

# ENVIRONMENTAL MARKETS FOR CO-FIRING OF BIOMASS

Adrian REEVES - IT Power, UK

## *Abstract:*

*The climate change issue and its potential implications are areas of concern globally to the public and policy makers alike. As a result, 150 countries, including most of the leading industrialised nations, have signed up to the Kyoto Protocol and made a commitment to reducing greenhouse gas emissions.*

*A number of environmental markets in existence globally to fulfil these commitments and promote the reduction of Greenhouse Gas (GHG) emissions, either directly through the adoption of more efficient or less environmentally-harmful processes, or indirectly through the promotion of sustainable energy production from renewable energy technologies replacing more traditional fossil-fuelled power generation.*

*Co-firing of biomass with fossil fuels is one such direct method of reducing emissions, and as a renewable source of energy it is able to benefit from the financial incentive mechanisms in place within the UK and many other countries. In having numerous policies aimed at promoting emission reductions, however, there gives rise to cases of “multiple counting” where numerous incentives are being paid for a single emission reduction.*

*Whilst co-firing is a pragmatic step towards reducing emissions it is viewed by UK Government as an interim measure for meeting commitments under Kyoto, being incentivised primarily to help grow the biomass fuel supply chain within the UK, with a view also towards gaining technical and operational expertise to develop successful, dedicated biomass plants in the future. Beyond 2016, however, it is likely that this process will cease to benefit from such incentives provided by the UK Government, but may find that the trading of carbon allowances, generated through the substitution of fossil fuels with biomass, could give sufficient incentive to continue the process.*

## **Introduction:**

The climate change issue and its potential implications are areas of concern globally to the public and policy makers alike. As a result, 150 countries worldwide, including most of the leading industrialised nations, have signed up to the Kyoto Protocol and made a commitment to reducing greenhouse gas emissions.

Against this background, the UK Government are proposing to make an ambitious 60% reduction in UK carbon dioxide (CO<sub>2</sub>) emissions from 1990 levels by 2050, a target derived from a study undertaken by the Royal Commission on Environmental Pollution. This builds on the Government's previous national goal of a 20% reduction in CO<sub>2</sub> emissions by 2010, which would place the UK on a path to meeting the 2050 target. These challenging targets extend beyond the UK's Kyoto Protocol target of a 12.5% reduction in greenhouse gas (GHG) emissions by 2008-12.

The recent acknowledgement by the UK Government however, that it will fail to meet its self-imposed targets to cut carbon dioxide emissions by 20 per cent from 1990 levels by 2010 reflects the considerable difficulties in the UK of turning ambitious goals into realities. Even though the UK is currently on course to meet its Kyoto targets, the debate about how to get there is ongoing and intense. Key to the Government's strategy in achieving its stated aims are its renewable energy targets, but now questions are also being asked about whether the UK Government's continued emphasis on wind power as the main route is at the expense of other sustainable alternatives, including co-firing.

### **Environmental Markets:**

There are currently a number of environmental markets in existence globally to promote the reduction of Greenhouse Gas (GHG) emissions either directly through the adoption of more efficient or less environmentally-harmful processes, or indirectly through the promotion of sustainable energy production from renewable energy technologies replacing more traditional fossil-fuelled power generation. Whilst there are several different interactions between different national policies and international markets, the focus of this paper will be on the UK, and the policy and market interactions which occur therein.

There are three major environmental markets from which co-firing facilities in EU Member States could potentially benefit;

- EU Emissions Trading Scheme (EU ETS)
- National Green Energy Schemes (Green Certificates)
- National Energy Efficiency Schemes (e.g. CHP markets)

### *Direct CO<sub>2</sub> Reduction Mechanisms:*

The international markets are relatively new, and thus still unpredictable, but a number of individual countries have had environmental markets established for a substantial amount of time which have matured into an efficient mechanism for reducing emissions directly through "cap & trade" principles. The concept of trading is to ensure that reductions in emissions take place where the cost of the reduction is lowest, thus reducing the overall costs of combating climate change and not severely affecting those sectors or businesses where the nature of their activity makes reductions difficult to achieve. Additionally, by keeping costs down, Governments can also adopt more stringent targets for emission reductions. Co-firing is one such low-cost solution in terms investment required per MWe of green generation.

