass heat and electricity among the eight most cost-effective and sustainable technologies that will help meet future green goals.

The 2012 *UK Bioenergy Strategy* aims to provide policy support to renewable technologies that are the most cost-effective in reducing emissions compared to alternative options. To this end, the main role of biomass in electricity generation is seen as displacing coal as a fuel source. The strategy document also promotes more efficient energy generation. It encourages the employment of technologies that produce both power and heat, which biomass has the potential to deliver, although producing heat on a large scale in the UK is challenging due to the lack of district heating infrastructure. In contrast, in Europe the majority of biomass is used for heat generation.

The 2012 *Renewables Obligation Banding Review* in particular emphasises coal-to-biomass conversions through maintained support and the creation of a number of new bands for biomass power generation.

EMR to provide greater clarity

The UK is significantly enhancing its support regime for renewable electricity as part of EMR. The current support scheme for renewable electricity, the RO, will continue to 2037 but will close to new projects in 2017. New low carbon power generation projects coming online after that date will receive a low carbon contract. These low carbon contracts will act as CfDs that top up revenue from the wholesale electricity market to enable renewable electricity generators to achieve a pre-determined total revenue level. This revenue level will initially be set on a technology-by-technology basis to ensure viability for a variety of project types. The intent is then to introduce competition, firstly within each technology, and then between technologies, as a way of reducing costs and setting appropriate support levels.

The incentive and regulatory treatment of biomass power generation has to reflect a number of material differences between biomass and other forms of low carbon generation. These include:

- The wide range of biomass fuels that can be used for power generation.
- Volatility in the cost of biomass that complicates the support structure and changes the commercial risk profile for biomass projects.
- Biomass sustainability concerns that are reflected in evolving regulatory requirements and restrictions on biomass sourcing. Potential regulatory changes create risks for biomass projects.

The clarity of the regulatory regime is crucial for a sector where government subsidies are an integral part of the revenue stream. Government support will therefore shape the future of biomass and its potential to contribute to the UK's 2020 targets to reduce carbon emissions in a cost effective manner.

The specific characteristics of biomass have already influenced the regulatory treatment of biomass generation projects. As an example, the existing RO provides several different support levels for biomass, with the number of ROCs issued to a project per MWh of generation being dependent on the type of biomass and the fuel mix (see Appendix 1).

It is anticipated that the initial technology specific approach to offering low carbon contracts will recognise a number of different fuel source/generation technology combinations. Long term, biomass power generation will be subject to the same cross-technology competition as other technologies.

The impact of carbon price support

Biomass power generation accredited under the RO will initially be a beneficiary of the EMR measures through the imposition of carbon price support on the effective cost of carbon emissions from thermal power generation in the UK market.

Carbon price support represents a tax on power sector carbon emissions in addition to the cost of EU Allowances (EUAs), provided the cost of EUAs is below a target level that increases through time (from £16 per tonne in 2013 to £30 per tonne in 2020).

The additional cost of carbon emissions will raise, absent other factors, the price at which thermal generators offer power in the UK wholesale electricity market. However, the increase in prices can be 'captured' by projects under the RO because the value realised from ROCs represents a premium over wholesale electricity prices.

The extent to which new biomass generation can continue to benefit from carbon price supports (or from changes in the cost of EUAs) under the CfD regime will depend on the process for determining who gets low carbon contracts, and on whether carbon price support continues beyond 2020.

In contrast to the RO, under low carbon contracts, the CfD top-up payment will be reduced to offset any increase in wholesale power prices. Carbon price support will therefore only provide a benefit to biomass projects if it creates a competitive advantage for biomass.

If carbon price support continues beyond 2020, it may influence the competitiveness of different low carbon technologies in the competition for low carbon contracts for differences. This is because biomass generation can target hours when themal generation is setting the marginal price and will therefore receive the full benefit of additional carbon costs for themal generation. Technologies that also run in hours when low carbon generation sets the system price will have the beneficial influence of additional carbon price support diluted on a per MWh basis. This effect is likely to grow through time as the penetration of low carbon generation into the UK market increases.

Feedstock

Biomass is one of the most plentiful resources available globally, and demand for it is likely to increase. However, at present it is not traded widely on commodity markets. The biomass market overall is currently dominated by long term, customised contracts that can be challenging to obtain with limited spot markets and fragmented asset ownership.

