



Biomass: the fourth energy source



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Myth - Biomass technology is unproven.

Reality: For years biomass has provided more renewable electricity in the UK than any other renewable source. Other countries, however, have had much better developed supply chains and regulatory incentives, and so have used biomass to an even greater extent.

Foreword by Dorothy Thompson



Energy policy in the UK is facing a dilemma: how do we meet very demanding climate change targets affordably, whilst ensuring we do not run short of electricity generating capacity and maintain UK competitiveness?

Between now and 2020, the electricity industry is facing the challenge of replacing old coal and nuclear power stations which currently account for over a third of its generating capacity. Against this, we cannot ignore the impact of high energy prices on the end consumer, in particular those people defined as living in fuel poverty.

In the past, the UK would turn to its indigenous fossil fuels to bridge the gap between demand and supply, but neither coal nor gas can now play the key role they once did. Neither are as plentiful as they were and, without abatement, neither are low carbon.

No single energy source will provide the solution. The answer is a balanced and diverse energy mix which makes the most of all the energy sources at our disposal, including biomass. Electricity generation from biomass is unique in that it is renewable, cost effective, reliable, can respond to changes in demand and can be sustainable. Above all, it is plentiful since biomass is the world's fourth largest energy resource after coal, oil and gas.

New energy supplies, with limited carbon impact, cannot be delivered overnight and they cannot be delivered for free. The UK and its energy policy should nurture an environment which encourages investment. Energy policy in the UK must continue to recognise the true potential of biomass as a cost effective, renewable technology which has an important role to play in the future energy mix of the UK and in helping to meet the country's 2020 targets.

As the owner of the UK's biggest coal-fired power station and the provider of 7% of the UK's electricity, Drax takes security of supply seriously, as we do our responsibility to the environment. We understand and fully support measures to tackle the threat of climate change. That is why we have invested significantly to maintain Drax as the UK's most efficient coal-fired power station and why today we are capable of generating an eighth of our power from renewable sources by co-firing biomass with coal. In fact, through burning sustainable biomass, Drax is already the UK's largest single producer of renewable power, but our ambitions do not stop there.

We are willing and able to go further. Through further investment in equipment and the supply chain we will work towards transforming Drax into a predominantly renewable generator. We are ready to back our insight and our commitment with investment, and believe that by 2020 we could be supplying renewable power to over two million homes, but the UK policy framework must facilitate this.

Biomass: the fourth energy source explains how biomass can become an essential part of the renewables mix and highlights the policy framework needed to make real progress in developing this attractive renewable energy source.

A handwritten signature in black ink, appearing to read 'Dorothy Thompson'.

Dorothy Thompson
Chief Executive

Executive summary

Biomass, or organic plant-based material, is plentiful – it is the world's fourth largest energy resource. It is renewable and can be sustainable. Biomass for electricity generation is typically sourced from discarded forestry and agricultural residues, and some purpose grown energy crops which can be grown on marginal or low grade land. Over its entire life cycle, biomass can deliver significant carbon savings compared to even the least carbon intensive gas-fired power plants.



Electricity generation from biomass is flexible. Unlike wind, tidal or solar power, biomass-fired generation technologies can respond quickly to changes in electricity demand. It is also more reliable than other renewables and with high availability is the perfect complement to intermittent forms of renewable generation.

Biomass is one of the most economical of all renewable technologies to construct. Adjusted for availability, the capital cost of co-firing biomass alongside coal is much less than that of equivalent offshore wind capacity and even a dedicated biomass power station is cheaper than offshore wind.

Unlike some renewable technologies, biomass generation does incur costs in fuel procurement. Biomass fuels are more expensive than fossil fuels, but despite this and the ongoing fuel cost, biomass technologies are still cost effective compared to other renewables and can reduce the overall cost to the consumer of meeting Government's targets for renewables and carbon dioxide (CO₂) emissions reduction.



Myth - Burning biomass releases carbon into the atmosphere that would otherwise be trapped in plant matter.

Reality: When biomass is burnt carbon is released into the atmosphere, but as sustainably sourced biomass is replanted and grows the whole process starts again with the new plants capturing CO₂ as they grow.

What is biomass?