The majority of the environmental markets focusing directly on emissions set "caps" or allowances for certain industry sectors within the designated area(s), which tend to be those in the energy or energy-intensive sectors such as power generation, ferrous metals, paper and ceramics. These designated areas are typically individual countries or collections of countries, but in some cases (e.g. USA) they can be a collection of states or provinces within a country.

Firm emissions limits, along with monitoring requirements and strict non-compliance penalties, both ensure that the environmental result will be reached and that it will create financial value for the allowances. Thus, the environmental and financial integrity of the system are mutually supportive.

Emissions allowance trading with firm emissions limits, or a cap, is a straightforward concept that is already operational in a national scale. The U.S. sulphur dioxide emissions market is a primary example, established in 1990. By setting a permanent cap at 50 percent below 1980 levels, the programme allowed U.S. industry to comply by either investing in modifications themselves or financing other lower cost solutions to be implemented through the emissions market. This market, which has subsequently been used as the template for the EU's carbon market (EU ETS) is based, is widely praised for accelerating emissions reductions at a lower cost than originally anticipated by industry.

A similar voluntary scheme, the UK Emissions Trading Scheme, was introduced in March 2002 as a pre-cursor to the EU ETS, in which companies and other organisations (known collectively as 'Direct Participants') bid emission reductions over the five years 2002 to 2006 in return for a share of £215 million incentive funding from the UK Government. This scheme covered a variety of industrial & business sectors but not the power generation or energy-intensive sectors, so no direct link exists between this scheme and the EU ETS.

In short, trading emission permits allow industry to meet emissions targets in a least-cost manner. It also permits maximum flexibility in how companies comply and provides a financial incentive for cost-effective technical innovation.

#### *Indirect CO<sub>2</sub> Reduction Mechanisms:*

Whilst the primary objective of the EU ETS and similar such direct mechanisms is the reduction of the six most harmful GHG emissions, of which CO<sub>2</sub> is a major component, the primary objective of the National Green Energy Schemes, such as the UK Renewables Obligation (RO) is the promotion of renewable generation. While these schemes do help to reduce CO<sub>2</sub> emissions, they have other objectives, which may include:

- nurturing a national industry, in terms of technology development and operational expertise, with large export potential;
- encouraging economies of scale and learning effects that should improve the competitiveness of renewable technologies;
- improving supply security by increasing the diversity of generation sources;
- contributing to rural development;
- improving air quality;
- reducing acid deposition.

There exists, however, a plethora of different policies tailored to each Member State's different needs and aspirations, aimed at providing wider public good and mitigation of non-CO<sub>2</sub> externalities. The provision of these wider public goods and mitigation of non-CO<sub>2</sub> externalities does therefore provide a justification for supporting technologies which do not provide the least cost option for CO<sub>2</sub> abatement in the short-term but, since these

non-CO<sub>2</sub> objectives are local, regional or national in character, makes any international trade of Green Certificates problematic.

For example, if a UK supplier purchased Green Certificates from the Netherlands, this would contribute nothing to supply security or employment in the UK – two key non-CO<sub>2</sub> objectives of the UK Renewables Obligation. Hence, the RO does not, at present, allow for international trade. Similarly, it could be argued that international trade in Green Certificates would also require associated adjustment of Assigned Amounts under the Kyoto Protocol for the Member States involved, for which no regulatory mechanism is in place.

However, it should be noted that an EU-wide green certificates scheme may be emerging based on “green tariffs” for final consumers which may facilitate trans-boundary trade of these certificates. More details of this scheme can be found at [www.re-go.info](http://www.re-go.info) and [www.e-track-project.org](http://www.e-track-project.org).