The fact that the biomass traded market is illiquid is a major hurdle to the expansion of biomass power generation in the UK. Without securing long term contracts for sufficient quality and quantity of fuel, financing biomass plants becomes very challenging. Much has been done by leading industry participants to seek to mitigate these risks. Innovative arrangements such as strategic partnerships with suppliers and vertical integration have made progress more attractive. While there is scope for domestic sources of biomass to expand, it is clear that the rapidly growing needs of the UK market will be met predominantly by international supplies.

While future demand is expected to grow...

Two separate 2011 reports by LCAworks and the Royal Society for the Protection of Birds (RSPB) estimate that UK demand for biomass for energy and heat generation will reach between 40 and 50 million tonnes by 2020.[4] The RSPB compares this figure to the 5.2 million tonnes of biomass used in 2010. At present, almost three-quarters of UK biomass fuel is sourced domestically, mostly from municipal waste, forestry and agricultural residues.

The majority of current UK biomass operations are small (generating less than 50MW). These include boilers often built to burn a particular type of fuel. This fuel is mainly sourced locally, such as poultry litter, straw or woodchip.

The pipeline of plants under construction and in the planning stage, however, suggests that most of the newly built operations will be large (generating more than 50MW). Most of these will have standardised large boilers and require wood pellets, which are popular in Europe, the US and Canada. While the majority of planned (partial or full conversion) biomass plants can burn a variety of fuel types, it is likely that they are going to use fuel that is available in bulk at affordable prices and has low carbon characteristics. While North America is currently a key source of imported biomass, South America and the Russian Federation in particular offer significant alternative sources of supply. As the demand for biomass grows, a number of countries could be considered as possible sources of supply. Although there is the potential to increase domestic biomass through better practices, it is clear that the fuel needs of all future UK plants cannot be supplied locally. According to RSPB estimates, if all the plants in the planning stage were to be built, the amount of imported biomass would increase from 1.3 million tonnes in 2010 to 39.1 million tonnes by 2020. Imported biomass fuel would then make up as much as 81 per cent of all UK fuel supplies.

... an illiquid biomass fuel market...

One barrier to investment in biomass conversion is the illiquid traded short term fuel market. Currently, the majority of UK biomass is traded locally under long term customised, fixed-price contracts between producers and end-users. While such contracts provide the parties with some measure of income and fuel security, they also lock in both supplier and customer, and neither is able to take advantage of price fluctuations.

Contrary to the oil and gas or coal industries, asset ownership of biomass production is highly fragmented. The majority of forests, agricultural or ex-agricultural land are owned by individuals, local authorities or smaller corporations. This makes it difficult to obtain contracts for large quantities of fuel. Securing and retaining such contracts therefore represent major risk factors for any project developer.

Increased demand, both in the UK and internationally, is expected to change market conditions for solid biofuels. This could lead to higher prices and in turn result in increased vertical integration through the supply chain.

... makes investing in biomass more risky

Currently, obtaining project finance for biomass plants is almost impossible without evidence of long term and sustainable fuel supplies. Conversely, without proof of committed financing, securing fuel represents a significant challenge.

There is great uncertainty regarding the future level of biomass prices. Biomass is different from most forms of renewable energy generation in that there is a cost for the fuel used. Fuel costs represent a large portion of the plant's ongoing costs. According to engineering company Arup, the cost of woody biomass

To attract more investment, developers need to manage and mitigate risks associated with future price increases. This could be achieved by creating strategic partnerships with fuel suppliers or vertically integrating the supply chain.

in conventional and enhanced co-firing biomass plants can reach 80 to 90 per cent of ongoing costs, while in small new-build plants similar fuel costs typically account for 37 to 53 per cent of overall costs.[5] With demand for biomass expected to grow both in the UK and internationally, prices may increase significantly. Given the high proportion of fuel costs, returns could be at risk to future price fluctuations.

An increasing proportion of imported, mostly woody, fuel will be needed to meet future UK biomass demand. Foreign exchange considerations therefore will become more important for many operators and an additional risk factor that needs to be managed and mitigated.