Put at its simplest, biomass is a form of stored solar energy. It is organic, plant-based material and has been used as an energy source for thousands of years to produce heat. Today the technology to generate electricity from biomass is well established.



Biomass used in energy production comes in many different forms, but the important characteristics shared by the wide range of biomass fuels are that they are renewable and can be sustainable and that they would often be discarded if not used to produce energy.

The three common types of biomass used to generate electricity are agricultural residues, forestry products and residues and energy crops. Recovered materials offer another, very useful, source of biomass.

Agricultural residues The by-products of food production, such as straw, oat husks, peanut husks, grape flour, cocoa shells, olive cake and many more, can all be used as biomass for energy production. Importantly, because they are by-products of food production they do not reduce the amount of land available for farming, and they are readily available. Residues from non-food crops, such as cork fines, can also be used. By placing a value on what may be an unwanted by-product of farming, the use of biomass to produce energy actually provides a new income stream for farmers and supports UK farming.

Forestry products and residues Sustainably produced woody biomass can be produced from managed forests and forestry residues, such as bark, thinnings, tree tops and branches that are often discarded after trees are felled for timber.

Energy crops These are crops that are planted specifically for the purpose of producing energy. Energy crops include short rotation coppice willow and miscanthus, commonly known as elephant grass. Since the start of the UK's Energy Crop Scheme in 2000, thousands of hectares of miscanthus and other short rotation coppice crops have been planted in the UK alone and there is the potential to increase this.

Recovered materials Recovered wood is an example of a material that could be used as a biomass fuel. The construction and demolition sectors are very large producers of recoverable wood. The total UK wood waste could be as much as 4.5 million tonnes in a year.



Myth - Burning imported biomass causes more carbon pollution than burning fossil fuels.

Reality: 'Field to furnace' life cycle analysis, which gives the total carbon footprint of the biomass burnt by Drax, shows that much less CO₂ is released compared to fossil fuel-fired plants, even if the biomass is imported.

Biomass market potential

Biomass is a diverse, readily available and plentiful fuel source. According to the International Energy Agency, biomass is the fourth largest energy resource in the world after oil, coal and gas¹. It estimates that by 2050 sustainable sources of biomass could be enough to supply the world with 10%–20% of its primary energy requirements.



The EU² has indicated that the use of biomass will double over the next few years, and be responsible for around a half of the total effort in reaching the EU's 20% renewable energy target by 2020. In the UK, AEA Technology³ has estimated that by 2020 sustainable biomass could meet 20% of our primary energy demand and by 2030 this could more than double or even treble.

The UK Renewable Energy Roadmap,⁴ published by the Department of Energy and Climate Change (DECC) in July 2011, set out the UK Government's approach to unlocking the potential for renewables. The Roadmap recognises the cost effectiveness of biomass as a substitute for coal in existing power stations and names biomass electricity as one of eight key renewable technologies that has the greatest potential to help meet the UK's 2020 renewables target. It estimates that electricity produced from sustainable biomass could provide a third or more of the required renewable power by 2020, some 32-50TWh a year.

In the Renewables Obligation Banding Review Public Consultation⁵, published in October 2011, DECC refers to maximising deployment of "the cheapest renewable technologies, such as coal-to-biomass conversions and co-firing". Recognition is given to the strategically important role that sustainably sourced biomass electricity can play in the future UK renewable energy mix.

Drax has, for some years, been at the forefront of developing the biomass supply chain and efforts need to continue to encourage further development locally and nationally. However, it is recognised that imported biomass will continue to play an important role in the expansion of electricity generation from biomass in the UK.

Indeed, DECC's RO Banding Review Consultation is clear that it expects the "overwhelming majority of fuels for the expansion of biomass electricity will be imported".

Investment in the supply chain is already taking place and more is needed. For example, Drax has already built one straw pellet plant which is now processing straw purchased from local farmers into a form readily usable for electricity production. Drax has also worked with key partners to establish critical logistics components such as bespoke rail wagons to transport biomass and a biomass handling, storage and rail loading facility at the Port of Tyne.

In the UK, the 'Green Shoots' programme launched by Drax in 2009 to source energy crops, such as miscanthus and short rotation coppice willow, and straw has successfully encouraged farmers and landowners to supply sustainable biomass. It is known that global supply is plentiful and, to the extent that biomass is imported, the Drax Sustainability Policy has been developed to ensure that imported fuels are subject to the same level of scrutiny and audit as indigenous ones.