Additionally, under some National Energy Efficiency Schemes, the environmental climate change benefits of good quality combined heat and power (CHP) are recognised, with generators able to claim exemption from national environmental taxes or levies placed on fossil fuel power generation. In the UK, Levy Exemption Certificates (LECs), issued to the generator for each kilowatt-hour of energy exported to the network from good quality CHP, have a value by enabling suppliers to avoid paying the Climate Change Levy (CCL). The CCL is a tax on energy, including electricity, which licensed electricity suppliers must levy on their supply to non-domestic customers unless they are able to show (LECs) against this supply. It should be noted however that in other countries, for example in Belgium, benefits are given for producing energy from renewable energy sources and also from good quality combined heat and power under the same certificate system, thus reducing the administrative burden and simplifying the registration and monitoring process.

### **Co-firing Benefits in the UK**

Within the UK there are several policy instruments forming the basis of the UK Climate Change Programme (UKCCP), aimed at increasing the take-up of renewable technologies and reduction of greenhouse gas emissions. These are:

- UK Emissions Trading Scheme (UK ETS)
- EU Emissions Trading Scheme (EU ETS)
- UK Renewables Obligation;
- Climate Change Levy (CCL) & Climate Change Agreements (CCA);
- Energy Efficiency Commitment (EEC).
- Fuel Mix Disclosure
- Various Subsidies & Support Programmes

A generator choosing to co-fire biofuels with traditional fossil fuels could positively contribute to the UKCCP goals, and obtain financial reward either directly or indirectly from many of these policies. Whilst there shouldn't be any “multiple counting” of

benefits, with so many policies aimed at achieving the outcome from differing angles, invariably there are some cases where multiple incentives could be received for the same tonne of CO<sub>2</sub> emission reduction.

The following sections will address each of the above pieces of UK legislation and describe how co-firing could relate to it.

#### *UK Emissions Trading Scheme (UK ETS)*

Introduced in March 2002, this voluntary scheme was developed independently by the UK Government at a time where much division was present within the European Union as to the best mechanism to impose on Member States to assist them in complying with their commitments under the Kyoto Protocol. The scheme targeted companies and organisations within the UK who were not likely to be subject to any EU-driven policies for GHG emissions reductions, i.e. the power generation and energy-intensive sectors, and who could deliver significant (and absolute) emissions reductions between 2002 to 2006 in return for a share of £215 (~€325) million incentive funding. This currently equates to approximately €18 /tCO<sub>2</sub> reduction.

It is unclear at present whether this scheme will continue beyond 2006, or whether the scope of the EU ETS will be expanded within the second phase (2008 to 2012) to incorporate these organisations. Currently, though, these two emissions trading schemes are independent of each other, and there are no opportunities for co-firing facilities to participate.

#### *EU Emissions Trading Scheme (EU ETS)*

The EU Emissions Trading Scheme (EU ETS) has been established across the 25 Member States of the European Union, commencing on 1<sup>st</sup> January 2005.

EU ETS is a two-phase scheme initially covering CO<sub>2</sub> emissions, the first phase running from 2005-2007 and the second phase from 2008-2012, coinciding with the first Kyoto Commitment Period.

Under the rules of EU ETS, EU Member State governments were required to set an emission cap for all installations covered by the scheme (ranging from large combustion plants, to refineries and other energy intensive processes) for the first phase, which is set out in a published National Allocation Plan (NAP). Approval of these plans was then required from the EU before notification of Allocations could be provided to the installations affected. In total, some 12,000 installations across Europe have been covered by this Scheme for the first phase, representing close to half of Europe's emissions of CO<sub>2</sub>.

The UK NAP covers some 1200 installations, and allocations have been based on the projected needs of those industries which are exposed to international competition. Therefore, the majority of these emission reductions are expected to be borne by the power generators, as it has only limited competition from outside the UK.