Government has signalled that it does not intend to offer any form of fuel cost indexation for biomass projects in the low carbon CfDs. This is similar to the RO, which does not offer any variation in the number of ROCs granted to offset changes in biomass cost. Increasing fuel prices could leave biomass at a disadvantage, compared with other renewable technologies under the proposed EMR. The lack of clarity on support levels for various technologies and volume contracts creates a degree of uncertainty for investors. This uncertainty may hold investment in biomass back.

Conclusion and outlook

For biomass to reach its potential in contributing to the UK's 2020 targets, larger quantities of fuel need to come to market either under more standardised contracts or shorter term agreements. A limited wood pellet spot market in northwest Europe already exists, but the development of short term delivery markets for other biomass forms would increase investor confidence in biomass projects.

On a project level, developers face uncertainty in terms of future fuel prices with no prospect of compensation for fuel cost increases under the proposed EMR arrangements. To attract more investment, developers need to manage and mitigate risks associated with future price increases. Leading industry participants are mitigating these risks successfully through the creation of strategic partnerships with fuel suppliers and vertical integration of the supply chain.

Sustainability

The government recently introduced new sustainability regulations to ensure that biomass delivers desired carbon savings while also protecting biodiversity. A further DECC consultation addressing both sustainability and affordability is currently in progress.[6] Complying with these regulations adds to plant owners' operational risks and subsequently their costs. In addition, new European regulations are being considered – introducing a level of uncertainty both for some project developers and investors.

For biomass to deliver on its potential, it is essential that companies adopt strict sustainability policies and strong ethical business standards.

Sustainability concerns on the rise

The majority of UK biomass fuel comes from local waste products of sawmills, agricultural residues and industrial residues with little or no commercial value. Thus concerns over the sustainability of fuel supply have so far been limited.

With the potential expansion of the UK biomass sector, and the expected growth in imported biomass, assurance over the sustainability of fuel supplies will become critical to the success of future biomass projects.

Is biomass carbon neutral?

The 2009 *Biomass: Carbon Sink or Carbon Sinner* report for the Environment Agency highlights how complex the biomass carbon footprint issue is.

- Energy generation from biomass can emit less greenhouse gases (GHGs) than fossil fuels.
- Following best practices associated with production, processing and transport of biomass fuel can result in major carbon emissions savings.
- Land use change can cancel out emissions savings.
- If energy conversion efficiency factors are taken into consideration, substantial emissions savings can be made.
- By 2030, biomass electricity will need to be more competitive in terms of GHG emissions per unit than the average for the electricity grid.
- Co-firing biomass can only have a long term future if it is fitted with carbon capture and storage, and its heat utilised.[7]

Regulatory response: Obligatory sustainability reporting in the UK

The Environment Agency findings prompted the government to introduce a mandatory sustainability reporting structure to ensure significant carbon savings and protect biodiversity. From April 2011, the new guidelines have required electricity generators over 50kW, that use solid biomass and biogas, to submit an Annual Sustainability Report to Ofgem indicating that they have met the following sustainability criteria:

- Minimum 60 per cent GHG emission savings for electricity generation using solid biomass or biogas relative to fossil fuel.
- Restricted use of materials sourced from land with high biodiversity value or high carbon stock – including primary forest, peatland and wetlands.[8]

It is proposed that from October 2013, those generating above 1MW will need to meet sustainability criteria in order to receive ROCs.[9]

Many industry participants consider that UK regulations are already tighter than European requirements and believe that European standards should mirror those proposed in the UK. Clearly, the risk exists that at some point in the future EU regulations are introduced that go beyond the UK's proposals.

Further environmental regulations

Similar to other combustion technologies, biomass plants are already subject to a wide range of pollution regulations depending on a number of factors. These factors include the size and location of the plant and the fuel it burns. Most plants are regulated by the Environment Agency with local authorities being responsible for smaller plants.

From the project developers' perspective, compliance with sustainability standards is a prerequisite for subsidies and essential for maximising income. UK plant owners should adopt voluntary certification schemes, establish their own sustainability criteria and adhere to them to increase investor confidence.