References:

- ¹ World Energy Outlook, International Energy Agency, 2008
- ² EU Renewable Energy Road Map, 2007
- ³ UK and Global Bioenergy Resource - Final Report, AEA Technology, 2011
- ⁴ UK Renewable Energy Roadmap, Department of Energy and Climate Change, 2011
- ⁵ Consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-2017 and the Renewables Obligation Order 2012, Department of Energy and Climate Change, 2011

Myth - There is no need for biomass because wind and wave power will provide all the answers.

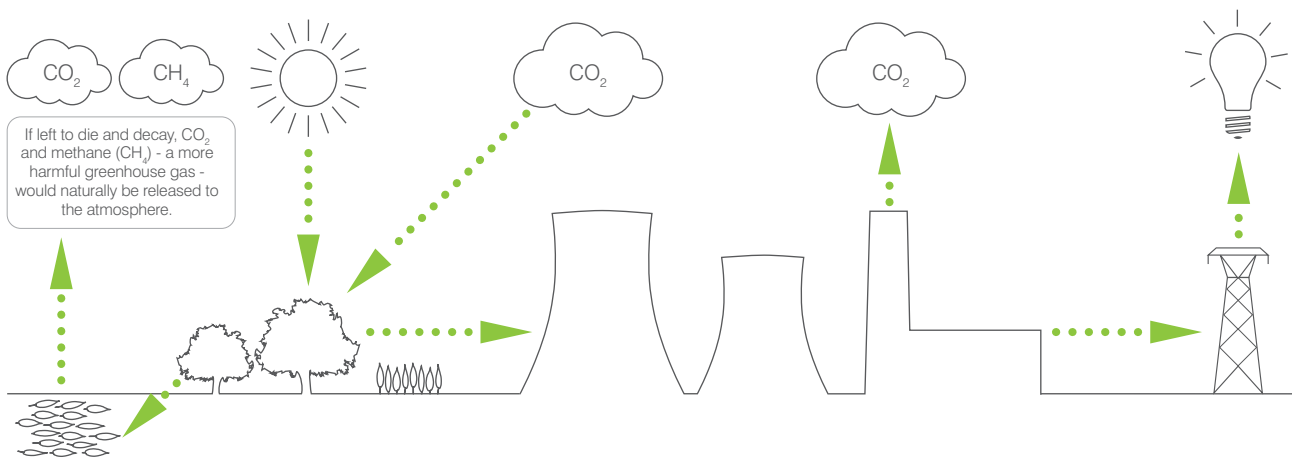
Reality: *The UK needs a balanced energy mix drawing on all renewables including wind, tidal, solar and hydro power, as well as biomass. Whereas some renewables are intermittent, when generating electricity from biomass you get renewable power which is reliable and has high availability. On top of that, it is cheaper for the consumer than most other renewables.*

A sustainable low carbon fuel

Biomass can be a sustainable, low carbon fuel. At the point of combustion it is carbon neutral because biomass takes carbon out of the atmosphere while it is growing, and returns it as it is burnt.

If biomass is managed on a sustainable basis it is harvested as part of a constantly replenished crop. This maintains a closed carbon cycle with no net increase in atmospheric CO₂ levels.

Over its entire life cycle biomass can deliver significant reductions in CO₂ emissions relative to both coal-fired and gas-fired generation.





Robust, mandatory sustainability criteria are vital to maintain and enhance public acceptance of biomass, and ensure that sustainable practices are implemented. Assessment of the full life cycle carbon footprint of generating electricity from biomass, which calculates the emissions associated with each step of the supply chain from planting, through harvesting, processing and transportation to combustion – in other words, from ‘field to furnace’ – is now well developed, especially in the UK where a mandatory life cycle standard of 79gCO₂/MJ comes into effect in 2013.

At Drax Power Station the biomass burnt over the last few years has resulted in carbon footprints in the region of 20-75gCO₂/MJ, which compares favourably with a life cycle carbon footprint of 280gCO₂/MJ for electricity produced by the average UK coal plant and 122-193gCO₂/MJ for combined cycle gas turbine plant.