There are a number of ways for these generators to meet their "cap", however, which can be summarised as follows:

- Buy additional Emissions Allowances (EUAs)
- Reduce emissions through fuel switching, e.g. coal→gas or co-firing of biomass
- Invest in Clean Development Mechanism Projects (Linking Directive)
- Reduce emissions through reduced generation/export
- Reduce emissions through advance carbon abatement technologies/supply side efficiency improvements

The last option is not realistically going to be economically viable for another 10 or so years, however, whilst the fourth options is already in operation by the larger generators in the UK, through the careful management of the portfolio assets and driven by fuel costs and the electricity market price rather than emissions. This therefore leaves three potential routes for compliance.

EU Allowances, even though they had not physically been issued to installations<sup>1</sup>, have been traded on markets for in excess of a year mainly by large European utilities. The trading price of these EUAs has been nothing if not volatile, with the price currently around €18/tCO<sub>2</sub> having hit a low in January 2005 of only €6.35/tCO<sub>2</sub>. These fluctuations are in part a reflection of the coal and gas prices, with large generators switching between the two dependent on fuel price and at the same time entering the emissions market to reflect the changes in emissions from the two different fuels. Additionally, they are also a reflection of the weather, with the potential for hydro-electric generation for the forthcoming year and demand forecasts due to the weather being two significant factors. With a penalty of €40/tCO<sub>2</sub> for those installations exceeding their cap at the end of the year, it is likely that this fluctuating trend is likely to continue throughout the year.

The EU Linking directive allows EU Member States or private enterprises to invest in overseas emissions reduction projects, and use the emission credits generated through Kyoto's flexible project based instrument, the Clean Development Mechanism (CDM) towards their own targets. Similarly, for the second phase of the EU ETS, emission credits generated through Kyoto's Joint Implementation (JI) instrument can also be used to meet targets. These investments are, however, seen as longer-term solutions to meeting Kyoto targets, and any investment made now would be unlikely to contribute towards first phase targets due to the lead times for commissioning such projects. There are Certified Emission Reduction (CER) credits generated from CDM projects currently being traded, but typically have only had a value of around €5/tCO<sub>2</sub>. This price differential is simply down to the fact that CERs are, so far, seen as higher risk instruments than EUAs.

Therefore, of all the ways to meet "caps" on generator emissions, the most straightforward and pragmatic solution for the short-term is to develop co-firing facilities.

By co-firing, it is meant the dual firing of biomass with fossil fuel, usually coal. Using biomass for co-firing, which may be energy crops, industrial or agricultural waste biomass, existing fossil-fuelled generating stations are able to reduce overall CO<sub>2</sub> emissions through the replacement of fossil fuel with biomass, which is considered to emit zero CO<sub>2</sub>. Thus for the same station electrical output, an overall reduction in CO<sub>2</sub> emissions has occurred. Depending on the levels of reduction required by the installation,

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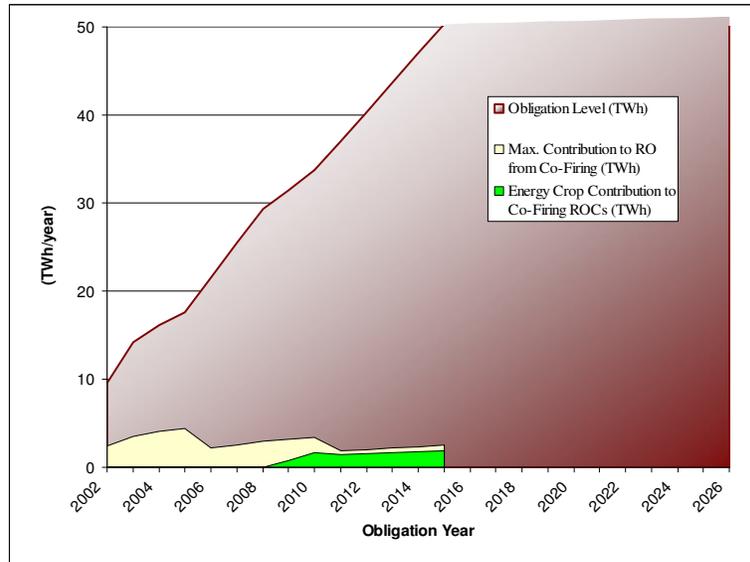
<sup>1</sup> Some EUAs were issued in May 2005, with the registry reportedly working well to date.

there may be considerable benefit in installing co-firing equipment with capabilities to supply emissions reductions in excess of that required within the first phase of the EU ETS, as the penalties for non-compliance with the EU ETS during the second phase are likely to be €100/tCO<sub>2</sub>, with more stringent caps also likely to be put in place.