In cities, where an Air Quality Management Area has been declared, obtaining permissions for biomass plants can be difficult due to tight EU regulations. This particularly impacts small scale and domestic plants without dust arrestment equipment. Incidents of breaching EU limits have already led to EU court proceedings against the UK and other member states, and could result in fines of several hundred million pounds. While these costs would be borne directly by investors or plant operators, recent suggestions that fines could be passed to local authorities are causing them to become increasingly cautious about granting planning permission for biomass plants.[10] These create additional risk factors for project planners and potential investors.

Biomass from countries where regulations are not stringent can carry further risk. This is because the sector has to be able to demonstrate that the material has been sourced in compliance with sustainability standards and that relevant business and ethical practices have been followed.

These include complying with the UK Bribery Act, preventing fraudulent activity, and adhering to health and safety measures.

Conclusion and outlook

Current and future sustainability regulations will increase the risks and costs for project developers and investors. For biomass to reach its potential in maximising carbon savings in the energy sector, it is essential that plant developers are incentivised to meet current sustainability and ethical business standards.

Given the uncertainty surrounding the future sustainability regulations, one option that could be considered would be 'grandfathering' sustainability criteria for existing biomass projects, effectively exempting them from future changes in requirements. The current DECC consultation purposes to introduce limited 'grandfathering' until 2020 with improved sustainability criteria.[11]

From the project developers' perspective, compliance with sustainability standards is a prerequisite for subsidies and essential for maximising income. Until such time as EU and UK regulations comprehensively address all aspects of sustainability, UK plant owners should adopt voluntary certification schemes, establish their own sustainability criteria and adhere to them to increase investor confidence. Such a system for example, was set up by Drax Group in 2008.

Supply chain

Given that biomass is not traded widely as a commodity, a supply chain has not yet been developed that could provide satisfactory handling, processing, logistical and storage facilities. While this creates opportunities for those aiming to enter the supply market, it also increases costs and operational risks for biomass power generation.

Several investment opportunities…

Several global studies in recent years have shown that there is sufficient, available land to produce significant amounts of biomass without having an impact on food crops or encouraging deforestation.[12] However, the supply chain required to support the generation of significant levels of renewable energy is still in its infancy.

A 2010 report for the European Climate Foundation highlighted that a substantial amount of biomass fuel would need to be imported to meet EU targets.[13] This suggests that there are opportunities for potential suppliers ranging from forestry companies suffering from reduced paper demand in a digital age to farmers whose land cannot competitively support other crops.

Increasing demand from the EU as well as potentially from Asia will encourage investment in developing processing and handling techniques. One technique that has continued to evolve over recent years is torrefaction which heats biomass without oxygen.[14] It reduces moisture, increases energy density, makes the biomass easier to grind prior to burning and reduces transport costs. Continued improvements to this process and other innovation should reduce the cost of biomass per MWh and increase its competitiveness when compared to coal and other fossil fuels.

The costs, effort and time involved in harvesting, collecting, drying and treating biomass (especially contaminated waste), and converting it into a condensed form such as pellets are significant. However these only represent part of the operating costs and capital investment in the supply chain. Transporting biomass from its often rural base to port in a cost effective and sustainable manner is critical. Investment in handling equipment at port will also be required as will minimum volume guarantees. In addition, shipping and rolling stock will need to be converted to handle large quantities of highly inflammable biomass. The recent fire at Tilbury, which at its height had 120 fire fighters dealing with the blaze, highlights the risks associated with handling large volumes of biomass.[15]

In the absence of a liquid market, suppliers will be looking for long term offtake arrangements from the power companies to support the investment case. This is required in particular to finance the construction of pellet plants and to support the investment in securing transport links to relevant ports. Such agreements would also provide clear economic incentives to encourage key players to invest in identifying innovative production techniques.

… but more regulatory certainty is needed

The lack of clarity regarding future sustainability requirements and subsidies has led to the current cautious levels of investment despite the potential opportunities. The lack of a clear long term regulatory regime has also stopped power generators from securing the supply chain through acquiring or entering into joint ventures with biomass suppliers. A secure revenue stream would make it easier for generators to access financial resources necessary for supply chain investments.

It is still unclear whether power generated from biomass in the UK will come from dedicated power stations, co-firing or converting existing coal fired power although the government's proposals to cap supplier RO obligation at a contribution of 1GW from dedicated biomass will impact its attractiveness in favour of conversion and co-firing.[16] When the regulatory regime is put in place, additional investment in storage and burning of biomass will lead to increasing demand for specialist manufacturers, engineers, consultants and professional services. If this demand cannot be met, there could be potential delays in delivering some of the projects.