As part of the Drax Sustainability Policy, biomass suppliers are required to provide all their supply chain data to enable an accurate ‘field to furnace’ calculation of greenhouse gas emissions, which is verified by independent auditors.

	Biomass co-firing ¹	Gas-fired generation (CCGT North Sea gas) ²	Gas-fired generation (CCGT Middle East LNG) ²	Gas-fired generation (CCGT Russian piped gas) ²	Coal-fired generation (UK-mined coal average) ³
Fuel life cycle emissions, gCO₂/MJ	20-75	122	183	193	280

Notes:

¹ Biomass co-fired at Drax Power Station

² Friends of the Earth

³ Environment Agency

CCGT = combined cycle gas turbine

LNG = liquefied natural gas

Drax Sustainability Policy

Drax has developed and implemented comprehensive sustainability criteria into its biomass procurement activities. Our biomass procurement process is designed to ensure that the production and delivery of our biomass will:

- » Significantly reduce greenhouse gas emissions compared to coal-fired generation and give preference to biomass sources that maximise this benefit.
- » Not result in a net release of carbon from the vegetation and soil of either forests or agricultural lands.

- » Not endanger food supply or communities where the use of biomass is essential for subsistence (for example, heat, medicines and building materials).
- » Not adversely affect protected or vulnerable biodiversity and, where possible, give preference to biomass production that strengthens biodiversity.
- » Deploy good practices to protect and/or improve soil, water (both ground and surface) and air quality.
- » Contribute to local prosperity in the area of supply chain management and biomass production.
- » Contribute to the social well being of employees and the local population in the biomass producing areas.



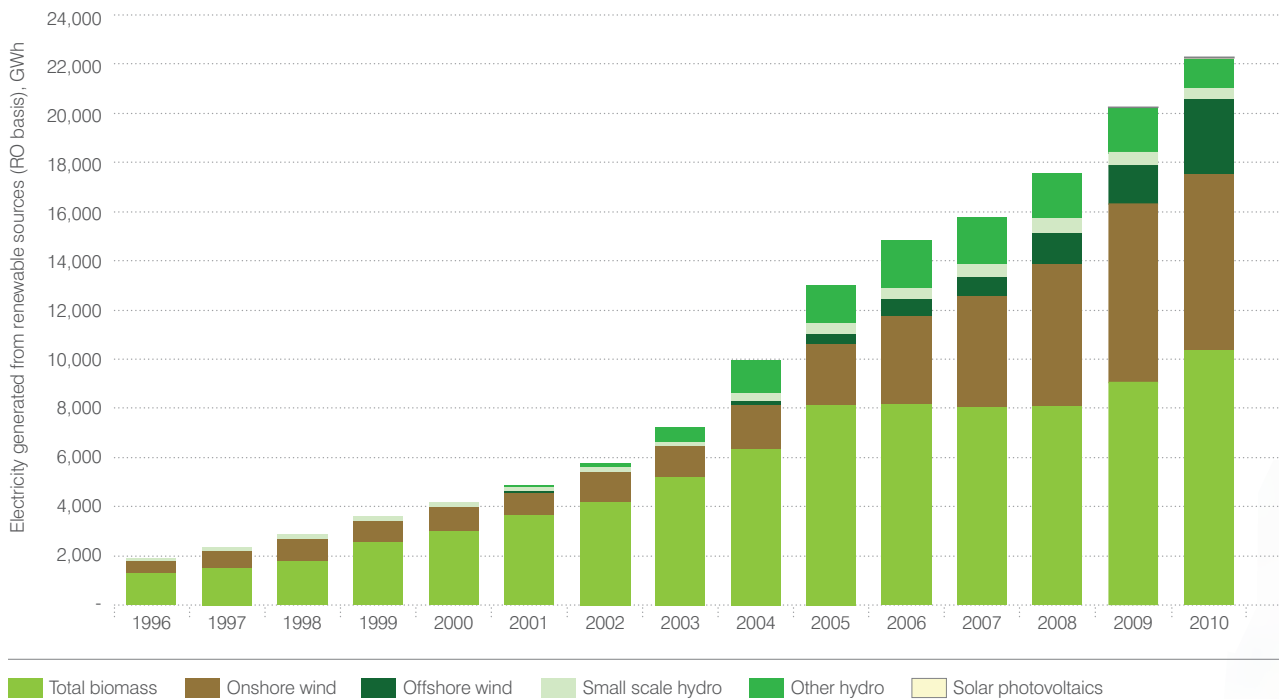
The benefits of biomass

Biomass as a source of energy has many benefits:

- » **Biomass is a proven renewable technology** With the right investment incentives biomass technologies can deliver significant renewable power and make meaningful cuts in CO₂ emissions in the very near term.
- » **Biomass can play a significant role in achieving the UK's renewables and CO₂ emissions reduction targets** The UK has a tough target to reduce CO₂ emissions levels by 34% on 1990 levels by 2020 and at least 80% by 2050. The amount of electricity generated from renewables needs to rise from approaching 7% in 2010 to over 30% in 2020. As shown in the chart, under

the Renewables Obligation (RO), biomass has contributed more electricity than any other renewable for the entire period 1996 to 2010 (the latest figures available). The contribution from biomass has been constrained since 2005 - this is due to the policy environment.

- » **Biomass can be sustainable** The fuel is renewable, has lower air emissions and wastes compared to fossil fuels, and can provide social and economic benefits to communities. With responsible procurement practices, biomass can be fully sustainable.



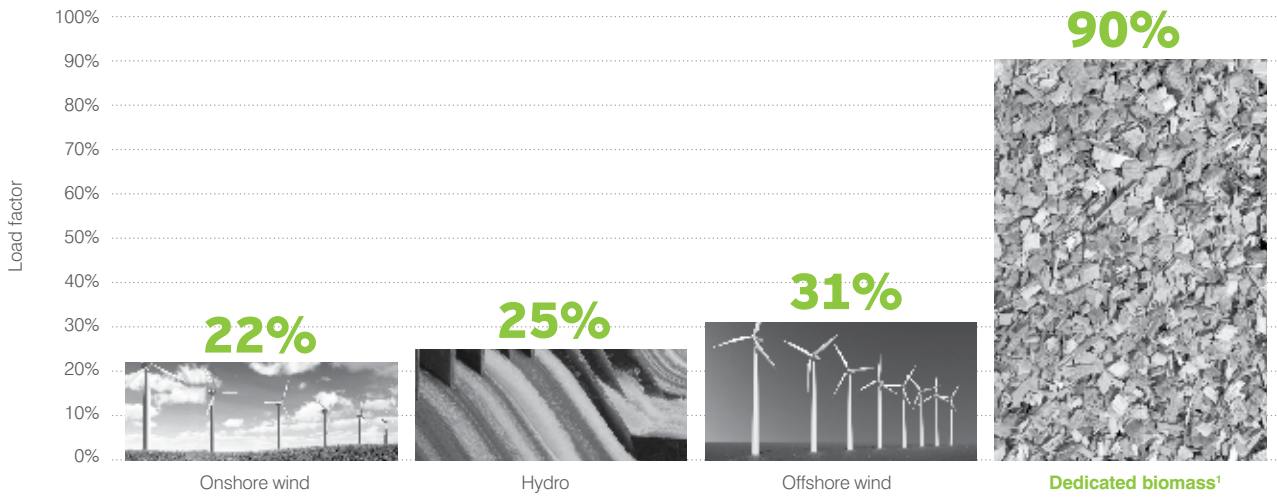
Source: Digest of UK Energy Statistics, 2011



» **Biomass has higher availability than most renewables**

This is known as the load factor of a generating technology. A dedicated biomass plant, for example, has a load factor of up to 90% - the missing 10% accounts for down time for maintenance. The intermittent nature of other renewable technologies leaves them trailing.

» **Biomass is reliable** Critical to delivering secure supplies of electricity, biomass-fired generation is reliable, which when coupled with high availability means it is there when you need it.



Source: Digest of UK Energy Statistics, 2011

Notes:

¹ Drax projects a load factor of up to 90% for dedicated biomass plants.

» **Biomass is flexible** Unlike wind, solar or tidal generation it is easy for biomass-fired generation to respond quickly to changes in demand on the electricity system or sudden falls in the supply provided by intermittent generators. In fact, it is a straight choice between biomass and fossil fuels when it comes to balancing supply and demand across the electricity system because most other technologies cannot respond to changes in demand as quickly.