#### *UK Renewables Obligation*

Under the UK's Renewables Obligation (RO) Scheme, all licensed electricity suppliers in England & Wales (and as from 1<sup>st</sup> April 2005, Scotland and Northern Ireland too) are required to supply a specified and growing proportion of their electricity sales from a choice of eligible renewable sources, including co-firing. The RO is the key policy mechanism by which the Government is encouraging the growth necessary to reach the UK's renewable energy target of 10% of electricity from renewable sources by 2010. The level of the RO was 3% when it was introduced in April 2002 and now stands at 5.5% as from April 2005 (4.9% for the previous obligation period of 2004/05), increasing each year to reach 10.4% in 2010/11 and now secondary legislation has been recently introduced increasing that figure to 15.4% by 2015/16.

The UK Government are using the co-firing of biomass, which includes energy crops, as a transitional measure to encourage the planting and use of energy crops as a fuel for electricity generation. The existing fossil-fuelled generating stations are able to burn a proportion of biomass, including energy crops, and this is what the renewables obligation encourages by awarding Renewables Obligation Certificates (ROCs) for the electricity produced from the biomass element. At the outset of the Renewables Obligation, co-firing generating stations must have had 75 per cent of their biomass by energy content as energy crops from 2006 and the eligibility of co-firing for ROCs ceased in 2011. After a detailed study on co-firing, the UK Government concluded that more time was needed to develop energy crops and that farmers and generators need greater security. The requirement for 25 per cent biomass to be energy crops was therefore deferred until 2009, rather than 2006, whereupon there will be a stepped increase up to 75 percent by 2011. Co-firing stations will continue to be eligible for ROCs until 2016, giving time for farmers to harvest three full crops of new short rotation coppice. To balance this and to reduce the risk of co-firing ROCs flooding the market, the Renewable Obligation (Amendment) Order 2004 tightened the cap on co-fired ROCs that may be used to meet an individual supplier's obligation. This was set to be progressively reduced from 25 per cent currently to 10 per cent in 2006 and to 5 per cent in 2011 until 2016 (See Figure 1 for graphical interpretation). After 2016, no ROCs will be issued to co-firing facilities. One factor behind this decision is due to concern regarding the extent to which the environmental benefit of using biomass is offset by an increase in the burning of coal, due to the revenue from the RO increasing the economic viability of coal-fired power stations.