Conclusion and outlook

The lack of an established supply chain for the production, transport and storage of biomass fuel can pose significant operational risks for project owners. Biomass plant operators are likely to be required to support significant supply chain investment either through higher operating costs, long term contracts, volume guarantees or direct capital investment.

These costs have an impact on a plant owner's profit margins and operational efficiency and may subsequently reduce investor interest in biomass projects. This may act as a constraint on the sector's potential to contribute to the UK's 2020 targets.

A key priority for project developers will be to mitigate supply chain related risks. This could include forming links with other industries, such as paper or pulp, which potentially use the same fuel but already have an established supply chain.

Increasing demand from the EU as well as potentially from Asia will encourage investment in developing processing and handling techniques. One technique that has continued to evolve over recent years is torrefaction which heats biomass without oxygen.

Financing

The last significant challenge for biomass in achieving its potential is financing. The availability of credit is a key concern. Bank credit can be difficult to obtain and therefore bond markets that large utilities can access and large company balance sheets are the most likely sources of financing.

We have modelled the attractiveness of biomass projects to potential investors. Our modelling indicates that full conversion and co-firing (both standard and enhanced) can provide attractive returns for investors, both on a project and equity return basis. Provided the challenges outlined in the previous sections are met and biomass projects provide satisfactory returns, we expect that financing will be available to pursue future opportunities.

Credit availability

Small plant and standalone project developers have traditionally approached banks to finance debt. During the financial crisis, however, the availability of credit has become less certain. With European banks deleveraging their balance sheets, and new global and national banking regulations on capital levels, credit supply is significantly constrained. As a result, obtaining bank debt has become more challenging and costly.

Despite the limited availability of credit, a number of banks have recently shown interest in biomass projects. An example is the successful financing of Eco 2's Sleaford project by three banks and Siemens Financial Services.

Using the balance sheets of utilities to finance large-scale biomass plants has better prospects. UK and continental European utilities have access to healthier bond markets. However, commitments to biomass projects will depend on the utility's priorities within its own project portfolio and its view on future regulatory developments.

The Deloitte biomass model

Our modelling assesses, on a relative basis, the illustrative returns that investors could expect to see on a typical biomass project across a number of biomass technologies. (For assumptions used in the model please see Appendix 2.)

Our modelling considered five types of biomass plants: dedicated biomass >50MW, dedicated biomass 5-50MW, conventional co-firing, enhanced co-firing and full conversion. Technical data published by DECC and Arup suggests that on a levelised cost basis, conventional and enhanced co-firing are the cheapest of the biomass technologies considered.[17] Comparing these costs with the levelised costs of other renewable technologies such as onshore wind, offshore wind Round 1, offshore wind Round 2 and solar power published by DECC and Arup, shows that the levelised costs of conventional and enhanced co-firing are marginally lower than all the wind and solar technologies. While full conversion of fossil fuel plants is more expensive, it is still cheaper than offshore wind or solar power. This shows that co-firing and conversion are competitive with other renewable technologies on a levelised cost basis.

It is worth highlighting that such levelised cost analysis excludes other costs ultimately borne by the customer. Factoring in relative costs such as existence or otherwise of existing grid connections, intermittency and flexibility is likely to reduce the relative cost of biomass generation in comparison to other technologies.

From our analysis of net levelised costs, which takes into account the effect of ROC banding, it appears that enhanced co-firing is the cheapest of the biomass generation methods, followed by full conversion and conventional co-firing.[18] This is because conventional co-firing receives less governmental support under the RO (0.5 ROC compared to 0.6 and 1 for enhanced co-firing and full conversion respectively).

Analysis of data provided by Arup also highlights the high proportion of biomass costs within levelised costs.[19] In conventional and enhanced co-firing biomass plants fuel costs can reach as much as 80 to 90 per cent of levelised costs. In full conversion this is lower, 70 to 80 per cent, while in new-build dedicated biomass plants fuel costs can make up between 37 and 53 per cent of levelised costs.