» **Biomass is dependable** No one is arguing that biomass is the sole answer to our energy needs, but as part of a balanced energy mix biomass has an important role to play. There is a global market in readily available biomass, and although the UK market is in its infancy, given the right encouragement it can grow.

» **Biomass can reduce the use of landfill** Some of the organic material currently sent to landfill could be recovered and used as biomass fuel. In fact, it is much better for the environment to burn biomass rather than send it to landfill where, if not captured for landfill gas electricity generation, it will

decompose and not only emit CO₂, but also the much more harmful greenhouse gas, methane (CH₄).

» **Biomass can maintain the viability of agricultural land, forests and woodlands** The sustainable use of certain types of biomass from agricultural land, forests and woodlands will help to keep them viable and preserve them for future generations.

» **Biomass has socio-economic benefits** In addition to direct employment benefits, other socio-economic benefits may include the diversification of rural economies and new revenue opportunities for farmers.

Myth - Biomass will only ever be a marginal source of energy, there simply isn't enough of it.

Reality: There is no shortage of biomass, either now or in the future. As supply chains mature more sources will become available. Even if imports are required, life cycle analysis has shown that significant CO₂ savings relative to fossil fuel-fired generation are achievable.

Generating electricity from biomass

Electricity can be generated from biomass in three ways: co-firing with coal in existing coal-fired power stations; converting existing coal-fired generating units to solely burn biomass; and in dedicated biomass-fired power stations.

Co-firing with coal is a process through which biomass is burnt alongside coal in existing coal-fired power stations. This is a recognised renewable and carbon abatement technology. Coal-fired power stations in the UK have been co-firing since 2002. By substituting coal with biomass, emissions of CO₂ can be reduced significantly.

Co-firing biomass to deliver up to 4% heat output requires relatively little capital expenditure and can be achieved with minor modifications to the existing facilities. Increasing the heat output to much above this level requires quite significant capital expenditure on new biomass processing, handling and firing systems.

Generating unit conversion is the full conversion of existing coal-fired generating units. This entails retrofitting existing facilities to burn biomass only. Utilising existing infrastructure takes coal out of the energy mix and delivers a cost effective form of renewable power.

Dedicated plants are new build plants that are dedicated to burning solely biomass. Such plants use proven technology and have similar reliability and availability to coal-fired plants. However, being new build, they are a more expensive option than co-firing or conversion.

Each of these biomass technologies has different characteristics, costs and benefits. One thing that they have in common, along with other renewable technologies, is that they are not economically viable without some form of support. Currently support is provided through the RO.

Myth - Biomass is too expensive.

Reality: All renewable sources of energy require support, but generating electricity from biomass is one of the most cost effective forms of renewable power. To play its full part the cost drivers for the different biomass technologies need to be recognised if fair treatment is to be achieved.

Renewables Obligation

The Renewables Obligation (RO) is the current main mechanism for supporting large scale generation of renewable electricity. Since its introduction in 2002, the RO has been subject to various reforms and improvements. The most significant reform was in April 2009, with the introduction of banding, giving different technologies different levels of support. In April 2010, the end date for support was extended to 2037 or 20 years (whichever is the earlier) for new projects.

The RO works by placing an obligation on licensed electricity suppliers to source a specified and annually

increasing proportion of their electricity sales from renewable sources, or pay a buy-out price. The cost is passed on to the end consumer through their electricity bill.

The RO is administered by Ofgem which issues Renewables Obligation Certificates (ROCs) to eligible renewable electricity generators. These ROCs are traded and are thus a source of finance for the generators. The electricity suppliers purchase and redeem the ROCs in fulfilment of their obligation.

Biomass technologies are some of the most cost effective of all renewable technologies. Accounting for the fact that biomass generation technologies have higher availability or load factor than most other renewables, the capital cost of co-firing biomass alongside coal is much cheaper than that of offshore wind and even a dedicated biomass power station is cheaper than offshore wind.

Unlike some renewable technologies, biomass generation does incur costs in fuel procurement. For many biomass fuels the largest cost component is the cost of collection, processing and transport. Biomass fuels are more expensive than fossil fuels, but despite this and the ongoing fuel cost, biomass technologies are still cost effective compared to many other renewables.