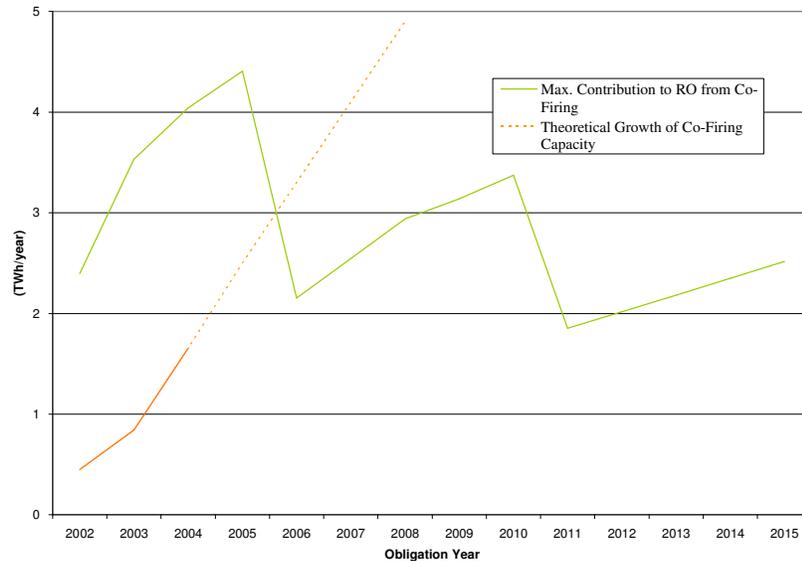


**Figure 1:** The Role of co-firing in the UK Renewables Obligation

In 2004 alone, however, Ofgem, the UK’s electricity and gas markets regulator, estimated that there was 509MWe of eligible power generation capacity in the UK for co-firing of biomass, and this number has increased to 806MWe as at the end of May 2005. If fully utilised, over 6TWh/year of renewable electricity could therefore be generated solely from co-firing activities. In reality, however, this figure stood at around 1.7GWh<sup>2</sup> for the third RO period of 2004/05, but co-firing capacity coming online has so far doubled for each consecutive year of the RO since it began. If this trend of increasing co-fired generating capacity is continued at only 50 per cent of the current rate, it can be seen from Figure 2 that problems will be encountered in the next two years where generation will exceed market demand, due to the limitations of co-fired ROCs in meeting the Obligation, leading to a significant fall in market value of these certificates.

The average value of a ROC for the 3<sup>rd</sup> obligation period was approximately £47/MWh (~€70/MWh), but the actual worth of each certificate was theoretically worth closer to £51/MWh (~€76/MWh), which is derived from the buy-out payment as set by the UK Government in 2002 (increasing with retail price index year-on-year) plus the “recycled” buy-out payments made by those suppliers who cannot comply with the obligation level to those suppliers who have surrendered ROCs. This means whilst the cost of the Obligation to end consumers is capped, the value of the certificates may exceed this cost. With the additional cap on eligible ROCs from co-firing, however, the market value of these certificates could be significantly less than for other renewable energy ROCs, and if all the existing accredited capacity is fully utilised, could lead to a value equal to approximately one-third that of the current market price of a ROC, i.e. ~€20/MWh.

<sup>2</sup> Data ROCs Issued in March 2005 not yet available, so have been estimated on pro-rata basis from previous 11 months.



**Figure 2:** Co-firing growth trend in UK

### *Climate Change Levy Exemption Certificates (LECs)*

Levy Exemption Certificates (LECs) are awarded to Renewable and Good Quality CHP generators for each kilowatt-hour of energy exported to the network. Co-firing is included under the renewables banner, but LECs are only awarded for the proportion of generation from the biomass, and these LECs have a value by enabling suppliers to avoid paying the Climate Change Levy (CCL). The CCL is a tax on energy, including electricity, which licensed electricity suppliers must levy on their supply to non-domestic customers unless they are able to show (LECs) against this supply. The CCL is set at £4.30/MWh (~€6.30/MWh) and has not been changed since its introduction in April 2001.

Under the climate change levy (CCL) agreements, certain major energy users are able to reduce the normal CCL payment (£4.30/MWh on all business customers) to a fifth (i.e. £0.86/MWh) if they purchase renewable electricity from eligible power plants or undertake certain energy efficiency measures (agreed with the Energy Savings Trust). This provides a value for Levy Exemption Certificates (LEC = 1 MWh). The major users must provide proof of LECs to both Ofgem and to Customs and Excise in order to claim this reduction but, due to very unclear legislation and guidance on how LECs can be traded, and the absence of a LECs registry, electricity suppliers have very differing legal views on what is acceptable.

The future of the Levy is uncertain, not least because its purpose (to mitigate climate change) now overlaps that of the EU ETS. The UK Government is currently consulting on changes to the UK Climate Change Programme, of which the Levy is a part. The outcome of the consultation should be known later this year.