Conventional co-firing requires significantly less capital expenditure than full conversion and dedicated new-build biomass plants (on a per MW basis). Capital is likely to be spent on furnace modification or building infrastructure associated with transporting, handling and storing biomass. These costs are considerably lower than the capital needed to build new plants, onshore/offshore wind farms or new infrastructure for electricity transmission.

Our modeling suggests that on a project basis full conversion and enhanced co-firing provide the best Internal Rates of Return (IRR). Conventional co-firing is negatively impacted by a typical plant's shorter economic life, as the majority of these plants are old, but this is counteracted by its higher ROC banding. Our modelling indicates that returns on new-build dedicated biomass projects are the least attractive of the technologies considered due to the relatively high upfront capital costs.

Given the high proportion of fuel costs within levelised costs, returns on biomass projects are particularly sensitive to rises in the cost of fuel. In particular, the conventional co-firing project return almost halves when assuming a 15 per cent increase in biomass prices.

In terms of IRR on equity invested, our modelling indicates that conversion and co-firing (standard and enhanced) provide the best returns. All three technologies have the potential to achieve above 20 per cent IRR. While these are indicative figures due to the number of assumptions used to calculate them, they are attractive in terms of investment.[20] Our modelling also shows that new dedicated biomass plants are less attractive as returns on equity fall below 20 per cent due to higher capital costs.

Conclusion and outlook

Bank credit may be challenging to obtain, therefore the most likely source of credit may be through utility companies accessing the bond market.

Based on our modelling of the biomass technologies considered, full conversion, conventional and enhanced co-firing biomass plants will offer the most attractive investment returns.

Our findings also raise an interesting question: whether closing fossil-fired power stations under the LCPD and EU's *IED* rather than converting or co-firing them, represents a missed opportunity for them to contribute to energy security, meeting the government's 2020 targets and providing potential customer cost savings.

Re-permitting offers a potential solution to enforced closure, but the requirement to meet new plant standards, including for example Best Available Technique (BAT) tests, could make this prohibitive for all but a few.

Our modelling indicates that full conversion and co-firing (both standard and enhanced) can provide attractive returns for investors, both on a project and equity return basis.

Appendix 1

Technologies where a different approach is being taken to that consulted on.

Renewable electricity technologies	Current (2012-2013) ROCs per MWh[21]	Proposed in consultation document Level of support ROCs per MWh[22]	 Other proposed changes	Post-consultation decision Level of support ROCs per MWh	 Comments and other changes
Advanced gasification **Advanced pyrolysis**	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	Proposed change to definition and merger of advanced gasification and advanced pyrolysis to create a combined 'advanced ACT' band	**2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17**	**One ACT band supporting 'standard' and 'advanced' ACTs at the same ROC level**
Anaerobic digestion	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17		**2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17**	**Closure of band to new projects at or below 5 MW from 1 April 2013, subject to consultation**
Biomass conversion	No current band but 1.5 ROCs under current banding arrangements	1	Proposal for a new band	**1**	**New band. Unit by unit approach. No energy crops uplift. Change to definition of relevant fossil fuel generating station**
Biomass conversion with CHP	No current band but 2 ROCs under current banding arrangements	1.5	Proposal for a new band and to close this band to new accreditations from 1 April 2015.	**1.5 in 2013/14 and 2014/15**	**New band. Unit by unit approach. No energy crops uplift. Change to the definition of relevant fossil fuel generating station. Close band to new accreditations from 1 April 2015**
Co-firing of biomass (standard)	0.5	0.5 (less than 15% biomass co-firing in a station)	Changes proposed to add fossil derived bioliquids	**Solid and gaseous biomass (less than 50% biomass co-fired in a unit): 0.3 (proposed) in 2013/14 and 2014/15; 0.5 from 2015/16** **Bioliquids (less than 100% biomass co-fired in a unit): 0.3 (proposed) in 2013/14 and 2014/15; 0.5 from 2015/16**	**Unit by unit approach. ROC levels in 2013/14 and 2014/15 subject to further consultation**
Co-firing of biomass (enhanced)	No current band but 0.5 ROCs under current banding arrangements	1	Proposal for a new band	**Mid-range co-firing (50-less than 85%): 0.6** **High-range co-firing (85-less than 100%): 0.7 in 2013/14; 0.9 from 2014/15**	**New band. Unit by unit approach. Excludes bioliquids (other than energy crops). Cost control mechanism to be introduced, subject to consultation**
Co-firing of biomass with CHP (standard)	1	1	Changes proposed to add fossil derived bioliquids and to close this band to new accreditations from 1 April 2015	**0.5 ROC uplift in addition to prevailing ROC support available to new accreditations until 31 March 2015**	**Unit by unit approach. Close band to new accreditations from 1 April 2015**
Co-firing of biomass with CHP (enhanced)	No current band but 1 ROC/MWh under current banding arrangements	1.5	Proposal for a new band	**0.5 ROC uplift in addition to prevailing ROC support available to new accreditations until 31 March 2015**	**New band. Unit by unit approach. Close band to new accreditations from 1 April 2015**