There is also the additional consideration that biomass technologies, being both reliable and predictable, do not impose increased costs on the operation of the electricity system when matching supply and demand. In short, electricity generation from biomass can reduce the cost to the consumer of meeting Government's targets for renewables and CO₂ emissions reduction.



Biomass and energy policy

The UK's commitment to an ambitious renewables target and to delivering significant cuts in CO₂ emissions makes a powerful case for biomass becoming an increasingly significant part of our future energy mix. It is essential that the policy framework facilitates this.

Investors need long term certainty to invest and will look to the regulatory framework to provide that. As we look ahead to 2020 and the UK's renewables and carbon reduction targets, it is clear that the RO will effectively determine whether the targets are met and at what cost.

It is now apparent that carbon abated fossil fuel technologies have an important role to play in the longer term energy mix of the country. This is due to the vital contribution that they will make to security of supply, through providing diversity to the energy mix, and offering high availability, reliability and flexibility.

With large scale and commercially proven carbon capture and storage (CCS) still some years away, there is no need to sit and wait when co-firing can deliver meaningful CO₂ savings today and provide a lower carbon route to a low carbon future.

Beyond co-firing, innovative thinking brings the prospect of converting existing coal-fired generating units to burn just biomass. Going further still, CCS with biomass offers the prospect of negative carbon emissions - the only technology to do so.

Energy policy must encourage the development of cost effective biomass technologies. The consequence of not doing so will be a higher price paid for renewables by the end consumer.

Whether optimising biomass co-firing, converting existing generating units, or building new dedicated plants, investment needs to be incentivised and a fair regulatory regime put in place. To enable cost effective renewable solutions to flourish the policy framework needs to develop at the same pace as industry thinking.

Myth - Biomass is a risky investment.

Reality: *One of the risks associated with biomass is regulatory uncertainty. Indeed, as a proven technology it could be considered less of a risk than most other renewable sources.*



Addressing the identified regulatory barriers and unlocking the potential of biomass will be possible only if:

- an appropriate level of ROC support is awarded for each of the biomass generation technologies, explicitly recognising the different capital expenditure requirements for low levels of co-firing, enhanced co-firing, conversion of existing plant to 100% biomass and dedicated biomass plants;
- the carbon price support is discounted as part of the overall support level, on the grounds that it is not deemed 'bankable' by investors given that it can change at Government's discretion;
- the ROC support is grandfathered, so underpinning the investment and facilitating long term biomass contracting, which in turn ensures the supply chain develops;
- the cap on co-firing regular (non-energy crop) biomass is removed; and
- long term biomass contracting is encouraged by ensuring certainty in sustainability and life cycle criteria, for example, by grandfathering these criteria at the point of fuel supply contract signing.

In conclusion, electricity generation from biomass:

- **can be delivered in a timely manner and in material volumes to facilitate the achievement of Government's climate change targets;**
- **will make efficient use of existing assets;**
- **will complement the increased deployment of other intermittent and inflexible low carbon generation;**
- **will reduce the carbon intensity of the current UK generation mix; and**
- **will offer negative carbon emissions when combined with CCS.**



Low carbon, low cost, low risk

There are many compelling arguments why biomass should have a key role in the UK's long term energy mix. Biomass has huge potential, it can not only provide security of supply benefits, but it can do so in a sustainable, low carbon way at affordable prices. It ticks all the boxes of what energy policy should set out to deliver.

Increased use of biomass to produce electricity is the best way to deliver meaningful and cost effective CO₂ reductions in the near term. The UK is currently trailing behind other EU countries in exploiting the use of biomass to generate electricity and in order to realise the full potential of biomass an appropriate and sustained level of regulatory support is needed.

With the right support Drax alone could be using biomass to supply over 2 million homes with renewable power by 2020. The even better news is that the necessary policy framework and the practical measures Drax would subsequently need to take, in order to realise the full potential of biomass, are both achievable in the very near term.

Myth - Biomass will affect food production.

Reality: *This need not be the case. For example, the biomass sourced by Drax is typically agricultural residues, such as straw, forestry residues, such as tree tops and bark, and energy crops grown on marginal land, none of which displace food production.*





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