### *Other Potential Sources of Benefits*

Biomass energy technology, whether dedicated or co-fired, is inherently flexible and offers a number of advantages over other renewable energy sources. Unlike wind power,

for example, it is free from the problems of intermittency – it can be stored and used on demand to provide controllable energy. The variety of technological options available means that it can be applied at a small, localised scale primarily for heat, or it can be used in much larger base-load power generation capacity whilst also producing heat. Biomass generation can thus be tailored to rural or urban environments, and utilised in domestic, commercial or industrial applications, where heat generated has a value to the local community and is therefore a potential additional source of revenue.

As co-firing is considered as technology closest to market, it is not applicable for any additional subsidies or grants.

### **The Future for Co-firing**

Improvements in conventional fossil-fuelled technology, co-firing of biomass and energy efficiency measure in power sector could help meet the short-term reduction targets and is rightly being encouraged within the UK. At present there is a large amount of “low-hanging fruit” in most industrial sectors that can cost effectively contribute to meeting the near-term CO<sub>2</sub> reduction goals. It is important that any non-technical barriers to utilisation of these options are identified and removed, but it is equally as important that multiple benefits are not being awarded to certain emission reduction activities through inconsistencies in monitoring and regulation.

Such “double counting” can now be observed with co-firing. Whilst financially-supporting co-firing through the Renewables Obligation has been limited to 2016, the introduction of the EU Emissions Trading Scheme has now produced a second significant mechanism of financing this facilities considering co-firing. Whilst this double subsidy is short-lived, with baseline conditions of an installation reviewed prior to the commencement of each phase of the EU ETS, there is a window of opportunity for these facilities to take advantage of these financial rewards, which is undoubtedly part of the reason for a significant increase in co-firing activities during 2004.

Other benefits of co-firing within the UK can come through the award of Levy Exemption Certificates (LECs) for the biomass fraction of electricity generation, with the lack of clarity and guidance on the use of these certificates a major issue under review.

By way of summary of these benefits, the following benefits could currently be accrued by a conventional combustion plant co-firing biomass in the UK.

<u>Scheme</u>	<u>Value</u>
➤ Renewables Obligation (based on low/conservative value with ROCs from co-firing considerably over-subscribed)	€20/MWh
➤ Levy Exemption Certificates	€6/MWh
➤ EU Allowances (at current market value and not at penalty payment value, calculated from 1MWh = 0.43tCO <sub>2</sub> )	€7-9/MWh
	<hr/>
TOTAL	>€33/MWh

This sum is not insignificant, and whilst there are cost implications in replacing fossil fuels with biomass and also investing in new plant equipment, the numbers show there is sufficient financial incentive to undertake co-firing activities even when based on the most pessimistic cost valuations. Other considerations, however, may need to be given to the fuel supply chain and the effect on this supply as Member States currently supplying the biomass into the UK develop their own Renewable Energy Sources incentives, leading to imported fuel price increases.

Following the implementation of EU Directives 2001/77/EC and 2004/8/EC, all EU Member States (MS) are required to establish a Guarantee of Origin for high-efficiency cogeneration and renewable energy which authenticates the source of electricity production, which it is hoped will introduce transparency into the electricity supply market and facilitate better potential trade between Member States.

In order to meet the longer-term UK targets of 2020 and 2050, co-firing is not envisaged to play a active part, although its successful implementation and operation now will be a major contributor to meeting these targets as it will help create the biomass supply chain within the UK for dedicated plants, as well as provide the knowledge and operational experience required to give investors reassurance in biomass technologies.

**IT Power** are a leading global sustainable energy consultancy offering world class expertise and services, assisting its clients to meet their environmental challenges through strategic planning and the integration of sustainable energy. For more that 24 years the company has been undertaking resource assessments, feasibility studies, energy planning, design, installation and monitoring for renewable energy technologies, and more recently have helped countries in developing and implementing green electricity markets and policies to promote renewable energy uptake.

IT Power with its subsidiary in India and offices in China and worldwide operates as a Group and offers a complete bouquet of services to clients, including business and financial solutions and technical consultancy. The IT Power Group also provides support to several multilateral agencies on investment management.