Source: *2012 Renewable Obligation Banding Review, DECC*
http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5936-renewables-obligation-consultation-the-government.pdf

Renewable electricity technologies	Current (2012-2013)	Proposed in consultation document		Post-consultation decision	
	ROCs per MWh[21]	Level of support ROCs per MWh[22]	Other proposed changes	Level of support ROCs per MWh	Comments and other changes
Co-firing of energy crops (standard)	1	1	Changes proposed to the definition of energy crops	**0.5 ROC uplift in addition to prevailing ROC support for co-firing of biomass (standard). No uplift available for mid-range or high-range co-firing**	**Band to be closed, subject to consultation. Unit by unit approach. Changes to definition of energy crops.**
Co-firing of energy crops with CHP (standard)	1.5	1.5	Changes proposed to the definition of energy crops and to close this band to new accreditations from 1 April 2015	**0.5 ROC uplift in addition to prevailing ROC support for co-firing of energy crops (standard). Band not available for mid-range or high-range co-firing**	**Band to be closed, subject to consultation Unit by unit approach. Changes to the definition of energy crops. Close band to new accreditations from 1 April 2015**
Dedicated biomass	1.5	1.5 until 31 March 2016; 1.4 from 1 April 2016	Changes proposed to exclude biomass conversions and to add fossil-derived bioliquids	**1.5 until 31 March 2016; 1.4 from 1 April 2016**	**Introduction of a supplier cap, subject to consultation**
Dedicated energy crops	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	Changes proposed to the definition of energy crops and to exclude biomass conversion	**2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17**	**Changes to the definition of energy crops**
Dedicated energy crops with CHP	2	2 in 2013/14 and 2014/15	Changes proposed to the definition of energy crops, to exclude biomass conversion and to close the band to new accreditations from 1 April 2015	**2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17**	**Changes to the definition of energy crops**
Energy from waste with CHP	1	0.5		**1**	**Decision to retain support at current level following consultation**
Hydro-electricity	1	0.5	–	**0.7**	**Closure of band to new projects at or below 5MW, from 1 April 2013, subject to consultation**
Landfill gas	0.25	0		**0 for open landfill sites** **0.2 for closed sites** **0.1 for new Waste Heat to Power band at open and closed sites**	**New bands for closed landfill sites and Waste Heat to Power**
Onshore wind	1	0.9		**0.9**	**Closure of band to new projects at or below 5MW, from 1 April 2013, subject to consultation**
Solar PV	2	2 in 2013/14 and 2014/15: 1.9 in 2015/16 and 1.8 in 2016/17			***Banding proposals subject to re-consultation. Closure of bands to new projects at or below 5MW, from 1 April 2013, subject to consultation**
Standard gasification **Standard pyrolysis**	1	0.5	Proposed change to definition and merger of standard gasification and standard pyrolysis to create a combined 'standard ACT' band	**2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17**	**One ACT band supporting 'standard' and 'advanced' ACTs at the same ROC level**

Appendix 2
Modelling assumptions

Deloitte modelling

- Five types of technologies considered:
  - Dedicated biomass >50MW
  - Dedicated biomass 5 – 50MW
  - Co-firing conventional
  - Co-firing enhanced
  - Co-firing conversion
- For each, the following data is taken from Arup's *Review of the generation costs and deployment potential of renewable electricity technologies in the UK*
  - Plant lifetime
  - Load factor
  - Efficiency
  - Capital and operating costs
  - Feedstock split (domestic vs imported)

Note: Load factors will be dependent on the UK generation mix. This is therefore an uncertain area, and will vary for each incremental investment decision.

- Feedstock cost assumptions are based on DECC's *Consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order 2012*
  - Domestic c.£12/MWh
  - Imported c.£25/MWh
- ROC is assumed to be £42/MWh
  - Dedicated biomass >50MW – 1.5
  - Dedicated biomass 5-50MW – 1.5
  - Co-firing conventional – 0.5
  - Co-firing enhanced – 1.0
  - Co-firing conversion – 1.0
- Electricity price assumptions are based on current wholesale spot prices with assumed price increases to 2030 of circ. four per cent per annum.
- Electricity price assumptions are based on current wholesale spot prices with assumed price increases to 2030 of circa four per cent per annum.

Modelling for equity IRRs

- Funding assumptions:
  - Dedicated biomass >50MW – Through equity
  - Dedicated biomass 5-50MW – Project financed
  - Co-firing conventional – Through corporate debt
  - Co-firing enhanced – Bond financed through corporate shareholder
  - Co-firing conversion – Bond financed through corporate shareholder
- Project financing assumptions:
  - 75 per cent gearing
  - 10 per cent interest rate
  - 2.7 per cent arrangement fee
  - 1.5 per cent commitment fee
- Bond financing assumptions:
  - 50 per cent gearing
  - 5 per cent interest rate
  - 0.6 per cent arrangement fee
- Corporate debt assumptions:
  - 50 per cent gearing
  - 5 per cent interest rate

Notes

1 http://www.nationalgrid.com/NR/rdonlyres/DF928C19-9210-4629-AB78-BBAA7AD8B89D/47178/Operatingin2020_finalversion0806_final.pdf

2 http://www.official-documents.gov.uk/document/hc1213/hc01/0189/0189.pdf

3 http://www.sciencebusiness.net/Assets/fedba2ae-51e2-4adf-bf66-0ba3993159b6.pdf

4 http://www.lcaworks.com/Low%20Carbon%20Bioelectricity%20in%20the%20UK.pdf
http://www.rspb.org.uk/Images/Bioenergy_a_burning_issue_1_tcm9-288702.pdf

5 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf

6 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/6339-consultation-on-biomass-electricity--combined-hea.pdf

7 http://www.environment-agency.gov.uk/static/documents/Biomass__carbon_sink_or_carbon_sinner_summary_report.pdf

8 http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/sustainability/sustainability.aspx DECC have developed a free online greenhouse gas lifecycle assessment tool, called "the UK Biomass & Biogas Carbon Calculator", which is available on the Ofgem website. The tool enables users to assess the emissions associated with biomass electricity and heat generation, looking at emissions across the whole bio-energy lifecycle.

9 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/6339-consultation-on-biomass-electricity--combined-hea.pdf

10 http://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/news/air-quality-a-follow-up-report/

11 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/6339-consultation-on-biomass-electricity--combined-hea.pdf

12 http://www.europeanclimate.org/documents/Biomass_report_-_Final.pdf

13 http://www.europeanclimate.org/documents/Biomass_report_-_Final.pdf

14 http://biomassmagazine.com/articles/5917/torrefaction-of-biomass-materials

15 http://www.bbc.co.uk/news/uk-england-essex-17186513

16 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/6339-consultation-on-biomass-electricity--combined-hea.pdf

17 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf

18 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf For relevant ROC numbers please go to Appendix 1.

19 http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf

20 The returns are sensitive to the funding structures assumed. The assumptions that underpin our results for IRR on equity invested have been taken from a variety of publicly available sources that include articles and databases in the Infrastructure Journal, the International Project Finance Association and ProjectFinance magazine. It should be noted that information in these publications has not been verified by Deloitte. In instances where a range was available, the lower end was taken for gearing and the higher end for interest costs.

21 Different levels of support may apply to certain types of generating station accredited before 1 April 2009. The default rate of 1 ROC/MWh applies to eligible generation that does not fall within any other banding provision.

22 Years refer to obligation periods under the RO. For example, 2013/14 refers to the period 1 April 2013 to 31 March 2014.

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Designed and produced by The Creative Studio at Deloitte, London. 21155A

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